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METHODS FOR OBTAINING IRON OXIDE NANOPARTICLES

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Annotation. Today, the importance of chemistry in the scientific and technical life of the world is showing its true impact. The increasing number of publications in the field of synthesis of magnetic sorption materials and their application in chemical analysis indicates that the search for new magnetic sorbents is ongoing. Although the sorption capacity of iron oxide nanoparticles is directly quite high, they are rarely used as magnetic sorbents. The relative simplicity and low cost of obtaining magnetic sorbents allow for their synthesis.

Key words: Chemistry, Magnetic nanocomposite sorbents, nanoparticles, inorganic or organic compounds, pH value, iron oxide, sorbent, natural polymers.

Introduction. Nanoparticles are mainly used as magnetic materials to create magnetic sorbents using the MTFE method, which is due to the relative simplicity of MNZ synthesis, the ability to control their size by changing the synthesis conditions, and their high magnetization. Maghemite (γ-Fe_2O_3), which has ferrimagnetic properties, is less commonly used. Although the sorption capacity of iron oxide nanoparticles is directly much higher, they are rarely used as magnetic sorbents[1]. First of all, this is due to the tendency of nanoparticles to aggregation due to the high surface energy inherent in finely dispersed structures, as well as their non-selectivity. Changing the orientation of the surface of Fe_3O_4 nanoparticles allows you to increase their aggregative stability and give them the necessary sorption properties[2].

Main part: Methods for synthesizing MNZs of iron oxides are fully described in the reviews [3], therefore, in this section we will mention some works devoted to modern methods for preparing MNZs of iron. One of the most convenient and frequently used methods for obtaining Fe_3O_4 nanoparticles is the method of co-precipitation of iron (II) and (III) salts (Massard method) [4]. The essence of the method is to precipitate Fe_3O_4 in an aqueous medium by adding ammonia to a solution of a mixture of iron (II) and (III) chlorides in a ratio of 1 : 2. Various modified versions of this technique have been described, differing in the type of iron salts and hydroxides used, salt concentration, temperature, and duration of heating. The most important parameters affecting the shape, size and composition of the particles are the molar ratio of Fe(II) / Fe(III), the nature of the precipitate, the heating temperature and duration [3]. Fe_3O_4 particles have been shown to form at ~80°C, while Fe_2O_3 particles are formed at a lower temperature (~60°C) [5]. Depending on the synthesis conditions, the size of Fe_3O_4 nanoparticles ranges from 2 to 20 nm [6]. In some cases, magnetite is synthesized in the presence of various stabilizers, such as oleic acid [7] or cetyltrimethylammonium bromide [8], which also significantly affects the morphology and size of the resulting Fe_3O_4 nanoparticles. In this case, nanoparticles with a diameter of 20–50 nm are formed [9]. The use of microwave heating allows to increase the uniformity of particle size and reduce the synthesis time. Nano-sized γ-Fe_2O_3 particles are often obtained by adding ammonia to an aqueous solution of iron (III) chloride in the presence of Na_2SO_3 [10]. The second most common, but more difficult to implement, method of synthesis of Fe_3O_4 MNZ for obtaining magnetic sorbents is the solvothermal method. The essence of the method is the reduction of iron salts with polyhydric alcohols (usually ethylene glycol) at high temperatures in the presence of various salts. The synthesis

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is carried out in an autoclave under high pressure. In the reaction system, polyols act as both a solvent and a reducing agent. A typical synthesis process is as follows: iron (III) salt (usually chloride) and sodium acetate are dissolved in ethylene glycol in the presence of a small amount of water, then placed in an autoclave, heated to 200 °C and maintained. at this temperature for 4 to 18 hours, cooled to room temperature, and isolated precipitate of magnetite. Despite the length and complexity of the process, in recent years this synthesis method has been increasingly used to obtain magnetic sorbents, as it allows obtaining nanoparticles of uniform size [11]. It is the thermolysis of organometallic compounds in incompatible solvents. For example, 100 nm Fe3O4 nanoparticles were obtained by thermolysis of iron acetate in benzyl alcohol at 175 °C for two days in a nitrogen atmosphere [12]. By reducing iron acetylacetonate in 1,2-hexadecanediol at 263 °C in the presence of oleic acid and oleinamine, 5 nm Fe3O4 nanoparticles were obtained, which were used to obtain magnetic sorbents coated with a layer of silicon oxide [13]. In some cases, commercially available nanoparticles of iron oxides are used to synthesize magnetic sorbents, the production of which is mastered by a number of companies in industry. Other examples of commercially available MNZ nanoparticles are given in the reviews. To achieve students' understanding of the most important basic knowledge of science, concepts, laws, theories, or the foundations of science. To form a scientific materialistic worldview. To cultivate in students such qualities as a positive attitude towards the development of modern society, diligence, interest in science, and care for and protection of nature[14].

Conclusion. Thus, the second most common, but more difficult to implement, method for the synthesis of Fe3O4 MNZ for obtaining magnetic sorbents is the solvothermal method. The synthesis of magnetic nanomaterials based on Fe3O4 using saponins as surfactants is a topical and promising research topic, which can lead to the creation of new materials with improved properties and wide application.

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