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3,102,010

DURABLE ROTATIVE ABRASIVE STRUCTURE AND METHOD OF MAKING THE SAME

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The present invention relates to novel rotative abrasive structures comprising an annulus of many radially extending flap sections of abrasive sheet material retained together at the radially inner ends thereof. My invention pertains particularly to abrasive flap wheel structures which, by virtue of novel treatments applied to the flap sections forming said wheels, are especially suitable for heavy duty abrading operations due to their extreme wear resistance, durability and extended abrading life. The present invention pertains also to methods of making such novel treated abrasive flap wheel structures.

In accordance with the present invention I have discovered that various advantages are obtained by treating, as herein described, the flap sections of abrasive sheet material so as to ensheath the same in a thin binder film or coating of certain specific types of polymeric materials. I found, for example, that in my novel treated wheels very substantial increases in wear resistance, durability and abrading life are attained. Indeed, often these improvements are in the order of several hundred percent over identical but untreated structures.

In describing my invention, I am aware that it has been well-known in the abrasive art generally to treat or impregnate abrasive sheet material to provide waterproofness, to avoid deterioration, etc. In this regard, see Kugler et al. Patent No. 2,357,335, and Oakes Patent No. 2,357,350, both granted September 5, 1944. With respect to flap wheel type rotative abrasive structures, to which the present invention particularly is directed, I am aware that the suggestion has been made to apply grease or other lubricating material to flaps; see Block Patent No. 2,798,343, granted July 9, 1957, on application filed July 3, 1956.

In view of the art, and the types of materials taught therein to be suitable for treatments and further in view of what ordinarily would be considered applicable as a treating material to improve abrading characteristics, it would be entirely unexpected that certain non-lubricating binder materials could have anything but an adverse effect as a treatment for abrasive flap wheel structures.

However, I have discovered that by ensheathing the flap sections of abrasive flap wheel structures with certain polymerized flexible resinous binder materials, having characteristics antithetical to those of greases or lubricants, rotative abrasive structures are produced having remarkable wear resistance, durability and increased abrasive life. As will be apparent from the specific examples which follow, the treating materials which I employ ensheath and penetrate or impregnate at least slightly, the abrasive flaps of the wheel structures. Said sheaths are in the form of a thin flexible highly-adherent centrifugally-stable polymerized binder film or coating. The composition of the sheath further may be characterized, whether such be a solid or a very highly viscous liquid, in that (in the same dried or cured form in which it exists in place on the abrasive flaps) it provides a tenacious surface slip-resistant to the touch when formed by itself in a continuous smooth film, sheet or block, etc. The sensation one receives from such surface when he attempts to push or slide his finger thereover may be likened to that experienced from the well-known "hectograph" jelly, or from

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the film surface of an extremely viscous sticky or tacky substance, for example, a sheet of fly paper. Surprisingly, I have found this characteristic of providing a tenacious surface to the touch when formed per se in a continuous smooth film or sheet to be common with the treating materials providing the improved abrading characteristics in the novel treated structures hereof. It should be noted that the treating compositions hereof demonstrate the sensible properties above described to a somewhat lesser extent when applied in place on the flap wheel structures. Indeed when some of the compositions are employed in small (but nevertheless effective) amounts, these properties may hardly be evident at all on the treated abrasive articles.

Preferably the treating compositions, in liquid form (e.g., solution or as hot melts) are applied by dipping the abrasive sheet flap sections therein to ensheath the flap sections or otherwise coating the same. The dipped treated structures can then be mounted and spun centrifugally to remove excess treating material. The flap sections are then heated to cure the composition or to drive off solvent. This step thickens the treating composition and, in conjunction with the previous removal of excess material, renders the residuum stable to removal by centrifugal forces when the treated wheels are utilized in the abrading operations.

Having now generally described my invention, the following non-limitative examples will serve specifically to illustrate the same. Parts given are by weight unless otherwise noted.

Example I

A treating solution of curable resin composition was prepared as follows: To 40 parts of xylol were added 48 parts of "Versamid" 125 and 12 parts of "Epon" 828 liquid epoxy resin, the components being thoroughly stirred to provide a homogeneous solution. "Versamid" 125, supplied by General Mills, is an amine-terminated polyamide resin made by reacting polymeric fat acids and aliphatic polyamines. It is a viscous resin having a viscosity at room temperature of about 50,000 cps. and an amine value of about 305 grams of resin per amine equivalent. Resins of this general type are described in U.S. Patents Nos. 2,450,940 and 2,705,223. "Epon" 828, supplied by the Shell Chemical Company, is the resinous reaction product of bisphenol A and epichlorohydrin. It has an epoxy number of 192 grams per —OH equivalent and a viscosity at room temperature of about 10,000 cps. A mixture of "Versamid" 125 and "Epon" 828 having the same ratio disclosed in this example but without the inclusion of the xylol solvent can be cast into a block which, after being cured one hour at 190° F., is tacky, gelatinous, and has a percent extension at break, measured at a rate of extension of .2 inch per minute, of more than 500%. The tensile strength of such a block is approximately 40 pounds per square inch.

An abrasive flap wheel structure was formed of 175 flaps die-cut from grit 60 coated abrasive cloth having a starch- and glue-filled drills cloth backing and a phenolic resin bond and sandsize coating. The flaps had a width of 2½ inches and a length of 2⅞ inches. The flaps were assembled in annular form and retained together at the radially inner ends thereof, in accordance with known procedures, to provide an abrasive flap wheel having an outside diameter of 6 inches and an inside diameter of 1¾ inches. The wheel thus described was then immersed in the resin solution prepared as described until the flap sections were substantially completely coated, as indicated by the cessation of bubbles of displaced air rising from the flaps. The total immersion time required was about one minute. The wheel was then removed from the solution and spun at 1,000 r.p.m. for about 30 seconds to

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remove excess treating solution. Inspection of the thus treated wheel showed that the abrasive surface of the individual flaps was wet and shiny, the back surface of the flaps was considerably darker, and the lower parts of the weave were covered with resin, leaving only the tops protruding. (Greater amounts of resin tend to run and cause the individual flaps to stick together.)

Following spinning, the resin treatment was cured by heating the treated wheel for one hour at 190° F., after which time the surfaces of the flaps were somewhat tacky. Upon cooling to room temperature, however, the tackiness was greatly reduced. It was found that the wheel now weighed 29.2 grams more than it had prior to treatment. The finished wheel was darker than before it was treated, and it had a generally shiny and attractive appearance. The individual flaps were somewhat stiffer, but they were not embrittled. The flex marks (created when, as is conventionally done, the abrasive sheet stock of which the flap sections were formed was flexed to crack the abrasive bond and sandsize coating to flexibilize the sheet) were healed, and the edges of the flaps had a greatly reduced tendency to ravel.

The wheel described in the present example was then compared in performance to a similar wheel which had not been treated with the resin treating material. The test was run by determining the total amount of stock removed by the two wheels when used to grind cold rolled steel. It was found that the treated wheel of the present example removed approximately three-fourths again as much stock as did the control wheel, during the entire abrading life of the latter; and in so doing the wheel of the present example was not even fully consumed.

A treated wheel identical to that described in the present example was further treated by briefly immersing it in diethylene glycol, and then removed, and spun for 30 seconds at 1000 r.p.m. This wheel, the flaps of which were somewhat more flexible than those of the treated wheel above described, was then used to remove flash from aluminum sand castings by hand. Whereas a control wheel (i.e., completely untreated) was worn to the hub after 26 castings, the experimental wheel completed 50 castings before being worn out.

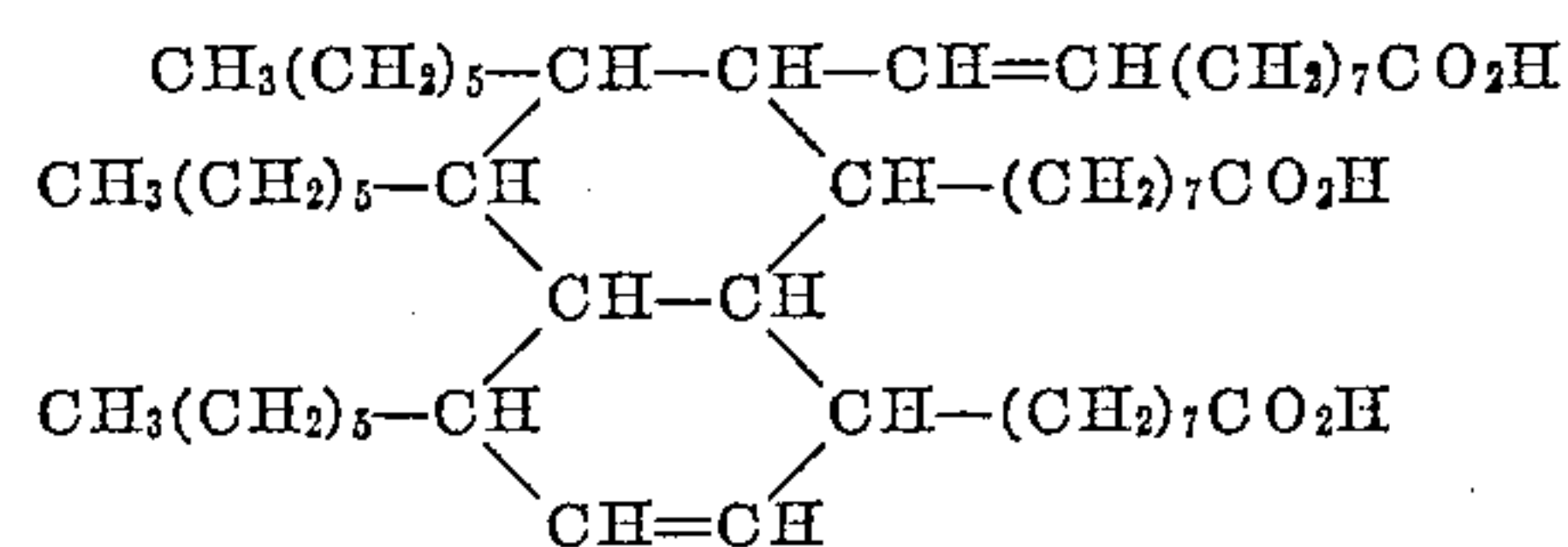
Various other ratios of polyamides and epoxy resins may be successfully employed as treating materials. For example, 90 parts of a polyamide of the type described may be blended with 10 parts of the liquid epoxy to produce, after heating, a tacky, viscous substance which is slip-resistant to the touch and which may be applied from xylol solution. A blend of 65 parts of polyamide and 35 parts of epoxy resin may be similarly employed. A block cast from this material and heated has a tensile strength of about 1000 pounds per square inch, and an ultimate elongation of over 50%; the surface of such block has a tenacious surface slip-resistant to the touch. However, I have found that as the ratio of epoxy resin to polyamide resin increases, the resulting heat-advanced composition becomes correspondingly less flexible and more brittle. In fact blends containing equal amounts of the particular polyamide and epoxy resins of this example have been found excessively to embrittle the flaps of abrasive sheet material. Blocks cast from such 50-50 blend have a tensile strength of over 4000 pounds per square inch and an ultimate elongation of less than 3%. Of course, it is to be noted that the physical characteristics of otherwise embrittling composition materials may be modified by appropriate addition of plasticizing materials.

Example II

A treating solution was first formulated. To 40 parts of xylol were added 36 parts of "Emery Trimer Acid 3055-S," 16 parts of the aforementioned liquid epoxy resin "Epon" 828, and 8 parts diethylene glycol. The trimer acid employed is substantially like a tribasic acid trimer of linoleic acid of average molecular weight of approximately 845. The structure of this acid is not

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definitely known, but it has been postulated that it is as follows:



A block of material cast from this resin blend, but without the inclusion of the xylol, was cured one hour at 190° F., after which time it was found to be rubbery, somewhat tacky, and to have an elongation at break of 109% when extended at a rate of .2 inch per minute. Its tensile strength was about 70 pounds per square inch.

A 6 inch diameter wheel similar to that described in Example I was formed from grit 50 coated abrasive material having a starch- and glue-filled drills cloth backing and a phenolic resin bond and size. The inner diameter of this wheel, however, was 2¾ inches, and the overall dimensions of each individual flap were 2 inches wide by 1½ inches long. Because of the increased inner diameter, 230 flaps were required to fill the working face of the wheel, and the angle between adjacent flaps was somewhat less than that of the wheel described in Example I.

The wheel thus described was then immersed in the treating solution of the present example and processed in the same manner as described in Example I. When used to sand cold rolled steel at a substantially constant rate of cut, the experimentally treated wheel of this example cut approximately twice as much steel while losing approximately one-half as much abrasive material as an untreated control wheel.

Example III

A wheel identical to the control wheel of Example I, except that it contained 156 flaps of grit 50 material, was treated by immersing it in a blend of 39 parts of "Versamid" 125, 13 parts of "Epon" 828, 8 parts of diethylene glycol, and 40 parts of xylol, all as hereinbefore defined. After removing the wheel from the solution, spinning it dry, and curing it for one hour at 190° F., it was used to deburr and finish the sidewalls of pneumatic tires. It was found that the experimental wheel deburred and finished 6750 sidewalls before failure, whereas the control (untreated) wheel could be used for only 2450 tires before failure. When a block was cast of the treating material, omitting the xylol, and cured at 190° F. for one hour, it was found to have a tensile strength of 20 pounds per square inch and an ultimate extension at break of over 500% when tested at a rate of extension of .2 inch per minute. The surface of said block had a feel similar to that of the conventional "hectograph" (glycerine) jelly.

Example IV

An untreated wheel like that described in Example II was treated with a polyisobutylene synthetic rubber solution as follows: 53 parts of Polybutene No. 128, 7 parts of "Vistanex" MS, and 40 parts of xylol were mixed together to form a treating solution. Polybutene No. 128 is supplied by the Oronite Chemical Company. This product is a catalytically polymerized normal and branched chain butene having a molecular weight of about 1500. Each monomer unit contains one independent bond and two methyl or one ethyl side chain. The product has a pour point of about 70° F. "Vistanex" MS is supplied by the Butyl Division of the Enjay Company, Incorporated, located in New York, New York. It is an isobutylene polymer having an average molecular weight of between 8700 and 10,000 and a viscosity of well over 100,000 cps. After evaporating the xylol, a sample of this blend was found to be tacky and noncuring, and to have a viscosity of about 50,000 cps.

The wheel treated with this material was dried at 190° F. for one hour to remove the solvent. When the ex-

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perimental wheel of this example was used to sand cold rolled steel it cut at approximately the same rate of speed as an untreated control wheel, while wearing only about $\frac{1}{3}$ as rapidly.

Example V

Diethylene glycol, 177 parts, adipic acid, 289.5 parts, and trimethylol propane, 10.3 parts, were reacted for about 5 hours at 125–150° C., i.e., until an acid number of 52 had been reached. This product, which was tacky and which had a viscosity of 70,000 cps. at room temperature, was dissolved in a 9:1 xylol:methylisobutyl ketone mixture to form a 60% solids solution. A wheel like the untreated wheel of Example II was treated with this treating solution as above described. When the experimental wheel of this example was heated for one hour at 190° F. to evaporate the solvent and thereafter used to sand cold rolled steel, it cut at approximately the same rate of speed as an untreated control wheel, while wearing only about $\frac{1}{3}$ as rapidly.

Example VI

470 parts of "Emery Dimer Acid 3079-S" was esterified with 128 parts of diethylene glycol by reacting for 12 hours at a temperature of 150° C. ("Emery Dimer Acid 3079-S" is a dibasic dimerized linoleic acid of approximately 600 molecular weight. Its structure is similar to the trimer acid described in Example II, except that, of course, only two linoleic acid molecules are involved.) The final product had a viscosity of 6000 cps. at room temperature, an acid number of 3.5, and a hydroxyl number of 88.

A 60% solution of xylol of the material thus described was used to treat flap wheels in the manner described in the previous examples. Solvent was removed by heating the treated wheel one hour at 190° F. It was found that the wheels so treated had an abrasive grain efficiency approximately five times as high as that of the control, but that there was an initial tendency for some of the treating material to be thrown off because the operating rotative speed was much higher than the rotative speed employed during treatment. This is because the resin composition, even the residuum left after complete manufacture of the wheel (including spinning), was somewhat flowable and thus in the twilight zone of centrifugal stability. Preferably the compositions hereof are sufficiently centrifugally stable after spinning at some moderate rotational speed of the treated wheel during manufacture, and after a thickening (e.g., curing) of the composition, such that little or no material will be lost even at high operating rotational speeds.

The centrifugal stability of the resin composition of the present example can be improved by utilizing a suitable cross-linking agent, for example about 25% toluene diisocyanate. The latter is incorporated into the composition just prior to treatment of the wheel followed by heating the treated wheel to cross-link the resin in situ. Such resin when coated by itself, on a surface, and then similarly cured, provides a material having a tenacious surface and a viscosity greater than 100,000 cps.

Although the resin composition of the present example was applied to the flap wheel structure from the solution, it, like various of the other treating compositions hereof, may be applied as a 100% solids hot melt. By way of caution it might be mentioned that where hot melt application procedures are employed for heat advancing treating compositions, the melt should not be heated to a temperature or for a time which will prematurely thicken the composition and render it non-penetrative of the back or non-abrasive surface of the flap sections.

Example VII

A blend of 62 parts of "Emery Trimer Acid 3055-S," previously described in Example II, 38 parts of N,N'-bis-1,2-ethylene isosebacamide, and 15 parts diethylene glycol

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was prepared. A wheel like the untreated wheel of Example II was treated with this material in the manner described in the preceding examples. This wheel was able to sand over twice as much cold rolled steel as an untreated control wheel, while incurring only about $\frac{2}{3}$ as much flap wear.

The N,N'-bis-1,2-ethylene isosebacamide is only one of a large group of substituted ethylene imines ("bis-amides") which may be used successfully in the formulation of the present example, as well as in other formulations.

From the foregoing description of my invention and the various specific examples disclosed, other suitable and equivalent structures and/or compositions undoubtedly will suggest themselves. However, it is to be understood that it is not my intention to be limited to the embodiments here shown, but rather I intend only to be limited by the spirit and scope of the specification as a whole including the appended claims.

I claim:

1. A heavy duty rotative abrasive wheel structure comprising an annulus of radially disposed uniformly positioned flap sections of abrasive sheet material retained together at the radially inner ends thereof, said flap sections being ensheathed in and penetrated by a thin flexible highly-adherent centrifugally-stable polymerized binder film or coating, said film or coating imparting durability, improved wear resistance and increased abrading life to said structure, the composition of said film or coating being further characterized by presenting a tenacious surface slip-resistant and at least slightly tacky to the sliding touch when formed per se in a continuous smooth-surfaced film or body.

2. A heavy duty rotative abrasive wheel structure comprising an annulus of radially disposed uniformly positioned flap sections of abrasive sheet material retained together at the radially inner ends thereof, said flap sections each having one abrasive-coated surface and one non-abrasive surface, at least the non-abrasive surface of said flap sections being provided with and penetrated by a thin flexible highly-adherent centrifugally-stable polymerized binder film or coating, said film or coating imparting durability, improved wear resistance and increased abrading life to said structure, the composition of said film or coating being further characterized by presenting a tenacious surface slip-resistant and at least slightly tacky to the sliding touch when formed per se in a continuous smooth-surfaced film or body.

3. A heavy duty rotative abrasive wheel structure comprising an annulus of radially disposed uniformly positioned flap sections of abrasive sheet material retained together at the radially inner ends thereof, said flap sections being ensheathed in and penetrated by a thin flexible highly-adherent centrifugally-stable polymerized binder film or coating which imparts durability, improved wear resistance and increased abrading life to said structure, said film or coating comprising the in situ-cured reaction product of (1) from 90 to 65 parts of an amine-terminated polyamide resin made by reacting polymeric fat acids and aliphatic polyamines and (2) correspondingly from 10 to 35 parts of a resinous epoxy-terminated reaction product of bisphenol A and epichlorohydrin.

4. A heavy duty rotative abrasive wheel structure comprising an annulus of radially disposed uniformly positioned flap sections of abrasive sheet material retained together at the radially inner ends thereof, said flap sections each having one abrasive-coated surface and one non-abrasive surface, at least the non-abrasive surface of said flap sections being provided with and penetrated by a thin flexible highly-adherent centrifugally-stable polymerized binder film or coating which imparts durability, improved wear resistance and increased abrading life to said structure, said film or coating consisting essen-

tially of a tacky noncuring blend of polybutene and polyisobutylene.

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