

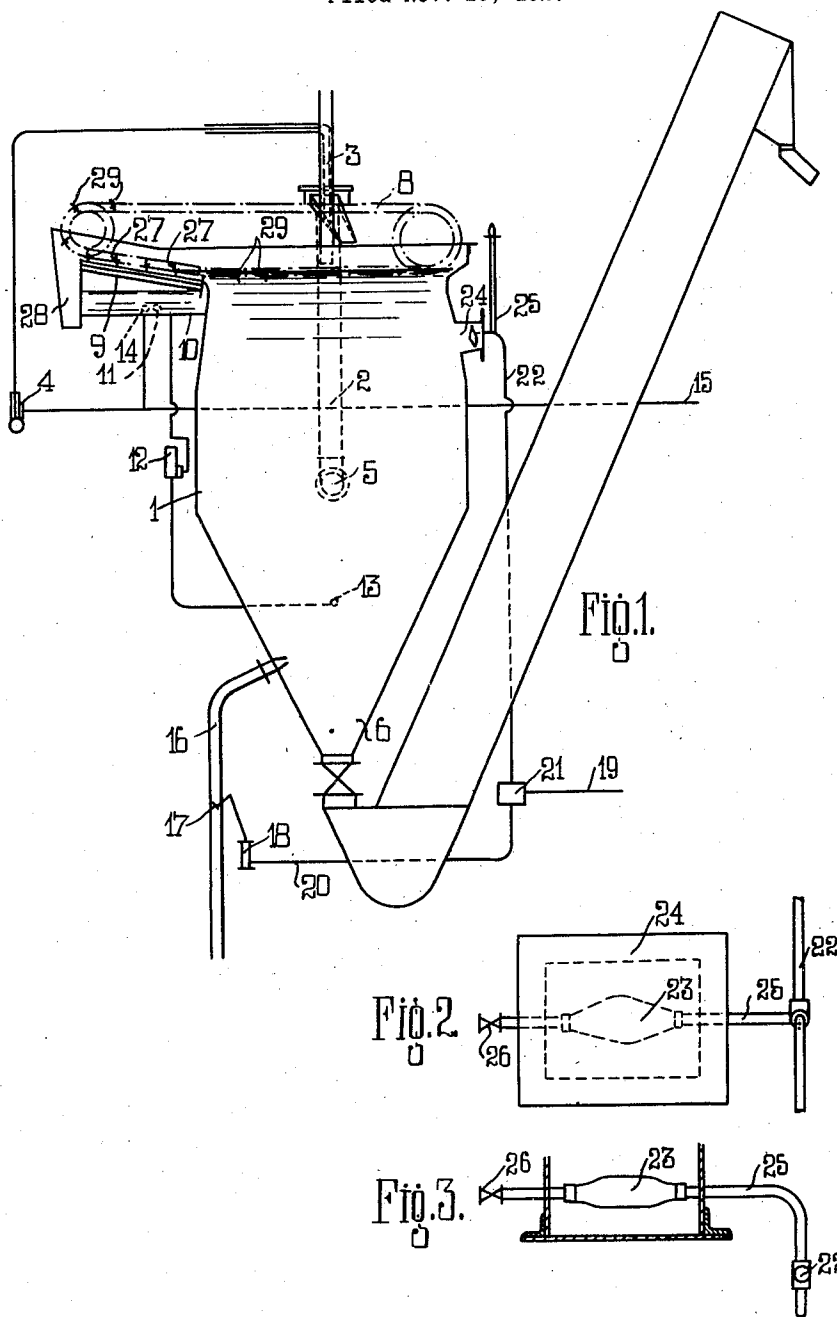
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CLEANING OF CARBONACEOUS MATERIALS

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CLEANING OF CARBONACEOUS MATERIALS

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This invention relates to an improvement in the cleaning or separation of carbonaceous materials and especially of coal, more particularly for the purpose of obtaining therefrom coal having a low proportion of ash-forming constituents.

The invention relates to processes in which the carbonaceous material is subjected to gravity separation in an aqueous solution the specific gravity of which lies between the specific gravities of the components to be separated, so that the heavier fragments tend to sink and the lighter fragments tend to float.

In the operation of such processes as described, for example, in the prior British patent specifications No. 276,723 and No. 282,874 of one of the present applicants it has been found that satisfactory separation can be obtained without any preliminary grading of the coal, in contradistinction to the known washing processes in which there is a rapid movement of the body of washing water. It is desirable, however, to reduce as far as possible the proportion of fine dust.

According to the present invention in a separating process of the kind described above, a small upward current of controlled magnitude, exceeding about one half of a foot per minute, is maintained in the liquor of the separating bath. The magnitude of the upward current employed depends upon the physical properties of the material treated, as well as upon the specific gravity of the liquid and the degree of separation desired. The velocity must not exceed the velocity of fall in the still bath liquor of those particles whose presence in the floated material is not desired.

In considering the velocity which is most suitable, regard must be had to the size of the smallest particles in the sink and the degree of separation which is required. Thus, if the material to be separated contains particles of very different sizes, it may not be possible to employ upward velocities of such magnitude as can be employed when the finer particles are substantially absent.

For example, when treating material of which a substantial proportion passes through a 20 I. M. M. sieve, the velocity of the upward current should not exceed about 2.5 feet per minute, as otherwise a proportion of material of a smaller size than that indicated above, but of high specific gravity, may appear in the float. The maximum velocity which can be employed increases with the size of the smallest particles of material which it is desired to exclude from the float. Thus, for example, where the smallest particles do not pass through a quarter inch screen, ve-

locities up to about 20 feet per minute could be employed.

In any case, however, it is desirable to reduce as far as possible the proportion of fine dust, i. e. particles passing through a 50 I. M. M. sieve, in the material before treatment according to the present invention.

The sieve designations above employed have reference to the standard form of sieve or screen established by the Institute of Mines and Metallurgy. In this standard screen the diameter of each strand is equal to the distance between them. Thus, if there are 50 strands to the linear inch each strand is one-hundredth of an inch in diameter and each hole is a square whose side is one-hundredth of an inch. This screen is numbered 50 on the I. M. M. scale, as it is called. Again a 100 I. M. M. screen has a hundred meshes to the linear inch each strand being one two-hundredths of an inch in diameter and each hole being a square one two-hundredths of an inch across.

It has been found that when using a bath, e. g. a solution of calcium chloride, of specific gravity 1.4, a satisfactory separation of a high proportion of a component having an extremely low content of ash-forming ingredients can be obtained from small coal. If the specific gravity is increased to 1.5, the proportion of material which floats is substantially increased and although the proportion of ash-forming ingredients therein is also higher, it is yet small enough to enable the float to constitute a very valuable cleaned product. The employment of solutions of calcium chloride having a specific gravity as high as 1.5 is, however, attended with some difficulty since solutions of this concentration are of high viscosity and are liable to crystallize.

It has been found that the slight upward current in the liquor of the separating bath gives very substantially the effect of an increased specific gravity, without the compensating disadvantages which would be produced by employing a more concentrated solution. Further, the employment of an upward current in the bath liquor results in a more rapid accumulation of floated material, and in consequence a higher output of clean coal per hour is obtained.

Moreover the employment of an upward current enables the floated coal to be carried off continuously from the top of the bath in a liquid stream, from which the excess of liquor can readily be separated, and returned to the bath.

The upward current in the bath liquor can be produced in various ways. Thus, in the apparatus described in the prior British patent speci-

fication No. 286,723 referred to above, as inlet for liquor may be provided on, or just above, the conical lower end of the separator. The coal to be separated may be fed through this inlet into the separator with the aid of a stream of bath liquor. This produces an upward current in the bath and also facilitates distribution of the coal in the separator.

The method of feeding the coal to the bath by means of a current of liquor is of advantage in various directions. Thus, the rate of feed of the coal may be controlled entirely by the rate of feed of the liquor. On shutting off the liquor flow completely, the coal feed is arrested. In consequence, by employing a current of bath liquor in the coal inlet, it has been found possible to dispense entirely with other positive means for feeding the coal. Thus the coal feed may consist simply of a tube attached to the wall of the separator into the upper end of which coal and liquors are supplied through suitable chutes or pipes. The coal passing from the chute is carried down the inlet pipe by means of the current of bath liquor and distributed in a satisfactory manner across the separator. The inlet is most suitably situated at or about the middle of the separator.

The liquor which passes upwards through the bath is utilized in carrying off the material which floats and this material, before treatment for final recovery of bath liquor, may be allowed to pass over suitable strainers or screens, for example, a wedge wire screen, for the purpose of separating the excess amount of bath liquor and returning this to the bath at a lower point by means of a circulating pump.

Scrapers are most suitably employed for carrying away the coal from the top of the bath. These scrapers may be arranged to scrape the strainer or screen to prevent blockage, e. g. by providing suitable wipers thereon. The strainer or screen is most suitably sloped towards the separator so that it can be kept flooded by the liquor, without allowing an excessive amount of liquor to be carried away with the coal.

The liquor passing through the screens or strainers falls into a suitable sump whence it is removed by a circulating pump by which it can be delivered again to the bath at a point below the coal inlet. By thus passing this liquor up through the bath again the upward current is maintained. Such upward current may be assisted by the liquor introduced with the material, when this is fed in with the aid of a current of liquor. The liquor thus circulates through the bath and may carry with it some of the finer particles passing out of the bath with the floated material, but this is no disadvantage.

The invention includes apparatus suitable for carrying out the process of separation described above, consisting of a separating vessel to contain the gravity separating liquid, an inlet for feeding in materials to be separated, an outlet at the bottom for removal of the sink, an inlet for bath liquor to produce an upward current in the bath, a sloping grid adjacent the upper surface of the liquid and scraper means to carry the float over the grid for drainage of the bath liquor overflowing therewith.

A preferred form of the invention will now be described with reference to the accompanying drawing in which:—

Figure 1 is an elevation of the gravity separator.

Figures 2 and 3 are front and side views of the

sensitive element of the automatic device for control of the liquid level.

In the drawing 1 is the gravity separator which is filled with an aqueous solution of calcium chloride. Coal to be separated is fed from a hopper (not shown) into the inlet 2. Here it meets a stream of bath liquor fed down a central pipe 3 by a pump 4 and is carried into the gravity separator 1 at a point 5. The heavy material sinks into the conical bottom 6 and is removed by an elevator 7 to be dealt with for recovery of the bath liquor. The lighter material floats to the top and is carried off by a scraper arrangement 8 over an inclined grid 9 preferably of wedge wire by which the excess of bath liquor is drained into the sump 10. From the sump 10 it is drawn from the outlet 11 by the pump 12 and delivered to the gravity separator at 13, producing an upward current therein. From another outlet 14 in the sump 10 liquor is drawn by the pump 4 for the coal feed. Additional liquor may be fed to the pump 4 and/or the pump 12 through the line 15 if desired, e. g. drained from the sink, or obtained from a suitable supply tank.

The liquor removed from the bath by the float and sink and not drained therefrom is replaced by liquor fed in through the make-up pipe 16. The amount fed in is required to maintain the level of liquid in the separator at the desired height and to maintain as constant as possible the desired upward current in the bath. It is accordingly regulated by a valve 17 which may be controlled as shown by automatic means. These means may suitably comprise a fluid actuated operating member of the plunger type 18, actuated by fluid such as oil from pipes 19 and 20 passing through a regulator 21. The opening and closing of the regulator 21 is governed by the head of liquor in a column. This in turn is governed by a pressure sensitive member 23 housed in a flanged projection 24 from the wall of the vessel 1. This member 23 consists essentially of a membraneous bag e. g. of rubber on a tube sealed at 26.

A fall in level of the liquid in the gravity separator 1 causes a lowering of pressure and the member 23 inflates by its consequent increase in volume and reduces the head of liquid in 22, actuating the regulator 21 accordingly. The heads of liquid in 1 and 22 thus move in sympathy without direct communication therebetween, and the supply of liquor from pipe 16 is governed accordingly.

During the passage of the coal over the grid 9 a portion of the bath liquor is removed therefrom and is received in sump 10. To prevent blockage of the grid, especially when separating duff or other fine materials, wipers 27 of rubber may be attached to the arms 29 of the scraper device 8. The coal is delivered from the chute 28 to a suitable conveyor for transport to the liquor recovery apparatus (not shown).

The apertures of the grid need not be so fine as to prevent all the coal from passing there-through since the liquor draining off is returned to the bath.

By way of example we may mention results obtained when working with small coal of high ash content passing through a $\frac{3}{8}$ " screen, but substantially free from material passing a 50 I. M. M. sieve. A still liquor of 1.385 specific gravity yielded 48.0% of floated material of an average ash content of 1.65%. By employing a still liquor of 1.45 specific gravity, the yield of float was increased to 68.5% while the average ash content thereof was only increased to 2.86%.

When employing a bath liquor of 1.385 specific gravity and an upward current having a velocity of 10 inches per minute, it was found that the proportion of float was 68.0% of an average ash content of 2.69%. Thus, the result obtained with a liquor of 1.385 specific gravity and an upward velocity of 10 inches per minute is comparable with the result obtained with a still liquor of specific gravity 1.45.

The above figures are given by way of example only and will obviously depend upon the properties of the coal treated, as well as its source. The actual figures required in any particular case can readily be ascertained by small scale tests.

The amount of liquor required to feed in the coal may not suffice to produce velocities above about one half of a foot per minute. It may produce an upward current of a useful velocity but in most cases it will be advisable to provide an additional liquor inlet situated below the coal inlet.

The magnitude of the upward current may be varied to suit the circumstances of the moment. Thus, if the specific gravity of the bath liquor is varied for any reason, this can be compensated for by a suitable adjustment of the upward current of the liquor. Again, the upward current need not be uniform throughout the whole of the bath, since, if desired, liquor may be introduced at the bottom of a separator, having a conical lower end where the cross section is least, producing at this point a relatively high upward current which may assist in the separation of the last portions of lighter constituents carried down with the sink. It is necessary that at the point above which the coal is fed in, the upward current shall not be less than is required to permit the flotation of a cleaned coal of the required specific gravity.

The cross-sectional area of the separator must be taken into consideration in determining the points at which to introduce the liquor. It may be desirable in certain cases to modify the construction of the separator with these considerations in view. Thus, a suitable separator might taper outwardly from the bottom to the point of introduction of the material and be of uniform or even reduced cross-section above this point.

In order to vary the velocity a removable element may be inserted in the separator which will reduce the cross-sectional area available to the liquor. For this purpose a sleeve may be rigidly or adjustably mounted in the separator or a fixed or movable conical or cylindrical element suspended therein.

In operating the process according to the present invention, it may be desirable to conduct the separation of the raw material in a still bath or a bath with a small upward current and then utilize the material which sinks as the raw material in another separator operating with a higher upward current of bath liquor. By the employment of two or more separators in series in this manner several components may be separated from the raw material.

Instead of employing a substantially steady or continuous upward current the upward current may be intermittent or pulsating. For this purpose the pump or pumps may be constructed and operated to deliver the liquor to the bath at the desired rate of pulsation or suitable reciprocating means may be produced, so that, however, an upward current is maintained at all times.

We declare that what we claim is:

1. A continuous process for the separation of coal into heavier and lighter fragments by subjecting it to gravity separation in a bath comprising an aqueous solution of calcium chloride whose specific gravity is such that the heavier particles tend to sink and the lighter particles tend to float, which consists in continuously feeding calcium chloride solution in at a lower point in said bath to maintain therein an upward current of controlled magnitude exceeding about one-half of a foot per minute, continuously introducing the coal to be separated below the level of said aqueous solution with the assistance of a stream of calcium chloride solution, maintaining the level of liquid in said bath constant by providing automatic regulation of said calcium chloride solution fed in at a lower point by means governed by the depth of liquid in said bath, continuously removing material which floats and continuously removing material which sinks.

2. A continuous process for the separation of carbonaceous materials into heavier and lighter fragments by subjecting said materials to gravity separation in a bath comprising an aqueous solution whose specific gravity is such that the heavier fragments tend to sink and the lighter fragments tend to float, which consists in continuously introducing materials to be separated into said bath, continuously removing fragments which float, continuously removing fragments which sink, maintaining in the liquid of the bath an upward current by continuously feeding liquid to the bath through a liquid inlet at the lower part thereof and controlling the liquid inlet by the depth of liquid in the bath so as to maintain said depth constant.

3. A continuous process for the separation of coal into heavier and lighter fragments by subjecting said coal to gravity separation in a bath comprising an aqueous solution of calcium chloride whose specific gravity is such that the heavier fragments tend to sink and the lighter fragments tend to float, which consists in continuously introducing said coal below the level of said aqueous solution with the assistance of a stream of calcium chloride solution, continuously feeding calcium chloride solution into said bath at a lower point to maintain therein an upward current of controlled magnitude exceeding about one-half of a foot per minute, continuously removing fragments which float, continuously removing fragments which sink and maintaining the level of liquid in said bath constant by providing automatic regulation of said calcium chloride solution fed in at a lower point by the depth of liquid in said bath.

4. In apparatus for the separation of carbonaceous materials into heavier and lighter fragments by flotation in a bath of liquid of specific gravity intermediate between the specific gravity of the fragments to be separated, a liquid inlet at the lower part of said bath, a device adapted to be actuated by pressure of liquid situated at a point below the surface of the bath, means connecting such pressure actuated device and said inlet to control the flow of liquid through said inlet and maintain a predetermined level in the bath and means for continuously removing fragments which float.

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