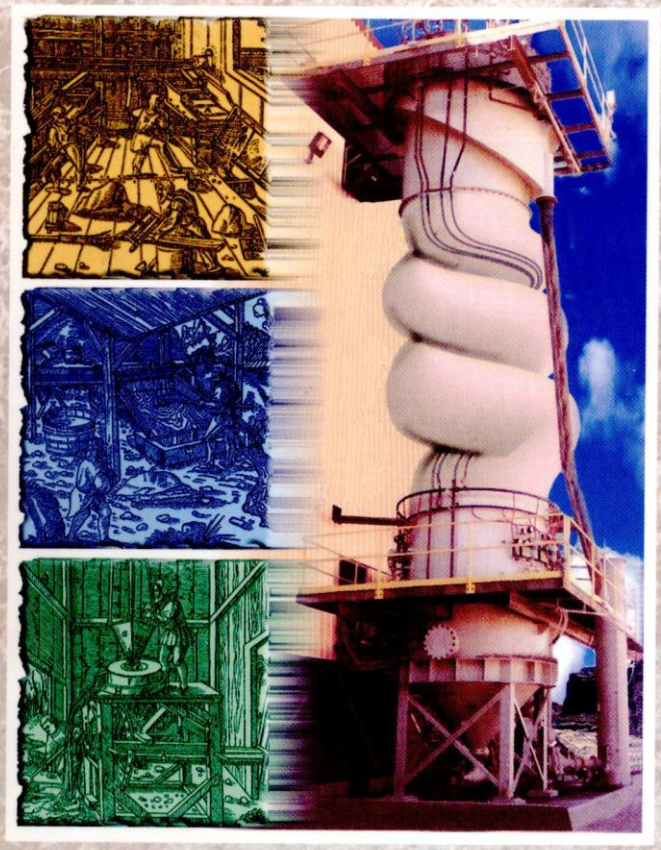
MINERAL PROCESSING IN THE 21ST CENTURY



Varna, Bulgaria
June 15 - 20, 2003

Edited by
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IMPULSE HYDROCYCLONING THE COPPER ORE OF BUCHIM, REPUBLIC OF MACEDONIA

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ABSTRACT:

The very good results obtained during the use of impulse in the hydrocycloning of the iron and kaolin ores were the major reason to use the method in the hydrocycloning of the copper ore of Buchim, Macedonia.

The content of solid at feed of cyclone was 35%, and inlet pressure 0.05 MPa. The investigation aimed at optimising the impulse parameters and the optimal results obtained are compared with those obtained with no pulsation. With optimum sizes of pulsator, increased efficiency of classification of over 9% was accomplished, so that cleaner products were obtained. The pulsator is of very simple construction, does not require electrical power and can easily be added to flotation plants.

Key words: Pulsation, hydrocyclone.

INTRODUCTION

Hydrocyclones are the most commonly used classifiers in flotation plants. Their simple construction and small size are their basic advantages. Efficiency of classification that they perform is not very high. The productivity of the mill and good conduct of flotation processes depend on the quality of classification. At low efficiency of classification along with underflow product, large quantities of fine material enters the mill, productivity decreases and the material is re-ground. This leads to difficult flotation and great losses of valuable minerals that go into the waste. On the other hand, in overflow product there are a lot of unground intergrown grains that also make the flotation process very hard.

It is obvious that each investigation that may lead to the increase of efficiency of separation is important. Good results can also be accomplished by the introduction of pulsation of the pulp that enters the hydrocyclon. During the classification of Kremikovtzi ore with the use of pulsation, the efficiency has improved by 13 to 15%. Significant improvement of separation can be accomplished with concentration of kaolin ore. In this process, a cleaner kaolin product and quartz sands are obtained (Djendova, S. (1998). An original hydrodynamic...7th Int.Min.Proc.Symp., 1998.).

The improvement of classification in hydrocyclone when the material is fed by pulsation can be explained by the better disintegration of the particles in the hydrocyclone and hence the better possibility for separation. Besides, pulsation particles easily liberate from mechanically present grains – fine grains in underflow and the other way round – coarse grains towards fine grains. This improves the separation process in the apparatus. As a result, cleaner underflow and overflow products are obtained.

The aim of this investigation was to determine the possibilities for improvement of the classification process in copper ore of Buchim, Macedonia with the use of pulsation

flow in the feed of hydrocyclone. Optimization of pulsator was carried out.

APPARATUS, RAW MATERIAL AND METHODS APPLIED

Laboratory hydrocyclone the diameter of 100 mm was used (fig 1). Fig.2 shows the scheme of the connection of the pulsator with the hydrocyclone and the supplying tank. Underflow and overflow diameters, content of solid and inlet pressure were optimised earlier. They were kept constant during the whole experiment with pulsations. Pulsator was pipe-shaped without moving parts and very simple construction.

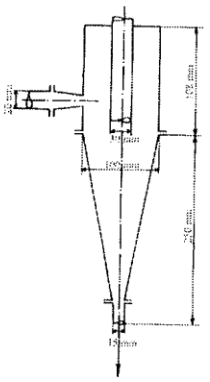

Fig.1 Scheme of the hydrocyclone

The sample was taken from the ore that feeds the mill in the Buchim flotation plant. The granulometric class of the sample is shown in table 1.

Table1. Granulometric class of the sample

Class [mm]	M [%]	Σ(+)	Σ(−)
+0.0417	9.73	9.73	100.00
-0.417+0.295	8.60	18.33	90.27
-0.295+0.208	8.86	27.19	81.67
-0.208+0.147	9.86	37.05	73.81
-0.147+0.104	10.28	47.33	62.95
-0.104+0.074	12.92	60.25	52.67
-0.074+0.000	39.75	100.00	39.75
	100.00		

Two products were obtained during each experiment that underwent sieving analysis through a sieve the size of 0.074 mm and the dried out products were weighed. The efficiency of classification was calculated by the formula:

where:
a - the content of class -d+0 in inlet; (%)
b - the content of class -d+0 in underflow; (%)
c - the content of class -d+0 in overflow; (%)

Constructive parameters of the hydrodynamic pulsator used were the subject matter of examination. Three values of variable factors were studied. In that regard, 9 different conditions of classification were investigated. Each experiment was performed 3 times and the results were taken as mean value.

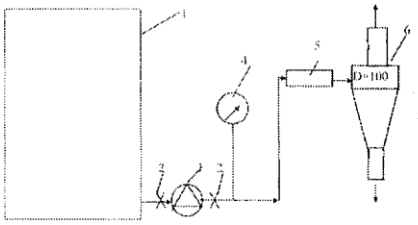

Figure 2.- Scheme of the hydrocyclone with the pulsator 1- pulp tank; 2 – cock for pressure regulation; 3 – pump; 4–manometer; 5 – pulsator; 6- hydrocyclone

The results are shown in table 2 and figs 3, 4 and 5.

Table 2. Results of the experiments carried out.

No	L (mm)	D (mm)	Content of class -0.074mm (%)			E (%)
			a	c	b	
without pulsations			45.3	89.3	37.94	67.37
1	10	16	45.3	92.2	36.54	69.15
2	20	16	45.3	90.7	37.64	68.96
3	40	16	45.3	95.6	35.43	71.92
4	10	14	45.3	96.2	35.57	73.07
5	20	14	45.3	95.6	35.68	72.42
6	40	14	45.3	95.5	35.31	71.53
7	**10**	**12**	**45.3**	**97.7**	**35.07**	**74.16**
8	**20**	**12**	**45.3**	**98.2**	**34.77**	**74.23**
9	40	12	45.3	96.8	35.22	73.20

The basic experiment carried out was with no pulsations with the conditions as follows: underflow diameter 13 mm, overflow diameter 35 mm, content of solid 35%, inlet pressure

$$E = \frac{(a-b)\cdot(c-a)}{a(100-a)\cdot(c-b)}\cdot 10^4$$

0.05 MPa.
L–pulsator length(mm);
D–pulsator diameter (mm);
c–content of – 0.074 mm in overflow (%);
b – content of -0.074 mm in underflow (%);
a - content of –0.074 mm in feed(%);
E – efficiency of classification according to class –0.074 mm (%).

Data in table 2 yielded the influence of pulsations on the efficiency of classification. The experiments nos. 7 and 8 yielded efficiency values of over 74%, 66,37% for the basic experiment which was without pulsations. Improvement of the efficiency amounts to some 9%.

This high efficiency was accomplished as a result of cleaner overflow product in which the class – 0,074 mm amounts to 98.2%.The underflow product in the experiment with pulsations (34.77% - 0.074 mm) is 3% cleaner.

The influence of the two basic pulsator parameters on the results of classification are shown in figs. 3, 4 and 5. Fig. 4 shows that the influence of the pipe diameter on the cleanness of underflows is the greatest with the smallest length of the pipe and amounts to 10 mm. This influence decreases with length of 20 mm and changes with the greatest length of 40 mm. In other words, the longer the pulsator the smaller the influence of its diameter.

An analysis can also be made regarding the cleanness of overflow product. The highest content of the class –0.074 mm is obtained with the smallest diameter of the pipe, but with length of 40 mm the influence of diameter decreases.

In regard to efficiency, the influence of diameter is equal with lengths of 10 and 20 mm. Here, the increase of the diameter of pipe does not show any influence on the efficiency.

The explanation of the determinations obtained can be looked for in the compensation of the influence of the pipe diameter with length.

If we take that the pipe diameter characterises the intensity of pulsation, then its length determines its continuation. In other words, lower pulsation requires longer time to accomplish the effect.

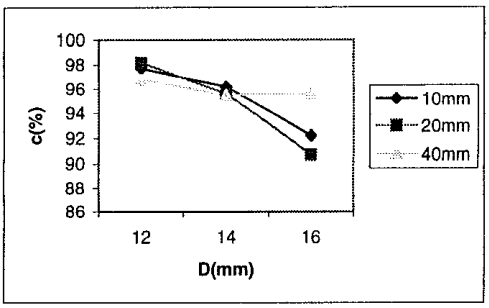

Figure3. Influence of pipe diameter on the content of class –0.074mm in overflow product with different lenght of pulsator

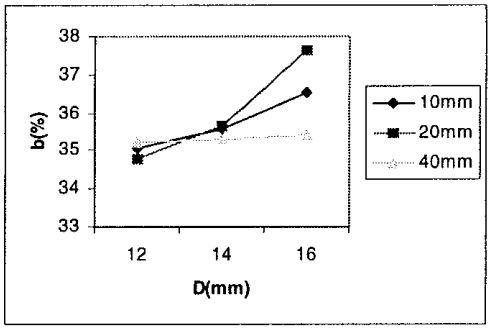

Figure 4. Influence of pipe diameter on the content of class –0.074mm in underflow product with different lenght of pulsator

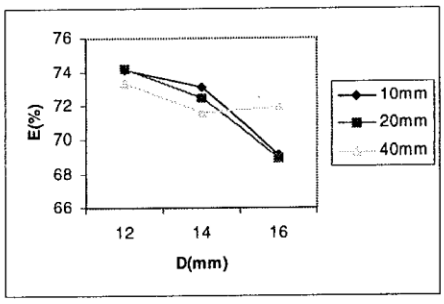

Figure 5. Influence of pipe diameter on the efficiency of classification with different lenght of pulsator

CONCLUSION

Hydrodynamic pipe pulsator can be used in hydroclycloning of copper ore. The use of pulsation flow at inlet of hydrocyclone significantly improves the efficiency of classification. Increase of over 9% efficiency was accomplished. It is the result of the improvement of the quality of overflow product. The pulsator dimensions influence the efficiency of the process. This method allows elimination of the influence of one dimension with optimisation of the other. Further investigations should include optimisation of the configuration of the pulsator that would not only improve the results, but would lower losses. This has been proved with classification of kaolin ore. The simple construction and the lack of moving parts ease considerably the practical implications of impulse cycloning.

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