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(54) **BIODEGRADABLE COMPOSITIONS COMPRISING RENEWABLY-BASED, BIODEGRADABLE 1,3-PROPANEDIOL**

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(57) **ABSTRACT**

Disclosed herein are biodegradable compositions comprising 1,3-propanediol, wherein the 1,3-propanediol in said biodegradable composition has a bio-based carbon content of about 1% to 100%. In addition, it is preferred that the 1,3-propanediol be biologically-derived, and wherein upon biodegradation, the biologically-derived 1,3-propanediol contributes no anthropogenic CO2 emissions to the atmosphere.

| Product | Molecular weight | product | product | $CO_2$ fixated | $CO_2$ released | Anthropogenic emissions of $CO_2$ from Product Biodegradation |
|---|---|---|---|---|---|---|
| | g/mol | kg | mol | mol | mol | kg |
| EG | 62.068 | 1 | 16.1 | 0.0 | 32.2 | 1.4 |
| PG | 76.094 | 1 | 13.1 | 0.0 | 39.4 | 1.7 |
| Chem-PDO | 76.094 | 1 | 13.1 | 0.0 | 39.4 | 1.7 |
| Bio-PDO™ | 76.094 | 1 | 13.1 | 39.4 | 39.4 | 0.0 |

FIGURE 1

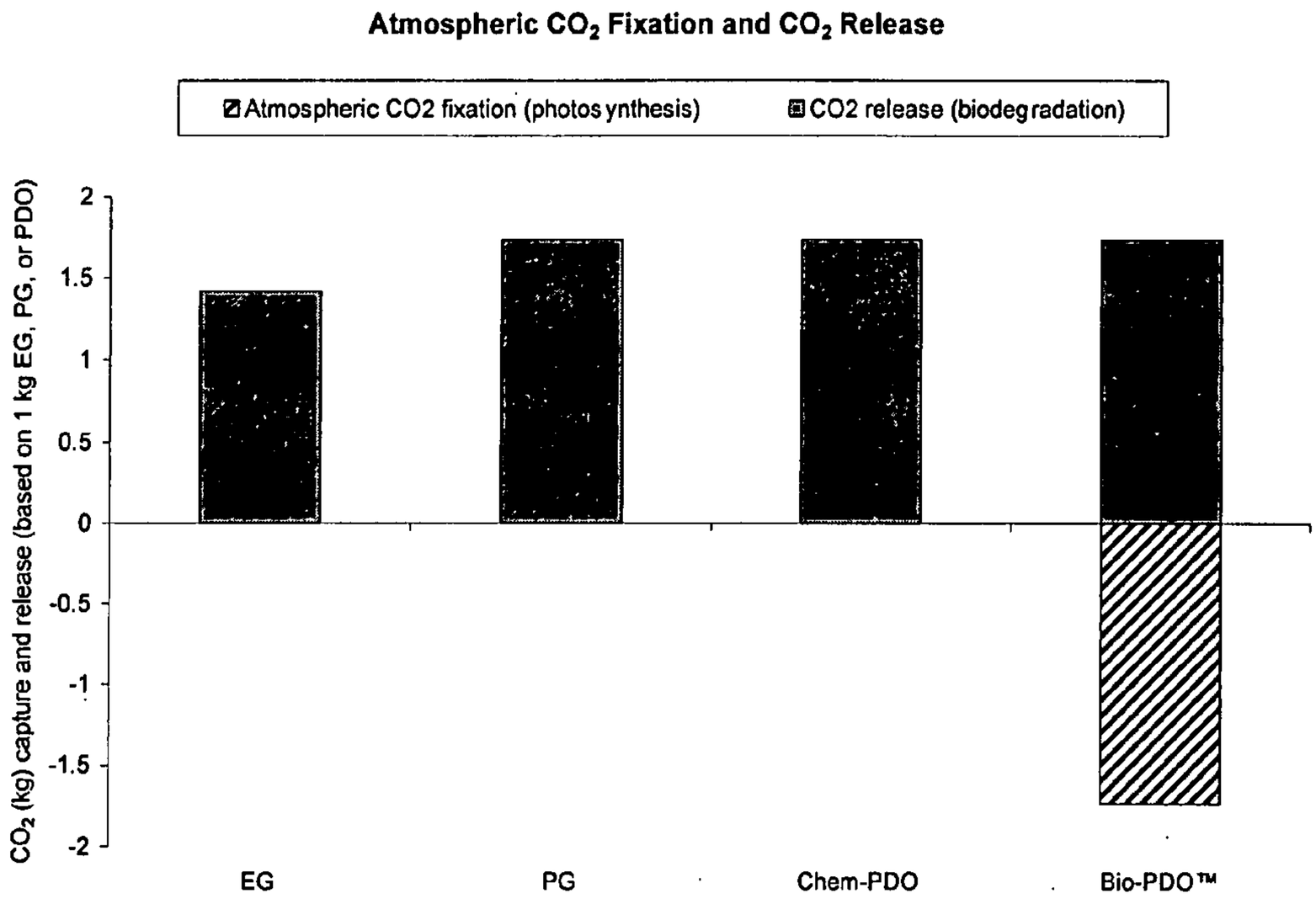
Atmospheric $CO_2$ Fixation and $CO_2$ Release
Atmospheric CO2 fixation (photosynthesis)
CO2 release (biodegradation)
$CO_2$ (kg) capture and release (based on 1 kg EG, PG, or PDO)
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
EG
PG
Chem-PDO
Bio-PDO™

**FIGURE 2**

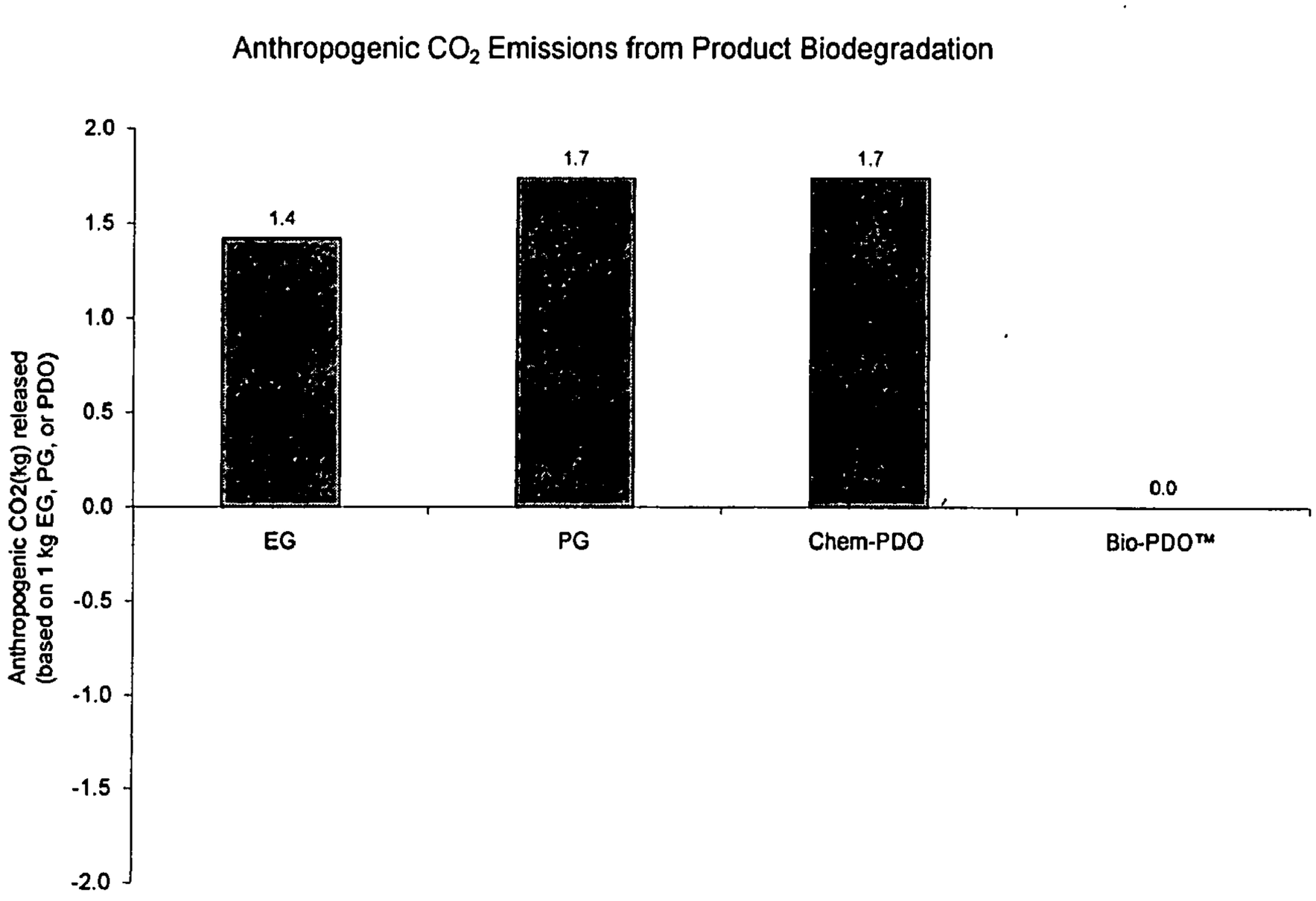
Anthropogenic $CO_2$ Emissions from Product Biodegradation
Anthropogenic CO2(kg) released (based on 1 kg EG, PG, or PDO)
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
1.4
1.7
1.7
0.0
EG
PG
Chem-PDO
Bio-PDO™

FIGURE 3

| Product | Molecular weight | product | product | $CO_2$ fixated | $CO_2$ released | Anthropogenic emissions of $CO_2$ from Product Biodegradation |
|---|---|---|---|---|---|---|
| | g/mol | kg | mol | mol | mol | kg |
| EG | 62.068 | 1 | 16.1 | 0.0 | 32.2 | 1.4 |
| PG | 76.094 | 1 | 13.1 | 0.0 | 39.4 | 1.7 |
| Chem-PDO | 76.094 | 1 | 13.1 | 0.0 | 39.4 | 1.7 |
| Bio-PDO™ | 76.094 | 1 | 13.1 | 39.4 | 39.4 | 0.0 |

# BIODEGRADABLE COMPOSITIONS COMPRISING RENEWABLY-BASED, BIODEGRADABLE 1,3-PROPANEDIOL

## CROSS REFERENCE TO RELATED APPLICATIONS

[0001] The present application claims the benefit of U.S. Provisional Application Ser. No. 60/772,471, filed Feb. 10, 2006; U.S. Provisional Application No. 60/772,194, filed Feb. 10, 2006, U.S. Provisional Application No. 60/772,193, filed Feb. 10, 2006, U.S. Provisional Application No. 60/772,111, filed Feb. 10, 2006, U.S. Provisional Application No. 60/772,120, filed Feb. 10, 2006, U.S. Provisional Application No. 60/772,110, filed Feb. 10, 2006, U.S. Provisional Application No. 60/772,112, filed Feb. 10, 2006, U.S. Provisional Application No. 60/846,948, filed Sep. 25, 2006, U.S. Provisional Application No. 60/853,920, filed Oct. 24, 2006, U.S. Provisional Application No. 60/859,264, filed Nov. 15, 2006, U.S. Provisional Application No. 60/872,705, filed Dec. 4, 2006 and U.S. Provisional Application No. 60/880,824, filed Jan. 17, 2007, the disclosures of which are expressly incorporated herein by reference in their entirety.

## FIELD OF THE INVENTION

[0002] Disclosed herein are biodegradable compositions comprising 1,3-propanediol wherein the 1,3-propanediol in said biodegradable composition has a bio-based carbon content of about 1% to 100%. In addition, it is preferred that the 1,3-propanediol be biologically-derived, and wherein upon biodegradation, the biologically-derived 1,3-propanediol contributes no anthropogenic $CO_2$ emissions to the atmosphere.

## BACKGROUND OF THE INVENTION

[0003] Consumers of biodegradable products, such as personal care, cosmetics and detergents, among many others, consider many factors in selecting products for use. Recently certain factors have been a focus of and have driven scientific study and product development. These driving factors include, product safety, environmental impact, the extent to which the components are natural, and the aesthetic quality of the overall product. Therefore, manufacturers have to be concerned with the environmental impact of their products. In fact, the effort towards environmental impact awareness is a universal concern, recognized by government agencies. The Kyoto Protocol amendment to the United Nations Framework Convention on Climate Change (UNFCCC) currently signed by 156 nations is one example of a global effort to favor safer environmental manufacturing over cost and efficiency. When applied to biodegradable products, consumers are increasingly selective about the origins of the products they purchase. The 2004 Co-operative Bank's annual Ethical Consumerism Report (www.cooperativebank.co.uk) disclosed a 30.3% increase in consumer spending on ethical retail products (a general classification for environmental safe, organic and fair trade goods) between 2003 and 2004 while total consumer spending during the same period rose only 3.7%.

[0004] Glycols such as ethylene glycol, propylene glycol, 1,3-butylene glycol, and 2-methyl-1,3-propanediol are biodegradable compounds useful in compositions ranging from cosmetics and personal care formulations to detergents to heat transfer compositions. While biodegradability is an important factor in protecting the environment, biodegradation of glycols derived from fossil-based sources has the unavoidable consequence of releasing previously fixed $CO_2$ into the atmosphere. Thus, while glycols in general are advantageous for their biodegradability, the resulting global warming potential of fossil-based glycols during biodegradation is significant.

[0005] Carbon dioxide is singled out as the largest component of the collection of greenhouse gases in the atmosphere. The level of atmospheric carbon dioxide has increased 50% in the last two hundred years. Recent reports indicate that the current level of atmospheric carbon dioxide is higher than the peak level in the late Pleistocene, the epoch before modern humans (Siegenthaler, U. et al. Stable Carbon Cycle-Climate Relationship During the Late Pleistocene, Science, Vol. 310, no. 5752 (Nov. 25, 2005), pp. 1313-1317). Therefore, any further addition of carbon dioxide to the atmosphere is thought to further shift the effect of greenhouse gases from stabilization of global temperatures to that of heating. Consumers and environmental protection groups alike have identified industrial release of carbon into the atmosphere as the source of carbon causing the greenhouse effect.

[0006] Greenhouse gas emission can occur at any point during the lifetime of a product. Consumers and environmental groups consider the full lifespan of a product when evaluating a product's environmental impact. Consumers look for products that do not contribute new carbon to the atmosphere considering the environmental impact of production, use and degradation. Only organic products composed of carbon molecules from plant sugars and starches and ultimately atmospheric carbon are considered to not further contribute to the greenhouse effect.

[0007] In addition to adding carbon dioxide to the atmosphere, current methods of industrial production of glycols produce contaminants and waste products that include among them sulfuric acid, hydrochloric acid, hydrofluoric acid, phosphoric acid, oxalic acid tartaric acid, acetic acids, Alkali metals, alkaline earth metals, transitional metals and heavy metals, including Iron, cobalt, nickel, copper, silver, molybdenum, tungsten, vanadium, chromium, rhodium, palladium, osmium, iridium, rubidium, and platinum (U.S. Pat. Nos. 2,434,110, 5,034,134, 5,334,778, and 5,10,036).

[0008] Also of concern to consumers of biodegradable products, especially consumers of personal care, cosmetics and detergent products, is an individual's reaction to such a product. The rate of development of hypersensitivity has markedly increased in the US in the last two decades. Many of these reactions are attributed to trace amount of substances. Other reactions are of idiopathic origin. Consumers seek products that are composed of ingredients of a more purified source and/or of all natural composition.

## SUMMARY OF THE INVENTION

[0009] The present invention is directed to a biodegradable composition comprising 1,3-propanediol and an ingredient, wherein said 1,3-propanediol has a bio-based carbon content of at least 1%.

[0010] The present invention is further directed to a biodegradable composition comprising 1,3-propanediol and an

ingredient wherein the ingredient is selected from the group consisting of an acceptable carrier, an active, water, an aqueous solution, a surfactant, a builder, a pH control agent, a corrosion inhibitor, a defoamer, a dye and a food ingredient, and wherein said 1,3-propanediol has a bio-based carbon content of at least 1%.

[0011] The present invention is even further directed to a biodegradable composition comprising 1,3-propanediol and an ingredient, and further comprising a composition selected from the group consisting of a personal care product, a cosmetic, a detergent, a heat transfer composition, a deicing composition, a food, a paint, and an ink, wherein said 1,3-propanediol has a bio-based carbon content of at least 1%.

[0012] The present invention is also directed to a biodegradable composition comprising 1,3-propanediol wherein said 1,3-propanediol has an ultraviolet absorption at 220 nm of less than about 0.200 and at 250 nm of less than about 0.075 and at 275 nm of less than about 0.075.

[0013] The present invention is additionally directed to a biodegradable composition comprising 1,3-propanediol wherein said 1,3-propanediol has a concentration of total organic impurities of less than about 400 ppm.

[0014] The present invention is even further directed to a biodegradable composition comprising 1,3-propanediol, wherein the 1,3-propanediol in said composition has an anthropogenic $CO_2$ emission profile of zero upon biodegradation.

## BRIEF DESCRIPTION OF THE DRAWINGS

[0015] FIG. **1** is a graph showing $CO_2$ emissions for $CO_2$ fixation from the atmosphere during photosynthesis for renewably based 1,3-propanediol (Bio-PDO™) (−1.7 kg $CO_2$/kg product) and $CO_2$ release to the atmosphere during biodegradation (kg $CO_2$/kg product) for ethylene glycol (EG) (+1.4 kg $CO_2$/kg product), propylene glycol (PG) (+1.7 kg $CO_2$/kg product), fossil-based 1,3-propanediol (Chem-PDO) (+1.7 kg $CO_2$/kg product), and fermentatively-derived 1,3-propanediol (Bio-PDO™) (+1.7 kg $CO_2$/kg product).

[0016] FIG. **2** is a graph showing that the net emissions of $CO_2$ to the atmosphere for renewably based 1,3-propanediol (Bio-PDO) is zero (0).

[0017] FIG. **3** is a table that shows the calculations for the data shown in FIGS. **1** and **2**.

## DETAILED DESCRIPTION OF THE INVENTION

[0018] Applicants specifically incorporate the entire content of all cited references in this disclosure. Further, when an amount, concentration, or other value or parameter is given as either a range, preferred range, or a list of upper preferable values and lower preferable values, this is to be understood as specifically disclosing all ranges formed from any pair of any upper range limit or preferred value and any lower range limit or preferred value, regardless of whether ranges are separately disclosed. Where a range of numerical values is recited herein, unless otherwise stated, the range is intended to include the endpoints thereof, and all integers and fractions within the range. It is not intended that the scope of the invention be limited to the specific values recited when defining a range.

[0019] Compositions disclosed herein comprise 1,3-propanediol, having at least 1% bio-based carbon content, as greater as up to 100% of the glycol component of the composition. In one embodiment, the 1,3-propanediol comprises substantially all of the glycol component of the composition of the invention. In another embodiment, the 1,3-propanediol comprises all of the glycol component of the composition.

### 1,3-propanediol

[0020] The terms "bioPDO", "biologically-derived, biodegradable 1,3-propanediol", "biologically derived 1,3-propanediol", "renewably-based 1,3-propanediol", "renewably-based, biodegradable 1,3-propanediol,""biosourced, and "biologically-produced 1,3-propanediol" and similar terms as used here in refer to 1,3-propanediol derived from microorganism metabolism of plant-derived sugars composed of carbon of atmospheric origin, and not composed of fossil-fuel carbon.

### Anthropogenic $CO_2$ Emission Profile

[0021] Applicants' invention relates to biodegradable compositions, such as, among many others, personal care products, cosmetics, detergents, heat transfer fluids, deicing fluids, foods, paints and inks, comprising renewably-based, biodegradable 1,3-propanediol, in which said renewably-based, biodegradable 1,3-propanediol has an anthropogenic $CO_2$ emission profile of zero (0). An "anthropogenic emission profile" means anthropogenic $CO_2$ emissions that are contributed to the atmosphere upon biodegradation of a compound or composition. p

[0022] "Biodegradable" or "Biodegradability" means the capacity of a compound to be broken down by living organisms to simple, stable compounds such as carbon dioxide and water.

[0023] Whereas photosynthesis is the process of creating growing matter through the conversion of carbon dioxide ($CO_2$) and water ($H_2O$) into plant material through the action of the sun, biodegradation is the process of converting organic material back into $CO_2$ and $H_2O$ through the activity of living organisms.

[0024] There are many published test methods for measuring the biodegradability of organic chemicals such as glycols. One internationally recognized method is ASTM E1720-01, Standard Test Method for Determining Ready, Ultimate Biodegradability of Organic Chemicals in a Sealed Vessel $CO_2$ Production Test.

[0025] Chemicals that demonstrate 60% biodegradation or better in this test method will biodegrade in most aerobic environments and are classified as ready biodegradable. All of the glycols referred to in this document meet this criteria.

[0026] Calculations setting forth the finding that the 1,3-propanediol of the present invention provides no anthropogenic COs emissions upon biodegradation is set forth below. A table in support of these calculations is provided in FIG. **3**.

[0027] When one molecule of 1,3-propanediol degrades, three molecules of $CO_2$ are released into the atmosphere. Because all of these molecules of $CO_2$ released during

degradation from "fermentatively-derived" 1,3-propanediol have an atmospheric origin, the net release of $CO_2$ to the atmosphere is thus zero. Comparatively, because a fossil fuel-derived propylene glycol and fossil-derived 1,3-propanediol contains three carbon atoms which originate from a fixed carbon source (i.e., the fossil fuel), degradation of one molecule of fossil fuel-derived propylene glycol or 1,3-propanediol results in a net release of three molecules of $CO_2$ into the atmosphere. Similarly, because fossil fuel-derived ethylene glycol contains two carbon atoms, which originate from a fixed carbon source, degradation of one molecule of fossil fuel-derived ethylene glycol results in a net release of two molecules of $CO_2$ into the atmosphere.

[0028] In order to quantify the $CO_2$ released for one kilogram of each ethylene glycol, propylene glycol, chemical 1,3-propanediol and "fermentatively-derived" 1,3 propanediol (Bio-PDO™), the product weight (1 kg) is divided by its molecular weight. For each carbon atom present in the molecule, one molecule of $CO_2$ is released. The molecules of $CO_2$ are multiplied by the molecular weight of $CO_2$ (44 kg/kmole) to quantify the impact of $CO_2$ release (kg) per one unit (kg) of product.

Fossil-Fuel Based Carbon Feedstock Release

1 kg of fossil fuel derived ethylene glycol*(1 kmol EG/62.068 kg)*(2 kmol $CO_2$/1 kmol EG)*(44 kg $CO_2$/kmol $CO_2$)=1.4 kg $CO_2$

1 kg of fossil fuel derived propylene glycol*(1 kmol PG/76.094 kg)*(3 kmol $CO_2$/1 kmol PG)*(44 kg $CO_2$/kmol $CO_2$)=1.7 kg $CO_2$

1 kg of fossil fuel derived 1,3-propanediol*(1 kmol chem-PDO/76.094 kg)*(3 kmol $CO_2$/1 kmol chem-PDO)*(44 kg $CO_2$/kmol $CO_2$)=1.7 kg $CO_2$

Bio-Based Carbon Feedstock Balance

[0029] Capture:

1 kg of Bio-PDO™*(1 kmol Bio-PDO™/76.094 kg)*(−3 kmol $CO_2$/1 kmol Bio-PDO™)*(44 kg $CO_2$/kmol $CO_2$)=−1.7 kg $CO_2$

[0030] Release:

1 kg of Bio-PDO™*(1 kmol Bio-PDO™/76.094 kg)*(3 kmol $CO_2$/1 kmol Bio-PDO™)*(44 kg $CO_2$/kmol $CO_2$)=1.7 kg $CO_2$

[0031] Net:

−1.7 kg+1.7 kg=0 kg

[0032] This Bio-based Carbon Feedstock Balance result demonstrates that there are no anthropogenic $CO_2$ emissions from the biodegradation of the renewably sourced Bio-PDO. The term "anthropogenic" means man-made or fossil-derived.

Bio-Based Carbon

[0033] "Carbon of atmospheric origin" as used herein refers to carbon atoms from carbon dioxide molecules that have recently, in the last few decades, been free in the earth's atmosphere. Such carbons in mass are identifiable by the present of particular radioisotopes as described herein. "Green carbon", "atmospheric carbon", "environmentally friendly carbon", "life-cycle carbon", "non-fossil fuel based carbon", "non-petroleum based carbon", "carbon of atmospheric origin", and "biobased carbon" are used synonymously herein.

[0034] "Carbon of fossil origin" as used herein refers to carbon of petrochemical origin. Such carbon has not been exposed to UV rays as atmospheric carbon has, therefore masses of carbon of fossil origin has few radioisotopes in their population. Carbon of fossil origin is identifiable by means described herein. "Fossil fuel carbon", "fossil carbon", "polluting carbon", "petrochemical carbon", "petrocarbon" and carbon of fossil origin are used synonymously herein.

[0035] The abbreviation "IRMS" refers to measurements of $CO_2$ by high precision stable isotope ratio mass spectrometry.

[0036] The term "carbon substrate" means any carbon source capable of being metabolized by a microorganism wherein the substrate contains at least one carbon atom.

[0037] "Renewably-based" denotes that the carbon content of the 1,3-propanediol is from a "new carbon" source as measured by ASTM test method D 6866-05 Determining the Biobased Content of Natural Range Materials Using Radiocarbon and Isotope Ratio Mass Spectrometry Analysis, incorporated herein by reference. This test method measures the C-14/C-12 isotope ratio in a sample and compares it to the C-14/C-12 isotope ratio in a standard 100% biobased material to give percent biobased content of the sample. "Biobased materials" are organic materials in which the carbon comes from recently (on a human time scale) fixated $CO_2$ present in the atmosphere using sunlight energy (photosynthesis). On land, this $CO_2$ is captured or fixated by plant life (e.g., agricultural crops or forestry materials). In the oceans, the $CO_2$ is captured or fixated by photosynthesizing bacteria or phytoplankton. A biobased material has a C-14/C-12 isotope ratio in range of from 1:0 to greater than 0:1. Contrarily, a fossil-based material, has a C-14/C-12 isotope ratio of 0:1.

[0038] A small amount of the carbon dioxide in the atmosphere is radioactive. This 14C carbon dioxide is created when nitrogen is struck by an ultra-violet light produced neutron, causing the nitrogen to lose a proton and form carbon of molecular weight 14 which is immediately oxidized in carbon dioxide. This radioactive isotope represents a small but measurable fraction of atmospheric carbon. Atmospheric carbon dioxide is cycled by green plants to make organic molecules during the process known as photosynthesis. The cycle is completed when the green plants or other forms of life metabolize the organic molecules producing carbon dioxide which is released back to the atmosphere. Virtually all forms of life on Earth depend on this green plant production of organic molecule to produce the chemical energy that facilitates growth and reproduction. Therefore, the 14C that exists in the atmosphere becomes part of all life forms, and their biological products. These renewably based organic molecules that biodegrade to CO2 do not contribute to global warming as there is no net increase of carbon emitted to the atmosphere. In contrast, fossil fuel based carbon does not have the signature radiocarbon ratio of atmospheric carbon dioxide.

[0039] Atmospheric origin and fixed carbon source as used herein are relative terms in that the time period of when CO2 is of atmospheric or fixed origin relates to the life cycle of the 1,3-propanediol. Thus, while it is quite possible that, at one time, carbon from a fossil fuel was found in the atmosphere (and, as a corollary, that atmospheric CO2 may one day be incorporated into a fixed carbon source), for

purposes herein carbon is considered to be from a fixed carbon source until it is released into the atmosphere by degradation.

[0040] Assessment of the renewably based carbon in a material can be performed through standard test methods. Using radiocarbon and isotope ratio mass spectrometry analysis, the biobased content of materials can be determined. ASTM International, formally known as the American Society for Testing and Materials, has established a standard method for assessing the biobased content of materials. The ASTM method is designated ASTM-D6866.

[0041] The application of ASTM-D6866 to derive a "biobased content" is built on the same concepts as radiocarbon dating, but without use of the age equations. The analysis is performed by deriving a ratio of the amount of radiocarbon (14C) in an unknown sample to that of a modem reference standard. The ratio is reported as a percentage with the units "pMC" (percent modern carbon). If the material being analyzed is a mixture of present day radiocarbon and fossil carbon (containing no radiocarbon), then the pMC value obtained correlates directly to the amount of Biomass material present in the sample.

[0042] The modern reference standard used in radiocarbon dating is a NIST (National Institute of Standards and Technology) standard with a known radiocarbon content equivalent approximately to the year AD 1950. AD 1950 was chosen since it represented a time prior to thermo-nuclear weapons testing which introduced large amounts of excess radiocarbon into the atmosphere with each explosion (termed "bomb carbon"). The AD 1950 reference represents 100 pMC.

[0043] "Bomb carbon" in the atmosphere reached almost twice normal levels in 1963 at the peak of testing and prior to the treaty halting the testing. Its distribution within the atmosphere has been approximated since its appearance, showing values that are greater than 100 pMC for plants and animals living since AD 1950. It's gradually decreased over time with today's value being near 107.5 pMC. This means that a fresh biomass material such as corn could give a radiocarbon signature near 107.5 pMC.

[0044] Combining fossil carbon with present day carbon into a material will result in a dilution of the present day pMC content. By presuming 107.5 pMC represents present day biomass materials and 0 pMC represents petroleum derivatives, the measured pMC value for that material will reflect the proportions of the two component types. A material derived 100% from present day soybeans would give a radiocarbon signature near 107.5 pMC. If that material was diluted with 50% petroleum derivatives, it would give a radiocarbon signature near 54 pMC.

[0045] A biomass content result is derived by assigning 100% equal to 107.5 pMC and 0% equal to 0 pMC. In this regard, a sample measuring 99 pMC will give an equivalent biobased content result of 93%.

[0046] A sample of "fermentatively-derived" 1,3-propanediol was submitted by DuPont to Iowa State University for biobased content analysis using ASTM method D 6866-05. The results received from Iowa State University demonstrated that the above sample was 100% bio-based content (ref: Norton, Glenn. Results of Radiocarbon Analyses on samples from DuPont Bio-Based Materials—reported Jul. 8, 2005).

[0047] Assessment of the materials described herein were done in accordance with ASTM-D6866. The mean values quoted in this report encompasses an absolute range of 6% (plus and minus 3% on either side of the biobased content value) to account for variations in end-component radiocarbon signatures. It is presumed that all materials are present day or fossil in origin and that the desired result is the amount of biobased component "present" in the material, not the amount of biobased material "used" in the manufacturing process.

[0048] Results of Radiocarbon Analyses on Samples from DuPont Bio-Based

[0049] Materials

[0050] Reported Jul. 8, 2005

| PRODUCT | BIOBASED CONTENT (%) |
|---|---|
| 1,3-Propanediol | 100 |

[0051] There may be certain instances wherein a biodegradable composition of the invention may comprise a combination of a biologically-derived 1,3-propanediol and one or more non biologically-derived glycol components, such as, for example, chemically synthesized 1,3-propanediol. In such occasions, it may be difficult, if not impossible to determine which percentage of the glycol composition is biologically-derived, other than by calculating the bio-based carbon content of the glycol component. In this regard, in the biodegradable compositions of the invention, the glycol component, and in particular, the 1,3-propanediol, can comprise at least about 100% bio-based carbon content up to 100% bio-based carbon content, and any percentage therebetween.

Purity

[0052] "Substantially purified," as used by applicants to describe the biologically-produced 1,3-propanediol produced by the process of the invention, denotes a composition comprising 1,3-propanediol having at least one of the following characteristics: 1) an ultraviolet absorption at 220 nm of less than about 0.200 and at 250 nm of less than about 0.075 and at 275 nm of less than about 0.075; or 2) a composition having L*a*b* "b*" color value of less than about 0.15 and an absorbance at 270 nm of less than about 0.075; or 3) a peroxide composition of less than about 10 ppm; or 4) a concentration of total organic impurities of less than about 400 ppm.

[0053] A "b*" value is the spectrophotometrically determined "Yellow Blue measurement as defined by the CIE L*a*b* measurement ASTM D6290.

[0054] The abbreviation "AMS" refers to accelerator mass spectrometry.

[0055] By the acronym "NMR" is meant nuclear magnetic resonance.

[0056] By the terms "color" and "color bodies" is meant the existence of visible color that can be quantified using a spectrocolorimeter in the range of visible light, using wavelengths of approximately 400-800 nm, and by comparison with pure water. Reaction conditions can have an important

effect on the nature of color production. Examples of relevant conditions include the temperatures used, the catalyst and amount of catalyst. While not wishing to be bound by theory, we believe color precursors include trace amounts of impurities comprising olefinic bonds, acetals and other carbonyl compounds, peroxides, etc. At least some of these impurities may be detected by such methods as UV spectroscopy, or peroxide titration.

[0057] "Color index" refers to an analytic measure of the electromagnetic radiation-absorbing properties of a substance or compound.

[0058] Biologically-derived 1,3-propanediol useful in personal care and cosmetic compositions disclosed herein has at least one of the following characteristics: 1) an ultraviolet absorption at 220 nm of less than about 0.200 and at 250 nm of less than about 0.075 and at 275 nm of less than about 0.075; or 2) a composition having L*a*b* "b*" color value of less than about 0.15 and an absorbance at 270 nm of less than about 0.075; or 3) a peroxide composition of less than about 10 ppm; or 4) a concentration of total organic impurities of less than about 400 ppm. A "b*" value is the spectrophotometrically determined Yellow Blue measurement as defined by the CIE L*a*b* measurement ASTM D6290.

[0059] The level of 1,3-propanediol purity can be characterized in a number of different ways. For example, measuring the remaining levels of contaminating organic impurities is one useful measure. Biologically-derived 1,3-propanediol can have a purity level of less than about 400 ppm total organic contaminants; preferably less than about 300 ppm; and most preferably less than about 150 ppm. The term ppm total organic purity refers to parts per million levels of carbon-containing compounds (other than 1,3-propanediol) as measured by gas chromatography.

[0060] Biologically-derived 1,3-propanediol can also be characterized using a number of other parameters, such as ultraviolet light absorbance at varying wavelengths. The wavelengths 220 nm, 240 nm and 270 nm have been found to be useful in determining purity levels of the composition. Biologically-derived 1,3-propanediol can have a purity level wherein the UV absorption at 220 nm is less than about 0.200 and at 240 nm is less than about 0.075 and at 270 nm is less than about 0.075.

[0061] Biologically-derived 1,3-propanediol can have a b* color value (CIE L*a*b*) of less than about 0.15.

[0062] The purity of biologically-derived 1,3-propanediol compositions can also be assessed in a meaningful way by measuring levels of peroxide. Biologically-derived 1,3-propanediol can have a concentration of peroxide of less than about 10 ppm.

[0063] It is believed that the aforementioned purity level parameters for biologically-derived and purified 1,3-propanediol (using methods similar or comparable to those disclosed in U.S. Patent Application No. 2005/0069997) distinguishes such compositions from 1,3-propanediol compositions prepared from chemically purified 1,3-propanediol derived from petroleum sources, as per the prior art.

Fermentation

[0064] "Biologically produced" means organic compounds produced by one or more species or strains of living organisms, including particularly strains of bacteria, yeast, fungus and other microbes. "Bio-produced" and biologically produced are used synonymously herein. Such organic compounds are composed of carbon from atmospheric carbon dioxide converted to sugars and starches by green plants.

[0065] "Biologically-based" means that the organic compound is synthesized from biologically produced organic components. It is further contemplated that the synthesis process disclosed herein is capable of effectively synthesizing other monoesters and diesters from bio-produced alcohols other than 1,3-propanediol; particularly including ethylene glycol, diethylene glycol, triethylene glycol, 1,2-propylene glycol, dipropylene diol, tripropylene diol, 2-methyl 1,3-propanediol, neopentyl glycol and bisphenol A. "Bio-based", and "bio-sourced"; "biologically derived"; and "bio-derived" are used synonymously herein.

[0066] "Fermentation" as used refers to the process of metabolizing simple sugars into other organic compounds. As used herein fermentation specifically refers to the metabolism of plant derived sugars, such sugar are composed of carbon of atmospheric origin.

[0067] Biologically-derived 1,3-propanediol can be obtained based upon use of the fermentation broth ("fermentatively-derived") generated by a genetically-engineered *Eschericia coli* (*E. coli*) previously disclosed in, for example, U.S. Pat. No. 5,686,276. However, other single organisms, or combinations of organisms, may be used to biologically produce 1,3-propanediol, using organisms that have been genetically-engineered according to methods known in the art. "Fermentation" refers to a system that catalyzes a reaction between substrate(s) and other nutrients to product(s) through use of a biocatalyst. The biocatalysts can be a whole organism, an isolated enzyme, or any combination or component thereof that is enzymatically active. Fermentation systems useful for producing and purifying biologically-derived 1,3-propanediol are disclosed in, for example, Published U.S. Patent Application No. 2005/0069997 incorporated herein by reference.

[0068] The biologically derived 1,3-propanediol for use in the current invention, produced by the process described herein, contains carbon from the atmosphere incorporated by plants, which compose the feedstock for the production of Bio-PDO. In this way, the Bio-PDO used in the compositions of the invention contains only renewable carbon, and not fossil fuel based, or petroleum based carbon. Therefore the compositions of the invention have less impact on the environment as the propanediol used in the compositions does not deplete diminishing fossil fuels and, upon degradation releases carbon back to the atmosphere for use by plants once again. Thus, the present invention can be characterized as more natural and having less environmental impact than similar compositions comprising petroleum based glycols.

[0069] Moreover, as the purity of the Bio-PDO utilized in the compositions of the invention is higher than chemically synthesized 1,3-propanediol and other glycols, risk of introducing impurities that may cause irritation is reduced by its use over commonly used glycols, such as propylene glycol.

[0070] This 1,3-propanediol of the invention can be isolated from the fermentation broth and is incorporated into personal care and cosmetic compositions of the invention, by processes as are known to those of ordinary skill in the applicable art.

Renewably-Based, Biodegradable 1,3-propanediol-Containing Compositions

[0071] As mentioned above, 1,3-propanediol can be incorporated into numerous compositions as a glycol component. For example, 1,3-propanediol can be part of or the sole glycol component of personal care and cosmetic compositions.

[0072] It is contemplated herein that other renewably-based or biologically-derived glycols, such as ethylene glycol, dietheylene glycol, triethylene glycol, 1,2 propylene glycol, dipropylene glycol, tripropylene glycol, neopentyl glycol and bisphenol A, among others, can be used in the biodegradable compositions of the present invention.

[0073] Bio-PDO can be combined with one or more of any ingredients typically used in biodegradable compositions. Set forth below are typical biodegradable end use products as well as typical ingredients used therein, general formulations and examples, all of which can be used in the invention.

Personal Care and Cosmetics

[0074] While in it is a general practice in the art to distinguish between personal care compositions and cosmetic compositions, indeed it is often the case certain personal care products will often be referred to as cosmetic products, and vice versa. As such, in order to simplify and avoid confusion, it is intended, for purposes of this application, that the words "personal care" and "cosmetics", while used separately at times, will be considered synonymous and will be used interchangeably throughout the application to describe the compositions of this invention.

[0075] In compositions of the invention that are generally referred to in the art as cosmetic compositions (also referred to in the art as endermic liminent compositions), Bio-PDO can serve as a humectant, solvent, neutralizer, preservative, emulsifier, emollient, softening agent, handfeel effector, water activity reducer and/or fragrance enhancer. Similarly, in compositions of the invention that are generally referred to in the art as personal care compositions, the Bio-PDO typically serves as a surfactant, humectant, solvent, neutralizer, emulsifier, preservative and/or fragrance enhancer.

[0076] Some examples of typical personal care and cosmetic compositions include, but are not limited to, lipstick, lip gloss, lip pencil, eye shadows, foundation, blush, liquid rouge, facial powder, make-up, concealer, gel eye color, mascara, lip gloss, eye pencil, lip pencil, eye make-up remover, eye liners, eye shadow, lotion eye color, gel eye color, nail polish, lipstick nail polish, gel polish removers, liquid rouges, blush, and facial powder, skin care composition, skin cleansing composition, skin cleansing bar, skin cleansing liquid, facial lotion, facial cream, cream moisturizer, body wash, body lotion; foot care products like foot cream, hand cream; deodorant and antiperspirant sticks, roll-ons, aerosols, gels, creams, pump sprays, powders, odor-masking, odor-neutralizing, odor-quenching, odor-inhibiting; cologne sticks, perfumes, shaving cream, shaving lotion, cream depilatory, lotion depilatory, wax depilatory, facial mask made with clay materials, anti-aging product, anti-wrinkle product, anti-cellulite product, cuticle remover, cuticle cream, acne cream, acne cleansing scrub; oral products like toothpaste, gargle, mouth wash, mouth rinse, film, gum; shampoo, hair care products like conditioner, hair treatment cream, styling gel, styling foam, hair mousse, hair spray, set lotion, blow-styling lotion, hair color lotion, creams and dyes, hair bleaching cream, hair relaxer, hair straightener, curl activator gel, fragrant hair gloss, dressings (styling products & aids); bleach; sun care products like sun stick and sun screen, artificial tanning products, skin-whitening products; soaps, hand wash, body scrub, hand scrub, bubble bath, bath oils, instant hand sanitizer, hand sanitizer gels, antibacterial hand cleaner, deodorants, antiperspirants, baby lotion, diaper rash cream, wet wipe, and baby bath, and vitamin creams, among others. This list is not intended to be all-inclusive or otherwise limiting in any way, and those having skill in the art are very familiar with all types of personal care and cosmetic products that can function effectively with the Bio-PDO glycol component of the invention.

[0077] Bio-PDO can be present in the aforementioned personal care and cosmetics compositions in amounts well known to those of ordinary skill in the appropriate art, typically up to about 12% by weight based on the weight of the total composition, though some compositions, for example, bath preparations may contain as much as 50% glycol, and some specialty formulations like vitamin creams can contain even higher percentages of glycol up to as much as 65%, and deodorants up to as much as 85%.

Preferred Bio-PDO Concentration Ranges

[0078] Baby products, such as, for example, baby shampoos, soaps, wipes, lotions, oils, powders, and creams, wherein preferred Bio-PDO concentration ranges are from about 0.1% to about 25% by weight, and more preferably from about 1% to about 10% by weight, and even more preferably 1 to 5%.

[0079] Bath preparations such as, for example, bath oils, tablets, and salts; bubble baths and bath capsules, wherein preferred Bio-PDO concentration ranges are from about 0.001% to about 50%, and more preferably from about 0.1% to about 10%, and even more preferably from about 1% to about 5%.

[0080] Eye makeup preparations such as, for example, eyebrow pencil; eyeliner; eye shadow; eye lotion; eye makeup remover; and mascara, wherein preferred Bio-PDO concentration ranges are from about 0.001% to about 75%, more preferably 0.01% to about 25%, and even more preferably, 0.05% to about 5%.

[0081] Fragrance preparations such as, for example, colognes and toilet waters; perfumes; powders (dusting and talcum) (excluding aftershave talc); and sachets, wherein preferred Bio-PDO concentration ranges are from about 0.001% to about 99%, more preferably from about 0.01% to about 10%, and even more preferably from about 0.05% to about 5%.

[0082] Hair preparations (noncoloring) such as, for example, hair conditioners; hair sprays (aerosol fixatives); hair straighteners; permanent waves; rinses (noncoloring); shampoos (noncoloring); tonics, dressings, and other hair grooming aids; and wave sets, wherein preferred Bio-PDO concentration ranges are from about 0.001% to about 90%, more preferably from about 0.01% to about 50%, and even more preferably from about 0.05% to about 10%.

[0083] Hair coloring preparations such as, for example, hair dyes and colors (requiring caution statement & patch

test); hair tints; hair rinses (coloring); hair shampoos (coloring); hair color sprays (aerosol); hair lighteners with color; and hair bleaches, wherein preferred Bio-PDO concentration ranges are from about 0.001% to about 50%, more preferably from about 0.1% to about 25%, and even more preferably, from about 1% to about 10%.

[0084] Makeup preparations (not eye) such as, for example, blushers (all types); face powders; foundations; leg and body paints; lipstick; makeup bases; rouges; and makeup fixatives, wherein preferred Bio-PDO concentration ranges are from about 0.001% to about 99%, more preferably from about 0.01% to about 25%, and even more preferably from about 0.05% to about 10%.

[0085] Manicuring preparations such as, for example, basecoats and undercoats; cuticle softeners; nail creams and lotions; nail extenders; nail polish and enamel; and Nail polish and enamel removers, wherein preferred Bio-PDO concentration ranges are from about 0.001% to about 50%, more preferably from about 0.1% to about 10%, and even more preferably from about 1% to about 5%.

[0086] Oral hygiene products such as, for example, dentifrices (aerosol, liquid, pastes, and powders); and mouthwashes and breath fresheners (liquids and sprays), wherein preferred Bio-PDO concentration ranges are from about 0.001% to about 80%, and more preferably from about 1% to about 5%.

[0087] Personal cleanliness products, such as, for example, bath soaps and detergents; deodorants (underarm); antiperspirants; douches; and feminine hygiene deodorants, wherein preferred Bio-PDO concentration ranges are from about 0.001% to about 99%, more preferably from about 0.01% to about 50%, and even more preferably from about 0.05% to about 10%.

[0088] Shaving preparations such as, for example, shaving lotions, aftershave lotions; beard softeners; men's talcum; preshave lotions (all types); shaving cream (aerosol, brushless, and lather); and shaving soap (cakes, sticks, etc.), wherein preferred Bio-PDO concentration ranges are from about 0.001% to about 50%, more preferably from about 0.01% to about 10%, and even more preferably from about 0.1% to about 5%.

[0089] Skin care preparations (creams, lotions, powder, and sprays), such as, for example, cleansing (cold creams, cleansing lotions, liquids, and pads); depilatories; face and neck (excluding shaving preparations); body and hand (excluding shaving preparations); foot powders and sprays; hormone products; moisturizing; night; paste masks (mud packs); skin lighteners; skin fresheners; and wrinkle-smoothing products (removers), wherein preferred Bio-PDO concentration ranges are from about 0.001% to about 50%, more preferably from about 0.01% to about 15%, and even more preferably from about 0.05% to about 5%.

[0090] Suntan preparations such as, for example, suntan gels, creams, liquids, powders, sticks and sprays; and indoor tanning preparations; wherein preferred Bio-PDO concentration ranges are from about 0.001% to about 25%, and more preferably from about 1% to about 10%.

[0091] Preservatives (antiseptic/antifungal/antimicrobial agents), such as, for example, parabens; salicylic acid; sorbic acid; and phenoxy ethanol, wherein preferred Bio-PDO concentration ranges are from about 0.001% to about 100%, and more preferably from about 95% to about 99.99%.

Typical Broad Formulations for Certain End Use Applications

[0092] Set forth in this section are general, broad range formulations for a handful of personal care and cosmetic end use applications intended to provide the reader with a general idea of the variety of applications and uses for Bio-PDO in personal care and cosmetic products. This section is by no means intended to be limiting in any way, and those having skill in the art can readily determine appropriate uses of Bio-PDO as a glycol component in all other known personal care and cosmetic products.

Skin Products

[0093] Some examples of vehicles for skin product formulations include oil-in-water emulsion (O/W), water-in-oil emulsion (W/O), water-in-silicon (W/Si), Oleaginous emulsion, water-soluble emulsion, aqueous gel emulsion and absorption bases emulsion.

[0094] A typical O/W skin product formulation may include 5%-35% surfactant, 2%-15% emulsifier, 0.5%-15% Bio-PDO and 5%-60% water.

[0095] A typical W/O skin product formulation may include 45%-80% surfactant, 0.5%-5% emulsifier, 0.5%-15% Bio-PDO and 20%-50% water.

[0096] A typical O/W/O & W/O/W skin product formulation may include 18%-23% surfactant, 3%-8% emulsifier, 0.5%-15% Bio-PDO and 60%-70% water.

[0097] A typical W/Si & O/Si skin product formulation may include 5-35% surfactant, 2%-3% emulsifier, 0.5%-15% Bio-PDO; and 60%-80% water.

Hair Products

[0098] Some examples of vehicles for hair product formulations include oil-in-water emulsion (O/W), water-in-oil emulsion (W/O), Water-in-silicon (W/Si), oleaginous, water-soluble, aqueous gel, and absorption bases, among others.

[0099] A typical shampoo & conditioner may include 0.1-40% surfactant; 0.1-10% Bio-PDO, and 35-55% water.

[0100] A typical liquid & cream color dye may include 70-80% dye base, 5-25% Bio-PDO, 0.1-5% dye intermediates, and 0.1-10% developer

[0101] A typical relaxer or straightener formulation may include 30-60% oil/wax, 10-60% water, 1-10% Bio-PDO, and 0.1-5.0% caustic.

[0102] A typical dressing formulation may include 0.01-7% film former/plasticizer, 0.01-90% Bio-PDO, 0-30% propellant and 10-90% water.

Oral Products

[0103] Some examples of vehicles for oral product formulations include solid forms, such as paste, gel, cream, and ointment; and liquid forms such as washes, rinses, gargles, and sprays.

[0104] A typical tooth paste/gel/cream/ointment formulation may include 1-60/15-55/30-50% abrasive, 1-80/1-50/

1-30% Bio-PDO; 0.01-30/0.1-15/0.5-5% thickener, 0.01-10/0.1-7.5/0.5-5% surfactant, and 0.0001-2/0.001-1/0.01-0.5% antiseptic.

[0105] A typical mouth wash/rinse/gargle/spray may include 0.1-55/0.5-40/1-25% Bio-PDO, 0.1-55/0.5-40/1-25% alcohol, 0.01-10/0.1-7.5/0.5-5% thickener, 0.001-2/0.01-1/0.1-0.5% surfactant, and 0.0001-5/0.001-2.5/0.01-1% antiseptic.

Color Cosmetics

[0106] Some examples of vehicles for color cosmetic formulations include, for foundation: O/W & W/O emulsions, anhydrous powders & sticks, and oil & aqueous suspensions; for mascara: O/W & W/O emulsions and anhydrous solvent; for eyeliner: aqueous and anhydrous; for eye shadow: creams and powders; for blushers: powders; and for lip Color: gloss & matte (classical) and solvent (Volatile).

[0107] A typical formulation for an O/W foundation product may include 2%-15% emulsifier, 50%-75% Bio-PDO, 6%-12% pigment and 8%-12% pearlizer

[0108] A typical formulation for a W/O foundation product may include 4%-6% emulsifier, 50%-75% Bio-PDO, 6%-12% pigment and 8%-12% pearlizer.

[0109] A typical formulation for an anhydrous foundation product may include 30-60% Bio-PDO, 5-10% wax, 0.5-1.0% wetting agents, and 30-60% texturizing agent.

[0110] A typical formulation for a O/W, W/O mascara product may include 4%-10% emulsifier, 2%-5% thickener, 40%-60% Bio-PDO and 6%-12% pigment.

[0111] A typical formulation for a solvent-based mascara product may include 40-60% Bio-PDO 10-20% wax, 3-10% resin, 3-7% thickener, 5-15% colorant, and 2-10% filler.

[0112] A typical formulation for an eye shadow product may include 35-55% Bio-PDO, 1.5-3.5% thickener, 7-12% wax, 3-8% emollient, 5-20% colorant, and 5-20% filler.

[0113] A typical formulation for an eye liner product may include 50-70% water, 0.5-1.5% thickener, 4-12% Bio-PDO, 10-20% colorant, 5-10% alcohol, and 3-8% dispersant.

[0114] A typical formulation for a classical lipstick product may include 40-70% Bio-PDO, 8-15% wax, 2-5% plasticizer, 0.5-8% colorant, 1-6% pearlizer, 1-15% filler and 0.1-0.5% preservative.

[0115] A typical formulation for a volatile lipstick product may include 25-60% solvent, 1-85% Bio-PDO, 10-25% wax, 1-10% fixative, 1-15% filler and 1-15% colorant.

Deodorants

[0116] Some examples of vehicles for deodorant formulations include sticks, aerosols and pump sprays, among others well known in the art.

[0117] A typical formulation for a stick deodorant may include 5-9% emulsifier, 1-30% Bio-PDO, 5-80% clarifying agent, and 0.1-2% deodorizer.

[0118] A typical formulation for an aerosol deodorant may include 0.1-2% emulsifier, 30-50% Bio-PDO, 5-80% clarifying agent, 0.1-2% deodorizer, and 40-60% propellant

[0119] A typical formulation for a hydroalcoholic pump spray deodorant may include 30-40% solvent, 50-70% Bio-PDO, 0.1-5% solubilizer, and 0.1-5% deodorizer.

[0120] A typical formulation for a Phase Inversion Temperature Emulsion (PIT) emulsion pump spray deodorant may include 0.1-10% surfactant, 0.1-15% oil, 65-85% Bio-PDO, and 0.1-5% deodorizer.

Antiperspirants

[0121] Some examples of vehicles for antiperspirant formulations include sticks (suspension, gel, and emulsion), roll-ons (Emulsion O/W, W/O, W/Si, Clear Hydroalcoholic and suspension), and aerosols, among others well known in the art.

[0122] A typical stick antiperspirant formulation may include 1-30% gel agent, 15-55% Bio-PDO, 1-20% emollient, 0-20% surfactant, and 15-55% antiperspirant.

[0123] A typical roll-on antiperspirant formulation may include 0-5% surfactant, 0.5-15% gel agent, 0-5% emollient, 15-25% antiperspirant and 60-85% Bio-PDO.

[0124] A typical aerosol antiperspirant formulation may include 0.1-2% gel agent, 5-15% antiperspirant, 5-20% Bio-PDO, and 70-80% propellant.

Ingredient Listings:

[0125] Cosmetic and personal care compositions of the invention preferably contain Bio-PDO and one or more conventional cosmetic or dermatological additives or adjuvants including, but not limited to, carriers; actives; fillers; surfactants; thixotropic agents; antioxidants; preserving agents; dyes; pigments; fragrances; thickeners; vitamins; hormones; moisturizers; UV absorbing sunscreens; UV scattering inorganic sunscreens; wetting agents; cationic, anionic, nonionic, or amphoteric polymers; and hair coloring active substances.

[0126] Conventional optional ingredients are well known to those skilled in the art. These include, but are not limited to, emollients, oil absorbents, antimicrobial agents, binders, buffering agents, denaturants, cosmetic astringents, external analgesics, film formers, humectants, opacifying agents, perfumes, pigments, skin soothing and healing agents, preservatives, propellants, skin penetration enhancers, solvents, suspending agents, emulsifiers, cleansing agents, thickening agents, solubilizing agents, waxes, inorganic and organic sunblocks, sunless tanning agents, antioxidants and/or radical scavengers, chelating agents, anti-acne agents, anti-inflammatory agents, desquamation agents/exfoliants, organic hydroxy acids, vitamins, natural extracts and inorganic particulates such as silica and boron nitride. Nonexclusive examples of such materials are described in Harry's Cosmeticology, 7th Ed., Harry & Wilkinson (Hill Publishers, London 1982); in Pharmaceutical Dosage Forms—Disperse Systems; Lieberman, Rieger & Banker, Vols. 1 (1988) & 2 (1989); Marcel Decker, Inc.; in The Chemistry and Manufacture of Cosmetics, 2nd. Ed., deNavarre (Van Nostrand 1962-1965); and in The Handbook of Cosmetic Science and Technology, 1st Ed. Knowlton & Pearce (Elsevier 1993) can also be used in the present invention.

[0127] However, it is to be understood that the active and other ingredients useful herein can in some instances provide more than one cosmetic and/or therapeutic benefit or

operate via more than one mode of action. Such components are particularly preferred additional ingredients, their use often saving both money and formulation space. Examples of such components include ethanol, isopropyl myristate, and the many components that can act as both structurants and sensory modifiers, for example silica. Therefore, classifications herein are made for the sake of convenience and are not intended to limit an ingredient to the particularly stated application or applications listed.

[0128] The adjuvants are well known in the field of cosmetics and are described in many publications, for example see *Harry's Cosmeticology,* 8th Edition, Martin Rieger, ed. Chemical Publishing, New York (2000). Amounts of adjuvants generally present in the aforementioned cosmetic and personal care compositions are well known in the art (see, e.g., co-owned, co-filed U.S. patent application entitled "Personal Care Compositions", Attorney Docket No. CL3428 US PRV

Carriers

[0129] The compositions of the present invention preferably comprise a safe and effective amount of an acceptable carrier, suitable for topical application to the skin within which the essential materials and optional other materials are incorporated to enable the essential materials and optional components to be delivered to the skin at an appropriate concentration. The carrier can thus act as a diluent, dispersant, solvent, or the like for any active ingredients which ensures that they can be applied to, and distributed evenly over, the selected target at an appropriate concentration.

[0130] The type of carrier utilized in the present invention depends on the types of product form desired for the composition. The topical compositions useful in the subject invention may be made into a wide variety of product forms such as are known in the art. These include but are not limited to lotions, creams, gels, sticks, sprays, ointments, pastes and mousses. These product forms may comprise several types of carriers including, but not limited to, solutions, aerosols, emulsions, gels, solids and liposomes.

[0131] It is preferred that the carrier(s) of the invention contain a dermatologically acceptable, hydrophilic diluent, such as, preferably, renewably-based, biodegradable 1,3-propanediol.

Actives

Actives for Regulating Skin Condition

[0132] The compositions of the invention optionally comprise a safe and effective amount of an active for regulating skin condition including prophylactically and therapeutically regulating the skin condition. Prophylactically regulating skin condition includes delaying, minimizing, and/or preventing visible and/or tactile discontinuities in the skin. Therapeutically regulating the skin condiments includes ameliorating e.g., diminishing, minimising, and/or effacing such discontinuities. Regulating the skin condition also involves improving the skin appearance and/or feel. Also included is regulating the signs of ageing which can involve prophylactically regulating and/or therapeutically regulating one or more of such signs e.g., fine lines, wrinkles, pores etc.

[0133] Ingredients that are known to be useful for regulating the skin condition are selected from Vitamin B3 compounds, retinoids, and combinations thereof. As described for the humectants, the aforementioned compounds may, when used by themselves, give rise to a high level of tack, especially when used at the higher levels. It has been found, however, that this tacky feel can be offset by using the particulates of the present invention. The compositions of the present invention preferably comprise from about 0.1% to about 15%, more preferably from about 0.3% to about 10%, even more preferably from about 1 to about 5% of the active.

[0134] As used herein, "vitamin B3 compound" means a compound having the formula: 1

[0135] wherein R is —$CONH_2$ (i.e., niacinamide), —COOH (i.e., nicotinic acid) or —$CH_2OH$ (i.e., nicotinyl alcohol); derivatives thereof; and salts of any of the foregoing. One or more vitamin $B_3$ compounds, or their salts, or mixtures thereof may be used herein. In a preferred embodiment, the vitamin $B_3$ compound typically contains less than about 50% of the compound in a salt form. As used herein, "retinoid" includes all natural and/or synthetic analogues of Vitamin A or retinol-like compounds which possess the biological activity of Vitamin A in the skin as well as the geometric isomers and stereoisomers of these compounds. Again, all skin regulating materials discussed in application WO 00/24372 should be considered as suitable for use in the present invention.

Anti-Bacterial Actives

[0136] Any antibacterial active acceptable for underarm application can be used in the deodorant compositions. Antibacterial ingredients, by non-limiting example, include those selected from the group consisting of triclosan, bacteriostatic quaternary ammonium compounds such as benzalkonium chloride, benzethonium chloride, cetyl pyridium chloride, lauryl pyridium chloride and methyl benzethonium chloride; triclocarbon; zinc phenol sulfonate; zinc ricinoleate; triethyl citrate; essential oils; and combinations thereof and the like. The most preferred deodorant active is triclosan. The fragrance may also have antibacterial properties.

Anti-Inflammatory Agents

[0137] A safe and effective amount of an anti-inflammatory agent may be added to the compositions of the subject invention, preferably from about 0.1% to about 5%, more preferably from about 0.1% to about 2%, of the composition. The anti-inflammatory agent enhances the skin appearance benefits of the present invention, e.g., such agents contribute to a more uniform and acceptable skin tone or colour. The exact amount of anti-inflammatory agent to be used in the compositions will depend on the particular anti-inflammatory agent utilised since such agents vary widely in potency. Anti-inflammatory agents useful herein include steroids such as hydrocortisone; non-steroidal anti-inflammatory drugs (NSAIDS) such as ibuprofen; panthenol and ether and ester derivatives thereof e.g. panthenol ethyl ether, panthenyl triacetate; pantothenic acid and salt and ester derivatives thereof, especially calcium pantothenate; aloe vera, bisabolol, allantoin and compounds of the liquorice (the plant genus/species Glycyrrhiza glabra) family, including glycyrrhetic acid, glycyrrhizic acid, and derivatives thereof e.g. salts such as ammonium glycyrrhizinate and esters such as stearyl glycyrrhetinate. Particularly preferred herein are

panthenol, pantothenic acid and their ether, ester or salt derivatives and mixtures thereof; suitable levels are from about 0.1 to about 5%, preferably from about 0.5 to about 3%. Panthenol is especially preferred.

Antimicrobial Agents

**[0138]** Conventional organic anti-microbial agents may also be advantageously employed in the methods and products of the present invention. Levels of incorporation are preferably from 0.01% to 3%, more preferably from 0.03% to 0.5% by weight of the composition in which they are present, excluding any volatile propellant also present. Most of the classes of agents commonly used in the art can be utilised. Preferred additional organic anti-microbials are bactericides, for example quaternary ammonium compounds, like cetyltrimethylammonium salts; chlorhexidine and salts thereof; and diglycerol monocaprate, diglycerol monolaurate, glycerol monolaurate, and similar materials, as described in "Deodorant Ingredients", S. A. Makin and M. R. Lowry, in "Antiperspirants and Deodorants", Ed. K. Laden (1999, Marcel Dekker, New York). More preferred additional anti-microbials for use in the compositions of the invention are polyhexamethylene biguanide salts; 2,4,4'-trichloro,2'-hydroxy-diphen-yl ether (triclosan); and 3,7,11-trimethyldodeca-2,6,10-trienol (farnesol).

**[0139]** Inorganic anti-microbial agents may also be used in the compositions of the invention. Such materials can often function as anti-perspirant actives when present at a suitable concentration. Examples are often selected from astringent active salts, including, in particular, aluminium, zirconium and mixed aluminium/zirconium salts, including both inorganic salts, salts with organic anions and complexes. Preferred astringent salts include aluminium, zirconium and aluminium/zirconium halides and halohydrate salts, such as chlorohydrates. When included, preferred levels of incorporation are from 0.5% to 60%, particularly from 5% to 30% or 40% and especially from 5% or 10% to 30% or 35% by weight of a composition. Especially preferred aluminium halohydrate salts, known as activated aluminium chlorohydrates, are described in EP 6,739 (Unilever PLC and NV). Zirconium aluminium chlorohydrate actives are also preferred materials, as are the so-called ZAG (zirconium-aluminium-glycine) complexes, for example those disclosed in U.S. Pat. No. 3,792,068 (Procter and Gamble Co.). Zinc phenol sulphonate may also be used, preferably at up to 3% by weight of the composition.

Anti-Oxidants/Radical Scavengers

**[0140]** Compositions of the subject invention can further include an anti-oxidant/radical scavenger. The anti-oxidant/radical scavenger is especially useful for providing protection against UV radiation which can cause increased scaling or texture changes in the stratum corneum and against other environmental agents which can cause skin damage. Suitable amounts are from about 0.1% to about 10%, more preferably from about 1% to about 5%, of the composition.

**[0141]** Anti-oxidants/radical scavengers such as ascorbic acid (vitamin C) and its salts, ascorbyl esters of fatty acids, ascorbic acid derivatives (e.g., magnesium ascorbyl phosphate), beta.-carotene, tocopherol (vitamin E), tocopherol sorbate, tocopherol acetate, other esters of tocopherol, butylated hydroxy benzoic acids and their salts, gallic acid and its alkyl esters, especially propyl gallate, uric acid and its salts and alkyl esters, sorbic acid and its salts, amines (e.g., N,N-diethylhydroxylamine, amino-guanidine), sulfhydryl compounds (e.g., glutathione), dihydroxy fumaric acid and its salts, bioflavonoids, lysine, methionine, proline, superoxide dismutase, silymarin, tea extracts, grape skin/seed extracts, melanin, and rosemary extracts may be used. Preferred anti-oxidants/radical scavengers are selected from tocopherol acetate, tocopherol sorbate and other esters of tocopherol, more preferably tocopherol acetate. As described for the humectants, the aforementioned compounds may, when used by themselves, give rise to a high level of tack, especially when used at the higher levels. It has been found, however, that this tacky feel can be offset by using the particulates of the present invention.

Chelators

**[0142]** The inclusion of a chelating agent is especially useful for providing protection against UV radiation which can contribute to excessive scaling or skin texture changes and against other environmental agents which can cause skin damage. A suitable amount is from about 0.01% to about 1%, more preferably from about 0.05% to about 0.5%, of the composition. Exemplary chelators that are useful herein are disclosed in U.S. Pat. No. 5,487,884, incorporated herein by reference. Preferred chelators useful in compositions of the subject invention are ethylenediamine tetraacetic acid (EDTA), furildioxime, and derivatives thereof.

Colorants and Preservatives

**[0143]** Further additional components that may also be included are colorants and preservatives, for example C1-C3 alkyl parabens.

Desquamation Agents/Exfoliants

**[0144]** A safe and effective amount of a desquamation agent may be added to the compositions of the subject invention, more preferably from about 0.1% to about 10%, even more preferably from about 0.2% to about 5%, also preferably from about 0.5% to about 4% of the composition. Desquamation agents enhance the skin appearance benefits of the present invention. For example, the desquamation agents tend to improve the texture of the skin (e.g., smoothness). A variety of desquamation agents are known in the art and are suitable for use herein, including organic hydroxy acids such as salicylic acid, glycolic acid, lactic acid, 5-octanoyl salicylic acid, hydroxyoctanoic acid, hydroxycaprylic acid, and lanolin fatty acids. One desquamation system that is suitable for use herein comprises sulphydryl compounds and zwitterionic surfactants and is described in WO 96/01101, incorporated herein by reference. Another desquamation system that is suitable for use herein comprises salicylic acid and zwitterionic surfactants and is described in WO 95/13048, incorporated herein by reference. Salicylic acid is preferred.

Emollients

**[0145]** Emollients are a known class of materials in this art, imparting a soothing effect to the skin. These are ingredients which help to maintain the soft, smooth, and pliable appearance of the skin. Emollients are also known to reduce whitening on the skin and/or improve aesthetics. Examples of chemical classes from which suitable emollients can be found include:

[0146] (a) fats and oils which are the glyceryl esters of fatty acids, or triglycerides, normally found in animal and plant tissues, including those which have been hydrogenated to reduce or eliminate unsaturation. Also included are synthetically prepared esters of glycerin and fatty acids. Isolated and purified fatty acids can be esterified with glycerin to yield mono-, di-, and triglycerides. These are relatively pure fats which differ only slightly from the fats and oils found in nature. The general structure may be represented by Formula III:

[0147] wherein each of $R_1$, $R_2$, and $R_3$ may be the same or different and have a carbon chain length (saturated or unsaturated) of 7 to 30. Specific examples include peanut oil, sesame oil, avocado oil, coconut, cocoa butter, almond oil, safflower oil, corn oil, cotton seed oil, castor oil, hydrogenated castor oil, olive oil, jojoba oil, cod liver oil, palm oil, soybean oil, wheat germ oil, linseed oil, and sunflower seed oil;

[0148] (b) hydrocarbons which are a group of compounds containing only carbon and hydrogen. These are derived from petrochemicals. Their structures can vary widely and include aliphatic, alicyclic and aromatic compounds. Specific examples include paraffin, petrolatum, hydrogenated polyisobutene, and mineral oil.

[0149] (c) esters which chemically, are the covalent compounds formed between acids and alcohols. Esters can be formed from organic carboxylic acids and any alcohol. Esters here are derived from monocarboxylic acids and alcohols (mono alcohols or polyols as glycols). The general structure would be $R_4COOR_5$. The chain length for $R_4$ and $R_5$ can vary from 7 to 30 and can be saturated or unsaturated, straight chained or branched. Specific examples include isopropyl myristate, isopropyl palmitate, isopropyl stearate, isopropyl isostearate, butyl stearate, octyl stearate, hexyl laurate, cetyl stearate, diisopropyl adipate, isodecyl oleate, diisopropyl sebacate, isostearyl lactate, $C_{12\text{-}15}$ alkyl benzoates, myreth-3 myristate, dioctyl malate, neopentyl-glycol diheptanoate, neopentyl glycol dioctanoate, dipropylene glycol dibenzoate, $C_{12\text{-}15}$ alcohols lactate, isohexyl decanoate, isohexyl caprate, diethylene glycol dioctanoate, octyl isononanoate, isodecyl octanoate, diethylene glycol diisononanoate, isononyl isononanoate, isostearyl isostearate, behenyl behenate, $C_{12\text{-}15}$ alkyl fumarate, laureth-2 benzoate, propylene glycol isoceteth-3 acetate, propylene glycol ceteth-3 acetate, octyldodecyl myristate, cetyl ricinoleate, myristyl-myristate.

[0150] Esters, made using compounds such as Bio-PDO or other biologically derived glycols, can also be used in these compositions. The esters produced include all the appropriate conjugate mono and diesters of biologically derived 1,3 propanediol using organic carboxylic acids. Some esters in particular that are produced include propanediol distearate and monostearate, propandiol dilaurate and monolaurate, propanediol dioleate and monooleate, propanediol divalerate and monovalerate, propanediol dicaprylate and monocaprylate, propanediol dimyristate and monomyristate, propanediol dipalmitate and monopalmitate, propanediol dibehenate and monobehenate, propanediol adipate, propanediol maleate, propanediol dioxalate, propanediol dibenzoate, propanediol diacetate, and all mixtures thereof.

[0151] (d) saturated and unsaturated fatty acids which are the carboxylic acids obtained by hydrolysis of animal or vegetable fats and oils. These have general structure $R_6COOH$ with the $R_6$ group having a carbon chain length between 7 and 30, straight chain or branched. Specific examples include lauric, myristic, palmitic, stearic, oleic, linoleic and behenic acid.

[0152] (e) saturated and unsaturated fatty alcohols (including guerbet alcohols) with general structure $R_7OH$ where $R_7$ can be straight or branched and have carbon length of 7 to 30. Specific examples include lauryl, myristyl, cetyl, isocetyl, stearyl, isostearyl, oleyl, ricinoleyl and erucyl alcohol;

[0153] (f) lanolin and its derivatives which are a complex esterified mixture of high molecular weight esters of (hydroxylated) fatty acids with aliphatic and alicyclic alcohols and sterols. General structures would include $R^8CH_2—(OCH_2CH_2)_{nOH}$ where $R^8$ represents the fatty groups derived from lanolin and n=5 to 75 or $R_9CO—(OCH_2CH_2)_{nOH}$ where $R_9CO—$ represents the fatty acids derived from lanolin and n=5 to 100. Specific examples include lanolin, lanolin oil, lanolin wax, lanolin alcohols, lanolin fatty acids, isopropyl lanolate, ethoxylated lanolin and acetylated lanolin alcohols.

[0154] (g) alkoxylated alcohols wherein the alcohol portion is selected from aliphatic alcohols having 2-18 and more particularly 4-18 carbons, and the alkylene portion is selected from the group consisting of ethylene oxide, and propylene oxide having a number of alkylene oxide units from 2-53 and, more particularly, from 2-15. Specific examples include PPG-14 butyl ether and PPG-53 butyl ether.

[0155] (h) silicones and silanes the linear organo-substituted polysiloxanes which are polymers of silicon/oxygen with general structure:

[0156] (1) $(R_{10})_3SiO(Si(R_{11})_{20})_xSi\ (R_{12})_{-3}$ where $R_{10}$, $R_{11}$ and $R_{12}$ can be the same or different and are each independently selected from the group consisting of phenyl and C1-C60 alkyl;

[0157] (2) $HO(R_{14})_2SiO(Si(R_{15})_{20})_xSi\ (R_{16})_2OH$, where $R_{14}$, $R_{15}$ and $R_{16}$ can be the same or different and are each independently selected from the group consisting of phenyl and C1-C60 alkyl; or

[0158] (3) organo substituted silicon compounds of formula $R_{17}Si(R_{18})_2OSiR_{193}$ which are not polymeric where $R_{17}$, $R_{18}$ and $R_{19}$ can be the same or different and are each independently selected from the group consisting of phenyl and C1-C60 alkyl optionally with one or both of the terminal R groups also containing an hydroxyl group. Specific examples include dimethicone, dimethiconol behenate, C30-45 alkyl methicone, stearoxytrimethylsilane, phenyl trimethicone and stearyl dimethicone.

[0159] (i) mixtures and blends of two or more of the foregoing.

[0160] Emollients of special interest include C12-15 alkyl benzoate (FINSOLV TN from Finetex Inc., Elmwood Park, N.J.), isopropyl myristate; and neopentyl glycol diheptanoate.

[0161] The emollient or emollient mixture or blend thereof incorporated in compositions according to the present invention can, illustratively, be included in amounts of 0.1-20%,

preferably 1-15%, more preferably 1-10%, by weight, of the total weight of the composition.

Emulsifiers/Surfactants

[0162] Compositions herein preferably contain an emulsifier and/or surfactant, generally to help disperse and suspend the discontinuous phase within the continuous aqueous phase. A surfactant may also be useful if the product is intended for skin cleansing. For convenience hereinafter emulsifiers will be referred to under the term 'surfactants', thus 'surfactant(s)' will be used to refer to surface active agents whether used as emulsifiers or for other surfactant purposes such as skin cleansing. Known or conventional surfactants can be used in the composition, provided that the selected agent is chemically and physically compatible with essential components of the composition, and provides the desired characteristics. Suitable surfactants include non-silicone derived materials, and mixtures thereof. All surfactants discussed in application WO 00/24372 should be considered as suitable for use in the present invention.

[0163] The compositions of the present invention preferably comprise from about 0.05% to about 15% of a surfactant or mixture of surfactants. The exact surfactant or surfactant mixture chosen will depend upon the pH of the composition and the other components present.

[0164] Preferred surfactants are nonionic. Among the nonionic surfactants that are useful herein are those that can be broadly defined as condensation products of long chain alcohols, e.g. C8-30 alcohols, with sugar or starch polymers i.e., glycosides. Other useful nonionic surfactants include the condensation products of alkylene oxides with fatty acids (i.e. alkylene oxide esters of fatty acids). These materials have the general formula RCO(X)nOH wherein R is a C10-30 alkyl group, X is —OCH2CH2- (i.e. derived from ethylene glycol or oxide) or —OCH2CHCH3- (i.e. derived from propylene glycol or oxide), and n is an integer from about 6 to about 200. Other nonionic surfactants are the condensation products of alkylene oxides with 2 moles of fatty acids (i.e. alkylene oxide diesters of fatty acids). These materials have the general formula RCO(X)nOOCR wherein R is a C10-30 alkyl group, X is —OCH2CH2- (i.e. derived from ethylene glycol or oxide) or —OCH2CHCH3- (i.e. derived from propylene glycol or oxide), and n is an integer from about 6 to about 100. Even further suitable examples include a mixture of cetearyl alcohols, cetearyl glucosides such as those available under the trade name Montanov 68 from Seppic and Emulgade PL68/50 from Cognis UK Ltd. An example of a suitable cetearyl glucoside material without added fatty alcohols is Tego™ Care CG90 commercially available from Goldschmidt GmbH. Other nonionic surfactants are fatty alkanolamides with the general formula R—CO—N—(CH2CH2OH)n where R is a hydrocarbon chain and n is the integer 1 or 2. The most commonly used are cocoamide DEA (diethanolamide) and cocoamide MEA (monoethanolamide).

[0165] The hydrophilic surfactants useful herein can alternatively or additionally include any of a wide variety of cationic, anionic, zwitterionic, and amphoteric surfactants such as are known in the art. See, e.g., McCutcheon's, Detergents and Emulsifiers, North American Edition (1986), published by Allured Publishing Corporation; U.S. Pat. No. 5,011,681 to Ciotti et al., issued Apr. 30, 1991; U.S. Pat. No. 4,421,769 to Dixon et al., issued Dec. 20, 1983; and U.S. Pat. No. 3,755,560 to Dickert et al., issued Aug. 28, 1973. A wide variety of anionic surfactants are also useful herein. See, e.g., U.S. Pat. No. 3,929,678, to Laughlin et al., issued Dec. 30, 1975.

[0166] A wide variety of anionic surfactants are also useful herein. See, e.g., U.S. Pat. No. 3,929,678, to Laughlin et al., issued Dec. 30, 1975. Exemplary anionic surfactants include the alkoyl isethionates (e.g., C.12-C30), alkyl and alkyl ether sulfates and salts thereof, alkyl and alkyl ether phosphates and salts thereof, alkyl methyl taurates (e.g., C12-C30), and soaps (e.g., alkali metal salts, e.g., sodium or potassium salts) of fatty acids.

[0167] Amphoteric and zwitterionic surfactants are also useful herein. Examples of amphoteric and zwitterionic surfactants which can be used in the compositions of the present invention are those which are broadly described as derivatives of aliphatic secondary and tertiary amines in which the aliphatic radical can be straight or branched chain and wherein one of the aliphatic substituents contains from about 8 to about 22 carbon atoms (preferably C8-C18) and one contains an anionic water solubilising group, e.g., carboxy, sulfonate, sulfate, phosphate, or phosphonate. Examples are alkyl imino acetates, and iminodialkanoates and aminoalkanoates, imidazolinium and ammonium derivatives. Other suitable amphoteric and zwitterionic surfactants are those selected from the group consisting of betaines, sultaines, hydroxysultaines, and branched and unbranched alkanoyl sarcosinates, and mixtures thereof.

Fragrance

[0168] Fragrance is also a desirable additional component in the compositions of the invention. Suitable materials include conventional perfumes, such as perfume oils and also include so-called deo-perfumes, as described in EP 545,556 and other publications. These latter materials may also qualify as additional organic anti-microbial agents. Levels of incorporation are preferably up to 4% by weight, particularly from 0.1% to 2% by weight, and especially from 0.7% to 1.7% by weight of a composition. Synergies can exist between the essential components of the invention and certain fragrance components—long-lasting odor control being the result.

[0169] The fragrance may be selected from the group consisting of any cosmetically acceptable fragrance or fragrances acceptable for topical application. The fragrance should be suitable for masking malodor, such as malodor associated with human sweat. By way of non-limiting examples, these fragrances include those comprising middle note and/or top note volatile constituents, like those selected from the group consisting of allyl amyl glycolate, dihydromyrcenol, aldehyde C-12 MNA, decanol, isobornyl acetate, LILAL™, tricyclo decenyl acetate, benzyl salicylate, and the like, and combinations thereof.

Humectants

[0170] Humectant is also a desirable additional component which helps contribute moisturizing properties in the compositions of the invention. Exemplary humectants can include, but are not limited to, polyhydric alcohols (i.e. 1,2-propanediol, 1,3 and 1,4-butanediol, 2-methyl-1,3-propanediol, glycerine, and hexylene glycol) and polyols (i.e. polypropylene glycols, polyethylene glycols) and mixtures thereof.

Propellants

[0171] When the present invention involves the use of an aerosol composition, a volatile propellant is an essential component of such composition. The level of incorporation of the volatile propellant is typically from 30 to 99 parts by weight and particularly from 50 to 95 parts by weight. Non-chlorinated volatile propellant are preferred, in particular liquefied hydrocarbons or halogenated hydrocarbon gases (particularly fluorinated hydrocarbons such as 1,1-difluoroethane and/or 1-trifluoro-2-fluoroethane) that have a boiling point of below 10.degree. C. and especially those with a boiling point below 0.degree. C. It is especially preferred to employ liquefied hydrocarbon gases, and especially C3 to C6 hydrocarbons, including propane, isopropane, butane, isobutane, pentane and isopentane and mixtures of two or more thereof. Preferred propellants are isobutane, isobutane/isopropane, isobutane/propane and mixtures of isopropane, isobutane and butane.

[0172] Other propellants that can be contemplated include alkyl ethers, such as dimethyl ether or compressed non-reactive gases such air, nitrogen or carbon dioxide.

Sensory Modifiers

[0173] Certain sensory modifiers are further desirable components in the compositions of the invention. Such materials are preferably used at a level of up to 20% by weight of a composition. Emollients, humectants, volatile oils, non-volatile oils, and particulate solids which impart lubricity are all suitable classes of sensory modifiers. Examples of such materials include cyclomethicone, dimethicone, dimethiconol, isopropyl myristate, isopropyl palmitate, talc, finely divided silica (eg. Aerosil 200), polyethylene (eg. Acumist B18), polysaccharides, corn starch, C12-C15 alcohol benzoate, PPG-3 myristyl ether, octyl dodecanol, C7-C14 isoparaffins, di-isopropyl adipate, isosorbide laurate, PPG-14 butyl ether, glycerol, hydrogenated polyisobutene, polydecene, titanium dioxide, phenyl trimethicone, dioctyl adipate, and hexamethyl disiloxane.

Thickening Agent (Including Thickeners and Gelling Agents)

[0174] The compositions of the present invention can also preferably comprise a thickening agent, more preferably from about 0.1% to about 10%, even more preferably from about 0.1% to about 9%, and most preferably from about 0.25% to about 8%, of a thickening agent.

[0175] Preferred compositions of the present invention include a thickening agent selected from carboxylic acid polymers, crosslinked polyacrylates, polyacrylamides, xanthan gum and mixtures thereof, more preferably selected polyacrylamide polymers, xanthan gum and mixtures thereof. Preferred polyacrylamides are predispersed in a water-immiscible solvent such as mineral oil and the like, containing a surfactant (HLB from about 7 to about 10) which helps to facilitate water dispersibility of the polyacrylamide. Most preferred for use herein is the non-ionic polymer under the CTFA designation: polyacrylamide and isoparaffin and laureth-7, available under the trade name Sepigel 305 from Seppic Corporation. Also useful are acrylic acid/ethyl acrylate copolymers and the carboxyvinyl polymers sold by the B. F. Goodrich Company under the trade mark of Carbopol resins. Suitable Carbopol resins are described in WO98/22085. All thickening agents discussed in application WO 00/24372 should be considered as suitable for use in the present invention.

[0176] Also, Any gelling agent used in the art of soaps or deodorants may be used in the invention. These gelling agents are generally a metal salt of one or more fatty acids having a chain length of 12-22 carbon atoms. The fatty acid portion of the gelling agent is preferably a relatively pure saturated or unsaturated C12-C22 fatty acid including myristic, palmitic, stearic, oleic, linoleic, linolenic, and combinations thereof. Preferred gelling agents include sodium stearate, potassium stearate, sodium palmitate, potassium myristate, sodium myristate, combinations thereof and the like.

Structurants

[0177] Structurants also may be additional component of the compositions of the invention that are highly desirable in certain product forms. Structurants, when employed, are preferably present at from 1% to 30% by weight of a composition,

[0178] Suitable structurants include cellulosic thickeners such as hydroxy propyl cellulose and hydroxy ethyl cellulose, and dibenzylidene sorbitol. Other suitable structurants include sodium stearate, stearyl alcohol, cetyl alcohol, hydrogenated castor oil, synthetic waxes, paraffin waxes, hydroxystearic acid, dibutyl lauroyl glutamide, alkyl silicone waxes, quaternium-18 bentonite, quaternium-18 hectorite, silica, and propylene carbonate.

Silicone Based Ingredients

[0179] The compositions of the present invention preferably also contain silicone based ingredients. Preferred examples are discussed below:

[0180] i) Silicone Based Emollients. Organopolysiloxane oils may be used as ingredients with emollient benefits in the present compositions. Suitable organopolysiloxane oils include volatile, non-volatile, or a mixture of volatile and non-volatile silicones. The term "non-volatile" as used in this context refers to those silicones that are liquid under ambient conditions and have a flash point (under one atmospheric of pressure) of or greater than about 100.degree. C. The term "volatile" as used in this context refers to those silicone oils having a flash point of less than 100.degree. C. Suitable organopolysiloxanes can be selected from a wide variety of silicones spanning a broad range of volatilities and viscosities. Non-volatile polysiloxanes are preferred. Suitable silicones are disclosed in U.S. Pat. No. 5,069,897, issued Dec. 3, 1991, which is incorporated by reference herein in its entirety.

[0181] Preferred for use herein are organopolysiloxanes selected from the group consisting of polyalkylsiloxanes, alkyl substituted dimethicones, dimethiconols, polyalkylaryl siloxanes, and mixtures thereof. More preferred for use herein are polyalkylsiloxanes and cyclomethicones. Preferred among the polyalkylsiloxanes are dimethicones for example DC200 available from Dow Corning and SF96 available from GE Silicone.

[0182] ii) Silicone Based Emulsifiers. Preferred emulsions of the present invention include a silicone containing emulsifier or surfactant. A wide variety of silicone emulsifiers are useful herein. These silicone emulsifiers are typically organically modified organopolysiloxanes, also known to

those skilled in the art as silicone surfactants. Useful silicone emulsifiers include dimethicone copolyols. These materials are polydimethyl siloxanes which have been modified to include polyether side chains such as polyethylene oxide chains, polypropylene oxide chains, mixtures of these chains, and polyether chains containing moieties derived from both ethylene oxide and propylene oxide. Other examples include alkyl-modified dimethicone copolyols, i.e., compounds which contain C2-C30 pendant side chains. Still other useful dimethicone copolyols include materials having various cationic, anionic, amphoteric, and zwitterionic pendant moieties.

Skin Lightening Agents

**[0183]** The compositions of the present invention can also comprise a skin lightening agent. When used, the compositions preferably comprise from about 0.1% to about 10%, more preferably from about 0.2% to about 5%, also preferably from about 0.5% to about 2%, of a skin lightening agent. Suitable skin lightening agents include those known in the art, including kojic acid, arbutin, ascorbic acid and derivatives thereof, e.g., magnesium ascorbyl phosphate. Further skin lightening agents suitable for use herein also include those described in WO 95/34280 and WO 95/23780; each incorporated herein by reference.

Suncreens

Inorganic Sunscreens

**[0184]** Inorganic sunscreens use titanium dioxide and zinc oxide. They work primarily by reflecting and scattering UV light. The organics include widely used ingredients such as octyl methoxycinnamate (OMC), 4-methylbenzylidene camphor (4-MBC), avobenzone, oxybenzone, and homosalate. They work primarily by absorbing UV light and dissipating it as heat.

**[0185]** Formulators often combine inorganic and organic sunscreens for a synergistic effect. In fact, that is how most are capable of achieving very high SPF—sun protection factor—ratings. SPF is a measure of how effectively a sunscreen in a formulation limits skin exposure to the UV-B rays that burn skin. The higher the number, the more protection a sunscreen formula affords against sunburn.

**[0186]** Set forth below is a listing of approved sunscreen drug products for over-the-counter human use that are applicable for us in the invention when used in combinations, formulation must follow FDA guidelines (21 CFR 352 Sec. 352.10).

| Active | Limit, wt % |
|---|---|
| a. Aminobenzoic acid (PABA) | 15 |
| b. Avobenzone | 3 |
| c. Cinoxate | 3 |
| d. Dioxybenzone | 3 |
| e. Ensulizole | 4 |
| f. Homosalate | 15 |
| g. Menthyl anthranilate | 5 |
| h. Meradimate | 5 |
| i. Octinoxate | 7.5 |
| j. Octisalate | 5 |
| k. Octocrylene | 10 |
| l. Octyl methoxycinnamate | 7.5 |
| m. Octyl salicylate | 5 |

-continued

| Active | Limit, wt % |
|---|---|
| n. Oxybenzone | 6 |
| o. Padimate O | 8 |
| p. Phenylbenzimidazole sulfonic acid | 4 |
| q. Sulisobenzone | 10 |
| r. Titanium dioxide | 25 |
| s. Trolamine salicylate | 12 |
| t. Zinc oxide | 25 |

**[0187]** In addition to the organic sunscreens compositions of the present invention can additionally comprise inorganic physical sunblocks. Nonlimiting examples of suitable physical sunblocks are described in CTFA International Cosmetic Ingredient Dictionary, 6th Edition, 1995, pp. 1026-28 and 1103, Sayre, R. M. et al., "Physical Sunscreens", J. Soc. Cosmet. Chem., vol 41, no 2, pp. 103-109 (1990). Preferred inorganic physical sunblocks are zinc oxide and titanium dioxide, and mixtures thereof.

**[0188]** When used, the physical sunblocks are present in an amount such that the present compositions are transparent on the skin (i.e., non-whitening), preferably less than or equal to about 5%. When titanium dioxide is used, it can have an anatase, rutile, or amorphous structure. Physical sunblock particles, e.g., titanium dioxide and zinc oxide, can be uncoated or coated with a variety of materials including but not limited to amino acids, aluminium compounds such as alumina, aluminium stearate, aluminium laurate, and the like; carboxylic acids and their salts e.g., stearic acid and its salts; phospholipids such as lecithin; organic silicone compounds; inorganic silicone compounds such as silica and silicates; and mixtures thereof. A preferred titanium dioxide is commercially available from Tayca (Japan) and is distributed by Tri-K Industries (Emerson, N.J.) under the MT micro-ionised series (e.g., MT 100SAS).

**[0189]** The compositions of the present invention preferably comprise from about 0.1% to about 10%, more preferably from about 0.1% to about 4%, and most preferably from about 0.5% to about 2.5%, by weight, of inorganic sunscreen.

Esters

**[0190]** Esters can function as many of the above noted ingredients. While those in those having skill in the art can readily determine which esters are most appropriate to provide a particularly desired function, applications specifically note that esters used in this invention may include the esters produced, including all the appropriate conjugate mono and diesters, from biologically-derived 1,3 propanediol using organic carboxylic acids. Some esters in particular that are produced include propanediol distearate and monostearate, propandiol dilaurate and monolaurate, propanediol dioleate and monooleate, propanediol divalerate and monovalerate, propanediol dicaprylate and monocaprylate, propanediol dimyristate and monomyristate, propanediol dipalmitate and monopalmitate, propanediol dibehenate and monobehenate, propanediol adipate, propanediol maleate, propanediol dioxalate, propanediol dibenzoate, propanediol diacetate, and all mixtures thereof.

Natural Ingredients

[0191] Any natural or nature-derived ingredients similar in composition or in function to the above ingredients can be used in these compositions.

Viscosity

[0192] Preferred compositions have an apparent viscosity of from about water thin to about 1,000,000 mPa·s (centipoise). For example, preferred lotions have an apparent viscosity of from about 500 to about 25,000 mPa·s; preferred creams have an apparent viscosity of from about 20,000 to about 250,000 mPa·s.

[0193] Some personal care compositions containing Bio-PDO, such as clear shampoos and sulfate-free shampoo, may require approximately 30% less salt to adjust the viscosity than other compositions containing comparable glycols such as propylene glycol, butylene glycol, 2-methyl-1,3 propanediol etc. In other compositions such as body wash—Bio-PDO may help maintain and build viscosity.

pH

[0194] The compositions of the present invention are usually formulated to have a pH of 9.5 or below and in general have a pH in the range from about 4.5 to about 9, more preferably from about 5 to about 8.5. Some compositions, particularly those comprising an additional active such as salicylic acid, require a lower pH in order for the additional active to be fully efficacious. These compositions are usually formulated to have a pH of from about 2.5 to about 5, more preferably from about 2.7 to about 4.

Skin Irritation and Sensitization

[0195] In a human skin patch test with approximately 100 subjects, 5, 25, and 50% PDO did not cause any skin reactions indicative of irritation or sensitization. A second human skin patch test did not produce any clinically significant dermal irritation or sensitization reactions with concentrations of 25, 50, and 75% PDO at pH 7, or 75% PDO at pH 4 and 9. Based on these studies PDO is not expected to be a skin irritant or sensitizer in humans. In the second human skin patch test, propylene glycol (1,2-propanediol or PG) was also tested at 25, 50, and 75% (pH 7) and all three concentrations of PG were patch test irritants and cumulative irritants for human skin.

Detergents

[0196] In detergent compositions, the glycol component typically is an emulsifier and/or phase stabilizer a hydrotrope/solvent or an enzyme stabilizer.

Forms of the Composition

[0197] The composition of the invention can take a variety of physical forms including granular, gel, tablet, bar and liquid forms. These compositions include a so-called concentrated granular detergent composition adapted to be added to a washing machine by means of a dispensing device placed in the machine drum with the soiled fabric load.

[0198] Exemplary detergents include, but are not limited to, hand dish-washing detergents; machine dish-washing detergents, including solid block detergents; solid laundry detergents, liquid laundry including light-duty liquid detergents (LDLD) and heavy-duty liquid detergents (HDLD); organic or inorganic clothing softeners, laundry bar soaps and car wash detergent, among others.

[0199] The detergent compositions of the invention can comprise any form known or used in the art, such as powders, liquids, granules, gels, pastes, tablets, small bags, bars, and double-partitioned containers, sprays or foamed detergents and other homogenous or multi-phase daily detergent product forms. The products can be manually used or coated, and/or can be used in a constant or freely variable amount of use, or by automatic charge means, or can be used in electric products such as washing machines. These products can have a wide range of pH of, e.g., from 2 to 12 or more, and several tens gram-equivalent, per 100 g of the formulation, of NaOH may be added. These products can have a wide range of preliminary alkalinity. Both high suds and low suds detergents are included.

[0200] Light-Duty Liquid Detergents (LDLD) compositions include LDLD compositions containing magnesium ions for improving surface activity and/or organic diamines and/or various foam stabilizers and/or suds boosters, such as amine oxides and/or skin feeling improvers of surfactant and relaxing agents and/or enzyme types including protease, and/or sterilizers.

[0201] Heavy-Duty Liquid Detergents (HDLD) compositions include all of so-called "structured" or multi-phase and "non-structured" or isotropic liquid types, and generally include aqueous or non-aqueous bleaching agents, and/or enzymes, or do not include bleaching agents and/or enzymes.

[0202] Heavy-duty granular detergents (HDGD) compositions include both of a so-called "compact" or coagulated, or non-spray dried type and a so-called "flocculated" or spray dried type. These compositions include both of a phosphate addition type and a phosphate non-addition type. Such detergents can include a type comprising a more general anionic surfactant as a substrate, or may be a so-called "highly nonionic surfactant" type comprising a generally nonionic surfactant held on an absorbent, for example, in or on the surface of a zeolites or other porous inorganic salt.

[0203] Softener (STW) compositions include various types of granular or liquid products that are softened by laundry, and can generally include organic (such as quaternary) or inorganic (such as clay) softeners.

[0204] Bar Soap (BS & HW) compositions include laundry bars and include both of a type comprising a synthetic detergent and a soap as substrates and a type containing a softener. Such compositions include compositions manufactured by general soap manufacture techniques, such as pressure molding, or techniques that are no so general, such as casting and absorption of surfactant into a porous support. Other hand wash detergents are also included.

[0205] Fabric softeners (FS) include both of the conventional liquid and concentrated liquid types and kinds to be added by dryers or supported by a substrate. Other fabric softeners include those that are solid.

[0206] Special purpose cleaners (SPC) including the following products are also considered detergents for purposes of this invention: house-hold dry detergent modes, pre-

treatment products of laundry bleaching agents, pre-treatment products for fabric protection, liquid higher fabric detergent types, especially high suds products, liquid bleaching agents including both of chlorine type and oxygen bleaching agent type, disinfectants, detergent aids, pre-treatment types including, for example, bleaching additives and "stain-stick" or special sudsing type cleaners, and anti-fading treatment by sunlight.

[0207] Specialty household cleanser (SHC) including the following products are also considered detergents for the purposes of this invention: all purpose cleansing in the form of creams, gels, liquids, and floor cleaners; all-purpose sprays such as for cleaning glass surfaces; wipes including all-purpose wipes, glass cleaners, floor cleaners and disinfectants; bathroom, shower and toilet cleaners; mildew cleaners and bleach.

[0208] The renewably-based, biodegradable 1,3-propanediol of the present invention is present in the aforementioned detergent compositions in amounts well known to those of ordinary skill in the appropriate art, typically up to about 25% by weight based on the weight of the total composition.

[0209] A typical nonspecific detergent formulation may include, but is not limited to, the following components by weight percent: 0.01-50.0% renewably-based, biodegradable 1,3-propanediol, 5.0-40.0% fatty acid and lower carbon number carboxylic acid esters, or mono and/or di-esters (a surfactant), and 1.0 to 70.0% of other surfactants or surfactant blends. Additionally, up to 5.0% by weight of the following components may be included: suds stabilizer/booster (preferred 1-10%), pH buffer (preferred 2-8%), enzymes, chelating agent, perfumes, builders, antioxidants, adjuvants, detersives.

[0210] A basic formula embodiment for a Light Duty Liquid Detergent (LDLD) product may include 0.1-70% of a surfactant, 0.1-20% of Bio-PDO and q.s. to 100% water. LDLDs are commonly used in dishwashing applications, including automatic, manual, dishwasher rinses, plastic stain removers, pots & pans cleaners, pre-treatments and water softeners.

[0211] A basic formula embodiment for a Heavy Duty Liquid Detergent (HDLD) product may include 0.1-50% of a surfactant, 0.1-20% of Bio-PDO and q.s. to 100% water. HDLDs are commonly used in laundry applications, including laundry products containing bleach, hypo-allergenics, phosphate-free materials, dry cleaning materials, fabric conditioners, fabric enhancers, fabric finishes, fabric sizing, fabric softeners, pre-washes, stain removers and starches.

[0212] A basic formula embodiment for a Liquid Automatic Dishwasher Detergent (LADD) product may include 0.1-30% of a builder, 0.1-17% of a caustic/Bleach, 0.1-20% of Bio-PDO and q.s. to 100% of water. Applications include dishwash, liquid Pre-spotters, rinse aids, phosphate-free materials, hypochlorite-free materials and enzymes.

[0213] A basic formula embodiment for a specialty household cleanser (SHC) may include 0.1-70% of a surfactant, 0.1-50% of Bio-PDO, and q.s. to 100% water. Specific applications include, all purpose cleansing in the form of creams, gels, liquids, and floor cleaners; all-purpose sprays such as for cleaning glass surfaces; wipes including all-purpose wipes, glass cleaners, floor cleaners and disinfectants; bathroom, shower and toilet cleaners; mildew cleaners and bleach.

Detergent Components

[0214] Detergent compositions of the invention can contain from 0.01 to 99% by weight of one or more of any of the following general auxiliary components: builders, surfactants, enzymes, polymers, bleaching agents, bleach surfactants, catalyst components, various active components or special components such as dispersant polymers, color speckles, silver protecting agents, anti-fogging agents and/or corrosion inhibitors, dyes, fillers, sterilizers, alkaline agents, hydrotropic agents, antioxidants, enzyme stabilizers, pro-perfumes, perfumes, plasticizers, carriers, processing aids, pigments, and solvents for liquid formulations.

[0215] In general, detergent components are included for converting a composition containing only the minimum essential components into a composition useful for the desired detergent purpose. It is recognized that those skilled in the art can readily determine which detergent components are required for desired detergent applications.

[0216] The precise nature of these additional components, and levels of incorporation thereof, will vary depending upon the physical form of the composition and the nature of the cleaning operation for which it is to be used.

Detergent Surfactants

[0217] The detergent compositions of the invention may contain any known detergent surfactant, and such surfactants are well known to those having skill in the art. Specifically, detergent surfactants of the invention can include anionic, nonionic, zwitter-ionic or amphoteric, betaine, and diamine are, surfactants that are known to be useful in detergent applications.

[0218] In all of the detergent surfactants, the chain length of the hydrophobic moiety is typically in the general range of from C8 to C20, and especially in the case of laundering with cold water, the chain length is often preferably in the range of from C8 to C18.

Detergent Enzymes

[0219] The detergent composition of the invention may use enzymes for various purposes such as removal of protein-based, carbohydrate-based, or triglyceride-based soils from substrates, transfer inhibition of refugee dyes in fabric laundering, and fabric restoration. "Detergent enzymes" as used herein mean all enzymes having advantageous effects in washing, soil removal, and others in laundering.

Builders

[0220] Builder compositions are preferably those that control the hardness of minerals in washing water, especially Ca and/or Mg, thus simplifying the removal and/or dispersal of granular soils from the surface, while also optionally imparting an alkaline agent and/or buffering action. In granular or powder detergents, the builder may function as an absorbent for the surfactant. Alternatively, some compositions can be formulated in a completely water-soluble form, which may be either organic or inorganic, depending on the intended utility.

[0221] Suitable silicate builders include water-soluble types and hydrated solid types, and include other kinds such as those having a chain, layer or steric structure, amorphous solid silicates, and those as prepared such that they are used as not particularly structured liquid detergents.

[0222] Aluminosilicate builders, so-called zeolites, are particularly useful in granular detergents, but can be incorporated into pastes or gels. The aluminosilicates may be crystalline or amorphous, or may be natural or synthetic.

[0223] For the purpose of making it easy to control the hardness of minerals in the washing water, especially Ca and/or Mg, or of making it easy to remove granular solids from the surface, the composition of the invention may optionally contain detergent builders in place of or in addition to the foregoing silicates and aluminosilicates. The builders can be made to function in various mechanisms so as to form soluble or insoluble complexes with mineral ions by ion exchange or by providing mineral ions with the surface more adherent than the surface of the material to be cleaned. The amount of the builder can be varied widely depending on the final utility and physical form of the composition.

[0224] Here, suitable builders can be selected from the group consisting of phosphates and polyphosphates, especially sodium salts, carbonates, bicarbonates, sodium carbonate, organic mono-, di-, tri-, and tetracarboxylates, especially water-soluble non-surfactant carboxylates in acid, sodium, potassium or alkanolammonium forms, and aliphatic and aromatic type-containing oligomers or water-soluble low-molecular polymer carboxylates. For example, for the purpose of pH buffer, these builders can be complemented by all of fillers or carriers that are important in the techniques of detergent compositions including borates or sulfates, especially sodium sulfate, and other stabilized surfactants and/or builders.

[0225] In the invention, builder mixtures can be used. In general, the builder mixture optionally comprises two or more usual builders, and is complemented by a chelating agent, a pH buffer, or a filler.

[0226] Examples of phosphorus-containing builders include polyphosphates, represented by tripolyphosphates, pyrophosphates, and glassy polymer metaphosphates, of alkali metals and ammonium and alkanolammoniums, and phosphonates.

[0227] Suitable carbonate builders include carbonates of an alkaline earth metal or an alkali metal, inclusive of carbonate minerals such as sodium bicarbonate and sodium carbonate, complex salts of sodium carbonate or potassium carbonate, and calcium carbonate.

[0228] As described herein, the "organic detergent builders" suitable for the use along with the alkylaryl sulfonate surfactant include polycarboxylate compounds including water-soluble non-surfactant dicarboxylates and tricarboxylates. More generally, the builder polycarboxylate has plural carboxylate groups, preferably at least three carboxylates. The carboxylate builder can be incorporated in an acidic or partially neutral, neutral or excessively basic form. In the case of the salt form, salts of alkali metals such as sodium, potassium, and lithium, or alkanolammonium salts are preferred. The polycarboxylate builder includes ether polycarboxylates.

[0229] Nitrogen containing builders including amino acids such as lysine, or lower alcohol amines like mono, di-, and tri-ethanolamine, try(hydroxymethyl)amino methane, 2-amino-2-methylpropanol, and disodium glutamate.

[0230] Citric acid salts such as citric acid and soluble salts thereof are a polycarboxylate builder important for, for example, heavy-duty liquid detergents (HDL) because they are available from resources that can be regenerated and are biodegradable. The citric acid salts can also be used in granular compositions especially in combination of zeolites and/or layered silicates. Oxydisuccinic acid salts are especially useful in such compositions and combinations.

[0231] In the detergent composition of the invention, any builders known in this field can be incorporated generally in an amount of from about 0.1 to about 50% by weight, more preferably 0.5 to 30% by weight and most preferably 1 to 25% by weight.

Oxygen Bleaching Agents

[0232] In one embodiment, the invention comprises an "oxygen bleaching agent" as a part or whole of the detergent composition. Any known oxidizing agents can be used. Alternatively, oxidizing agent bleaching agents such as systems of generating hydrogen peroxide by oxygen or an enzyme, or hypohalogenic acid salts, for example, chlorine bleaching agents such as hyposulfites, can also be used.

[0233] Examples of peroxide-based general oxygen bleaching agents include hydrogen peroxide, inorganic peroxohydrates, organic peroxohydrates, and organic peroxy acids including hydrophilic or hydrophobic mono- or di-peroxy acids. These components may be peroxycarboxylic acids, perpoxyimide acids, amidoperoxycarboxylic acids, or salts thereof including their calcium, magnesium or mixed cationic salts. Various kinds of peracids can be used in a liberated form or as precursor materials called "bleach surfactant" or "bleach promoters", which release peracids corresponding to hydrolysis in the case of a combination with a supply source of hydrogen peroxide.

[0234] Inorganic peroxides, suproxides, organic hydroperoxides such as cumene hydroperoxide and t-butyl hydroperoxide, and inorganic peroxo acids and salts thereof, such as peroxosulfates, are also useful as the oxygen bleaching agent.

[0235] Mixed oxygen bleaching agent systems are generally effective as in mixtures of oxygen bleaching agents with known bleach surfactant, organic catalysts, enzyme catalysts, or mixtures thereof. Further, these mixtures can further contain brighteners, light bleaching agents, and dye transfer inhibitors of types that are well known in this field.

[0236] Hydroperoxides and peroxohydrates are organic salts, or more generally, inorganic salts that can readily release hydrogen peroxide. The peroxohydrates are a general example of a "hydrogen peroxide source" and include perborates, percarbonates, perphosphates, and persilicates. Preferred peroxohydrates include all of sodium carbonate hydroperoxide and equivalent commercially available "percarbonate" bleaching agents, and so-called sodium perborate hydrates, and sodium pyrophosphate hydroperoxide can also be used. Urea hydroperoxides are also useful as the peroxohydrate.

[0237] There are included inorganic peroxohydrates, organic peroxohydrates, hydrophilic or hydrophobic mono- or diperacids, organic peracids including peroxycarboxylic acids, peroxyimide acids, and amidoperoxycarboxylic acids, salts of calcium, magnesium, or mixed cationic salts.

[0238] In the detergent composition of the invention, any oxygen bleaching agents are added in such formulations preferably in ranges from about 0 to 15%, and most preferably from about 0.2 to 12%

[0239] Bleach Surfactant can be used as well. Examples of useful bleach surfactants include amides, imides, esters, and acid anhydrides. Generally, in such bleach surfactants, there is present at least one substituted or unsubstituted acyl moiety having a leaving group in the structure, R—C(O)-L. One alternative method of use comprises a combination of the bleach surfactant with a hydrogen peroxide supply source such as perborates and percarbonates. One or more peracid-forming moieties or leaving groups can be present. Mixtures of bleach surfactants can be also used.

[0240] The bleach surfactant can be used in an amount of up to 20% by weight, and preferably from 0.1 to 10% by weight of the composition. For the form of highly concentrated bleaching agent additive products or the form in which the bleach surfactant is used in an automatic charge device, it can be used in an amount of 40% by weight or more.

[0241] Transition Metal Bleaching Agent Catalysts can also be used in the invention. For example, manganese compounds can be optionally used as the bleaching compound to have a catalytic action. As useful cobalt bleaching catalysts, ones that are known may be used.

[0242] In addition to the above-enumerated bleach surfactant, Enzyme-Based Supply Sources of Hydrogen Peroxide. For instance, suitable hydrogen peroxide generating mechanisms include combinations of C1 to C4 alkanol oxidases and C1 to C4 alkanols, especially a combination of methanol oxidase (MOX) and ethanol. Bleaching-related other enzymatic materials such as peroxidases, haloperoxidases, and oxidases, superoxide molecular displacement enzymes, catalases, and their reinforcing agents, or more generally, inhibitors can be optionally used in the composition.

Oxygen Transfer Agents and Precursors

[0243] All known organic bleaching agent catalysts, oxygen transfer agents, or precursors thereof are also useful herein. These materials include their compounds themselves and/or precursors thereof, such as all of ketones suitable for manufacture of dioxiranes, and/or dixoirane precursors or all different atom-containing analogues of dioxiranes. As preferred examples of such components, are especially included hydrophilic or hydrophobic ketones that manufacture the dioxiranes on the spot, along with monoperoxysulfate. Examples of such oxygen bleaching agents that are preferably used along with the oxygen transfer agent or precursor include percarboxylic acids and salts, percarbonic acids and slats, peroxy monosulfuric acid and salts, and mixtures thereof.

Polymeric Soil Releasing Agents

[0244] The composition of the invention can optionally comprise one or more soil releasing agents. The polymeric soil releasing agent is characterized by having hydrophilic segments to hydrophilize the surface of hydrophobic fibers such as polyester and nylon and hydrophobic segments to deposit upon hydrophobic fibers and remain adhered thereto through completion of the laundry cycle to function as an anchor for the hydrophilic segments. This can enable stains occurring sequent to treatment with the soil releasing agent to be more easily cleaned in later washing procedures.

[0245] In the case of the use, the soil releasing agent generally accounts for from about 0.01 to about 10% by weight of the composition.

Clay Soil Removal/Anti-Redeposition Agents

[0246] The composition of the invention can also optionally contain water-soluble ethoxylated amines having clay soil removal and anti-redeposition properties. Granular detergent compositions containing these compounds typically contain from about 0.01% to about 10.0% by weight of the water-soluble ethoxylated amines, and liquid detergent compositions typically contain about 0.01% to about 5% by weight of the water-soluble ethoxylated amines.

[0247] Preferred soil release and anti-redeposition agents are ethoxylated tetraethylenepentamine. Other preferred soil release removal/anti-redeposition agents are ethoxylated amine polymers, zwitter-ionic polymers, and amine oxides. Other soil release removal and/or anti-redeposition agents that are known in this field can also be used in the composition of the invention. Another type of the preferred anti-redeposition agent includes carboxy methyl cellulose (CMC)-based components.

Polymeric Dispersing Agents

[0248] Polymeric dispersing agents can be effectively used in an amount of from about 0.01 to about 10% by weight of the composition of the invention especially in the presence of zeolite and/or layered silicate builders. Suitable polymeric dispersing agents include polymeric polycarboxylates and polyethylene glycols, although others known in the art can also be used. It is believed that polymeric dispersing agents enhance overall detergent builder performance, when used in combination with other builders (including lower molecular weight polycarboxylates) by crystal growth inhibition, particulate soil release, peptization, and anti-redeposition.

[0249] Polymeric polycarboxylate materials can be prepared by polymerizing or copolymerizing suitable unsaturated monomers, preferably in their acid forms. Unsaturated monomeric acids that can be polymerized to form suitable polymeric polycarobyxlates include acrylic acid, maleic acid (or maleic anhydride), fumaric acid, itaconic acid, aconitic acid, mesaconic acid, citraconic acid, and methylenemalonic acid.

[0250] Particularly suitable polymeric polycarboxylates can be derived from acrylic acid. Such acrylic acid-based polymers that are useful herein are the water-soluble salts of polymerized acrylic acid. The average molecular weight of such polymers in the acid form preferably ranges from about 1,000 to 500,000, more preferably from about 2,000 to 250,000, and most preferably from about 3,000 to 100,000. Water-soluble salts of such acrylic acid polymers can include, for example, the alkali metal, ammonium and substituted ammonium salts.

[0251] Acrylic acid/maleic acid-based copolymers may also be used as a preferred component of the dispersing/anti-redeposition agent. Such materials include the water-soluble salts of copolymers of acrylic acid and maleic acid. The average molecular weight of such copolymers in the acid form preferably ranges from about 2,000 to 100,000, more preferably from about 3,000 to 80,000, and most preferably from about 4,000 to 70,000. The ratio of acrylate to maleate segments in such copolymers generally ranges from about 9:1 to about 1:9, and more preferably from about 8:2 to 3:7. Water-soluble salts of such acrylic acid/maleic acid copolymers can include, for example, the alkali metal, ammonium and substituted ammonium salts.

[0252] Copolymers of acrylic acid and/or maleic acid and a polyalkylene glycol can also be used as a preferred component of the dispersing/anti-redeposition agent. The copolymers are preferably graft polymers of acrylic acid and/or maleic acid and a polyalkylene glycol, copolymers of acrylic acid and/or maleic acid and an alkylene oxide adduct of allyl alcohol or isoprenol, and copolymers of acrylic acid and/or maleic acid and a polyalkylene glycol acrylate or methacrylate, and more preferably graft polymers of acrylic acid and/or maleic acid and a polyalkylene glycol and copolymers of acrylic acid and/or maleic acid and an alkylene oxide adduct of allyl alcohol or isoprenol.

[0253] The average molecular weight of the copolymers preferably ranges from about 2,000 to 100,000, more preferably from about 3,000 to 80,000, and most preferably from about 4,000 to 70,000.

[0254] Acrylic acid/acrylamide based copolymers may also be used as a preferred component of the dispersing/anti-redeposition agent. The average molecular weight of such copolymers in the acid form preferably ranges from about 3,000 to 100,000, more preferably from about 4,000 to 20,000, and most preferably from about 4,000 to 10,000. The acrylamide content in such copolymers generally is less than about 50%, preferably less than about 20%, and most preferably about 1 to about 15%, by weight of the polymer.

[0255] Another polymeric component that can be incorporated is polyethylene glycol (PEG). PEG can exhibit dispersing agent performance as well as act as a clay soil removal/anti-redeposition agent. Typical molecular weight ranges for these purposes range from about 500 to about 100,000, preferably from about 1,000 to about 50,000, and more preferably from about 1,500 to about 10,000.

[0256] Polyasparatate and polyglutamate dispersing agents may also be used, especially in conjunction with zeolites builders. Dispersing agents such as polyasparatate preferably have a (weight average) molecular weight of about 10,000.

[0257] In the detergent composition of the invention, Polymeric Dispersing Agents known in this field can be incorporated generally in an amount of from about 0.01 to about 15%, more preferably from 0.05 to 10%, then most preferably 0.1 to 5%.

Brighteners

[0258] In the detergent composition of the invention, any optical brighteners or other brightening or whitening agents known in this field can be incorporated generally in an amount of from about 0.01 to about 1.2% by weight. Such optical brighteners are often used in the case where the detergent is designed for fabric washing or processing applications.

Polymeric Dye Transfer Inhibiting Agents

[0259] The composition of the invention may also include one or more materials effective for inhibiting the transfer of dyes from one fabric to another during the cleaning process. Generally, such dye transfer inhibiting agents include polyvinylpyrrolidone polymers, polyamide N-oxide polymers, copolymers of N-vinylpyrrolidone and N-vinylimidazole, manganese phthalocyanine, peroxidases, and mixtures thereof. If used, these agents generally comprise from about 0.01 to about 10% by weight, preferably from about 0.01 to about 5% by weight, and more preferably from about 0.05 to about 2% by weight of the composition.

[0260] The optical brightener selected for use in the invention exhibits especially effective dye transfer inhibition performance benefits when used in combination with the polymeric dye transfer inhibiting agent. The combination of such selected polymeric materials with such selected optical brightener provides significantly better dye transfer inhibition in aqueous wash solutions than does either of these two detergent composition components when used alone.

Chelating Agents

[0261] The detergent composition of the invention may also optionally contain one or more chelating agents, especially chelating agents for transition metal coming from others. The transition metals generally seen in washing solutions include water-soluble, colloidal or granular iron and/or manganese and may sometimes associate as oxides or hydroxides. Preferred chelating agents are chelating agents that effectively inhibit such transition metals, especially inhibit such transition metals or their compounds to adhere to fabrics, and/or inhibit non-preferred redox reaction occurred in the washing medium and/or on the interface of the fabric or hard surface. The general chelating agents can be selected from the group consisting of amino carboxylates, amino phosphates, polyfunctionally-substituted aromatic chelating agents, and mixtures thereof.

[0262] The composition of the invention may also contain water-soluble methyl glycine diacetic acid salts as a chelating agent that can effectively be used together with insoluble builders such as zeolites and layered silicates.

[0263] If utilized, the chelating agent generally accounts for from about 0.1 to about 15% by weight of the composition. More preferably, if utilized, the chelating agent accounts for from about 0.1 to about 3.0% by weight.

Suds Suppressors

[0264] In the case where washing is required in intended utilities, especially washing by washing machines, compounds for reducing or suppressing the formation of suds can be incorporated into the composition of the invention. For other compositions, for example, compositions as designed for hand washing, high sudsing may be desired, and such components can be omitted. Suds suppression can be of particularly importance in the so-called "high concentration cleaning process" and in front-loading European-style washing machines (so-called drum type washing machines).

[0265] A very wide variety of materials may be used as suds suppressors. The composition of the invention generally comprises from 0% by weight to about 10% by weight of suds suppressors.

Fabric Softeners

[0266] Various through-the-wash fabric softeners can optionally be used in an amount of from about 0.5 to about 10% by weight to provide fabric softener benefits concurrently with fabric cleaning. Clay softeners can be used in combination with amine and cationic softeners. Further, in the cleaning process of the invention, known fabric softeners including those of biodegradation type can be used in modes including the pre-treatment, main cleaning, post-laundry, and addition into washing machines and dryers.

Perfumes

[0267] Perfumes and perfumery ingredients useful in the compositions and processes comprise a wide variety of natural and synthetic chemical ingredients, including, but not limited to, aldehydes, ketones, and esters. Also, included are various natural extracts and essences that can comprise complex mixtures of ingredients such as orange oil, lemon, oil, rose extract, lavender, musk, patchouli, balsamic essence, sandalwood oil, pine oil, and cedar. Finished perfumes typically comprise from about 0.01 to about 2% by weight of the detergent composition, and individual perfumery ingredients can comprise from about 0.0001 to about 90% by weight of a finished perfume composition.

Esters

[0268] Esters can function as many of the above noted ingredients. While those in those having skill in the art can readily determine which esters are most appropriate to provide a particularly desired function, applications specifically note that esters used in this invention may include the esters produced, including all the appropriate conjugate mono and diesters, from biologically-derived 1,3 propanediol using organic carboxylic acids. Some esters in particular that are produced include propanediol distearate and monostearate, propandiol dilaurate and monolaurate, propanediol dioleate and monooleate, propanediol divalerate and monovalerate, propanediol dicaprylate and monocaprylate, propanediol dimyristate and monomyristate, propanediol dipalmitate and monopalmitate, propanediol dibehenate and monobehenate, propanediol adipate, propanediol maleate, propanediol dioxalate, propanediol dibenzoate, propanediol diacetate, and all mixtures thereof.

Other Components

[0269] A wide variety of other ingredients useful in detergent compositions can be included in the composition, including other ingredients, carriers, hydrotropes, processing aids, dyes or pigments, solvents for liquid formulations, and soil fillers for bar compositions. If high sudsing is desired, suds boosters such as C10 to C16 alkanolamides can be incorporated into the composition, typically in an amount of from 1% by weight to 10% by weight. C10 to C14 monoethanl and diethanol amides illustrate a typical class of such suds boosters. Use of such suds boosters with high sudsing adjuvant surfactants such as the amine oxides, betaines and sultanines noted above is also advantageous. If desired, water-soluble magnesium and/or calcium salts can be added typically in an amount of from 0.1% by weight to 2% by weight, to provide additional suds.

[0270] Various detergent ingredients employed in the composition can optionally be further stabilized by absorbing the ingredients onto a porous hydrophobic substrate, then coating the substrate with a hydrophobic coating. Preferably, the detergent ingredient is admixed with a surfactant before being absorbed into the porous substrate. In use, the detergent ingredient is released from the substrate into the aqueous washing liquor, where it performs its intended detergent function.

[0271] The liquid detergent composition can contain water and other solvents as diluents. Low-molecular weight primary or secondary alcohols exemplified by methanol, ethanol, propanol, and isopropanol are suitable. Monohydric alcohols are preferred for stabilizing the surfactant, but polyols such as those having from 2 to about 6 carbon atoms and from 2 to about 6 hydroxyl groups (such as 1,3-propanediol, ethylene glycol, glycerin, and propylene glycol) can also be used. The composition can contain such diluents in an amount of from 5% by weight to 90% by weight, and preferably from 10% by weight to 50% by weight.

[0272] The detergent composition is preferably formulated such that, during use in aqueous cleaning operations, the wash water has a pH of from about 6.5 to about 12.5, preferably from 7 to 12, and more preferably from about 7.0 to about 11. Laundry products are typically at a pH of from 9 to 11. Techniques for controlling the pH at recommended usage levels include the use of buffers, alkalis, acids, etc.

[0273] The detergent compositions of the invention can contain any natural ingredients where appropriate. Natural ingredients include any natural or nature-derived ingredients similar in composition or in function to any of the ingredients listed above.

Liquid Laundry Detergents

[0274] While the following listing of ingredients is particularly suited for liquid laundry detergents, it is clearly within the scope of one having skill in the art to determine whether such ingredients may be useful for other detergent applications.

[0275] Bio-PDO is preferably provided in liquid laundry detergents at concentration ranges of about 0.1% to about 25%, more preferably about 0.5% to about 20% and most preferably about 1% to about 15%

Thickeners

[0276] The physical stability of the liquid product may be improved and the thickness of the liquid product may be altered by the addition of a cross linking polyacrylate thickener to the liquid detergent product as a thixotropic thickener.

PH Adjusting Components

[0277] The above liquid detergent product is preferably low foaming, readily soluble in the washing medium and most effective at pH values best conducive to improved cleaning performance, such as in a range of desirably from about pH 6.5 to about pH 12.5, and preferably from about pH 7.0 to about pH 12.0, more preferably from about pH 8.0 to about pH 12.0, and most preferably, less than about 9.0

pH The pH adjusting components are desirably selected from sodium or potassium hydroxide, sodium or potassium carbonate or sesquicarbonate, sodium or potassium silicate, boric acid, sodium or potassium bicarbonate, sodium or potassium borate, and mixtures thereof. NaOH or KOH are the preferred ingredients for increasing the pH to within the above ranges. Other preferred pH adjusting ingredients are sodium carbonate, potassium carbonate, and mixtures thereof.

Low Foaming Surfactant

[0278] The liquid nonionic surfactant detergents that can be used to practice the present invention are preferably are alkyl ethoxylates in non-chlorine bleach liquid ADW compositions. One example of a non-chlorine bleach stable surfactant is SLF18™ manufactured by BASF Corporation. Alternatively, in chlorine bleach containing liquid ADW compositions, chlorine bleach stable low foaming surfactants are preferred and such surfactants are present in a range of from about 0.1% to about 10% by weight of the liquid composition. Such surfactants are generally known to one skilled in the art and need not be elaborated here, for purposes of brevity. An example of a chlorine bleach stable surfactant is Dowfax™ anionic surfactant available from the Dow Chemical Company.

[0279] Examples of the nonionic surfactant include polyoxyalkylene alkyl ethers, polyoxyalkylene fatty acid esters, polyoxyalkylene sorbitan esters, polyoxyalkylene sorbitan fatty acid esters, polyoxyalkylene sorbitol fatty acid esters, polyoxyalkylene glycerin fatty acid esters, monoglycerides, sorbitan fatty acid esters, fatty acid monoethanolamides, fatty acid diethanolamides and alkyl polyglucosides.

[0280] Examples of the amphoteric surfactants include acetic acid betaines, amidoacetic acid betaines, sulfobetaines, amidosulfobetaines, phosphobetaines, alkylamine oxides, and amidoamine oxides. Of these, fatty acid amidopropylbetaines such as cocamidopropyl betaine and lauramidopropyl betaine are preferred. Include imidazoline derived amphoterics: disodium cocoa amphodiproprionate.

[0281] Two or more of these surfactants may be used in combination. The surfactant is preferably contained in an amount of from 5 to 50 wt. %, more preferably from 10 to 30 wt. %, even more preferably from 10 to 20 wt. % based on the detergent composition of the present invention, from the viewpoints of foaming property, liquid properties during use and detergency.

Silicones

[0282] The detergent composition of the present invention may contain silicones for further improvement in the conditioning effects. The silicones include dimethylpolysiloxanes (viscosity: 5 mm·sup·2/s to 20 million mm·sup·2/s), amino-modified silicones, polyether-modified silicones, methylphenylpolysiloxanes, fatty acid-modified silicones, alcohol-modified silicones, alkoxy-modified silicones, epoxy-modified silicones, fluorine-modified silicones, cyclic silicones and alkyl-modified silicones, of which dimethylpolysiloxanes are preferred. The content of the silicone in the detergent composition of the present invention is preferably from 0.01 to 10 wt. %. The detergent composition of the present invention may contain other conditioning components such as a cationic polymer (cationic cellulose, cationic guar gum, or the like). Their content in the detergent composition of the present invention is preferably from 0.1 to 5 wt. %.

General Liquid Components

[0283] The detergent composition of the present invention may contain, in addition, components employed ordinarily for detergent compositions according to the intended use. Examples of such components include humectants such as propylene glycol, glycerin, diethylene glycol monoethyl ether, sorbitol and panthenol; colorants such as dyes and pigments; viscosity regulators such as methyl cellulose, polyethylene glycol and ethanol; plant extracts; antiseptics; bactericides; chelating agents; vitamin preparations; anti-inflammatory agents; perfumes; ultraviolet absorbers; and antioxidants.

Solid and Semi-Solid Laundry Detergents

[0284] While the following listing of ingredients is particularly suited for solid laundry detergents, it is clearly within the scope of one having skill in the art to determine whether such ingredients may be useful for other detergent applications.

[0285] The solid laundry detergent compositions of the invention comprises a ratio of Bio-PDO to binder portion in the range of 1:20 to 20:1, by weight percentage; preferably in the range of from 1:5 to 5:1, and most preferably from 1:2 to 2:1 therefore 0.1 to 25%, 0.5 to 15%, 1 to 10% from about 0.001 wt % to about 0.5 wt %, more preferably from about 0.1 wt % to about 0.25 wt %, and most preferably from about 0.25 wt % to about 0.1 wt % bio-PDO.

[0286] Preferably, the detergent composition has a particle size distribution such that no more than 10 wt % by weight of the composition, has a particle size greater than 850 micrometers, and no more than 10 wt % by weight of the composition, has a particle size less than 250 micrometers.

[0287] The composition optionally comprises one or more adjunct components. The adjunct components are typically selected from the group consisting of other anionic surfactants, cationic surfactants, non-ionic surfactants, zwitterionic surfactants, other builders, polymeric co-builders such as polymeric polycarboxylates, bleach, other hydrotropes, chelants, enzymes, anti-redeposition polymers, soil-release polymers, polymeric soil-dispersing and/or soil-suspending agents, dye-transfer inhibitors, fabric-integrity agents, fluorescent whitening agents, suds suppressors, fabric-softeners, flocculants, cationic fabric-softening components, perfumes and combinations thereof.

[0288] A suitable adjunct component may be an anionic surfactant other than the alkyl alkoxylated sulphate surfactant and the linear alkyl benzene sulphonate surfactant. Suitable other anionic surfactants are branched or linear C.sub.8-C.sub.18 alkyl sulphate surfactants. An especially suitable other anionic surfactants are methyl branched C.sub.8-C.sub.18 alkyl sulphate surfactants.

[0289] A suitable adjunct component may be an anionic surfactant other than the alkyl alkoxylated sulphate surfactant and the linear alkyl benzene sulphonate surfactant. Suitable other anionic surfactants are branched or linear C.sub.8-C.sub.18 alkyl sulphate surfactants. An especially suitable other anionic surfactants are methyl branched C.sub.8-C.sub.18 alkyl sulphate surfactants.

[0290] A suitable adjunct component may be a hydrotrope other than the alkoxylated alkyl alcohol. Suitable hydrotropes include sodium cumene sulphate, sodium toluene sulphate and sodium xylene sulphate.

Gel Detergents

[0291] While the following listing of ingredients is particularly suited for gel detergents, it is clearly within the scope of one having skill in the art to determine whether such ingredients may be useful for other detergent applications. Auto-dish washing formulations are most commonly used in gel form.

[0292] Bio-PDO is preferably provided in liquid laundry detergents at concentration ranges of about 0.1% to about 25%, more preferably about 0.5% to about 20% and most preferably about 1% to about 15%.

[0293] Preferably, the lamellar-phase gel laundry composition of the invention comprises from 1 to 8%, more preferably from 3 to 6%, by weight of a gelling agent.

[0294] Such a gelling agent may suitably be a fatty alcohol having the formula R.sub.1-(CHOH)-R.sub.2, wherein R.sub.1, R.sub.2 are independently selected from hydrogen and saturated or unsaturated, linear or branched, C.sub.1-C.sub.16 alkyl groups, whereby the total number of carbon atoms in the fatty alcohol is between 8 and 17.

[0295] Preferably a fatty alcohol gelling agent is used that has the above formula, wherein R.sub.1 is hydrogen and R.sub.2 is selected from saturated or unsaturated, linear or branched C.sub.9-C.sub.13 alkyl groups. Favorable results could generally be obtained when applying as gelling agent a fatty alcohol in which the total chain length is similar to the average chain length of the surfactants present in the formulation. Such a gelling agent is preferably selected from the group consisting of 1-decanol, 1-dodecanol, 2-decanol, 2-dodecanol, 2-methyl-1-decanol, 2-methyl-1-dodecanol, 2-ethyl-1-decanol, and mixtures thereof. Commercially available materials that are particularly suitable for use as gelling agent include Neodol 23 or Neodol 25 produced by Shell Chemical Co., Exxal 12 or Exxal 13 produced by Exxonmobil Chemical Co. and Isalchem 123 or Lialchem 123 produced by Sasol Chemical Co.

[0296] The gelling agent may also suitably be a non-neutralised fatty acid having the formula $R_3$—(COOH)—$R_4$, wherein $R_3$ and $R_4$ are independently selected from hydrogen and saturated or unsaturated, linear or branched $C_1$-$C_{22}$ alkyl groups, whereby the total number of carbon atoms in the fatty acid is between 10 and 23. Such a fatty acid gelling agent is preferably selected from oleic acid, lauric acid, myristic acid, palmitic acid, stearic acid, linoleic acid, linolenic acid and mixtures thereof.

[0297] Furthermore, the gelling agent may suitably be a naturally obtainable fatty acid selected from tallow, coconut, and pal kernel fatty acids.

Anionic Surfactant

[0298] The anionic surfactant that may be present in the gel composition of the invention is preferably selected from the group consisting of linear alkyl benzene sulphonates, alkyl sulphonates, alkylpolyether sulphates, alkyl sulphates and mixtures thereof.

Nonionic Surfactant

[0299] The surfactant system in the gel composition of the invention may also contain a nonionic surfactant.

[0300] Nonionic detergent surfactants are well-known in the art. They normally consist of a water-solubilizing polyalkoxylene or a mono- or d-alkanolamide group in chemical combination with an organic hydrophobic group derived, for example, from alkylphenols in which the alkyl group contains from about 6 to about 12 carbon atoms, dialkylphenols in which primary, secondary or tertiary aliphatic alcohols (or alkyl-capped derivatives thereof), preferably having from 8 to 20 carbon atoms, monocarboxylic acids having from 10 to about 24 carbon atoms in the alkyl group and polyoxypropylene. Also common are fatty acid mono- and dialkanolamides in which the alkyl group of the fatty acidradical contains from 10 to about 20 carbon atoms and the alkyloyl group having from 1 to 3 carbon atoms. In any of the mono- and di-alkanolamide derivatives, optionally, there may be a polyoxyalkylene moiety joining the latter groups and the hydrophobic part of the molecule.

Builders

[0301] Builders in this embodiment that may be used according to the present invention include conventional alkaline detergent builders, inorganic or organic, which can be used at levels of from 0% to 50% by weight of the gel composition, preferably from 1% to 35% by weight.

[0302] Examples of suitable inorganic detergency builders that may be used are water soluble alkali metal phosphates, polyphosphates, borates, silicates, and also carbonates and bicarbonates. Specific examples of such builders are sodium and potassium triphosphates, pyrophosphates, orthophosphates, hexametaphosphates, tetraborates, silicates, and carbonates.

[0303] Examples of suitable organic detergency builders are: (1) water-soluble amino polycarboxylates, e.g. sodium and potassium ethylenediaminetetraacetates, nitrilotriacetates and N-(2 hydroxyethyl)-nitrilodiacetates; (2) water-soluble salts of phytic acid, e.g. sodium and potassium phytates; (3) water-soluble polyphosphonates, including specifically sodium and potassium salts of ethane-1-hydroxy-1,1-diphosphonic acid; sodium and potassium salts of methylene diphosphonic acid; sodium and potassium salts of ethylene diphosphonic acid; and sodium and potassium salts of ethane-1,1,2-triphosphonic acid.

[0304] In addition, polycarboxylate builders can be used satisfactorily, including water-soluble salts of mellitic acid, citric acid, and carboxymethyloxysuccinic acid, salts of polymers of itaconic acid and maleic acid, tartrate monosuccinate, and tartrate disuccinate.

[0305] Desirably, the detergency builder is selected from the group consisting of carboxylates, polycarboxylates, aminocarboxylates, carbonates, bicarbonates, phosphates, phosphonates, silicates, borates and mixtures thereof.

[0306] Alkalimetal (i.e. sodium or potassium) citrate is most preferred builder material for use in the invention.

[0307] Amorphous and crystalline zeolites or aluminosilicates can also be suitably used as detergency builder in the gel composition of the invention.

Enzymes

[0308] Suitable enzymes for use in the present embodiment of the invention include proteases, amylases, lipases, cellulases, peroxidases, and mixtures thereof, of any suitable origin, such as vegetable, animal bacterial, fungal and yeast origin. Preferred selections are influenced by factors such as pH-activity, thermostability, and stability to active bleach detergents, builders and the like. In this respect bacterial and fungal enzymes are preferred such as bacterial proteases and fungal cellulases.

[0309] Enzymes are normally incorporated into detergent composition at levels sufficient to provide a "cleaning-effective amount". The term "cleaning effective amount" refers to any amount capable of producing a cleaning, stain removal, soil removal, whitening, or freshness improving effect on the treated substrate. In practical terms for normal commercial operations, typical amounts are up to about 5 mg by weight, more typically 0.01 mg to 3 mg, of active enzyme per gram of detergent composition. Stated otherwise, the composition of the invention may typically comprise from 0.001 to 5%, preferably from 0.01 to 1% by weight of a commercial enzyme preparation.

[0310] Protease enzymes are usually present in such commercial preparations at levels sufficient to provide from 0.005 to 0.1 Anson units (AU) of activity per gram of composition. Higher active levels may be desirable in highly concentrated detergent formulations.

[0311] Suitable examples of proteases are the subtilisins that are obtained from particular strains of *B. subtilis* and *B. licheniformis*. One suitable protease is obtained from a strain of *Bacillis*, having maximum activity throughout the pH-range of 8-12, developed and sold as ESPERASE®™ by Novozymes of Industries A/S of Denmark.

[0312] Other suitable proteases include ALCALASE®., EVERLASE®., LIQUANASE®., and SAVINASE®., and POLARZYME®. from Novozymes, from PURAFECT®., and PROPERASE®., from Genencor International and MAXATASE®. from International Bio-Synthetics, Inc., The Netherlands.

[0313] Suitable lipase enzymes for use in the composition of the invention include those produced by microorganisms of the *Pseudomonas* group, such as *Pseudomonas stutzeri* ATCC 19.154, as disclosed in GB-1,372,034. A very suitable lipase enzyme is the lipase derived from *humicola lanuginosa* and available from Novozymes, Denmark Nordisk under the tradename LIPOLASE®. Other suitable lipase enzames are LIPEX®. from Novozymes.

[0314] Suitable cellulose enzymes for use in the composition of the invention include those produced by microorganism of the *Aspergillus* sp. Suitable cellulose enzymes are available under tradename CAREZYME®., CELLUZYME®., from Novozymes, PURADAX®., AND PRIMAFAST®LUNA from Genencor International.

[0315] Alpha-amylase enzymes can be produced by microorganism of *Bacillus* sp. and are available under the tradename as TERMAMYL®., STAINZYME®., DURAMYL®., from Novozymes, Denmark. Alpha-amylase enzyme is available as PURASTAR®. from Genencor International.

[0316] Mannanase enzymes are available under tradename MANNAWAY®., from Novozymes, Denmark and PURABRITE® from Genencor International.

[0317] Mixtures or blends of enzymes for use in the compositions of the invention are available under tradename as T-BLEND EVERLASE/DURAMYL/LIPEX®., T-BLEND SAVINASE/CAREZYME®., T-BLEND SAVINASE/LIPEX®., T-BLEND SAVINASE/LIPOLASE®., T-BLEND SAVINASE/STAINZYME®., T-BLEND SAVINASE/TERMAMYL®., T-BLEND SAVINASE/TERMAMYL/CELLUZYME®., from Novozymes, Denmark.

Other Optional Components

[0318] In addition to the anionic and nonionic surfactants described above, the surfactant system of the invention may optionally contain a cationic surfactant.

[0319] Furthermore, alkaline buffers may be added to the compositions of the invention, including monethanolamine, triethanolamine, borax, and the like.

[0320] As another optional ingredient, an organic solvent may suitably be present in the gel composition of the invention, preferably at a concentration of up to 10% by weight.

[0321] There may also be included in the formulation, minor amounts of soil suspending or anti-redeposition agents, e.g. polyvinyl alcohol, fatty amides, sodium carboxymethyl cellulose or hydroxy-propyl methyl cellulose.

[0322] Optical brighteners for cotton, polyamide and polyester fabrics, and anti-foam agents such as silicone oils and silicone oil emulsions may also be used.

[0323] Other optional ingredients which may be added in minor amounts, are soil release polymers, dye transfer inhibitors, polymeric dispersing agents, suds suppressors, dyes, perfumes, colourants, filler salts, antifading agents and mixtures thereof.

Liquid Hand Dishwashing Detergents

[0324] While the following listing of ingredients is particularly suited for liquid hand dishwashing detergents, it is clearly within the scope of one having skill in the art to determine whether such ingredients may be useful for other detergent applications.

[0325] The concentration of the polyethylene glycol in the instant composition is 0.5 to 10 wt. %, more preferably 0.75 wt. % to 6 wt. %.

Anionic Surfactants

[0326] Anionic sulfonate surfactants suitable for use herein include the salts of C.sub.5-C.sub.20 linear alkylbenzene sulfonates, alkyl ester sulfonates, C.sub.6-C.sub.22 primary or secondary alkane sulfonates, C.sub.6-C.sub.24 olefin sulfonates, sulfonated polycarboxylic acids, alkyl glycerol sulfonates, fatty acyl glycerol sulfonates, fatty oleyl glycerol sulfonates, and any mixtures thereof.

[0327] Anionic sulfate surfactants suitable for use in the compositions of the invention include linear and branched primary and secondary alkyl sulfates, alkyl ethoxysulfates, fatty oleoyl glycerol sulfates, and alkyl phenol ethylene oxide ether sulfates.

[0328] Suitable anionic carboxylate surfactants include alkyl ethoxy carboxylates, alkyl polyethoxy polycarboxylate surfactants and soaps ("alkyl carboxyls").

[0329] An example of a preferred anionic surfactant (sulfonates & sulfates) would be the sodium salt of secondary alkane sulfonate commercially available under the tradename of Hostapur™ SAS (Clariant Corporation, Charlotte, N.C.).

[0330] Sulfonates: linear alkylbenzene sulfonate (LAS), alpha-olefin sulfonate (AOS), paraffin sulfonate (PS).

[0331] Sulfates: sodium lauryl sulfate (SLS), sodium lauryl ethoxy sulfate (SLES).

Water

[0332] The final ingredient in the inventive compositions is water. The proportion of water in the compositions generally is in the range of 35% to 85%, preferably 50% to 80% by weight of the usual composition.

Amine Oxide

[0333] Amine oxides useful in the present invention include long-chain alkyl amine oxides, ie., those compounds having the formula:

$$R^3(OR^4)—(NO)—(R^5)_2$$

[0334] wherein $R^3$ is selected from an alkyl, hydroxyalkyl, acylamidopropyl and alkyl phenyl group, or mixtures thereof, containing from 8 to 26 carbon atoms, preferably 8 to 16 carbon atoms; $R^4$ is an alkylene or hydroxyalkylene group containing from 2 to 3 carbon atoms, preferably 2 carbon atoms, or mixtures thereof; x is from 0 to 3, preferably 0; and each $R^5$ is an alkyl or hydroxyalkyl group containing from 1 to 3, preferably from 1 to 2 carbon atoms, or a polyethylene oxide group containing from 1 to 3, preferably 1, ethylene oxide groups. The $R^5$ groups can be attached to each other, e.g., through an oxygen or nitrogen atom, to form a ring structure.

[0335] These amine oxide surfactants in particular include $C_{10}$-$C_{18}$ alkyl dimethyl amine oxides and $C_8$-$C_{12}$ alkoxy ethyl dihydroxyethyl amine oxides and alkyl amido propyl amine oxide. Examples of such materials include dimethyloctylamine oxide, diethyldecylamine oxide, bis-(2-hydroxyethyl)dodecylamine oxide, dimethyldodecylamine oxide, dodecylamidopropyl dimethylamine oxide and dimethyl-2-hydroxyoctadecylamine oxide. Preferred are $C_{10}$-$C_{18}$ alkyl dimethylamine oxide, and $C_{10}$-$C_{18}$ acylamido alkyl dimethylamine oxide.

Betaine

[0336] The betaines useful in the present invention are those compounds having the formula $R(R^1)_2N^+R^2COO^-$ wherein R is a $C_6$-$C_{18}$ hydrocarbyl group, preferably $C_{10}$-$C_{16}$ alkyl group, each $R^1$ is typically $C_1$-$C_3$, alkyl, preferably methyl, and $R^2$ is a $C_1$-$C_5$ hydrocarbyl group, preferably a $C_1$-$C_8$ alkylene group, more preferably a $C_1$-$C_2$ alkylene group. Examples of suitable betaines include coconut acylamidopropyldimethyl betaine; hexadecyl dimethyl betaine; $C_{12}$-$C_{14}$ acylamidopropylbetaine; $C_{12}$-$C_{18}$ acylamidohexyldiethyl betaine; 4-[$C_{14}$-$C_{16}$ acylmethylamidodiethylammonio]-1-carboxybutane; $C_{16}$-$C_{18}$ acylamidodimethylbetaine; $C_{12}$-$C_{16}$ acylamidopentanediethyl-betai-ne; $C_{12}$-$C_{16}$ acylmethyl-amidodimethylbetaine, and coco amidopropyl betaine. Preferred betaines are $C_{12}$-$C_{18}$ dimethylamoniohexanoate and the $C_{10}$-$C_{18}$ acylamidopropane (or ethane) dimethyl (or diethyl) betaines. Also included are sulfobetaines (sultaines) of formula $R(R_1)_2N+R_2$ $SO_3$—, wherein R is a $C_6$-$C_{18}$ Hydrocarbyl group, preferably a $C_{10}$-$C_{16}$ alkyl group, more preferably a $C_{12}$-$C_{13}$ alkyl group; each $R_1$ is typically $C_1$-$C_3$ alkyl, preferably methyl and $R_2$ is a $C_1$-$C_6$ hydrocarbyl group, preferably a $C_1$-$C_3$ alkylene or, preferably, hydroxyalkylene group. Examples of suitable sultaines are $C_{12}$-$C_{14}$ dihydroxyethylammonio propane sulfonate, and $C_{16}$-$C_{18}$ dimethylammonio hexane sulfonate, with $C_{12}$-$C_{14}$ amido propyl ammonio-2-hydroxypropyl sultaine being preferred.

Alkanolamide Compounds

[0337] The present formulation can include an alkanolamide compound such as an alkyl monoalkanol amide, an alkyl dialkanol amide, and mixtures thereof.

[0338] The formulation of the present invention can include a hydrotrope selected from the group consisting of ethanol, isopropanol, sodium xylene sulfonate, propylene glycol, sodium cumene sulfonate, urea, polyethylene glycol and mixtures thereof.

Solvents

[0339] The formulation of the present invention can include a solvent selected from the group consisting of alcohols (ethanol, isopropanol) glycols (propylene glycol, polyethylene glycol) polyols and polyethers (dipropylene glycol, dipropylene glycol methyl ether) and mixtures thereof. A variety of other water-miscible liquids such as lower alkanols, diols, other polyols, ethers, amines, and the like may be used in the present invention. Preferred are the C1-C4 alkanols. When present the composition will preferably contain at least about 0.01%, more preferably at least about 0.5%, even more preferably still, at least about 1% by weight of the composition of solvent. The composition will also preferably contain no more than about 20%, more preferably no more than about 10%, even more preferably, no more than about 8% by weight of the composition of solvent.

Inorganic Salt

[0340] The formulation of the present invention can include an inorganic or organic salt or oxide of a multivalent cation, particularly Mg.sup.++ which has phase stabilization properties. The multivalent cation salt or oxide provides several benefits including improved cleaning performance in dilute usage, particularly in soft water areas, and minimized amounts of perfume required to obtain the microemulsion state. Magnesium sulfate, either anhydrous or hydrated (e.g., heptahydrate), is preferred as the magnesium salt. Good results also have been reported with magnesium oxide, magnesium chloride, magnesium acetate, magnesium propionate and magnesium hydroxide. These magnesium salts can be used with formulations at neutral or acidic pH since magnesium hydroxide will not precipitate at these pH levels.

[0341] Although magnesium is a preferred multivalent cation from which the salts (inclusive of the oxide and hydroxide) are formed, other polyvalent metal ions also can be used provided that their salts are nontoxic and are soluble in the aqueous phase of the system at the desired pH level.

Other Components

[0342] The liquid cleaning composition of this invention may, if desired, also contain other optional components either to provide additional effect or to make the product more attractive to the consumer. The following are mentioned by way of example: Colorants or dyes in amounts up to 0.5% by weight; preservatives or antioxidizing agents, such as formalin, 5-bromo-5-nitro-dioxan-1,3; 5-chloro-2-methyl-4-isothaliazolin-3-one, 2,6-di-tert.butyl-p-cresol, etc., in amounts up to 2% by weight; and pH adjusting agents, such as sulfuric acid or sodium hydroxide, as needed. Furthermore, if opaque compositions are desired, up to 4% by weight of an opacifier may be added. Preferably, the optional ingredients are selected from the group consisting of hydrotropes, perfumes, colorants, pH adjusting agents, preservatives, biocidal agents, inorganic salts, opacifiers, viscosity modifiers, and mixtures thereof

Specialty Household Cleansers (SHC)

[0343] Specialty household cleaners of the invention comprise Bio-PDO and one or more of the typical detergent ingredients set forth in the above sections. Those having skill in the art can readily determine appropriate ingredients to combine with the Bio-PDO in order to obtain a desired specialty household cleaner.

Viscosity

[0344] Some detergent compositions containing Bio-PDO may require approximately 30% less salt to adjust the viscosity than other compositions containing comparable glycols such as propylene glycol, butylene glycol, 2-methyl-1,3 propanediol etc. In other compositions, Bio-PDO may help maintain and build viscosity.

Heat Transfer Compositions

[0345] The term "heat transfer fluid" as used herein refers to a fluid or liquid that is capable of transferring and/or dissipating a quantity of thermal energy from a first point to second point. Heat transfer fluids include coolants.

[0346] Heat transfer fluid as used herein may include both concentrated solutions of Bio-PDO mixtures as well as to diluted solutions of the same mixed with water, preferably deionized water. It will be appreciated that although heat transfer fluid may be purchased, transported or used in concentrated solutions, such concentrates will often be diluted with water, especially deionized water, prior to incorporation or use in, for example, a fuel cell. Exemplary heat transfer composition include, but are not limited to, heating medium for radiant heating systems and industrial heating applications, and Heating, Ventilation, and Air Conditioning applications, and thermal energy storage, heating and cooling. Heat transfer fluids can also be used in a variety of markets, including vehicles and equipment (as antifreeze), process manufacturing industries (e.g., chemicals, pharmaceuticals, plastics, fiber and food), energy production, asphalt, laundry, biotechnology, cryogenic preservation, metalworking, mining, ice rinks, refrigeration systems and heating systems, metalworking, transportation, mining and others such as ice rinks.

[0347] In heat transfer compositions, the glycol is typically the major component of the composition, present in a range of from about 1% to about 100%.

[0348] In antifreeze compositions, the glycol is typically the major component of the composition, present in a range of from about 1% to about 100%.

[0349] In the heat transfer and antifreeze compositions of the invention, the Bio-PDO can be the major component of the composition, present in amounts up to 100% by weight based on the weight of the total composition. The amount of Bio-PDO used in the products is generally the balance after adding the percentages of typical ingredients such as corrosion inhibitors, foam suppressants, dyes and water,

[0350] Those of ordinary skill in the art will now understand that, under appropriate circumstances, considering issues such as corrosion, toxicity, viscosity, fluid life, equipment specifications, fluid color, cost, etc., other elements, such as for example, one or more of a colorant, a wetting agent, an antifoam agent, a biocide, a bitterant, a nonionic dispersant, anti-foam agents, anti-icing additives, anti-wear additives, demulsifiers, detergents, dispersants, emulsifiers, EP additives, oiliness agents, oxidation inhibitors, pour point depressants, rust inhibitors, tackiness agents, viscosity improvers, preservatives, alcohols, or combinations thereof, and any other optional ingredients, may be added to the heat-transfer or antifreeze composition of the invention.

[0351] More particularly, in addition to the Bio-PDO or other biologically-derived glycol component, a typical heat transfer fluid formulation of the invention may include one or more of water from 1.0-95.0% by weight, corrosion inhibitors from 0.10% to 50.0%, foam suppressors from 0.10% to 50.0%, and/or dyes from 0.10% to 50.0%.

[0352] In a typical antifreeze fluid or coolant formulation of the invention, in addition to the Bio-PDO or other biologically-derived glycol component, such formulations may also include one or more of water from 1.0-90.0% by weight, corrosion inhibitors from 0.10% to 50.0%, foam suppressors from 0.10% to 50.0%, and dyes from 0.10% to 50.0%.

Ingredients

[0353] Set forth below is a non-limiting listing of ingredients that may be used in combination with Bio-PDO in heat transfer and antifreeze formulations of the present invention. This listing is not intended to be all-inclusive, and those having skill in the art are familiar with other known ingredients that may apply to formulations of the invention.

Corrosion Inhibitors

[0354] Useful corrosion inhibitors can be used in an amount sufficient to inhibit or reduce corrosion of exposed metal surfaces in contact with the engine cooling composition of the present invention, preferably in an amount of from 0.01 to 50% by weight. Preferable corrosion inhibitors include any conventionally or commercially used corrosion inhibitor, including, but not limited to, inorganic nitrates and nitrates, preferably selected from the Na, K, Mg, Ca, and Li salts; azoles selected from tolyltriazole, hydrocarbyl triazole, benzotriazole, mercaptobenzothiazole, pyrazoles, isooxazoles, isothiazoles, thiazoles, thiadiazole salts, 1,2,3-benzotriazole, 1,2,3-tolyltriazole, and Na 2-mercaptobenzothiazole; inorganic molybdates such as Na molybdate, K molybdate, Li molybdate, ammonium molybdate, ammonium dimolybdate, MoO3, heteropolymolybdates, disodium molybdate dihydrate, silicoheteropolymolybdates, and

phosphoheteropolymolybdates; monocarboxylic acids, typically C3-16-carboxylic (or fatty) acids (or the corresponding alkali metal salts), esp. hexanoic, heptanoic, isoheptanoic, octanoic, 2-ethylhexanoic, nonanoic, decanoic, undecanoic, dodecanoic, and neodecanoic acids; inorganic phosphates include K2HPO4, Na2HPO4, KH2PO4, K3PO4, NaH2PO4, and Na3PO4 and mixtures thereof, for example. More preferably the corrosion inhibitor is one of the PENRAY corrosion inhibitors available from The Penray Companies, such as PENRAY 2792 (an aqueous solution of nitrites, nitrates and sodium hydroxide).

Defoamers

[0355] Defoamers are used in an amount sufficient to reduce buildup of foam or reduce foam or trapped air by causing the bubbles to burst, thus releasing the trapped air. Preferably a defoamer is used in an amount of from 0.01 to 50% by weight. One or more than one defoamer may be present. Preferable defoamers include, but are not limited to, PATCOTE 415 or 462 (an ethylene glycol n-butyl ether based defoamer made by American Ingredients Company), PLURONIC L61 (a block copolymer manufactured by BASF Corp.), DOW AF9020 (a silicone emulsion produced by Dow Chemical), ADVANTAGE 831 (a hydrocarbon oil emulsion produced by Hercules, Inc.), POLYTERGENT P32A (an EO/PO copolymer made by Olin Corp.), LANDA 5600 (oil soluble, water miscible defoamer produced by Landa Corp.) and AF-20F (a silicone oil emulsion produced by Performance Chemicals LLC), for example.

Water

[0356] The water contained in the composition can be any desired amount, preferably from 1 to 99% by weight. More preferably, the amount of water is in the range from 30 to 70% by weight, most preferably from 40 to 60% by weight. The water is preferably distilled and/or deionized. Preferably, the water is deionized before contacting with the other components of the composition.

Colorant/Dye

[0357] The present invention composition can contain a colorant/dye in order to help a user readily distinguish the composition from colorless liquids, particularly from water. Suitable colorants can be any conventional colorant, and can be any desired color, including but not limited to orange, blue, green, red and yellow, and any combination thereof. If present, the dye can be used in any amount to provide the color desired, preferably from 0.01 to 50% by weight. One or more than one dye may be present. More preferably, any light stable, transparent water soluble organic dye is suitable, including but not limited to, Acid Red dyes, methylene blue, uranine dye, wool yellow dye and rhodamine dye, with dyes such as 15189 EOSINE O (an Acid Red 87 based dye commercially available from Chemcentral Dyes and Pigments) being particularly preferred.

Fluorosurfactant

[0358] The composition of the present invention further comprises at least one fluorosurfactant in an amount of 0.001 to 50% by weight. The fluorosurfactant desirably causes a reduction in contact angle (e.g., droplet height) compared to an untreated water/glycol mixture, modifies the surface properties of liquids or solids, or reduces surface tension in a fluid or the interfacial tension between two immiscible fluids, for example oil and water. The measurement of contact angle and/or surface tension is known in the art. The terms, fluorosurfactant and fluorinated surfactant are used interchangeably herein. Preferably, the fluorosurfactant is soluble in water. Preferable fluorosurfactants include, but are not limited to, the ZONYL fluorosurfactants (anionic, non-ionic and amphoteric fluorinated surfactants) including, but not limited to, ZONYL FSA, FSE, FSJ, FSP, TBS, FSO, FSH, FSN, FSD and FSK, more preferably the non-ionic ZONYL fluorosurfactants, most preferably ZONYL FSH, FSN or FSP (typically mixtures of a fluoroalkyl alcohol substituted polyethylene glycol with water and a glycol or glycol ether such as dipropylene glycol methyl ether) (all commercially available from DuPont). The fluorosurfactant can be used alone, or can be combined with other fluorosurfactants or non-fluorine containing surfactants as desired.

Esters

[0359] Esters can function as many of the above noted ingredients. While those in those having skill in the art can readily determine which esters are most appropriate to provide a particularly desired function, applications specifically note that esters used in this invention may include the esters produced, including all the appropriate conjugate mono and diesters, from biologically-derived 1,3 propanediol using organic carboxylic acids. Some esters in particular that are produced include propanediol distearate and monostearate, propandiol dilaurate and monolaurate, propanediol dioleate and monooleate, propanediol divalerate and monovalerate, propanediol dicaprylate and monocaprylate, propanediol dimyristate and monomyristate, propanediol dipalmitate and monopalmitate, propanediol dibehenate and monobehenate, propanediol adipate, propanediol maleate, propanediol dioxalate, propanediol dibenzoate, propanediol diacetate, and all mixtures thereof.

Additional Ingredients

[0360] The present composition may optionally include one or more other additives. These include, but are not limited to, for example, alkali metal borates as corrosion-inhibitors such as disclosed in U.S. Pat. Nos. 4,149,985, 2,566,923, 3,960,740, 2,373,570, and 2,815,328; alkali metal sebacates as corrosion inhibitors such as disclosed in U.S. Pat. No. 2,726,215, U.K. Patent 1,004,259, U.S. Pat. Nos. 4,382,008, 4,561,990, 4,587,028, and 4,588,513; alkali metal molybdates as corrosion-inhibitors such as disclosed in U.S. Pat. Nos. 2,147,409 and 4,561,990; alkali metal mercaptobenzothiazole such as disclosed in U.S. Pat. Nos. 2,815,328, 4,455,248, 4,414,126, and 4,545,925; alkali metal nitrates as corrosion-inhibitors such as disclosed in U.S. Pat. Nos. 2,815,328, 4,508,684, 4,455,248, and 4,587,028; tolyltriazole such as disclosed in U.S. Pat. Nos. 4,242,214, 2,587,028, 4,382,008, and U.K. Patent 1,004,259; alkali metal silicates such as disclosed in U.S. Pat. Nos. 2,815,328, 4,242,214, 4,382,008, 4,382,870, 4,455,248, and 4,149,985, the relevant portions of each of which are hereby incorporated by reference.

Natural Ingredients

[0361] The heat transfer or antifreeze compositions of the invention can contain any natural ingredients where appropriate. Natural ingredients include any natural or nature-derived ingredients similar in composition or in function to any of the ingredients listed above.

Deicing Compositions

[0362] The deicing/anti-icing compositions can be used in any application requiring deicing and/or anti-icing. In some embodiments, the compositions are used for the removal of, and/or time-limited protection against, deposits of frost, ice, and/or snow on exterior aircraft surfaces prior to take off, or on roadway/runway surfaces. The compositions can be applied through a commercial deicing/anti-icing vehicle system to the surfaces at pressures and flow rates normal for intended use.

[0363] In addition to application to aircraft, the compositions can also be used for other anti-icing/deicing applications, such as, surfaces of, for example, airport pavements, roadways, walkways, sidewalks, bridges, entrances, electrical tower structures and their components, electricity transmission lines, canals, locks, vessels, nautical components, railroad switches, and motor vehicles. In addition, the compositions can be used in applications such as birdbaths, outdoor fountains, decorative ponds, and other outdoor areas where water freezing would be aesthetically or functionally unacceptable. In these applications the fluids can prevent water from freezing during the winter in cold climates with reduced biological risk to wildlife or domestic animals.

[0364] It is also envisioned that the compositions of the present invention can be used in either a liquid or a solid format. For instance, the compound can be prepared as a liquid and sprayed on or spread on surfaces. Alternatively, it can be prepared in a solid form and employed as a powder. Optionally, the solid may be further processed using methods well known in the art, such as, for example, pelletizing, prilling, flaking, or macerating to provide the formulation in a final useable powdered or granular form. Any of the binders known to those skilled in the art optionally may be present and may either be inert or may be comprised of components that actively help lower the freezing point. For example, cinders, sawdust, sand, gravel, sugars, maltodextrins and mixtures thereof and the like can be used.

[0365] In the methods of the present invention, the deicing and/or anti-icing compositions of the present invention are applied, such as by spraying or injecting for liquid forms.

[0366] In the anti-icing or deicing compositions of the invention, the Bio-PDO or other bio-derived glycol component can be the major component of the composition, present in amounts up to 100% by weight based on the weight of the total composition. The amount of Bio-PDO used in the products is generally the balance after adding one or more of surfactant, corrosion inhibitors, water, and any optional ingredients. Deicing/anti-icing fluids preferably contain from about 10% to about 95% Bio-PDO by weight, and more preferably from about 25% to about 92%. A typical formulation for aircraft deicing/anti-icing may include, but is not limited to, the following components: 25-95% by weight of Bio-PDO or mixture thereof; and up to 1% each of the following components: at least one surfactant or surfactant blend, at least one corrosion inhibitor, a pH control agent, a thickening agent, and a dye. Water can make up the balance of this formulation. Further details on alternative formulations and ingredients is provided below.

[0367] In certain embodiments, such as those containing glycerol in combination with Bio-PDO, the compositions of the invention preferably contain from about 10% to about 88% glycerol and as such, from as little as about 1% to about 30% Bio-PDO.

Functional and Other Ingredients

[0368] The deicing/anti-icing products of the invention can include one or more functional and other ingredients. Functional and other ingredients useful herein may be categorized or described herein by their benefit or their postulated mode of action in the deicing or anti-icing composition. However, it is to be understood that the functional and other ingredients useful herein can in some instances provide more than one benefit or operate via more than one mode of action. Therefore, classifications herein are made for the sake of convenience and are not intended to limit an ingredient to the particularly stated application or applications listed.

Surfactants

[0369] A preferred surfactant is a nonionic surfactant; anionic, cationic, and amphoteric (zwitterionic) surfactants are less preferred. Some nonlimiting examples of suitable nonionic surfactants are: alkylphenol ethoxylates ($C_{12}$ or lower, $C_8$ or lower preferred); fatty or oxo-alcohol polyethyleneglycol ethers ($C_{16}$ or lower, $C_6$ or lower preferred); ethylene oxide-propylene oxide polymers ($C_{80}$ or lower, $C_2$ or lower preferred); fatty alcohol polyglycol ethers ($C_{18}$ or lower, $C_8$ or lower preferred); polyethoxylates such as polyoxyethylene ethers; polypropyloxylates such as polyoxypropylene ethers; sugar-based surfactants such as alkyl glycosides (e.g., alkyl benzene and tert-butoxyethanol); ethers of $C_1$ to $C_8$ polyethylene oxide repeat units of 2 to 50 polyethylene oxide units (low carbon alkyl group and somewhat higher carbon ethoxylate group preferred); polyvinyl alcohols having MW 1000-10,000; and polyvinyl pyrrolidones.

[0370] The nonionic surfactants can be selected from polyoxyalkylene ethers. Some preferred polyoxyalkylene ethers are ethers of $C_{12}$ to $C_{18}$ alcohols with polyethylene oxide repeat units of 2 to 100 polyethylene oxide units. Such surfactants include, for example, the Brij™ series of surfactants manufactured by ICI (e.g., Brij 30, 35, 52, 56, 58, 72, 76, 78, 92, 97, 98 and 700). Brij 35 is polyoxyethylene lauryl ether, 718 average MW, having the chemical formula: $CH_3(CH_2)_{11}(CH_2CH_2O)_{xH}$, where x on average is 23.

[0371] The fluids can contain any suitable amount of surfactant. Preferably, the fluids contain from about 0.01% to about 0.9% surfactant by weight, and more preferably from about 0.05% to about 0.5%.

pH Control Agent

[0372] The deicing/anti-icing compositions of the invention can optionally include one or more pH control agents to maintain the fluid at constant pH. The compositions can have any suitable pH. The pH of the compositions can range anywhere from about 3.5 to about 12, and preferably from about 6 to about 9. The desired pH can be obtained using inorganic bases such as sodium hydroxide, ammonium hydroxide and potassium hydroxide, or amines such as triethanol amine, diethanol amine or monoethanol amine.

[0373] Some nonlimiting examples of suitable buffers include: phosphate salts ($K^+$, $NH_4^+$); pyrophosphates ($Na^+$, $K^+$, $NH_4^+$); metaphosphates ($Na^+$, $K^+$, $NH_4^+$); carbonic acid and its salts ($Na^+$, $K^+$, $NH_4^+$); hydroxylammonium ($Na^+$, $K^+$, $NH_4^+$); adidic acid and its salts ($Na^+$, $K^+$, $NH_4^+$); maleic acid and its salts ($Na^+$, $K^+$, $NH_4^+$); and ascorbic acid and its salts ($Na^+$, $K^+$, $NH_4^+$).

Defoamers

[0374] Defoamers may also be employed. Any commercially available defoamer or antifoamer can be used, but particularly preferred defoamers are a silicone defoamer of Union Carbide Corporation sold under the trademark SAG, and FOAMBAN™ defoamer available from Ultra Additives Inc., Patterson, N.J. The amount of defoamer to be used is preferably in the range of from about 0.05% to about 0.5% by weight based on the weight of the total composition.

Corrosion Inhibitors

[0375] Suitable corrosion inhibitors are known to the art, and typically comprise mixtures of various functional materials, e.g., buffers, chelating agents, and the like, esters of inorganic acids such as the phosphorus and boron, aromatic triazoles such as tolyl- and benzyltriazole, and the like, in one or more solvents. A preferred anticorrosion mixture is that product sold by Sandoz under the designation "Sandocorin 8132". Those having skill in the art understand that selection of appropriate corrosion inhibitor may be made based upon the type of surfaces which the present compositions are likely to come in contact with, and how long and under what conditions they are likely to remain on that surface.

[0376] Suitable corrosion inhibitors include those belonging to the group comprising inorganic metal salts, alkali metal salts of fatty acids, monoalkyl amines and dialkyl amines optionally alkoxylated—and salts thereof, alkanol amines—optionally alkoxylated and salts thereof, esters of phosphorus acid or of phosphoric acid, and triazoles. The amount of corrosion inhibitor to be used is preferably in the range of from about 0.05% to about 0.8% by weight based on the weight of the total composition.

Thickening Agents

[0377] Thickening agents can be used in the compositions of the invention, and often comprise polymeric water-activated thickening agents. Thickening agents will typically comprise between 0.1 and 15.0 weight percent of the total composition. Examples include polysaccharide thickeners, natural gum thickeners, marine algae colloids, and cellulose ether thickeners. A preferred thickener is a polysaccharide known generically as Xanthan Gum.

Oils

[0378] The composition can optionally contain at least one non-polar oil, such as aliphatic and aromatic oils such as mineral oil, paraffin oil, silicone oil, and propylene oxide/ethylene oxide copolymers. The amount of such oils is frequently in the range of from about 0.01% to about 5% by weight based on the total weight of the composition. The preferred range is between 0.1% to 1.0% by weight based on the total weight of the composition.

Thermal Stabilizing Agents

[0379] The deicing/anti-icing products can further include a material that improves the thermal stability of the material. Any suitable material having these properties can be used, for example certain of the phosphate salts. A particular example is a mixture of mono-basic sodium phosphate and di-basic sodium phosphate, such as the monohydrate mono-basic and heptahydrate di-basic sodium phosphates.

[0380] The products can contain any suitable amount of the buffer/freezing point depressant. The fluids preferably contain from about 0.02% to about 2% mono-basic sodium phosphate and from about 0.02% to about 2% di-basic sodium phosphate by weight, more preferably from about 0.3% to about 1.5% mono-basic sodium phosphate and from about 0.3% to about 1.5% di-basic sodium phosphate.

Anti-Microbial Agents

[0381] The deicing/anti-icing products can optionally include one or more anti-microbial agents. Some nonlimiting examples of suitable anti-microbial agents include: sodium azide; quaternary ammonium compounds (e.g., 2-methyl-4,5-trimethylene-4-isothizoline-3-one; n-alkyl dimethyl benzyl ammonium $X^-$[where alkyl carbon number is $C_{12-18}$]; n-alkyl trimethyl ammonium $X^-$[where alkyl carbon number is $C_{12-18}$]; dialkyl dimethyl ammonium $X^-$[where alkyl carbon number is $C_{12-18}$]; octyl decyl dimethyl ammonium $X^-$[where $X^-$ is $Cl^-$, $Br^-$, $I_3^-$, $HCO_3^-$, $CO_3^{2-}$, phosphates, phosphonates, OH, carboxylates, polycarboxylates]); $M^+$ benzoates (where $M^+$ is $Na^+$, $K^+$, $NH_4^+$; alkyl dimethyl benzyl ammonium chlorides; and alkyl dimethyl benzyl/ethyl benzyl ammonium chlorides.

Fire Retardants

[0382] The deicing/anti-icing products can also optionally include one or more flame and/or corrosion inhibitors. Some common additives used for both fire and corrosion inhibition include sodium tolyltriazole and 1H-benzotriazole, methyl.

Vinylpyrrolidone

[0383] In another embodiment of the invention, the deicing/anti-icing fluids include a biobased freezing point depressant as described above, in combination with a vinylpyrrolidone polymer having a molecular weight between about 10,000 and about 700,000, and water. By "vinylpyrrolidone polymer" is meant a homopolymer or a copolymer of vinylpyrrolidone, or a derivative thereof. Suitable derivatives of vinylpyrrolidine polymer may include alkylated polyvinylpyrrolidones, 2-menthyl. Preferably, the vinylpyrrolidone polymer is polyvinylpyrrolidone.

[0384] The vinylpyrrolidone polymer preferably has a molecular weight between about 10,000 and about 700,000, and preferably not greater than about 360,000. It is believed that higher molecular weight vinylpyrrolidone polymers may produce deicing/anti-icing fluids having less desirable properties, particularly for aircraft and runway deicing.

[0385] The deicing/anti-icing products can contain any suitable amount of the vinylpyrrolidone polymer. Typically, the products contain about 5% or less vinylpyrrolidone polymer, and usually between about 0.1% and about 3%.

[0386] Advantageously, the vinylpyrrolidone polymer often functions as both a thickener and a surfactant in the fluid. Consequently, products having desirable properties can be produced using a minimal number of ingredients. However, optionally the products can also contain other ingredients such as an antioxidant and/or a second surfactant.

Aqueous Solvents

[0387] The deicing/anti-icing products can also include an aqueous solvent (i.e. water) in any suitable amount, usually in an amount of from about 30% to about 70% by weight.

It should be noted that the percentages of ingredients given herein are based on a ready-to-use products. The products of the invention can also be provided in a concentrate formulation, in which case the percentage of aqueous solvent will decrease (e.g., the concentrate may contain from about 5% to about 20% water) and the percentages of other materials will increase accordingly.

Colorants or Dyes

[0388] The deicing/anti-icing products can also include an colorants or dyes in any suitable amount, usually in an amount up to 0.25% by volume of the formulation.

Esters

[0389] Esters can function as many of the above noted ingredients. While those in those having skill in the art can readily determine which esters are most appropriate to provide a particularly desired function, applications specifically note that esters used in this invention may include the esters produced, including all the appropriate conjugate mono and diesters, from biologically-derived 1,3 propanediol using organic carboxylic acids. Some esters in particular that are produced include propanediol distearate and monostearate, propandiol dilaurate and monolaurate, propanediol dioleate and monooleate, propanediol divalerate and monovalerate, propanediol dicaprylate and monocaprylate, propanediol dimyristate and monomyristate, propanediol dipalmitate and monopalmitate, propanediol dibehenate and monobehenate, propanediol adipate, propanediol maleate, propanediol dioxalate, propanediol dibenzoate, propanediol diacetate, and all mixtures thereof.

Miscellaneous Additives

[0390] The composition may also contain various other functional ingredients such as UV inhibitors, odor-modification agents, stabilizers and the like. Each of these components will typically comprise less than 1.0 weight percent of the total composition.

[0391] In specific applications, certain embodiments of the present invention are especially preferred due to certain regulatory or industry guidelines. For example, in the deicing and/or anti-icing of aircraft, it is preferred to use deicing and/or anti-icing fluids of Bio-PDO, water; a mixture of Bio-PDO and other bio-derived glycols and water, or a mixture of Bio-PDO, petrochemically derived glycols, and water. agents of methyl glucoside; a mixture of sorbitol and Bio-PDO; or a mixture of methyl glucoside, sorbitol and Bio-PDO with sodium lactate and/or potassium lactate.

[0392] For the deicing and/or anti-icing of runways, it may be preferable to use deicing and/or anti-icing agents of sodium lactate; potassium lactate; a mixture of sodium lactate and potassium lactate; a hydroxyl-containing organic compound in combination with sodium lactate, potassium lactate and/or potassium acetate as well as Bio-PDO; a mixture of sodium lactate and/or potassium lactate with potassium acetate; or potassium carbonate and Bio-PDO.

[0393] For de-icing and/or anti-icing of pre-harvest fruits and vegetables, such as fruit trees or grape vines, it may be preferable to use de-icing and/or anti-icing agents of a hydroxyl-containing organic compound in combination with Bio-PDO and an organic acid salt, particularly a lactate salt.\

[0394] The deicing and anti-icing compositions of the invention can contain any natural ingredients where appropriate. Natural ingredients include any natural or nature-derived ingredients similar in composition or in function to any of the ingredients listed above.

Food Compositions

[0395] The food compositions of the invention include a food or food component consisting of one or more food ingredients. Further, a food composition includes human food, substances migrating to food from food-contact articles, beverages, pet food, and animal feed compositions.

[0396] A "food ingredient" includes any ingredient that can be used in a food composition. It is preferred that an ingredient be of appropriate food grade; that it be prepared and handled as a food ingredient; and that the quantity of the ingredient added to food does not exceed the amount reasonably required to accomplish the intended physical, nutritional, or other technical effect in food.

[0397] Food compositions of the invention can comprise from 0.1% to 100% Bio-PDO by weight, and more preferably from about 2% to about 97% Bio-PDO by weight. A typical food composition formulation of the present invention could include 2% to 97% Bio-PDO and 3% to 98% of one or more ingredients.

[0398] In the food compositions of the invention, the Bio-PDO can be an anticaking agent, free-flow agent, antioxidant, dough strengthener, emulsifier, emulsifier salt, flavoring agent, flavoring adjuvant, formulation aid, humectant, processing aid, solvent, vehicle, stabilizer, thickener, surface-active agent, and/or texturizer.

[0399] As they relate to the function of the Bio-PDO in the food compositions of the invention, the following definitions are applicable.

[0400] "Anticaking agents and free-flow agents" are generally defined as substances added to finely powdered or crystalline food products to prevent caking, lumping, or agglomeration.

[0401] "Antioxidants" are generally defined as substances used to preserve food by retarding deterioration, rancidity, or discoloration due to oxidation.

[0402] "Dough strengtheners" are generally defined as substances used to modify starch and gluten, thereby producing a more stable dough, including the applicable effects listed by the National Academy of Sciences/National Research Council under "dough conditioner."

[0403] "Emulsifiers and emulsifier salts" are generally defined as substances which modify surface tension in the component phase of an emulsion to establish a uniform dispersion or emulsion.

[0404] "Flavoring agents and adjuvants" are generally defined as substances added to impart or help impart a taste or aroma in food.

[0405] "Formulation aids" are generally defined as substances used to promote or produce a desired physical state or texture in food, including carriers, binders, fillers, plasticizers, film-formers, and tableting aids, etc.

[0406] "Humectants" are generally defined as hygroscopic substances incorporated in food to promote retention of moisture, including moisture-retention agents and antidusting agents.

[0407] "Processing aids" are generally defined as substances used as manufacturing aids to enhance the appeal or utility of a food or food component, including clarifying agents, clouding agents, catalysts, flocculents, filter aids, and crystallization inhibitors, etc.

[0408] "Solvents and vehicles" are generally defined as substances used to extract or dissolve another substance.

[0409] "Stabilizers and thickeners" are generally defined as substances used to produce viscous solutions or dispersions, to impart body, improve consistency, or stabilize emulsions, including suspending and bodying agents, setting agents, jellying agents, and bulking agents, etc.

[0410] "Surface-active agents" are generally defined as substances used to modify surface properties of liquid food components for a variety of effects, other than emulsifiers, but including solubilizing agents, dispersants, detergents, wetting agents, rehydration enhancers, whipping agents, foaming agents, and defoaming agents, etc.

[0411] "Texturizers" are generally defined as substances which affect the appearance or feel of the food.

Food Ingredients

[0412] As described above, in a preferred embodiment, the food composition of the invention comprises the 1,3-propanediol of the invention and at least one food ingredient. Below is a non-limiting description of ingredients that can be used in the food compositions of the invention.

[0413] The U.S. Food and Drug Administration (FDA) Center for Food Safety and Applied Nutrition (CFSAN) maintains a database ("EAFUS: A Food Additive database"; http://vm.cfsan.fda.gov/~dms/eafus.html) under an ongoing program known as the Priority-based Assessment of Food Additives (PAFA). PAFA contains administrative, chemical and toxicological information on over 2000 substances directly added to food, including substances regulated by the U.S. FDA as direct, "secondary" direct, and color additives, and Generally Recognized As Safe (GRAS) and prior-sanctioned substances. In addition, the database contains only administrative and chemical information on less than 1000 such substances. The more than 3000 total substances together comprise an inventory often referred to as "Everything" Added to Food in the United States (EAFUS). It is contemplated that all ingredients listed in the EAFUS can be used as ingredients in the food compositions of the invention, and those having skill in the art can readily determine appropriate ingredients for particular food products. The EAFUS Food Additive Database described above is herein incorporated by reference in its entirety.

[0414] The EAFUS list of substances contains ingredients added directly to food that FDA has either approved as food additives or listed or affirmed as GRAS. Nevertheless, it contains only a partial list of all food ingredients that may in fact be lawfully added to food, because under federal law some ingredients may be added to food under a GRAS determination made independently from the FDA. The list contains many, but not all, of the substances subject to independent GRAS determinations. For information about the GRAS notification program please consult the Inventory of GRAS Notifications. Additional information on the status of Food and Color Additives can be obtained from the Food Additive Status List or the Color Additive Status List (formerly called Appendix A of the Investigations Operations Manual).

[0415] The following summary is copied directly from the EAFUS Food d Additive Database and lists certain types of common food ingredients, why they are used, and some examples of the names that can be found on product labels. Some additives are used for more than one purpose.

[0416] The ingredient listings below are organized as follows:

Ingredient Category

[0417] Ingredient Function

[0418] Food Category

[0419] Ingredient Example

[0420] Preservatives

[0421] Prevent food spoilage from bacteria, molds, fungi, or yeast (antimicrobials); slow or prevent changes in color, flavor, or texture and delay rancidity (antioxidants); maintain freshness

[0422] Fruit sauces and jellies, beverages, baked goods, cured meats, oils and margarines, cereals, dressings, snack foods, fruits and vegetables

[0423] Ascorbic acid, citric acid, sodium benzoate, calcium propionate, sodium erythorbate, sodium nitrite, calcium sorbate, potassium sorbate, BHA, BHT, EDTA, tocopherols (Vitamin E)

[0424] Sweeteners

[0425] Add sweetness with or without the extra calories

[0426] Beverages, baked goods, confections, table-top sugar, substitutes, many processed foods

[0427] Sucrose (sugar), glucose, fructose, sorbitol, mannitol, corn syrup, high fructose corn syrup, saccharin, aspartame, sucralose, acesulfame potassium (acesulfame-K), neotame

[0428] Color Additives

[0429] Offset color loss due to exposure to light, air, temperature extremes, moisture and storage conditions; correct natural variations in color; enhance colors that occur naturally; provide color to colorless and "fun" foods

[0430] Many processed foods, (candies, snack foods margarine, cheese, soft drinks, jams/jellies, gelatins, pudding and pie fillings)

[0431] FD&C Blue Nos. 1 and 2, FD&C Green No. 3, FD&C Red Nos. 3 and 40, FD&C Yellow Nos. 5 and 6, Orange B, Citrus Red No. 2, annatto extract, beta-carotene, grape skin extract, cochineal extract or carmine, paprika oleoresin, caramel color, fruit and vegetable juices, saffron (Note: Exempt color additives are not required to be declared by name on labels but may be declared simply as colorings or color added)

[0432] Flavors and Spices

[0433] Add specific flavors (natural and synthetic)

[0434] Pudding and pie fillings, gelatin dessert mixes, cake mixes, salad dressings, candies, soft drinks, ice cream, BBQ sauce

[0435] Natural flavoring, artificial flavor, and spices

[0436] Flavor Enhancers

[0437] Enhance flavors already present in foods (without providing their own separate flavor)

[0438] Many processed foods

[0439] Monosodium glutamate (MSG), hydrolyzed soy protein, autolyzed yeast extract, disodium guanylate or inosinate

[0440] Fat Replacers (and Components of Formulations Used to Replace Fats)

[0441] Provide expected texture and a creamy "mouth-feel" in reduced-fat foods

[0442] Baked goods, dressings, frozen desserts, confections, cake and dessert mixes, dairy products

[0443] Olestra, cellulose gel, carrageenan, polydextrose, modified food starch, microparticulated egg white protein, guar gum, xanthan gum, whey protein concentrate

[0444] Nutrients

[0445] Replace vitamins and minerals lost in processing (enrichment), add nutrients that may be lacking in the diet (fortification)

[0446] Flour, breads, cereals, rice, macaroni, margarine, salt, milk, fruit beverages, energy bars, instant breakfast drinks

[0447] Thiamine hydrochloride, riboflavin (Vitamin B2), niacin, niacinamide, folate or folic acid, beta carotene, potassium iodide, iron or ferrous sulfate, alpha tocopherols, ascorbic acid, Vitamin D, amino acids (L-ryptophan, L-lysine, L-leucine, L-methionine)

[0448] Emulsifiers

[0449] Allow smooth mixing of ingredients, prevent separation. Keep emulsified products stable, reduce stickiness, control crystallization, keep ingredients dispersed, and to help products dissolve more easily

[0450] Salad dressings, peanut butter, chocolate, margarine, frozen desserts

[0451] Soy lecithin, mono- and diglycerides, egg yolks, polysorbates, sorbitan monostearate

[0452] Stabilizers and Thickeners, Binders, Texturizers

[0453] Produce uniform texture, improve "mouth-feel"

[0454] Frozen desserts, dairy products, cakes, pudding and gelatin mixes, dressings, jams and jellies, sauces

[0455] Gelatin, pectin, guar gum, carrageenan, xanthan gum, whey

[0456] pH Control Agents and Acidulants

[0457] Control acidity and alkalinity, prevent spoilage

[0458] Beverages, frozen desserts, chocolate, low acid canned foods, baking powder

[0459] Lactic acid, citric acid, ammonium hydroxide, sodium carbonate

[0460] Leavening Agents

[0461] Promote rising of baked goods

[0462] Breads and other baked goods

[0463] Baking soda, monocalcium phosphate, calcium carbonate

[0464] Anti-Caking Agents

[0465] Keep powdered foods free-flowing, prevent moisture absorption

[0466] Salt, baking powder, confectioner's sugar

[0467] Calcium silicate, iron ammonium citrate, silicon dioxide

[0468] Humectants

[0469] Retain moisture

[0470] Shredded coconut, marshmallows, soft candies, confections

[0471] Glycerin, sorbitol, Propylene Glycol

[0472] Yeast Nutrients

[0473] Promote growth of yeast

[0474] Breads and other baked goods

[0475] Calcium sulfate, ammonium phosphate

[0476] Dough Strengtheners and Conditioners

[0477] Produce more stable dough

[0478] Breads and other baked goods

[0479] Ammonium sulfate, azodicarbonamide, L-cysteine

[0480] Firming Agents

[0481] Maintain crispness and firmness

[0482] Processed fruits and vegetables

[0483] Calcium chloride, calcium lactate

[0484] Enzyme Preparations

[0485] Modify proteins, polysaccharides and fats

[0486] Cheese, dairy products, meat

[0487] Enzymes, lactase, papain, rennet, chymosin

[0488] Gases

[0489] Serve as propellant, aerate, or create carbonation

[0490] Oil cooking spray, whipped cream, carbonated beverages

[0491] Carbon dioxide, nitrous oxide

[0492] In addition, esters can function as many of the above noted ingredients. While those in those having skill in

the art can readily determine which esters are most appropriate to provide a particularly desired function, applications specifically note that esters used in this invention may include the esters produced, including all the appropriate conjugate mono and diesters, from biologically-derived 1,3 propanediol using organic carboxylic acids. Some esters in particular that are produced include propanediol distearate and monostearate, propandiol dilaurate and monolaurate, propanediol dioleate and monooleate, propanediol divalerate and monovalerate, propanediol dicaprylate and monocaprylate, propanediol dimyristate and monomyristate, propanediol dipalmitate and monopalmitate, propanediol dibehenate and monobehenate, propanediol adipate, propanediol maleate, propanediol dioxalate, propanediol dibenzoate, propanediol diacetate, and all mixtures thereof.

[0493] The food compositions of the invention can contain any natural ingredients where appropriate. Natural ingredients include any natural or nature-derived ingredients similar in composition or in function to any of the ingredients listed above.

Food and Beverage Applications

[0494] Below is a non-limiting listing of food compositions of the invention comprising the 1,3-propanediol of the invention:

[0495] Herbs, seeds, spices, seasonings, blends, extracts, and flavorings, including all natural and artificial spices, blends, and flavors, containing up to about 97% by weight Bio-PDO by weight.

[0496] Confections and frostings, including candy and flavored frostings, marshmallows, baking chocolate, and brown, lump, rock, maple, powdered, and raw sugars containing up to about 24% Bio-PDO by weight.

[0497] Alcoholic beverages, including malt beverages, wines, distilled liquors, and cocktail mix containing up to about 5% Bio-PDO by weight.

[0498] Nuts and nut products, including whole or shelled tree nuts, peanuts, coconut, and nut and peanut spreads, containing up to about 5% Bio-PDO by weight.

[0499] Frozen dairy desserts and mixes, including ice cream, ice milks, sherbets, and other frozen dairy desserts and specialties, containing up to about 2.5% Bio-PDO by weight.

[0500] Baked goods and baking mixes, including all ready-to-eat and ready-to-bake products, flours, and mixes requiring preparation before serving, containing up to about 2% bio-PDO by weight.

[0501] Nonalcoholic beverages and beverage bases, including only special or spiced teas, soft drinks, coffee substitutes, and fruit and vegetable flavored gelatin drinks, containing up to about 2% Bio-PDO by weight.

[0502] Breakfast cereals, including ready-to-eat and instant and regular hot cereals, containing up to about 2% Bio-PDO by weight.

[0503] Cheeses, including curd and whey cheeses, cream, natural, grating, processed, spread, dip, and miscellaneous cheeses, containing up to about 2% Bio-PDO by weight.

[0504] Chewing gum, including all forms, containing up to about 2% Bio-PDO by weight.

[0505] Coffee and tea, including regular, decaffeinated, and instant types, containing up to about 2% Bio-PDO by weight.

[0506] Condiments and relishes, including plain seasoning sauces and spreads, olives, pickles, and relishes, but not spices or herbs, containing up to about 2% Bio-PDO by weight.

[0507] Dairy product analogs, including nondairy milk, frozen or liquid creamers, coffee whiteners, toppings, and other nondairy products, containing up to about 2% Bio-PDO by weight.

[0508] Egg products, including liquid, frozen, or dried eggs, and egg dishes made therefrom, i.e., egg roll, egg foo young, egg salad, and frozen multicourse egg meals, but not fresh eggs, containing up to about 2% Bio-PDO by weight.

[0509] Fats and oils, including margarine, dressings for salads, butter, salad oils, shortenings and cooking oils, containing up to about 2% Bio-PDO by weight.

[0510] Fish products, including all prepared main dishes, salads, appetizers, frozen multicourse meals, and spreads containing fish, shellfish, and other aquatic animals, but not fresh fish, containing up to about 2% Bio-PDO by weight.

[0511] Fresh eggs, including cooked eggs and egg dishes made only from fresh shell eggs, containing up to about 2% Bio-PDO by weight.

[0512] Fresh fish, including only fresh and frozen fish, shellfish, and other aquatic animals, containing up to about 2% Bio-PDO by weight.

[0513] Fresh fruits and fruit juices, including only raw fruits, citrus, melons, and berries, and home-prepared "ades" and punches made therefrom, containing up to about 2% Bio-PDO by weight.

[0514] Fresh meats, including only fresh or home-frozen beef or veal, pork, lamb or mutton and home-prepared fresh meat-containing dishes, salads, appetizers, or sandwich spreads made therefrom, containing up to about 2% Bio-PDO by weight.

[0515] Fresh poultry, including only fresh or home-frozen poultry and game birds and home-prepared fresh poultry-containing dishes, salads, appetizers, or sandwich spreads made therefrom, containing up to about 2% Bio-PDO by weight.

[0516] Fresh vegetables, tomatoes, and potatoes, including only fresh and home-prepared vegetables, containing up to about 2% Bio-PDO by weight.

[0517] Fruit and water ices, including all frozen fruit and water ices, containing up to about 2% Bio-PDO by weight.

[0518] Gelatins, puddings, and fillings, including flavored gelatin desserts, puddings, custards, parfaits, pie fillings, and gelatin base salads, containing up to about 2% Bio-PDO by weight.

[0519] Grain products and pastas, including macaroni and noodle products, rice dishes, and frozen multicourse meals, without meat or vegetables, containing up to about 2% Bio-PDO by weight.

[0520] Gravies and sauces, including all meat sauces and gravies, and tomato, milk, buttery, and specialty sauces, containing up to about 2% Bio-PDO by weight.

[0521] Hard candy and cough drops, including all hard type candies, containing up to about 2% Bio-PDO by weight.

[0522] Jams and jellies, home-prepared, including only home-prepared jams, jellies, fruit butters, preserves, and sweet spreads, containing up to about 2% Bio-PDO by weight.

[0523] Jams and jellies, commercial, including only commercially processed jams, jellies, fruit butters, preserves, and sweet spreads, containing up to about 2% Bio-PDO by weight.

[0524] Meat products, including all meats and meat containing dishes, salads, appetizers, frozen multicourse meat meals, and sandwich ingredients prepared by commercial processing or using commercially processed meats with home preparation, containing up to about 2% Bio-PDO by weight.

[0525] Milk, whole and skim, including only whole, low-fat, and skim fluid milks, containing up to about 2% Bio-PDO by weight.

[0526] Milk products, including flavored milks and milk drinks, dry milks, toppings, snack dips, spreads, weight control milk beverages, and other milk origin products, containing up to about 2% Bio-PDO by weight.

[0527] Plant protein products, including the National Academy of Sciences/National Research Council "reconstituted vegetable protein" category, and meat, poultry, and fish substitutes, analogs, and extender products made from plant proteins, containing up to about 2% Bio-PDO by weight.

[0528] Poultry products, including all poultry and poultry-containing dishes, salads, appetizers, frozen multicourse poultry meals, and sandwich ingredients prepared by commercial processing or using commercially processed poultry with home preparation, containing up to about 2% Bio-PDO by weight.

[0529] Processed fruits and fruit juices, including all commercially processed fruits, citrus, berries, and mixtures; salads, juices and juice punches, concentrates, dilutions, "ades", and drink substitutes made therefrom, containing up to about 2% Bio-PDO by weight.

[0530] Processed vegetables and vegetable juices, including all commercially processed vegetables, vegetable dishes, frozen multicourse vegetable meals, and vegetable juices and blends, containing up to about 2% Bio-PDO by weight.

[0531] Snack foods, including chips, pretzels, and other novelty snacks, containing up to about 2% Bio-PDO by weight.

[0532] Soft candy, including candy bars, chocolates, fudge, mints, and other chewy or nougat candies, containing up to about 2% Bio-PDO by weight.

[0533] Soups, home-prepared, including meat, fish, poultry, vegetable, and combination home-prepared soups, containing up to about 2% Bio-PDO by weight.

[0534] Soups and soup mixes, including commercially prepared meat, fish, poultry, vegetable, and combination soups and soup mixes, containing up to about 2% Bio-PDO by weight.

[0535] Sugar, white, granulated, including only white granulated sugar, containing up to about 2% Bio-PDO by weight.

[0536] Sugar substitutes, including granulated, liquid, and tablet sugar substitutes, containing up to about 2% Bio-PDO by weight.

[0537] Sweet sauces, toppings, and syrups, including chocolate, berry, fruit, corn syrup, and maple sweet sauces and toppings, containing up to about 2% Bio-PDO by weight.

## INDUSTRIAL APPLICATIONS

[0538] Biologically-derived 1,3-propanediol is also useful in industrial and other miscellaneous applications wherein biodegradability is an issue. Examples of industrial applications include: agriculture, automotive, coatings, paints, inks, construction and foundry, mining, petroleum, pharmaceutical plastics, pulp & paper, rubber, synthetic lubricants, textiles and fibers, water treatment and cryogenic preservation, among others.

[0539] In agricultural applications, Bio-PDO can function as an irrigation aid and/or a pesticide (emulsifier, spreader, sticking agent, and foaming agent) in end uses such as pesticides (herbicide, insecticide, fungicide), fertilizers, animal feeds, and soil amendments. The general amount of Bio-PDO in such compositions can range from about 0.1% to about 80% by weight.

[0540] In automotive application, Bio-PDO can function as a surfactant, solvent, or thickener in end uses such as vehicle washes, waxes & polishes. The general amount of Bio-PDO in such compositions can range from about 0.1% to about 50% by weight.

[0541] In coating and paint, Bio-PDO can function as a solvent, stabilizer, dispersant, or anti-freeze agent in end uses such as varnish, antimicrobials, pharmaceuticals, textiles, rubber, etc. The general amount of Bio-PDO in such compositions can range from about 1% to about 50% by weight.

[0542] In inks, Bio-PDO can function as an emulsion, polymerizer, stabilizer, dispersant and/or wetting agent in end uses such as printing and tattoos. The general amount of Bio-PDO in such compositions can range from about 1% to about 50% by weight.

[0543] In mining applications, Bio-PDO can function as a lubricant, solvent, or humectant, in end uses such as drilling and hydraulic fluid. The general amount of Bio-PDO in such compositions can range from about 1% to about 75% by weight.

[0544] In petroleum applications, Bio-PDO can function as a dessicant, emulsifier, demulsifier, corrosion inhibitor, lubricant, surfactant, biocide and/or defoamer, in end uses such as well drilling fluid, oil production, cementing and stimulation. The general amount of Bio-PDO in such compositions can range from about 0.5% to about 50% by weight.

[0545] In pharmaceutical applications, Bio-PDO can function as an emulsifier, stabilizer, solvent, or antimicrobial in end uses such as drug carriers (tablets, capsules, liquids, gums). The general amount of Bio-PDO in such compositions can range from about 0.5% to about 95% by weight.

[0546] In pulp & paper applications, Bio-PDO can function as an emulsifier, digestion, deinking, defoaming, bio-

cide, solubilizer, or dispersant in end uses such as treatment & processing. The general amount of Bio-PDO in such compositions can range from about 0.1% to about 5% by weight.

[0547] In synthetic lubricants, Bio-PDO can functions as a cleaner, corrosion inhibitor, or lubricant in end uses such as engine compressor, hydraulics, oil drilling, metal working fluid, rolling oils, wire extrusion, plate rolling, and sheet metal processing. The general amount of Bio-PDO in such compositions can range from about 0.5% to about 50% by weight.

[0548] In water treatment applications, Bio-PDO can function as an antimicrobial, biocide, surfactant, or foam control agent in end uses such as agriculture, pulp & paper, oil production, personal care, detergents, etc. The general amount of Bio-PDO in such compositions can range from about 0.1% to about 50% by weight.

[0549] The Bio-PDO can also function as a humectant or in ester form in applications such as, for example, agricultural applications to increase uptake of actives, in tobacco handling to maintain softness, moisture retention and minimize dust formation, in ink, and in pharmaceutical transdermal applications; as a solvent for the spinning of poly-(vinyl alcohol); as a low VOC (volatile organic compound) paint stripper; as a lubricant for synthetic fiber spinning; and as a stripping solution for electronic components; as a liquid dessicant in the dehydration of natural gas during production and transportation.

[0550] In paint compositions, the glycol component typically is a compatabilizer, a reactive diluent or improves the application properties because of its slow evaporation rate. Exemplary paint compositions include, but are not limited to, water-based (latex) architectural coatings, especially semi-gloss paints. Glycols are present in the aforementioned paint compositions in amounts well known to those of ordinary skill in the appropriate art, typically up to about 20% by weight based on the weight of the total composition. A typical formulation latex paint formulation may include, but is not limited to, the following components: 1 to 20% by weight of glycol, 20 to 60% by weight of latex emulsion, 0 to 30% by weight of fillers and up to 20% of the following additives: coalescing agents, surfactants, defoamers, stabilizers, biocides and thickeners.

[0551] Bio-PDO can also be used in certain biodegradable plastic applications.

[0552] Bio-PDO can further be used as a low toxic, vitrifying, bio-derived cell/tissue/organ (for human, animal and plant) cryoprotectant material.

[0553] Esters can function as many of the above noted ingredients. While those in those having skill in the art can readily determine which esters are most appropriate to provide a particularly desired function, applications specifically note that esters used in this invention may include the esters produced, including all the appropriate conjugate mono and diesters, from biologically-derived 1,3 propanediol using organic carboxylic acids. Some esters in particular that are produced include propanediol distearate and monostearate, propandiol dilaurate and monolaurate, propanediol dioleate and monooleate, propanediol divalerate and monovalerate, propanediol dicaprylate and monocaprylate, propanediol dimyristate and monomyristate, propanediol dipalmitate and monopalmitate, propanediol dibehenate and monobehenate, propanediol adipate, propanediol maleate, propanediol dioxalate, propanediol dibenzoate, propanediol diacetate, and all mixtures thereof.

[0554] The industrial compositions of the invention can contain any natural ingredients where appropriate. Natural ingredients include any natural or nature-derived ingredients similar in composition or in function to any of the ingredients listed above.

[0555] All of the compositions and methods disclosed and claimed herein can be made and executed without undue experimentation in light of the present disclosure. While the compositions and methods of the present disclosure have been described in terms of preferred embodiments, it will be apparent to those of skill in the art that variations may be applied to the compositions and methods and in the steps or in the sequence of steps of the method described herein without departing from the concept, spirit, and scope of the invention. More specifically, it will be apparent that certain agents, which are chemically related, may be substituted for the agents described herein while the same or similar results would be achieved. All such similar substitutes and modifications apparent to those skilled in the art are deemed to be within the spirit, scope, and concept of the invention as defined by the appended claims.

## EXAMPLES

[0556] The present invention is further defined in the following Examples. It should be understood that these Examples, while indicating preferred embodiments of the invention, are given by way of illustration only. From the above discussion and these Examples, one skilled in the art can ascertain the preferred features of this invention, and without departing from the spirit and scope thereof, can make various changes and modifications of the invention to adapt it to various uses and conditions.

### Example 1

[0557]

Renewably-based, biodegradable 1,3-Propanediol in Cosmetic Emulsion

| Ingredients: | % Wt. |
|---|---|
| Phase A | |
| Water, deionized | 61.34 |
| Tetrasodium EDTA | 0.10 |
| Bio-PDO | 5.00 |
| Carbopol 980 (2% solution) | 10.00 |
| Phase B | |
| Puresyn ® 2 | 5.00 |
| Lipomulse ® 165 | 2.50 |
| Stearic Acid XXX | 2.50 |
| Cetearyl Alcohol | 0.50 |
| Dimethicone DC 200-100 | 1.00 |
| Phase C | |
| NaOH (20% solution) qs to Ph 7.0-7.5 | 1.06 |
| Phase D | |
| Germaben II | 1.00 |

[0558] Phase A was combined at 75° C. Phase B was combined at 75° C. Phase B was added to Phase A. Phase C was then added to the Phase A/B. Phase A/B/C was cooled

to 40° C. and then Phase D was added. Ph was adjusted to 7.0-7.5 with Phase C. The formulation produced was a smooth white and apparently stable emulsion.

[0559] RESULTS—Ph 7.38, viscosity 12000 cps at 20 RPM

[0560] Oven stability was examined. Results were deemed acceptable.

[0561] Freeze/thaw stability was also examined. Freeze/thaw stability was deemed acceptable.

[0562] The viscosity of the cosmetic emulsion containing biologically-derived 1,3-propanediol was on par with that of propylene glycol (12600 cps) and higher than that of 1,3-butylene glycol (6000 cps) or 2-methyl-1,3-propanediol (9600 cps).

Example 2

[0563]

Renewably-based, biodegradable 1,3-Propanediol in Clear Face and Hand Lotion

| Ingredients: | % Wt. |
|---|---|
| Deionized water | 66.20 |
| Bio-PDO | 16.00 |
| Ritasail 190 (RITA) (dimethicone copolyol) | 2.00 |
| Pationic ® 122A (RITA) (sodium caproyl lactylate 21.1% aqueous) | 3.80 |
| Rhodapex ® ESY (Rhodia) (sodium laureth sulfate 26% aqueous) | 4.00 |
| Germaben II (ISP/Sutton) (propylene glycol, diazolidinyl urea, methylparaben and propylparaben) | 1.00 |
| Tetrasodium EDTA 5% aqueous | 1.00 |
| Aculyn ® 22 (ISP/Rohm & Haas) (acrylates/steareth-20 Methacrylate copolymer 25% aqueous) | 5.00 |
| Triethanolamine | 1.00 |
| Fragrance | q.s. |

[0564] Procedure: Ingredients are combined in order as listed.

[0565] Properties: Ph: 7.0 viscosity: 6,780 cps

Renewably-based, biodegradable 1,3-Propanediol in Hand and Body Cream

| Ingredients: | % Wt. |
|---|---|
| Deionized water | 75.49 |
| Cellosize ® PCG 10 (Amerchol) | 0.20 |
| Trisodium EDTA (Universal Preserv-A-Chem) | 0.10 |
| Bio-PDO | 6.50 |
| Shebu ® Refined (RITA) (shea butter) | 2.00 |
| Arlacel ® 60 (Uniqema) | 4.00 |
| MYRJ ® 52S (Uniqema) | 0.50 |
| Glycol stearate (Stepan) | 2.00 |
| DC SF 200/350 (Dow Corning) | 4.00 |
| Isopropyl palmitate (Stepan) | 3.00 |
| Vitamin A palmitate (Roche) | 0.01 |
| Aloe vera gel (Bio-Botanica) | 0.50 |
| Cucumber extract (Bio-Botanica) | 0.50 |
| Ginko biloba extract (Bio-Botanica) | 0.50 |
| Red Clover extract (Bio-Botanica) | 0.50 |
| Biopein ® (Bio-Botanica) | 0.20 |

[0566] Procedure: Disperse Cellosize® PCG 10 into deionized water with mixing. Add trisodium EDTA and Bio-PDO™ with mixing and heat to 80° C. Add the next seven items and continue mixing until uniform. Remove heat and allow to cool. At 30° C., add aloe vera gel, cucumber extract, *ginkgo biloba* extract and red clover extract. Add Biopein® and mix until homogenous.

Example 4

[0567]

Renewably-based, biodegradable 1,3-Propanediol in Moisturizing Body Care Cream

| Ingredients: | % Wt. |
|---|---|
| Phase A | |
| Cremophor ® A6 (BASF) (ceteareth-6) | 2.0 |
| Cremophor ® A25 (BASE) (ceteareth-25) | 2.0 |
| Vitis vinifera (grape) seed oil | 6.0 |
| Glyceryl Stearate SE | 3.0 |
| Cetearyl alcohol | 2.0 |
| Dimethicone | 0.5 |
| Luvitol EHO (BASF) (cetearyl octanoate) | 8.0 |
| Oxynex ® 2004 (Merck KgaA) (1,3-Propanediol, BHT, ascorbyl palmitate, glyceryl stearate and citric acid) | 0.1 |
| Phase B | |
| Bio-PDO | 5.0 |
| Edeta BD (BASF) (disodium EDTA) | 0.1 |
| D-Panthenol USP (BASF) | 1.0 |
| Preservative | q.s. |
| Water | q.s. to 100 |
| Phase C | |
| Luvigel EM (BASF) (caprylic/capric triglycerides and sodium acrylates copolymer) | 1.0 |
| Phase D | |
| Vitamin E Acetate (BASF) | 0.5 |
| Perfume | q.s. |

[0568] Procedure: Heat phase A and phase B to about 80° C. Stir phase B into phase A while homogenizing. Add phase C to phase A/B and homogenize again. Cool to about 40° C., add phase D and homogenize shortly.

[0569] Properties: Viscosity: approx. 25,000 mPa·s (Brookfield); Ph value: 6.5

Example 5

[0570]

Renewably-based, biodegradable 1,3-Propanediol in Moisturizing Body Care Cream

| Ingredients: | % Wt. |
|---|---|
| Phase A | |
| Cremophor ® GC 7 (BASF) (PEG 7-glyceryl-cocoate) | 8.0 |
| Cremophor ® A-25 (BASF) (ceteareth-25) | 22.0 |
| Cremophor ® WO 7 (BASF) (hydrogenated castor oil) | 1.0 |
| Bio-PDO | 3.0 |
| Masil ® SF19 (BASF) (PEG 8 methicone) | 1.0 |

-continued

Renewably-based, biodegradable 1,3-Propanediol in Moisturizing Body Care Cream

| Ingredients: | % Wt. |
|---|---|
| Phase B | |
| Water | 65.0 |
| Phase C | |
| Preservative | q.s. |
| Fragrance | q.s. |

[0571] Procedure: Add ingredients in above order at 80° C. and mix until uniform. Assure each is dissolved prior to next addition. Heat phase B to 80° C. and combine with phase A. Cool to 50° C. Add fragrance and preservative. Pour into containers while liquid and allow to set at room temperature.

Example 6

[0572]

Renewably-based, biodegradable 1,3-Propanediol in Moisturizing Hand and Body Lotion

| Ingredients: | % Wt. |
|---|---|
| Phase A | |
| Varisoft ® TA-100 (Goldschmidt) (distearyldimonium chloride) Crodacol C-70 (Croda) (cetyl alcohol) | 4.75<br>2.00 |
| Penreco Snow White Petrolatum (Penreco) (petrolatum) | 4.00 |
| DC Fluid 200, 1,000 cst (Dow Corning) (dimethicone) | 0.25 |
| Phase B | |
| Deionized water | q.s. |
| Stepan ® IPM (Stepan) (isopropyl myristate) | 3.25 |
| Bio-PDO | 4.00 |
| Phase C | |
| Sensomer ® CI-50 (Ondeo Nalco) (starch hydroxypropyltrimonium chloride) | 3.00 |
| AA040513 Cucumber (Arylessence) (fragrance) | 0.25 |
| Preservative | q.s. |
| Sodium hydroxide | q.s. to Ph 6 |

[0573] Procedure: In separate containers, thoroughly mix the ingredients of phase A and phase B to 75° C. Pour phase A into phase B; mix well at temperature for 10 minutes. Remove heat and continue mixing until temperature is under 40° C. Add phase C ingredients in the order listed, mixing well between additions. Adjust Ph to 6.

Example 7

[0574]

Renewably-based, biodegradable 1,3-Propanediol in Moisturizing Lotion SPF15

| Ingredients: | % Wt. |
|---|---|
| Phase A | |
| Stearyl alcohol | 2.00 |
| Estol ® 1543 (Uniqema) (ethylhexyl palmitate) | 5.00 |
| Estol ® 3609 (Uniqema) (triethylhexanoin) | 5.00 |
| Tween ® 60 (polysorbate 60) | 2.00 |
| Isohexadecane | 7.50 |
| Solaveil ® CT100 (Uniqema) ($C_{12}$-$C_{15}$ alkyl benzoate (and) titanium dioxide (and) polyhydroxystearic acid (and) aluminum stearate (and) alumina) | 15.00 |
| Phase B | |
| Distilled water | 54.40 |
| Arlatone ® 2121 (Uniqema) (sorbitan stearate (and) sucrose cocoate) | 2.50 |
| Monomate RMEA-40 (aqua (and) disodium ricinoleamido MEA-sulfosuccinate) | 0.200 |
| Phase C | |
| Veegum ® Ultra (RT Vanderbilt) (magnesium aluminum silicate) | 0.80 |
| Keltrol ® RD (Nutrosweet Kelco) (xanthan gum) | 0.20 |
| Sodium lactate 50% | 0.40 |
| Germaben ® II (ISP) (propylene glycol (and) diazolidinyl urea (and) methylparaben (and) propylparaben) | 1.00 |
| Bio-PDO | 4.00 |

[0575] Procedure: Heat phase B to 80° C. with moderate stirring, until Arlatone® 2121 is fully dispersed. Add Keltrol® and Veegum®; stir until homogeneous. Add remaining water phase ingredients, maintaining temperature at 80° C. Heat phase A to 80° C. Add phase A to B/C with vigorous mixing. Homogenize for two minutes. Cool with moderate stirring to room temperature.

Example 8

[0576]

Skin Treatment Lotion

| Ingredients: | % Wt. |
|---|---|
| Phase A | |
| Deionized water | 61.7 |
| Keltrol ® CG (Kelco) (xanthan gum) | 0.2 |
| Bio-PDO | 5.0 |
| Multifruit ® BSC (Arch Personal Care) | 3.0 |
| Jeescreen Benzophenone-4 (Jeen) (benzophenone-4) | 0.1 |
| Jeechem GMS-165 (Jeen) (glyceryl stearate (and) PEG-100 stearate) | 3.0 |
| Phase B | |
| Jeesilc IDD (Jeen) (dimethicone crosspolymer-3 (and) isododecane) | 4.0 |
| Jeesilc 245 (Jeen) (cyclomethicone) | 8.0 |
| Jeesilc 200 MV (100 cst) (dimethicone) | 2.0 |
| Simulgel ® NS (Seppic) | 4.0 |

-continued

Skin Treatment Lotion

| Ingredients: | % Wt. |
|---|---|
| Phase C | |
| Jeesilc 6056 (Jeen) (dimethylpolysiloxane gum) | 3.0 |
| Jeecide G-II (Jeen) (propylene glycol (and) diazolidinyl urea (and) methylparaben (and) propylparaben) | 1.0 |
| Arnica Extract (Botanicals Plus) (arnica □rabic□) | 2.0 |
| Flamingo Super Red | 1.0 |
| Phase D | |
| Jeesorb L-20 (Jeen) (polysorbate 20) | 1.0 |
| Vitamin E Acetate (Jeen) (tocopheryl acetate) | 0.5 |
| Fragrance | 0.5 |

[0577] Procedure: Heat water to 65° C. Pre-mix Keltrol® and Bio-PDO and add to the water phase. Mix until dissolved. Add the other ingredients of phase A one at a time and mix well. Cool to 50° C. In the oil phase tank, add the Jeesilc IDD, Jeesilc 245 and Jeesilc 200 MV (100 cst) and mix until uniform. Add the Simulgel® and mix to 50° C. Using a homogenizer, add phase B to phase A and mix for 10 minutes. Cool to 40° C. Switch to prop agitation. Add the ingredients of phase C one at a time into the main tank and mix well after each addition. Pre-mix phase D in a side vessel and add to the main tank. Mix well.

Example 9

[0578]

Broad Spectrum SPF Sunscreen

| Ingredients: | % Wt. |
|---|---|
| Phase A | |
| Deionized water | 57.85 |
| Carbopol 980 (Noveon) (carbomer) | 0.30 |
| Disodium EDTA (Dow Chemical) | 0.10 |
| Bio-PDO | 4.00 |
| Phase B | |
| Escalol 557 (ISP) (octinoxate) | 7.50 |
| Escalol 567 (ISP) (oxybenzone) | 6.00 |
| Escalol 517 (ISP) (avobenzone) | 2.00 |
| X-Tend 226 (ISP) (2-phenylethyl benzoate) | 10.00 |
| Prolipid ® 141 (ISP) (glyceryl stearate, behenyl alcohol, palmitic acid, stearic acid, lecithin, lauryl alcohol, myristyl alcohol and cetyl alcohol) | 4.00 |
| Phase C | |
| Deionized water | 5.00 |
| Triethanolamine 99% | 0.40 |
| Phase D | |
| Liquapar Optima (ISP) (phenoxyethanol, methylparaben, isopropylparaben, isobutylparaben and butylparaben) | 1.25 |
| Liquapar Oil (ISP) (isopropylparaben, isobutylparaben and butylparaben) | 0.40 |
| Lexguard O (Inolex) (caprylyl glycol) | 1.00 |
| Phase E | |
| Glycacil ®-L (Lonza) (iodopropynyl butylcarbamate) | 0.20 |

[0579] Procedure: Combine ingredients in phase A; mix until uniform and heat to 75° C. Combine ingredients in phase B; heat to 75° C. Combine phase B with phase A with homogenization. Combine phase C with phase A/B with homogenization. Cool to 45° C. (heat Lexguard 0 and add to LiquaPar Optima) and add phase D. Add phase E. Cool to room temperature. Qs for water loss.

[0580] Properties: Viscosity: 17,600 cps, Ph 6.44

Example 10

[0581]

Standard sunscreen

| Ingredients | % Wt. |
|---|---|
| Phase A | |
| Lanolin | 5.0 |
| Homosalate | 8.0 |
| White petrolatum | 2.5 |
| Stearic acid | 4.0 |
| Propylparaben | 0.1 |
| Phase B | |
| Methylparaben | 0.1 |
| Edetate disodium | 0.1 |
| Bio-PDO | 5.0 |
| Triethanolamine | 1.0 |
| Purified water USP | 74.3 |

[0582] Procedure: Preparation A and preparation B are heated separately to 77 to 82 [deg]C, with constant stirring, until the contents of each part are solubilized. Add preparation A slowly to preparation B while stirring. Continue stirring until the emulsion formed is cooled to room temperature (15 to 30 [deg]C). Add sufficient purified water to obtain 100 grams of standard sunscreen preparation.

Example 11

[0583]

Water-Resistant Sunscreen Lotion SPF 21

| Ingredients: | % Wt. |
|---|---|
| Phase A | |
| Deionized water | 63.10 |
| Versene ® NA (Dow) (disodium EDTA) | 0.05 |
| Carbopol Ultrez 10 Polymer (Noveon) (carbomer) | 0.25 |
| Pemulen ® TR-2 Polymeric Emulsifier (Noveon) (acrylates/C10-30 alkyl acrylate crosspolymer) | 0.15 |
| Bio-PDO | 3.00 |
| Phase B | |
| NeoHeliopan, Type AV (Haarmann & Reimer) (octyl methoxycinnamate) | 5.00 |
| Octyl salicylate | 3.00 |
| HallBrite ® BHB (C. P. Hall) (butyloctyl salicylate) | 5.00 |
| Parsol ® 1789 (Roche) (avobenzone) | 3.00 |
| Procol CS-20-D (Protameen) (cetearyl alcohol and ceteareth-20) | 1.50 |
| Crodamol CAP (Croda) (cetearyl octanoate) | 2.00 |
| Vitamin E acetate (BASF) | 0.50 |
| Phase C | |
| Crovol A-70 (Croda) (PEG-60 almond glycerides) | 0.50 |
| DC 1401 Fluid (Dow Corning) (dimethiconol and cyclomethicone) | 1.50 |

-continued

Water-Resistant Sunscreen Lotion SPF 21

| Ingredients: | % Wt. |
|---|---|
| Ultrasil Copolyol-1 Silicone (Noveon)(PEG-8 dimethicone) | 1.50 |
| Phenonip ® (Clariant) (phenoxyethanol, methylparaben, ethylparaben, propylparaben, butylparaben and isobutylparaben) | 1.00 |
| Tapioca Pure (National Starch) (tapioca starch) | 4.00 |
| Sodium hydroxide 18% | 1.00 |
| Avalure ® UR 450 Polymer (Noveon) (PPG-17/IPDI/DMPA copolymer 38% solids) | 3.95 |

[0584] Procedure: Dissolve disodium EDTA in warm water (~50° C.). Add Carbopol Ultrez 10 polymer and allow to wet out for approximately five minutes. Disperse Pemulen® Polymeric emulsifier and allow to mix in for about 15 minutes. Add Bio-PDO™. Bring phase A to ~70° C. Add approximately 15% of the total neutralizing agent necessary to phase A. Blend phase B ingredients and bring to ~80° C., making sure solid ingredients are dissolved. Add phase B to phase A with vigorous agitation. Add PEG-60 almond glycerides. Add dimethiconol and cyclomethicone. Add Ultrasil Copolyol-1 silicone. Add Phenonip® after the emulsion cools to <60° C. Add tapioca starch. Add the remainder of the neutralizing agent. Add Avalure® UR 450 polymer.

[0585] Ph: 7.0-7.5

[0586] Viscosity (mPa™s)*: 15,000-21,000

[0587] SPF (waterproof)**: 21 (in-vitro method, 80 min. immersion)

Example 12

[0588]

Waterproof Protective Suncare SPF 20

| Ingredients: | % Wt. |
|---|---|
| Phase A | |
| Simusol 165 (Seppic) (glyceryl stearate and PEG-100 stearate) | 3.20 |
| Montanov ® S (Seppic) (coco-glucoside and coconut alcohol) | 1.30 |
| Isodecyl neopentanoate | 10.00 |
| PVP □rabic□te□ copolymer | 5.00 |
| Bio-PDO | 5.00 |
| Ethyl hexyl methoxycinnamate | 7.50 |
| Benzophenone-3 | 2.50 |
| Ethyl hexyl salicylate | 5.00 |
| Zinc oxide | 7.10 |
| Phase B | |
| Sepicalm VG (Seppic) (sodium palmitoyl □rabic□ and Nymphea alba flower extract) | 3.00 |
| Cyclomethicone | 5.00 |
| Phase C | |
| Simulgel ® EG (Seppic) (sodium acrylate/acryloyldimethyltaurate copolymer, isohexadecane and polysorbate 80) | 1.00 |
| Phase D | |
| Tromethamine | q.s. |
| Tetrasodium EDTA | 0.20 |

-continued

Waterproof Protective Suncare SPF 20

| Ingredients: | % Wt. |
|---|---|
| Xanthan gum | 0.15 |
| Magnesium aluminum silicate | 1.00 |
| Water | q.s. to 100 |
| Phase E | |
| Sepicide HB (Seppic) (phenoxyethanol (and) methylparaben (and) ethylparaben (and) propylparaben (and) butylparaben) | 0.30 |
| Sepicide CI (Seppic) (imidazolidinyl urea) | 0.20 |
| DL-alpha tocopherol | 0.05 |
| Fragrance | 0.30 |

[0589] Procedure: Melt phase A ingredients at 75-80° C. and disperse zinc oxide in the warm fatty phase. Disperse silicate and xanthan gum in water until homogeneous, then introduce EDTA and tromethamine. Add Simulgel® EG to this blend with vigorous stirring to obtain swelling of the polymer, then heat to 80° C. Add fatty phase A to the water phase and begin homogenizing for five minutes. Start cooling while continuously homogenizing. Introduce Sepicalm VG and cyclomethicone at 60° C. and homogenize for five minutes. Cool with moderate stirring and add phase E ingredients at 30° C.

Example 13

[0590]

Hand Barrier Cream

| Ingredients: | % Wt. |
|---|---|
| Phase 1 | |
| D.I. Water | q.s. to 100.0 |
| Bio-PDO | 4.00 |
| Ammonyx ® GA-70PG* | 2.86 |
| Phase 2 | |
| Petrolatum | 4.00 |
| Stepan ® IPP | 3.00 |
| Stepan ® Cetyl Alcohol, NF | 2.00 |
| TiO2Sperse 40% solution in Octyldodecyl Neopentanoate (Collaborative Labs) | 10.00 |
| Phase 3 | |
| KCl | 0.40 |
| Citric Acid | q.s. |
| Preservatives | q.s. |
| Total | 100.00 |

[0591] Procedure: Prepare water phase by adding water, Bio-PDO™ and Ammonyx® GA-70PG*. Mix well. Start heating to 160° F. Prepare oil phase by adding Petrolatum, Stepan® IPP, Stepan® Cetyl Alcohol and TiO2Sperse. Heat to 160-165° F. Add oil phase to the water phase. Emulsify for 20-25 minutes. Cool to room temperature. Premix KCl with water and add to batch. Add preservatives. Adjust Ph to 4.0 if necessary.

[0592] Physical Properties Ph 4.0-5.0; Viscosity 2,000-3,000 cps

Example 14

[0593]

Lotion for Normal-Oily Skin

| Ingredients: | % Wt. |
|---|---|
| Phase 1 | |
| D.I. Water | q.s. to 100.0 |
| Carbopol 934 (BF Goodrich) Carbomer | 0.15 |
| Bio-PDO | 3.00 |
| Phase 2 | |
| Stepan ® Octyl Isononanoate | 5.00 |
| Dow Corning 200 Fluid (Dow Corning) Dimethicone | 0.10 |
| Wecobee ® S | 0.50 |
| Stepan ® Cetyl Alcohol, NF | 0.50 |
| Kartacid 1890 (Akzo Nobel BV) Stearic Acid | 3.00 |
| Phase 3 | |
| Versene ® 200 (Dow Corning) Tetrasodium EDTA | 0.10 |
| Triethanolamine | 1.80 |
| Preservative | q.s. |
| Total | 100.0 |

[0594] Procedure: Prepare Phase 1 by adding D.I. water to a suitable mixing vessel and begin agitation. Add Carbopol 934 with good agitation and mix at high speed until the solution is free of lumps. Add Bio-PDO™ and mix. Heat to 165-170° F. In a separate container prepare Phase 2 and heat to 170-175° F. Add Phase 2 to Phase 1 with good agitation and mix for 30 minutes. Start cooling to 90° F. At 110° F. add Phase 3 ingredients. Stop cooling and agitation at 90° F.

[0595] Properties: Viscosity at 25° C.: 2000-5000 cps; Ph 7.8-8.0

Example 15

[0596]

Skin Soothing Lotion

| Ingredients: | % Wt. |
|---|---|
| Phase 1 | |
| D.I. Water | q.s. to 100.0 |
| Carbopol 940 (B. F. Goodrich) Carbomer | 0.20 |
| Glucam ® P-20 (Amerchol) PPG-20 Methyl Glucose Ether | 0.14 |
| Bio-PDO | 2.25 |
| Phase 2 | |
| Neobee ® M-20 | 4.50 |
| Wecobee ® S | 0.75 |
| Stepan ® 653 | 0.50 |
| Stepan ® Cetyl Alcohol, NF | 0.50 |
| Kartacid 1890 (Akzo Nobel BV) Stearic Acid | 2.95 |
| Phase 3 | |
| Preservative | 0.10 |
| Versene ® 220 (Dow) Tetrasodium EDTA | 0.10 |
| Triethanolamine | 0.25 |
| Total | 100.0 |

[0597] Procedure: Prepare Phase 1. Add Carbopol 940 to D.I. water with good mixing until solution is free of lumps. Add PPG-20 methyl glucose ether and Bio-PDO™. Mix until completely dissolved. Heat to 165° F. In a separate container, prepare Phase 2. Heat to 165-170° F. Add Phase 2 to Phase 1 (both at 165-170° F.) with good agitation. Emulsify for 20 minutes and then begin to cool with slow agitation. At 110° F. add ingredients from Phase 3. At 90° F. stop cooling and agitation.

[0598] Properties: Viscosity: at 25° C.: 2200-3700 cps

Example 16

[0599]

Clear Moisturizer

| Ingredients: | % Wt. |
|---|---|
| *Aloe Vera* Gel | q.s. to 100.0 |
| Bio-PDO | 3.50 |
| Methyl Paraben | 0.15 |
| Carbopol 934 | 0.50 |
| Alcohol 190 Proof | 20.00 |
| Stepan ® PEG 600 ML | 1.00 |
| Tween ® | 2.00 |
| Fragrance | q.s. |
| TEA 88% | 0.8 |
| Glydant | q.s. |
| Total | 100.0 |

[0600] Procedure: Combine Aloe Vera Gel and Bio-PDO™. Start mixing. Add methyl paraben. Mix until solution is clear. Add Carbopol 934. Mix until solution does not have lumps. Add alcohol. Mix well. Premix PEG 600 Monolaurate, Tween 20 and perfume. Add to batch. Mix well. Add Glydant. Add TEA. Solution should be clear.

[0601] Physical Properties: Ph 6.0-6.5

Example 17

[0602]

Therapeutic Hand & Body Lotion

| Ingredients: | % Wt. |
|---|---|
| Phase 1 | |
| D.I. Water | q.s. to 100.0 |
| Bio-PDO | 4.00 |
| Ammonyx ® GA-70PG | 18.4 |
| Phase 2 | |
| Petrolatum | 4.0 |
| Stepan ® IPP | 3.0 |
| Silicone DC-200 (350 cps) | 1.0 |
| Stepan ® Cetyl Alcohol, NF | 2.0 |
| Phase 3 | |
| KCl | 0.4 |
| Citric Acid | q.s. |
| Glydant | q.s. |
| Total | 100.0 |

[0603] Procedure: Prepare water phase by adding water, Bio-PDO™, and Ammonyx® GA-70PG. Mix well. Start

heating to 160° F. Prepare oil phase by adding petrolatum, Stepan® IPP, silicone, Stepan® Cetyl Alcohol. Heat to 160-165° F. Add oil phase to water phase. Emulsify for 20-25 minutes. Start cooling. Premix KCl with water and add into the batch at 100-110° F. Add Glydant at 100° F. Adjust Ph if necessary. Homogenize if necessary.

**[0604]** Physical Properties: Ph 4.0-4.5; viscosity: 3,000-4,000 cps

Example 18

**[0605]**

Cream Conditioner for Permanent - Waved Hair

| Ingredients: | % Wt. |
|---|---|
| Ammonyx ® 4 | 5.00 |
| Bio-PDO | 1.50 |
| Panthenol | 0.50 |
| Citric Acid | q.s. |
| D.I. Water | q.s. to 100 |
| Stepan ® Cetyl Alcohol, NF | 2.50 |
| PPG-Ceteth 20 | 1.25 |
| Stepan ® Stearyl Alcohol 97 | 0.75 |
| Fragrance, Dye & Preservative | q.s. |
| Total | 100.0 |

**[0606]** Procedure: Add ingredients and mix while heating to 75° C. Mix until well blended. Cool with mixing to 30° C. and add fragrance, preservative, and dye if desired. Adjust Ph with citric acid to 3-5.

**[0607]** Physical Properties: Appearance: Opaque, white liquid; Viscosity: 2000 cps

Example 19

**[0608]**

Clear Hair Conditioner

| Ingredients: | % Wt. |
|---|---|
| Ammonyx ® KP | 3.00 |
| Ammonyx ® CETAC | 1.50 |
| Bio-PDO | 1.50 |
| Hydroxyethylcellulose | 0.90 |
| Polyquaternium 10 | 0.25 |
| Fragrance, Dye & Preservative | q.s. |
| Citric Acid | q.s. |
| D.I. Water | q.s. to 100 |
| Total | 100.0 |

**[0609]** Procedure: Disperse hydroxyethylcellulose in D.I. water with mixing until clear. Add Ammonyx® KP and mix until homogeneous. Slowly add Ammonyx® CETAC and mix until homogeneous. Disperse Polyquaternium-10 in Bio-PDO and add to above solution with mixing until clear. Adjust Ph to 5.5, if necessary, with citric acid. Add fragrance, dye and preservative, if desired.

**[0610]** Physical Properties: Ph 5.5; viscosity: 750 cps

Example 20

**[0611]**

Spray-On Detangling Conditioner

| Ingredients: | % Wt. |
|---|---|
| D.I. Water | q.s. to 100.0 |
| Bio-PDO | 1.50 |
| Ammonyx ® KP | 1.00 |
| Surfactant 193 (Dow Corning) Dimethicone Copolyol | 1.00 |
| Tween ® 20 (ICI) Polysorbate-20 | 0.30 |
| Citric Acid (50%) | q.s. |
| Fragrance, Dye & Preservative | q.s. |
| Total | 100.0 |

**[0612]** Procedure: Into a vessel equipped with agitation, add first four ingredients. Mix well. Premix fragrance and Tween® 20 in a separate container. Add to the batch. Mix well. Adjust Ph with citric acid, if necessary. Add dye and preservative as desired.

**[0613]** Physical Properties: Ph 4.0-4.4; Viscosity at 25° C.: water thin

Example 21

**[0614]**

Moisturizing Spray

| Ingredients: | % Wt. |
|---|---|
| Water | 70.8 |
| Preservative | 0.2 |
| Bio-PDO | 28.0 |
| Ammonyx ® GA-70PG | 0.9 |
| Hydrolyzed Silk | 0.1 |
| Fragrance | 0.1 |
| Total | 100.0 |

**[0615]** Procedure: Charge water. Add Bio-PDO™. Heat to 50° C. and blend in Ammonyx® GA-70PG. Mix well until homogeneous. Cool with mixing. At 30° C., add propyl paraben and hydrolyzed silk. Cool to 25° C., add fragrance. Adjust Ph to 5.5-6.5 with citric acid or sodium hydroxide.

**[0616]** Physical Properties: Viscosity: 20 cps

Example 22

**[0617]**

Men's After Shave - Clear Microemulsion

| Ingredients: | % Wt. |
|---|---|
| Phase 1 | |
| Stepan ® PEG 400 MO | 12.7 |
| Stepan ® IPM | 11.0 |
| Stepan ® PEG 400 ML | 7.0 |
| Bio-PDO | 3.5 |

-continued

Men's After Shave - Clear Microemulsion

| Ingredients: | % Wt. |
|---|---|
| Stepan ® GMO | 3.0 |
| DC 556 Silicone Fluid (Dow Corning) | 1.0 |
| Phase 2 | |
| Ethanol | 25.0 |
| Triethanolamine | q.s. |
| Fragrance, dye, preservative | q.s. |
| D.I. Water | q.s. to 100 |
| Total | 100.0 |

[0618] Procedure: Heat D.I. water to 95° C. Mix the components of Phase (1) and heat to 95° C. Add Phase (1) to D.I. water with mixing. Cool to 30° C., and add ethanol. Adjust Ph to 7.0-8.0 with triethanolamine. Add fragrance, dye, and preservative, if desired. This formula will create a clear microemulsion.

[0619] Physical Properties: Ph 7.0-8.0; viscosity: 40 cps

Example 23

[0620]

Hand Cleanser

| Ingredients: | Wt. % |
|---|---|
| Ammonium Lauryl Sulfate (ALS) (28%) | 26.0 |
| Cocamide DEA | 6.0 |
| Sodium Lauryl Sulfate (SLS) (25%) | 18.0 |
| Bio-PDO Propanediol | 1.0 |
| Water | 44.5 |
| Bio-PDO Stearate | 0.5 |
| Irgasan | 0.2 |
| Tetrasodium EDTA (5 wt %) | 2.0 |
| Fragrance | 0.2 |
| Citric acid (50 wt %) | QS |

[0621] Procedure

[0622] Blend ALS, Cocamide DEA, SLS and Zemea™ Propanediol

[0623] Add Bio-PDO Stearate and Irgsan

[0624] Heat to 60° C.

[0625] Cool to 30° C., add EDTA

[0626] Stir until a homogeneous solution is formed

[0627] Adjust to Ph 6 with citric acid

[0628] Add fragrance

[0629] Benefits

[0630] Highly Stable

[0631] Higher Viscosity

[0632] Excellent Foaming

Example 24

[0633]

Hand Cleanser

| Ingredients: | Wt. % |
|---|---|
| Carbopol 934 NF | 0.50 |
| Germaben II | 0.06 |
| Bio-PDO | 5.00 |
| Isopropyl alcohol (IPA) | 47.70 |
| D.I. Water | 43.79 |
| Triethanolamine (20 wt %) | 2.50 |
| Fragrance | 0.50 |

[0634] Procedure

[0635] Heat water and germaben II solution at 50° C.

[0636] Add carbopol

[0637] Stir contents to form uniform gel

[0638] Add Bio-PDO, IPA and water

[0639] Stir until a homogeneous solution is formed

[0640] Cool below 30° C.

[0641] Adjust to Ph 7 with TEA

[0642] Add fragrance

[0643] Benefits

[0644] Highly Stable

[0645] Higher Viscosity

[0646] Excellent Hydrotrope

Example 25

[0647]

Hair Conditioner

| Ingredients | Wt % |
|---|---|
| Ammonyx$^{R}$4[4] | 5.00 |
| Bio-PDO[1] | 1.50 |
| Panthenol | 0.50 |
| Cetyl alcohol[2] | 3.50 |
| Ceteareth[3] | 1.25 |
| Germaben II[2] | 0.50 |
| Fragrance, Dye | QS |
| D.I. Water | QS to 100 |

[1]DuPont Tate & Lyle Bio Products
[2]The Chemistry Store.com, Cayce, SC
[3]Somerset Cosmetic Co. LLC, Renton, WA
[4]Stephan Co. Northfield, IL

[0648] Procedure: Combine components listed in the table, mix well and heat to 75° C. Mix until well blended. Cool mixture and add preservative. Adjust the Ph to 5, if required using citric acid. Mix the mixture overnight. Opaque white liquid is formed.

[0649] Physical Properties: Ph: 5; Opague white liquid is formed.

Example 26

[0650]

| Hand Cleanser | |
|---|---|
| Ingredient | Wt. % |
| Carbopol 934 NF[2] | 0.50 |
| BioPDO[1] | 5.00 |
| Isopropyl alcohol | 57.0 |
| D.I. Water | 35.0 |
| Triethanolamine (20 wt %) | 2.0 |
| Fragrance | QS |

[1]DuPont Tate & Lyle Bio Products
[2]Noveon, Cleveland, OH

[0651] Procedure: Heat the 100 g water to 50° C. and add this hot solution to 4 g Carbopol 940. Stir the gel at 50° C. for 4 h. Stop heating and continue the agitation for 20 h. A uniform gel will formed. Add the Bio-PDO, Isopropyl alcohol and water, agitate until a homogenous mixture is formed and cool the Adjust the Ph to 7 using dilute triethanolamine solution. Add fragrance. Mixture should be clear after Ph is adjusted.

Example 27

[0652]

| Solid Deodorant | |
|---|---|
| Ingredients | Wt % |
| Bio-PDO[1] | 48.0 |
| Sodium stearate | 6.5 |
| Poly(ethylene glycol) monolaurate[6] | 2.0 |
| Irgasan[6] | 0.2 |
| Water | QS |

[1]DuPont Tate & Lyle Bio Products
[6]Sigma-Aldrich, Milwaukee, WI

[0653] Procedure: To the mixture of Bio-PDO and water add sodium stearate and heat it to 100° C. until a clear liquid is formed add PEG monolaurate. Cool the mixture to 50° C. and pour into containers.

Example 28

[0654]

| Clear Tanning Spray Gel | |
|---|---|
| Ingredients | Wt % |
| Phase A | |
| D.I water | 12.5 |
| Carbopol 934[5] | 0.5 |
| Germaben II[2] | 0.05 |
| Phase B | |
| Bio-PDO[1] | 5.0 |
| Ethanol | 20.0 |

-continued

| Clear Tanning Spray Gel | |
|---|---|
| Ingredients | Wt % |
| Poly(ethylene glycol) monolaurate[6] | 1.0 |
| Polysorbate 60[3] | 2.0 |
| Phase C | |
| 2-Phenyl-5-benzimidazolesulfonic acid[6] | 2.0 |
| Triethanol amine | 2.0 |
| D.I. water | 25.0 |
| Phase D | |
| D.I water | QS |
| Germaben II[2] | 0.8 |

[1]DuPont Tate & Lyle Bio Products
[2]The Chemistry Store.com, Cayce, SC
[3]Somerset Cosmetic Co. LLC, Renton, WA
[4]Stephan Co. Northfield, IL
[5]Noveon, Cleveland, OH
[6]Sigma-Aldrich, Milwaukee, WI

[0655] Procedure: Mix water and Germaben II of phase and heat the mixture to 50° C. and add this hot solution to Carbopol. Stir the gel at 50° C. for 4 h. Stop heating and continue the agitation for 20 h. In a separate container, take 2-Phenyl-5-benzimidazolesulfonic acid, add water and triethanolamine. Mix the components until a clear solution is formed. Add Bio-PDO, ethanol PEG monolaurate and polysorbate 60. Mix until a uniform gel is formed. Add phase C, mix the gel thoroughly. Add water and preservative continue agitation until a clear gel is formed. Ph should be about 7.

Example 29

[0656]

| Men's After Shave | |
|---|---|
| Ingredients | Wt % |
| Phase A | |
| Poly(ethylene glycol) monooleate[6] | 17.5 |
| *Aloe Vera* | 5.0 |
| Poly(ethylene glycol) monolaurate[6] | 7.0 |
| Bio-PDO[1] | 5.0 |
| Sorbitol[3] | 3.0 |
| Panthenol | 0.5 |
| Phase B | |
| Ethanol | 25.0 |
| GermabenII[2] | 0.5 |
| Triethanol amine, Fragrance, dye | QS |
| Water | QS to 100 |

Viscosity 21 cps
[1]DuPont Tate & Lyle Bio Products
[2]The Chemistry Store.com, Cayce, SC
[3]Somerset Cosmetic Co. LLC, Renton, WA
[4]Stephan Co. Northfield, IL
[5]Noveon, Cleveland, OH
[6]Sigma-Aldrich, Milwaukee, WI

[0657] Procedure: Combine components of phase A and heat to 80° C. Add water and heat to 80° C. Cool to 30° C. and add ethanol. Adjust the Ph to 7.0-8.0 with triethanolamine, if required Add fragrance, dye and preservative.

Example 30

[0658]

| Skin Lotion | |
|---|---|
| Ingredients | Wt % |
| **Phase A** | |
| D.I. Water | 20 |
| Carbopol 934 NF[5] | 0.15 |
| Bio-PDO[1] | 3.00 |
| **Phase B** | |
| Stephan IPM[4] | 5.00 |
| Dimethicone[3] | 0.10 |
| Cetyl Alcohol[2] | 0.50 |
| Stearic acid | 3.00 |
| **Phase C** | |
| Triethanolamine | 1.80 |
| Tetrasodium EDTA (5%) | 4.00 |
| Preservative | Q.S. |
| D.I. Water | Q.S. to 100 |

Physical Properties: Ph 7.5; Viscosity: #4@ 60 rpm 2240 cps
[1]DuPont Tate & Lyle Bio Products
[2]The Chemistry Store.com, Cayce, SC
[3]Somerset Cosmetic Co. LLC, Renton, WA
[4]Stephan Co. Northfield, IL
[5]Noveon, Cleveland, OH

[0659] Procedure: Combine components of phase A, mix well and heat to 80° C. Combine Stephan IPM, dimethicone and cetyl alcohol in a different container and heat the mixture to 80° C. until a clear solution is formed. Add stearic acid to phase B and heat the mixture again at 80° C. until a clear solution is formed. Combine the Phase A and Phase B until well blended Cool the mixture to 50° C. and add triethanol amine and tetrasodium EDTA solution. Heat the mixture until mixture is well blended. Cool the mixture and add required amounts of water and preservative.

Example 31

[0660]

| Clear Moisturizer | |
|---|---|
| Ingredients | Wt % |
| **Phase A** | |
| *Aloe Vera* Gel | QS to 100 |
| Bio-PDO[1] | 3.5 |
| Carbopol 934[5] | 0.5 |
| Ethanol | 20 |
| PEG | 1.0 |
| Triethanol amine | 0.8 |
| Fragrance | Qs |
| Germaben II[2] | 0.2 |

[1]DuPont Tate & Lyle Bio Products
[2]The Chemistry Store.com, Cayce, SC
[3]Noveon, Cleveland, OH

[0661] Procedure: Combine Aloe Vera Gel, Bio-PDO and GermabenII. Mix until the solution is clear. Add Carbopol. Heat the mixture to 60° C. with stirring until the solution does not have lumps. Add alcohol. Mix well. Add PEG. Mix well until it forms clear solution. Add perfume, TEA and preservative.

Example 32

[0662]

| Clear Shampoo | |
|---|---|
| Ingredients | Wt % |
| Blend 213[2] | 25 |
| Sodium Laureth Sulfate | |
| Cocamidopropyl Betaine Cocamide DEA | |
| PEG-150 Distearate | |
| Cocamidopropyl Betaine[2] | 5 |
| Bio-PDO[1] | 5 |
| DI Water | 65 |
| Sodium chloride solution (25 wt %) | QS |

[1]DuPont Tate & Lyle Bio Products
[2]The Chemistry Store.com, Cayce, SC

[0663] Procedure: Mix Blend 213 and cocamidopropyl betaine, add BioPDO, mix well. Add water and stir for 20 h. Adjust the viscosity with sodium chloride solution, if required.

Example 33

[0664]

| Kid's Soap with Antibacterial Agent | |
|---|---|
| Ingredients | Wt % |
| **Phase A** | |
| Custom Blend BSC | 40.0 |
| Bio-PDO[1] | 2.0 |
| Chloroxylenol | 0.75 |
| **Phase B** | |
| NaCl (25 wt %) solution | 1.00 |
| D.I Water, Fragrance | QS |

[1]DuPont Tate & Lyle Bio Products
[7]Custom Ingredients, Inc. Chester, SC

[0665] Properties: Ph: 7; Viscosity: 3000 cps

[0666] Procedure: Combine components of phase A and mix well. Apply heat to completely dissolve and achieve a clear solution. Add warm water slowly and heat to clarity. Cool very slowly with mixing. Adjust the viscosity with sodium chloride. Add desired fragrance.

Example 34

[0667]

Foundation

| SEQ | INGREDIENT | % Wt |
|---|---|---|
| A | Deionized Water | 63.00 |
| A | CMC 7H3SF | 0.30 |
| A | Veegum Ultra Granules | 0.35 |
| A | Alcolec S (Lecithin) | 0.40 |
| A | Triethanolamine 99% | 1.25 |
| A | Bio-PDO (1,3 Propanediol) | 6.00 |
| B | Titanium Dioxide (water dispersible | 8.00 |
| B | Red Iron Oxide | 0.40 |
| B | Yellow Iron Oxide | 0.80 |
| B | Black Iron Oxide | 0.10 |
| B | Collodial Kaolin | 2.00 |
| B | Methyl Paraben | 0.20 |
| C | Permethyl ® 102A (Isoeicosane) | 10.00 |
| C | Isostearic Acid | 1.00 |
| C | Stearic Acid Triple Pressed | 2.50 |
| C | LIPO GMS 450 (Glyceryl Monostearate) | 1.50 |
| C | Liponate TDTM (Tridecyl Trimelitate) | 1.00 |
| C | LIPO GMS 470 (Glyceryl Monostearate) | 1.00 |
| C | Propyl Paraben | 0.20 |
| | FORMULA TOTALS: | 100.00 |

[0668] The manufacturing procedure for this emulsion was typical for all oil-in-water type products. Sequence A was dispersed and when the gums were completely hydrated and the phase was uniform, pre-ground Sequence B (pigment phase) was added to it and mixed until both phases were completely uniform and homogeneous. Sequence C was weighed in a separate vessel and heated to 75°-80° C. until all the solids were melted and the phase was uniform. Sequence A was then heated to 75°-80° C. When all the phases were all at the proper temperatures, Sequence C (oil phase) was slowly added to Sequences A & B (water phase). The emulsion was allowed to mix at 75° C. for 15 minutes and then cooled to 25° C. Samples for testing were then poured off and placed at their respective stability stations in preparation for the 4 week study. The color and powder fill loading in these formulations was kept constant at 11.30% dry pigment. Conventional powder fill ingredients were chosen for these formulations as to eliminate any potential variability in test results.

[0669] Physical Testing:

Brookfield Model RV - Spindle 5 at 20 rpm for 1 minute (factor × 200)

| initial Ph | initial Viscosity | 1 week Viscosity | 2 week Ph | 2 week Viscosity | 3 week Viscosity | 4 week Ph | 4 week Viscosity |
|---|---|---|---|---|---|---|---|
| 8.03 | 2400 | 2900 | 7.94 | 2900 | 2900 | 8.02 | 2900 |

[0670] Viscosity readings throughout the 4 week test period showed that there was no unusual build or decrease in viscosity. Oven stability consisted of R/T, 45° C., and 2 Freeze/Thaw cycles. After 4 weeks, samples showed no signs of separation, sweating, severe loss of viscosity, change in consistency, loss of structure, odor problems, or color change at any temperature.

Aesthetic Properties

[0671] All samples were evaluated for potential differences in odor, color, appearance, application, texture, feel, wearability, or any other differences, if any. All foundation samples were evaluated side-by side. In no cases were there any perceivable differences in any of the aesthetic properties associated with these types of cosmetic properties. Any differences noticed were insignificant and were not a result of the ingredient changes. These were all fragrance free formulations, and there were no apparent odor differences in any of the samples.

Example 35

[0672]

Mascara

| SEQ | INGREDIENT | % Wt. |
|---|---|---|
| A | Deionized Water | 49.00 |
| A | Xanthan Gum | 0.15 |
| A | Veegum HV Granules | 0.55 |
| A | Disodium EDTA | 0.05 |
| A | Triethanolamine 99% | 0.50 |
| A | Alcolec S (Lecithin) | 0.20 |
| A | Methyl Paraben | 0.30 |
| A | Bio-PDO | 10.00 |
| B | Black Iron Oxide | 9.00 |
| C | DC 345 Fluid (D5 Cyclomethicone) | 4.50 |
| C | DC5225C Formulation Aid | 0.90 |
| C | White Beeswax | 7.25 |
| C | Carnauba Wax #1 | 3.50 |
| C | Stearic Acid Triple Pressed | 1.80 |
| C | Lipomulse 165 (Glyceryl Monostearate) | 1.80 |
| C | Indopol H100 (Polybutene) | 3.50 |
| C | Phenoxyethanol | 1.00 |
| C | Propyl Paraben | 0.20 |
| C | PVP/Eicosene Colpolymer | 4.00 |
| C | Lipocol S (Stearyl Alcohol) | 1.80 |
| | FORMULA TOTALS: | 100.00 |

[0673] The manufacturing procedure for this formula was similar to that of the foundation in Example 24. Higher temperatures were required for the oil phase due to the high level of hard waxes employed in this product. Sequence A was dispersed and when the gums were completely hydrated and the phase was uniform, pre-ground sequence B (pigment phase) was added to it and mixed until both phases were completely uniform and homogeneous. Sequence C was weighed in a separate vessel and heated to 80°-85° C. until all the solids were melted and the phase was uniform.

Sequence A was then heated to 75°-80° C. When all the phases were all at the proper temperatures, Sequence C (oil phase) was slowly added to Sequences A & B (water phase). The emulsion was allowed to mix at 75° C. for 15 minutes. When the batch began to thicken at around 45° C., a paddle mixer was used to adequately turn over and mix the batch. The batch was mixed and cooled to 35° C. Samples for testing were then poured off and placed at their respective stability stations in preparation for the 4 week study. The color loading in these formulations was kept constant at 9.00% dry pigment. No other powder fill, except for the black iron oxide pigment, was employed in these formulations. Additional powder fills will lend to a whitening and ashyness, which, in mascaras, is unacceptable.

[0674] Physical Testing

| Brookfield Model RV - Spindle T at 5 rpm for 1 minute (factor × 10,000) | | | | | | | |
|---|---|---|---|---|---|---|---|
| initial Ph | initial Viscosity | 1 week Viscosity | 2 week Ph | 2 week Viscosity | 3 week Viscosity | 4 week Ph | 4 week Viscosity |
| 8.58 | 180,000 | 320,000 | 8.55 | 380,000 | 430,000 | 8.55 | 420,000 |

[0675] Viscosity readings throughout the 4 week test period showed that there was no unusual build or decrease in viscosity. The variations seen are very typical for a product of this type and fall within an acceptable range for a mascara type product. Oven stability consisted of R/T, 45° C., and 2 Freeze/Thaw cycles. After 4 weeks, samples showed no signs of separation, sweating, severe loss of viscosity, change in consistency, loss of structure, odor problems, or color change at any temperature.

Aesthetic Properties:

[0676] All samples were evaluated for potential differences in odor, color, appearance, application, texture, feel, wearability, or any other differences, if any. All mascara samples were evaluated side-by side. In no cases were there any perceivable differences in any of the aesthetic properties associated with these types of cosmetic properties. Any differences noticed were insignificant and were not a result of the ingredient changes. Additionally, the mascara samples showed no differences in water resistance. Even though the mascara was not specifically designed to be water resistant, side by side, the products performed equally. These were all fragrance free formulations, and there were no apparent odor differences in any of the samples.

Example 36

[0677]

| Body Wash | |
|---|---|
| Ingredients: | % Wt. |
| Water | 45.0 |
| Ammonium Lauryl Sulfate, 25% | 21.0 |
| Ammonium Laureth Sulfate, 28% | 21.0 |
| Cocamidopropyl Betaine, 35% | 4.0 |
| Acrylates Copolymer, Structure 3001 (30%) | 5.0 |

-continued

| Body Wash | |
|---|---|
| Ingredients: | % Wt. |
| Bio-PDO | 1.0 |
| Glycerin | 1.0 |
| PEG 10 Sunflower Glycerides | 0.5 |
| Soybean Oil | 0.2 |
| Fragrance | (0.2) |
| Cocamide MEA | 0.2 |
| PEG 5 Cocamide | 0.2 |
| Guar Hydroxypropyl trimonium Chloride | 0.2 |
| Diisopropanolamine | 0.1 |
| Methylcellulose | 0.05 |

-continued

| Body Wash | |
|---|---|
| Ingredients: | % Wt. |
| Carbomer | 0.05 |
| Tetrasodium EDTA | 0.05 |
| Methylchloroisothiazolinone, Methylisothiazolinone | 0.05 |
| Etidronic Acid | 0.05 |
| Guanine (CI 75170) | 0.05 |
| Mica (CI 77019) | 0.05 |
| Titanium Dioxide (CI 77891) | 0.05 |
| TOTAL | 100 |

[0678] Ingredients were combined in the following order, with propeller mixer agitation, allowing each ingredient to dissolve, disperse completely before adding the next. Batch was processed at 60° C.: Water, Acrylates polymer, ALS, ALES, GAB, Guar Hydroxypropyl trimonium Chloride, EDTA, PEG 10 Sunflower glycerides, soybean oil, cocamide MEA, PEG 5 cocamide, iisopropanolamine/methylcellulose/carbomer/guanine, mica/titanium oxide, glycerin.

Example 37

[0679]

| Baby Lotion | |
|---|---|
| Ingredients: | % Wt. |
| Water | 85.2 |
| Bio-PDO | 3.0 |
| Myristyl Myristate | 2.5 |
| Glyceryl Stearate | 1.5 |
| Oleic Acid | 1.2 |
| Stearic Acid | 1.2 |

-continued

| Baby Lotion | |
|---|---|
| Ingredients: | % Wt. |
| Polysorbate 61 | 0.6 |
| C12-15 Alkyl Benzoate | 0.5 |
| Dimethicone | 0.5 |
| Isopropyl Palmitate | 0.5 |
| Sorbitan Stearate | 0.5 |
| Cetyl Alcohol | 0.5 |
| Synthetic Beeswax | 0.5 |
| Stearyl Alcohol | 0.5 |
| Benzyl Alcohol | 0.4 |
| Carbomer 934 | 0.4 |
| Fragrance | 0.1 |
| Methylparaben | 0.2 |
| Propylparaben | 0.05 |
| Butylparaben | 0.05 |
| BHT | 0.05 |
| D&C Red 3 | trace |
| TOTAL | 100 |

[0680] Ingredients were combined in the following order, allowing each to dissolve/disperse completely before adding the next:

[0681] Phase A: Disperse Carbomer in water with high speed agitation, allowing particles to wet completely. Add Bio-PDO. Heat to 70° C.

[0682] Phase B: Combine Myristyl Myristate, glyceryl stearate, Oleic Acid, Polysorbate 61, C12-15 Alkyl Benzoate, Dimethicone, Isopropyl Palmitate, Sorbitan Stearate, Cetyl Alcohol, Synthetic Beeswax, Stearyl; Alcohol, Benzyl Alcohol, Methylparaben, Propylparaben, Butylparaben, and BHT, heat to 70° C.

[0683] With continuous high speed agitation, slowly add Phase B to Phase A to form emulsion. Remove from heat and begin cooling with continued agitation. After several minutes of mixing, add NaOH, dissolved in a small amount of water. Batch will thicken. When Batch reaches room temperature, add color, fragrance, and replace water lost to evaporation. Batch is complete.

Example 38

[0684]

| Sulfate-Free Shampoo | | |
|---|---|---|
| Phase | Ingredients: | % Wt. |
| A | Water | 33.82 |
| A | $NA_2EDTA$ | 0.05 |
| A | BIOTERGE AS 40 | 45.00 |
| A | GLUCAMATE DOE 120 | 1.50 |
| A | Bio-PDO | 4.75 |
| B | MONAMID CMA | 3.00 |
| B | VELVETEX BK 35 | 10.00 |
| C | KATHON CG | 0.06 |
| C | MACKPEARL 140V | 1.50 |
| D | CITRIC ACID, 20% SOLN TO PH 6.0-6.5 | 0.32 |
| TOTAL | | 100.00 |

Manufacturing Process:

[0685] Phase A: Combine Phase A ingredients into water and heat with mixing to 75° C. Slowly add remaining Phase A ingredients. Hold temperature at 75° C. and mix slowly.

[0686] Phase B: Combine phase B ingredients and heat to 75° C. with slow mixing. Add Phase B to Phase A and mix until uniform.

[0687] Phase C: Add Phase C one at a time

[0688] Phase D: Use Phase D to adjust the Ph of batch to 6.0-6.5

Example 39

Colored Cosmetic Composition (Liquid Make-Up)

[0689] Preparation: Mix the ingredients of phase B (aqueous phase) and heat the mixture to 65° C. with thorough stirring to form a homogeneous aqueous phase.

[0690] Separately mix the contents of phase A until a uniform gel is formed. Mix phase A and phase B and heat the mixture while stirring at 65° C. for 1 hour. Cool the composition and transfer into containers.

| Ingredients | Wt % |
|---|---|
| Phase A | |
| Titanium Dioxide | 6.0 |
| Iron Oxide, red | 1.0 |
| Pigment Blend 5 | 0.5 |
| Bourdaux Mica | 0.5 |
| Caster Oil | 8.0 |
| Phase B | |
| Water | 46.9 |
| Bio-PDO | 22.0 |
| Emulsifying Vax | 9.0 |
| Sodium Stearate | 4.5 |
| GelMaker EMU | 1.3 |
| Methylbaraben | 0.3 |

[0691] Stable oil in water emulsions were obtained.

Example 40

Colored Cosmetic Composition (Liquid Make-Up)

[0692] Preparation: Mix the ingredients of phase B (aqueous phase) and heat the mixture to 65° C. with thorough stirring to form a homogeneous aqueous phase.

[0693] Separately mix the contents of phase A until a uniform gel is formed. Mix phase A and phase B and heat the mixture while stirring at 65° C. for 1 hour. Cool the composition and transfer into containers.

| Ingredients | Wt % |
|---|---|
| Phase A | |
| Titanium Dioxide | 5.0 |
| Iron Oxide, red | 1.0 |
| Pigment Blend 5 | 0.5 |

-continued

| Ingredients | Wt % |
|---|---|
| Bourdaux Mica | 0.5 |
| Caster Oil | 9.0 |
| Phase B | |
| Water | 46.9 |
| Bio-PDO | 22.0 |
| Emulsifying Vax | 9.0 |
| Sodium Stearate | 4.5 |
| GelMaker EMU | 1.3 |
| Methylbaraben | 0.3 |

[0694] Stable oil in water emulsions were obtained.

Example 41

[0695]

EYE MAKEUP REMOVER

| INGREDIENT | Weight Percent |
|---|---|
| C13-15 Alkanes (Gemseal ® 25) | 5.00 |
| C15-19 Alkanes (Gemseal ® 40) | 10.00 |
| Oleth-5 | 13.00 |
| DEA Oleth-3 Phosphate | 5.75 |
| Deionized Water | 47.45 |
| Bio-PDO | 12.00 |
| Glycerin 99% | 6.50 |
| Germaben II-E | 0.30 |

[0696] Manufacturing Procedure:

[0697] Weigh the ingredients in Sequence A in a suitable vessel. Begin heating to 75-80° C. with good mixing. Weigh ingredients in Sequence B in a secondary vessel. Begin heating to 75-80° C. with good mixing. When both sequences are at the proper temperatures, slowly add Sequence B to Sequence A with continuous propeller mixing. Increase mixer speed as the sequences are combined. Switch to a side wiping mixer and continue mixing until the batch is smooth, uniform and homogeneous. Mix for 15 minutes and begin cooling the batch with continuous mixing. Cool the batch to 25° C. At 25° C., remove the batch and store in airtight containers. Check the viscosity and Ph of the batch.

Example 42

[0698]

Eye Shadow

| Ingredient | Weight Percent |
|---|---|
| Deionized Water | 44.15 |
| Keltrol F | 0.20 |
| Veegum Regular Granules | 2.00 |
| Disodium EDTA | 0.10 |
| Triethanolamine 99% | 0.50 |
| Bio-PDO | 10.00 |
| Lubrajel Oil | 1.00 |
| Isodecyl Neopentanoate | 7.35 |

-continued

Eye Shadow

| Ingredient | Weight Percent |
|---|---|
| Lipo GMS 450 | 2.00 |
| Behenyl Alcohol | 0.50 |
| Myristyl Alcohol | 0.50 |
| Cetyl Alcohol | 0.50 |
| Stearic Acid | 1.50 |
| Alcolec S | 0.15 |
| Isostearyl Neopentanoate | 5.00 |
| Tocopheryl Acetate | 0.05 |
| Allianz ™ OPT | 1.00 |
| DC 345 Fluid - Cyclomethicone | 7.50 |
| Germaben II-E | 1.00 |
| Cosmetic Russet C33-5138 | 0.60 |
| Cosmetic Yellow C33-1700 | 0.12 |
| Black Iron Oxide LC989 | 0.24 |
| Sericite PHN | 0.24 |
| Timica Sparkle 110P | 13.80 |

[0699] Manufacturing Procedure:

[0700] Combine ingredients in Phase A and begin mixing until the Phase is smooth and uniform. Combine Phase B ingredients and begin heating to 80° C. with continuous mixing. Heat Phase A to 75-80° C. When Phase A and Phase B are at the proper temperatures slowly add Phase B to Phase A using continuous high speed homogenizing mixing. Add Phase C to the batch with homogenizing mixing. When the batch is uniform, begin cooling the batch to 55° C. with continuous homogenizer mixing. At 55° C. add Phase D to the batch. Mix until uniform. Add Phase E to the batch and mix until uniform. Weigh Phase F in a suitable blender. Grind Phase F through a micropulverizer or equivalent. When Phase F is free of pigment specks, add Phase G to Phase F and blend until uniform. In the main batch vessel, switch to a side wiping mixer and begin cooling the batch to 25° C. At 25° C. add Phase F & G to the batch and mix until all the powders are dispersed and batch is smooth and uniform. Store the batch in airtight containers until ready for filling. Check the viscosity and Ph of the batch.

Example 43

[0701]

Cheek Color

| Ingredients | Weight Percent |
|---|---|
| Deionized Water | 62.00 |
| Bio-PDO | 8.00 |
| Stepanquat ML | 2.00 |
| Germaben II-E | 1.00 |
| SI-TEC ™ CM-040 Cyclomethicone | 20.00 |
| Abil EM-90 | 1.00 |
| Salcare SC-95 | 2.00 |
| Phenoxyethanol | 1.00 |
| SI-TEC ™ CM-040 Cyclomethicone | 1.80 |
| Titanium Dioxide 328 | 0.68 |
| D&C Red 30 (Puricolor Red VRE1) | 0.52 |

[0702] Manufacturing Procedure:

[0703] NOTE: This is a cold process emulsion and must be manufactured at room temperature (25° C.). Combine Phase

A in a suitable mixing vessel. Mix until the Phase is clear and uniform. Combine Phase B in a suitable mixing vessel. Mix until the Phase is clear and uniform. Premix Phase C in a separate container and grind through a 3-roll mill until there are no pigment specks present. Add Phase C to Phase B and mix until all the color is dispersed. When Phases A and B & C are uniform, slowly add Phase A to combined Phases B & C and mix until all the phases are combined. Switch to a homogenizing mixer and mix for 10-15 minutes. Store the batch in airtight containers until ready for filling. Check the viscosity and Ph of the batch.

Example 44

[0704]

Liquid Eyeliner

| Ingredients | Weight Percent |
|---|---|
| Deionized Water | 35.00 |
| Keltrol F | 0.20 |
| Methyl Paraben | 0.25 |
| PVP K-30 (10% Aq Solution) | 11.75 |
| Triethanolamine 99% | 1.00 |
| Bio-PDO | 10.00 |
| Cosmetic Russet C33-5138 | 5.00 |
| Cosmetic Yellow C33-1700 | 1.00 |
| Black Iron Oxide LC989 | 2.00 |
| Sericite PHN | 2.00 |
| Carnauba Wax #1 | 4.00 |
| White Beeswax | 2.00 |
| Permethyl 104A | 6.00 |
| Stearic Acid | 2.50 |
| Lipo GMS 450 | 1.00 |
| Propyl Paraben | 0.20 |
| Phenoxyethanol | 1.00 |
| Deionized Water | 1.00 |
| Germall 115 | 0.10 |
| Lubrajel Oil | 14.00 |

[0705] Manufacturing Procedure:

[0706] Combine Phase A ingredients in a suitable mixing vessel, Mix until the Phase is uniform. Grind Phase B in a micropulverizer. When Phase B is free of pigment specks, add Phase B to Phase A with continuous mixing. Mix until the phases are uniform and free of lumps. Homogenize the batch for 10-15 minutes or as necessary to make Phase A & B smooth and homogeneous. In a separate vessel combine Phase C ingredients and begin heating to 80-85° C. with good mixing. Begin heating Phase A to 75-80° C. When all phases are at the proper temperatures slowly add Phase C to Phases A & B with continuous mixing. Mix for 15 minutes with the batch covered to prevent water loss. Begin cooling the batch. Combine Phase D ingredients in a separate vessel. At 50° C. slowly add Phase D to the batch with continuous mixing. Continue cooling the batch to room temperature. At 25° C. remove the batch and store in airtight containers until ready for filling. Check the viscosity and Ph of the batch.

Example 45

[0707]

Hair Dye Base and Shade Formulations

| Ingredient | Dye Base | Dk Ash Bn | Med Auburn |
|---|---|---|---|
| Water | 59.78 | 59.78 | 59.78 |
| AlkylPolyglucoside | 1.75 | 1.75 | 1.75 |
| Oleic Acid | 10.00 | 10.00 | 10.00 |
| Nonoxynol-1 | 0.70 | 0.70 | 0.70 |
| Nonoxynol-4 | 1.23 | 1.23 | 1.23 |
| Ammonium Hydroxide | 4.00 | 4.00 | 4.00 |
| EDTA (4Na) | 0.05 | 0.05 | 0.05 |
| Erythorbic Acid | 0.40 | 0.40 | 0.40 |
| Sodium Sulfite | 0.10 | 0.10 | 0.10 |
| Bio-PDO | 7.00 | 7.00 | 7.00 |
| Heat to 80 C. for 10 min., cooled, q.s., add IPA | | | |
| Isopropanol 99% | 5.00 | 5.00 | 5.00 |
| Water | 10.00 | 6.06 | 8.137 |
| | 100.00 | | |
| p-Phenylenediamine | | | 0.369 |
| Toluene-2,5-Diamine Sulfate | | 1.763 | 0.000 |
| m-Aminophenol | | 0.146 | 0.018 |
| Resorcinol | | 1.685 | 0.000 |
| 1-Naphthol | | 0.168 | 0.047 |
| N,N-Bis(2-Hydroxyethyl)-PPD Sulfate | | 0.176 | 0.046 |
| 4-Amino-2-Hydroxytoluene | | | 0.922 |
| p-Aminophenol | | | 0.461 |
| Ammonium Hydroxide (q.s. to Ph 10.0) | | q.s. | q.s. |
| | | 100.00 | 100.00 |
| Ph (25 C.) | 10.03 | | |
| Viscosity cps (20 C; RVT; #2; 100 RPM) | 425 | 380-440 | 350-390 |

Example 46

[0708]

Composition for use before shaving

| Ingredient | Weight Percent |
|---|---|
| EDTA | 35% |
| Sodium lauryl sulfate | 3.3% |
| Nipagin | 20% |
| Nipazol | 0.08% |
| Cetyl alcohol | 1.8% |
| Carbopol 940 | 1.4% |
| White wax | 0.15% |
| Polysorbate 80 | 4% |
| Bio-PDO | 11.5% |
| Triethanolamine | 1.7% |
| Water | 21.07% |

Example 47

[0709]

| Aftershave | |
|---|---|
| Ingredient | Weight Percent |
| Isopropanol | 30-70% |
| SD alcohol-40 | 10-30% |
| Acetylsalicylic acid | 8-22% |
| Carbomer | 0.25-1.75% |
| Propylene glycol | 2-15% |
| Glycerin | 2-15% |
| PEG | 1-8% |
| Water | q.s. to 100% |

Example 48

[0710]

| Shaving cosmetics containing moisturizers | |
|---|---|
| Ingredients | Weight Percent |
| Bio-PDO | 50-90% |
| Oils | 0.1-30% |
| H2O | 0.01-10% |
| Also: | |
| H2O | 5.0% |
| Glycerin | 31.5% |
| 1,3-butylene glycol | 20.0% |
| Bio-PDO | 20.0% |
| Polyethylene glycol | 15.0% |
| Isostearic acid | 7.0% |
| Dimethylpolysiloxane | 1.0% |
| Perfume | 0.5% |

Example 49

[0711]

| Stick delivery system<br>Treatment of razor burn | |
|---|---|
| Ingredient | Weight percent |
| Solvent* | |
| Bio-PDO | 72% |
| Gelling agent** | |
| Sodium stearate | 8% |
| Agent*** | |
| lidocaine | 4% |
| Menthol | 1% |
| Water | 15% |

*polyhydric alcohol
**alkali metal stearate and/or palmitate
***anesthetic, an antihistamine, an anti-inflammatory agent, an antifungal

Example 50

[0712]

| Water-in-oil emulsion Brushless nonlathering shaving cream | |
|---|---|
| Ingredient | Weight Percent |
| Long-chain fatty alcohol* | 4-15% |
| Surfactant** | 1-10% |
| Wetting agent*** | 1-10% |
| Emollient**** | 4-20% |

*lauryl, stearyl, cetyl, myristyl
**anionic, nonionic, amphoteric, or quaternary surfactants/emulsifiers
***glycerol, propylene glycol, sorbitol, or polyethylene glycol
****□rabic□t or mineral oils

Example 51

[0713]

| Shaving cream | |
|---|---|
| Ingredient | Weight Percent |
| 70% sorbitol | 6.19% |
| Bio-PDO | 6.19% |
| Stearic acid | 22.80% |
| C10-16 fatty acids | 19.00% |
| 40% KOH | 20.60% |
| Boric acid | 0.70% |
| H2O | 23.35-26.37% |
| Perfume | 1.00-1.17% |
| Allantoin | 0.20% |
| Nipagin | 0.20% |
| Vegetable oil | 3.00% |

Example 52

[0714]

| Shaving creams | |
|---|---|
| Ingredient | Weight Percent |
| A) | |
| Stearin and coconut oil | 40.56% |
| 40% KOH | 20.68% |
| 70% sorbitol and Bio-PDO | 13.66% |
| H3BO3 | 2.74% |
| Allantoin | 2.74% |
| Anesthesin | 2.74% |
| Nipagin | 2.74% |
| H2O | 22.36% |
| B) | |
| Stearin | 31% |
| Coconut oil | 10% |
| 40% KOH | 20.48% |
| 70% sorbitol | 6.0% |
| Bio-PDO | 7.65% |
| H3BO3 | 0.65% |
| Nipagin | 1.0% |
| Allantoin | 1.0% |
| Anesthesin | 0.74% |
| Perfume | 1.0% |

-continued

Shaving creams

| Ingredient | Weight Percent |
|---|---|
| Dye | 0.05% |
| Na alginate | 0.07% |
| H2O | 20.36% |

Example 53

[0715]

Pre-shave sticks

| Ingredient | Weight Percent |
|---|---|
| A) | |
| Glyceryl monooleate | 25-70% |
| Sodium stearate | 8-25% |
| Bio-PDO | 0-50% |
| H2O | 1-10% |
| B) | |
| Atlas G-3496 | 61.65% |
| Sodium stearate | 15.0% |
| Water | 3.0% |
| Perfume | 0.35% |
| Bio-PDO | 20.0% |

Example 54

[0716]

Liquid shaving compositions

| Ingredient | Weight Percent |
|---|---|
| A) | |
| Nonionic surfactant | 60-97% |
| Bio-PDO | 2-25% |
| H2O | 1-15% |
| B) | |
| Glycerol monooleate | 77.8% |
| polyoxyethylene (20) sorbitan monolaurate | 6.6 |
| H2O | 6% |
| Bio-PDO | 9.6% |

Example 55

[0717]

Shaving Solution

| Ingredient | Weight Percent |
|---|---|
| Bio-PDO | 50-80% |
| Deionized water | 1-50% |

Example 56

[0718]

Shaving Solution

| Ingredient | Weight Percent |
|---|---|
| Bio-PDO | 50-80% |
| Deionized water | 1-50% |

Example 57

[0719]

Skin Preparation Solution
Application to the surface of the skin prior to shaving

| Ingredient | Weight Percent |
|---|---|
| Bio-PDO | 10-80% |
| Deionized water | 10-80% |
| Imidazolidinyl urea | 0.02-4% |
| Methylparaben | 0.02-4% |
| Propylparaben | 0.01-2% |

Example 58

[0720]

Post hair removal skin care lotion

| Ingredient | Weight Percent |
|---|---|
| Deionized water | q.s. to 100% |
| Aloe vera gel | 6-7.4% |
| Soybean oil | 6-7.4% |
| Alpha lipoic acid | 0.2-1.3% |
| Stearic acid | 3.5-4.3% |
| Glyceryl monostearate | 3-3.7% |
| Bio-PDO | 2.5-3.1% |
| Lauramide DEA | 1.4-1.6% |
| Vitamin E | 0.4-0.5% |
| Hydrocortisone acetate | 0.2-0.5% |
| Vitamin C | 0.2-0.25% |
| Carbomer | 0.2-0.25% |
| Hydroxymethylcellulose | 0.2-0.25% |
| Methylparaben | 0.2-0.25% |
| Propylparaben | 0.09-0.1% |
| Polyquaternium-15 | 0.09-0.1% |

Example 59

[0721]

Transparent shaving gel

| Ingredient | Weight Percent |
|---|---|
| Bio-PDO | 15-20% |
| Lubricant/skin conditioners | 2-5% |
| Thickener | 0.5-0.8% |

-continued

Transparent shaving gel

| Ingredient | Weight Percent |
|---|---|
| Neutralizer | 0.5-0.8% |
| Preservative | 0.2-0.5% |

Example 60

[0722]

Enzyme-containing toothpastes

| Ingredient | Weight Percent |
|---|---|
| Bio-PDO | 20-73 |
| Friction materials | 15-50 |
| Thickening agent | 1-1.7 |
| Surfactant | 1-6 |
| Essence | 0.8-1.2 |
| Water | 8-35 |
| Saccharin | 0.1-0.3 |
| Pigment | 0-0.5 |
| PEG | 0-6 |
| Biological enzyme | 0.01-2 |
| Menthol | 0-0.1 |
| Sodium dihydrogen phosphate | 0.1-0.5 |
| Titanium dioxide | 0-1 |
| Biological enzyme stabilizer | 0.1-4 |

Example 61

[0723]

Composition for treatment of oral cavity
Anti-inflammatory and antibacterial treatment of the oral cavity with toothpaste

| Ingredient | Weight Percent |
|---|---|
| Clindamycin | 0.01-0.1% |
| Metronidazole | 0.01-0.1% |
| Propylene glycol | 5-10% |
| Sorbitol (70%) | 1-10% |
| Sodium dimethyl-p-hydroxybenzoate | 0.1-0.5% |

Example 62

[0724]

Beautifying toothpaste

| Ingredient | Weight Percent |
|---|---|
| Beautifying agent | 0.5%-5 |
| Sepiolite | 0.25-4% |
| Polyvinylpyrrolidone (PVP) | 0.1-2.5% |
| Humectant | 15%-25% |
| Bio-PDO | |
| Adhesive | 1%-2.5% |
| Xanthan gum | |

-continued

Beautifying toothpaste

| Ingredient | Weight Percent |
|---|---|
| Foaming agent | 1.5-2.5% |
| Sodium dodecyl sulfate (SDS) | |
| Abrasive/Friction agent | 40-50% |
| Calcium carbonate | |
| Essence | 1%-1.5% |
| Saccharin | 0.1-0.5 |
| Water | q.s. to 100 |

Example 63

[0725]

| Ingredient | Weight Percent |
|---|---|
| Abrasives | 30-55 |
| CaCO3, CaHPO4, Al(OH)3 or SiO2 | |
| Wetting agent | 15-25 |
| Bio-PDO | |
| Thickening agent | 1.0-1.4 |
| xanthan gum | |
| Destaining agent (surfactant) | 2.0-2.5 |
| Na dodecyl sulfate | |
| Polymer | 0.1-2.0 |
| Triclosan | 0.1-0.3 |
| Chinese medicine ext. | 0.1-0.5 |
| Desensitizer | 0.2-0.4 |
| Fluoride | 0.2-0.8 |
| Saccharine | 0.25-0.35 |
| Perfume | 0.8-1.2% |
| Water | to 100% |

Example 64

[0726]

Dentifrice composition

| Ingredient | Weight Percent |
|---|---|
| Abrasive | 5-50% |
| Silica | |
| Binder | 0.1-30% |
| Xanthan gum | |
| Humectant | 10-80% |
| Propylene glycol | |
| Surfactant | 0.1-5% |
| Alkyl polyglycosides as nonionic | |

Example 65

[0727]

Toothpaste

| Ingredient | Weight Percent |
|---|---|
| Calcium carbonate | 40-45% |
| Hydroxyethylcellulose | 1-1.3% |
| Bio-PDO | 22-25% |

-continued

Toothpaste

| Ingredient | Weight Percent |
|---|---|
| Sodium laurylsulfate | 1.8-2% |
| Nipagin | 0.09-0.10% |
| Nipasol | 0.025-0.30% |
| Protease | 0.25-0.50% |
| Sodium acetate | 0.15-0.25% |
| Saccharin | 0.10-0.15% |
| Flavoring | 0.75-1% |
| Water | q.s. to 100% |

Example 66

**[0728]**

Mouthwash for infants
A mouthwash for infants contains, for every 100 g or Ml

| Ingredient | Weight Percent |
|---|---|
| Sorbitol | 3.00 |
| Glycerol | 3.00 |
| Methylparaben | 0.20 |
| Propylparaben | 0.10 |
| Bio-PDO | 4.00 |
| Disodium EDTA | 0.10 |
| Sodium lauryl sulfate | 0.40 |
| Sodium saccharin | 0.06 |
| Petitgraine essential oil | 0.02 |
| Tea tree essential oil | 0.03 |
| Potassium sorbate | 0.20 |
| Sodium citrate | 0.05 |
| Potassium phosphate | 0.10 |
| Citric acid | 0.50 |
| CI19140 | 0.02 |
| CI47090 | 0.01 |
| Water | q.s. to 100 |

Example 67

**[0729]**

Aqueous antiplaque oral compositions
Mouth rinse comprising antibacterial ester, arginine derivative, surfactant, humectant

| Ingredient | Weight Percent |
|---|---|
| Ethyl lauroylarginate-HCl | 0.1 |
| Sorbitol | 10.0 |
| Glycerin | 10.0 |
| Bio-PDO | 7.0 |
| Polysorbate-20 | 0.8 |
| Cocoamidopropylbetaine | 0.8 |
| Sodium saccharin | 0.03 |
| Flavor | 0.10 |
| Water | q.s. to 100% |

Example 68

**[0730]**

Prophylactic and therapeutic agent for mouth care

| Ingredient | Weight Percent |
|---|---|
| Binders<br>Na CM-cellulose | 0.1-5.0% |
| Foaming components<br>Na lauryl sulfate | 0.1-5.0% |
| Antidesiccants<br>Bio-PDO | 1.0-15.0% |
| Preservatives<br>Me or Pr p-hydroxybenzoate | 0.02-0.5% |
| Flavors<br>peppermint oil | 0.1-2.0% |
| Abrasives<br>colloid silica, silica powder | 5.0-25% |
| Solvents | 0.1-90.0% |
| Water | 50.0-90.0% |
| phosphate buffer Ph 6.5-7.5 | 0.5-3.0% |
| ethanol | 0.1-50.0% |
| Biologically active components | 0.01-8.0% |
| Protamin sulfate | 0.1-5.0% |
| Allantoin | 0.05-1.0% |
| Sodium fluoride | 0.03-3.0% |
| Vitamin PP | 0.01-5.0% |
| Provitamin B5 | 0.05-8.0% |

Example 69

**[0731]**

Antimicrobial compositions
Antimicrobial cream or ointment

| Ingredient | Weight Percent |
|---|---|
| Glycerol | 6% |
| Bio-PDO | 5.5% |
| Sodium lauryl sulfate | 1% |
| Cetyl alcohol | 4.5% |
| Cetyl palmitate | 4% |
| Stearic alcohol | 4.5% |
| Stearic acid | 4% |
| White petrolatum | 5% |
| Antimicrobial agent | 1% |
| Water | 64.5% |

Example 70

**[0732]**

Oral compositions containing antimicrobial
Mouthwashes, Gargles, Dentifrices, Anti-plaque compounds, Oral film dentifrices, General antiseptic, Denture cleansing tablets or solutions.
Mouth rinse:

| Ingredient | Weight Percent |
|---|---|
| Alcohol | 15% |
| Antimicrobial agent | 0.05% |
| Flavoring oil | 0.1% |
| Bio-PDO | 3% |

-continued

| Oral compositions containing antimicrobial Mouthwashes, Gargles, Dentifrices, Anti-plaque compounds, Oral film dentifrices, General antiseptic, Denture cleansing tablets or solutions. Mouth rinse: | |
|---|---|
| Ingredient | Weight Percent |
| Sodium lauryl Me cocoyl taurate | 0.3% |
| Sodium citrate | 0.08% |
| Citric acid | 0.02% |
| Saccharin sodium | 0.1% |
| FD&C Green No | 30.0002% |
| Water | q.s. to 100% |

Example 71

**[0733]**

| Antiseptic mouthwash | |
|---|---|
| Ingredient | Weight Percent |
| Ethyl alcohol | 6-7 |
| Bio-PDO | 12-13 |
| Propolis | 0.001-0.10 |
| Cinnamic aldehyde | 0.003-0.35 |
| Alkyl dimethylbenzylammonium chloride | 0.003-0.35 |
| Water | q.s. to 100% |

Example 72

**[0734]**

| Composition containing antibacterial agent | |
|---|---|
| Ingredient | Weight Percent |
| Phenolic antibacterial agent | 0.05-5 |
| Disinfecting alcohol | 1-40 |
| Gelling agent | 0.1-5 |
| Hydrotrope | 0.1-30% |
| Bio-PDO | 0.1-50% |
| H2O | q.s. to 100% |

Example 73

**[0735]**

| Mouthwash composition containing bactericide | |
|---|---|
| Manual spray: Ingredient | Weight Percent |
| Cineole | 2.7 |
| Thymol | 1.8 |
| Methyl salicylate | 1.5 |
| Menthol | 1.5 |
| Ethoxylated hydrogenated castor oils | 10 |

-continued

| Mouthwash composition containing bactericide | |
|---|---|
| Manual spray: Ingredient | Weight Percent |
| Shellac | 1.0 |
| Bio-PDO | 30 |
| Ethanol | 51.5 |

Example 74

**[0736]**

| Liquid Automatic Dishwashing Detergent | |
|---|---|
| Ingredients: | Wt. % |
| Water | 54.30 |
| Citric Acid | 5.93 |
| Bio-PDO | 6.92 |
| Carbopol ™ 934 | 2.18 |
| NaOH (50%) | 5.74 |
| Sodium Borate | 0.99 |
| Sodium Citrate | 3.96 |
| Sodium Formate | 1.98 |
| CaCl | 0.10 |
| Sodium Xylene Sulfanate (40%) | 4.95 |
| EO/PO Block Copolymer | 1.98 |
| Sodium Polyacrylate Mn1200 (45%) | 9.89 |
| Protease | 0.69 |
| Amylase | 0.20 |
| Lemon Essential Oil | 0.20 |
| Total | 100.0 |

**[0737]** Procedure: Combine and stir water $H_2O$, citric acid and Bio-PDO™. Add Carbopol™ to mixture and □rab until dissolved. Slowly add sodium hydroxide, and thereafter add remaining ingredients.

Example 75

**[0738]**

| Liquid Laundry Detergent | |
|---|---|
| Ingredients: | Wt. % |
| Linear Dodecyl Benzene Sulfonate | 6.93 |
| Coconut Fatty Acid (C12-C18) | 7.52 |
| Tergitol 15-S-7 | 16.83 |
| Triethanolamine | 7.52 |
| Bio-PDO | 10.89 |
| Citric Acid (50%) | 6.33 |
| KOH (45%) | 9.30 |
| Water | 33.65 |
| Protease | 0.69 |
| Amylase | 0.20 |
| Lavendar Essential Oil | 0.10 |
| FD&C Blue 1 | 0.03 |
| FD&C Red 40 | 0.01 |
| Total | 100.0 |

**[0739]** Procedure: Combine Linear Dodecyl Benzene Sulfonate, $H_2O$, Triethanolamine and Bio-PDO™, and stir mixture at 70° C. Add Tergitol. Melt the fatty acids and add

to the mix. Slowly add KOH, then slowly add the citric acid. Cool mixture below 30° C. Add the enzymes, fragrance and dye.

Example 76

[0740]

Liquid Laundry Detergent

| Ingredients: | Wt. % |
|---|---|
| C12-C13 Linear Alcohol EO-7 | 4.0 |
| Linear Dodecyl Benzene Sulfonate (60%) | 14.0 |
| Sodium Laureth Sulfate (60%) | 5.0 |
| Sodium Citrate | 4.0 |
| Sodium Borate | 4.0 |
| Bio-PDO | 3.0 |
| Tinopal CBS-X | 0.1 |
| Protease | 0.7 |
| Amylase | 0.2 |
| Monethanolamine | 0.5 |
| Coconut Fatty Acid (C12-C18) | 2.0 |
| Water | 62.5 |
| Total | 100.0 |

[0741] Procedure: Ingredients were combined in the following order, allowing each to dissolve/disperse completely before adding the next ingredient: water, Tinopal CBS-X, sodium citrate, sodium borate, monoethanolamine, coconut fatty acid, C12-C13 linear alcohol EO-7, linear dodecyl benzene sulfonate (60%), sodium laureth sulfate (60%), protease, amylase, and Bio-PDO™.

Example 77

[0742]

Hand Dishwashing Liquid

| Ingredients: | Wt. % |
|---|---|
| Bio-PDO | 15.35 |
| Linear Dodecyl Benzene Sulfonate | 19.95 |
| Triethanolamine | 6.14 |
| Cocamide DEA | 10.74 |
| Tergitol 15-S-7 | 4.60 |
| Sodium Laureth-3EO Sulfate (28%) | 4.60 |
| Coco Amido Propyl Betaine | 7.67 |
| Polyquaternium-6 (20%) | 3.07 |
| NaCl (25%) | 1.53 |
| Sodium Xylene Sulfanate (40%) | 6.55 |
| Water | 19.19 |
| Lemon Essential Oil | 0.58 |
| FD&C Yellow 5 | 0.03 |
| FD&C Red 40 | 0.01 |
| Total | 100.0 |

[0743] Procedure: Combine all liquid ingredients and stir mixture at 70° C. Gradually add Linear Dodecyl Benzene Sulfonate and stir until dissolved in mixture and mixture is clear. Cool mixture below 30° C. and add fragrance and coloring.

Example 78

[0744]

Hand Dishwashing Liquid

| Ingredients: | Wt. % |
|---|---|
| Bio-PDO | 15.56 |
| Linear Dodecyl Benzene Sulfonate | 20.23 |
| Triethanolamine | 6.22 |
| Cocamide DEA | 10.89 |
| Tergitol 15-S-7 | 4.67 |
| Sodium Lauryl Sulfate | 4.67 |
| Coco Amido Propyl Betaine | 7.78 |
| Polyquaternium-6 (20%) | 3.11 |
| NaCl (25%) | 3.11 |
| Sodium Xylene Sulfanate (40%) | 3.50 |
| Water | 19.45 |
| Lemon Essential Oil | 0.78 |
| FD&C Yellow 5 | 0.04 |
| Total | 100.0 |

Procedure: Combine all liquid ingredients and stir mixture at 70° C. Gradually add Sodium Lauryl Sulfate and stir until dissolved and liquid mixture is clear. Gradually add Linear Dodecyl Benzene Sulfonate and stir until dissolved and liquid mixture is clear. Cool mixture below 30° C. and add fragrance and coloring.

Example 79

[0745]

Engine Coolant

| Ingredient | Weight Percent |
|---|---|
| Bio-PDO | 30-60 |
| Deionized water | 36.5-69 |
| Pyrrole compound | 0.05-0.22 |
| Polymer | 0.60-1.60 |
| Polyacrylic acid | 0.05-0.20 |
| Sodium benzoate | 0.15-0.90 |
| AEO9 purging agent | 0.05-0.10 |
| Monocarboxylic acid | 0.05-0.25 |
| Dicarboxylic salt | 0.05-0.25 |
| 4-hydroxy Bu benzoate | 0.0001-0.0002 |
| Antifoam | 0.0001-0.0002 |
| Green dye | 0.0001-0.0002 |

Example 80

[0746]

Heat transfer liquids with glass corrosion protection

| Ingredient | Weight Percent |
|---|---|
| Bio-PDO | 94% |
| Polyacrylic acid | <0.5% |
| KOH (50%) | <0.3% |
| Tolutriazole | <0.2% |
| Benzotriazole | <0.1% |
| Sodium molybdate dehydrate | <0.1 |

-continued

Heat transfer liquids with glass corrosion protection

| Ingredient | Weight Percent |
|---|---|
| Hydroxyalkylamine | <5% |
| Antifoam | 0.004% |
| Sodium metasilicate | 0.2% |
| Water | q.s. to 100% |

Example 81

[0747]

Antifreeze and/or coolant

| Ingredient | Wt, % |
|---|---|
| Bio-PDO | 0.1-99.9% |
| 3-hydroxypropionic acid salts or esters | 0.1-99.9% |

Example 82

[0748]

Anhydrous phosphate-free antifreeze

| Ingredient | Wt, % |
|---|---|
| Bio-PDO | 92-98% |
| Borate (as B4O7) | 0.16-0.81% |
| Molybdate (as MoO4) | 0.13-0.66% |
| Nitrate (as NO3) | 0.073-0.36% |
| Nitrite (as NO2) | 0.67-0.33% |
| Tolyltriazole | 0.15-0.50% |
| Silicate (as SiO2) | 0.014-0.07% |

Example 83

[0749]

Antifreeze composition for diesel engines

| Ingredient | Wt, % |
|---|---|
| Monobasic carboxylic acid | 0.1-10% |
| Nitrate salt | 0.01-10% |
| Nitrite salt | 0.001-10% |
| Azole | 0.01-5.0% |
| Molybdate | 0.001-5.0% |
| Silicone-silicate copolymer | 0.01-10% |
| Poly(vinylpyrrolidone) | 0.001-5.0% |
| Bio-PDO | q.s. to 100% |

Example 84

[0750]

Aqueous antifreeze coolant

| Ingredient | Wt, % |
|---|---|
| Sodium polyacrylate/polyacrylic acid | 0.001-10% |
| Nitrate salt | 0.001-10% |
| Nitrite salt | 0.001-10% |
| Azole | 0.001-10% |
| Polysilicate | 0.001-10% |
| Phosphate | 0.001-10% |
| Molybdate | 0.001-10% |
| Bio-PDO | q.s. to 100 |

Example 85

[0751]

Antifreeze-type coolant

| Ingredient | Wt, % |
|---|---|
| Bio-PDO | 93% |
| 2-ethylhexanoic acid | 3.1% |
| Neodecanoic acid | 1.1% |
| Sodium nitrate | 0.2% |
| Sodium nitrite | 0.4% |
| Tolyltriazole | 0.09% |

Example 86

[0752]

Sealing agents containing antifreeze

| Ingredient | Wt, % |
|---|---|
| Natural rubber latex | 55% |
| Tackifier resin emulsion | 15% |
| Bio-PDO ™ | 30% |

Example 87

[0753]

Water-based coating materials applicable at freezing point

| Ingredient | Wt, % |
|---|---|
| Acronal YJ 2730D | 45% |
| Solvent-soluble resin | 15% |
| Bio-PDO | 2% |
| Methanol | 3% |
| Butoxyethanol | 5% |

Example 88

[0754]

Antifreeze foam

| Ingredient | Wt, % |
|---|---|
| Bio-PDO ™ | 45% |
| Isopropanol | 40% |
| Polyethylene glycol stearyl ether | 5% |
| Dichlorodifluoromethane | 7.5% |
| Propane | 2.5% |

Example 89

[0755]

Antifreeze for freezing of foods

| Ingredient | Wt, % |
|---|---|
| Ethanol | 49% |
| Water | 48.5% |
| Polydimethylsiloxane | 0.2% |
| Bio-PDO | 1.7% |
| Sodium malate | 0.3% |
| Glycerin monocaprylate/caproate | 0.2% |
| Glycine | 0.1% |

Example 90

[0756]

Antifreeze for solid surfaces

| Ingredient | Wt, % |
|---|---|
| Bio-PDO | 70.0% |
| Ethanol | 5.0% |
| EO/PO copolymer | 20.0% |
| Water | 5.0% |
| Corrosion inhibitor | 0.12% |
| Nonionic surfactant | 0.5% |
| Perfume | 0.1% |

Example 91

[0757]

Liquid antifreeze for agrochemicals

| Ingredient | Wt, % |
|---|---|
| 2,4-dichlorophenoxyacetic acid | 43% |
| Sulfonated lignin | 1.5% |
| Bio-PDO | 2% |
| Aluminum hydroxide gel (10%) | 9.0% |
| Hydroxypropyl guar | 0.2% |
| Antifoam agent | 0.1% |
| Water | 44.2% |

Example 92

[0758]

Antifreeze for fuel tanks

| Ingredient | Wt, % |
|---|---|
| Isopropanol | 69.95% |
| Bio-PDO | 29.95% |
| Triethanolamine | 0.05% |
| Sodium nitrate | 0.03% |
| Benzotriazoleamine salt | 0.02% |

Example 93

[0759]

Heat transfer fluid for electrically heated boilers

| Ingredient | Wt, % |
|---|---|
| Bio-PDO | 30-55% |
| Sodium phosphate | 0.04-0.10% |
| Ammonium molybdate | 0.03-0.09% |
| Water | q.s. to 100% |

Example 94

[0760]

Concentrate for preparing antifreezes and heat-transfer agents

| Ingredient | Wt, % |
|---|---|
| Phosphoric acid (78%) | 2.0-20.0% |
| Triethanolamine | 10.0-60.0% |
| 2-mercaptobenzothiazole sodium salt | 0.1-1.2% |
| EDTA disodium salt dihydrate | 0.5-1.5% |
| Caprolactam | 0.1-3.0% |
| 1,4-dihydroxybenzene | 0.001-3.0% |
| Phosphite P-24 | 0.001-0.005% |
| Antifoaming agent | 0.02-0.03% |
| Dye | 0.05-0.06% |
| Butoxyethanol | 0.2-0.3% |
| Water | 10.0-35.0% |
| Bio-PDO | q.s. to 100% |

Example 95

[0761]

Heat transfer fluid for solar installations

| Ingredient | Wt, % |
|---|---|
| Triethylene glycol | 45-98% |
| Bio-PDO | 1-55% |
| Corrosion inhibitors | 1-6% |

Example 96

[0762]

Preparation of a non-foaming liquid heat transfer agent

| Ingredient | Wt, % |
|---|---|
| Bio-PDO | 96.42% |
| Sodium salt of poly(acrylic acid) | 0.02% |
| Sodium borate | 2% |
| Sodium benzoate | 1% |
| Sodium nitrite | 0.15% |
| Sodium nitrate | 0.1% |
| Benzotriazole | 0.2% |
| Poly(dimethylsiloxane) | 0.01% |
| Sodium silicate | 0.1% |

Example 97

[0763]

Heat transfer refrigeration fluid

| Ingredient | Wt, % |
|---|---|
| Bio-PDO | 45% |
| Propylene carbonate | 5% |
| H2O | 50% |

Example 98

[0764]

Antifreeze composition

| Ingredient | Wt, % |
|---|---|
| Part A | |
| Cellulose gum | 0.5% |
| Alginic acid | 0.5% |
| Gelatin | 2% |
| Water | 47% |
| Bio-PDO | 50% |
| Part B | |
| Ferric chloride | 5% |
| Water | 45% |
| Bio-PDO | 50% |

Example 99

[0765]

Engine Coolant

| | |
|---|---|
| Bio-PDO | 49.74% |
| Water | 48.76% |
| Fluoro-surfactant | 0.01% |
| Corrosion inhibitor | 1.29% |
| Defoamer | 0.08% |
| Dye | 0.12% |

Example 100

Heat Transfer Composite

[0766] The composite comprises Bio-PDO, and/or glycerin, and water as major components, and contains 0.5-5.0 wt. % of C8-12 aliphatic dibasic acids and the alkali metal salts, 0.5-5.0 wt. % of benzoic acid and the alkali metal salts, 0.05-1.0 wt. % of triazoles, and 0.01-0.5 wt. % of thiazoles.

Example 101

Reusable Thermal Pack and Flow Retardant Gel

[0767] The thermal pack for therapeutic use includes a gel pad in a 1st flexible sealed bag connected to a pressure chamber from a 2nd flexible sealed bag which can be inflated. The gel comprises clay (bentonite) and Bio-PDO, and includes a fibrous material to prevent flow and increase heat capacity.

Example 102

Non-Aqueous Heat Transfer Fluid

[0768] The invention is directed to a heat transfer system comprising a heat transfer fluid. The heat transfer fluid comprising non-buffered Bio-PDO, and at least one Bio-PDO™ soluble additive selected from the group consisting of a molybdate salt, a nitrate compound and an azole compound.

Example 103

Antifreeze Coolant Composition for High Temperature Applications

[0769] The present invention comprises an improved antifreeze coolant composition with certain additives (0.01 wt. % to 5.0 wt. %) that serve to increase the thermal stability of the Bio-PDO™ component of a Bio-PDO/water (5-95:95-5) coolant composition and to reduce the tendency of the Bio-PDO component to degrade under elevated thermal conditions. These additives comprise organic compounds with a carboxylic acid moiety and a hydroxyl moiety, and also tricarballylic acid. Another aspect of this invention concerns a method for improving the stability of the Bio-PDO component of a Bio-PDO/water coolant composition in engine cooling/heating systems by formulating a Bio-PDO/water coolant composition with the thermal stability additive to form an improved coolant composition, and contacting the engine cooling/heating system with the improved coolant composition.

Example 104

[0770]

Cryopreservation composition of Bio-PDO and a vehicle solution

| Component | Concentration |
|---|---|
| Bio-PDO | 0.05M to about 6.0M<br>0.5M to about 4.0M (more preferred)<br>0.5M to about 3.0M (most preferred) |

-continued

Cryopreservation composition of Bio-PDO and a vehicle solution

| Component | Concentration |
|---|---|
| EuroCollins solution: | |
| Sodium (Na+) | 10 Mm |
| Potassium (K+) | 115 Mm |
| Chloride (Cl−) | 15 Mm |
| Phosphate monobasic (H2PO4−) | 15 Mm |
| Phosphate dibasic (HPO42−) | 42.5 Mm |
| Bicarbonate (HCO3) | 10 Mm |
| Glucose | 194 Mm |

Example 105

[0771]

Aircraft Deicing Fluid

| Ingredients: | % Wt. |
|---|---|
| Bio-PDO | 92 |
| Water | 7.14 |
| Polyethylene glycol ether | 0.2 |
| EO/PO alkoxylate | 0.2 |
| KOH (50% solution) | .06 |
| Sandocorin 8132C | 0.4 |

Example 106

[0772]

Aircraft Deicing Fluid

| Ingredients: | % Wt. |
|---|---|
| Bio-PDO | 45.5 |
| Water | 53.165 |
| Tolytriazole | 0.4 |
| Silicon anti-foamer | 0.2 |
| Potassium Hydroxide | .035 |
| Triethanolamine | 0.3 |
| Sodium arylalkyl sulfonate | 0.4 |

Example 107

[0773]

Aircraft runway deicing composition

| Ingredient | Wt, % |
|---|---|
| Alkali metal carboxylate | 20-25% |
| Alkali earth metal carboxylate | 1-15% |
| Bio-PDO | 1-35% |
| Alkali metal phosphate | 0.01-1% |
| Alkali metal silicate | 0.01-1% |
| Triazole | 0.01-1% |

Example 108

[0774]

Aircraft runway deicing composition

| Ingredient | Wt, % |
|---|---|
| Alkali metal carboxylate | 1-40% |
| Alkali earth metal carboxylate | 1-25% |
| Bio-PDO | 1-35% |
| Alkali metal phosphate | 0.01-1% |
| Alkali metal silicate | 0.01-1% |
| Triazole | 0.01-1% |
| Water | q.s. to 100 |

Example 109

[0775]

Deicer/anti-icer for aircraft

| Ingredient | Wt, % |
|---|---|
| Water | 41% |
| Bio-PDO | 50% |
| Polysaccharide | 3% |
| Corrosion inhibitors | 6% |

Example 110

[0776]

Deicers for polyurethane foam-lined LPG tanks

| Ingredient | Wt, % |
|---|---|
| Isopropanol | 40% |
| Bio-PDO | 60% |

Example 111

Liquid Carboxylate Deicer Composition

[0777] The liquid deicer compounds suitable for roadways, runways, and bridges include: (a) aqueous carboxylate salt of alkali metal, especially as formate, propionate, and/or lactate; (b) corrosion inhibitors for protection of galvanized steel; (c) auxiliary corrosion inhibitors for nonferrous metals, esp. Al alloys; and (d) optional Bio-PDO. The corrosion inhibitor is preferably a polyvalent metal compd., esp. La acetate hydrate or a mixed lanthamide salt sol. In water, or optionally a Mg-ion compd. And/or a sulfide salt. The deicer optionally includes 50-10,000 ppm of tolyltriazole as auxiliary inhibitor for nonferrous metal surfaces. The typical aqueous deicer contains potassium acetate 50%, tolyltriazole 0.15-0.75%, lanthamide nitrate hexahydrate 1.0-3.0%, and trimercaptotriazine tri-Na salt 10.10-0.75%, water q.s. to 100%.

Example 112

Water-Activated Exothermic Chemical Deicing Formulation

[0778] Deicing compositions are provided for removing ice from a surface which include either succinic acid or

succinic anhydride, or both, and a neutralizing base such as sodium hydroxide, potassium hydroxide, or ammonium hydroxide wherein the deicing compositions when mixed with water produce succinate salts in a reaction that rapidly releases sufficient heat to melt the ice on the surface and the succinate salts act as a deicer and freeze point depressant. The deicing compositions may further include Bio-PDO which inhibits reformation of the ice on the deiced surface. The deicing compositions are suitable and effective for airport applications in which corrosion of aircraft alloys and concrete runways are of concern.

Example 113

Anti-Icing Fluid or Deicing Fluid

[0779] The title non-electrolytic, non-toxic, biodegradable anti-icing or deicing composition comprises: (a) water; (b) a non-toxic freeze point depressant selected from the group consisting of C2-6 monohydric alcohols, Bio-PDO, mono-Me or Et ethers of C3-12 polyhydric alcohols or mixtures thereof, (c) a nontoxic thickener. The composition is a continuous single phase liquid that exhibits pseudoplasticity, and is useful on the surfaces of, for example, aircraft, airport pavements, roadways, walkways, bridges, entrances, structures, canals, locks, components, vessels, nautical components, railroad switches, and motor vehicles. A typical composition contained water, Bio-PDO™ and/or propanol and xanthan.

Example 114

[0780]

Animal feed supplement WO9733488A1

| Ingredient | Weight Percent |
|---|---|
| Sodium Propionate | 10% |
| Bio-PDO | 5% |
| White Grease | 40% |
| Filler (Dairy, fiber, grains, and flavor enhancers) | 45% |

Example 115

[0781]

Energetic feed additive

| Ingredient | Weight Percent |
|---|---|
| Bio-PDO | 25-48% |
| Glycerol | 25-48% |
| Nutritionally suitable acid (e.g. C2-C20 aliphatic carboxylic acids) | 1-17% |
| Water | 1-32% |
| Vitamins & Minerals | .0001-4% |

Example 116

[0782]

Aerosol compositions for animal feeds US2006034978A1

| Ingredient | Weight Percent |
|---|---|
| Molasses | 25% |
| Propylene Glycol | 23% |
| Soy Lecithin | 10% |
| Water | 22% |
| Bio-PDO | 4.5% |
| Flavoring | 0.5% |
| Isobutane/Propane/Butane | 15% |

Example 117

[0783]

Flavored Ink Jet Printing Fluid

| Ingredient | Amount |
|---|---|
| Bio-PDO | 94.2% |
| Glycerin | 4.0% |
| FD &C Blue 1 | 1.6% |
| Balls of fire flavor | 0.2% |

Example 118

[0784]

Berry Flavor Concentrate

| Ingredient | Amount |
|---|---|
| Bio-PDO | 53% |
| Ethanol | 10% |
| Water | 30% |
| Berry flavor | 3% |
| Citric acid | 4% |

Example 119

[0785]

Edible Pet Chew

| Ingredient | Amount |
|---|---|
| Proteins | 5-50% |
| Carbohydrates | 20-80% |
| Bio-PDO | 5-50% |
| Water | 5-30% |

Example 120

[0786]

Low calorie sugar substitute

| Ingredient | Amount |
|---|---|
| Sorbitol | 48.34% |
| Water | 48.34% |
| Sodium alginate | 0.4% |
| Calcium sulfate □rabic□te | 0.3% |
| Guar gum | 1.0% |
| Wheat plant fiber | 0.5% |
| Bio-PDO | 1.0% |
| Neotame | 0.02% |
| Potassium sorbate | 0.1% |

Example 121

[0787]

Ice cream toppings

| Ingredient | Amount |
|---|---|
| Flavoring agent | 0.05-40% |
| Fat | 0.01-50% |
| Bio-PDO | 0.1-40% |
| Sweetener | up to 80% |
| Emulsifier | up to 10% |
| Water | 0-20% |

Example 122

[0788]

Frozen beverage

| Ingredient | Amount |
|---|---|
| Water | 60.6% |
| Bio-PDO | 20.2% |
| Polyethylene | 18.3% |
| Propylene glycol alginate | 0.7% |
| Caramel colorant | 0.2% |

Example 123

[0789]

Flavor delivery system

| Ingredient | Amount |
|---|---|
| Benzaldehyde | 20% |
| Polysorbate 80 | 40% |
| Bio-PDO | 40% |

Example 124

[0790]

Soft-frozen cocktail drink

| Ingredient | Amount |
|---|---|
| Ethanol | 2-15% |
| Bio-PDO | 12-14% |
| Base flavor mix | q.s. to 100% |

Example 125

[0791]

Flavored micro emulsion for Beverages

| Ingredient | Amount |
|---|---|
| Flavor oil | 4.1% |
| Tween-60 | 4.1% |
| Water | 16.5% |
| Bio-PDO | 75.4% |

Example 126

[0792]

Food flavoring material

| Ingredient | Amount |
|---|---|
| Glutamate | 9.5 g |
| IMP | 0.25 g |
| GMP | 0.25 g |
| Lactose | 5.0 g |
| Sodium chloride | 10.0 g |
| Water | 60.0 kg |
| Bio-PDO | 15.0 kg |

Example 127

[0793]

Heat-stable flavoring

| Ingredient | Amount |
|---|---|
| Tamarind seed gum | 50 g |
| Bio-PDO | 50 g |
| Water | 200 g |
| Sodium pyrophosphate | 3 g |

Example 128

[0794]

Fried Food Preservative

| Ingredient | Amount |
|---|---|
| Soybean oil | 75 parts |
| Lecithin | 20 parts |
| Bio-PDO | 5 parts |

Example 129

[0795]

Non-aqueous Beverage Gel

| Ingredient | Amount |
|---|---|
| Me cellulose | 10 parts |
| Bio-PDO | 100 parts |

Example 130

[0796]

Food Preservation Emulsifier

| Ingredient | Amount |
|---|---|
| Capric acid monoglyceride | 75% |
| Bio-PDO | 15% |
| Water | 7% |
| Sodium glutamate | 3% |

Example 131

[0797]

Liquid Heat-Setting Confections

| Ingredient | Amount |
|---|---|
| Bio-PDO | 17.7% |
| Glycerol monooleate | 0.7% |
| Lecithin | 0.7% |
| Antioxidant | 0.0% |
| Honey | 0.1% |
| Coloring | 0.3% |
| Flavoring | 0.3% |
| Potassium citrate | 1.2% |
| Artificial sweetener | 0.2% |
| Glycerol | 53.1% |
| Starch | 23.6% |
| Carrageenan | 2.1% |

Example 132

[0798]

Instant dumplings

| Ingredient | Amount |
|---|---|
| Flour | 40-60 parts |
| Potato starch | 20-30 parts |
| Acetic acid starch | 10-20 parts |
| Refined salt | 0.5-5 parts |
| Emulsifying agent | 0.2-1 parts |
| Sorbitol | 2-8 parts |
| Bio-PDO | 2-6 parts |

Example 133

[0799]

Grated Cheese Preservative

| Ingredient | Amount |
|---|---|
| Bio-PDO | 20 parts |
| Sodium chloride | 18 parts |
| Lactic acid | 0.1 parts |
| Propionic acid | 0.1 parts |
| Sucrose | 2 parts |
| Ascorbic acid | 0.05 parts |
| Glycerol monostearate | 0.1 parts |
| Water | 59.65 parts |

Example 134

[0800]

Edible solid for confectionery coatings or cake or cookie dough

| Ingredient | Amount |
|---|---|
| Bio-PDO | 80% |
| Nonfat dry milk solid | 20% |

Example 135

[0801]

Ready-made/Instant Food Preservative

| Ingredient | Amount |
|---|---|
| Bio-PDO | 50 parts |
| Acetic acid | 3 parts |
| Sodium acetate | 1.5 parts |
| Ethanol (95%) | 105.3 parts |

Example 136

[0802]

| Multi-phase delivery system for food supplements and meal replacements | |
|---|---|
| Ingredient | Amount |
| Creatine monohydrate | 16.71% |
| Glycerol | 15.97% |
| Corn syrup | 21.20% |
| High-fructose corn syrup | 24.78% |
| Gelatin | 5.51% |
| Bio-PDO | 5.51% |
| Modified starch | 2.75% |
| Water | 4.96% |
| Other ingredients | 2.61% |

Example 137

[0803]

| Mulberry Leaf Preservative | | |
|---|---|---|
| Ingredient | Wt, % | Overall |
| Actives | | 3-8% |
| Ph regulator | | 20-30% |
| Malic acid | 1-35% | |
| Citric acid | 18-25% | |
| Sorbic acid | 15-20% | |
| Hydrochloric acid | 8-14% | |
| Phytic acid | 16-25% | |
| Dewatered acetic acid | 8-15% | |
| Redox agent | | 20-30% |
| Sodium sulfate | 15-25% | |
| Potassium sulfate | 18-28% | |
| Pepsin | 25-40% | |
| Papain | 5-42% | |
| Moisture activity-reducing agent | | 20-30% |
| Sodium pyrophospahte | 10-15% | |
| Sodium chloride | 6-10% | |
| Bio-PDO | 8-15% | |
| Agar | 5-40% | |
| Kara gum | 15-25% | |
| Gelatin | 21-30% | |
| Disinfectant | | 15-25% |
| Josamycin | 15-40% | |
| Fupaisuan | 18-25% | |
| Phage | 22-30% | |
| Lysozyme | 20-30% | |
| Water | | q.s. to 100% |

Example 138

[0804]

| Fining product | |
|---|---|
| Ingredient | Amount |
| Collagen | 3-40% |
| Bio-PDO | 2-50% |
| Buffering system | 0.5-5% |
| Preservative | 0.1-5% |

Example 139

[0805]

| Semi-moist feed for herbivorous animals | |
|---|---|
| Ingredient | Amount |
| Gelatinized starch | 5-55% |
| Sugars | 5-80% |
| Bio-PDO | 2-8% |
| Water | 15-30% |

Example 140

[0806]

| Preservative for bakery products | |
|---|---|
| Ingredient | Amount |
| Ethanol | 1.0% |
| Bio-PDO | 0.5% |
| Acetic acid | 0.03% |
| Sodium acetate | 0.02% |
| Water | 98.45% |

(Sweet rice flour 600 g, water 400 Ml and preservative 16 g)

Example 141

[0807]

| Food moistening agent for starch and(or) protein raw materials | |
|---|---|
| Ingredient | Amount |
| Bio-PDO | 40-90% |
| Sorbitol | 10-60% |

(Fish cake (kamaboko) 96% and moistening agent 4%)

Example 142

[0808]

| Solid food condiment | |
|---|---|
| Ingredient | Amount |
| Bio-PDO | 1-70 parts |
| Gelatin | 10 parts |
| Condiment* | 80-93% total solids |

*Catsup, vinegar, apple butter, dried onion flakes, mustard, pickle relish

Example 143

[0809]

Microbial stabilized cooked dehydrated meat, vegetables, or fruits

| Ingredient | Amount |
|---|---|
| Freeze-dried chicken solids | 34.3% |
| Glycerol | 32.4% |
| H2O | 27.8% |
| Salt | 0.8% |
| Sugar | 1.5% |
| Monosodium glutamate | 1.8% |
| Bio-PDO | 1.1% |
| Potassium sorbate | 0.3% |

Example 144

[0810]

Stable emulsifier for sponge cakes and creams

| Ingredient | Amount |
|---|---|
| Sorbitol (70%) | 570 g |
| Bio-PDO | 200 g |
| Ethanol | 20 g |
| Water | 800 g |
| Sucrose monosterate | 160 g |
| Sodium hydroxide (10%) | 16 ml |
| Propylene glycol monostearate | 40 g |
| Glycerol monostearate | 200 g |

Example 145

[0811]

Fruit coating

| Ingredient | Amount |
|---|---|
| Bio-PDO | 5% |
| Water | 45% |
| Ethanol | 50% |

Example 146

[0812]

Frozen or processed meats coating

| Ingredient | Amount |
|---|---|
| cellulose propionate flake | 45 parts |
| acetyl tributyl citrate | 55 parts |
| Bio-PDO | 5 parts |

Example 147

[0813]

Stabilizer for semidry feeds

| Ingredient | Amount |
|---|---|
| Bio-PDO | 51.2% |
| Glycerol | 35.3% |
| Sorbitol | 13.5% |

Example 148

[0814]

Brine solution for freezing fresh foods (fish, meat, vegetable, etc)

| Ingredient | Amount |
|---|---|
| Ethanol | 40-60% |
| Bio-PDO | 2-20% |
| Preservatives | 0.05-1% |
| H2O | q.s. to 100% |

Example 149

[0815]

Lycopene pigment

| Ingredient | Amount |
|---|---|
| Lycopene pigment | 0.8 g |
| Natural vitamin E | 0.2 g |
| d-limonene | 2 g |
| Palm oil | 5 g |
| SAIB | 6 g |
| Water | 60 g |
| Arabic gum | 20 g |
| L-ascorbic acid | 0.1 g |
| Bio-PDO | 10 g |

Example 150

[0816]

Low Calorie Honey Substitute

| Ingredient | Amount |
|---|---|
| CM-cellulose gum | 0.500% |
| HPM-cellulose gum | 0.500% |
| Xanthan gum | 0.223% |
| Propylene glycol alginate | 0.0525% |
| Sodium bicarbonate | 0.131% |
| Glycerin | 5.91% |
| Bio-PDO | 1.31% |
| Aspartame | 0.223% |
| Acesulfame K | 0.0421% |
| Food Color Blend | 0.237% |
| Honey Flavor | 0.17% |
| Vanilla extract | 0.0657% |
| Water | 90.7% |

Example 151

[0817]

Fabricated fruit pieces

| Ingredient | Wt % | % of Piece |
|---|---|---|
| Soft Berry Center | | 90.0% |
| Corn syrup | 20.3% | |
| Blueberry Flavor | 1.1% | |
| Bio-PDO | 52.8% | |
| Water | 7.2% | |
| Modified corn starch | 5.4% | |
| Modified tapioca starch | 5.5% | |
| Fructose | 4.0% | |
| Malic acid | 0.7% | |
| Citric acid | 1.0% | |
| Grape skin extract color | 1.0% | |
| Dried blueberry powder | 0.5% | |
| Salt | 0.5% | |
| | 100% | |
| Thin Film Coating | | 10.0% |
| Sodium citrate | 0.23% | |
| Water | 76.98% | |
| Gellan gum | 0.59% | |
| Citric acid | 0.20% | |
| Sucrose | 10.0% | |
| Grape skin extract color | 0.5% | |
| Blueberry powder | 0.5% | |
| Bio-PDO | 10.0% | |
| Sunflower oil | 0.5% | |
| | 100% | |

Example 152

[0818]

Method for producing feed

| Ingredient | Weight Percent |
|---|---|
| Fish meal | 70% |
| Wheat powder | 19% |
| Bio-PDO | 6% |
| Soybean cake | 3% |
| Vitamins | 3% |
| Minerals | 0.8% |
| Salt | 0.4% |

Example 153

[0819]

Agricultural Chemical Suspension

| Ingredient | Weight Percent |
|---|---|
| Ammonium Sulfate | 30-70% |
| Bio-PDO | 20-80% |
| Igepal ® RC-630 | 1-9% |

Example 154

[0820]

Liquid and paste automotive cleaner

| Ingredient | Weight Percent |
|---|---|
| Bio-PDO | 0.5-20% |
| Coco fatty acid alkanolamines | 0.8-50% |
| Sodium lauryl ether sulfate | 0.5-45% |
| Sodium lauryl sulfate | 0.5-40% |
| Dodecylbenzenesulfonic acid | 1-50% |
| Cocoamidopropylbetaine | 1-35% |
| Coco fatty acid diethanolamides | 0.3-35% |
| Triethanolamine | 1-30% |
| Sodium tripolyphosphate | 0.2-10% |
| Sodium metasilicate | 0.5-20% |
| NaCl | 0.2-10% |
| MgCl2 | 0.2-10% |
| NaOH | 0.2-10% |
| Formaldehyde | 0.1-5% |
| Pigments/dyes | 0.1-50% |
| Fragrance | 0.3-10% |

Example 155

[0821]

Latex Paint

| Ingredient | Weight Percent |
|---|---|
| Water | 10-40% |
| Hydroxyethyl cellulose | 0.2-1.0% |
| Defoaming agent | 0.2-1.0% |
| Dispersing agent | 0.2-1.0% |
| Mildew-proof and preservative agent | 0.2-0.8% |
| Bio-PDO | 1-5% |
| Pigment | 5-30% |
| Kaolin | 10-50% |
| Nanoparticles | 0.5-1.5% |
| Silicone | 0.5-1.5% |
| Styrene-acrylate copolymer microemulsion | 15-45% |
| Film-forming auxiliary agent | 0.5-5% |
| Auxiliary agents' | 0.2-1.0% |

Example 156

[0822]

Rainproof Paint

| Ingredient | Weight Percent |
|---|---|
| Acrylic emulsion | 23-32 |
| Polycarboxylate dispersing agent | 0.5-1.2 |
| Antifoam BA-202 | 0.4-1.0 |
| Bio-PDO | 1.5-2.5 |
| Preservative LXE | 0.1-0.3 |
| KOH (40%) | 0.2-0.4 |
| Ester 12 as film-forming aid | 1.5-2.5 |
| Acrylic polycarboxylate thickener | 0.5-1.5 |
| Nanoscale SiO2 | 1.0-3.0 |
| Nanoscale TiO2 | 0.8-1.8 |
| Titanium dioxide | 10-20 |

-continued

Rainproof Paint

| Ingredient | Weight Percent |
|---|---|
| Calcium carbonate | 8-15 |
| Kaolin | 8-15 |
| Fluorocarbon resin | 5-15 |
| Deionized water | 10-20 |

Example 157

[0823]

Ink jet for printing of food

| Ingredient | Weight Percent |
|---|---|
| Bio-PDO | 92% |
| Glycerin | 4% |
| Isopropyl alcohol | 2% |
| FD&C Blue No. 1 | 2% |

Example 158

[0824]

Cuttlefish ink mixture

| Ingredient | Weight Percent |
|---|---|
| Cuttlefish ink | 15-30% |
| Bio-PDO | 15-30% |
| Sweetener | 30-60% |
| Ethanol | 10-15% |

Example 159

[0825]

Blue writing ink

| Ingredient | Weight Percent |
|---|---|
| Bio-PDO | 1-10% |
| Prussian blue | 1.0-5% |
| Oxalic-acid | 0.2-5% |
| Dodecylbenzenesulfonate | 0.01-2% |
| Gum □rabic | 0.1-1% |
| Anticorrosive agents | 0.1-1% |
| Water | q.s. to 100% |

Example 160

[0826]

Hydraulic-lubricating fluid

| Ingredient | Weight Percent |
|---|---|
| Ethylene oxide-propylene oxide-glycerol | 27.6% |
| Bio-PDO | 16.7% |
| PEG-600 | 6.6% |
| Styrene-maleic polyester | 5.0% |
| Methylphenylsilicone oil | 0.5% |
| Triethanolamine | 0.5% |
| Benzotriazole | 0.1% |
| NaNO2 | 0.5% |
| Water | 42.5% |

Example 161

[0827]

Liquid suspension

| Ingredient | Weight Percent |
|---|---|
| Bio-PDO | 27.6% |
| Glycerine | 47.0% |
| Polymeric fatty acid ester | 0.2% |
| Dispersing agent | 0.2% |
| Polyethylene Oxide (dry) | 25% |

Example 162

[0828]

Liquid denitrogenation agent for petroleum oils

| Ingredient | Weight percent |
|---|---|
| Bio-PDO | 5-20% |
| Ethylene glycol | 10-30% |
| Propanoic acid | 10-20% |
| Malonic acid | 20-50% |
| Oxalic anyhydride | 20-30% |

Example 163

[0829]

Pharmaceutical Composition

| Ingredient | Weight Percent |
|---|---|
| Drug Active (1) | 0.35% |
| Drug Active (2) | 0.28% |
| Phenylephrine hydrochloride | 0.28% |
| Methyl paraben | 0.25% |
| Propyl paraben | 0.03% |
| Bio-PDO | 7.30% |
| Saccharin sodium | 0.09% |
| Citric acid | 0.14% |
| Strawberry flavor | 0.28% |

-continued

| Pharmaceutical Composition | |
|---|---|
| Ingredient | Weight Percent |
| Banana flavor | 0.28% |
| Sorbitol (70%) | 90.56% |
| Water | 0.14% |

Example 164

[0830]

| Pharmaceutical composition | |
|---|---|
| Ingredient | Weight Percent |
| Polyoxyethylene hydrogenated castor oil | 5-50% |
| Azone | 0-10% |
| Ginseng extract | 0-10% |
| Ginkgo leaf extract | 0-10% |
| Collagen protein | 0-10% |
| Hyaluronic acid | 0-3% |
| Allantoin | 0.1-1% |
| Zinc gluconate | 0-3% |
| Vitamin C | 0.1-1% |
| Vitamin E | 0.01-0.1% |
| Bio-PDO | 3-30% |
| Glycerol | 3-30% |

Example 165

[0831]

| Water-soluble lubricant composite | |
|---|---|
| Ingredient | Weight Percent |
| Polyethylene glycol ether | 70-90% |
| Water resin | 5-15% |
| Leveling agent | 0.5-1.5% |
| Bio-PDO | 0.5-1.5% |
| Polyethylene wax oxide | 1-7% |
| Deionized water | 1.5-10% |

Example 166

[0832]

| Biocide and antifouling dispersant | |
|---|---|
| Ingredient | Weight Percent |
| Alkyldimethylbenzylammonium chloride | 5.0-45.0% |
| Dialkyldimethylammonium chloride | 1.0-15% |
| Bio-PDO | 10-3.0% |
| Water | q.s. to 100% |

Example 167

[0833]

| Composition for inhibition of corrosion and deposits in water system | |
|---|---|
| Ingredient | Weight Percent |
| Oxyethylidene diphosphonic acid | 1-58% |
| Alkyldimethylamine oxide | 1-26% |
| Bio-PDO | 1-30% |
| Water | q.s. to 100% |

Example 168

[0834]

| Completely biodegradable plastic alloy | |
|---|---|
| Ingredient | Weight Percent |
| Starch | 30-60 |
| Poly(vinyl alcohol) | 10-35 |
| Ethylene-acrylic acid copolymer | 2-5 |
| Ethylene glycol | 0-25 |
| Polyethylene glycol | 0-25 |
| Bio-PDO | 0-25 |
| Polypropylene glycol | 0-25 |
| Sorbitol acetate | 0-25 |
| Sorbitol ethoxylate | 0-25 |
| Glycerol | 0-25 |
| Magnesium hydroxide | 2-5 |
| Magnesium borate | 0.2-0.4 |
| Water | 10-20 |

Example 169

Embryo Transfer of Cryopreserved and In-Vitro Fertilized Rabbit Oocytes

[0835] Ovulatory oocytes, collected from the oviduct of virgin 13 hours after induction of ovulation by HCG injection, can be cryopreserved slowly to −30 degrees C. and plunged directly into liquid nitrogen. A mixture of 1.5 M Bio-PDO and 0.1 M sucrose can be used as a cryoprotectant. After thawing, the oocytes can be incubated with in-vitro capacitated sperm for 5 h in defined Brackett's medium. Fertilized ova can then be cultured for an additional 20 h until the 4-to-8-cell stage is reached. These embryos can be transferred to pseudopregnant recipient rabbits which should be 'asynchronous' in the sense that they are given an injection of HCG 30, 24 and 18 h before starting to do the embryo transfer.

What is claimed:

**1**. A biodegradable composition comprising 1,3-propanediol and an ingredient, wherein said 1,3-propanediol has a bio-based carbon content of at least 1%.

**2**. The biodegradable composition of claim 1 wherein the ingredient is selected from the group consisting of an acceptable carrier, an active, water, an aqueous solution, a surfactant, a builder, a pH control agent, a corrosion inhibitor, a defoamer, a dye and a food ingredient.

**3**. The biodegradable composition of claim 1, further comprising a composition selected from the group consist-

ing of a personal care product, a cosmetic, a detergent, a heat transfer composition, a deicing composition, a food, a paint, and an ink.

**4**. The biodegradable composition of claim 1 wherein the 1,3-propanediol has at least 5% biobased carbon.

**5**. The biodegradable composition of claim 1 wherein the 1,3-propanediol has at least 10% biobased carbon.

**6**. The biodegradable composition of claim 1 wherein the 1,3-propanediol has at least 25% biobased carbon.

**7**. The biodegradable composition of claim 1 wherein the 1,3-propanediol has at least 50% biobased carbon.

**8**. The biodegradable composition of claim 1 wherein the 1,3-propanediol has at least 75% biobased carbon.

**9**. The biodegradable composition of claim 1 wherein the 1,3-propanediol has at least 90% biobased carbon.

**10**. The biodegradable composition of claim 1 wherein the 1,3-propanediol has at least 99% biobased carbon.

**11**. The biodegradable composition of claim 1 wherein the 1,3-propanediol has 100% biobased carbon.

**12**. The biodegradable composition of claim 1 wherein the 1,3-propanediol is biologically-derived.

**13**. The biodegradable composition of claim 12 wherein the biologically-derived 1,3-propanediol is biologically produced through a fermentation process.

**14**. A biodegradable composition comprising 1,3-propanediol wherein said 1,3-propanediol has an ultraviolet absorption at 220 nm of less than about 0.200 and at 250 nm of less than about 0.075 and at 275 nm of less than about 0.075.

**15**. The biodegradable composition of claim 14 wherein said 1,3-propanediol has a "b" color value of less than about 0.15 and an absorbance at 275 nm of less than about 0.050.

**16**. The biodegradable composition of claim 14 wherein said 1,3-propanediol has a peroxide concentration of less than about 10 ppm.

**17**. The biodegradable composition of claim 14 wherein said 1,3-propanediol has a concentration of total organic impurities in said composition of less than about 400 ppm.

**18**. The biodegradable composition of claim 14 wherein said 1,3-propanediol has a concentration of total organic impurities of less than about 300 ppm.

**19**. The biodegradable composition of claim 14 wherein said 1,3-propanediol has a concentration of total organic impurities of less than about 150 ppm.

**20**. A biodegradable composition comprising 1,3-propanediol wherein said 1,3-propanediol has a concentration of total organic impurities of less than about 400 ppm.

**21**. The biodegradable composition claim 20 wherein said 1,3-propanediol has a concentration of total organic impurities of less than about 300 ppm.

**22**. The biodegradable composition claim 20 wherein said 1,3-propanediol has a concentration of total organic impurities of less than about 150 ppm.

**23**. The biodegradable composition claim 20 wherein said 1,3-propanediol has a concentration of peroxides of less than about 10 ppm.

**24**. The biodegradable composition claim 20 wherein said 1,3-propanediol has a concentration of carbonyl groups of less than about 10 ppm.

**25**. A biodegradable composition comprising 1,3-propanediol, wherein the 1,3-propanediol in said composition has an anthropogenic $CO_2$ emission profile of zero upon biodegradation.

* * * * *