Fizykochemiczne Problemy Mineralurgii, 20 (1988) 107—113

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PRACTICE OF APPLYING FLOCCULATION IN MINERAL PROCESSING

The cases of selective flocculation applied for processing of ores in Bulgaria are described and the obtained results. The reasonss for limited application of the selective flocculation method in Bulgaria is given and some considerations for future development of the methoo are expressed.

A harmful action of slimes in flotation is very well known. Particularly hard to tackle, in this respect, are gangue slimes smaller than 10 μm. In industrial conditions, usually a diminishing quality of the concentrate is noted when the degree of grinding is increased. When the ore contains fine intergrowth of ore minerals with the rock mass, to clean the concentrates, they have to be reground finely. Fine regrinding leads to formation of gangue slimes and further contamination of the concentrates. The only solution for this case is to use a proper forther, that is the frother producing a relatively dry and easily decompositing froth. Most often, such frothers are alcohol-type frother.

Currently the following methods are applied for decreasing the harmful effects of slime particles in the flotation:

a/ Adding of non-polar oils;

b/ Preliminary flocculation and flotation of slimes;

c/ Introduction of a collector in the grinding circuit cycle;

d/ Separate treatment of slimes and sands.

At present, the following facts are well established:

1. For a wide range of minerals, types of flotation machines, and

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classes of reagents, a maximum recovery are obtained for particles having from 10 to 100 μm. When the size is below 10 μm, the recovery gradualy decreases.

2. As a rule, slimes float at a lower speed than do particles of an average size. A detailed examination has shown, that every fraction of particles contains some quickly and some slowly floating grains. The negative effect is connected with the poor flotation of fines of hard to float particles.
3. The reasons for the necessity of desliming, in flotation with cationic collectors are known.
4. The separate flotation fraction of slimes and sands does not always improve the technological index.
5. Slimes usually accumulate in middlings such as the concentrate of cleaners. The introduction in these operations of the material with normal flotation sizes, in many respects, improves recovery. A typical example is the introduction of the coarse bulk concentrate to the circuit of reflotation of the waste material from the first cleaner, in flotation with an open cycle scheme. Our experiments carried out in this manner, showed very good results.

The use of an emulsion of non-polar oil, to recover the main mineral and to reduce the losses in the final tailings has, for a very long time been used as a technological procedure. In this way, the recovery of all sulphide minerals can be increased. Our experience shows that the addition of kerosene emulsion to the Na_2CO_3 aqueous solution in the grinding circuit enhances the recovery of molybdenium slimes. The addition of emulsion of neutral oil (emulsified in an aqueous solution of xanthogenate and sodium carbonate) for lead flotation during processing of lead and zinc ore and under a scheme of direct separation, is also beneficial. It was shown by means of the electron microscopic analysis of lead concentrate obtained in the presence and absence of oil emulsion, that the surface of the galena grains is enveloped by an insoluble in inorganic slovent film havig a thickness of more than 0.5μm. Also. aggregation (flocculation) of particles of the size below 1-2 μm around the particles of a size of above 10 μm has been observed, what is a typical phenomenon after the use of the oil emulsion

The sphalerite grains in the zinc concentrate differ in the degree of coverage with reagents, depending upon the grain size composition. Grains of a size below 5 μm are usually clean, where as, the larger grains are covered with spotlike, situated, defuse, or hard layers [Boteva, 1985]. The recovery of zinc in zinc concentrates is enhanced due to the liberation of galena - sphalerite middlings.

The formation of solid-oil aggregates improves the filtration properities of mineral suspensions. As a results of this, the moisture content in the concentrates is considerably lowered; in the lead concentrate on the average by 1.5 percent, and in the zinc concentrate by 0.8 percent.

As a result of one year long practice at the Oustrem factory in Bulgaria with neutral oil as an additional reagent - collector, the extraction of the lead in the lead concentrate was increased by 0.8 percent, the coctent of lead in the lead concentrate - by 2.8 percent, the extraction of zinc in the zinc concentrate - by 5.2 percent, and the content of zinc in te zinc concentrate by - 1.7 percent (Boteva 1985).

Preliminary flocculation and subsequent flotation of slimes also finds application in our practice. Most often, polyethyleneoxide or polyacrylamide are feed into the grinding circuit or bulk flotation. According to Vakleev (1976), the existing flocculants do not provide the necessary selectivity with regard to the sulphide of nonferrous metals, regardless of the fact that investigations under industrial conditions [Tiurinkova et al., 1975], suggest that in the collective flotation of copper - molybdenium ores, polyethyleneoxide should be used in combination with butyl xanthogenate. The increase of a tehnological recovery under the regime with regard to copper was 5.0 pertcent. In the Kodzhoran flotation factory in the USSR, by adding 100 g/t polyethyleneoxide and 5.0 g/t butyl xantogenate to the grinding circuit, the recovery of molybdenum was increased by 2.0 percent and copper by 2.5 percent. The conditions for selectivity of the concentrate have been improved [Tiurinkova and Hachatryan, 1974].

Separate flotation of slimes and sands is practiced in the flotation of minerals for a long time. However, it has not yet found a wide application in our country. The main reason for this is the difficulties encountered in the construction and reconstruction for the mounting of the necessary equipment. It is applied in two variants; fractional agitation of slimes and sands and and a collective flotation or separate flotation. These processes are at present introduced into one of the largest factory of the USSR - Dzezkazgansk factory.

The role of the size of particles on their interaction with flotation reagents is a question widely discussed in many monographs of flotation. When the flotation pulp is agitated with reagents, unfavorable conditions are created for hydrophobization both for large and fine particles. Accordind to Glembotski et al. (1968), the pulp is divided into sands and slimes fractions, for example by means of hydrocyclon. The whole collector, or its greater part, is put into the sand fraction of the pulp. A rapid and effective hydrophobization of the coarse particles takes place. Subsequently, the sand and slime fractions are mixed together and a bulk flotation takes place. According to Glembotski et al.(1968), such a scheme of the process considerably diminishes the expenditure of the reagent in improving the indexes of flotation. Thus, under industrial conditions, a lead factory in Central Asia processing sulphide oxide ore (2.7 percent Pb in the form of cerussite, plumbojarosite, galena, slimes of iron hydrooxides, limonite, barite) has succesed in decreasing the expenditure of Na_2S by 15 percent, with an increased content of lead in the concentrate from 25.6 to 38 percent and recovery from 70.1 to 82.7 percent. In industrial conditions, according to Strelnikov et al. (1976), the possibility of improving the technological indexes in the processing of cooper - oxide ore is trough the fractional flotation of slimes and sands. Under the new technology the recovery of the copper - oxide is increased by 0.5 percent, and of cobalt - by 3.13. According to Glembotski and Zakim (1968), it is most expedient to perform the fractional preparation, in a fractional class 100 - 150 µm. The boundary between the sand and the slime parts is determined by to the maximum size and the distribution of the minerals, in the three main granulometric groups of polydispersed product : namely, large grains, (requiring the greatest desity of reagent coverage), medium and slime grains (requiring seletive flocculation and a great concentration of the collector). Our experience with the separate flotation of ore pulp, allows us to make the following conclusions regarding the prospects of this method :

1. It is necessary to avoid a fractional flotation of slimes and sand fractions. The main reason is that for a selective flotation of slimes particles, strongly diluted pulp is needed, which unnecessarily lengthens the flotation front. The slimes have a low velocity of flotation and a great overconsumption of reagents.
2. The division of the pulp into slimes and sands must lead to the separation of a real slime fraction, for example below 15 µm. Otherwise the goal will not be attained.
3. The sand fraction is agitated according to the general rule of pulp conditioning. Before agitating the slime fraction, its density being brought at least to the normal flotation density - above 30 percent.

The agitation of slime fraction is effected under these conditions in tanks with increased periferial velocity. The expenditure of the collector and the emulsion of non - polar reagent depends upon the character of the mineral and the disperser of the slime gangue fractions. In an experiment carried out by us, the combination of Na_2CO_3 with sodium silicate, or Na_2CO_3, NaCl and hexametaphosphate were appropriate. The emulsion of non - polar reagent must be finely dispersed. the use of the dispersants is not recommended, because they the surface of the non - polar oil drops hydrophilic. The time of agitation is of the order of 120 seconds. It is only after this when the slime and sand fractions are mixed again agitated, depending upon proper ties of the raw material. Also, the constriction caracteristics of the propellers tank are important. It is necessary to secure a maximum periferial velocity. Cutting propellers are unsuitable. Best suited are the propellers in the form of a perforated disc.

The selective floculllation with polymers of high molecular weight is of practical interest. The main requiements of this process by our experience are:

a/ The necessity of a good dispersion, of at least one of the components participating in the slime mixture;

b/ The selective adsorption of the polymer - a very essential fact, for improving the selectivity of the flotation with selective inhibition of the absorption of the flocculants on one of the minerals. The adsorption of the flocculant can be inhibited by electrostatic repulsion, preliminary adsorption of other substances, and the removal of the free hydroxide radicals from the surface of the quartz through "aging" or through alkaline processing. At present, the process must be considered more as selective dispersion than selective flocculation. It is preferable to use polymers which be adsorbed selectively on a given mineral, rather than the polymers whose action depends upon selective inhibition.

Selective flocculation in the pulp can be realized in the following ways:

The first possibility is the desliming prior to flotation. This process has been realized in 1975 [Rosas and Poling, 1975].

Other authors have established that carboxymethyl cellulose flocculates the rock mass at pH 11.5 but dose not hinder the flotation of chromite.

Of substantial interest, is the selective flocculation of rock - forming minerals in the dressing of sulphide ores of non - ferrous metals. The best results are obtained with neutral polyacrylamides used in conjuction with suitable selection of depressors.

The selection of reagents for the selective flocculation is always of paramount significance.

According to Bogdanov et al. (1980) , a drastic decrease of losses of iron minerals with slimes can be achieved by the use of selective flocculation. It includes dispersion of the pulp, selective flocculation of the ferrous minerals, sedimentation in the form of flocs and deslilming in which in the overflow the fine particles of the rock mass are throughly separated. As depressor, in the introduction of the process, water glass, Na-polyphosphate, and ligninsulphate were used. As flocculant starch was used flocculation takes place at pH 11.

In conclusions, it may be said that the selective flocculation of minerals in all variants has found limited application. The reasons for this must be looked for, first of all, in the poor study of the process which makes it difficult to control in practice. In view of the necessity of dressing and ever greater ore deposits containig different kinds of minerals with slime sizes, it should be expected that the coming years will bring a rapid development of the theory and practice of this progress.

REFERENCES

Bogdanov,O.S., Theory and Technology of the Ore Flotation, Moscov,1980, in Russian.

Boteva,A. and Kovachev,K .,Application of agglomerative flocculation in flotation of finely impregnated coppere-pyrite ores,Rudodobiv Magazine,4,1977,in Bulgarian.

Boteva,A., in: "Libaration and Flotation", Denev,S., Stoicova,R., Boteva,A., Sofia, ed Technika, 1985 in Bulgarian.

Charlamov,B.S. and Vitovatov Yu.L., Proccedings of the Scientific and Technological Conference on Useful Minerals, Krivoy Rog, 1981,in Russian.

Glembotski ,B.I. and Zakim,S.A., Scientific Information of the Institute of Mining, N° 45, 1968, in Russian.

Goodman,R.M., Panzer H.P., U.S.A. Pat.4274945 CUXX registr.on 07 II 79 N°92002 from 23.06.81 TUX VOZY 04 HK 209.5.

Rosas,I.E. and Poling G.W., 1975 - XXII IMPC,Calgari.

Strelnikow,I.I. et al., Collection of Scientific Works of the All-union Institute of Mineral Processing Useful Minerals,1976, I 44, in Russian.

Vakleev,I.I., Gorlovski ,S.I., Zahishin,N.B. and Litkina,T.E., Theory and Practice of the Aplication of Polymers in Mineral Processing of Non-Ferrous Metals, Proccedings of the V-th Scientific and Technological Seasson of the Mechanobr Institute,1980, in Russian.

Tiurinkowa, V.I. and Hachtryan,L.S., Armenian Greshka Industry, N°5, 1974.

Tiurinkowa,V.I. et al., Scientific Collection, Scientific and

Practical Instit ute of Non-Ferrous Metals, Armenprotsvemet,

Glembotski ,B.I. et al., Investigation of separate conditioning of sands and slimes with reagents prior to jonit flotation as method of intesyfing flotation. Volume II, VIII IM PC, Leningrad, 1968, in Ru ssian.

STRESZCZENIE

Botewa A.,1988., Wykorzystanie selektywne flokulacji przy wzbogacaniu rud. Fizykochemiczne Problemy Mineralurgii 20; 107-113.

Przenanlizowano różne zastosowania selektywnej flokulacji przy wzbogacaniu rud w Bułgarii. Dokonano porównań wyników tego procesu uzyskiwanych w Bułgarii i w świecie. Przedyskutowano przyczyny niewielkiego rozpowszechnienia technologii selektywnej flokulacji i wskazano niektóre kierunki rozwoju zastosowań tej metody

А.Ботева, 1988. Практика использования селективной флокуляции при обогащении полезных ископаемых. Физико-химические вопросы обогащения, 20; 107-113.

Рассмотрены случаи применения селективной флокуляции при обогащении полезных ископаемых в Болгарии. Проведено сравнение полученных результатов у нас и в мире по использованию селективной флокуляции при обогащении руд цветных металлов. Сделан анализ причин ограниченного распространения у нас и в мире и высказаны некоторые соображения о будущем развитии метода.