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STUDY OF THE PROPERTIES OF WATER-AIR MICRODISPERSION OF A FLOATATION AGENT SOLUTION

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The objective of the study is to investigate the properties of water-air microdispersion of floatation agent solution. The air-water emulsion of flotation agent solution is obtained in the air-water microemulsion generator. Butyl airfloat, foaming agent C-7 and cationic collector butyltriethylenetetramine B-TETA have been studied as reagents. The factors influencing emulsion stability have been determined. It was found that the temperature increase worsens the stability of microdispersion, the optimal speed of the generator is 6 000 rpm and higher. Floatation agent solutions give stable microdispersions at different solution concentrations. The optimum microdispersion is obtained at a generator speed of 6 000 rpm from 0,5 g/l solution of butyl airfloat, from 50 g/l solution of C-7 and B-TETA. The particle size of the dispersion ranges from 41-59 μm.

Keywords: water-air microemulsion, floatation agent, foaming agent, particle size, properties

INTRODUCTION

Technologically, the problem of microdispersion flotation is related to the fact that as the size of mineral particles decreases, their behaviour in hydrodynamic flows changes, they lose mass, and a threshold limit comes thereunder a microparticle cannot accumulate any kinetic energy in motion providing it the ability to overcome the water-structure energy barrier when meeting the bubbles. In floatation concentration it results in loss of extraction of non-ferrous metals with microdispersions from 5 to 30 %.

The problem of flotation of particles smaller than 25 μm can only be solved by using air bubbles of less than 50 μm in the flotation process [1-3]. There is a so-called "turbulent micro floatation" method [4]. The fundamental difference between this method and conventional flotation is that the air bubbles used in the process are formed concentrated water-air micro-dispersion

which is then mixed with the pulp. There are different ways to produce microbubbles in the flotation process. The method of pneumatic flotation with preliminary aeration of pulp in centrifugal flotation machines is known. This method is implemented in the machine with pre-aeration of "KHD HumboldtWedag AG" that includes a chamber in the upper part of which there are "slot aerators", through which the feed pulp is tangentially supplied, and there is a pipe for discharge of concentrate in the central part [5].

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There is a known method involving the simultaneous use of bubbles of two sizes for floatation where micro-bubbles are obtained as a result of gas extraction from the pulp when it is pumped through the ejector, and macro-bubbles as a result of hydrodynamic influence of pulp flows on the bubble surface in the floatation machine chamber [6].

With the purpose to obtain water-air microdispersion, a generator [7] was used, the main element of which is a dispersion chamber, inside which, by means of a high-speed electric drive, a highly inhomogeneous hydrodynamic field is created, through which a mixture of air and concentrated solution of foaming agent is transformed into microdispersion of air in the aqueous phase.

When microdispersion is used, bubbles of different sizes are also formed in the floatation system: micro-bubbles of 20-70 μm, medium bubbles due to the attraction of several micro-bubbles (so-called bubble cascade) and macro-bubbles generated by the aerator of the floatation machine. The micro-bubbles and the bubble cascade, being mobile and more flotation active, attract fine minerals of less than 30 μm and stick to the surface of the macro-bubbles, which float to the pulp surface as a floatation concentrate.

By using stable microbubble sizes, the correct ratio of bubbles of different sizes accelerates the floatation extraction of microparticles. When creating the generator, the main task is to regulate the optimum ratio of macro and micro bubbles and to stabilise the dispersion of micro bubbles.

The properties of water-air microdispersion were studied in this work: temperature changes during the operation of the flotation machine and generator, the influence of the type of floatation agent on the stability of microbubble dispersion in the floatation system.

MATERIALS AND METHODS

The object of the investigation is butyl airfloat that has both gathering and foaming properties. The concentration of the solution is 0,5 g/l. The changes of pulp temperature in flotation chamber depending on operating time of flotation machine, on operating time of water-air-microdispersion and on frequency of rotation of the generator were studied. The results are shown in Figure1.

The results show that with the duration of time the pulp is heated, and with the use of a generator with increasing number of rotations the heating is more intense (curves 3,4 in Figure1). When laboratory test experiments were performed for a short period of time the heating of the head and consequently the heating of the pulp has no negative impact on the quality of water-air microemulsion. When enlarged tests were performed, an additional cooling enclosure to cool the dispersant head is required for longer tests.

The influence of floatation agent type on properties of water-air microdispersion was studied. Butyl airfloat, foaming agent C-7 and cationic collector butyl-triethylenetetramine B-TETA widely applied at processing plants of Kazakhstan were used as flotation reagents. The concentration of the reagent solution was varied from 0,05 to 50 g/l. Besides, the influence of temperature on the properties of the water-air microdispersion was studied, the temperature was varied from 20 °C to 80 °C.

The following concept was introduced - the stability of the water-air microemulsion that is the time it takes for the emulsion to be destroyed. For this purpose, a 500 dm^3 flotation agent solution is passed through a generator and a water-air microemulsion is obtained (Figure 2a). Then the mixing device and a stopwatch are switched on, and the time taken to destroy the microemulsion to a certain state is recorded (Figure 2b). The time taken for destruction indicates the stability of the water-air microdispersion.

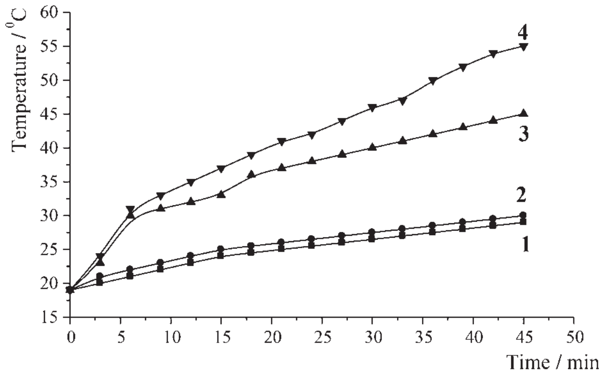
Size of water-air microdispersion was determined with a PhotocorCompact particle size analyzer.

The influence of generator speed on the size and stability of water-air microdispersion obtained from 0,5 g/l butyl airfloat solution was studied, the results are given in Table 1.

The results show that at low speeds the stability of the water-air microdispersion is insignificant. A quittance process begins at rotational speeds above 6 000 rpm: the stability of the microdispersion increases proportionally, and the size of the microemulsion decreases.

Table 1 **Dependence of size and stability of water-air micro-dispersion on generator speed**

Generatorspeed / rpm	Stability / sec	Size / µm
2 000	10	460
3 000	20	189
4 000	35	124
5 000	45	103
6 000	80	40
7 000	120	32
8 000	140	19



1 - laboratory flotation machine;
2 - with generator, 4 000 rpm;
3 - with generator, 5 000 rpm;
4 - with generator, 6 000 rpm

Figure 1 Dependence of pulp temperature on operating time of the flotation machine and on different modes of the generator

a) b)

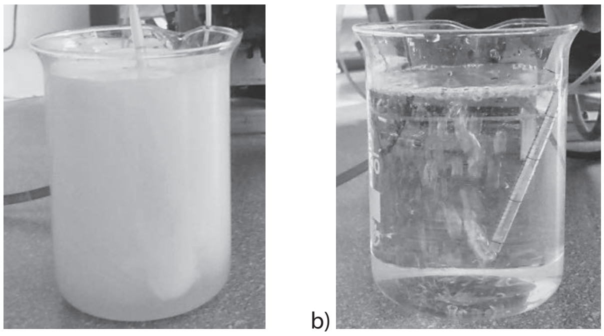
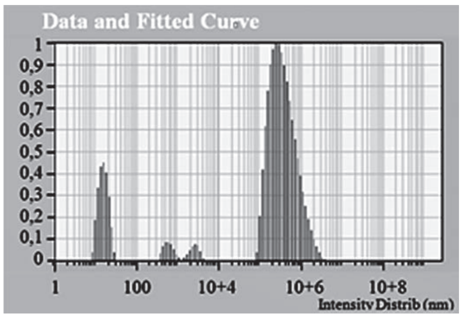


Figure 2 Image of water-air microdispersion before (a) and after (b) destruction



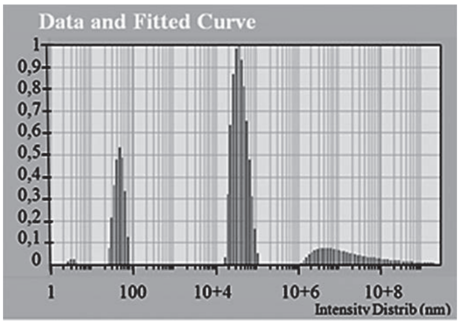
Peak Num	Area	Mean	Position	STD
1	0,149	15,53	15,19	4,355
2	0,027	589,6	573,1	165,6
3	0,020	2554	2601	575,3
4	0,804	4,6e+5	2,4e+5	4,1e+5

Figure 3 Distribution of particle in microbubbles (2 000 rpm)

Figures 3-5 shows the optimum dimensions of the water-air microdispersion obtained from a 0,5 g/l butyl airfloat solution at generator speeds of 2 000, 6 000 and 8 000 rpm.

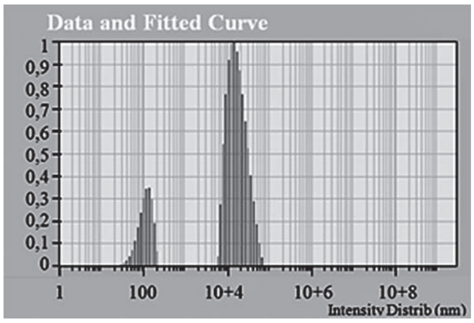
The results show that:

– the average particle size of microbubbles is 460 µm, the content (fraction) of these particles is 80,4 % (Figure 3) at 2 000 rpm;



Peak Num	Area	Mean	Position	STD
1	0,005	3,036	2,979	0,449
2	0,226	44,96	45,34	12,38
3	0,629	4,0e+4	3,5e+4	1,7e+4
4	0,141	3,9e+7	3,8e+6	7,8e+7

Figure 4 Distribution of particle in microbubbles (6 000 rpm)



Peak Num	Area	Mean	Position	STD
1	0,190	114,2	131,3	39,76
2	0,810	1,9e+4	1,4e+4	1,1e+4

Figure 5 Distribution of particle in microbubbles (8 000 rpm)

- the average size of microbubbles particles is 40 microns, the content (fraction) of these particles is 62,9 % (Figure 4) at rotational speeds of 6 000 rpm;
- the average size of microbubbles particles is 19 microns, content (fraction) of these particles is 81,0 % (Figure 5) at rotational speed 8 000 rpm.

RESULTS AND DISCUSSION

Table 2 shows the results of the effect of the concentration of the reagent solution and the temperature of the solution on the stability of water-air microdispersion and the size of the microemulsion (size) at a speed of the generator 6 000 rpm.

The results show that the temperature increase of the floatation agent solution, regardless of its type, negatively influences the stability of water-air microdispersion. The temperature increase results in coalescence of micro-bubbles that results in a decrease in the stability of the micro-dispersion. It is advisable not to raise the pulp temperature above 40 °C.

Table 2 **Dependence of microemulsion size and water-air microdispersion stability on concentration and temperature of the floatation agent solution**

Temperature/ °C	Floatation agent solution concentration / g/l							
	0,05		0,5		5		50	
	Stability/ sec	Size/ μm	Stability/ sec	Size/ μm	Stability/ sec	Size/ μm	Stability/ sec	Size/ μm
1	2	3	4	5	6	7	8	9
Butyl Aeroflot								
20	55	90	80	42	70	65	70	65
30	45	100	80	43	65	73	70	69
40	40	110	80	41	65	76	70	67
50	35	120	70	65	65	75	70	66
60	35	123	70	68	65	72	65	73
70	30	142	60	81	60	83	65	75
80	25	150	50	85	50	93	55	86
C-7								
20	30	143	40	112	70	55	75	55
30	30	142	40	116	70	57	75	54
40	25	153	40	114	65	75	70	58
50	25	156	40	113	65	74	70	59
60	25	151	30	145	60	82	65	72
70	25	154	30	147	55	88	65	71
80	25	152	30	143	55	87	65	71
B-TETA								
20	20	180	50	91	60	83	75	53
30	20	185	50	94	55	89	75	54
40	20	188	50	93	55	88	70	59
50	20	181	50	93	50	95	70	60
60	20	189	45	103	50	94	70	59
70	20	187	40	117	45	105	65	73
80	20	185	35	125	45	104	60	81

The type of floatation agent influences the stability of the water-air microdispersion. Butyl airfloat gives a more stable microdispersion at a concentration of 0,5 g/l, and the reagents C-7 and B-TETA at a concentration of 50 g/l. At these concentrations and a pulp temperature of 20-40 °C, the microdispersion size is between 41-59 µm.

Thus, the stability of the water-air microdispersion is influenced by the pulp temperature, the reagent concentration and the speed of the water-air microdispersion generator.

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Note: The responsible for English language is KurashA. A., Almaty, Kazakhstan