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THE COMPARISION OF VARIOUS ANALYTIC TECHNIQUES OF THE SUSPENSIONS PARTICLES SIZE DISTRIBUTION FROM ENRICHMENT PROCESS OF COPPER ORE

In the article there are described researches of particle size pattern in the float fluid of ore copper made by means of two different methods: analyses of the particle size in the stream of infrared rays stream, and analyses by use of sedimentation weight. Results of sedimentation process simulation are shown with use of certain parameters of particle composition. Used measurement techniques were analyzed whether they are useful for the industrial suspended particle fluids analyses.

Introduction. Almost in all of newest processing technologies we are dealing with the processing of small size particle materials. Effectiveness of the small particles processing is extremely dependent on the size of particles, therefore learning about size of the particles is vital for description how to run the processes. In real industrial processes particles create domains of different sizes – polydispersive domains and polydispersive suspended particles fluids.

Description of a particle size in analytical manner with help of random variables allow to describe different physical values, depend on particle size (average sedimentation particles speed, effectivity of sedimentation), in the shape of clear analytical equations, which are easy in writing and interpretation. For example for the process sedimentation effectiveness for so called limit of the particle diameter. Therefore being familiar with the composition of the particle sizes suspended in liquid allow to formulate engineers conclusions necessary for design and as well to run technological processes.

Parameters of particles grains in solid phase of fluids can be described by means of different type reading equipment, using for the measurement method different physical phenomenon. Character of those phenomena often have very important influence on the obtained results, directly (physical basics of measurement), or indirectly (other phenomena having influence on results of this measurements).

Research. The research presented in this article are the comparative research of the graining which were done by means of two different analysers: sedimentation balance and analyser IPS-L. The check of what results of the graining we reach from analysers basing on two different physical principle of measurement was the first research aim. The second – also important- was the determination of the relationship between the parameter values of the after-floating-suspensions produced by enrichment process of copper ore. This relationship is vital. Own research [1,2] showed that an increase of the suspension's concentration raises the m - parameter value of the logarithmic normal distribution, which is explained through occurring of the self-coagulation process. The above relationship refers to the diluted metallurgical suspensions, after-floating coal suspension and even to the model – PVC – suspensions.

The suspension produced by enrichment process of copper ore was the material for the research. The suspension was taken from the collector tank, where the suspension is being moved from the floating devices to the sedimentary tanks.

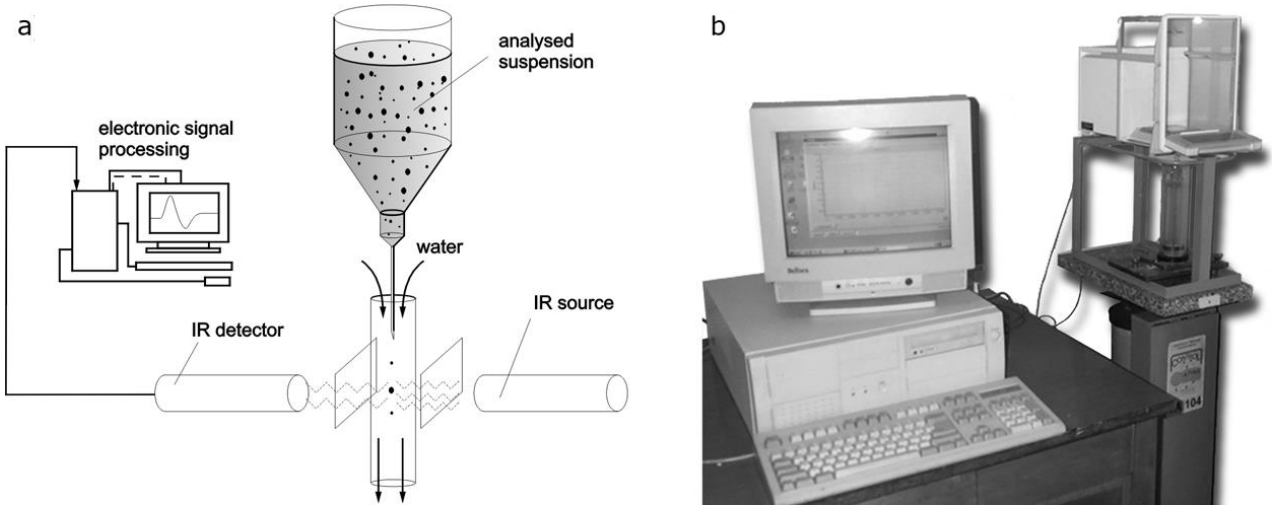
The average suspension density equal 2700 kg/m3 assumed.

Research methodology. IPS-L analyser. IPS-L analyser is the laboratory device used to the automatic measurement of the solid particle size in water, independently from their chemical and physics characteristics. The way of working of the IPS-L analyser (fig. a) is based on the measurement of the changes in the infrared radiation flux, which is being dispersed by the particles moving in the measurement zone. The computer registers the changes in the flux radiations after electronical treatment. After the completion of the sample tests the results are presented with the use estimator of the distribution parameters and with the distribution of various particles.

The analyser is composed of the measurement sensor, electronic system of the particle automatic dose integrated with the sensor. The above system guarantees the continuity of the measurement and the control of the particles concentration in the measurement zone.

The analyser's principle of operation (the measurement of the single solid phase particles of suspension) gives some limits: the concentration of suspension could not be too high, in order that sensor measurement space should not appear particle coincidence. As a result of the above the measurements concentration of suspension is very low and that does not reflect the real conditions in the settler.

The suspension sample with volume of 500 cm3 was diluted to the volume of 1000 cm3, and 5, 10, 15 and 20 cm3 one after another of this sample were taken. These were diluted in the analyser meter to the volume of 45 cm3. The measure was repeated 4 times and the results were averaging.



Measuring apparatus: a) IPS-L analyser (functioning schema), b) stand of sedimentation balance

Sedimentation balance. The tests of the suspension were done by means of the Mettle Toledo sedimentation balance (fig. 1b). Electronic system of the balance enables continuous reading of the mass accurate to 0,1/1 mg within the range 0 ÷ 62/405 g. The mass is settled on the scale pan, which could be underslung of the balance bottom. The reading results are saved continually on the computer. The precise description of the stand and way of interpretation of the results from the sedimentation balance are published in [3,4].

A special software, which supports the standard software "Balance Link" of the balance, was written in order to elaborate data. The range of balance set is very wide. The test duration was within the range from 2 to 12 and the reading of the mass happened every 0,5 s. The suspension taken form the collector tank after floating devices was averaging by mixing each time. To the measuring cylinder were taken subsequently 15, 45, 60 and 100 cm3 and they were diluted to the volume of 300 cm3 each time.

For the samples diluting there was only one type of filtrate used (coming from the same suspension). The purpose was a necessity to guarantee the same physical and chemical conditions to all the samples. The samples were made to sedimentation in the measuring cylinder, which was equipped with scale pan, which could be underslung of the balance

After subsequent measure the suspension was mixed and the measure was repeated 3 times. There was no dispersing agent.

As a result of each test the author reached the set of dependences of settled mass on the scale pane in time function. This set was treated as the input data for the author's software, which determined the grain parameters for assumed statistic distribution function [3]. This software used the procedures MINUIT of non-linear function from CERN library. The detailed method of results analysis was published in [5].

In contradistinction to the IPS-L analyser the measure with use the sedimentation scale does not introduce any deformations in the size distribution caused by the concentration changes – the measure is done on the suspension from real system, settling tank. Because of that the sedimentation scale is the device, which results are more proper for the sedimentation efficiency calculation purpose.

Results. IPS-L Analyser The distribution of the particles number in 256 size grades was the result of the measure, which by means of author's software was transformed and the parameters of logarithmic normal distribution of particles size were calculated

The results are presented in the table 1.

Table 1

IPS-L Analyser results

Sample	Relative concentration	Distribution parameters		Regression estimators	
		m	σ	R^2	F
UCU_0001	5	2,97961	0,59851	0,97552	1141,5
UCU_0003	5	2,95348	0,62554	0,97608	1169,088
UCU_0005	5	2,96238	0,59712	0,97943	1366,204
UCU_0007	5	3,02712	0,61412	0,97959	1377,524
Average		2,98	0,61	0,97765	1263,578
UCU_0101	10	3,05241	0,56682	0,95866	658,303
UCU_0103	10	3,06153	0,59205	0,96287	737,8238
UCU_0105	10	3,15273	0,63393	0,97047	938,823
UCU_0107	10	3,27997	0,57556	0,96591	807,3254
Average		3,13666	0,59209	0,964478	785,5688
UCU_0201	15	3,24367	0,63491	0,96408	764,0182
UCU_0204	15	3,23271	0,64978	0,96906	893,9192
UCU_0207	15	3,23239	0,58331	0,96176	715,2054
UCU_0210	15	3,40443	0,66105	0,96025	686,3715
Average		3,2783	0,63226	0,96378	764,8786
UCU_0301	20	3,23	0,62431	0,97114	961,4753
UCU_0303	20	3,36	0,67342	0,97111	960,4546
UCU_0305	20	3,56919	0,66278	0,94367	471,7036
Average		3,38637	0,6535	0,961973	797,8778

Sedimentation balance. The results of the balance were treated as the input data for the author's software, which determined the grain parameters for assumed logarithmic normal grain sizes distribution. The gained results are presented in the table 2.

Table 2

Sedimentation balance results

Sample	Concentration [g/dm^3]	Distribution parameters		Regression estimators	
		m	σ	R^2	F
p3-15-1	4,187	3,298	0,407	0,99124	700128
p3-15-2	3,801	3,187	0,416	0,99460	1337027
p3-15-3	3,970	3,145	0,473	0,98977	2683662
Average	3,98	3,21	0,432	0,99187	1573606
p3-45-1	10,429	3,234	0,296	0,99801	4083010
p3-45-2	10,504	3,231	0,311	0,99748	2041485
p3-45-3	10,414	3,225	0,319	0,99720	10159604
Average	10,49	3,21	0,432	0,99756	5428033
p3-60-1	13,447	3,167	0,284	0,99744	2189123
p3-60-2	13,241	3,127	0,289	0,99672	8787427
p3-60-3	13,373	3,122	0,293	0,99721	2097084
Average	13,353	3,138	0,288	0,99712	4357878
p3-100-1	20,922	2,964	0,523	0,98386	1536632
p3-100-2	21,171	2,964	0,532	0,98168	241979
p3-100-3	21,504	2,960	0,516	0,98398	498651
Average	21,199	2,963	0,524	0,98137	759087

Conclusion:

– The after-floating-suspensions produced by enrichment process of copper ore (as well as the diluted metallurgical suspensions and after-floating coal suspensions) show the tendency of changing of the grain constitution's parameters in dependency on the suspension's concentration.

– In the case of granulometric analysis (the measure is carried out by the IPS-L analyser, where the physical nature of the measure constrains a high diluted suspension), we have to do with an increase of m-parameter and an relative stable value of the σ logarithmic normal distribution parameter.

– The granulometric analysis of a high concentrated suspension (a sedimentation balance measure) shows a decrease of both m and σ parameters along with the concentration increase.

– The parameters values of the grain constitution gained from these two analyzing devices are not comparable. The physical nature of the measure carried out by the IPS-L analyzer constrains a high dilution. That makes appeared another physical phenomenon - self-coagulation. The self-coagulation does not occur within the high concentrated suspensions.

The laboratory research of sedimentation efficiency should be as the complement of this research. In order to compare of compatibility of real efficiency calculated on the basis of parameters values of grain constitution.

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