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ON THE MECHANISM OF ACTION OF REAGENTS IN FLOTATION

!\[Fig. 1. Trace of a drop of an aqueous solution of xanthate on the surface of a galena grain\](image)

1957-01-01T00:00:00+00:00

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Abstract

Full Text

PHYSICAL CHEMISTRY

V. I. KLASSEN and L. P. STARCHIK

ON THE MECHANISM OF ACTION OF REAGENTS IN FLOTATION

(Presented by Academician P. A. Rehbinder, March 25, 1957)

Already the early works in the theory of flotation drew attention to the exceptional importance of the linear zone of three-phase contact. P. A. Rehbinder pointed out that it is precisely in this zone that one should seek the key to the molecular mechanism by which reagents act on the adhesion of mineral grains to air bubbles ((^{1})). Ostwald suggested that collector reagents are fixed predominantly along the three-phase contact; reagents whose molecules have a "triphilic" structure, i.e., groups having affinity, respectively, for the mineral, water, and air, are especially suitable for this ((^{2})). Such molecules should be most firmly fixed at the three-phase boundary between phases. Bradley considered the phenomena of line tension and linear adsorption at three-phase boundaries, and D. Talmud experimentally established that nonpolar oil reagents form a thin thread along the phase boundary ((^{3})).

Fig. 1. Trace of a drop of an aqueous solution of xanthate on the surface of a galena grain

All these considerations were not, in essence, confirmed experimentally, especially as applied to cases of froth flotation. Therefore they are practically not taken into account by most investigators.

Meanwhile, if the increased concentration of molecules of collector reagents in the zone of three-phase contact is confirmed, it will be possible in many respects to clarify the mechanism by which mineral grains are fixed on bubbles, the causes of molecular hysteresis of wetting ((^{1})), and also to explain the possibility of flotation at extremely low concentrations of reagents. Experimental confirmation of the assumptions indicated may thus play a positive role in the development of the theory of flotation and, consequently, in its practice.

Previous investigations carried out by I. N. Plaksin and by us ((^{4})) confirmed

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Fig. 2. Trace of an air bubble that adhered to the surface of a galena grain in an aqueous xanthate solution

Figure 2: Fig. 2. Trace of an air bubble that adhered to the surface of a galena grain in an aqueous xanthate solution

that part of the hypothesis which concerned the behavior of reagents sparingly soluble in water. In the case of sufficient hydrophobicity of the mineral surface, droplets of such reagents are instantaneously drawn out into a continuous thread along the three-phase contact. This considerably increases the strength with which grains are fixed on bubbles. The presence of such reagents markedly raises the upper size limit of grains of coal, native sulfur, and similar minerals passing into the froth product during flotation.

The experiments described here made it possible to confirm the presence of an elevated concentration, in the zone of three-phase contact, of the principal collecting reagents, whose molecules have a heteropolar structure. Potassium ethyl xanthate with a radioactive sulfur isotope (S^{35}) was taken as a representative of such reagents, and galena* as the mineral. The principal method of investigation adopted was microautoradiography ((^{5})).

Fig. 2. Trace of an air bubble that adhered to the surface of a galena grain in an aqueous xanthate solution

In the first series of experiments, large galena crystals with clearly expressed cleavage planes were oriented so that one of the planes lay strictly horizontal. Drops of an aqueous xanthate solution (concentration (50) mg/l) were applied to it with a pipette. After 2 min the drop was removed with filter paper. The grain was placed on the emulsion of a photographic plate, and after a definite exposure the plate was developed. In almost all cases it was possible to observe the presence of a dark border along the former contour of adhesion (see the photograph in Fig. 1), which indicates a preferential concentration of xanthate molecules in this zone.

The second group of experiments corresponded even more closely to the flotation event. A galena grain was placed in the same xanthate solution. After 1–2 sec an air bubble was placed on its plane. After 1–2 min the grain was removed from the solution, carefully dried, and an autoradiographic print was made from its plane. The experiments showed that, even with this method of experiment, the molecules of radioactive xanthate are concentrated along the boundary of three-phase contact (Fig. 2).

Thus, it may be considered that the concentration of collector-reagent molecules in the zone of three-phase contact is increased in comparison with other regions of the mineral surface; further research in the theory of flotation must take this into account.

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Academy of Sciences of the USSR

Received
14 III 1957

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* The experiments with the drop were carried out by V. V. Troitskii.

Note: Figure translations are in progress. See original paper for figures.

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