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FUEL AND METHOD OF PRODUCING SAME.

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This invention relates to an improved fuel and method of producing fuels, whereby a stable admixture of a substantially pure powdered fuel and a liquid fuel is produced, comprising means for eliminating impurities from a powdered, carbonaceous material such as coal, coke, lignite, anthracite and the like, and forming a substantially stable fluid fuel by a substantially permanent suspension of said particles, with the impurities removed, in a liquid or fluid fuel, the consistency of which is rendered such as to receive and retain the particles suspended therein.

An object of the invention relates to a method, and the product produced thereby, for obtaining these results.

A further object of the present invention is to provide a fluid fuel product of the character indicated in which the impurities are removed from a powdered carbonaceous material by flotation methods employing a liquid hydrocarbon such as oil with water and other liquid, and featuring the principle of the preferential affinity of the oil or liquid hydrocarbon for the coal over the impurities therein, and either forming in the water or other suitable liquid a froth by agitation or aeration or forming an agglomerate or combined product of oil and solid particles of carbonaceous material freed of the impurities, to separate the impurities from the powdered particles in either case, the oil or liquid hydrocarbon used in the purification being usable as a fuel, the same being mixed with additional liquid fuel and water or other liquid, or the mixture is otherwise treated to form a substantially stable fluid fuel composed of a liquid fuel and a substantially pure powdered fuel suspended therein.

A further object of the present invention relates to a method of producing a fuel which comprises a mixture of a substantially pure powdered fuel and a liquid fuel in which the impurities from the powdered fuel are removed by the employment of flotation principles in which the impurities or the relatively pure powdered fuel particles are floated off and in which the powdered particles are stabilized in a liquid fuel by a treatment of the liquid fuel to so modify the consistency thereof as to suspend and retain the pure fuel particles in substantially permanent suspension.

A further object of the invention is to provide a method of the character indicated in which there may be a simultaneous purification and stabilizing action in that the liquid hydrocarbon used for the separation of the pure carbonaceous particles from foreign matter may be employed as a part of the carrier to form the fluid fuel and in the process of purification the consistency of this liquid hydrocarbon is rendered such as to suspend particles of solid fuel and the same, if not usable, is then mixed with a liquid fuel, the consistency of the resultant carrier being made such as to substantially permanently suspend the powdered fuel.

A further object of the present invention relates to the method of producing a fuel of the character indicated in which an unsaturated flotation oil may be used, and a partial oxidation or saturation with air or the equivalent, during either of the purification processes referred to, is provided to oxygenize the oil sufficiently to render the consistency thereof such as to thereafter form part of the carrier to suspend the solid particles of fuel with the impurities removed therefrom in a liquid fuel forming a liquid or fluid fuel product.

A further object of the present invention is to provide a substantially stable fluid fuel product comprising a mixture of a liquid fuel and solid fuel particles treated, as by the flotation or "agglomeration" methods, to eliminate the impurities therefrom and a partial simultaneous and subsequent modification or thickening of a liquid fuel carrier, as by the formation of an emulsion or by oxygenization, to form a fluid fuel product.

With these and other objects in view, the invention comprises the fuel product and the method of making the same described and set forth in the following specification.

In the present invention, the solid fuel is reduced by suitable grinding means, such as that used on a commercial scale, to a sufficient degree of fineness so that the particles may readily pass through the passages of the fuel burning apparatus without danger of clogging, the fuel preferably being ground as fine as is possible with the ordinary commercial methods. For example, the coal should be ground to 200 mesh or finer. The finely divided solid fuel particles are then uniformly dispersed in a liquid hydrocarbon

which may also be any liquid fuel through which the purification processes referred to above may be accomplished. For this purpose any hydrocarbon oil having a density or specific gravity heavier than 22° Baumé, may be employed. The characteristics of such oils vary widely, and it will be understood that the heavier and more viscous the oil, the less thickening will be required at a later stage of the process. If of an improper consistency to receive the particles of solid fuel the liquid fuel may be modified or thinned for example, so that the powdered particles may be mixed therewith.

The powdered solid particles are then mixed as one purification step herein employed, in the flotation vessel with a sufficient quantity of oil and water or other flotation liquid of the proper surface tension. The relative quantities of water and oil may vary considerably. Oils having a density greater than 22° Baumé may be freely emulsified with water, as up to 50%, but a much smaller proportion of water, for example, 10 to 20%, is preferable, as an excessive quantity of water cuts down the efficiency in the burning of the fuel. The mixture is then agitated and aerated until a froth is formed, of such consistency that the coal is carried to the surface in satisfactory quantities and the impurities will separate out into the water below. Any desired methods of agitating the mixture and of aerating it, may be used, and any gas besides air may be employed if desired, although as stated above the use of air, especially when an unsaturated oil is employed, will effect a partial oxidation or saturation during the froth formation which will have the advantage of modifying the oil so as to render the same usable as a part of the carrier resistant to the separation of the solid fuel particles therein or the water and oil will form such action. The time of aeration may vary according to the efficiency of the aerating apparatus, the type of gas used and of the materials operated upon. If the process is continuous, the raw material and air may be supplied continuously, and the coal and oil mixture and impurities may be removed as rapidly as they separate out. After the formation of the froth, the oil and particles of fuel, freed of impurities, are drawn off from the remaining water and sediment.

On the other hand, the impurities from the powdered carbonaceous material may be removed by an agglomerate forming process. In this instance, the finely divided solid fuel particles may be preliminarily treated by mixing with water in a suitable agitating and separating vessel in which some of the heavier suspended impurities, particularly iron sulphide, silica, silicates, etc., and the like, may be physically separated and the mixture of the water and the partially purified carbonaceous particles then placed in a suitable receptacle and subjected to the action of a liquid hydrocarbon such as fuel oil, crude oil or other suitable agent and further treated with water and properly agitated to form a mass of carbonaceous material, wherein the oil will expel the water but agglomerate and collect the carbonaceous material, the oil possessing a peculiar affinity for the carbonaceous material and a repulsion for the water and the impurities in the carbonaceous material, as is understood. In carrying out the process, standard equipment used in washing coal and in the separation of minerals by the flotation process may be used, apparatus of this type being well known in the art. The amount of water and liquid hydrocarbon employed will depend upon the characteristics of the carbonaceous material and sufficient amount of liquid hydrocarbon is added to bring about the reaction and form the agglomeration of substantially pure particles of carbonaceous material therein. The agglomeration settles to the bottom and the water with the impurities rises to the top and the same may be separated off as will be apparent. Agitation should be carried on as may be required during the execution of this step of my process.

After treatment by either steps referred to, or by other methods to remove the impurities from the powdered fuel, unless during the purification with the liquid hydrocarbon, in certain possible instances the amount of liquid fuel oil used, the consistency of which is thereby rendered so as to suspend powdered fuel be sufficient, the same is mixed with liquid fuel, the mixture may then be treated to render the consistency thereof such as to substantially permanently suspend the particles of now substantially pure powdered fuel. This step may consist in further emulsifying the mixture or in oxygenizing the same to thicken or modify the consistency of the carrier so that it will suspend the particles of solid fuel.

Any liquid fuel which may be thickened or the consistency of which may be modified to suspend, the coal may be used and any liquid hydrocarbon or oil, which at the same time may serve as the oil for the purification process, may be employed as the liquid fuel medium when the simultaneous action in certain instances is possible. Moreover, under certain conditions, if desired, a soap solution may be added to form an additional stabilizing agent when there is a tendency for the emulsion to become unstable and to separate into its constituents. Any of the standard "frothers" or "collectors" used in flotation methods may be used.

Water has been found to be a suitable emulsifying component for various fuel oils which may form the liquid fuel of the product referred to herein and a sufficient

amount of water may be used during the purification processes to form the final product. The water may be in the condition of purity in which it occurs or may have added to it certain materials which render its emulsion with the fuel oil more stable. The ground water or surface waters which are produced with certain crude petroleums are suitable. Other materials, which may be used in the purification processes, and to form the emulsion, may be employed but it is preferred to use water because of its cheapness and its property of promoting flotation and for its freedom from smoke forming characteristics when used with the fuel and burned.

In certain cases, an emulsion need not be formed since the liquid oil used may be sufficiently oxygenized by the aeration or agitation to render the same capable of supporting and carrying the coal particles which have been freed of impurities by the processes indicated.

The fuel product obtained as above may be used in substantially the same manner as the ordinary types of heavy fuel oils and for substantially the same purposes. In addition to utilizing many fuels which are at present wasted, it permits of a fuel of any desired quality to be obtained, and an especially advantageous combination which will be apparent to those skilled in the art, since the particles of solid fuel are substantially free of impurities.

It is apparent that, within the spirit of the invention modifications and different arrangements may be made other than as herein disclosed, and the present disclosure is illustrative merely, the invention comprehending all variations thereof.

Having thus described my invention, what I desire to secure by Letters Patent of the United States and claim is:

1. A fuel product comprising, finely divided, solid, carbonaceous materials, substantially free of impurities, a fluid fuel medium, and a substance capable of rendering the consistency of the fluid medium such as to receive and hold the solid fuel particles.

2. A fluid fuel product which comprises, a liquid fuel and a powdered fuel, substantially free of impurities, dispersed throughout said liquid fuel and of a size at which it readily settles out of said liquid fuel, said liquid fuel being treated to avoid settling of said powdered fuel.

3. A fuel product which comprises, a liquid fuel, a substantially pure powdered fuel dispersed throughout said liquid fuel, and of a size at which it settles out of said liquid fuel, and water emulsified in said liquid fuel, said liquid fuel being thickened through said emulsification to avoid settling of said powdered fuel.

4. A fluid fuel product which comprises, a liquid fuel oil and a powdered coal fuel, substantially free of impurities, dispersed throughout said liquid fuel and of a size at which it readily settles out of said liquid fuel, the consistency of said liquid fuel being such as to avoid settling of said powdered fuel.

5. A process of making a fluid fuel product which comprises; removing the impurities from powdered solid carbonaceous fuel by mixing said powdered fuel with a liquid hydrocarbon which has a preferential affinity for carbonaceous material over the impurities and another liquid which suspends the impurities; separating the impurities therefrom; rendering the consistency of a liquid fuel such as to receive and hold the solid particles of fuel and mixing the substantially pure carbonaceous material therewith.

6. A process of making a substantially stable fluid fuel product which comprises, removing the impurities from powdered solid fuel by mixing the powdered solid fuel in a liquid fuel oil and other liquid which retains the impurities, separating the mixture of solid fuel particles and liquid fuel from the mixture of other liquid and impurities, and rending the consistency of said fuel thereby such as to receive and hold solid particles of fuel, and mixing therewith an additional fuel oil carrier, the consistency of which is made such that the resultant carrier substantially permanently suspends the powdered fuel.

7. A process of making a fluid fuel product which comprises, removing the impurities from powdered solid carbonaceous fuel, mixing said powdered fuel with a liquid hydrocarbon which has a preferential affinity for pure carbonaceous material over the impurities and another liquid which suspends the impurities, agitating the mixture, separating the impurities therefrom, rendering the consistency of a liquid fuel such as to receive and hold the solid particles of fuel and mixing the substantially pure carbonaceous material therewith.

8. A process of making a substantially stable relatively pure fluid fuel product which comprises, removing the impurities from powdered solid fuel by mixing the powdered solid fuel in a liquid fuel oil which has a preferential affinity for the fuel content over the impurities and other liquid which retains the impurities, simultaneously rendering the consistency of said liquid fuel such as to receive and hold the solid particles of fuel and separating the mixture of solid fuel particles and liquid fuel from the mixture of other liquid and impurities.

9. That process of making a stable fluid fuel product of a solid and a liquid fuel which includes providing a powdered fuel

of a size at which it settles out of said liquid fuel, separating the impurities from said powdered fuel by mixing the powdered fuel with a liquid which has a preferential affinity for the powdered fuel over the impurities therein, and treating a liquid fuel with an agent to maintain said powdered fuel suspended in said liquid fuel and suspending said separated material therein.

10. A process of making a fluid fuel product which comprises, removing the impurities from powdered solid fuel by forming a froth with the powdered solid fuel in oil and water and separating said froth from the remaining water and sediment of impurities, and simultaneously mixing with said oil a substance to render the mixture resistant to the separation of the solid particles of the fuel from the liquid fuel, mixing a liquid fuel therewith and treating the same to maintain the powdered fuel in suspension.

11. A process of forming a fuel product whnch comprises, agitating finely divided solid fuel with air, in oil and water, forming a froth of coal, oil and water, and separating said froth from the remaining water and sediment, mixing a liquid fuel oil therewith, and rendering the oil of such consistency as to receive and hold said finely divided solid fuel.

12. A process of forming a fuel product which comprises, agitating finely divided solid fuel with air in oil and water, forming an oxidized oil froth, separating the froth of coal and solid fuel, and bringing the mixture of the oil and solid fuel particles to the requisite thickness to maintain the solid fuel in suspension by a liquid fuel carrier and an agent to render the consistency of the mixture such as to substantially permanently suspend the solid fuel therein.

13. A fluid fuel product which comprises a liquid fuel, a powdered fuel rendered substantially free of impurities disbursed throughout said liquid fuel, and of a size at which it readily settles out of said liquid fuel, and a soap emulsion mixed therewith to render the consistency thereof such as to avoid settling of said powdered fuel.

14. A process of making a fluid fuel product which comprises removing impurities from a powdered solid carbonaceous fuel, mixing said powdered fuel with a liquid fuel, adding a solution of soap emulsion thereto to render the consistency of the mixture such as to receive and hold the solid particles of fuel suspended in said liquid fuel.

15. The process of preparing a fluid fuel product comprising treating a mixture of powdered coal and of liquid fuel to remove the impurities from said coal, and treating the resulting mixture of substantially pure coal and liquid fuel to render the latter of such consistency that the powdered coal is permanently suspended therein.

16. The process of preparing a fluid fuel product comprising treating a mixture of powdered coal and liquid fuel by flotation to eliminate the impurities from said coal, and treating the resulting mixture of substantially pure coal and liquid fuel to render the latter of such consistency that the former is permanently suspended therein.

17. The process of preparing a fluid fuel product comprising treating a mixture of powdered coal and liquid fuel to remove the impurities from said coal, and emulsifying the liquid fuel with which the substantially pure coal is mixed by such treatment to render the consistency of said fuel such that the powdered coal is permanently suspended therein.

18. A process of making a composite fuel of solid and liquid fuels which comprises, reducing the solid fuel to a finely powdered size above colloidal dimensions, eliminating from said fuel these constituents having no affinity for said liquid fuel medium, mixing said fuels and thickening said liquid fuel medium to resist settling of said solid fuel particles.

19. A process of making a composite fuel of solid and liquid fuels which comprises, reducing the solid fuel to a finely powdered size above colloidal dimensions, eliminating from said fuel those constituents having no affinity for said liquid fuel medium, mixing said liquid and solid fuels and emulsifying said liquid fuels with another liquid to thicken the mixture and resist settling of said solid fuel particles.

20. A fuel comprising a thickened liquid fuel and finely powdered solid fuel particles above colloidal dimensions substantially free of constituents having no affinity for said liquid fuel and dispersed throughout said liquid fuel.

In testimony whereof, I affix my signature.

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