METHOD OF PRODUCING A SEPARATING SUSPENSION

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The present invention relates to methods of producing a separating suspension. The application is a continuation-in-part of the application of Maximilian G. Driessen and Freerk J. Fontein filed April 23, 1946, Serial No. 664,549, for Methods of Producing a Separating Suspension, and now abandoned.

Many separating procedures utilize suspensions having a specific gravity between certain limits. For example, in the sink-and-float treatment used during the washing of coal, a suspension bath is provided having a specific gravity between that of the coal and that of the slate or rock. Many different kinds of particles are used for such suspensions, for example, liquor, water, carbon tetrachloride, naphtalene, and hydrocarbons. The particles used for the suspension frequently are not available at the mine or plant where the suspension is to be used and sometimes they must be obtained from quite distant points so that their shipment involves considerable expense.

An object of the present invention is to enable use of the refuse of separating apparatus as the suspension particle. For example, by the present invention, the slime tailings of a froth-floatation separator may be used as the suspension particles.

Referring in more detail to the advantages obtained by use of the refuse of a froth-floatation separator as suspension particles, it will be appreciated that most plants for separating ores or raw coal include froth-floatation separators. For example, most large coal mines include large washeries divided among several buildings erected at various times. For example, a coal mine may have begun operation to exploit a high quality coal seam so that washing was not required. Later on, a washery may have been built, first a simple washery which, by further additions, became more complicated. Thus, while the mine eventually still may have a single coal washing plant, the plant has become sub-divided into several units, each of which is in itself a washery. The raw coal will be screened near the mining shaft, the nut sizes probably will be washed near the screens, while the fines resulting from the screening will be taken to one of the units to be separated by froth-floatation. In any event, the mine washery includes a froth-floatation separator, and a purpose of the present invention is to use the slime tailings from such a separator for the suspension medium in the sink-and-float process forming part of the washing plant.

Other objects and advantages of the invention will be apparent from the following specification and accompanying drawing wherein.

Figure 1 is an axial section of a hydrocyclone such as may be used in the process of the invention, and

Figure 2 diagrammatically shows the procedure of the invention as applied to treatment of raw coal.

In the preparation of a suspension in accordance with the invention, use is made of a hydrocyclone 10 such as shown in Figure 1. Hydrocyclone 10 includes a shallow top 11 including a base plate 12 having an axial opening 13. An infed supply pipe 14 opens tangentially to the portion 11. Beneath and concentric with portion 11 is a co-axial conical portion 15 provided with an axial apex opening 16.

Hydrocyclones of the above type heretofore have been used in the thickening of suspensions. Maximilian G. Driessen et al. Patent No. 2,543,689, issued February 27, 1951, for Process for the Separation of Solids of Different Specific Gravity and Grain Size, the application for which was filed of even date with the above identified original application, discloses use of such a hydrocyclone for the separation according to specific gravity of particles of different grain size and different specific gravity if there is added to a suspension of such particles a quantity of relatively fine particles of high specific gravity. In the absence of such relatively fine particles, the larger particles of the lighter constituent in a suspension will leave the apex opening of the hydrocyclone with the particles of high specific gravity, a condition which cannot be tolerated in practical operation.

We have discovered that when a suspension of the slime tailings of a froth-floatation apparatus or similar separator is supplied under pressure to a hydrocyclone, perhaps with previous addition of water, the hydrocyclone not only separates the infed according to specific gravity but also discharges the undesired very fine particles with the light fraction at the base aperture 17 of the hydrocyclone and discharges the heavier fraction, minus the undesired fine particles, through the apex opening 16. This is accomplished without the above-mentioned addition of relatively fine particles of high specific gravity because the slime tailings or other refuse already contain a high percentage of fine particles of relatively high specific gravity. Thus, in accordance with the invention, the apex discharge comprises a fraction of relatively high ash content and formed of particles within the desired size limits. Furthermore, no screening is necessary to eliminate the undesired fine particles, the ash content and size range factors being determined in a single pass through the hydrocyclone.

Figure 2 diagrammatically illustrates the application of the present invention to a coal washing plant. As is indicated in the upper portion of Figure 2, a mixture of raw coal and water is delivered to a screen or other classifier 20. For example, the raw coal may be delivered at the rate of two hundred tons per hour, and if a screen of thirty-two mesh is used, forty tons of screenings containing fine particles will leave the apparatus 20 by the line 21. The larger particle will leave apparatus 20 by the line 22 to move to the sink-and-float bath 23. With the above rate of infed, one hundred sixty tons of material per hour will move through the line 22.

The material moving through line 21 will be delivered to the froth-floatation apparatus 24 which will separate the infed into thirty-two tons of coal per hour which outfeeds through the line 25 while eight tons per hour of waste fines of slime tailings move through the line 26. The line 26 may be provided with a flow divider to enable some of the flow therethrough to be discharged to waste by a line 27. For example, a portion of the slime tailings as desired will be moved past the flow divider to a pump 28 which delivers its output at a pressure of the order of twenty-five pounds per square inch through the infed line 14 to cyclone or hydrocyclone separator 10. Hydrocyclone 10 may have a maximum diameter of fourteen inches, an overall height of twenty inches and an apex opening one-half inch in diameter. As is indicated by the dotted line 29, water may be added to the hydrocyclone infed between the flow divider and pump 28.

With hydrocyclone 10 operating in accordance with the principles mentioned above and described in said Driessen et al. patent fine light particles will be discharged from the base opening 13 of hydrocyclone 10 and may move through line 30 to waste. The larger heavy particles will be discharged from the apex opening 16 to move by a line 31 for the purpose hereinafter described. The outputs of hydrocyclone 10 are subsequently described.

Referring again to the line 22, the line 60 tons per hour of coarse particles moving through the line 22 to sink-and-float bath 23, these will be separated by the action of the suspension in the bath, which suspension may have a specific gravity of 1.53. In accordance with the invention, the coal particles will be moved from the upper portion of one end of the bath and on to a screen 32 while the waste particles from the lower portion of the bath will be moved from the opposite end of the bath and on to a screen 33. Water from heads 34 will be sprayed upon both screens, the heads 34 being connected to a water supply line 35. Each screen also will have
a second head 36 associated therewith, this head receiving water from a source hereinafter described. Compartments 37 and 38 are provided below the respective screens 32 and 33, and the water and fine particles falling through the screens will move from these compartments by lines 39 and 40 to a pump 41 which delivers the mixture of fine particles and water by a line 42 to a hydrocyclone 43 of the thickener type. The coal moving off the screen 32 will be collected and the waste moving from the screen 33 may be discarded.

With the process described above, the washings obtained in the compartments 37 and 38 obviously will be diluted suspension with a specific gravity of the order of 1.1. If the suspension in the bath 23 is to be maintained at 1.55, this diluted suspension must be thickened to that specific gravity before it is returned to bath 23. The fact that the coal and waste moving from the screens 32 and 33 will have some suspension particles adhering thereto will result in a loss of thirty-five hundred pounds of weighting or suspension material per hour. In other words, if this sprayed-off suspension is not replaced, new suspension must be added regularly to the bath 23. The waste fines or slime tailings moving through line 26 cannot be directly used for that purpose as they contain only about 60% of ash, and approximately 50% by weight of this is smaller than 50 microns.

In order to replace the above-mentioned thirty-five hundred pounds per hour of weighting material, five tons per hour of the slime tailings can be pumped into the hydrocyclone separator 10. This will result in discharge from the apex 16 of thirty-five hundred pounds of solids per hour with an average ash content of 80%, 78% by weight of this being of a size greater than 50 microns but naturally smaller than the mesh of screen 20. Because line 31 leading from the apex 16 of hydrocyclone 10 is connected to line 39, the apex discharge may move through the pump 41 to the hydrocyclone thickener 43 which will be operated to produce an apex discharge having the required specific gravity of 1.55. This apex discharge will move through the line 44 to the bath 23. The base discharge of thickener 43 will be primarily water and may move by lines 45 and 46 to the spray heads 36.

The base discharge of separating hydrocyclone 10, consisting of water, light particles and very fine particles, may be discharged through line 30. If all of the material moving through the line 39 to pump 41 is not required, a valve 47 may be suitably operated to discharge some of it to waste through a line 46.

It will be observed that the invention, results in the attainment of the objects stated above in that it permits lost suspension particles to be replaced by particles obtained from the raw coal itself and by use of the usually convenient froth-flotation apparatus. Thus, no foreign weighting material has to be used in the suspension. Moreover, the plant is quite simple, requiring but one specific gravity regulator for the bath, namely, the thickener 43.

It will be apparent that the process is applicable to material other than raw coal.

The terminology used in the specification is for the purpose of description and not of limitation, the scope of the invention being defined in the claims.

We claim:

1. The method of separating raw coal according to a predetermined specific gravity comprising the steps of removing fines from the raw coal, subjecting the remaining raw coal to sink-and-float separation in a suspension bath of said predetermined specific gravity and formed by fine particles and liquid, subjecting the fines removed from the raw coal to froth flotation to separate the same into fine coal and waste, treating the waste so obtained by hydrocyclone separation to remove therefrom very fine particles and particles of a specific gravity lower than that required to maintain the sink-and-float bath at said predetermined specific gravity, and delivering the remaining fraction of said waste to the sink-and-float suspension bath to replace losses therefrom.

2. The method of claim 1, wherein the coal and shale removed from the suspension bath is washed; said remaining fraction of treated waste is mixed with said washings, the resultant mixture is thickened to obtain a fraction of said predetermined specific gravity, and said thickened fraction is then delivered to the suspension bath.

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