The Sorption of Copper and Chromium Ions by Oxihydrate of Tin

Alaaddin Abbasov, Fizza Memmedova, Ayten Memmedova
Azerbaijan National Academy of Sciences, Nakhchivan Branch, Institute of Natural Resources

By treating water-organic solvent mixture of SnCl₄ with ammonia, highly porous samples of tin (IV) oxihydrate have been obtained, the influence of the dielectric constants of organic solvents on the special surface values of obtained precipitate has been elucidated as well.

The dissociation constants of the surface groups of oxihydrate were determined by means of heterogenic potentiometric titration method and it was established that at least two types of hydroxyl groups exist on the surface of oxihydrate: \( pK_1 = 7.3 \pm 0.2 \) and \( pK_2 = 9.4 \pm 0.1 \)

By changing in a wide interval the acidity of medium as well as the concentration and duration of contact of the ions subjected to sorption, the conditions of sorption of copper and chromate ions by tin (IV) oxihydrate were investigated, the values of the equilibrium and kinetic parameters in the static condition were evaluated and the sorption isotherms were constructed. It was affirmed that copper ions’ absorption process is not confined to ion exchange stage and the fact that the amount of absorbed copper exceeds that of the hydroxyl groups in the composition of oxihydrate approximately for four times was ascertained by means of calculations. Moreover, it was demonstrated that in the state of maximum absorption the product of sorption is characterized by \( \text{CuO} \cdot 1.72\text{SnO}_2 \cdot \text{H}_2\text{O} \) formula. On the other hand, the compound formed during the sorption of chromate ions conforms to \( \text{SnO}_2 \cdot 1.1\text{CrO}_3 \cdot \text{nH}_2\text{O} \) formula. The maximum absorption of copper ions by oxihydrate occurs from 0.4 mol/l ammonia solution, while that of chromate ions is observed in the strong acid medium (pH=1). In the given instances the entropy factor \( \lambda [\exp(\Delta s/R)]^{1/2} \) is characterized by fairly low values compared with other sorption conditions, which proves from theoretical standpoint that during the maximum absorption, the sorption equilibrium is established faster. It was determined that the isotherms of sorption of both ions by oxihydrate submit to Lengmuir and Freundlich equations and corresponding formulas were proposed. In the interval of 298-328K the dependence of the processes’ speed on temperature was investigated, the values of activation energy and thermodynamic parameters were calculated, and on the basis of obtained findings, the kinetic mechanism and thermodynamic picture of processes were determined. In the range of low values of saturation (\( F=0.3-0.35 \)), the linear character of \( B_t-t \) dependence makes it possible to argue that the kinetics of processes are under control of internal diffusion. The values evaluated for diffusion coefficients affirms it too: \( D = (2.25-8.85) \times 10^{-9} \) cm²/s. In the investigated interval of concentration the processes are characterized by the low values of enthalpy and free energy, the decrease in enthalpy and increase of entropy parallel with the saturation of sorbent with ions.

The results of the research can be applied to refining the waste water of electrolysis factories from chromate ions without reducing hexavalent chromium to trivalent chromium.