The Continuous System of Cyaniding in Pachuca Tanks.

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THE arrangement of a flow of cyanide-pulp through Pachuca tanks in agitation, so as to permit a continuous process, instead of alternate filling, agitation, and emptying, has been proposed by various writers within the last two years, and more particularly by A. T. Grothe, agent for the Brown patents on Pachuca tanks in Mexico. It was first put into practice, I believe, by M. H. Kuryla at the Esperanza mine in El Oro, Mexico.

The starting of agitation in Pachuca tanks after filling may offer no serious difficulties with ores which do not settle rapidly in such tall tanks; and the adaptation of the tanks to continuous agitation under such conditions may give simply a somewhat more convenient method of treatment and greater agitation-capacity for a given number of tanks, because of the saving of time lost in filling and discharging. But in the treatment of pulp which tends to settle rapidly, as in the cyaniding of concentrates or of the whole pulp of ores containing heavy sulphides, the packing of the slime at the bottom may cause much trouble. The use of the radial air-pipe attachments near the top of the cone and of the air-valve outside of the air-lift tube at the bottom may obviate the difficulty to some extent; but the action of the radial air-pipes on the cone-sides is that of a sand-blast, and their continuous use cuts through the tanks. Moreover, even when these pipes are used, some pulps will pack tightly below them in the cones. Under such conditions the use of Pachuca tanks with intermittent filling and discharging becomes a troublesome process. Time is lost in starting agitation; large quantities of compressed air are wasted; pulp is blown over the tank-tops; and not infrequently it may be necessary to dig out the bottoms of tanks by hand. This trouble is the only important one occurring in the use of Pachuca tanks; and, since it is caused by intermittent filling, the arrangement of a continuous flow of pulp from tank to tank,

kept always full and in agitation, offers a means of avoiding such losses and of making the process much more satisfactory.

For a continuous flow of pulp from tank to tank, the outflow must be equal to the inflow in each tank, that the level may remain constant; and if the inflow is mixed thoroughly with the pulp already in agitation in the tank, as it would be in the central air-lift, then, roughly speaking, that part of the inflowing pulp which flows out of a tank in a short period of time will be to the whole inflow in that time as the quantity of inflowing pulp is to the whole charge. Thus, if a tank contain 100 tons of pulp, and 10 tons flow in during an hour, roughly, one-tenth of the latter, or 1 ton, will flow out to the next tank in the first hour; one-tenth of the ton which flows into the second tank will pass to the third, and so on through the series. The number of tanks in the series will, therefore, determine the power to which the fraction is raised for a short period of time. As the process is continuous, obviously these figures are not exact; but for practical purposes we may assume that with a series of tanks, the part of the pulp receiving a shorter period of agitation than the average will be balanced by the part receiving a longer period, and that in a series of six tanks having a capacity of 600 tons in all, and with 10 tons an hour passing through the system, the pulp would receive 60 hours' agitation. The same tanks, if filled, agitated, and discharged by the intermittent system, would give only 40 hours' agitation.

As the thorough mixing of the pulp in the tanks takes place in the central air-lift tubes, the overflow-connections from one tank to the following should be arranged so as to sample the overflow of the air-lift. This sampling should make a cut of the whole thickness of the stream of pulp from the air-lift. Failure in this respect would lead to classification in the tank, which would prevent the consistency of the pulp remaining the same through the whole series, and cause a thickening or a thinning that would interfere with the smooth running of the process. Any arrangement for a continuous system should also be provided with by-pass connections, so that any tank or tanks may be thrown out of the series when necessary, to allow for changes or repairs in the air-valves or interior piping, which are subject to much wear, or for any accident which may occur,

such as the dropping of a tool into a tank; otherwise, costly shut-downs and the emptying of the whole series must occur from time to time.

A. T. Grothe[1] has proposed an arrangement for continuous agitation. The overflow-connections consist of straight piping at an inclination of 60°, having the intake in each tank at a point midway from the central air-lift tube to the tank-side at two-thirds the height of the tank, and the discharge into the succeeding tank at the top of the cone. The pipe-intake in one tank is joined to the discharge in the next by a piece of rubber hose. By-pass arrangements do not seem to have been provided, and the pipe-inlets are placed far below the pulp-surfaces.

M. H. Kuryla[2] installed continuous agitation in a roughly similar form at the Esperanza mine. The tanks are 45 ft. high and 14 ft. 10 in. in diameter. The pipe-connections have their inlets 2 ft. from the 15-in. air-lift tubes and 7 ft. below the tank-tops (5 ft. 3 in. to 3 ft. 3 in. below the pulp-levels), and their discharges just below the tops of the cones in the succeeding tanks. Valves and piping are provided for by-passing any tanks in the series at half the height of the tanks, and for compressed air to clear out the connecting-pipes, in order to prevent their clogging with slime.

Both the above systems are arranged with the inflow-openings of the pipe-connections in the form of pipe-ends far below the pulp-surfaces, which have the defect of not being so placed as to assure a good sampling of the contents of the tanks.

At the Natividad mine, Ixtlan, Oaxaca, Mexico, the 100-ton cyanide-plant has been equipped with continuous agitation in a different form.

The ore contains from 5 to 8 per cent. of the sulphides pyrite, galena, and blende, and the value is chiefly in gold occurring in the pyrite. The low value of these sulphides when concentrated to 10 per cent. insoluble, and the high freight- and treatment-costs, make inadvisable the shipment of concentrates if a fair extraction can be made by cyaniding them. Tests on cyaniding the concentrates showed an extraction of from 92 to 93 per cent. of the gold, and 90 per cent. of the total value, if ground fine

[1] *Mexican Mining Journal*, vol. xi., No. 2, pp. 2 to 5 (Aug., 1910).

[2] *Idem*, pp. 44 to 46.

enough. The mill, as first put into commission in January, 1910, was not equipped for concentration. The ore was as nearly all slimed as practicable in the ordinary way with tube-mills, and the overflow from the Dorr classifiers (of which 90 to 95 per cent. passed a 200-mesh sieve) went to Pachuca agitators after thickening in Dorr thickeners. Recently, Johnston vanners have been added, to concentrate the slime-overflow from the Dorr classifiers before the pulp passes to the agitation; and the concentrates (90 per cent. through 200-mesh) are now returned to the tube-mills for regrinding, and circulate from the tables through the tube-mills and classifiers back to the tables, until so fine as not to be caught among the concentrates,—after the method of F. C. Brown.[3]

While the pulp from the above dressing, even before the addition of the vanners, was probably as fine as any usually agitated in Pachuca tanks, nevertheless, during the filling of the tanks, a part of the pulp settled rapidly to the bottom, while the lighter part, containing schistose gangue, showed very little clear solution above it, if left to settle quietly for 6 hr. Though the Pachuca tanks used are smaller than those commonly installed in Mexico, being 12 ft. in diameter and 35 ft. in height, the starting of agitation after filling commonly gave such difficulty as to cause several hours' delay, during which, at intervals, the compressed air had to be shut off from other tanks in agitation, in order to raise the pressure to 60 or 100 lb. so as to blow out the settled slime at the bottom of the tank to be started. Frequently, it was necessary to make use of hydraulic force from a pipe-line of 500 ft. head (installed originally for another purpose) to force an opening through the bottom of the settled pulp. But for the help of this latter force, the intermittent agitation would have involved the frequent digging out of tanks by hand.

In Kuryla's installation at the Esperanza mine, although he used roughly diagonal pipe-connections from tank to tank, the last tank was arranged to discharge from the overflow of the central air-lift tube into a box a little below its top, in order to gain head in passing to thickening-tanks before filtering. Since the object of the connections should be to sample the stream overflowing from the air-lifts, the box-arrangement

[3] *Mining and Scientific Press*, vol. ci., No. 9, p. 273 (Aug. 27, 1910).

at Esperanza is nearer the desired form than the submerged pipes, and naturally suggested a similar arrangement for the whole series of tanks.

This arrangement was carried out at Natividad for the series of tanks, with the exception of the last, as shown in Fig. 1. A drop of 4 in. is used from tank to tank, and the central air-lift tubes are cut down or added to, in order to give this drop. Wooden boxes 7 in. wide, 10 in. long, and 6 in. deep (inside measurement) are fixed against the 15-in. central tubes, with their tops flush with those of the tubes, and 4-in. pipes, placed horizontally, pass from the bottom of each box to the next tank in the series. By-pass pipes, fitted with valves, join each pipe-connection with the next in the series, as shown in the plan, and the 4-in. drop from tank to tank is made in the by-passes. Since the level of the inflow-pipe in each tank is 2 in. below the tops of the air-lift tube and of the overflow-box connected with the outflow-pipe, but is slightly above the pulp-level in the tank, no part of the pulp entering can pass out of the tank without having first gravitated to the bottom, and risen through the air-lift tube, thoroughly mixed with the whole content of the tank. On the tops of the overflow-boxes are sliding iron covers, which open at right angles to the direction of the overflowing stream. The regulation of the flow from tank to tank is done entirely by means of these covers, and the valves are used only when it is desired to by-pass tanks. The boxes are sufficiently large for the tonnage passing through agitation, so that the covers need be opened only an inch or two, in order to give the required flow. The openings which sample the pulp-stream are thus rectangular, with their long axes parallel to the radial overflow at those points; and, while theoretically this is not as correct a shape to sample the stream as would be a sector of a circular ring, in practice it has been found to offer no difficulties, while it is simpler to install and to keep in order in the pulp-stream.

As the last tank in the series discharges to the pulp-tank of a Moore filter, where an intermittent feed is important, it is arranged with two pairs of sliding doors on the central air-lift tube, so as to permit agitation at various levels. The pulp is drawn off intermittently to the filter through the bottom discharge-opening of the tank, either by hydrostatic pressure in

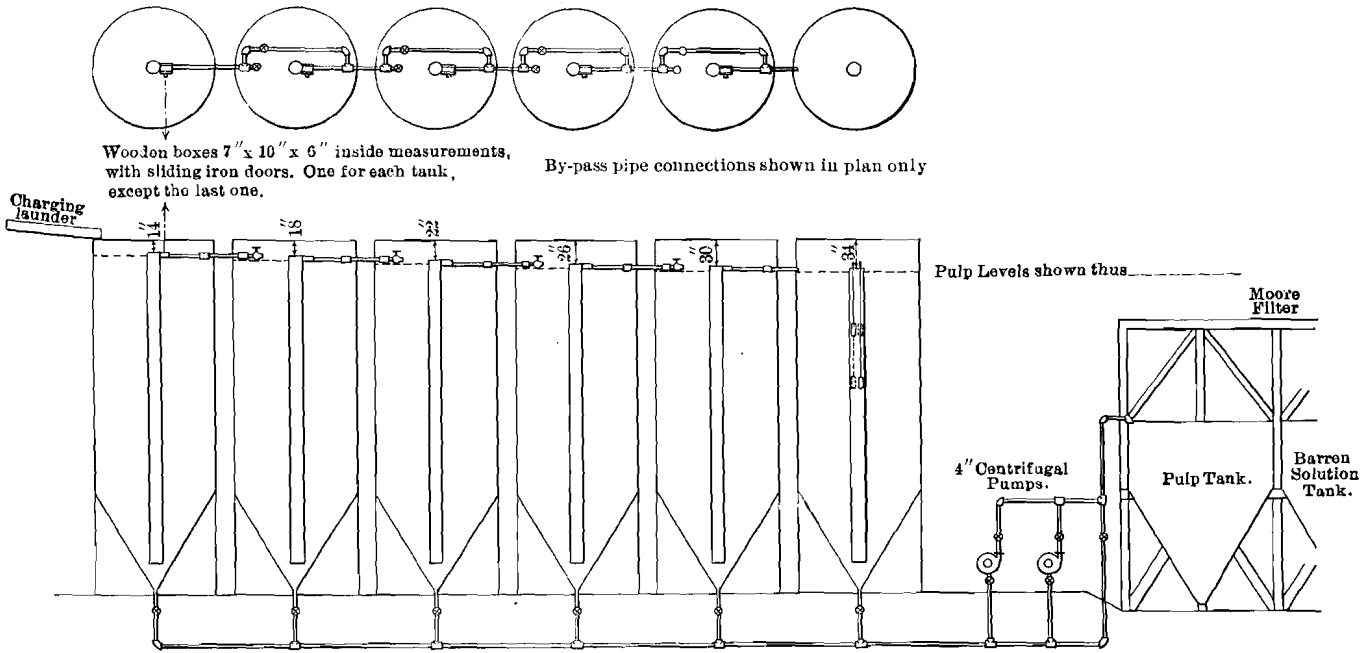

FIG. 1.—PACHUCA TANKS ARRANGED FOR CONTINUOUS OPERATION AT THE NATIVIDAD MINE, IXTLAN, OAXACA, MEXICO. PLAN, AND LONGITUDINAL VERTICAL SECTION.

the tank, if full enough, or by 4-in. Butters centrifugal slime-pumps.

All the tanks retain their bottom discharge-connections to the centrifugal pumps which lift to the filter, so that whenever it is necessary to empty any of them, they may be cut out of the series, to prevent fresh pulp entering, and after sufficient agitation, may be discharged to the filter.

In practice, the continuous system of agitation has removed completely the former difficulties in starting tanks, and gives greater capacity or longer agitation for the same tonnage. This is probably the cause of the better extraction noted by Kuryla at Esperanza with continuous agitation. While a better extraction is probably gained at Natividad for the same reason, it has not been readily measurable in practice, because slime-concentration for regrinding of the sulphides, as described above, was commenced simultaneously with the continuous agitation and caused a gain in extraction which obscures the slight gain there might be because of the change in the agitation arrangement. The continuous system of agitation has been in constant service since September, 1910, without having shown appreciable classification, though slight daily differences in the proportions of the pulp from tank to tank are caused by changes in the feed. The flow from tank to tank gives no difficulty, and is regulated by tank-boys at a cost of 62 cents American currency per 24 hr. The by-pass arrangements are very satisfactory, and any one or several tanks can be thrown out of the series whenever necessary.

The advantages of the arrangement for continuous agitation at Natividad over those of Grothe and Kuryla seem to be:

Greater simplicity of installation (the whole change from the intermittent to the continuous system was made in four days); greater accessibility for handling and supervision (all connections are above the pulp-levels of the tanks and within reach from the main deck on top of the tanks); no plugging of the pipe-connections can occur, and no compressed-air connections are necessary to free them; and as the boxes, by which the flow from tank to tank is regulated, make a good sampling-cut of the thoroughly mixed pulp overflowing from the air-lift tubes, no classification is liable to occur, and the proportion of solution to slime remains the same throughout the whole series of agitators.