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EXPERIMENTAL FLOTATION CELL

L. L. SIROIS & T. TAKAMORI

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EXPERIMENTAL FLOTATION CELL

by

L. L. Sirois* and T. Takamori

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ABSTRACT

A pneumatic experimental flotation cell was built to provide a well regulated apparatus to help in the study of the function of carbohydrate derivatives in oxide flotation. It was designed to permit direct control over all the variables which are encountered in flotation such as fluctuation in the level of the pulp, temperature, and variations in aeration, impeller speed and rate of removal of froth. Many tests done with this cell showed that it could give reproducible results.

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Direction des mines

Rapport de recherches R 135

CELLULE EXPÉRIMENTALE DE FLOTTATION

par

L. L. Sirois* et T. Takamori**

RÉSUMÉ

On a construit une cellule pneumatique expérimentale de flottation en vue de posséder un appareil facilement réglable pour servir à l'étude de l'action des composés hydrocarbonés dans la flottation des oxydes. La cellule a été conçue de manière à permettre le réglage direct de toutes les variables intervenant au cours de la flottation, tels les fluctuations du niveau de la pulpe, la température, et les variations dans l'aération, la vitesse de l'agitateur et le régime d'enlèvement de l'écume. Les nombreux essais poursuivis avec cette cellule ont montré qu'elle peut donner des résultats reproductibles.

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INTRODUCTION

A flotation cell was designed as part of a more extensive program entitled: "Study of the Function of Carbohydrate Derivatives in Oxide Flotation".* This investigation was undertaken to study the behaviour of some chemicals normally classed as iron depressants in cationic flotation of quartz from magnetite. Experimental statistical methods were used to study the modifying actions of these carbohydrate derivatives. The flotation tests were done with a pneumatic cell, using dodecylamine hydrochloride and methyl isobutyl carbinol as collector and frother. The flotation results were compared with adsorption tests and measurements of the electrochemical properties of the particle surfaces.

Since a wide range of particle sizes were to be investigated, a pneumatic-type cell was chosen. The Hallimond tube type flotation cell can only handle a narrow range of sizes and none of the finer sizes.

OUTLINE OF INVESTIGATION

The main criteria for this cell design were that it could handle material of a wide size range and that direct control could be obtained over most of the variables.

For these reasons a pneumatic-type cell was chosen and accessories were added to regulate the fluctuation in the level of the pulp, the temperature, and the variations in aeration, impeller speed and rate of removal of froth.

Tests were conducted during and after the installation of all the accessories to determine its reliability.

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*Mineral Processing Division Internal Report MPI 64-40.

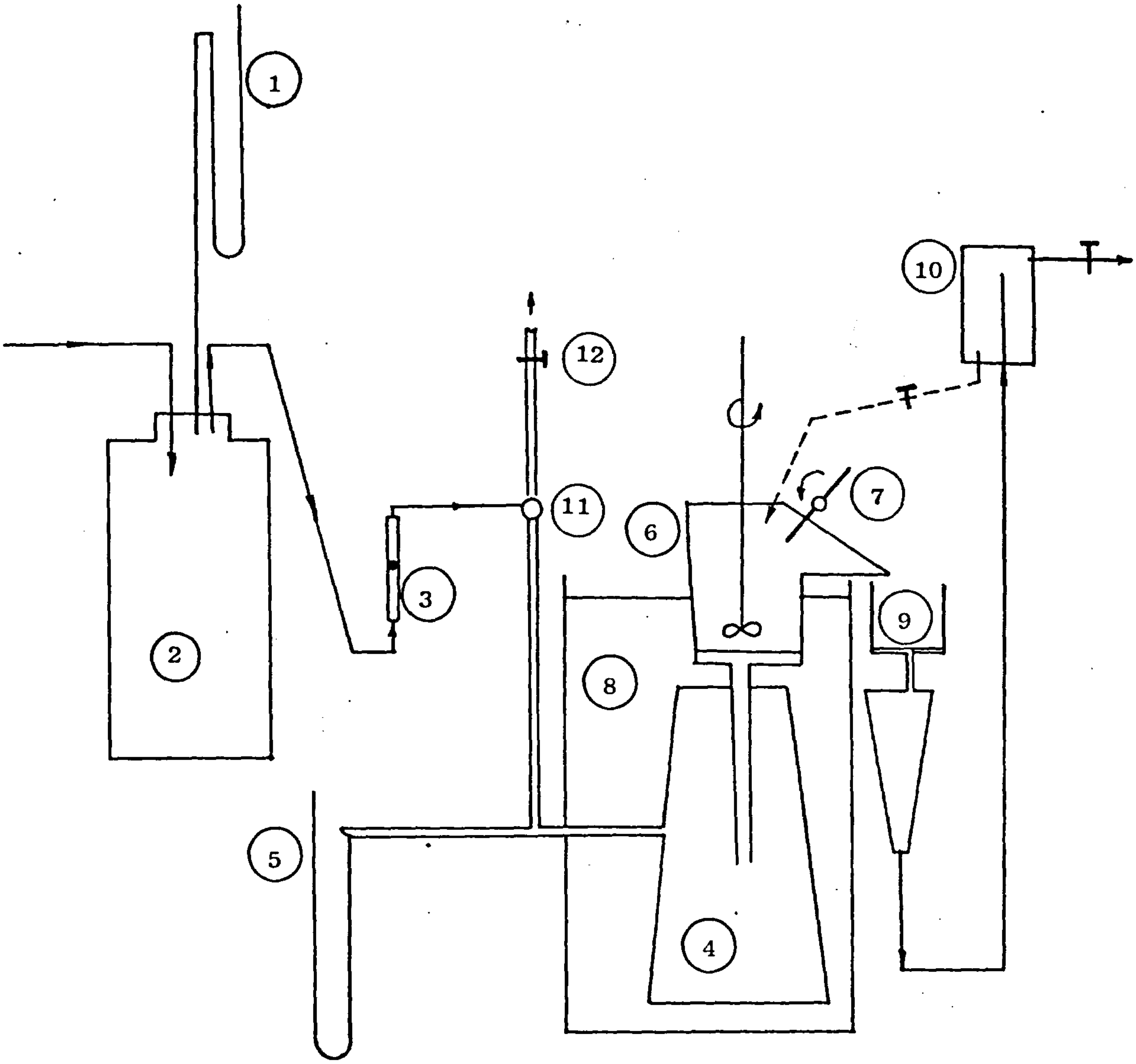
DESCRIPTION OF EXPERIMENTAL CELL

The cell is illustrated, schematically, in Figure 1. It consists of a 150 ml Büchner funnel (6), with a coarse fritted glass bottom, affixed through a rubber stopper on a 500 ml wide-mouth Erlenmeyer flask (4). Both the flask and the funnel are immersed in a constant temperature bath (8), which was kept at 25°C, with the water coming to within 1 cm of the lip of the funnel. The temperature of this constant temperature bath was regulated by water pumped from a larger bath controlled by a thermostatic unit.

The air flows to the cell through an empty jar to relieve any back pressure, a 10% KOH solution to scrub the air, a glass-wool container to remove moisture and finally through a very large container (2) to even out any fluctuation in pressure. The air from the line to the first empty jar is regulated by two needle valves. A manometer (1) indicates the pressure of the air in the large container and the amount of air flowing to the cell is shown by a flowmeter (3). Another manometer (5) indicates the pressure of the air in the flask supporting the funnel.

To permit the regulation of the rate of air flow before actually passing air through the cell, a three-way stopcock (11) was inserted in the line between the flowmeter and the Erlenmeyer flask. A resistance consisting of a polyethylene twistcock connector (12) was joined to the free arm of the three-way stopcock and calibrated to offer the same resistance to the air flow as the cell containing a pulp ready for flotation. The cell could thus be readied for a test without any disturbance and the required rate of air introduced, when ready, by turning the stopcock on line. The pressure in the Erlenmeyer flask was great enough to prevent any liquid flowing through the fritted glass bottom of the cell while loading and before actual flotation started.

A variable speed electric stirrer agitated the pulp in the funnel and the froth overflowing the cell fell into a filtering funnel (9) connected to a vacuum system. The filtrate collected in a small container (10) and was released back to the flotation cell at intervals through a stopcock to keep a relatively constant level in the cell.



1 - MANOMETER
2 - CONTAINER TO EVEN OUT FLUCTUATION IN PRESSURE
3 - FLOWMETER
4 - 500 ML WIDE-MOUTH ERLENMEYER FLASK
5 - MANOMETER
6 - BUCHNER FUNNEL
7 - MECHANICAL SKIMMER
8 - CONSTANT TEMPERATURE BATH
9 - FILTERING FUNNEL
10- CONTAINER FOR FILTRATE TO BE RELEASED BACK TO CELL
11- THREE-WAY STOPCOCK
12- RESISTANCE EQUAL TO THAT OF CELL

Figure 1. Flotation Cell

At this stage in the cell development, tests were conducted to determine the effectiveness of the cell. Their results showed a large error, as indicated in Table 1, of 15.29 with a contribution of 13.25%. After examination of the data, it appeared that manual skimming could be the largest contributing factor to this error.

A mechanical skimmer (7) consisting of two paddles driven by the electric stirrer was then installed. This electric stirrer was equipped with a horizontal shaft with a gear reduction of approximately 10 from the main vertical shaft. The paddles were fitted onto this horizontal shaft. Further testing proved the assumption correct as the error was greatly reduced, as indicated in Table 2. The cell gave reproducible results with an error of only 0.61 with a contribution of 0.2%.

Depending on the specific gravity of the material to be floated and the per cent solids of the pulp, up to 80 grams of mineral can be handled in the cell. The power of the stirrer and the volume of air are large enough to handle any variation encountered in flotation, the limiting factor being the size of the cell.

TABLE 1

Factorial Design Before Incorporation of Paddles

Factors	Levels		Sample: Quartz Collector: RADA Frother: MIBC
Amount of Collector	0.75 cc (A-)	1.00 cc (A+)	
Rate of Air	12 (B-)	14 (B+)	

Source of Variations	Sum of Square	Degrees of Freedom	Mean Square	Variance Ratio	Contribution %
Main Effects					
A (A-A+) = Collector	488.28	1	488.28	46.73$^+$	86.75
B (B-B+) = Air	0.00125	1	0.00125		
Two Factor Interaction					
A x B	1.53	1	1.53		
Remainder = Error	61.19	4	15.29		13.25
Total	551.00125	7			100.00
Pooled Remainder or Pooled Error	62.72125	6	10.45		

$^+$Significant at 1% level.

TABLE 2

Factorial Design After Incorporation of Paddles

Factors	Levels		Sample: Magnetite Collector: dodecylamine hydrochloride Frother: MIBC Rate of Air: 13
Size of Magnetite	Fine (A-)	Coarse (A+)	
Weight of Magnetite	30 g (C-)	15 g (C+)	
Amount of Collector	10 mg (E-)	15 mg (E+)	
Amount of Depressant	0 (B-)	1.5 lb/t (B+)	

Source of Variations	Sum of Square	Degrees of Freedom	Mean Square	Variance Ratio	Contribution %
Main Effects					
A (A-A+) = Size	3660.25	1	3660.25	6778.24$^+$	94.8
B (B-B+) = Depressant	18.92	1	18.92	35.04$^+$	0.5
C (C-C+) = Weight	17.64	1	17.64	32.66$^+$	0.4
E (E-E+) = Collector	101.00	1	101.00	187.04$^+$	2.6
Two Factor Interaction					
A x B	6.00	1	6.00	11.11$^+$	0.1
A x C	0.01	1	0.01	-	-
A x E	52.56	1	52.56	97.33$^+$	1.4
Remainder = Error	4.88	8	0.61		0.2
Total	3861.33	15			100.0
Pooled Error or Pooled Remainder	4.89	9	0.54		

$^+$Significant at 1% level.

CONCLUSIONS

The main advantages of this experimental flotation cell can be enumerated as follows:

1 - it can handle any size of flotation material down to micron size;

2 - all variables can be adjusted before the flotation operation begins;

3 - it is very easily cleaned;

4 - flotation tests can be done at constant temperature, over a wide range of temperatures;

5 - as the froth is filtered immediately on removal, the solution can be returned to the cell to keep a relatively constant level;

6 - the froth product, obtained as a filter cake, is immediately available for a refloat if need be;

7 - the paddles on the cell eliminate the human error in froth skimming;

8 - any gas could be used instead of air for the production of bubbles;

9 - it is inexpensive to build, and economical in its use of minerals and reagents;

10 - it is reliable and gives reproducible results.

It will have been noted that the two factorial designs illustrated in Table 1 and Table 2 are not concerned with the same system. However, comparison of errors between these two experiments is valid and shows that the installation of paddles for froth removal reduced the error considerably and that the results obtained after this new addition are reliable.

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LLS:TT/DV