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METHOD OF DEWATERING OF COAL SLURRIES

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2 Sheets-Sheet 1

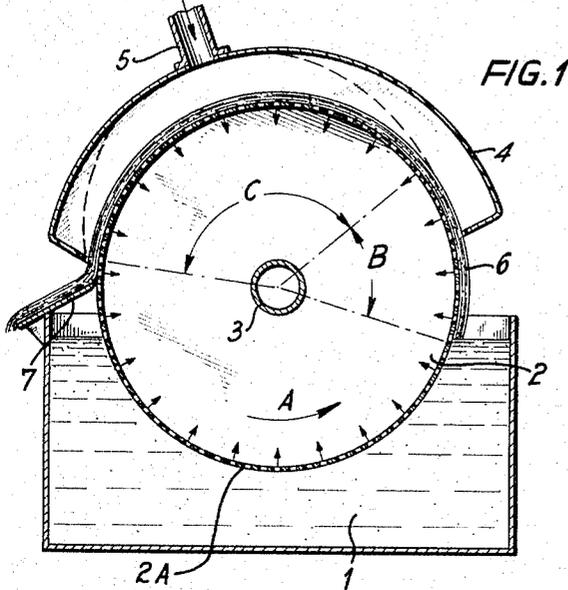


FIG. 1

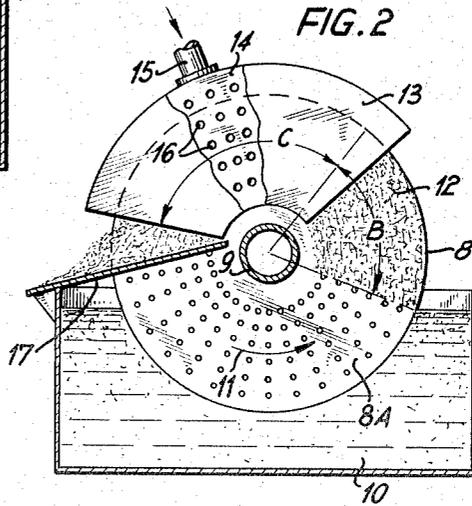


FIG. 2

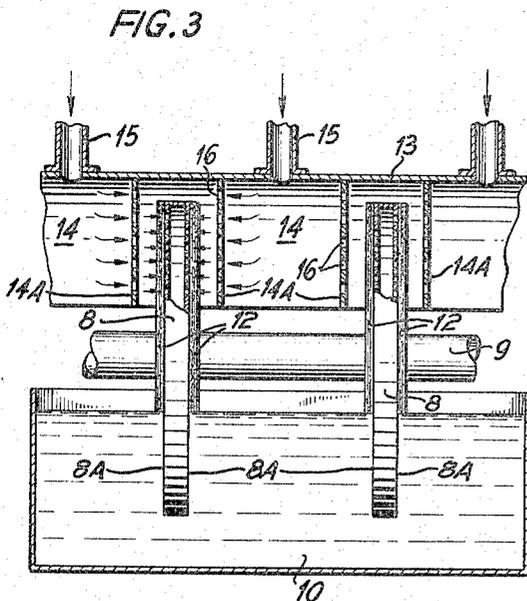


FIG. 3

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2 Sheets-Sheet 2

FIG. 4

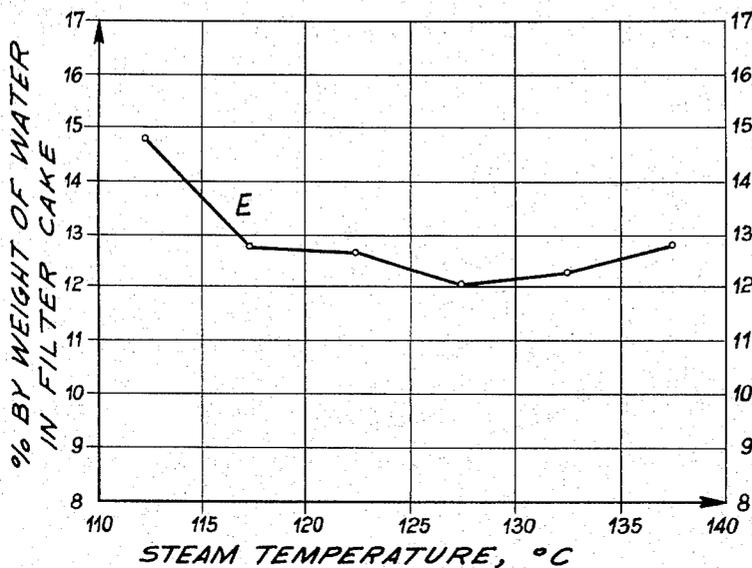
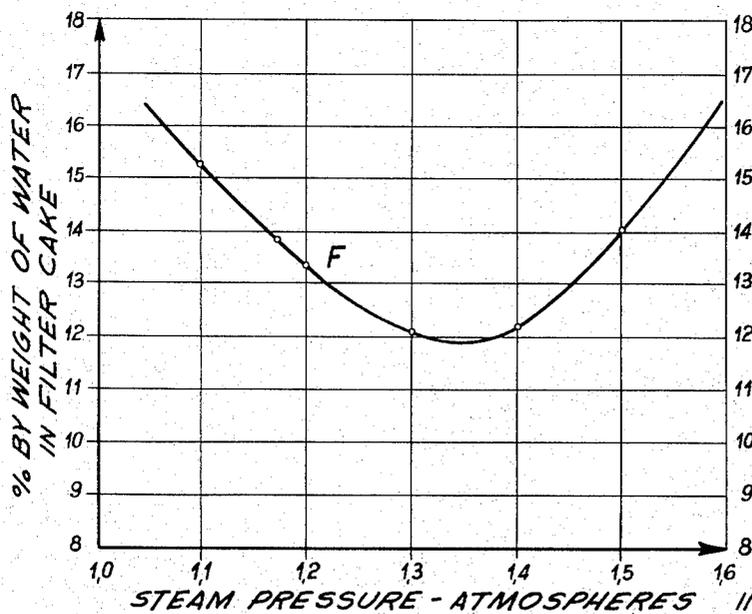


FIG. 5



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1

3,361,259

**METHOD OF DEWATERING OF COAL SLURRIES**  
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1 Claim. (Cl. 210—67)

### ABSTRACT OF THE DISCLOSURE

A process of dewatering coal slurry from about 30% water to about 12% water using a vacuum drum filter which comprises first subjecting the slurry to vacuum then to steam at a pressure of about 1.3 atmospheres and a temperature of about 125° C. and a steam consumption of about 14–20 kilograms per metric ton.

The present invention relates to a method of reducing the water content of coal slurries which are obtained in large amounts in the upgrading of coal.

In the past, raw coal and other flotation slurries have been dewatered by means of drum or disc filters whereby the initial high water content is reduced to about 18% to 25%. A slurry dewatered to such a degree may be added to coking coal; however the use of the slurry is limited since the water content of the coking coal obviously cannot be increased indefinitely. For this reason, a large portion of the slurry cannot be added to the coking coal and, hence, is either discarded as waste or sold as boiler fuel with a resultant loss in revenue. Moreover, since slurries having a water content of 18% to 25% are not capable of draining and tend to form clumps or the like, difficulties are encountered in mixing the slurry with the coking coal. Sludge clumps give rise to the formation of so-called sludge nests in the coking coal which are of great disadvantage in the manufacture of blast-furnace coke which must be of great strength.

Attempts have been made in the past to find an economical process capable of dewatering to a significantly lower level the water content of slurries obtained in the upgrading process. In order to achieve this objective, use has been made of flocculation means and surface-active agents, or the filter element has been heated and the filter cakes have been subjected to infra-red rays or hot gases. These measures, however, result in a reduction of the water content in the filter cake by only 2% to 4%. While high pressure filtration of the slurry or subjecting it to high centrifugal forces by centrifugal action yields a reduction of about 7% to 10%, these latter methods have met with little practical acceptance for the reason that they achieve only a moderate yield while being relatively costly.

There has been a long-standing need for economically dewatering slurries such that the residual or final water content is on the order of about 12% by weight. In accordance with a previous suggestion, the water content of the residues in vacuum filters and filter presses may be reduced by heating the residues such that the necessary heat is supplied by condensation of steam which penetrates the residues while they are resting on the filter. Tests have verified, however, that this previously-used method for removal of water from filter mud is impractical, the reason being that it is difficult to provide a heat insulating hood for filters or filter surfaces of, for example, 18 to 40 square meters. Moreover, the steam consumption in connection with this previous method is 68 kilograms per metric ton of filter cake, meaning that a filter would require about 1000 cubic meters of steam

2

per hour, and sealing of the hood would be practically impossible. Since the vacuum in the filter drum is capable of drawing in only a certain amount of water and air, the excessive steam would escape at the feeder and delivery sides. Furthermore, heating of the filter cake to temperatures of 90° C. to 100° C. could not be prevented, these temperatures being so high that, according to coke-oven plant specialists, the surface of the filter cake experiences modifications which are disadvantageous when the dewatered sludge is to be processed into coking coal.

As an overall object, the present invention seeks to provide a method and apparatus for dewatering coal and other flotation slurries such that the residual or final water content is minimized, and can be as little as 12%.

In accordance with the invention, it has been found, surprisingly enough, that dewatering of coal slurries by means of vacuum drums or vacuum disc filters and treatment of the filter cake with steam may be accomplished simply when the steam is brought into contact with a preliminarily dewatered filter cake and the treatment is carried out at superheated steam temperatures of 120° C. to 125° C., whereby the steam pressure is regulated such that the condensation point of the steam which penetrates the preliminarily dewatered filter cake is immediately adjacent the filter itself. That is, the steam will condense after passing through the filter cake and immediately before it passes through the filter element itself.

In this manner, the operating conditions may be optimized whereby the steam consumption is on the order of about 14 to 20 kilograms per metric ton and the filter cake is heated to only about 40° C. to 50° C. The proper location of the condensation point within the filter cake, that is, immediately adjacent the actual filter, may be determined by determining the liquid content of the filter cake at the exit side. Shifting of the condensation point may be accomplished by varying the steam pressure or the temperature within the limits prescribed herein. In accordance with a further feature of the invention, the admission pressure of the steam is between about 1.2 and 1.5 atmospheres (i.e., 1.2 and 1.5 times absolute atmospheric pressure), and the steam pressure within the filter cake is between 0.6 and 0.9 atmosphere. At such pressures, sealing may be omitted, the steam being admitted via a hood which is turned upside down over a portion of the filter emerging from the sludge.

According to actual test results, the success of the process is believed due to the fact that the sludge, drawn in by the filter vacuum at the feeder side, is preliminarily dewatered from between about 32% and 30% to about 27% to 25% water by weight in a preliminary dewatering zone which is not subject to the steam, whereby mainly the micro-capillary water is drained from the micro-capillaries of the filter cake. The preliminarily dewatered filter cake is then brought into the steam treatment zone by virtue of rotating the filter drum or filter discs. The superheated steam now penetrates the micro-capillaries of the preliminarily dewatered filter cake and eventually starts to condense in the third of the filter cake immediately adjacent the filter itself whereby the degree of superheat and the steam pressure are reduced gradually. When the condensation point, in accordance with the teachings of the subject invention, is at or close to the interface of the filter cake-vacuum zone, the completely condensed steam is drained off as water by virtue of the vacuum.

The process makes use of conventional vacuum drum filter or vacuum disc filter apparatus for dewatering of coal sludges; however, in accordance with another aspect of the invention, a hood having an inlet for the steam is erected upon the filter apparatus such that a portion of

3

the drum which is external with respect to the filter sludge is not within the action zone of the steam and defines the aforesaid preliminary dewatering zone, the spacing between the filter and the hood being, for example, about 20 centimeters. The preliminary dewatering zone may be provided by arranging the hood and the steam inlet above the circular filter in an off-center position such as by a structure where the hood and inlet are arranged off-set at a certain distance in the direction of rotation of the drum or disc. In a structure found suitable, the first third of the rotating filter which emerges from the sludge is beyond the action range of the steam, this first third constituting the preliminary dewatering zone mentioned above.

In vacuum disc filter apparatus, it is difficult to evenly distribute the steam over the filter surface covered with the filter cake. For this reason, and in accordance with the invention, the steam hood extends between the individual discs of disc-type filter apparatus, thereby forming steam distribution chambers, the front walls of the hood being spaced from and surrounding the individual discs provided with perforations for the passage of steam. In order to establish a preliminary dewatering zone in a manner similar to that in connection with vacuum drum filter apparatus, the perforations are provided in the front wall only over a section thereof, this section being arranged off-center with respect to the hood in the direction of the device which scrapes the mud off the filter. In order to evenly distribute the admission of steam to all discs of the filter apparatus, the steam distribution chambers are provided respectively with separate inlets for the steam.

It has been found that this process and the apparatus for carrying it out are suitable not only for dewatering coal sludges contained in connection with flotation upgrading of bituminous coal, but also for successfully dewatering other flotation concentrates. That is, in other concentrates the steam, admitted under pressure, exhibits a dehydrating effect. Such flotation concentrates to be dewatered in accordance with this invention are those which are obtained in connection with the upgrading of potassium hydroxide, ore dressing, and the upgrading of ceramic materials. In all instances, difficulties are experienced frequently in utilizing the fine-grained substance because of the high water content. These difficulties are largely eliminated by reducing the water content of such flotation concentrates in accordance with this invention.

The invention has also been found to be of great advantage in dehydrating organic residues which are obtained in emulsion form, for example, in processing crude oil and crude oil products and in connection with the various methods for processing refuse such as garbage and rubbish.

Although, depending upon the specific weight of the substance to be dewatered, the weight ratio between the substance to be treated and the water to be removed varies, the volumetric relationships are essentially the same, and essentially the same interrelationships are valid for the progression of the condensation front and, hence, for the selection of the appropriate temperature and pressures of the steam. Furthermore, the filter devices suitable for coal sludge are also applicable to other flotation concentrates.

The above and other objects and features of the invention will become apparent from the following detailed description, taken in connection with the accompanying drawings which form a part of this specification, and in which:

FIGURE 1 is an illustration of drum filter apparatus utilized in accordance with the present invention;

FIG. 2 is a side or plan view schematically illustrating a disc filter apparatus utilized in accordance with the present invention;

FIG. 3 is a front view of the disc filter apparatus shown in FIG. 2; and

4

FIGS. 4 and 5 are graphs illustrating the water content of the filter cake as a function of the steam temperature and steam pressure, respectively.

With reference now to the drawings, and particularly to FIG. 1, the filter mud or sludge constituting a suspension of coal mud, is contained within container 1 of the drum filter apparatus, the drum 2 being rotatable about a shaft 3. The drum 2 is of cylindrical configuration, the outer cylindrical peripheral wall 2A constituting the actual filter element. Within the drum there exists an underpressure of, for example, 0.5 atmosphere, the underpressure being produced by the creation of a vacuum in shaft 3 by means of a pump or the like, not shown. The steam hood 4 is set up above the container 1, the hood having an inlet 5 for the steam.

The drum 2 rotates in the direction of arrow A. Upon emerging from the container 1, the vacuum within the drum 2 causes a layer 6 of coal mud to adhere to the filter surface or wall 2A. Water is drained from this layer 6 of coal mud by virtue of the partial vacuum within the interior of the drum 2 while rotational motion of the drum is in progress. The mud layer 6 is separated from the filter at the other side thereof by means of a scraper 7 or the like.

The steam hood 4 is arranged above the drum such that the distance thereof from the container 1 is somewhat greater at the right side shown in FIG. 1 at which the filter with the mud layer 6 thereon emerges than at the left side at which the layer is scraped off by scraper 7. Moreover, the inlet 5 for the steam is arranged in an off-center position. That is, it is shifted with respect to a vertical line extending through the center of the shaft 3 a certain distance in the direction of drum rotation whereby, in operation, the preliminary dewatering zone, identified by the arc B, is formed wherein the mud is preliminarily dewatered under the influence of the vacuum only prior to introducing it into the steam action zone or arc C for further removal of water. A special seal between the hood 4 and filter 2 is not required. That is, slip gaskets or the like, not shown, are sufficient in order to prevent the steam from escaping and annoying operating personnel.

With reference to FIG. 2, there is illustrated disc filter apparatus in accordance with the invention. The container 10 in this case is filled with the sludge; however instead of using a drum as in FIG. 1, a plurality of disc assemblies 8 are provided, only two of such disc assemblies being shown in FIG. 3 for the purpose of clarity. The disc assemblies rotate about a hollow shaft 9 in the direction of arrow 11 shown in FIG. 2; and a partial vacuum is produced by extraction through the hollow shaft 9. In a manner analogous to the apparatus of FIG. 1, and the actual filter elements are constituted by the side walls 8A of the individual disc assemblies 8 on which the filter cakes 12 are deposited in operation.

In order to accomplish uniform distribution of the steam over the sides of the filter elements, a hood 13 has walls 14A extending between the individual discs, thereby forming steam distribution chambers 14 which are equipped, respectively, with inlets 15 for the steam. Preferably, the steam is permitted to come into contact with the filter cake by the steam passing through perforations 16 provided in sections of the hood walls 14A, said sections being defined by the arc C in FIG. 2 and displaced in the direction of the mud cake scraper 17. Thus, in a manner similar to FIG. 1, there is provided a preliminary dewatering zone B where the sludge is dewatered under the effect of the vacuum only and a steam action zone C where both the vacuum and steam act upon the sludge.

With reference, now, to FIG. 4, the steam temperature in degrees centigrade is plotted against the weight percentage of water in the resulting filter cake. In the example given, steam pressure was in the range of 1.2 and 1.5 atmospheres. By reference to curve E, it will be appre-

ciated that the water content in the filter cake reaches a minimum at a steam temperature of about 120° C. and 135° C. (248° F. and 275° F.) where the weight percentage of the water in the filter cake is between about 12% and 12.5%. Beneath a temperature of about 120° C. and above a temperature of about 135° C., the water content of the filter cake increases sharply.

In FIG. 5, the steam pressure in atmospheres is plotted against the weight percentage of water in the filter cake. The temperature of the steam utilized to derive the data of FIG. 5 was in the range between 120° C. and 135° C., the optimum conditions shown by the graph of FIG. 4. The curve F reveals a minimum water content in the sludge at steam pressures between 1.2 and 1.5 atmospheres (about 17.6 and 22 p.s.i.). Accordingly, a 12% dewaterization may be achieved at the indicated temperature and pressure ranges. This is an unexpected result, particularly when it is considered that the minimum dewaterization occurs between critical limits of pressure and temperature.

Although the invention has been shown in connection with certain specific examples, it will be readily apparent to those skilled in the art that various changes may be made to suit requirements without departing from the spirit and scope of the invention.

We claim as our invention:

1. The method of making a dewatered coal-slurry product having about 12% of water by weight from a bath of coal sludge containing about 30% to 35% of water by weight, a product of said low water content

being made with an economical low steam consumption of about 14 to 20 kilograms per metric ton of product, said method comprising contacting said bath of sludge with a rotating pervious member of a vacuum filter apparatus so as to cause the formation of a filter cake on said member, partially dewatering said filter cake further immediately after its emergence from said bath for a period of about the time that it takes for said rotating, pervious member to rotate through about one third of the arc corresponding to the part of said rotating, pervious member that lies outside said bath, and then continuing to dewater said filter cake while further rotating said pervious member and simultaneously subjecting said filter cake to the action of superheated steam at a pressure of about 1.3 to 1.4 atmospheres and at a temperature of about 125° C. to 130° C. with a steam consumption of about 14 to 20 kilograms per metric ton of said product, said product being heated as a result of treatment with said steam to a temperature of about 40° C. to 50° C., and removing said product from said rotating, pervious member of said vacuum filter apparatus.

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