Abstract

Dissertation topic: «Complex titanium-containing coagulants: synthesis and applications».

Relevance of the research. At present, the level of industrial development is steadily increasing, the list of manufactured products is expanding and, which leads to an increase in the volume of wastewater generated that requires treatment before being discharged. The most basic and widely used method of water treatment and water treatment is coagulation water treatment. However, due to the fact that the used aluminum- or iron-containing coagulants demonstrate insufficient efficiency and are expensive, there is a need to synthesize modern complex reagents for water purification and water treatment. The elimination of the disadvantages inherent in traditional coagulants is ensured by the synthesis and use of complex coagulants capable of exhibiting high efficiency due to the presence in their composition of several active metal salts that exhibit a synergistic effect.

Industrial technologies for obtaining both traditional coagulants based on aluminum and iron salts, and, in particular, titanium coagulant, are very expensive and require high reagent costs, since expensive components are used as feedstock. In view of this, seems to be relevant the synthesis of highly efficient and cheap complex reagents, for example, large-tonnage wastes from the enrichment of apatite-nepheline ore, which contain up to 30 wt. % aluminum oxide and waste from the production of refractory materials containing up to 80 wt. % by the sum of oxides of aluminum and magnesium. Acid leaching of aluminum-, iron- or titanium-containing raw materials, as well as the processes of drying liquid or pasty forms of coagulants, are accompanied by significant reagent and capital costs. These shortcomings can be significantly reduced by replacing traditional mineral acids with titanium tetrachloride solutions, the use of which will make it possible to obtain complex coagulants containing two active components involved in the water purification process.

The purpose of this work was to develop the fundamentals of energy- and resource-saving technologies for the production of innovative, highly efficient

complex titanium-containing coagulants from various mineral raw materials, including industrial waste.

To achieve this goal in the dissertation work, it was necessary to solve the following **tasks**:

1) to modernize the existing technology for obtaining a complex titanium-containing coagulant in order to improve the characteristics of the resulting product;

2) to study the effectiveness of the interaction of aqueous solutions of titanium tetrachloride with various neutralizing agents;

3) evaluate the possibility of obtaining complex coagulants from waste products of various industries;

4) confirm the coagulation efficiency of individual titanium compounds and complex coagulants based on them;

5) set restrictions on the content of $SiCl_4$ impurity in $TiCl_4$ solutions on the stability of the synthesized liquid coagulants in time.

Scientific novelty

- In the course of studying the chemical activity of aqueous solutions of titanium tetrachloride in relation to aluminum oxide and hydroxide, it was found that $TiCl_4$ solutions in reactions with aluminum oxide/hydroxide are 1,5-2 times superior in their chemical activity to hydrochloric acid solutions of an equivalent concentration;

- The efficiency of aluminum leaching with $TiCl_4$ solutions from nepheline concentrate (85%) and magnesium from brucite (40%) was determined.

- Based on studies of the effect of $SiCl_4$ impurity on the stability of aqueous solutions of $TiCl_4$, it was found that the admixture of silicon tetrachloride up to 0.4 wt.% does not affect the storage time and the rate of hydrolysis of 20 wt.% -30% titanium tetrachloride solutions;

- Specific surfaces of hydrolysis products of complex Al-Ti coagulants (77-201 m^2/g) were determined in comparison with individual aluminum salts (45-63 m^2/g);

- For the first time, an assessment was made of the effect of additives of titanium compounds on the effectiveness of aluminum-containing coagulants. It is shown that in the process of coagulation treatment of various types of wastewater, mutual neutralization of the charges of aluminum and titanium hydroxocomplexes occurs with an increase in the purification efficiency by an average of 10-15%.

Theoretical and practical significance

- The technology for obtaining titanium coagulant from the oil sands of the Yaregskoye field has been modernized, providing a 2-fold increase in the yield of a solid product with a high content of water-soluble aluminum compounds and a significant decrease in the inert phase of the coagulant.

- Pilot tests were carried out, specifications for the production of titanium-containing coagulants were developed (Specifications 20.13.31-003-87707082-2017 and Specifications 2163-001-87707082-2012);

- The fundamentals of an energy-saving technology for obtaining a complex sulfate-chloride coagulant by the method of chemical dehydration with the content of unreacted $Al(OH)_3$ less than 2 wt. %.

- The basics of technologies for obtaining complex coagulants (titanium-nepheline and titanium-magnesium) from apatite-nepheline ore enrichment waste and waste from the production of refractory materials (brucite) using titanium tetrachloride solutions as leaching agents are proposed. A patent for the production of Al-Ti-nepheline coagulant was received (RU 2624326 C1, 03.07.2017).

- It has been proven that the use of titanium compounds as a modifying additive (in an amount of 5 to 10 wt. %) helps to reduce the consumption of aluminum-containing coagulants (by 1.5-2 times) and improves the filtration characteristics of the coagulation sludge.