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INVESTIGATION OF THE INFLUENCE OF THE ZETA-POTENTIAL ON THE FILTRATION RATE IN THE PRESENCE OF COLLECTORS

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Translation of "Issledovaniye vliyaniya dzeta-potentsiala na skorost' fil'trovaniya v prisutstvii soberateley," Izvestiya Vysshikh Uchenykh Zavedeniy, Gornyy Zhurnal, Vol. 17, No. 2, 1974, pp. 160-163

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16. Abstract

The value of the zeta-potential does not have an explicit effect, which can be expressed by a simple math correlation, on filtration rate when a soln. of the tested collector is filtered through a cake prepd. under standard conditions from the examined particulate material. The zeta-potential measurements and filtration tests were carried out on silica and galena with solns. contg. a cationic container ANP and Et xanthate, resp. at pH= 6.5, varying concentration of the agent (0-2500 g/ton), and under a vacuum of 100-600mm Hg.

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Investigation of the Influence of the Zeta-Potential on the Filtration Rate in the Presence of Collectors

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The paper is devoted to a study of the influence of the zeta-potential of capillary systems formed by the solid phase of suspensions in the presence of collectors, and its influence on the filtration capacity of the sediment. /160*

We studied the influence of the cation collector ANP[1] on quartz suspensions and of ethyl xanthogenate on suspensions of galenite in distilled water at pH = 6.5.

In order to measure the zeta-potential, electric resistance and rate of filtration at constant height of the sediment layer in parallel for each object, we used an instrument designed by Zhukov and Kryukov [1] with internal diameter of the tube of 12 mm.

The zeta-potential as defined in terms of the flow potential:

$$\varphi = \frac{4\pi\eta\chi_v}{7} \frac{E}{P} \cdot 6.75 \cdot 10^7,$$

where ϕ is the zeta-potential, mV; P is the pressure, cm Hg; η is the viscosity of the solution, poise; χ_v is the electric conductivity of the solution, Ω^{-1} cm^{-1}; $6.75 \cdot 10^7$ is a scaling factor to obtain the value of the ϕ-potential, mV.

The tests were done under steady conditions. Through a sediment

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*Numbers in the margin indicate pagination of the original

[1]ANP - primary hydrochloride amines with slight admixture (3%) of secondary amines.

previously formed in the cell, we filtered solutions under a vacuum of 100-600 mm Hg, changing from one concentration to another without disrupting the structure of the sediment and repeatedly forming a sediment.

When solutions of ANP in the concentration interval from 1 10^{-4} to 5 10^{-3}% by weight (50-2500 g of 100% collector per ton of dry sediment) are filtered through a formed layer of quartz sediment with grain size of 60 μm, the zeta-potential of quartz varies continuously from -36.4 mv to +59 mv (Fig. 1, curve 1) because of adsorption of ANP on the surface of the solid particles. The size of the zeta-potential of quartz conforms to the data of other researchers [2]. The rate of filtration does not increase with rise in concentration of the solution of ANP, which is apparently due to blockage of the voids of the sediment and of the pores of the filter partition with adsorbed ANP.

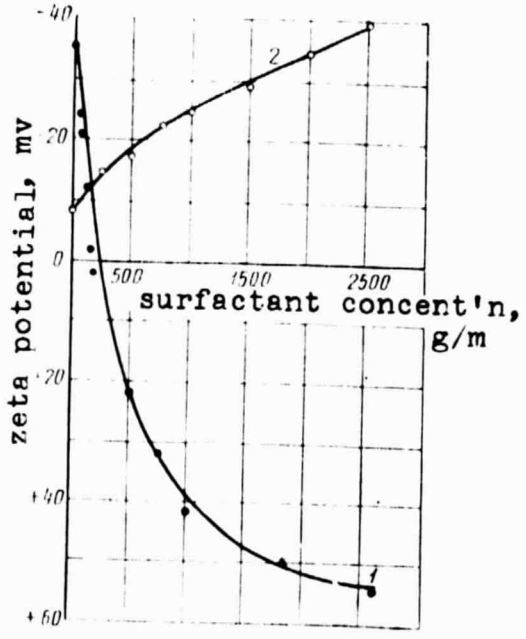

Fig. 1. The zeta-potential of quartz and galenite as function of the concentration of collectors at pH = 6.5; 1 - quartz + cation collector ANP; 2 - galenite + ethyl xanthogenate.

For a filtration with formation of sediment in the corresponding /162

solution with ANP outlay varying from 0 to 250 g/m, the rate of filtration of pure filtrate across a constant layer of sediment increases by a factor of 1.5-2, depending on the vacuum (Fig. 2, curves 3, 4), which corresponds to a decrease in the zeta-potential, while the maximum rate corresponds to a value of zero. The height of the sediment for a vacuum of 600 mm Hg was increased by 5%. Upon further increase in the outlay of ANP up to 1000 g/m, the rate of filtration remains constant for low vacuum and diminishes slightly as the vacuum is increased. The zeta-potential grows in positive value, suggesting the continuing adsorption of ANP by the surface of the particles. There are two possible reasons for the decrease in rate of filtration after its maximum.

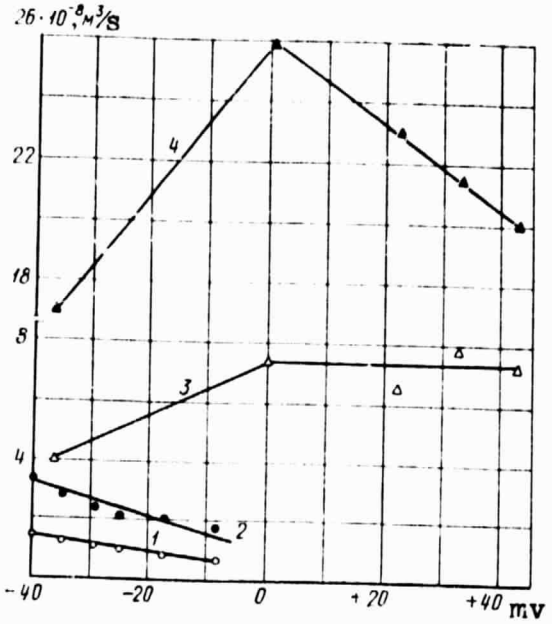

Fig. 2. Influence of the zeta-potential (abscissa) on the rate of filtration (ordinate) at constant height of the layer of sediment with repeated formation of it: 1, 2 - galenite + ethyl xanthogenatc; 3, 4 - quartz + cation collector ANP. Vacuum, mm Hg: ○ — 100; ◐ — 200; ●▲ 600

Deflocculation, corresponding to a rise in the positive zeta-potential produced by further binding of the hydrocarbon ions of the collector to the surface of the particles, or formation of

micelle-like coatings when the ions are oppositely oriented (polar portion of the ion toward the solution), is unlikely for the given system of quartz + ANP, according to the literature [3].

A blockage of the voids of the sediment and pores of the filter partition with collector is more probable.

Studies done on galenite with grain size of 20 μm in presence of ethyl xanthogenate with repeated formation of sediment as one concentration changes to another and a vacuum of 200-600 mm Hg revealed that, as the outlay of xanthogenate increases from 0 to 2500 g/m, the zeta-potential varies from -7.5 to -40 mv (Fig. 1, curve 2). The rate of filtration increases by 2.2 times for a vacuum of 200 mm Hg and 1.9 times for 600 mm Hg. The height of the sediment for a vacuum of 600 mm Hg is increased by 23%. For both quartz and galenite as the vacuum increases the efficiency of the collectors decreases, due to the greater compaction of the sediments produced in presence of the collectors.

The zeta-potential of galenite in distilled water is 19-20 mv. In our tests it is equal to -7.5 mv [2, 4]. The discrepancy in values of the zeta-potential can be explained by partial oxidation of the galenite surface [5].

On the basis of the findings we may infer that the chief reason for the increase in rate of filtration in presence of collectors is the change in structure of the sediment, produced by aggregation of particles.

When ANP is added to a quartz suspension, evidently a process of coagulation of the mineral grains occurs, the extent of which is governed by the size of the zeta-potential [6]. A decrease in the zeta-potential corresponds to a rise in degree of coagulation of the grains, with maximum coagulation occurring at the zero charge point.

In the presence of ethyl xanthogenate, the rate of filtration of

the galenite suspension increases with the zeta-potential. Consequently, a process of flocculation is possible with one of two mechanisms as proposed on the basis of experimental data [7].

Thus, change in the zeta-potential in the presence of collectors is not a unique characteristic of the filtration capacity of a sediment.

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