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Abstract

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Interaction of Oxy Forms of Oleic Acid with the Surface of Certain Minerals

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In the process of adsorption of flotation reagents on the surface of minerals, chemical reactions may occur not only with atoms of the lattice of the solid phase during the formation of a monomolecular layer. Surface-active substances of the type of unsaturated fatty acids affect the state of the surface, just as the surface changes their form ([1]). Infrared spectra of emulsions of oleic acid treated with oxygen showed a change in the structure of the molecules and the formation of thixotropic colloidal aggregates in the bulk ([2]). Similar treatment of certain minerals also indicates a change in the surface layer ([3]).

To study the structure of organic collector reagents and inorganic regulator reagents adsorbed on minerals, the method of infrared spectroscopy was used, which makes it possible to judge the properties of chemical compounds. IR comparison spectra were recorded on an IKS-12 spectrometer with a rock-salt prism. The samples were prepared according to a previously developed procedure ([4]). The amounts of reagents were those used in flotation experiments.

The data obtained are presented in Figs. 1 and 2. The comparison spectra on the absorption scale do not fall within the limits of 100%. This phenomenon is used in spectral-recording methods when mineral grains are covered with an oil film or distributed in a substance that transmits IR rays well.

The general character of the spectra confirms that the adsorption of oleic acid is film-like in nature ([5]). A similar phenomenon was also observed on coal particles ([6]).

In the surface layer of limonite particles treated only with oleic acid, epoxy compounds, ions, salts, and reagent molecules are observed. Owing to the acidic character of the hydroxyls of the surface atoms of the mineral lattice, epoxy compounds possessing a weak negative charge are adsorbed first. After their decomposition, the amount of iron hydroxyoxides possessing the same properties increases, and other components appear. Iron sulfate has a similar effect. This leads to the appearance of a strong band in the 3-micron region.

In the 10-micron region of the spectrum of the surface layer of limonite treated with oleic acid, no increase in transmittance is observed, which indicates a weak

concentration of hydroxyls of iron atoms of basic and amphoteric character. Treatment with ferrous sulfate, water glass, and oleic acid gives increased transmittance in the region of 980 cm^{-1}, which is associated with the formation of chemical compounds on basic hydroxyls. Blocking of acidic hydroxyls may occur by basic and amphoteric hydroxyls formed after hydrolysis of iron sulfate, and by the formation of thixotropic colloidal structures. Water glass, after hydrolysis and adsorption, builds up colloidal aggregates in the surface layer, increasing their strength.

Fig. 1. IR spectra of the limonite surface after treatment. Soda concentration 200 mg/l. Mineral layer thickness 1.8 mg/cm^2. *a* —oleic acid 133 mg/l; *b* — ($Fe_2(SO_4)_3$ + Na_2SiO_3) 133 mg/l; *c* —($Fe_2(SO_4)_3$ + Na_2SiO_3) 133 mg/l and oleic acid 133 mg/l.

Fig. 2. IR spectra of minerals after treatment. Soda concentration 200 mg/l. Oleic acid concentration 133 mg/l. Mineral layer thickness 1.8 mg/cm^2. *a* — ferruginized quartz; *b* —ferrimolybdite; *c* —molybdenum oxide sol.

Comparatively, the spectra of ferruginized quartz, ferrimolybdite, and molybdenum sol oxidized and treated with oleic acid show all the principal absorption bands observed earlier.

The band of acidic hydroxyls in the 3-micron region is caused by the presence of molybdenum atoms. In the 4-micron region, absorption bands are observed at 2100, 2210, 2380, and 2580 cm^{-1}. Analogous absorption is observed for compounds of the series $HC \equiv CR$ in the interval 2140-2100 cm^{-1}, and in the case of $RC \equiv CR'$, in the interval 2260-2190 cm^{-1} (7). The presence of an absorption band at 1780 cm^{-1}, unambiguously indicating the presence of peroxide structures of molecules of the fatty series, makes it possible to suppose that the oxidation of oleic acid by surface molybdenum groups may proceed with the formation of dioxides—$RC\left\langle\frac{O}{O}\right\rangle CR'$ (2100 and 2580 cm^{-1}), as well as of a six-membered ring of diperoxides—$RC\left\langle\frac{O—O}{O—O}\right\rangle CR$ (2210 and 2380 cm^{-1}). In the first case the oxy-forms arise at the site of the double bond, and in the second—from ions.

The formation of thixotropic colloids on the surface of limonite is confirmed by the clearly pronounced aggregation of particles in the pulp during flotation. Quasipolymeric structured films of the oxy-forms of the reagent cause strong flocculation of ferrimolybdite grains. The surface of ferruginized quartz, previously treated with a solution of sulfuric acid, has a large surface charge, which prevents flocculation of the particles.

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