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(54) **CORN STOVER FUEL OBJECTS WITH HIGH HEAT OUTPUT AND REDUCED EMISSIONS DESIGNED FOR LARGE-SCALE POWER GENERATION**

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(57) **ABSTRACT**

A Novel fuel object comprised of a proportion of corn stover and a proportion of wood fiber combined with a basically reacting compound. The object comprises fiber of the appropriate size and moisture content combined with an inorganic base. An appropriately sized object is readily manufactured, provides high heat output, is consistent in fuel characteristics, and is sized and configured for use in power generation facilities. Based on fiber selection and processing, the fuel object may be used in a variety of current power generation technologies including stoker, fluidized bed, gasifier, cyclonic, direct-fired, and pulverized coal technologies, and results in significant reduction of air emissions (including sulfur dioxide, nitrogen oxides, hydrochloric acid, carbon monoxide, carbon dioxide, and mercury) compared to coal with no loss of boiler or furnace efficiency.

FIG. 1

Mass Number 46 (NO_2)

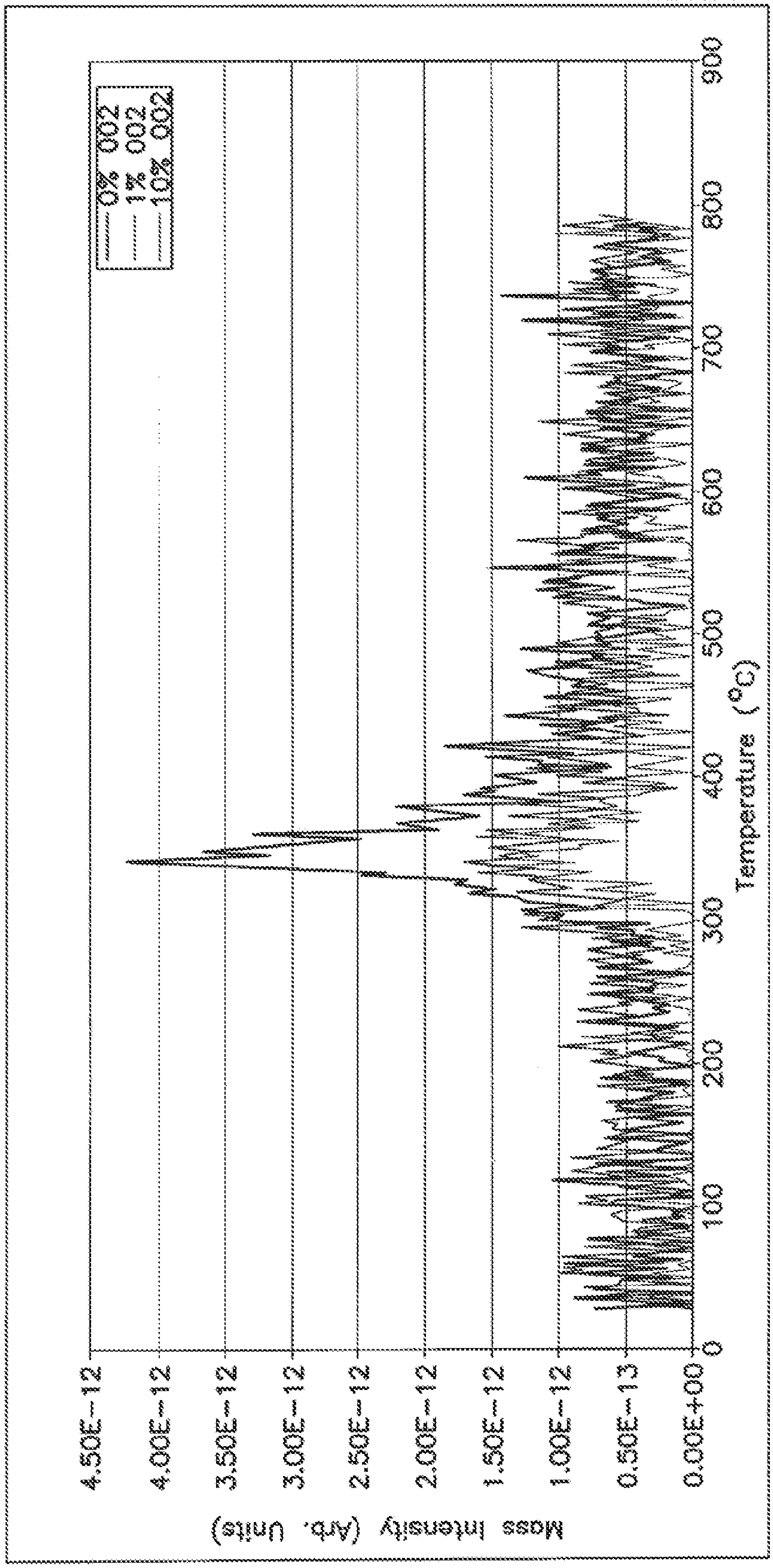


FIG. 2

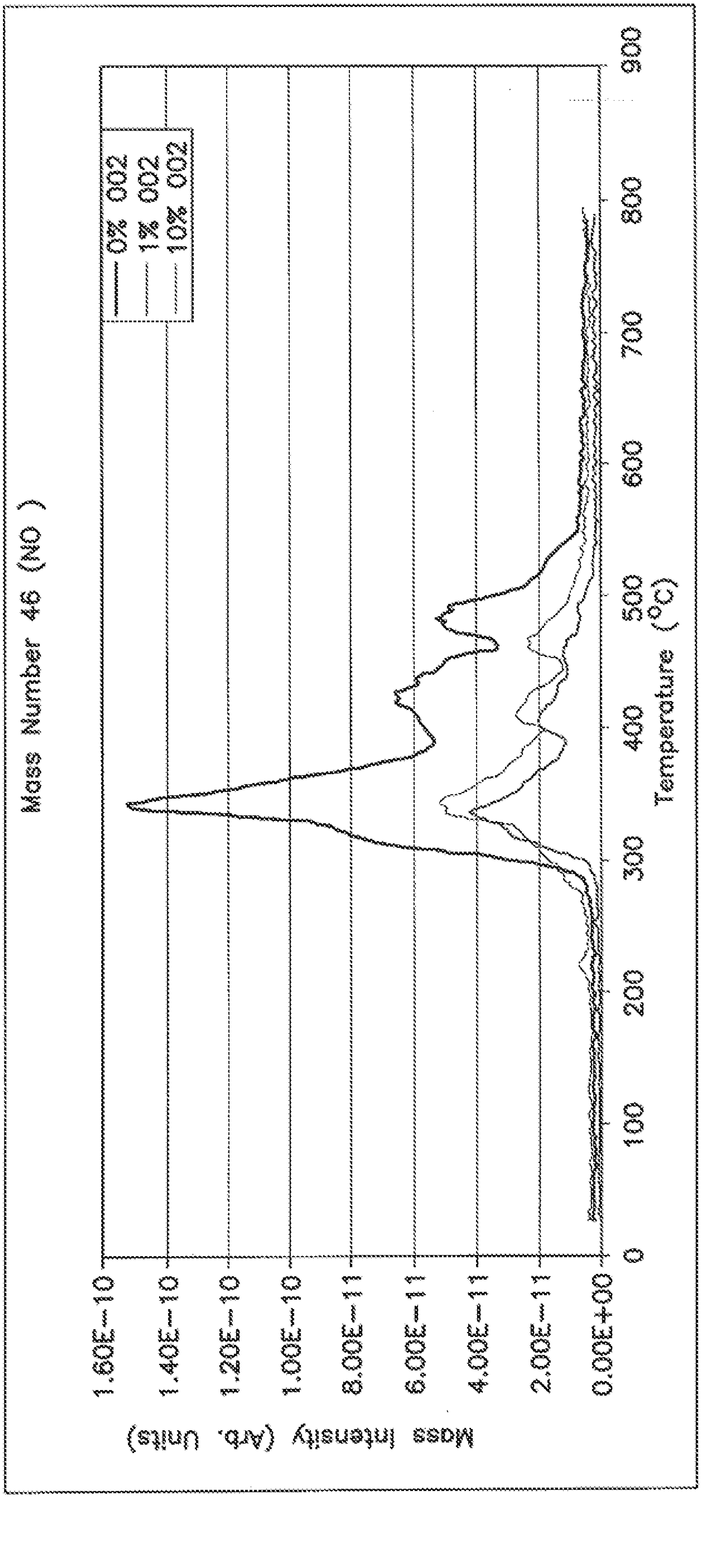

Mass Number 46 (NO)
0% 002
1% 002
10% 002
Mass Intensity (Arb. Units)
1.60E−10
1.40E−10
1.20E−10
1.00E−10
8.00E−11
6.00E−11
4.00E−11
2.00E−11
0.00E+00
0
100
200
300
400
500
600
700
800
900
Temperature (°C)

FIG. 3

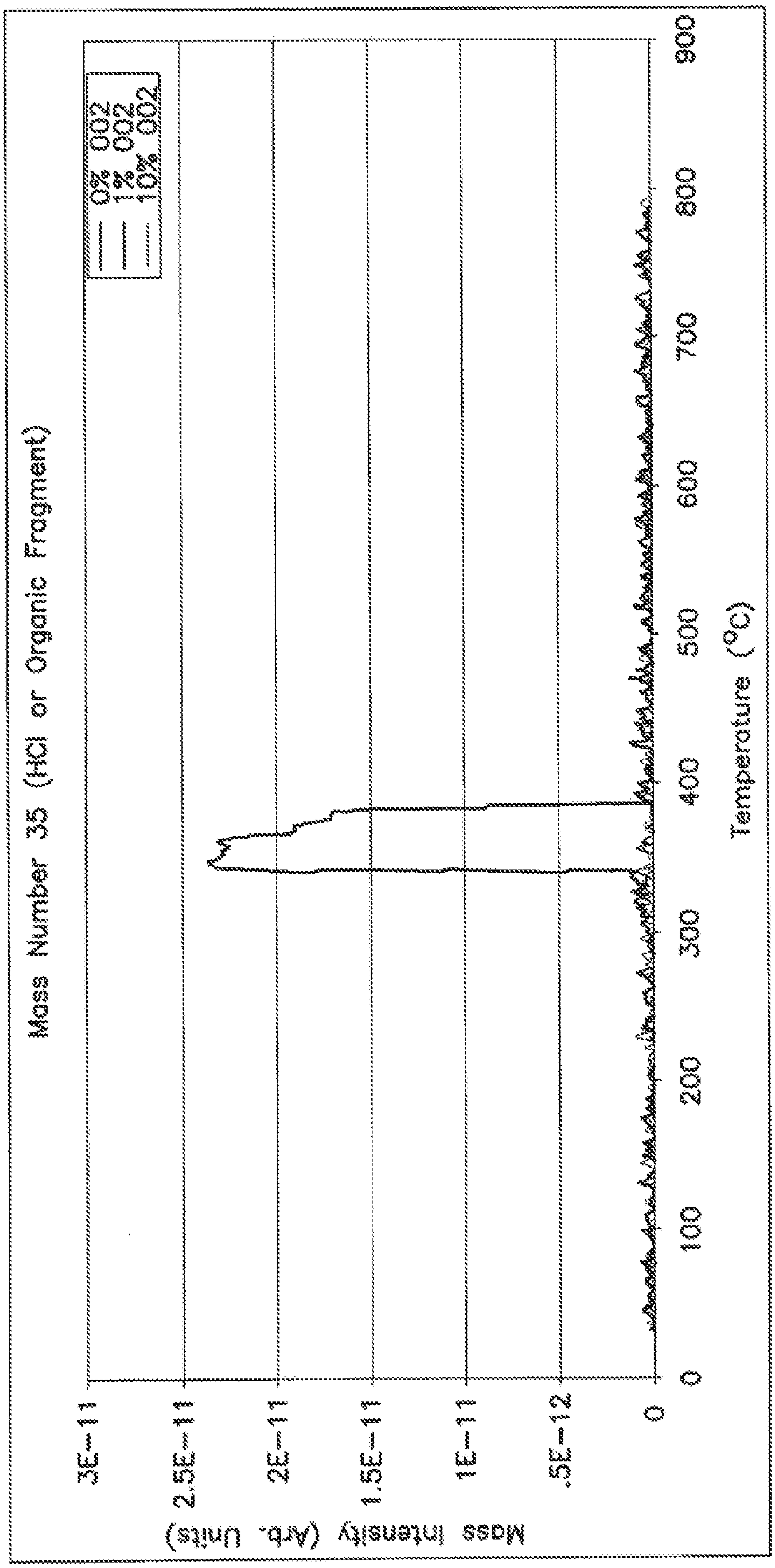
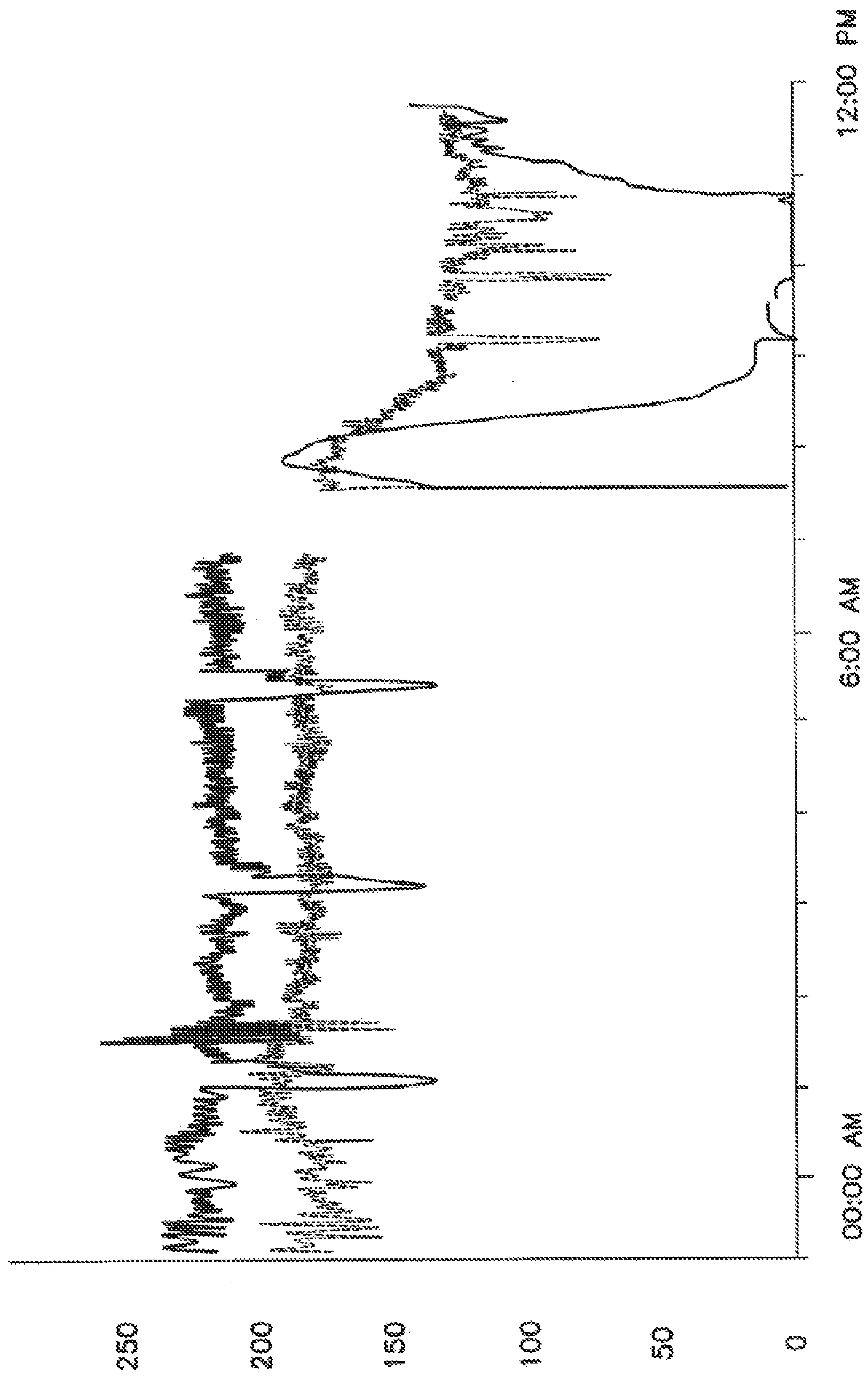

Mass Number 35 (HCl or Organic Fragment)
Mass Intensity (Arb. Units)
3E−11
2.5E−11
2E−11
1.5E−11
1E−11
.5E−12
0
Temperature (°C)
0
100
200
300
400
500
600
700
800
900
0% 002
1% 002
10% 002

FIG. 4



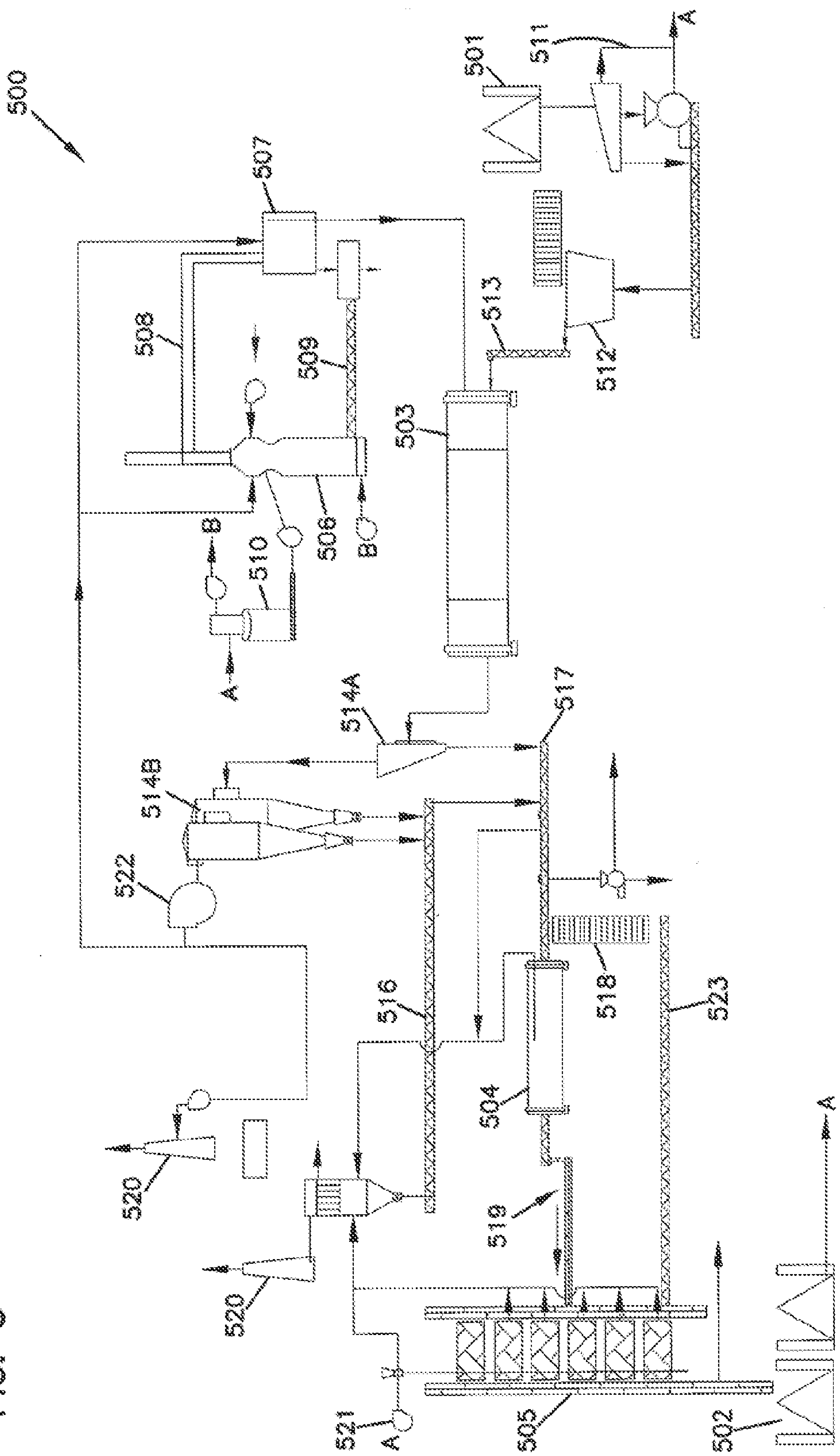

500
501
511
A
507
508
509
506
510
B
B
A
503
513
512
514A
514B
517
522
516
518
523
504
520
520
519
521
A
505
502
A

FIG. 5

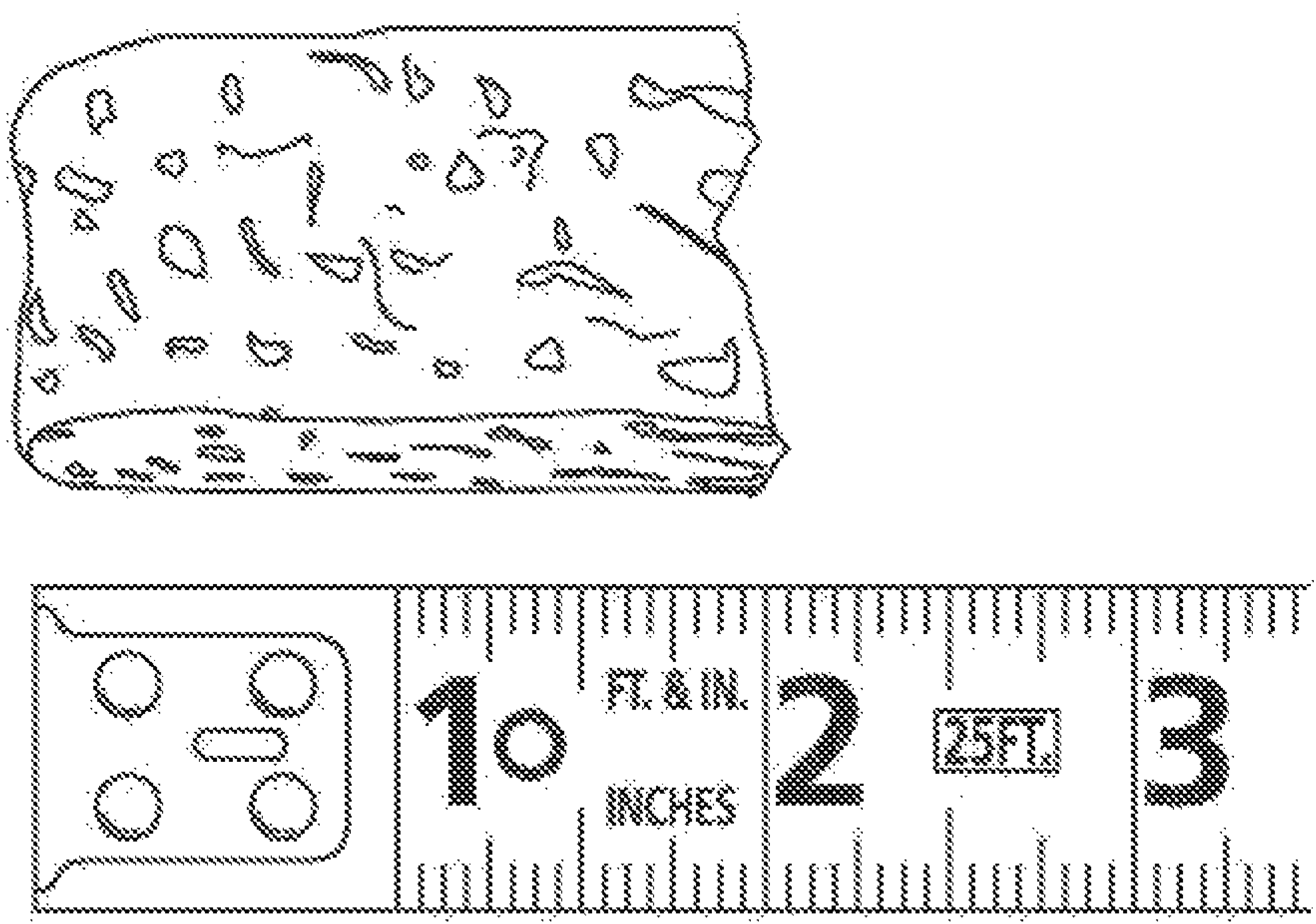


FIG. 6

CORN STOVER FUEL OBJECTS WITH HIGH HEAT OUTPUT AND REDUCED EMISSIONS DESIGNED FOR LARGE-SCALE POWER GENERATION

CROSS REFERENCES TO RELATED APPLICATIONS

[0001] This application claims priority to and the benefit as a continuation application of U.S. Patent Application entitled, "Corn Stover Fuel Objects With High Heat Output And Reduced Emissions Designed For Large-Scale Power Generation," Ser. No. 13/422,863, filed Mar. 16, 2012, which is a continuation application of Ser. No. 13/074,256, filed Mar. 29, 2011, which is a continuation application of Ser. No. 12/359,766, filed Jan. 26, 2009, the entire contents of which are incorporated herein by reference and relied upon.

BACKGROUND

[0002] The invention relates a high-energy, low-emission solid fuel made from natural renewable feedstocks.

[0003] In large part, energy generation in the United States and worldwide is based on combustion of conventional non-renewable fossil fuels such as coal, coal byproducts, petroleum-based oils and natural gas products. These energy sources provide a source of energy for power plants, industrial facilities, and institutions, however, they are not renewable in nature, have significant environmental impacts, are decreasing in supply, and increasing in cost. Continued use of these fossil fuel energy sources results in cumulative environmental impact including increased local and global concentrations of greenhouse gases, sulfur dioxide, nitrogen oxides, and mercury.

[0004] The decreasing supply and environmental impacts associated with fossil fuel use have led to consideration of potential for energy derived from combustion of natural products, typically cellulosic materials. Many of the natural sources comprising potential cellulosic fuels have not achieved commercial success in the past due to a variety of problems including high moisture content, low fuel heating value, impurities in the fuel, inconsistent fuel characteristics, transportation costs, difficulties in handling, and high processing costs. Further, such materials often have combustion problems or compositions that result in the formation of adverse emissions and substantial quantities of ash.

[0005] We have found, in the energy market segment, a substantial need for a new cellulosic based fuel containing substantially no conventional BTU source from fossil fuels such as coal, petroleum, natural gas or other such non-renewable sources. This need relates to a fuel that has a substantial heating value, is consistent in nature, is low in moisture, can be readily made at low cost, can be transported and handled at low cost, can be used in existing solid fuel systems with little or no modifications, has lower emissions than fossil fuels, and is specifically adapted for use in modern power plant installations.

SUMMARY

[0006] We have now found a fuel source that provides a substantial heat output satisfactory for use in large-scale power generation, even in the absence of coal, oil, gas or other conventional fossil fuels. A formed cylindrical object, briquette or cube is comprised of a blend of cellulosic material including corn stover and wood. As used herein, the term "cube", "briquette," "formed object," or "fuel object" are roughly synonymous and refer to a discrete particle of any size or shape that contains the natural cellulosic materials described herein. The major dimension of the fuel object is less than about 6 cm. The volume of the fuel object is about 10 to 100 cm3. "Conventional fossil fuel" refers to coal products including bituminous coal, anthracite coal, peat, coke and coking byproducts and to petroleum products such as oil, gas, natural gas liquids and products derived from shale and tar sands.

[0007] We have found that moisture content and particle size of the corn stover and wood fiber particles in the final fuel object are important for product formation, handling, and effective combustion. We have found that the addition of an effective amount of base material reduces corrosive and acidic byproducts from the combustion of the cellulosic materials and reduces emissions of sulfur oxides, nitrogen oxides, hydrogen chloride and other acidic materials. The processing and blend of materials provides a high energy output without the addition of any fossil fuels such as coal, oil or natural gas as found in prior art materials. In the preferred materials of the invention, no separately added binder is used.

[0008] We have also found that the fuel object of the invention can be made without conventional binder materials such as that used in forming a number of the prior art materials. Such binders, in the prior art, are typically polymeric binders or are additional lignent or hemicelluloses materials.

[0009] We have found that the fuel object, based on sizing and specifications, may be used immediately in existing solid fuel energy facilities (including those employing stoker, fluidized bed, gasifier, cyclonic, direct-fired, and pulverized coal technologies) and operate with an efficiency and higher heating heat value similar to some coals with a significant reduction in air emissions per million BTU of energy output compared to fossil fuels.

[0010] Additional features and advantages are described herein, and will be apparent from the following Detailed Description and the figures.

BRIEF DESCRIPTION OF THE FIGURES

[0011] FIG. **1** shows the cooperation in the reduction in formation of SO_2 in emissions from the use of base in combustion of the fuel of the invention.

[0012] FIG. **2** shows the cooperation in the reduction in formation of NO_x in emissions from the use of base in combustion of the fuel of the invention.

[0013] FIG. **3** shows the reduction in formation of HCl in emissions from the combustion of the fuel of the invention.

[0014] FIG. **4** shows the reduction in formation of both SO_2 and NO_x in emissions from the combustion of the fuel of the invention.

[0015] FIG. **5** is a process diagram for the fuel object forming process.

[0016] FIG. **6** shows an embodiment of the fuel object of the invention.

DETAILED DESCRIPTION

[0017] The embodiment that is the subject of this application includes a cylindrical object, briquette, cube or other such formed object comprising corn stover, wood and an inorganic base. The invention involves a fuel object processed, sized and configured for use in large-scale modern combustion energy generating systems. Composition, raw material particle size, moisture content, and fuel object size and structure, result in the fuel object having a high energy value, low emissions upon combustion, and highly efficient combustion, in a range of commercially available combustion technologies.

[0018] The fuel object can have a volume of about 10 to 100 cm^3; does not need to be symmetrical, but it is preferred that the fuel object be substantially symmetrical in shape such as cylindrical object, a cube, parallel-piped or the like. A cube can be roughly a rectangular prism or a cube that is 1 to 6 cm on a side. Typical density of the fuel object is 30 to 40 lbs/fl^3. A cylindrical object can be about 0.5 to 10 cm in height and about 0.5 to 10 cm in diameter.

[0019] The fuel object typically comprises about 60 to 80 weight percent corn stover and 20 to 40 weight percent wood. The corn stover component has a particle size of about 100 to 35,000 microns with about 90 percent of the particles greater than 1,000 microns. The wood fiber has a particle size of about 100 to 30,000 microns with about 90 percent of the particles greater than 1,000 microns.

[0020] The initial reduction of the particle size of the corn stover and wood fiber, to these proportions before fuel object formation, provides an input to the process that forms the fuel object leading to a mechanically stable fuel object that can be manufactured, stored, transported and used in modern combustion installations as is or is easily comminuted to a small particle size depending on the nature of the combustion process.

[0021] Chemical bases that can be used in a fuel object of the invention include typically alkali metal and alkaline earth metal bases. Such bases can be made from sodium potassium, calcium, magnesium and other such metal species. The base can be used in the form of oxides, hydroxides, carbonates, bicarbonates, phosphates, and any other inorganic anion that produces a basically reacting solution, a pH greater than 7.5, when the base is mixed in water (pH about neutral) at an amount of about 0.5 to 10%. The important characteristic of the chemical base is that during the combustion process the chemical base can react with combustion byproducts such as sulfur oxides (SO_2), nitrogen oxides (NO_x,), chloride (Cl^{-1}) hydrochloric acid (HCl) and other acidic producing gaseous species. The chemical base can aid in forming neutralized species and substantially reduced the effects of corrosive action on combustion equipment. Specifically, corn stover has higher chlorine content than wood and use of the base additive helps reduce chlorine/chloride gas formation upon combustion of the fuel object. A preferred base to neutralize acids in combustion is a bicarbonate or dolomite.

[0022] The fuel objects have a typical heating value of at least about 7,000 BTU/lb (about 3,500 cal.-gm^{-1}); about 7,300 BTU/lb (about 3,650 cal.-gm^{-1}) and typically at least 8,000 BTU/lb (about 4000 cal.-gm^{-1}) all on a dry basis.

[0023] FIG. **5** is a diagram of the process for the manufacture of the fuel object of the invention. The process **500** includes, as primary process stations, raw materials and fuels storage **501**, raw materials dryer unit **503**, a cooling unit **504** and a cubing or object forming unit **505**. These primary stations take blended wood fiber and renewable fuel component, adjust particle size, reduce moisture to a preferred level, cool the material and then form the fuel object as needed. Once formed, the fuel is then stored or transferred to an industrial combustion or burn unit (not shown).

[0024] The raw materials used in making the object of the invention is delivered to and stored in raw material delivery and storage unit **501**. That material is then transferred to a pretreatment screen **511** for the purpose of separating fines from useful material. Useful material is then transferred to a pretreatment hammer mill which adjusts the fiber size to appropriate fiber dimensions for final object formation. Fine materials from both the prescreening, pretreatment and from the hammermill are transferred to the colt exhaust bag house **515** through the conduit A-A. The sized fuel is transferred to a feed bin **512** for temporary storage. The sized fuel source is then transferred using a dryer and feed conveyor **513** to the dryer drum **503** for drying purposes. The output from dryer **503**, having moisture content of about 0.1 to 14 wt. % moisture, is then directed to drop out chamber **514**(*a*) that separates fines from the appropriately sized materials in a dried form. Heat for the dryer **503** is generated by Burner **506** and blending chamber **507**. Fuel for the burner **506** is stored in bin **510**. Fuel is transferred to the burner **506** through transfer line B-B from bin **510**. Heat and recycle gas stream from dryer **514***b* is sent conduit **508** through chamber **507** to the dryer **503**. Heat is recycled to the burner **506** through conveyor **509**.

[0025] The fines are directed to cyclone dryer **514**(*b*) while the appropriately sized materials are directed to cooling drum in feed conveyor **517**. Exhaust from the cyclone material is directed to recycle fan **522** which directs the exhaust either to ambient air or to the recycle through blending chamber **507**. The cold exhaust bag house **515** takes fines from the screen and hammermill station **511** and from the cubing stations **505**. Those bag house fines are collected on the particulate conveyor **516** which are combined from the 10 output from the cyclone dryer **514**(*b*) and are directed to the pulling drum and feed conveyor **517**. Cooling drum **504** cools the particulate material from the infeedment conveyor **517** and then conveys that material on conveyor **519** to the fuel object formation stations **505**. Optionally, if the cooling drum is not required for processing the fiber, the fiber before entry into the cooling drum in conveyor **517** can be directed to a dryer bypass bulk conveyor **518** and then to an optional dryer cooling drum bypass feed conveyor **523** that directs the fiber to the object formation stations **505**. Fines from screen **511**, through airlock **521**, the object forming units **505** and from drum **504** or conveyor **517** are directed to baghouse **515**. Air is vented to ambient from baghouse **515** from vent **520**. The input material placed in delivery and storage unit **501** is typically preblended with the appropriate amount of wood fiber and renewable fuel source. Once formed, the fuel objects of the invention can be stored in product stock pile **502** and then transferred to a combustion unit (not shown) for energy generation).

Reduced Air Emissions

[0026] The composition of the fuel and chemical base additive are designed to minimize air emissions from combustion of the fuel object. The impact of the addition of inorganic base additives at different concentrations on reduction of sulfur dioxide, nitrogen oxide and hydrochloric acid emissions during combustion of the fuel object was evaluated in bench-scale testing. The testing, is summarized in FIGS. **1-3** below, support that use of the additive results in reduced emissions of hydrochloric acid, sulfur dioxide and nitrogen oxide emissions.

[0027] The objects contain less than 0.5 percent sulfur by weight percent and therefore emit approximately 95 percent less sulfur dioxide emissions than derivation of a similar amount of energy from coal. Because wood and corn stover are biogenic in nature, combustion of the fuel object is considered carbon neutral under carbon registries and trading programs in place in the United States today and therefore results in a 100 percent reduction in creditable greenhouse gas emissions than derivation of a similar amount of energy from coal. Nitrogen content of the corn stover and wood and addition of the inorganic base additive also result in an approximately 40 percent reduction of nitrogen oxide emissions than derivation of a similar amount of energy from coal. FIG. **4** below demonstrates the reduction in tested emission rates of nitrogen oxide and sulfur dioxide where eastern coal is replaced 100 percent with the fuel object.

[0028] Data collected from combustion of the objects in a 15 percent fuel object/85 percent coal co-fire with eastern coal also confirms emission reductions of sulfur dioxide and carbon monoxide when compared to 100 percent eastern coal. Table 1 demonstrates the reductions in sulfur dioxide and carbon monoxide where the fuel object replaced 15 percent eastern coal in a 170,000 lb/hour steam boiler compared to combustion of 100 percent eastern coal.

TABLE

Emission Reductions from 15 Percent Replacement of Easter Coal with Claimed Fuel Gaseous Pollutant Emissions (lb/MMBtu)

Test ID Fuel	SO_2	CO_2
Baseline 1	2.49	0.081
Baseline 2 100% Coal	2.28	0.083
Baseline 3	2.48	0.085
Baseline 4	2.63	0.102
Cofire 1 Blended Fuel	2.12	0.089
Cofire 2 (85.1:14.9 - coal:Fuel)	2.11	0.081
Cofire 3 (14.9% wood)	2.26	0.081
Baseline Averages	2.47 ± 0.14	0.088 ± 0.010
Cofire Averages	2.16 ± 0.08	0.083 ± 0.05
% Difference	−12.4%	−5.02%

Object and Particle Size

[0029] The size and density of the fuel object is significant in that it allows for ease of handling, transportation, storage and conveyance in most power generation facilities. Object size also is important in that it allows the fuel object to burn on the grate of stoker-type combustion units and not combust prematurely.

[0030] Particle size within the fuel object also is significant in both manufacturing a fuel object that maintains its integrity though shipping and handling and that burns efficiently. Efficient combustion reduces emissions of nitrogen oxides and carbon monoxide and leaves minimal residue, such as ash, which would have to be disposed in a waste site. Sizing of the fuel particles also is critical to allow a fuel object to break into discrete particles in certain applications such as pulverized coal-type units.

Combustion Efficiency

[0031] The blend, composition, moisture and size of the fuel object allow efficient operation in existing power generation facilities. Testing by the Southern Research Institute demonstrated that use of the fuel object in combination with coal in a large steam boiler resulted in no loss of boiler efficiency compared to 100 percent coal. Table 2 provides a summary of collected data.

TABLE 2

Boiler Efficiency Comparison of 100 Percent Coal to 15 Percent Fuel Object and 85 Percent Coal (Source SRI April 2008)

Test ID	Fuel	Heat Input (MMBtu/hr)	Heat Output (MMBtu/hr)	Efficiency (%)
Baseline 1	100% Coal	264.6	224.4	84.8
Baseline 2	100% Coal	264.3	223.9	84.8
Baseline 3	100% Coal	264.8	223.7	84.5
Baseline 4	100% Coal	267.6	228.8	84.5
Cofire 1	85.1 Coal/14.9 Fuel Object	275.7	229.7	83.3
Cofire 2	85.1 Coal/14.9 Fuel Object	271.9	230.0	84.6
Cofire 3	85.1 Coal/14.9 Fuel Object	272.5	230.3	84.5
Baseline Average	NA	265.3	225.2	84.9 ± 0.4
Cofire Average	NA	273.4	230.0	84.1 + 0.7
Absolute Difference	NA	8.1	4.8	−0.7
% Difference	NA	3.0%	2.1%	−0.9%
Statistically Significant Change?	NA	NA	NA	NA

Corn Stover

[0032] Corn, also known as maize (*Zea mays;* also ssp. *mays* L.), is the source of corn stover. The term "corn stover" refers to the remains from the surface component of a corn plant, aside from the corn kernels. Stover does not typically include large amounts of the crown or surface roots. Corn stover is generally the leaves, stalk, husk, etc. Corn stover can also include incidental grasses and weeds. Corn stover is one of the largest sources of low cost cellulose in the United States. About one ton of corn stover is produced for every one ton of corn grain. About 250 million dry tons of stover are produced each year. Thus, the United States produces substantial amounts of corn stover for potential use in fuel applications.

Wood Fiber

[0033] The term "wood fiber" refers to a product derived from some part of a tree as that term is commonly used in the art. A number of direct products and byproducts can be derived by taking trees or portions of trees and reducing their particle size. The term "wood fiber" may refer to materials derived from fruit, leaves, sap, bark and other such tree byproducts. Wood fiber is typically derived from either the woody part of the tree within the bark and typically refers to either wood-like components of tree trunks, tree limbs and tree roots. Wood fiber is typically primarily cellulosic in nature but is known to be derived from wood cells that typically comprise a substantial proportion of cellulosic materials in combination with lignin and hemicellulosic materials in a fibrous woody cell structure. Wood fiber can be derived from a number of tree sources including both hard and soft woods. Such wood fiber materials can be derived from the processing of trees into sized lumber, the byproduct of clearing and shredding trees, the byproducts derived from any process that begins with a wood containing plant part leading to the formation of a substantially cellulosic wood fiber material.

General Method of Manufacturing a Fuel Object

[0034] The process for manufacturing fuel objects described herein starts by grinding cellulosic material. The cellulosic material can be ground by feeding a pulverizer or grinder to reduce the cellulosic material to a predetermined size. The corn stover component is ground to a size of about 100 to 35,000 microns with about 90 percent of the particles greater than 1,000 microns. The wood fiber is ground to a particle size of about 100 to 30,000 microns with about 90 percent of the particles greater than 1,000 microns).

[0035] After grinding, cellulosic materials a may be fed through a dryer. A dryer ensures that moisture content of the cellulosic material is at less than about 14 wt. % and often less than 10 wt. %. Preferably, moisture of a finished fuel object should be between 7 wt. % to 14 wt. %. Moisture content of the cellulosic material is significant to the integrity of a fuel object since moisture content of cellulosic material assists in bonding all of the materials in the composition prior to and following the pelletizing of the composition. However, an increase in the moisture of the cellulosic material beyond a disclosed limit would jeopardize the characteristics of the fuel object and its ability to withstand being transported. It is important that an object maintain its integrity prior to pre-combustion processing or burning. A fuel object should be rigid enough to be handled mechanically without crumbling. Achieving proper and desired moisture content for a fuel object is critical to achieve a desired heat output and in maintaining the ability to transport fuel objects without harming its integrity, shape, or composition.

[0036] After the cellulosic material has been sufficiently dried to desired moisture content, the cellulosic material can be fed through a secondary pulverizer as necessary. A secondary pulverizer can be the final grinding process for the cellulosic materials.

[0037] The base additive may be added once organic components have been appropriately sized and conditioned. Components of a fuel object may be further blended together by means of a blender, drum or other mechanical equipment.

[0038] A densification process can create a final composition of materials. Densification allows materials to be mixed and blended in a controlled manner with other particles comprising a fuel object. After the components of a fuel object have been sufficiently blended, the components/materials are processed and forced through densification equipment. Such equipment could include commercially available machines such as those produced by Warren and Baerg. Densification equipment forces a blended composition through a shaping die, thereby creating the fuel object. Faceplate temperature of the object forming extrusion equipment typically is between 165° F. and 185° F. A fuel object exits at a temperature of about 110° F. and not greater than 145° F. When a fuel object exits the extruder, there can be a slight coating on the external surface of the object. This coating can comprise lignin, which is a naturally occurring substance of the cellulosic material. Objects are then transferred to the finished object conveyor/cooler.

[0039] Following formation, fuel objects are cooled down by a cooling means including, but not limited to, an air cooler, an air conditioner, or liquid nitrogen. The cooling process causes the objects to harden into the shape created by the extruder and allows components of the object to maintain their integrity. In an embodiment, fuel objects are placed through a shaker screen after sufficiently cooling and hardening. This process separates fine and discrete particles of the composition. The discharge for the fine particles can be separated from a fuel object and are again recycled or forced through a extruder. This process minimizes the potential for waste generated by any excess particles that comprise a fuel object. The final object maintains its structure and provides an ease of handling and a highly consistent product for good combustion at the end user power facility.

Use Integration at Power Facilities

[0040] The fuel object is designed for immediate use in existing solid fuel fired systems. This may include facilities that produce heat or steam for cooling, heating, or electrical generation or direct induration or drying of a product. Such facilities may include power plants, industrial furnaces and boilers and steam and power generation facilities at large institutions such as universities and hospitals. The formed and densified fuel object is ideal for transport by truck, rail, and conveyer and storage in bunkers and silos that are designed for transport and storage of coal. In most instances the objects may be unloaded, stored, and transported at a facility by the existing mechanisms that transport coal without physical modification.

[0041] The fuel object is ideal for use in stoker fired systems where fuel is discharged on a large grate and burns on the grate over a period of time. The fuel object also works in systems where fuel is pulverized prior to entry of the combustion chamber and then combusted in suspension such as pulverized coal, cyclonic combustion, and direct-fired units. Because individual particles in the fuel object are reduced in size prior to cubing and dried to a low moisture content, they combust efficiently and with low emissions when fed through such suspension-based systems and do not result in slagging or increased ash or sparklers from unburned fuel. Because the fuels have such a high eating value, burn efficiently, and reduce emissions, facilities that use the fuel object may reduce emissions without capital expenditure on emission controls and maintain unit efficiencies.

EXAMPLE

Corn Stover Fuel Object

[0042] A fuel object derived from corn stover and wood was produced and was substantially free of coal or other fossil fuel source. FIG. **6** shows an embodiment of the fuel object of the invention. The corn stover fuel object was substantially cylindrical in shape with a length of 6.0 cm and a diameter of 2.5 cm.

TABLE 2

Fuel Objection Characterization	
Volume	15 cm^3
Moisture content	9.58 wt. %
Amount of particulate derived from corn stover-fiber size 100 to 35,00 microns	64.2 wt. %
Amount of particulate derived from wood fiber-fiber size 100 to 30,000 microns	26.1 wt. %
Sodium bicarbonate (inorganic base)	9.7 wt. %

[0043] In testing, this corn stover fuel object provided about 7,422 BTU/pound (lb.).

[0044] Although the invention has been disclosed in the context of certain embodiments and examples, it will be understood by those skilled in the art that the invention extends beyond the specifically disclosed embodiments to other alternative embodiments and/or uses and obvious modifications and equivalents thereof. Accordingly, the invention is not intended to be limited by the specific disclosures of preferred embodiments herein, but instead by reference to claims attached hereto. Reference to a single element in the claims is intended not exclude one or more of the same element. The above specification, examples and data provide a complete description of the manufacture and use of the composition of the invention. The invention resides in the claims hereinafter appended.

[0045] It should be understood that various changes and modifications to the presently preferred embodiments described herein will be apparent to those skilled in the art. Such changes and modifications can be made without departing from the spirit and scope of the present subject matter and without diminishing its intended advantages. It is therefore intended that such changes and modifications be covered by the appended claims.

The invention is claimed as follows:

1. A fuel object having maximum dimension of about 6 cm, a volume of about 10 to 100 cm^3, a moisture content of less than about 14 wt. %, the fuel object comprising:

(i) about 60 to 80 wt. % of a particulate derived from corn stover having a particle size of about 100 to 35,000 microns;

(ii) about 20 to 40 wt. % of a wood fiber having a particle size of about 100 to 30,000 microns; and

(iii) about 1 to 10 wt. % of sodium bicarbonate; and

(iv) wherein the fuel object is substantially free of coal as a heat source and the fuel object provides at least 7,000 BTU-lb^{-1} (3500 cal.-gm^{-1}).

2. The fuel object of claim **1** wherein the fuel object comprises a cubic unit with a side dimension of 2 to 6 cm.

3. A fuel source comprising a fuel object according to claim **1** and a conventional fossil fuel.

4. The fuel source of claim **3** wherein the conventional fossil fuel comprises coal.

5. A method of reducing emissions upon combustion of a conventional fossil fuel, said method comprising co-firing a fuel object of claim **1** with a conventional fossil fuel.

6. The method of claim **5** wherein HCl, SO_2 and NO_x emissions are reduced.

7. The method of claim **5** wherein the conventional fossil fuel is selected from coal products and petroleum products.

8. The method of claim **7** wherein the coal products are selected from bituminous coal, anthracite coal and peat.

9. The method of claim **8** wherein the coal comprises eastern coal.

* * * * *