Oct. 17, 1939. H. R. FIFE 2,176,128

FUEL TREATMENT

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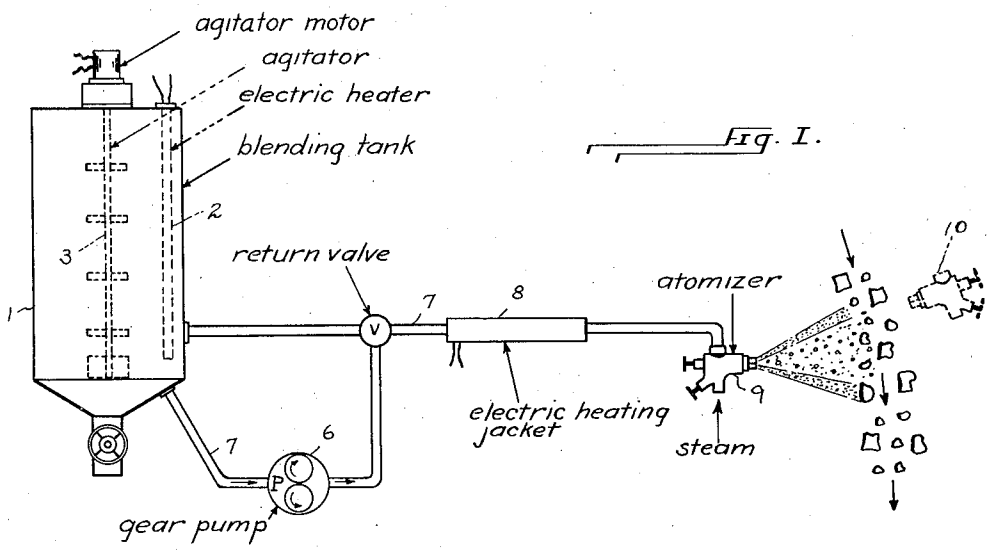


Fig. I.

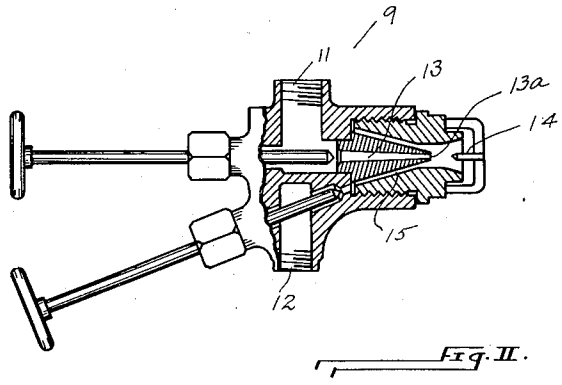


Fig. II.

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FUEL TREATMENT

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2 Claims. (Cl. 44—6)

This invention relates to the coating of coal to protect the coal from both chemical and mechanical degradation, and constitutes in part a continuation of my co-pending application Serial No. 36,365, filed August 15, 1935.

In my Patent No. 1,912,697, dated June 6, 1933, there is disclosed a method of applying to coal a thin sealed coating film of relatively non-fugitive nature. In accordance with the preferred procedure disclosed in that patent, I prepare a liquid suspension, desirably a water suspension, of paraffin wax or a waxy mixture. Into that suspension the coal is immersed and the suspended film-forming material flowed over its surface, or alternatively the liquid suspension is applied to the coal by simple spraying.

In certain respects the procedure disclosed in that patent lacks universality. It may be considered in its effect to be wholly satisfactory in coating coal lumps, coke lumps, and preformed briquettes of coal dust which are of substantial size. Difficulty is experienced when the material to be treated contains a substantial proportion of coal, or coke, particles of small size. Thus, difficulty begins when a batch of coal subjected to treatment contains a large proportion of fines below one-eighth inch in size, increases when a substantial proportion of 20-mesh coal is present, and becomes a major problem when a substantial proportion of 60-mesh coal is present in the batch.

One feature of the difficulty thus encountered is that the fine coal particles, when subjected to treatment by immersion in the bath, tend highly to agglomerate, or "ball-up," forming relatively large masses consisting wholly of fines and coating material and containing an inordinate quantity of coating material. This is due to the great excess of water which is present. This leads to combustion difficulties when the coal is burned.

When a water bath, such as that disclosed in my prior patent, is applied to the coal by simple spraying, there is a marked tendency for the fines to be washed away and wasted, while wastefully carrying with them coating material which has covered their surfaces.

For the above reasons I prefer protectively to coat by means of the preferred procedure described in my above-noted patent only screened coal, the particles of which are at least one-eighth inch in size. This, as above indicated, is for the underlying reason that with finer coal sizes the advantage of coating each coal particle individually is in large measure lost. Also the preferred procedure of the patent does not serve to wet, and therefore coat, particles of slate, shale, pyrites, and other impurities frequently associated with the coal, and leaves such particles free by their own degradation to give a substantial dust content to the coal batch. For this reason I prefer also to practice the method of the patent only upon clean coal, or coal which has been washed, or mechanically cleaned, to a state in which it is reasonably free of such impurities.

Primarily considered, the instant improvement in the formation of a protective waxy coating on coal consists in reducing or minimizing the proportion of carrying water, and without the use of a volatile solvent liquid so applying the coating material or blend to the coal that it is flowed over the coal particles without the high agglomerative tendency attributable to the use of a large excess of water, or the use of a volatile solvent, to carry the wax or blend.

The coating material which, by my instant method, I apply as a film to the coal protectively treated is fundamentally petrolatum; that is, an amorphous paraffin wax or waxy material blended with an oil content. Oil may be subtracted from or added to the petrolatum. Amorphous paraffin wax, having a negligible oil content, may be used, or a petrolatum may be made synthetically by adding oil to such amorphous wax. This range of wax, or waxy blend, I herein designate generically "petrolatum." This material I spray upon the coal.

Assuming that the process is conducted upon "run-of-the-mine" coal, containing fines and impurities, the problems encountered in treating the coal in satisfactory and economical manner may be here stated. Insofar as lumps of the coal itself are concerned, the problem is to avoid penetration of the coal by the petrolatum, and to maintain an impingement temperature on the surface of the coal adequate to cause a flow and spread of the petrolatum over the surface of each coal lump individually. Insofar as impurities, such as slate, shale, pyrites, and the like, are concerned, the problem is to wet the surface of the impurities with the petrolatum, since they are not preferentially wet by the petrolatum in the presence of an abundance of water. Insofar as dust is concerned, the problem is initially to adhere it to the surfaces of the larger pieces or lumps, and to encapsulate it to the larger coal pieces or lumps, without individually coating the dust particles, and without causing the fines including the dust so to agglomerate that balls of fines and petrolatum are formed.

These problems I have solved by the process

herein disclosed, which may be considered as a mode of minimizing the water of the coating suspension, while effecting contact between the petrolatum and coal at a contact temperature at the surface of the latter adequate to flow or spread the petrolatum over the coal surfaces. Considering this, my present process, as improvement over the process disclosed in my prior patent, it consists in lessening the quantity of water used as a carrier for the waxy material and as a carrier for heat, while otherwise providing a suitable carrying medium for the petrolatum, and economically and in satisfactory manner supplying adequate heat to the surface of the coal. In so doing I utilize water in controlled proportion, thus in part retaining the advantage peculiar to its use, and specifically the advantage of inhibiting penetration of the coal bodies by the petrolatum before it congeals on the coal.

In accordance with my process I heat petrolatum with water to a temperature above the vaporization temperature of the water and the normal atomizing temperature of petrolatum. Petrolatum with water exhibits a marked foaming tendency at elevated temperature, and I therefore maintain a pressure adequate to prevent foaming up to the instant of release. The pressure is released and commingled petrolatum and water are sprayed, expanding at such stage to the formation of the spray jet. It is to be understood that in my process it is unnecessary to utilize a velocity head of steam in order to atomize the petrolatum.

The exemplary drawing, made a part hereof, serves to facilitate an understanding of the process. In this drawing Fig. I is a diagrammatic elevation of one arrangement of equipment suitable for conducting my process; and Fig. II is a longitudinal, sectional view of one type of nozzle which I have adapted to my purpose of atomizing petrolatum.

Referring to the diagrammatic showing of Fig. I, reference number 1 designates a blending tank, provided with heating means such as the electric heater 2, and with an agitator 3. In this tank 1, I may physically commingle petrolatum and water. By means of a pump 6, in discharge line 7 from the tank, the commingled petrolatum and water is placed under pressure. The commingled petrolatum and water under pressure are heated, further to raise their temperature, by suitable heating means, which I have shown as an electric heating coil 8 surrounding the line 7 in a region beyond the pump. As heated, and under pump pressure, the petrolatum and water are brought to a spray nozzle 9, positioned to direct a spray toward a stream of falling coal. Desirably, a second spray nozzle 10 is placed on the opposite side of the coal stream, and is similarly supplied with petrolatum and water under pressure.

Turning to the exemplary nozzle shown in Fig. II of the drawing, this nozzle, designated generally by reference numeral 9, has an inlet 11 for commingled petrolatum and water and an inlet 12 which may be used for low pressure steam. Both inlets are valve-controlled. In the nozzle there is a forwardly tapering passage 13 for commingled petrolatum and water, which has its forward and most constricted opening 13a in line with a pin or post 14 arranged to oppose and break up the stream of petrolatum and steam from the nozzle opening 13a. A passage 15, in communication with inlet 12, surrounds the tapered passage 13.

Specifically to describe my process, fundamentally and in accordance with my preferred practice, a petrolatum blend comprising amorphous paraffin wax, or amorphous paraffin wax and a petroleum oil, and water are heated together with agitation. Preferably the temperature at which the blend ingredients are heated and commingled is within the range of 70° C. to 90° C., since this is the highest temperature to which the blend may be heated at atmospheric pressure without developing a foaming tendency.

The blend is then forced to the spray nozzle, and is placed under applied pressure, as by means of a pump. In its passage from the point of pressure application to the spray nozzle, the blend is heated. The heating will be apportioned to the desired temperature at the coal. The applied pressure performs a dual function, in that it sprays the blend and prevents foaming. I prefer to utilize for spraying an applied pressure approximating 400 pounds per square inch, and have found that this pressure exceeds the vapor pressure of the water in the blend at any temperature to which I may find it desirable to raise the blend.

Desirably, I surround the cone of blend issuing from the spray nozzle with an envelope of low pressure steam. This steam, at low pressure, performs a dual function. It lessens mixing of the sprayed material with air, and thus tends to preserve spraying temperature. It also provides, by condensation, an increment of water to the surface of the coal, thus assisting in accurately determining the water-wetness of the coal as it is sprayed. Incidentally, it imparts some slight quantity of condensation heat to the coal. It does not perform an atomizing function, the same degree of blend dispersion being obtained when the low pressure steam envelope is omitted.

The temperature of the coal surfaces during contact should not, for satisfactory results, substantially exceed 100° C. This is in order that water may momentarily exist as such on the surface of the coal. It may be explained that the presence of some water is necessary in obtaining the particular advantages which I contemplate. By having a film of water on them, and on the larger lumps of coal, the dust particles are caused initially by water wetness to adhere to the coal lumps, so that they may be encapsulated with the lumps by the petrolatum. Also the presence of even a thin water film on the coal inhibits "wicking-in" of the petrolatum in the period between its application and its congelation. The existence of a light water film on impurities, such as slate, shale, pyrites, and the like, does not inhibit formation of a petrolatum film from the heated mist on them. A prime difference between the process of my prior patent and the instant process is that in the former water in the form of substantial drops, or globules, is applied with the wax particles to the surface of the coal, and is therefore capable of washing away the fines, together with associated wax.

The upper limit of temperature which permits a film of water to exist on the coal and impurities pending congelation of the petrolatum is higher than the melting-point of any petrolatum I may use, and below this upper limit I employ a contact temperature at least equal to, and desirably about, 5° C. above the melting-point of the petrolatum. In this connection it may be noted that in subjecting a falling stream of coal to a spray of the sort described and shown, the period of contact between the spray and any par-

ticular coal particles is very short, and the coating temperature is, therefore, in fact the temperature of contact between the coal and the spray.

I have found that in most instances a contact, or momentary, temperature, within the range of 50° C. to 90° C., is suitable to flow and spread the petrolatum in accordance with the varying content of that material. If the petrolatum be of a sort in which the oil content is negligible, or which contains chiefly high melting waxes, the contact temperature should be toward the upper end of this range. If the oil content of the petrolatum is high, the contact temperature may be toward the lower end of the range. It may be desirable to use a temperature slightly above this range under peculiar circumstances, as when a supply of petrolatum may contain some foreign substance serving to raise its melting-point.

In conducting my process, I intentionally avoid conditions which would produce emulsification, in that separation of the water from the petrolatum may rapidly follow contact with the coal. There are present no evaporative solvents to delay solidification of the coating.

There are several factors which cause drop in temperature from the point at which the petrolatum blend is heated under pressure and the point of impingement of the spray jet with the coal. These factors are so variable that it is desirable to test the spray while raising the temperature of the blend, either taking the temperature of impingement, or observing the initial blend temperature at which the wax of the petrolatum ceases to ball upon impingement as its temperature is raised. Any impingement piece used in testing should approximate the distance of the coal stream from the nozzle, and the duration of its exposure should not substantially exceed the period during which the coal is exposed to the spray under the particular conditions of the process defining the period during which the coal is exposed to the jet. As above noted, under no circumstances should the temperature be raised to such point that a film of water is not deposited on the surface to be coated. It should be noted that such limitation of temperature at the coal, and the fact that even this limited temperature is effective merely during the fleeting contact period, serves additionally to avoid conditions favorable to oxidation at the coal.

The quantity of water desirably to be included in the spraying blend must be greater than that which is miscible with the wax or wax and oil under the conditions of the process. Mechanical agitation, which I prefer to employ, serves to prevent stratification, and to promote dispersion. In spraying a petrolatum containing any substantial proportion of wax to oil, I have found a 1:1 ratio with water satisfactory, without finding it necessary otherwise to supply water to the coal to form the penetration-inhibiting and dust-retaining film. The water of the enveloping steam jet may in practice be balanced with the water content of the blend to give the water film on the coal.

An example of my commercial practice under the process may be given as follows:

Petrolatum with added water was atomized under 400 pounds pressure and at 140° C. Steam at 10–12 pounds pressure was allowed to expand around the atomizing tip and to become part of the spray mist. The jet was caused to impinge upon coal at a distance of 10" from the spray tip. The contact temperature was about 75° C. and the time of contact was less than 5 seconds. Under these conditions I applied between 4 and 5 pounds of 112° F. melting-point petrolatum to a ton of stoker coal of ¼" to 1". The coal was the particularly dusty Freeport vein coal. As a result of the treatment the coal lumps were provided with a well adhered film. The coal dust was so held by the moisture film and encapsulated by the petrolatum film that there was no visible loss of dust. During a period of more than six months the coal released no substantial quantity of fly-dust.

I applied between 4 and 5 pounds each of both an oil having a viscosity of 100 Saybolt seconds at 100° F., and an oil having a viscosity of 600 Saybolt seconds at 100° F. These oils were applied each to a ton of the same dusty Freeport vein coal in accordance with various methods, including both the hot and cold oil vapor processes. In each instance the coal released fly-dust within a storage period of less than a month.

The rapid failure of the oil treatment on coal of this sort is attributable to the spreading of the oil over and its impregnation into the coal. The success of the wax-containing petrolatum is attributable to the fact that it forms a fixed film of "non-crawling" sort, and to the fact that it was applied under conditions of moisture and temperature suitable for the formation of an encapsulating surface coat on the coal lumps, in which the dust was embedded, rather than the formation of an impregnating coat susceptible to "wicking" and "crawling."

It is apparent that my process, herein disclosed, has particular advantage in dealing with coal, such as the Freeport vein coal, which is particularly dusty.

My process is capable of acting in satisfactory manner upon unwashed and unscreened "run-of-the-mine" coal. Thus by treating coal containing dust and impurities, the coal may advantageously by screened after rather than before treatment, reducing or eliminating mechanical dust formation during the screening operation and giving a cleaner and more uniformly sized coal. It also reduces or eliminates the hazard to health which resides in the presence of excessive quantities of coal dust in the coal tipples. Since my process, by utilizing water in controlled quantity, avoids the formation of large agglomerates of fines both before and during screening, the treating process does not present any obstacle to successful immediate screening. My process also leaves the coal in good condition to pass through air-cleaning plants without creating a tendency to plug the air vents for the separating currents in the manner which results from the like cleaning of oil-coated coal. The health hazard attendant upon the air cleaning of untreated coal is also reduced or eliminated.

It should be understood that in order wholly to avoid agglomeration of fines, and definitely to permit encapsulation of non-combustible mineral impurities occurring in a "run-of-the-mine" coal batch subjected to treatment, the water film on the various particles of the batch should be very thin. Particularly for the purpose of permitting encapsulation of the impurities, it is desirable that it be of an order of thickness rendering it invisible. The exemplary conditions given above produce on the particles of a coal batch a water film of such order. Starting with the 1:1 petrolatum and water ratio, given as exemplary, sub-

stantial variation at both sides of the ratio may be made without seriously changing the character of the water film on the coal. As a general proposition it is desirable to include in the treating mist a somewhat larger proportion of water for the soft coals than for the hard coals.

Whereas throughout the major portion of this specification I have used merely the word "coal" in describing the fuel which is treated, this I have done as a matter of convenience, intending that coke, lignite, and similar fuels be included under the term "coal" herein generically used. By the term "fines" I intend to define the coal particles from ⅛" down, and generally to include the smallest fines which constitute dust.

I claim as my invention:

1. The herein described method of protectively coating solid fuel susceptible to dusting and degradation which comprises forming a mechanical mixture of petrolatum and water, applying an extraneous mechanical pressure to the said mixture of petrolatum and water, heating the mixture while it is subjected to such pressure to a temperature adequate to liquefy the petrolatum and above the boiling point of the water for conversion of the water to steam upon release of the said pressure, and passing the mixture through a spraying nozzle under the combined extraneous mechanical pressure and the vapor pressure of the heated liquids while directing the hot spray on the coal.

2. The herein described method of protectively coating solid fuel susceptible to dusting and degradation and including a substantial proportion of fines which comprises forming a mechanical mixture of petrolatum and water in which the water is present in a quantity so apportioned to the proportion of fines in the fuel to be treated that it will not tend to agglomerate the fines when the mixture is applied to the fuel, applying an extraneous mechanical pressure to the said mixture of petrolatum and water, heating the mixture while it is subjected to such pressure to a temperature adequate to liquefy the petrolatum and above the boiling point of the water for conversion of the water to steam upon release of the said pressure, and passing the mixture through a spraying nozzle under the combined extraneous mechanical pressure and the vapor pressure of the heated liquids while directing the hot spray on the coal.

HARVEY R. FIFE.