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METHOD OF PRODUCING FUEL
BRIQUETTES

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This invention relates to a method of producing fuel briquettes of high calorific value and strength adequate to withstand the destructive influences of transportation, from fuels which are known to those skilled in the art as "non-self-binding". Non-self-binding fuels are those whose particles in common practice require the admixture of a gummy binder such as pitch or asphalt and pressing into ovoid or pillow-shaped briquettes by means of a roll press.

In such operations the cost of the binder is in all cases by far the largest single item of the total cost of briquetting. It is essential that each particle of fuel be thoroughly coated with the binding medium and every possible care is taken to avoid the use of excess binder. The difference of a half of one percent. may make or mar an operation. Special attention must be given to "sizing" of the fuel particles. Too small a fuel particle size means too great a binder requirement. Too great particle size means weakness of structure. There is an optimum condition between the two always difficult to realize. The common practice of the industry is to use rather too much than too little of the binding medium in order to make sure that the product will stand transportation.

Lignite of the type mined in Germany is known as self-binding because when heated to about 200° F. and pressed the particles are welded into a strong merchantable briquette. The same method will form briquettes of many other fuels but these products lack permanence of cohesion.

Briquettes can be made from most fuel by the use of excessive pressure, especially if the pressure remains on for some space of time. From these observations we concluded that binding material in some form must exist in the non-binding fuels. This conclusion was verified by the observation that fine coking coals heated, for example, for twenty-four hours at a temperature of 200° F. form a tough mass known as coke. Apparently something in the coal has melted, has bound carbon particles together and was then itself coked. Furthermore, such coals on distillation yield tars and pitches of the type frequently used as briquette binders.

But tars and pitches do not exist as such in coal. They are the products of chemical change induced by heat. At the same time it seemed to be a fair deduction to presume that the material in the coal from which the tars and pitches are made is probably gummy and resinous in character. If this is so, then it should be made avail-

able in connection with the binding of coal particles into briquettes.

Research has led to an identification in part at least of the original gummy ingredients in coal and lignite. These fuels are in effect fossilized vegetable debris. Included in that debris are exceedingly small vegetable spores and pollen grains. These spores and grains are encased in cellulosic matter highly resistant to decay. They are also highly resistant to such common solvents as carbon bisulphide and pyridine unless the coal is heated. Chemists are not agreed upon the composition of the resins in the spores of coal but there is no doubt whatsoever that these resins are good agglutinants. If they could be liberated from the carbon of the coal and melted they would to a degree at least take the place of the asphalts and pitches now so extensively used in briquette manufacture. Such liberation and utilization is the object of the herein described process.

In general the process is as follows: The coal is pulverized and then heated to a temperature equivalent to the melting point of the spore resins. At the same time a convenient extracting medium which is not necessarily an agglutinant in itself but is capable of dissolving the spore resins in the fuel to form a binding medium having strong cohesive powers, as for instance, Bunker C fuel oil, is heated to approximately the same temperature and the two are mixed in any convenient way. As soon as the mixture is fairly thorough, it is subjected to a macerating action of sufficient severity to break up spores and this action is carried on for a sufficient time to insure the breaking up of a very considerable proportion at least of the spores in the coal. During this time the temperature must be kept at the previously ascertained melting point of the resins which, released from their cases, are picked up, partially at least, by the extractor liquid. When the process has been carried on until sufficient of the resins has been dissolved by the exterior solvent to form a solution capable of functioning as an efficient briquette binder, the mix is cooled to pressing temperature and passed through the briquette press.

The temperatures, amount and character of extractor liquid and duration of treatment will vary for different coals and the optimum condition for each is easily determined by trial. For example, in the case of Pocohontas coal, a semi-bituminous variety much used in the briquetting industry, the coal is crushed, heated to 200° F. or above and mixed with 4½% of Bunker C fuel

oil or 15-18° Bé. fuel oil and when well mixed is macerated in the presence of live steam for a period of about fifteen minutes. It is then cooled and pressed. The briquettes thus made are excellent in every way and in making them a content of 6% asphalt is replaced by 4½% of an oil whose price is nearly one-half that of asphalt. Any good commercial macerator will accomplish the desired object. A common form of an efficient macerator for the purpose of this invention is one which consists of a cylinder containing two or more vertical shafts each provided with a plurality of blades, the shafts being so set up relatively to each other that the blades of one pass over and under the other so closely as nearly to engage. The coal extractor mix passes vertically through while the blades whip it rapidly with flail-like effect, thereby loosening the spores and pollen from the coal and breaking up the spore cases. The effect of this type of maceration is to constantly present freshly exposed surfaces to the extracting medium. So far as we are aware it has not been thus far known that Bunker C Fuel oil which is liquid at ordinary temperatures and has in itself insufficient cohesive power to bind the macerated fuel particles together in the condition of a permanently cohesive briquette, will dissolve coal resins to form a stiff binding solution capable of strongly cohering the fuel particles together when the latter are pressed into briquette form. Bunker C fuel oil according to the United States Government specifications, is a hydrocarbon oil which has a flash point not lower than 150° F. (Pensky-Martens Closed Tester), a viscosity (Saybolt Furol Viscosimeter) of 300 seconds at 120° F. (as distinguished from 100 seconds at 122° F. when the oil is of the Bunker B variety) and water and sediment not to exceed 2% and sediment not to exceed .25% (see United States Government Master Specification No. 2d for Lubricants and Liquid Fuels, Condensed Chemical Dictionary of 1934, and the Chemical Engineers' Handbook of 1934).

Another fuel whose value may be enhanced by the use of the new method is petroleum coke in which a residual of heavy asphaltic material has been left after the process of cracking and/or distillation. Generally speaking, such coke presents 8% of volatile matter. It is highly cellular and in some of these cells the asphaltic material is trapped. This coke is heated to the melting point of asphalt, about 190° F. and heavy maceration employed in the presence of a liquid fuel oil serving as an extractor solvent. A solution of the liberated asphalt follows, together with an evaporation of the lighter elements in the extraction medium. The mix is passed to a press and by the time it reaches there the greater part of the asphaltic material in the coke has been incorporated in the extractor forming a highly efficient binding medium. In this way an excellent briquette is formed at very low cost.

The percentage of extractor liquid roughly stated varies inversely with the quantity of spores in the coal or asphaltic material in the coke.

We claim:

1. The method of making fuel briquettes which comprises heating fuel containing occluded resinous material to the melting point of such resinous material, mixing with said heated fuel a relatively small amount of Bunker C fuel oil that is liquid at normal temperatures and has in itself relatively little binding power, but is

capable of dissolving said resinous material in the fuel to form a stiff binding solution having strong cohesive powers, subjecting said mixture to a macerating treatment at the melting point temperature of such resinous material and continuing such treatment until sufficient of the resinous material has been dissolved by the oil to form a solution capable of strongly cohering the fuel particles together when such particles are pressed into briquette form, cooling the mixture to pressing temperature and then forming briquettes therefrom.

2. The method of producing fuel briquettes from coal of the bituminous type using Bunker C fuel oil alone as the sole binding material, which comprises heating such coal to the melting point of the resinous matter contained therein, mixing the heated coal with a relatively small quantity of Bunker C fuel oil which has in itself relatively little binding power, but is capable of dissolving the resinous material of the coal to form an efficient binder, subjecting said mixture to a macerating treatment at the melting point temperature of such resinous material and in the presence of water vapor until sufficient of the resinous material has been dissolved by the oil to form an efficient binding material for the coal particles, cooling the mixture to pressing temperature, and then forming briquettes therefrom.

3. The method for the treatment of solid fuel of sub-soil origin containing resinous components which when liberated are soluble in Bunker C fuel oil which includes heating the fuel to a temperature which is approximate to the melting point of such soluble components, mixing the heated fuel with a small quantity of extractor liquid having in itself insufficient cohesive power to bind the fuel into permanently cohesive shape, but capable of functioning to an extent comparable with the result obtained when using Bunker C fuel oil as a solvent for said components, to form a solution having efficient binding qualities, submitting the mix to a macerating treatment of such intensity as to break up constantly the fuel particles and thereby to expose new surfaces, and conducting such macerating treatment at the stated temperature until sufficient of the said components have been exposed to and dissolved by the extractor liquid to increase its cohesive capacity to that of an efficient binder for the fuel material.

4. The method for the treatment of solid fuel of sub-soil origin containing resinous components which when liberated are soluble in Bunker C fuel oil which includes heating the fuel to a temperature which is approximate to the melting point of such soluble components, mixing the heated fuel with a small quantity of extractor liquid having in itself insufficient cohesive power to bind the fuel into permanently cohesive shape, but capable of functioning to an extent comparable with the result obtained when using Bunker C fuel oil as a solvent for said components, to form a solution having efficient binding qualities, submitting the mix to a macerating treatment of such intensity as to break up constantly the fuel particles and thereby to expose new surfaces, and conducting such macerating treatment at the stated temperature and in the presence of water vapor until sufficient of the said components have been exposed to and dissolved by the extractor liquid to increase its cohesive capacity to that of an efficient binder for the fuel material and then bringing the temperature of the mixed material down to a tem-

perature appropriate for shaping and pressing the mixed materials into their final cohesively united shapes.

5 5. The process of making fuel briquettes which
comprises subjecting coal of the bituminous type
to a macerating action of such intensity as to
constantly break up the coal particles and there-
by to expose new surfaces, conducting the macer-
ating action in the presence of a small quantity
10 of a solvent for liberated resinous components of
the coal which, when dissolved, will enhance the
binding capacity of the solvent, such solvent con-
sisting of Bunker C fuel oil which has not suffi-
cient cohesive power to bind the coal particles
15 together in the condition of a permanently co-
hesive briquette but which, when combined with
the said extracted components, forms an efficient
binder, conducting said simultaneous macerating
and extracting operations at a temperature in the
20 mix approximating the melting point of said
resinous components and continuing said opera-
tions until a substantial enhancement of the bind-
ing capacity of the solvent has been accomplished
and then forming briquettes from the thus
25 treated mix.

6. The process of making fuel briquettes which
comprises subjecting coal of the bituminous type
to a macerating action of such intensity as to
constantly break up the coal particles and there-
30 by to expose new surfaces, conducting the macer-
ating action in the presence of a solvent for com-
ponents of the coal which, when dissolved, will
enhance the binding capacity of the solvent, such
solvent consisting of Bunker C fuel oil which has
not sufficient cohesive power to bind the coal
35 particles together in the condition of a perma-
nently cohesive briquette but which, when com-
bined with the said extracted components, forms
an efficient binder, conducting said simultaneous
macerating and extracting operations at a tem-
40 perature in the mix approximating the melting
point of said components and continuing said
operations until a substantial enhancement of the
binding capacity of the solvent has been accom-
45 plished, cooling the resultant mixture and then
forming briquettes therefrom.

7. The process of making fuel briquettes which
comprises crushing coal of the bituminous type
and then subjecting the crushed particles to a
50 macerating action of such intensity as to con-
stantly break up the coal particles and thereby
to expose new surfaces, conducting the macerating
action in the presence of small quantities
of a solvent for liberated resinous components
55 of the coal which, when dissolved, will enhance the
binding capacity of the solvent, such solvent con-
sisting of Bunker C fuel oil which has not suffi-
cient cohesive power to bind the coal particles
together in the condition of a permanently co-
hesive briquette but which, when combined with
60 the said extracted components, forms an effi-
cient binder, conducting said simultaneous
macerating and extracting operations at a tem-
perature in the mix approximating the melting
point of said resinous components and continu-
65 ing said operations until a substantial enhance-
ment of the binding capacity of the solvent has
been accomplished and then forming briquettes
from the thus treated mix.

70 8. The process of making fuel briquettes which

comprises subjecting coal of the bituminous type
to a macerating action of such intensity as to
constantly break up the coal particles and there-
by to expose new surfaces, conducting the macer-
ating action in the presence of steam and small
5 quantities of a solvent for liberated resinous com-
ponents of the coal which, when dissolved, will
enhance the binding capacity of the solvent, such
solvent consisting of Bunker C fuel oil which has
not sufficient cohesive power to bind the coal par-
10 ticles together in the condition of a permanently
cohesive briquette but which, when combined
with the said extracted components, forms an
efficient binder, conducting said simultaneous
macerating and extracting operations at a tem-
15 perature in the mix approximating the melting
point of said resinous components and continuing
said operations until a substantial enhancement
of the binding capacity of the solvent has been
accomplished, and then forming briquettes from
20 the thus treated mix.

9. The process of making fuel briquettes which
comprises subjecting coal of the bituminous type
to a macerating action of such intensity as to
constantly break up the coal particles and there-
25 by to expose new surfaces, conducting the macer-
ating action in the presence of steam and small
quantities of a solvent for liberated resinous com-
ponents of the coal which, when dissolved, will
enhance the binding capacity of the solvent, such
30 solvent being approximately $4\frac{1}{2}\%$ of the coal-
solvent mixture and consisting of Bunker C fuel
oil which has not sufficient cohesive power to bind
the coal particles together in the condition of a
permanently cohesive briquette but which, when
35 combined with the said extracted components,
forms an efficient binder, conducting said simul-
taneous macerating and extracting operations at
a temperature in the mix approximating the
melting point of said resinous components and
40 continuing said operations until a substantial en-
hancement of the binding capacity of the solvent
has been accomplished, cooling the resultant
mixture, and then forming briquettes from the
thus treated mix.

10. The process of making fuel briquettes which
comprises crushing coal of the bituminous type
and then subjecting the crushed particles to a
macerating action of such intensity as to con-
stantly break up the coal particles and thereby
50 to expose new surfaces, conducting the macerating
action in the presence of steam and a small quan-
tity of a solvent for components of the coal
which, when dissolved, will enhance the binding
capacity of the solvent, such solvent being a fuel
55 oil of the order of Bunker C fuel oil which has
not sufficient cohesive power to bind the coal
particles together in the condition of a perma-
nently cohesive briquette but which, when com-
bined with the said extracted components, forms
60 an efficient binder, conducting said simultaneous
macerating and extracting operations at a tem-
perature in the mix approximating the melting
point of said components and continuing said
operations until a substantial enhancement of
65 the binding capacity of the solvent has been ac-
complished, cooling the resultant mixture, and
then forming briquettes therefrom.

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