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PROCESS FOR THE TREATMENT OF PULVERULENT MATERIAL

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The present application is a continuation-in-part of our co-pending application Serial No. 113,655, filed May 31, 1961, entitled "Method of Treating Pulverulent Material" and now abandoned. Application Serial No. 113,655 is a continuation-in-part of our application Serial No. 61,782, filed October 10, 1960, entitled "Briquetting Method" and now abandoned.

The present invention relates to a process for the treatment of a great variety of solid particulate materials so that the same will be easier to store, handle, transport or briquette and also so as to improve the storage qualities, thereof. For instance, coal dust and fine coal treated according to the present invention will be less subject to oxidation and briquettes formed thereof will have more equal and uniform surface characteristics and less binder, such as pitch, will be needed for forming such briquettes so that upon burning of the same less smoke will be produced.

In many cases, the processing of finely pulverulent or pulverized material, particularly of very fine dust, is connected with considerable difficulties. Frequently, normal handling, dosing, mixing, bagging or the like can hardly be accomplished. Thus, for handling and transporting such finely sub-divided powdery or pulverulent materials, frequently installation of special handling and transporting devices is required, and certain dusts are treated as waste materials since the special procedures and devices required for effectively handling such dust would render further processing of the same uneconomical.

It has been attempted to agglomerate finely sub-divided particulate or pulverulent materials prior to further processing of the same by subjecting such material to a thermal treatment. Thus, for instance, it has been suggested to increase the grain size of fly ash by sintering the same while blowing air therethrough, or to produce artificial coal from carbon black to which in an involved and expensive process either oil, soft pitch or a similar material had been admixed. In many cases, the costs of pre-treating finely sub-divided pulverulent materials so that the same can then be further processed will be so high as to render the further use of such materials uneconomical, notwithstanding the fact that such materials would be quite valuable if present in less finely sub-divided state.

It is therefore an object of the present invention to overcome the above discussed difficulties and disadvantages.

It is also an object of the present invention to provide a method for treating finely sub-divided solid materials so as to make the same easily manageable, particularly for purposes of storage, transportation and further processing.

It is another object of the present invention to provide a method for treating finely sub-divided materials so as to improve the storability thereof.

It is a further object of the present invention to provide a method of briquetting which can be carried out in a simple and economical manner and will result in briquettes of highly uniform quality.

It is yet another object of the present invention to provide a method of briquetting which will require lesser

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amounts of pitch or similar binders, so that the thus-produced briquettes will produce less smoke upon burning.

Other objects and advantages of the present invention will become apparent from a further reading of the description and of the appended claims.

With the above and other objects in view, the present invention proposes a method of treating solid, particulate materials, which method comprising the steps of applying to a mass of solid particulate material an emulsion of a hydrophobic oil in a binder-containing aqueous liquid so as to form a mass consisting essentially of particles of the material with the hydrophobic oil and the binder adhering thereto, whereby it will be achieved that the surface characteristics of the particles of the material will become more uniform and individual particles will agglomerate to form larger particles, resulting in a mass which lends itself to be more densely packed than the initial particulate material.

Broadly, the method of treating solid particulate materials according to the present invention may comprise the step of applying to a mass of solid pulverulent material a hydrophobic oil and a binder-containing aqueous liquid so as to form a mass consisting essentially of particles of the material with the hydrophobic oil and the binder adhering thereto, whereby the particles of the mass will be agglomerated to form larger particles of substantially uniform surface characteristics.

According to one preferred embodiment of the present invention, the treating of the solid particulate material comprises the step of forming an emulsion consisting essentially of between 60 and 95 parts by weight of an aqueous liquid having between 4 and 39 parts by weight of a binder (dry material) selected from the group consisting of sulphite waste liquor, sulphite pulp powder, starch, dextrine, mastic, gum arabic, casein, glue, gum tragacanth, water glass and methyl cellulose distributed therethrough, and between 1 and 39 parts by weight of a hydrophobic oil having a boiling point between 100 and 400° C. dispersed in the aqueous binder-containing liquid, and forming an intimate mixture of 100 parts by weight of the solid particulate material and between 1/2 and 30 parts by weight of the binder-containing aqueous liquid.

In many cases, it is desirable to further work up the agglomerated and densely packed material obtained according to the present invention so as to form thereof water-resistant briquettes. For this purpose, water-resistant binder materials such as cement and particularly pitch are mixed with the agglomerated material formed as described above. Mixing preferably is carried out under heating and is followed by pressing the thus-formed mixture into briquettes. In the case of the most frequently used binder, namely pitch, it is possible to form briquettes of very finely sub-divided material which has been treated according to the present invention. In this case, the particulate initial material when not treated according to the present invention would require between about 3% more pitch than the material pre-treated according to the present invention. The reduction in the amount of pitch required for forming briquettes has several advantages. Not only are there savings on pitch but, in addition, briquettes of highly uniform characteristics are formed. Furthermore, due to the lesser amount of pitch, less smoke is formed upon burning of the briquettes. Briquettes according to the present invention will contain only between about one-half and 2% by weight of the hydrophobic oil and an approximately equal percentage of the initial binder material plus between about 6 and 12% of pitch. Since the costs of pitch are considerably higher than that of the hydrophobic oil and binder material, the raw material costs of briquettes produced according to the present invention are lower than the cor-

responding costs of briquettes which are produced directly of the solid particulate starting materials and of a larger proportion of pitch, without being subjected to the agglomerating treatment of the present invention.

Thus, the present invention is also concerned with a method of forming briquettes which method comprises the steps of forming an intimate mixture of a solid particulate material adapted to be briquetted and of an emulsion consisting essentially of between 1 and 39 parts by weight of a hydrophobic oil dispersed in between 60 and 95 parts by weight of water as an aqueous liquid, the water having between 4 and 39 parts by weight of binder distributed therethrough, so as to form a mass consisting essentially of agglomerated particles of the material with the hydrophobic oil and the binder adhering thereto, which agglomerated particles will have substantially uniform surface characteristics and are adapted to be packed more densely than the initial solid particulate material, mixing the thus-formed mass with a water-resistant binder, and briquetting the thus-formed mixture, whereby briquettes of highly uniform quality are formed.

The present invention thus proposes to solve the problems involved in transforming fine-grained powdery materials of very different characteristics into easily manageable and treatable substances at relatively very low expenses. It has been found that by proceeding in accordance with the present invention it is possible to improve substantially those properties of the powdery substances which are essential for the further handling and processing thereof. This is accomplished by mixing the pulverulent or powdery mass which may have a particle size of up to about 6 mm., for instance in the case of coal fines, or as small as about 1 micron, for instance in the case of the red dust formed in the LD oxygen blast process, with an aqueous emulsion consisting of between about 1 and 39% by weight, preferably of between 1 and 49% by weight of a hydrophobic oil such as a hydrocarbon oil, between 4 and 39% by weight, preferably between 4 and 20% by weight, of a binder and between 60 and 95% of water.

Such emulsions are taken up, in a surprisingly short time, even by such powdery substances which are known for their bad wettability, so that in many cases simple mixing of the pulverulent materials and the emulsion will be sufficient to produce the required improvement, i.e., agglomeration of particles of the initial particulate pulverulent substance and greater uniformity of the surface characteristics thereof.

Thus, according to the present invention practically any kind of pulverulent material having particle sizes up to about 6 mm., may be mixed with the above described emulsion and thereby the properties of the pulverulent material will be improved so that the same can be more easily handled or further processed, for instance more easily packed or conveyed. The method is of particular importance with respect to finely pulverulent materials having particle sizes of up to 50 microns or up to 200 microns or up to 3 mm. The thus pre-treated material may then be further processed by briquetting. In this connection, briquetting with the help of pitch as a binder material is particularly improved by the pre-treating treatment. Briquetting with the help of pitch is carried out by mixing the pre-treated agglomerated material with pitch in a suitable kneading device, and subsequent processing of the thus-formed mixture into briquettes. However, for briquetting purposes it is also possible in many cases to replace the pitch with other suitable materials, known per se in the art.

In cases where subsequent briquetting of the agglomerated material is desired, it has been found particularly advantageous to carry out the above described pre-treatment of the pulverulent or particulate material in accordance with the present invention in connection with materials having a particle size of up to about 6 mm.

When using pitch as the binder for the purpose of

briquetting the material which has been pre-treated according to the present invention, it will be found that the amount of pitch required, based on the total weight of the briquettes will be reduced by between about 1 and 3% as compared with the amount of pitch which would have to be incorporated in the particulate or pulverulent starting material if the same were to be briquetted without being subjected to the agglomerating treatment of the present invention.

If the starting material is very finely sub-divided, briquetting will be made possible only by the preceding agglomerating treatment. Apart from the savings on pitch which are accomplished according to the present invention, it will also be found that briquettes formed of the agglomerated material produced according to the present invention are of more even quality and greater strength, notwithstanding the smaller proportion of pitch therein.

It must be noted, however, that the present invention is not limited with respect to briquetting to the use of pitch as the binder admixed for briquetting purposes. Any other binder materials conventionally used for briquetting purposes may also be employed in the briquetting of the agglomerated materials formed as described further above. If pitch is to be used as the briquetting agent, then preferably pitch having a softening point of between 50 and 75° C. according to Kraemer-Sarnow will be used.

Generally, a thorough change of the typical properties of the particulate material such as a powder or dust will be accomplished by a small addition of the emulsion in accordance with the present invention. Addition of the emulsion in an amount of between 1 and 10% by weight of the pulverulent material usually will suffice. In special cases, such as when treating extremely fine powders, additions of up to 20 or 30% of the weight of the finely pulverulent material may be suitable. When using such relatively large proportions of the emulsion, however, the proportion of hydrophobic oil and binder in the emulsion will normally amount to not more than 10% altogether, the share of the oil being not higher than about 5% by weight of the pulverulent material. The binder in the emulsion may be sulphite waste liquor such as calcium sulphite waste liquor or ammonium sulphite waste liquor. These waste liquors are available as 10-90%, preferably 40-60% aqueous solutions. For instance, sulphite waste liquor of 35° Bé. contains 45% water and sulphite waste liquor of 29° Bé. contains 50% water.

Preferably, the emulsion with which the solid particulate and frequently finely pulverulent material is to be mixed according to the present invention will contain between 4 and 39% binder, most preferably between 10 and 30% thereof, and between 1 and 39% hydrophobic oil, most preferably between 5 and 20% of the hydrophobic oil, the balance being water to which possibly an emulsifying agent might be added.

Generally, but not in all cases, within the above indicated quantitative limits, emulsions with a high percentage of binder and oil are used in cases where the solid particulate materials already contain some water.

Thus, preferably the emulsion may be admixed in amounts of between 1 and 15% by weight. In the case of finely pulverulent material, rather larger proportions of the emulsion, such as between 5 and 15% are admixed, while material of larger particle size, such as material having a particle size of between about 1 and 6 mm. will require relatively smaller proportions of the emulsion, for instance between 1 and 10% thereof.

For the briquetting of the agglomerated materials produced according to the present invention, 6-12% by weight of binders such as pitch will be required in cases where the initial material was of very small particle size, while in cases where the initial material was of somewhat larger particle size, between 3 and 8% of the pitch or the like will suffice. However, it has been found that

in every case briquetting according to the present invention will require less pitch than would have to be used for briquetting the initial solid particulate material without preceding agglomeration thereof in accordance with the present invention. The savings on pitch by proceeding in accordance with the present invention generally will be between 1 and 3% of the weight of the briquettes and frequently in the neighborhood of about 3%.

Surprisingly it has been found that the treatment described above will cause a marked increase of the grain size, especially in the finest grain size ranges, by formation of secondary grains. Even without a close examination, the essential changes which the material has undergone by such treatment become apparent by the greater ease of handling the same. It is one of the important results of the process according to the present invention that a high proportion of new and uniform surfaces is formed on the finest grains. It has to be taken into account that the surface properties of unprocessed fine-grained substances are in almost all cases non-uniform, in other words, there hardly will be found many individual grains with exactly the same surface conditions and, consequently, with the same surface properties.

The reason for these differences in the surface qualities of the individual particles may be found in the higher or lesser degree of unevenness and the different number of fissures, edges and pores of the individual grains. Moreover, many substances consist of unhomogeneous material. In a fine coal, e.g. coal derived from different seams, very different surface forces may act at the same time. Another important reason for the difference in the surface properties of the particles may be found in the absorption of foreign matter on such surfaces. Such absorbed foreign matter may be gaseous, liquid or solid.

In most cases the powdery product previously will have been subjected to another process, e.g., grinding or thermal treatment. These previous operational steps always will lead to a partial change at least of the surfaces of the original material. The changes may be of a physical or also of a chemical nature, e.g., opening of pores, oxidation or absorption of gas. Moreover, it is possible that owing to the large surface area of the materials, their physical and chemical properties will substantially deteriorate even after a short time of storage or transport.

For these reasons, fine grained and powdery materials are characterized in almost every case by very great differences in their surface properties. This leads to difficulties, especially when it is necessary to wet or to coat these unhomogeneous materials with relatively small quantities of a liquid. It is extremely difficult uniformly to wet large and non-uniform surfaces areas with a small quantity of liquid.

The application of the emulsion, according to the present invention, will permit to wet large and non-uniform surface areas rapidly, evenly and at low cost. The surfaces of the thus-wetted particulate product are protected against deteriorating effects during transport and storage. For instance, such coal fines which are prone to self-ignition by oxidation during storage, when treated with an emulsion according to the present invention, will practically no longer be subject to self-ignition. Also during the further processing of the products the treatment with the emulsion will prevent unpredictable difficulties previously caused by the uneven, non-uniform surface characteristics, and the treated material not only will be more easily manageable, but will be transformed into a product having homogeneous surface properties.

The process according to the invention is particularly suitable for dusts and extremely fine materials, particularly for substances with a medium grain size down to 200 or 100 and even to below 1 micron, but the process can be applied also without any difficulties to materials which consist completely or partially of coarser particles up to 1-3 mm. or more. It is applicable to all kinds of ma-

terials which are not soluble in water, including fine coal particle sizes of 0-3 mm., 0-6 mm. or the like.

Any hydrophobic oil and especially hydrocarbon oils, particularly within the boiling range of between 100 and 400° C., preferably between 150 and 360° C., may be used for forming the emulsion, e.g., paraffinic, naphthenic or aromatic hydrocarbons. The choice between the oils can be guided, therefore, by economic considerations, keeping in mind the intended further processing of the thus-treated material.

The choice of a suitable water-soluble binder will depend primarily on its price. All water-soluble binders are suitable, e.g., sulphite waste liquor, sulphite pulp powder, starch dextrines, mastic, gum-arabic, casein, glue, tragacanth, water glass, methyl cellulose and other natural or synthetic substances which in form of their aqueous solutions have agglutinating properties.

The stability of the emulsion can be improved by addition of well-known emulsifying agents, especially if the emulsifying effect of the binder is to be improved. With this end in view the following emulsifying agents give good results: sodium or potassium soaps, fatty alcohol sulfonates, alkyl sulfonates or alkyl-naphthyl sulfonates, ethanalamines, technical albuminous products and the like.

The process may be carried out in a simple and economical manner. Since the finely sub-divided powdery substance will absorb the emulsion easily, the entire surface of the powder is wetted or coated in an extremely short time; as a rule, a short thorough mixing of the emulsion and the powder will be sufficient, under certain conditions a few seconds, or up to 10 minutes at the most. It goes without saying that the mixing time depends on the type of mixing apparatus available. The usual simple mixers will give satisfactory results in many cases. Very suitable are mixers with kneading appliances and all types of intensive mixers and homogenizing machines, for instance machines mixing in the manner disclosed in U.S. Patents to Reerink et al. Nos. 2,744,626, 2,769,537, 2,769,538, 2,781,904, 2,842,319 and 2,859,917. The mixing process can be accelerated by heating either the entire material or only the emulsion up to about 100° C., but this is not a necessary requirement.

The thorough mixing of the emulsion and of the solid material can be facilitated by previously increasing the volume of the emulsion. For this purpose air is stirred into the emulsion, either when the emulsion is prepared or later on, immediately before its use. As a result of the aeration, the volume of the emulsion will reach twice to five times its original volume.

Generally, it will suffice according to the present invention to add about 10% of emulsion, for instance, to add to 100 parts by weight of the pulverulent material 10 parts by weight of an oil in water emulsion containing between about 0.1 and 39 parts by weight of hydrocarbon oil and between 0.4 and 39 parts by weight of the binder as well as a suitable amount of water. If the solid particulate material already contains an appreciable proportion of water, then a more concentrated emulsion may be admixed so that the aforesaid composition of the emulsion in the mass is reached. It is also possible to produce and store the emulsion in a more concentrated form and to dilute the same with water prior to or during use.

Intimate mixing of the pulverulent material with the emulsion will cause quick wetting of the hydrophobic as well as of the hydrophilic surface portions of the particles, under displacement of any gas adhering thereto. Simultaneously, the binder contained in the emulsion will form agglomerations of the individual particles of the pulverulent mass resulting in an apparent increase in the particle size since the thus-formed agglomerates appear as single particles. Thereby, the relationship between surface and volume of the material will change so that the surface area of a given volume of treated material will

be much smaller than that of the same volume of material prior to admixture of the emulsion.

It is a further desirable result of the present process that the water introduced thereby into the solid mass will be firmly and rather permanently bound to the surfaces of the material. In many cases this will permit to postpone further treatment of the material and will allow prolonged storage or transportation thereof without deterioration.

Another advantageous application of the present invention will be found in cases where during storage, etc., dust formation will occur. Treatment according to the present invention will serve to prevent undesirable changes in the surface particles of such newly formed dust. The process of the invention is also useful for binding and agglomerating very fine flue dust. In some cases it is advantageous to apply the emulsion prior to comminution of the material. In all these cases, admixture of the emulsion will cause formation of protective layers covering the surfaces of material and preventing or at least reducing oxidation or other harmful changes thereof. Thus, admixture of the emulsion in accordance with the present invention will also serve to protect pulverulent materials which during storage are exposed to atmospheric conditions, against the adverse effects of such exposure. Here too, the application of the emulsion will cause formation of protective coatings on the surface of the thus-treated pulverulent material.

Several compositions of the emulsion are described below by way of example only (all percent by weight):

COMPOSITION I

	Percent
Sulphite waste liquor (from fir) 33° Bé.	20
Anthracene oil	20
Water	60

COMPOSITION II

Sulphite waste liquor (from beech) 29° Bé.	30
Fuel oil	4
Water	66

COMPOSITION III

Potato starch paste (50% starch)	10
Mineral oil, density 0.980	2
Ethanolamin	0.2
Water	87.8

COMPOSITION IV

Cane sugar molasses	8
Tar oil	15
Water	80

COMPOSITION V

Water glass	8
Sulphite waste liquor	15
Anthracene oil	6
Water	74

COMPOSITION VI

Methyl cellulose	6
Ammonium lignin sulphonate	6
Light oil	1
Water	87

COMPOSITION VII

(Concentrated emulsion to be diluted before use or to be used for treating particulate material of high water content)

	Percent
Calcium sulphite waste liquor 32° Bé.	33
Crude paraffin oil	33
Water	34

COMPOSITION VIII

Casein	25
Linseed oil	2
Alkyl naphthylsulphonate	0.1
Water	72.9

The following examples of treating, in accordance with the present invention, finely particulate masses of, for instance, coal, ores and sands so as to improve the surface properties thereof are given as illustrative only without limiting the invention to the specific details of the examples. The present invention gives also very good results with very fine dusts, for instance the dust formed in the LD or oxygen blast process developed at Linz-Donawitz. This reddish dust is accumulated by electro-deposition and usually has a particle size below one micron.

EXAMPLE I

Coking fines having a size of up to 3 mm. and including 28% by weight of particles having a size below 0.1 mm., when stored in the open air, particularly when stored for prolonged periods of time, will give a coke of greatly reduced quality.

However, if such coking fines, in accordance with the present invention are intensively mixed with 6% (based on the weight of the coking fines) of an emulsion consisting of 15 parts by weight of anthracene oil of a boiling range of between 195 and 360° C. dispersed in a mixture of 15 parts by weight of sulphite waste liquor of 31° Bé. and 70 parts by weight of water, the quality remains unimpaired.

By such treatment, the percentage of fines having a size below 0.1 mm. is reduced from 28% to 8%, and the thus treated coke fines can be stored exposed to air without appreciable reduction in its coking quality.

EXAMPLE II

Iron ore dust originating from a thermal ore dressing plant and including 95% by weight of particles having a size below 0.06 mm. is to be charged into railroad cars. Charging of the ore dust in its original condition is nearly impossible due to heavy dust formation and losses. However, after mixing the ore dust in a whirling mixer for five mixtures with 10% of an emulsion consisting of 2 parts of fuel oil, 10 parts of molasses and 88 parts of water, the thus-treated ore dust can be handled and transported without difficulty.

EXAMPLE III

Blast furnace flue dust containing a high proportion of very fine particles is to be agglomerated by addition of cement and bentonite.

For this purpose, the flue dust is mixed for three minutes in an intensive mixer with 8% of an emulsion consisting of 3 parts of fuel oil having a boiling range of between 130 and 320° C., 10 parts of starch paste containing 50% starch, and 87 parts of water. Thereafter, 10% cement and 3% bentonite are added and the thus-formed mixture is then shaped and burned at a temperature of 1000° C. into bricks of great hardness.

EXAMPLE IV

Very fine dry coal dust having an indicated surface area of between 800 and 1000 cm.²/gram which is discharged from dust collectors after thermal drying of fine coal, does not lend itself to admixture to dried briquetting fines unless the amount of binder used for briquetting the coal is greatly increased.

However, after treating of such very fine dry coal dust in a continuous kneading mixer with between 6 and 7% of an aerated emulsion consisting of 20 parts of sulphite waste liquor of 30° Bé., 20 parts of anthracene oil and 60 parts of water, it is possible to admix the thus-improved coal dust practically in any desired proportion to the briquetting fines and to form briquettes thereof without increase in the proportion of binder.

The aerated emulsion is produced by mixing the components thereof in a Turax intensive mixer until, due to the incorporation of air, the volume of the mixture has been increased three fold. This might require mixing for about twenty minutes.

EXAMPLE V

Coal dust which is prone to self-combustion when stored in the open air is sprayed before stock-piling with 5% of an emulsion consisting of 15 parts of oil, 10 parts of water glass and 75 parts of water. Even after subsequent storage for more than one year, coal dust treated in this manner will not display any tendency of self-combustion.

After drying, the thus-agglomerated coal dust is mixed with 5% by weight of pitch and pressed to form briquettes, and in this manner briquettes of excellent quality and strength are obtained.

EXAMPLE VI

Iron powder of a grain size range below 0.075 mm. is to be shaped into solid and uniform briquettes, using as little binder material as possible.

After thorough mixing for 6 minutes in an intensive kneading mixer with 5% of an emulsion consisting of 10 parts by weight of fuel oil having a boiling range of between 150 and 350° C., 20 parts of molasses and 70 parts of water, the thus-formed mixture is briquetted at a pressure of 4,000 kg./cm.². The thus-formed briquettes are of uniform strength and density.

EXAMPLE VII

An anthracite coal having a particle size of up to 3 mm. is dried so as to have a residual water content of 2.5%. Thereafter, the particulate anthracite coal is intimately mixed with 1% by weight of an emulsion consisting of 40% tar oil, 30% sulphite waste liquor containing 50% dry substance, and 30% water. Due to the residual water content of the coal, the total water now available will be equal to about 5 times the amount of water admixed with the emulsion, and an even distribution of the oil in water emulsion on the surface of the anthracite particles will be achieved under formation of agglomerations of anthracite particles. The thus-agglomerated anthracite coal is then intimately mixed with 5.5% by weight of tar pitch and compressed in a conventional press into briquettes. The thus-formed briquettes have a smooth and even surface texture, are resistant against abrasion and develop relatively little smoke upon burning, considerably less than briquettes produced of the same type of anthracite coal without the admixture of the emulsion and with between 7 and 9% of tar pitch, i.e., the percentage which will be required for briquetting such anthracite coal if the same has not been previously agglomerated as described herein.

EXAMPLE VIII

A semibituminous coal at a temperature of 70° C. and a particle size of less than 1 mm. 45% being less than 0.1 mm., and a water content of 1.5% was mixed with 3% of an emulsion consisting of 20 parts tar oil, 30 parts sulphite waste liquor (55% solids) and 50 parts water in a continuous kneading mixer and subsequently mixed with 5% of ground briquetting pitch, led through a double mixer neck into a steam kneader and briquetted in a roll press. Notwithstanding the fineness of the initial coal and the small content of binding material, the breaking strength was between 80 and 105 kg.

EXAMPLE IX

An iron dust with a fineness of 100% less than 15 micron and 70% less than 1 micron was intimately mixed with an emulsion consisting of 33 parts anthracene oil, 33 parts sulphite waste liquor containing 50% solids and 34 parts water, and subsequently mixed with 8% ground briquetting pitch. This briquetting mixture was compressed to form nut briquettes in a double roll press. The breaking strength of the briquettes was 70-80 kg.

A briquetting process has become possible only by the pretreatment of the fine ore dust with emulsion. Without such pretreatment it is impossible to mix the fine ore dust with pitch.

EXAMPLE X

A coke dust at a temperature of 65° C., having a water content of 0.2%, a grain size less than 1 mm. with 59% less than 0.2 mm., was mixed with an emulsion consisting of 10 parts of oil, 20 parts of sulphite lye waste liquor of 50% solids content and 70 parts water, and was then formed into nut briquettes together with 8% of briquetting pitch by means of a steam kneader and a roll press. The briquettes possessed at normal temperature a breaking strength of 185 kg. and at 1,000° C., heated in annealing condition, a breaking strength of 140 kg.

EXAMPLE XI

50 parts of soot were intimately mixed with 40 parts of baking mineral coal (a very pure coal with 0.4% ash and 4% moisture) and 4% of an emulsion consisting of 25 parts of anthracene oil, 35 parts of a 50% solids content sulphite lye waste liquor and 40 parts of water. The mixture was subsequently treated with 7% ground briquetting pitch in a steam kneader and pressed into shaped. By carbonization a porous hard pressed shape was obtained with a specific electrical resistance of about 120 ohms per mm.²/m.

EXAMPLE XII

In the course of the discharging, hard coal nut briquettes are sprayed with 5% of an emulsion which consists of 10% of oil recovered from waste oils and fats (salvage products), 15% of sulphite waste liquor (about 50% solids) and 75% water. The briquettes are then dust-free.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspect of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be secured by Letters Patent is:

1. A method of treating solid particulate material having non-uniform surface characteristics and selected from the group consisting of solid carbonaceous materials, sand, flue dust, and ore and metal powders, and having a particle size of up to about 6 mm., comprising the steps of forming an intimate mixture of 100 parts by weight of said solid particulate material and between ½ and 30 parts by weight of an oil in water emulsion consisting essentially of between 1 and 39 parts by weight of a hydrophobic oil in between 60 and 95 parts by weight of water having between 4 and 39 parts by weight of a water-soluble binder dissolved therein, so as to form a mass consisting essentially of particles of said material with said hydrophobic oil and said binder adhering thereto, whereby a pulverulent material will be formed consisting of particles of more uniform surface characteristics than said solid particulate material, adapted to be packed more densely than said solid particulate material and also adapted to be briquetted upon admixture of a water-insoluble binder; mixing the thus formed mass with a water resistant binder in an amount sufficient to permit briquetting of the thus formed mixture; and briquetting the thus formed mixture, whereby briquettes of highly uniform quality are formed.

2. A method of treating solid particulate material having non-uniform surface characteristics and a particle size of up to about 200 microns, comprising the steps of forming an intimate mixture of 100 parts by weight of said solid particulate material and between ½ and 30

parts by weight of an oil in water emulsion consisting essentially of between 1 and 39 parts by weight of a hydrophobic oil in between 60 and 95 parts by weight of water having between 4 and 39 parts by weight of a water-soluble binder dissolved therein, so as to form a mass consisting essentially of particles of said material with said hydrophobic oil and said binder adhering thereto, whereby a pulverulent material will be formed consisting of particles of more uniform surface characteristics than said solid particulate material, adapted to be packed more densely than said solid particulate material and also adapted to be briquetted upon admixture of a water-insoluble binder; mixing the thus formed mass with a water resistant binder in an amount sufficient to permit briquetting of the thus formed mixture; and briquetting the thus formed mixture, whereby briquettes of highly uniform quality are formed.

3. A method of treating solid particulate carbonaceous material having non-uniform surface characteristics and a particle size of up to 6 mm., comprising the steps of forming an intimate mixture of 100 parts by weight of said solid particulate carbonaceous material and between 1/2 and 30 parts by weight of an oil in water emulsion consisting essentially of between 1 and 30 parts by weight of a hydrophobic oil in between 60 and 95 parts by weight of water having between 4 and 39 parts by weight of a water-soluble binder dissolved therein, so as to form a mass consisting essentially of particles of said material with said hydrophobic oil and said binder adhering thereto, whereby a pulverulent material will be formed consisting of particles of more uniform surface characteristics than said solid particulate material, adapted to be packed more densely than said solid particulate material and also adapted to be briquetted upon admixture of a water-insoluble binder; mixing the thus formed mass with pitch as a water-insoluble binder in an amount sufficient to permit briquetting of the thus formed mixture; and briquetting the thus formed mixture, whereby briquettes of highly uniform quality are formed.

4. A method of treating solid particulate carbonaceous material having non-uniform surface characteristics and a particle size of up to 6 mm., comprising the steps of forming an intimate mixture of 100 parts by weight of said solid particulate carbonaceous material and between 1/2 and 30 parts by weight of an oil in water emulsion consisting essentially of between 1 and 39 parts by weight of a mineral oil in between 60 and 95 parts by weight of water having between 4 and 39 parts by weight of a water-soluble binder selected from the group consisting of sulphite waste liquor, sulphite pulp powder, starch, dextrine, mastic, gum arabic, casein, glue, gum tragacanth, water glass and methyl cellulose, dissolved therein,

so as to form a mass consisting essentially of particles of said material with said mineral oil and said binder adhering thereto, whereby a pulverulent material will be formed consisting of particles of more uniform surface characteristics than said solid particulate material, adapted to be packed more densely than said solid particulate material and also adapted to be briquetted upon admixture of a water-insoluble binder; mixing the thus formed mass with pitch as a water-insoluble binder in an amount sufficient to permit briquetting of the thus formed mixture; and briquetting the thus formed mixture, whereby briquettes of highly uniform quality are formed.

5. A method of treating solid particulate material of non-uniform surface characteristics and selected from the group consisting of solid carbonaceous materials, sand, flue dust, and ore and metal powders, and having a particle size of up to about 6 mm., comprising the steps of forming an intimate mixture of 100 parts by weight of said solid particulate material and between 1/2 and 30 parts by weight of an oil in water emulsion consisting essentially of between 1 and 39 parts by weight of a hydrophobic oil in between 60 and 95 parts by weight of water having between 4 and 39 parts by weight of a water-soluble binder dissolved therein, so as to form a mass consisting essentially of particles of said material with said hydrophobic oil and said binder adhering thereto, whereby a pulverulent material will be formed consisting of particles of more uniform surface characteristics than said solid particulate material, adapted to be packed more densely than said solid particulate material and also adapted to be briquetted upon admixture of a water-insoluble binder; mixing the thus formed mass with pitch as a water resistant binder in an amount sufficient to permit briquetting of the thus formed mixture; and briquetting the thus formed mixture, whereby briquettes of highly uniform quality are formed.

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