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FROTH BREAKING

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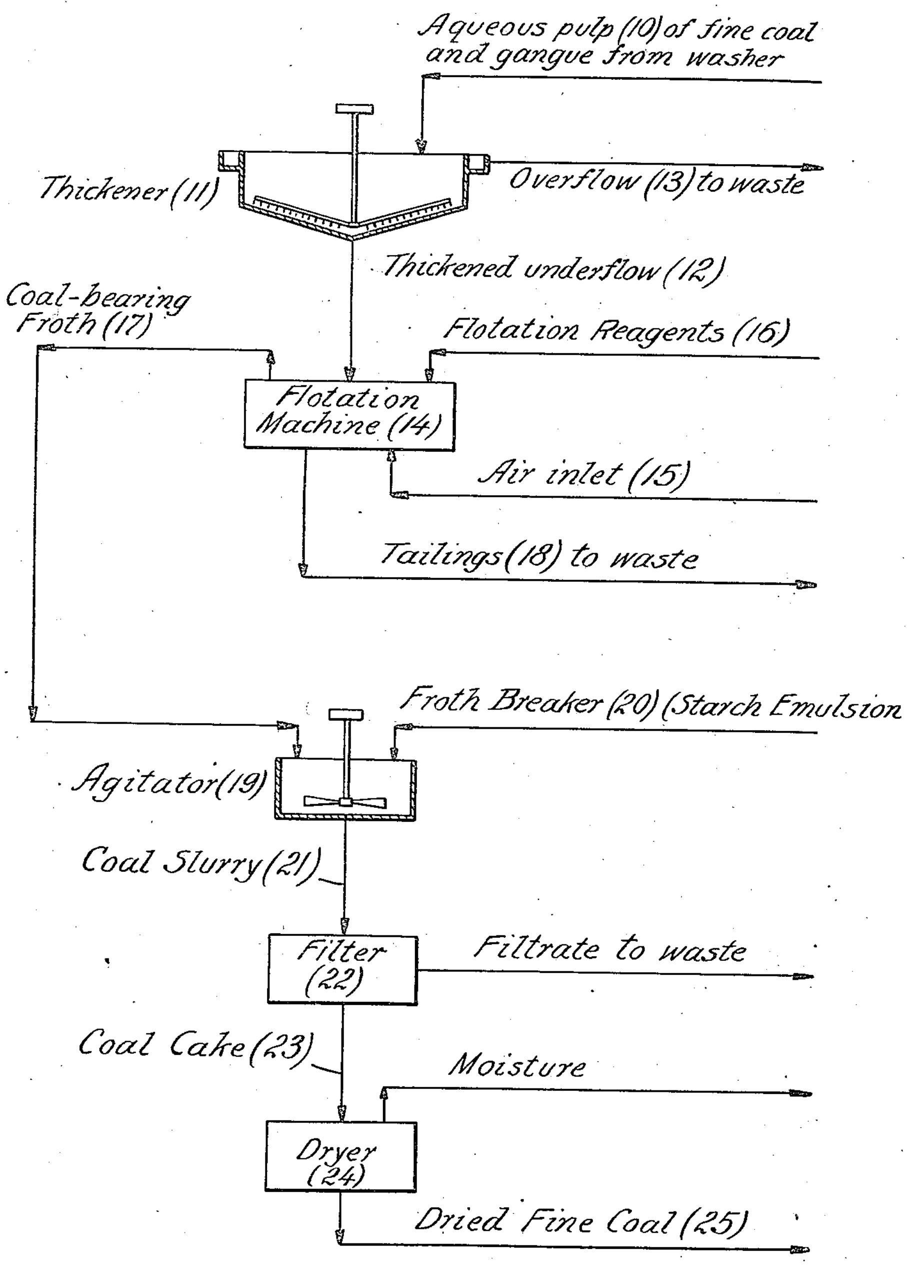

INVENTOR
Philip M. Frantz
BY
Pennie, Davis, Marvin and Edmonds
ATTORNEYS

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FROTH BREAKING

Philip Morhiser Frantz, Pueblo, Colo., assignor to The Colorado Fuel and Iron Corporation, Denver, Colo., a corporation of Colorado

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14 Claims. (Cl. 252—321)

This invention relates to breaking froth and particularly mineral-bearing froths derived in ore dressing and the like.

In the concentration of minerals by froth flotation, a froth is formed which comprises gas-filled bubbles coated with a film of collecting agent with mineral particles adhering thereto. The froth usually is formed by aeration of an aqueous suspension or pulp of a mineral aggregate in the presence of one or more flotation agents which usually are of soapy or oleaginous character. The froth forms on top of the pulp and is removed therefrom by simple overflow or by skimming or sluicing. The froth usually contains considerable entrained water.

The froth, once it is separated from the pulp, ordinarily is subjected to further treatment including a de-watering or filtration operation. If the froth is very tenacious and resists destruction by agitation and the like, de-watering, filtration and other subsequent operations are conducted with difficulty. Thus, a persistent froth may result in an unsatisfactory filter cake.

The froth formed in the flotation of fine coal and other non-metallic minerals is often most tenacious and is de-watered or otherwise treated to reduce its bulk with great difficulty. As a result of my investigations, however, I have discovered that the incorporation of a starch emulsion into tenacious froths results in destruction of bubbles and in conditioning the froth so that even upon subsequent aeration the bubbles do not re-form to a substantial extent. I have found, further, that froths so treated are much more amenable to filtration and the like.

Thus, in a process involving the formation of a froth comprising gas-filled bubbles coated with a collecting agent to which mineral particles adhere, my invention contemplates breaking said froth by incorporating an aqueous starch emulsion therein. I have found, further, that the presence of an acid or base in the emulsion, so that the latter is not neutral and has a pH other than 7, aids greatly in froth breaking.

The emulsion is made conveniently by boiling flour or other material of high starch content in water, and thereafter adding to the resulting paste an acid or base. Any suitable water-soluble base, such as alkali metal hydroxides, ammonium hydroxide, or calcium hydrate may be employed to alkalize the paste. Ordinarily, however, best results from the standpoints of cost of operation and performance will be obtained through the use of sodium hydroxide. Any suitable acid or acid-containing constituent may also be employed. Thus, I have found that acetic acid, strong mineral acids, such as nitric acid, hydrochloric acid, and sulfuric acid, and organic acids, and acid-containing substances such as cresylic acid, creosote, tar acids and crude or refined phenols, may be used advantageously.

I have found further that a starch of high protein content is particularly desirable when formed into an emulsion. Thus, wheat flour containing an excess of 10% protein or bean flour containing in the neighborhood of 21–22% protein are much more effective in emulsion form than is pure starch.

The amount of froth breaking reagent to be employed bears a direct relationship to the amount of flotation reagent present in the froth. The reagent apparently reacts in some way with most oleaginous or soapy connecting agents to form new compounds which do not tend to maintain froth. In any case, as the amount of flotation reagent in the froth is increased, the amount of froth breaking reagent needed must also be increased, but an excess of froth breaking reagent over and above that necessary to accomplish adequate froth destruction does not result in improvement and represents a waste. The amount of froth breaking reagent necessary will vary somewhat depending upon the nature of the flotation reagent employed. Generally speaking, however, the proportion of froth breaking reagent necessary is always less than the flotation reagent consumed, and, in fact, the amount of starch employed in froth breaking need not exceed $\frac{1}{10}$ of the weight of the collecting agent consumed.

These and other aspects of my invention will be more thoroughly understood in the light of the following detailed description of presently preferred practices thereof, taken in conjunction with the accompanying single figure which is a flow sheet of a coal flotation operation embodying the practice of my invention.

Referring now to the figure, it will be observed that an aqueous pulp **10** of fine coal mixed with gangue material and a large proportion of water (derived from customary coal washing operations) is passed to a Dorr thickener **11** of conventional construction. The coal and contaminating gangue materials tend to settle in the thickener and are removed as a thickened underflow **12**. An aqueous overflow **13** containing substantially no coal is derived from the thickener and sent to waste.

The coal-bearing underflow from the thickener is sent to a coal flotation apparatus **14** which may be any suitable froth flotation machine and is there agitated and aerated by means of air introduced through a conduit 15. Appropriate flotation reagents 16, usually of oleaginous character, are also introduced into the flotation machine and a coal-bearing froth 17 is formed in the conventional manner. The froth is removed from the flotation machine by sluicing or skimming and the tailings 18 pass out of the machine and are sent to waste.

A great variety of oleaginous or soapy flotation agents may be employed in the treatment of the coal. In one instance, the flotation reagent employed was a paraffin base crude oil diluted with kerosene to which had been added 10% by weight of creosote. Another suitable reagent comprises coal tar distillate having a gravity of about .825 to which is added 5% by weight of tar acids. Such reagents may be employed appropriately in the treatment of a coal-bearing pulp containing about 18% solids having the following screen analysis:

Mesh	Weight	Weight	Cumulative weight
		Per cent	Per cent
+14	1.0	.34	.34
14+35	10.0	3.42	3.76
35+65	40.3	13.80	17.56
65+100	67.5	23.10	40.66
100+150	26.0	8.90	49.56
150+200	20.2	6.85	56.41
200	127.0	43.50	99.91
	292.0	99.91	

In treatment of such pulp the flotation reagent consumption is about 2.8 lbs. per ton of solids, and the froth derived is a very tenacious one, which cannot be destroyed by agitation, because the bubbles broken in agitation tend to be re-formed. However, destruction of such a froth is facilitated and subsequent operations such as filtration are improved if the froth is treated with a starch emulsion.

The emulsion may be made conveniently by boiling one part of flour, preferably of high protein content, in 100 parts of water. To this boiling mixture, there is added one-half part of an acid or alkali (say acetic acid or sodium hydroxide) in a hot concentrated aqueous solution.

Very small proportions of such an emulsion are necessary for adequate froth destruction. Thus, I have found that with froth formed in the foregoing manner it is sufficient to employ about .13 lb. of flour and .065 lb. of caustic per ton of solids in the froth.

The ratio of starch to water and caustic or acid employed is not critical. However, in general, it will be found that an emulsion made of one part of flour or starch, 100 parts of water and about one-half part of acid or alkali will produce a very satisfactory reagent and one which is thin enough to be incorporated easily into the pulp.

As indicated hereinbefore, a great variety of alkalies and acids may be employed. I have found that the best reagents to employ with the starch or flour are, in the order of their efficiency, caustic soda, acetic acid and crude creosote.

The froth-breaking reagent may be added to the froth in any appropriate manner which assures thorough distribution therein. Thus, the reagent may be introduced into the froth as it flows, usually with additional sluicing water, in a launder from the flotation machine. Good results may also be obtained by introducing a large batch of the froth into a tank into which the froth-breaking reagent is also introduced, the whole being agitated for a short period of time, say five minutes. Ordinarily, however, it is better to break the froth in a continuous operation by passing it continuously through a small agitator 19 to which the froth-breaking reagent 20 in appropriate proportion is continuously supplied.

As indicated hereinbefore, the higher the protein content of the starch within limits, the more effective is the froth-breaking reagent in which the starch is incorporated. Thus, I have found that bean flour made by comminution of navy beans and containing about 22% protein is approximately twice as effective in froth-breaking as is a low-grade wheat flour containing about 12% protein, and in the practice of the invention, I prefer to employ a material containing at least 10% of protein on the weight of the starch.

The use of the froth-breaking reagent in the treatment of flotation pulps results in a great improvement in filtration operations conducted upon the solids present in the froth. Thus, I have found that when the coal froth made as described hereinbefore is treated on a continuous filter without use of the froth-breaking reagent, a very soft wet cake is formed and the filtration rate is very slow. The resulting cake contains about 39% moisture. On the other hand, when an identical froth is treated on identical apparatus after incorporation of the froth-breaker, I find that the broken froth filters approximately four times as fast and forms a hard dense filter cake containing only 34% water.

The use of the froth-breaking reagents in accordance with my invention perhaps offer greatest advantages in the treatment of froths of non-metallic minerals, such, for example, as flotation froths containing rock phosphates, fluorspar, or other non-metallic minerals. However, the process of my invention is also applicable to the destruction of flotation froths of minerals of metallic surface, such as those derived from the concentration of sulfide ores of copper, zinc, and the like. But the collecting agents employed in the flotation of sulfides, and the like, seldom result in a tenacious froth.

I have found that, generally speaking, acid froths or froths derived from acid pulps break more easily than do froths derived from basic or neutral pulps. Likewise, alkaline froths or froths derived from alkaline pulps break more easily than do neutral pulps. Consequently, for most effective practice of my invention, the pulp from which the froth is derived should be maintained with a pH that is definitely off the neutral point, i. e., above or below 7, and the froth-breaking reagent should be acid in the event that the pulp is acid and vice versa. However, the amount of froth-breaking reagent employed is ordinarily insufficient to bring about any substantial change in the pH of the froth.

As shown in the flow sheet, coal slurry 21 resulting from incorporation of the froth-breaking reagent in the froth is subjected to filtration on a filter 22 such, for example, as an Oliver filter, a Dorrco filter, or an American leaf-type filter. Filter cake 23 from this operation is subjected to drying in any suitable dryer 24 and the dried fine coal 25 is ready for market.

I claim:

1. In a process involving the formation of a froth comprising gas-filled bubbles coated with a collecting agent to which mineral particles are adhering by aeration of an aqueous mineral-bearing pulp containing the collecting agent, the improvement which comprises incorporating in said froth an aqueous starch emulsion of high protein content and thereby destroying the froth.

2. In a process involving the formation of a froth comprising gas-filled bubbles coated with a collecting agent to which mineral particles are adhering by aeration of an aqueous mineral-bearing pulp containing the collecting agent, the improvement which comprises incorporating in said froth an aqueous starch emulsion having a protein content of at least 10% on the weight of the starch.

3. In a process involving the formation of a froth comprising gas-filled bubbles coated with a collecting agent to which mineral particles are adhering by aeration of an aqueous mineral-bearing pulp containing the collecting agent, the improvement which comprises incorporating in said froth an aqueous starch emulsion derived from bean flour.

4. In a process involving the formation of a froth comprising gas-filled bubbles coated with a collecting agent to which mineral particles are adhering by aeration of an aqueous mineral-bearing pulp containing the collecting agent, the improvement which comprises incorporating in said froth an aqueous starch emulsion derived from wheat flour containing at least 10% by weight of protein.

5. In a process involving the formation of a froth comprising gas-filled bubbles coated with a collecting agent to which mineral particles are adhering by aeration of an aqueous mineral-bearing pulp containing the collecting agent, the improvement which comprises incorporating in the froth an alkaline aqueous starch emulsion.

6. In a process involving the formation of a froth comprising gas-filled bubbles coated with a collecting agent to which mineral particles are adhering by aeration of an aqueous mineral-bearing pulp containing the collecting agent, the improvement which comprises incorporating in said froth an acid aqueous starch emulsion.

7. In a process involving the formation of a froth comprising gas-filled bubbles coated with a collecting agent to which mineral particles are adhering by aeration of an aqueous mineral-bearing pulp containing the collecting agent, the improvement which comprises incorporating in said froth an aqueous starch emulsion containing alkali metal hydroxide.

8. In a process involving the aeration of an aqueous mineral-bearing pulp in the presence of a collecting agent to form a froth comprising air-filled bubbles coated with the collecting agent to which the mineral particles are adhering and the separation of said froth from said pulp, the improvement which comprises subsequently subjecting said froth to the action of an aqueous starch emulsion.

9. In a process involving the aeration of an aqueous mineral-bearing pulp in the presence of a collecting agent to form a froth comprising air-filled bubbles coated with the collecting agent to which the mineral particles are adhering and the separation of said froth from said pulp, the improvement which comprises subsequently incorporating in said froth an aqueous starch emulsion and thereafter subjecting the resultant product to filtration.

10. In a process involving the aeration of an aqueous mineral-bearing pulp in the presence of a collecting agent to form a froth comprising air-filled bubbles coated with the collecting agent to which the mineral particles are adhering and the separation of said froth from said pulp, the improvement which comprises maintaining a pH other than 7 in said pulp and incorporating in the froth after separation an aqueous starch emulsion.

11. In a process involving the aeration of an aqueous mineral-bearing pulp in the presence of a collecting agent to form a froth comprising air-filled bubbles coated with a collecting agent to which the mineral particles are adhering and the separation of said froth from said pulp, the improvement which comprises subsequently adding an aqueous starch emulsion to said froth and subjecting the resultant mixture to agitation to distribute the emulsion therethrough.

12. In a process involving the aeration of a mineral-bearing pulp in the presence of an oleaginous collecting agent to form a froth comprising air-filled bubbles coated with the oleaginous agent to which mineral particles are adhering, the improvement which comprises treating the froth after separation thereof from the pulp with an aqueous starch emulsion having a pH other than 7.

13. In a process involving the aeration of a mineral-bearing pulp in the presence of a collecting agent with resultant formation of a froth comprising gas-filled bubbles coated with the collecting agent to which the mineral particles adhere, the improvement which comprises incorporating in the froth after separation from the pulp an aqueous starch emulsion, the weight of starch in the emulsion thus incorporated being substantially less than the weight of the collecting agent employed.

14. In a process involving the formation of a froth comprising gas-filled bubbles coated with a collecting agent to which mineral particles are adhering by aeration of an aqueous mineral-bearing pulp containing the collecting agent, the improvement which comprises incorporating in said froth an aqueous starch emulsion containing a strong mineral acid.

PHILIP MORRISER FRANTZ.