Note: The development of AGITAIR flotation machines

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HISTORY

The first AGITAIR flotation machine was developed and patented in 1932. It has a capacity of 5 ft^3† and was named the No. 20. Next in line was the No. 24. Built in 1933, it had twice the capacity of the No. 20 unit. Then, in 1934 and 1939 came the No. 36 (22,5 ft^3) and No. 48 (40 ft^3) respectively. The next larger size, the No. 60, was produced as recently as 1964. This cell when 60 inches square and 30 inches deep has a capacity of 60 ft^3. An increase in the depth to 48 inches raises the capacity to 100 ft^3. Still in 1964, a three-fold increase in the maximum capacity of the No. 60 cell was effected when the No. 120 was introduced. Whereas up to then all the machines had had a single spindle per cell unit, the No. 120 had four spindles in a tank measuring 120 inches square by 36 inches deep for a capacity of 300 ft^3, which can be increased to 400 ft^3 in a 48-inch deep tank. A version of the No. 120 with a single spindle was developed in 1968. This machine was designated the No. 120A, and today it is not uncommon to see both the No. 120 and No. 120A cells operate at capacities as high as 500 ft^3. The latest additions to the AGITAIR range of flotation cells are the No. 144 and the No. 120×800. The former has a capacity of 650 ft^3 and measures 144 inches square by 54 inches deep; the latter is 240 inches wide, 120 inches long, and 52 inches deep with a capacity of 800 ft^3. Table I shows the different types of AGITAIR cells that are available.

DESIGN PRINCIPLES

Field testing has contributed extensively to the design features built into modern cells. These include the following:

(1) froth crowding action with single side discharge,
(2) the use of larger-diameter impellers, allowing lower peripheral speeds,
(3) the use of junction boxes for breaking pulp flow, reagent stage additioning, and pulp level control, and
(4) long row, high-throughput cell configurations compared with short parallel-row operations.

Ever-increasing costs and the gradual depletion of known high-grade mineral deposits have emphasized the importance of maximum recovery of valuable mineral. In 1971 alone, more than 10 000 tons of copper metal was produced by retreatment of the tailings from some of the porphyry copper concentrators in the United States. In these high-tonnage installations, the rougher tailings are deslimed in cyclones to between 10 and 15 per cent minus 200 mesh. The sand fraction, at 40 to 50 per cent solids by weight, is then introduced to a scavenger section consisting of a relatively small number of large cells. This has proved a highly profitable operation because of the savings associated with the large cells, which allow for simplified plants and reduced costs because of fewer pulp distributors, launders, pumps, pipe lines, and reagent feeders, and because of reduced requirements in electricals and floor space.

The following operating features of large cells are considered important:

(a) the effective treatment of solids of high specific gravity at relatively coarse grinds,
(b) the flotation of the coarse fraction only of a pulp,
(c) the passing of tramp oversize from malfunctioning cyclones without damage to the wearing parts,
(d) the maintaining of acceptable metallurgical results when 'pushing tonnage' through a milling circuit of constant capacity that results in a coarsening of the grind.

CONTROL MECHANISMS

The following control mechanisms are essential either for the improvement of metallurgical performance or the protection of wearing and working parts.

(1) *Control of wear patterns.* The symmetrical design of the AGITAIR impeller and stabilizer allows for reversal of the rotational direction of the impeller and turning over of the stabilizer. This adds appreciably to the useful life of these two parts.
(2) *Control of Circulation and Agitation.* The specific controlling features built into the cells to accomplish this function are as follows:
    (a) changing the impeller peripheral speed from 800 to 1200 r/min,
    (b) varying the clearance between the cell bottom and the impeller from 0,5 inch for very gentle agitation to 5 inches for intense agitation,
    (c) changing the diameter of the impeller, the length and size of the fingers, and the number of impellers per machine,
    (d) changing the design of the stabilizer by varying the size and number of the blades, as well as by adjusting the relative position of the impeller with respect to the stabilizer, and
    (e) balancing the external air with impeller action to ensure efficient froth formation and removal while providing sufficient circulation to prevent sanding. Air

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†As this paper relates to American-designed machines and all the cell numbers are related to inches and cubic feet, the metric system has not been used. All tonnages are given in short tons.

TABLE I

GALIGHER AGITAIR FLOTATION MACHINES

Model no. *	Tank size per cell W×LL×D † in	Diameter of impeller in	Usable cell volume ft³	Impeller speed ft/min	Air dispersed ft/min	Power consumed h.p.	Approximate throughput ton/d
LA-500		2,75	1,75 litres				500
		3,5	3,4 litres	Var.	Var.	0,3	1000
		4,25	6,5 litres				2000
8	8×8×8	4,5	0,3	930–1700	2	0,3‡	Up to 1000
12	12×12×12	7,5	1,0	840–1700	7	2‡	Up to 20
15	15×15×12	7,5	1,6	840–1700	10	2‡	Up to 35
24	24×24×27	12,5	10	1000–1430	20	3‡	Up to 300
36	36×36×30	17,5–18,25	22,5	900–1475	40	5‡	Up to 600
48×40	48×48×30	26,5–27	40	1000–1440	60–75	9–12‡	Up to 2000
48×50	48×48×40	27	50	1000–1440	60–75	9–12‡	Up to 2000
60×60	60×60×30	27	60	1050–1250	125–140	14–17‡	Up to 3000
60×75	60×60×36	27	75	1050–1250	125–140	14–17‡	Up to 3000
60×100	60×60×48	27	100	1170–1250	125–140	14–17‡	Up to 3000
78×150	78×78×48	27–30	150	1170–1270	140–200	19–20‡	Up to 4000
96×200	96×96×40	Four 27	200	1050–1170	240–300	20–22	Up to 10 000
120×300	120×120×36	Four 27	300	1170	400–500	28–30	Up to 15 000
120×400	120×120×48	Four 27	400	1170	400–500	28–30	Up to 20 000
90A×300	120×90×52	40	300	1200–1450	350	25–30	Up to 20 000
120A×400	120×120×52	40	400	1200–1450	400	25–30	Up to 20 000
120A×500	144×120×54	40	500	1200–1450	400	30–40	Up to 24 000
144×650	144×144×54	Four 27–30	650	1170–1270	600	30–35	Up to 24 000
120×800	240×120×52	Two 40	800	1200–1450	800	50–60	Up to 48 000

*Model number generally designates lip length × volume. Letter A designates single impeller on larger cells.
†W×LL×D=Width × lip length × depth at froth lip.
‡Power consumed per 2-cell unit.
Throughput can be dependent on volume, which in turn is dependent on percentage solids as well as tons per day.
The above throughput is based on 30 to 35 per cent solids. Higher percentage solids could increase the throughput.

from a blower is supplied at 1,75 to 2,00 lb/in² through the hollow shaft of the cell. The No. 120 cell can use 300 to 500 ft³/min dependent on the type of froth required and whether cleaning, roughing, or scavenging. Power requirements are about 1 h.p. per 100 ft³/min.

(3) *Control of Froth Depth.* Froth bars fitting into brackets along each cell lip and in each junction and discharge box control the depth of froth on each cell. Single- or double-side froth discharge is available.

(4) *Froth Crowding and Countercurrent Froth Flow.* This is accomplished by raising of the downstream froth lips, removal of the partition plates between individual cells, and progressive increase in external air supply from the head to the tail-end cell. The resulting graduated froth column now flows countercurrent to the pulp stream and tends to crowd, dropping out unwanted entrained gangue.

(5) *Junction and Tailings Boxes.* The greatest part of the recovered mineral is normally floated in the first bank of cells in a row of flotation cells. Junction boxes are useful in some installations where it is beneficial to keep this concentrate separate from the rest coming off the row. They are essential for controlling the pulp level in a bank of cells and serve as excellent points of reagent addition. They further serve to separate scavenger cells from rougher cells, and cleaner cells from recleaner cells. Discharge boxes can be adapted as pump boxes for in-line pumping between short banks of parallel rows for series operation. Dart valves installed in junction and discharge boxes allow for bleeding of sand and pulp level control when operated normally or automatically.

METALLURGICAL ADVANTAGES OF LARGE CELLS

In the change from laboratory-scale batch-type flotation tests to commercial-scale operations with conventional size cells, it was normal practice to use a factor greater than one in the calculation of the cell capacity required to give metallurgical results comparable with those obtained in the laboratory. With the introduction of large cells, this factor today approaches one, although it is doubtful whether unity will ever be reached. The reason is that the loss in recovery due to pulp that short-circuits from cell to cell is not made up by the pulp that remains in the cell for the corresponding period longer than the average retention time. The better metallurgical performance of large cells can be ascribed to more effective aeration and circulation, lateral as well as conventional longitudinal movement of pulp through the No. 120 cell, and reduced sensitivity to changes in pulp and ore conditions.

To perform at their best, large cells need large throughputs, with a minimum number of cells per bank to overcome the short-circuiting effect. This minimum is usually set at about eight, but ten is better when a final tailing must be produced. Up to twice this number of cells per bank is not uncommon. This means that 5000 to 15 000 tons of solids per day to a bank of No. 120 cells will give a retention time of 1,5 to 0,5 minutes respectively per cell at the usual solids-to-liquid ratio.

A multiplicity of short banks is not advisable and a small-tonnage plant should not use large cells in an attempt to economize.

LATEST DEVELOPMENT

In an effort to improve pulp circulation without affecting the life of the wearing parts, a new impeller (see Fig. 1), the PIPSA, is at present undergoing trials. Generally, the design involves the standard AGITAIR Chile — X (16 large fingers on a disc 27 inches in diameter), with a shrouded vane type of pumper impeller mounted on top of the disc. The shroud is open at the shaft for entry of feed, and the circulating pulp discharges between the vanes at the perimeter of the impeller. The standard fingers (9 inches long) at the same time aerate and circulate in the usual pattern.

Although this impeller is operated at a peripheral speed of 100 ft/min less than the conventional one, no signs of 'sanding out' have occurred to date, even with coarse feed having tramp oversize. Also, froth columns under these severe conditions are good. An added advantage of this impeller is that it cannot 'sand in' when operating in the reversed position, and the cell can be started under full load conditions after a power failure without damage to the parts.

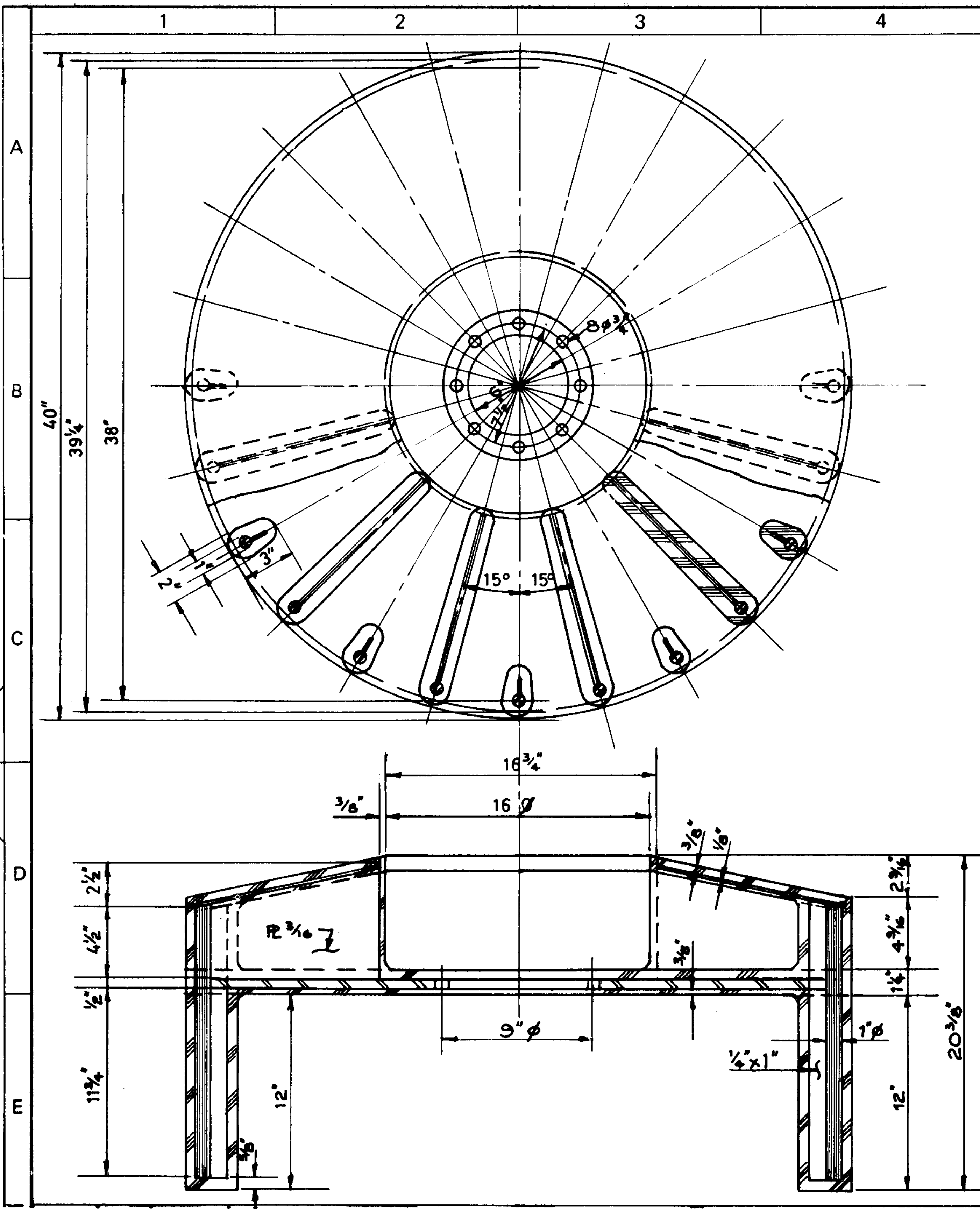

Fig. 1—The PIPSA impeller