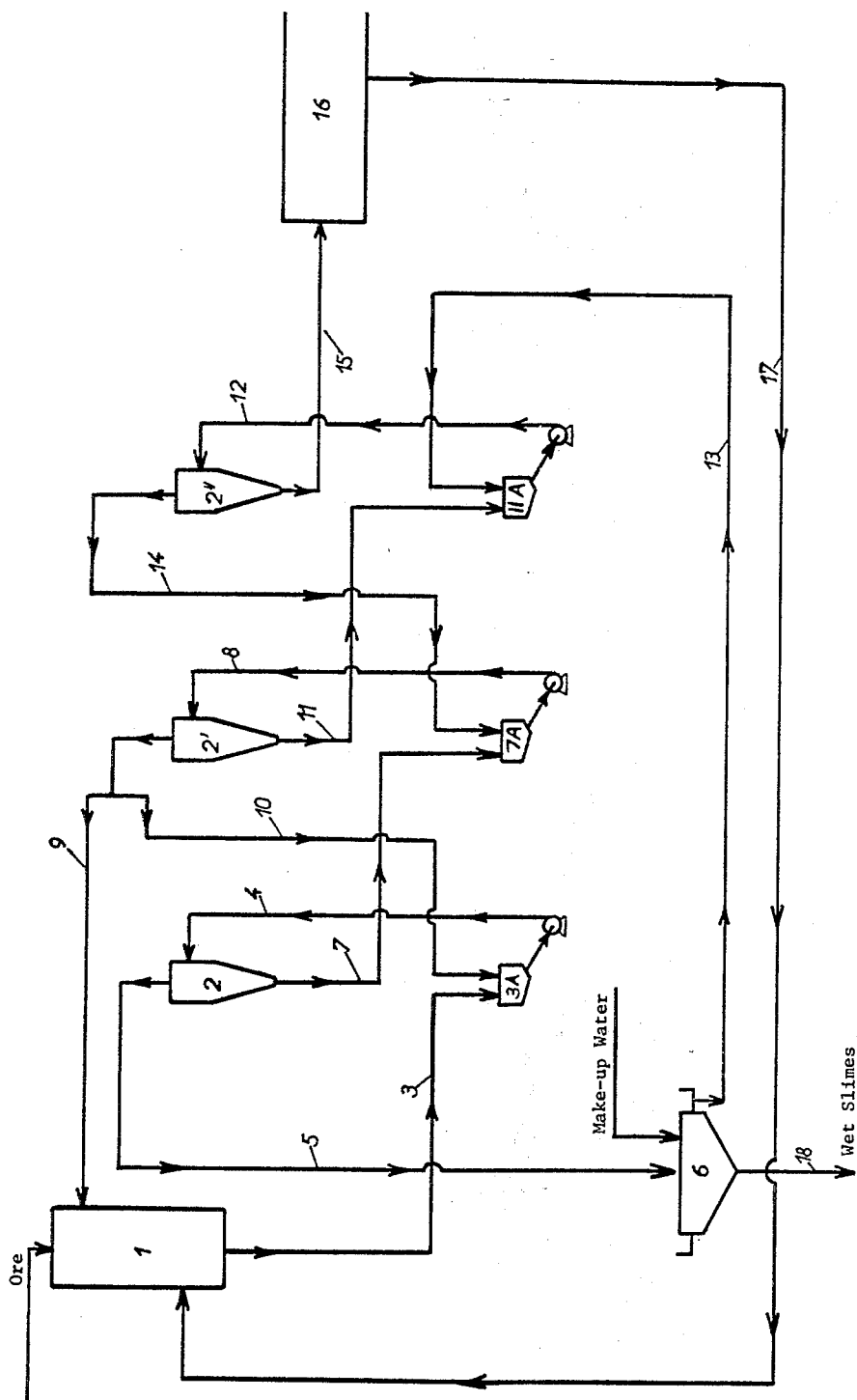


Dec. 23, 1969

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METHOD FOR THE TREATMENT OF ORES CONTAINING
SLIME-FORMING IMPURITIES
Filed April 8, 1968

3,485,356



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METHOD FOR THE TREATMENT OF ORES CONTAINING SLIME-FORMING IMPURITIES

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Filed Apr. 8, 1968, Ser. No. 719,341

Claims priority, application France Apr. 11, 1967, 102,219

Int. Cl. B03b 1/00; B03d 3/00

U.S. Cl. 209—3

7 Claims

ABSTRACT OF THE DISCLOSURE

In the desliming of ore, such as sylvinitic, using serially connected cyclones, the improvement of utilizing recycle techniques to reduce the quantity of overflow liquid which must be clarified.

This invention relates to the wet separation of solids in cyclones. It is particularly applicable to the pretreatment of ores for the removal of slimes, and is of special advantage for ores which are to be concentrated by flotation.

Any metallic or nonmetallic ore contains variable proportions of gangue comprising impurities of different kinds and mainly insoluble clay-like minerals. By comminution, at least a portion of such impurities are liberated and tend to form slimes when the ore comes into contact with an aqueous solution. The slimes hinder any wet beneficiation procedure, especially the concentration of ores by flotation. When large amounts of slimes are present, the separation by flotation of the different ore constituents is not economically feasible. Even when relatively low quantities of slimes are present, they deleteriously affect the separation by decreasing the flotation yields and/or the content of valuable constituents in the flotation concentrates. Furthermore, slimes absorb flotation reagents (collectors, frothing agent, etc.) which inordinately increases the reagent consumption thereby significantly increasing the flotation cost.

To avoid or substantially reduce the disadvantage resulting from the presence of slimes during ore concentration treatments, it is desirable to eliminate slimes as completely as possible before the separation of valuable constituents. According to one of the most generally used methods, the removal of the major part of the insoluble impurities comprises scrubbing the comminuted ore to free the dispersible impurities, in particular clay-like minerals, and then separating the so-obtained slimy liquid. When the treated ore is water-insoluble, the scrubbing is accomplished by suspending the ore in water; and when the ore is partly or totally water-soluble, it is suspended in an aqueous solution saturated with respect to the soluble ore constituents. The operation can be performed in scrubbers of any type comprising vigorous stirring means such as, for example, rotary drums, vats provided with an agitator rotating at relatively high speed, and the like. The separation of ore from the slimy liquid is then performed by different conventional methods: hydroseparation, screening, cycloning, etc.

It is well known that a series of cyclones constitutes a very effective means to separate the ore from the slimy liquid providing the separation takes place in a sufficiently dilute medium. For example, an aqueous suspension containing at least 4 m.³ and preferably 5 to 6 m.³ of water (or aqueous solution) per metric ton of treated ore must be generally used in industrial practice.

According to the conventional method, the cyclones are disposed in series. The suspension from the scrubbing step

enters the first cyclone of the series; a thickened suspension of ore is discharged from the apex of this first cyclone; and the major part of the slimy liquid (80 to 90%) is separated by overflow and sent to settling means, e.g., clarifiers, hydroseparators, etc. The thickened ore suspension discharged from the apex of the first cyclone passes to the second cyclone which simultaneously receives a volume of clear liquid equivalent to the volume of the slimy liquid overflowed from the first cyclone, and the process is repeated in subsequent cyclones.

Inherently, in this conventional method a considerable volume of overflow liquid having a low slime content must be clarified. Furthermore, the clarification is therefore performed under the worst conditions since the lower the slime content, the more difficult and long the clarification.

It is thus an object of this invention to provide a novel and improved system for separating solids wherein less, but more concentrated, overflow liquid is clarified.

Another object is to provide an improved slime separating process especially adaptable to pretreating ores prior to flotation and the like.

Upon further study of the specification and appended claims, other objects and advantages will become apparent.

In the following description the term "water" defines the scrubbing liquid but it must be understood that this liquid, through generally water for the treatment of water-insoluble ores such as metal oxide or sulfide ores, coal, phosphate rocks and so on, can also be an aqueous solution for treating water-soluble ores such as, for example, potash ores.

Summary of the invention

To attain the objects of this invention, a method is provided wherein the overflow from at least one serially connected cyclone is recycled to a preceding cyclone. In addition, it is highly advantageous to split the overflow from a cyclone (preferably the second) following the first cyclone in series, recycling one portion thereof to the first cyclone and the other to the scrubbing means. It is also preferred to pass overflow from the first cyclone to a clarifier, and then to pass resultant clarified liquid preferably to the last cyclone in series. Although all the preceding techniques when used in combination create the most desirable system, nevertheless, each technique taken in itself contributes to the desired result which is to provide a better system than known heretofore.

Detailed discussion of the invention

As the preferred integrated process, the ore is suspended in water, conventionally scrubbed, and the resultant aqueous slimy suspension is passed to the first cyclone of a series of at least two cyclones. The thickened suspension is discharged from the apex of the first cyclone and is passed to the following cyclone in series. In each of the cyclones, slime-containing water is removed by overflow at the upper part of the cyclone. The slimy water from the first cyclone of the series is passed to a clarifier, and the resultant clarified water is passed to the last cyclone in series. The overflow from the second cyclone is split into two portions, one portion being recycled to the first cyclone, and the other being sent to the scrubbing step. The thickened ore suspension withdrawn from the last cyclone in series is substantially deslimed and free of extremely fine ore particles.

When using a series of cyclones according to this invention, it is possible, despite the recycling of slimy water from a following cyclone to a preceding one of the series, to obtain a removal of slimes at least as complete as that obtained heretofore by conventional methods, that is to say when using the same number of cyclones having

the same capacity but operating in actual series. By this invention, the water volume to be circulated and then clarified is about n times as low, n being the number of cyclones in series, which permits considerable reduction of the size and cost of the accessory equipment such as pumps, settling and clarification devices and the like. This is an outstanding advantage of the invention for the cost of the settling and clarification equipment constitutes generally a very large part of the investment cost of a separation plant, and in particular of a flotation plant.

According to the nature of the treated ore, its content in clay-like minerals and the degree of desliming required for subsequent treatment, a variable number of cyclones is used. In certain cases, a succession of two cyclones is sufficient but more generally satisfactory results are obtained with three or four serially connected cyclones. For details of cyclones per se and their operation, reference is invited to the literature, for example, F.T.C. Doughty—British Chemical Engineering, September 1963—vol. 8, No. 9, pp. 616–17.

The fraction of the slime-containing water coming from the second cyclone to be recycled to the scrubbing step depends on the treated ore and on the operating conditions of a given plant and can be easily determined by the man skilled in the art. Accordingly, the recycled fraction can be selected so that all the cyclones of the series have the same capacity, this being an important advantage in industrial practice where it is desirable to utilize standard and uniform equipment types and sizes for purposes of simplicity and to avoid large inventories in diverse replacement parts.

The desliming process of the invention is especially applicable to the treatment of ores which are subsequently concentrated by flotation. In this case, the scrubbing-cycloning operation can be performed with an ore previously wet or dry comminuted to the particle size suitable for flotation. It can be also effected with an ore previously submitted to a first comminution, generally dry comminution, to reduce the particle size and which will be wet ground after desliming to obtain the particle size required for flotation. The man skilled in the flotation art is able to make a choice between these different solutions for each given case because the selection depends on the treated ore, on the flotation results desired, and especially on the desired particle size of the final product. For example, the second selection is preferable when a coarse final flotation product is desired.

Brief description of the drawing

The attached drawing is a schematic flow sheet of a preferred embodiment of the invention where the ore is pretreated for subsequent concentration by flotation.

Description of preferred embodiment

The ore previously comminuted to a particle size suitable for flotation is suspended in water and sent to scrubber means 1 where it is scrubbed in a series of agitated tanks. The so-obtained slimy suspension containing about 0.25 to 0.50 metric ton total solids per m^3 of water is passed from the scrubber means through conduit 3, dilution tank 3A, and conduit 4 to the first cyclone 2 of a series of three cyclones 2, 2' and 2''. In dilution tank 3A, the slimy suspension is diluted with overflow from cyclone 2' in order to obtain a suspension containing about 0.10 to 0.30 metric ton total solids per m^3 of water. The slimy water overflow discharged from cyclone 2 passes through conduit 5 to a clarifier 6 (or a series of clarifiers).

The thickened suspension discharged as underflow from the apex of cyclone 2 is sent through conduit 7 to dilution tank 7A. In dilution tank 7A the suspension is diluted with water having a low slime content coming from the overflow of cyclone 2'' so that it contains about 0.10 to 0.30 metric ton total solids per m^3 of water. The resultant diluted mixture is then passed through conduit 8 to cyclone 2'. The slimy water overflow from cyclone 2'

is divided in two fractions, about 15 to 60% and preferably about 25 to 40% of which is recycled through 9 to the scrubbing means and the other is sent through conduit 10 to dilution tank 3A.

The thickened suspension discharged from cyclone 2' is sent through conduit 11 to dilution tank 11A where it is diluted with clarified water withdrawn through conduit 13 from the clarifier tank 6 so that the suspension contains about 0.10 to 0.30 metric ton solids per m^3 of water. The resultant diluted mixture is then passed through conduit 12 to cyclone 2''.

The underflow discharge of cyclone 2'' is in form of a thickened suspension (containing for example about 1.2 to 1.6 metric ton solids per m^3 of water) substantially deslimed. This suspension is passed through conduit 15 directly to flotation cells 16. The water which has been recovered at the end of the flotation step where concentrates and tailings are dewatered is recycled through conduit 17 to the scrubbing means 1. Wet slimes are discharged through conduit 18 from clarifier tank 6 and discarded. Water taken from the circuit in the form of wet slimes, concentrates and tailings is balanced by the addition of make-up water to decanting tank 6.

The following example illustrates the advantages of this invention.

A sylvinitic ore containing 6% of clay-like minerals was treated in a plant similar to that described above. The scrubbing was performed with 3 m^3 of brine (aqueous solution saturated with respect to potassium chloride and sodium chloride) per metric ton of dry ore, that is in a medium sufficiently diluted in solids to prevent attrition grinding of sylvinitic grains. Each cyclone of the series received 4 m^3 of brine per metric ton of dry ore. In spite of this strong dilution in the cyclones, only 3.3 m^3 of brine per metric ton of ore is treated in the decanting tank. This volume of brine is 3 times as low as the volume used in a plant comprising cyclones disposed in actual series according to the conventional method. For details of the nature of slimes in ores, particularly potash ores, reference is directed to the patent and scientific literature, for example, Handbook of Mineral Dressing, A. F. Taggart, Second Printing, March 1947, pp. 12–21 and 15–04 and U.S.P. 2,330,158 of Sept. 21, 1943.

It must be understood that modifications can be made to the plant described by those of ordinary skill in the art of solids separation to adapt it to different kind of treated ores and/or to the special requirements for a given beneficiation. It is possible, for example, to combine ore classification with the operation of scrubbing-cycloning. For this purpose the ore suspension coming from the scrubbing step can be divided in two fractions: a fraction of coarser particles substantially free of slimes which is to be treated separately, and a finer fraction containing practically all the slimes for treatment in the cyclones. Any conventional means may be used to accomplish this classification before the ore suspension enters the cyclones as for example rake classifiers, sieve bend units and/or vibrating screens.

In other words, from the foregoing description, one skilled in the art can easily ascertain the essential characteristics of this invention, and without departing from the spirit and scope thereof, can make various changes and modifications of the invention to adapt it to various usages and conditions.

What is claimed is:

1. A method of separating slimes from ore comprising the steps of:

- (a) in a scrubbing stage, scrubbing a comminuted ore with liquid to liberate slimes and form an aqueous suspension;
- (b) passing resultant scrubbed suspension to a first dilution stage separate from said scrubbing stage and adding diluent liquid to said first dilution stage to obtain a first diluted suspension;
- (c) passing resultant first diluted suspension to a first

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cyclone to obtain a first slime-enriched overflow and a first slime-depleted apex discharge;

(d) passing resultant slime-depleted discharge to a second dilution stage and adding diluent liquid to said second dilution stage;

(e) passing said second resultant diluted suspension to a second cyclone to obtain a second slime-enriched overflow and a second slime-depleted apex discharge;

(f) passing 15-60% of said second slime-enriched overflow to said scrubbing stage (a) to be used as liquid therein, and

(g) passing 40-85% of said second slime-enriched overflow to said first dilution stage to be used as diluent liquid therein;

and with the provision that no intermediate scrubbing stages are employed between the cyclones, whereby a substantial reduction in water and energy is obtained.

2. A method as defined by claim 1 further comprising passing overflow from said first cyclone to a clarifier zone, and passing resultant clarified liquid as diluent fluid to the last dilution stage.

3. A method as defined by claim 1 wherein said suspension of solids comprises solids suspended in a brine solution.

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4. A method as defined by claim 3 wherein said solids comprise a potassium salt.

5. A method as defined by claim 1 comprising at least one further serially connected dilution stage and cyclone, wherein overflow from the last cyclone is recycled to the second dilution stage.

6. A method as defined by claim 5 further comprising passing overflow from said first cyclone to a clarifier zone, and passing resultant clarified liquid to the last dilution stage in series.

7. A method as defined by claim 1 wherein the percentage in step (f) is 25-40% and in step (g) 60-75%.

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U.S. Cl. X.R.

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