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MODIFIED ACTIVATED CARBON ON A COCONUT BASIS

Water supply from underground sources is due to a number of factors, among which there can be an increased concentration of iron and manganese, increased mineralization and a high bacteriological index [1]. Elevated iron content in water cause significant harm to human health. Excess iron also causes the overgrowing of fittings and networks of water supply. The permissible content of iron ions in drinking water in accordance with the requirements of WHO is 0.2 mg/dm^3 [2], and in some countries this concentration is set at 0.3 mg/dm^3.

The filter is the main element of the water deironing station, and the filtering loading is the main working element of them, so the correct choice of its parameters is of paramount importance for their normal operation. Loads for deironing filters could be divided on catalytic and filtering due to the chemical [3] and physical properties of this process.

Not all granular material can be used as filter material. The material should have certain characteristics, such as resistant to abrasion (wear), chemical resistance of materials to filtered water, uniform grain-size distribution, compliance with the proper fractional composition of the loading, free of impurities, cost-effective, the possibility of obtaining in the area of the filter complex.

At the moment, the most common filter loads are quartz sand, anthracite [3], granite chips, expanded clay and activated carbon. Today the following materials which can be used as a catalytic loads are synthesized: absolutely new ones (such as plastic-based loading, pumice, zeolite [4]) and modified materials based on existing ones: active pink sand, silica-based mesoporous material, nano-adsorbents are made of copper oxide.

One of the mechanisms for the removal of various chemical elements from water is applied to the surface of the filter material an effective oxidizing agent. [5]. Modification of materials for iron removal mainly consists in increasing the content of iron, manganese or copper on the surface of grains of loading by applying oxides of appropriate metals to its surface. Also among the oxides can be used zinc oxide, which has an inactivating effect on microorganisms and is a good prevention against biofouling.

In this study, the activated carbon on a coconut base was modified with the deposition of iron oxide on its surface. The choice of this type of loading is due to the availability of this material in several regions of the world. Also, activated carbon is made from a large number of low-cost materials and agricultural waste such as Camellia oleifera shell, bamboo, cherry stones, waste tea, and Paulownia flower. Fraction size of activated carbon granules is 0.5–2.5 mm. The measured bulk density amounts to 0.49–0.53 g/cm^3. This material is not dissolved in neutral, acidic, and alkaline media. It feature high resistance to attrition and crushing during filtering. Its porosity is 0.65cm^3/g.

The synthesis of catalytic coating on the surface of activated carbon was performed by the SCS in aqueous solutions [3] using stoichiometric mixtures of iron nitrate as well as citric acid and urea as a reducing agent. The synthesis is described by the following equation (for iron):

$$2Fe(NO_3)_3+5CH_4N_2O = Fe_2O_3+5CO_2+8N_2+10H_2O$$

$$6Fe(NO_3)_3+5C_6H_8O_7 = 3Fe_2O_3+30CO_2+9N_2+25H_2O$$

Samples were prepared from iron nitrate solutions with concentrations of 0.05 and 0.025 $Fe(NO_3)_3$ per 1 gram of activated carbon. The reducer-to-oxidizer ratio φ was 1.0 in all the cases. The initial components were dissolved in distilled water. These solutions were transferred into heat-resistant beakers filled with activated carbon in such way that the surface of solution covers it by 1–2 mm. Then the beakers with solution and activated carbon were placed on electric plate and heated for the fast removal of water.

The synthesis was conducted in the muffle oven by heating the samples until the end of exothermal reaction. After the termination of combustion reaction, the activated carbon with iron oxides acquired dark-red or dark-brown color.

The AAS analysis were carried out using solutions based on artificial tap water. The composition of the artificial tap water was a few amount of $NaHCO_3$, KCl, $MgSO_4·7H_2O$, $CaCl_2·2H_2O$, pH 7.5 (adjusted by 1% HCl). The solvent was ultrapure water. Samples of solutions with pH in range 4–8 (with single step) was made with using artificial tap water and 1% HCl. Then 1 gram of material have placed in 50 mL of every solution, stirred 24h and filtered. Obtained filtrate analyzed using Varian Spectra AA 220 Atomic Absorption Spectrometer. According to results solution didn't have iron in volume. That have shown that all samples have a chemical resistance. Also pH of solutions after adsorption through all materials was changed to average pH=8.12.

The EDX analysis showed the percent of chemical elements on the surface of materials. According to the analysis of samples with a dose of nitrate 0.025, the percentage of iron on the surface of two modified materials is not actually different. Analysis samples with a dose of nitrate 0.05, a higher percentage of iron is observed on the surface of the material modified using urea. In addition, these samples contain insignificant amount of calcium, alumina, silica etc. The calculated average size of crystalline grains of synthesized materials is equal to 15–20 nm. Based on this, we can conclude that the modifying coating represents a nanocrystalline iron and iron oxides that is intrinsic for materials synthesized by the SCS. The SEM analysis of sample surface have shown, the particles of iron containing phases representing aggregates of nanocrystals with the degree of dispersity from 1 to 20 μm are attached to this surface. SEM analysis was investigated with Hitachi Field Emission Scanning Electron Microscope SU-70 (Japan)), equipped with the X-Max Silicon Drift Detector (SDD) (Oxford Instruments, England) for using of EDX/EDS analysis method.

The fine-dispersed and highly amorphized phase of iron oxides is formed during the solution combustion synthesis. Comparing the results of the surface elemental analysis and images obtained, one can suggest that a considerable part of iron ions in samples under study is found in such fine-dispersed and amorphized phase.

The investigation results of using the samples obtained as a catalytic medium have shown, that performance efficiency of modified materials was better for 3 times than non-modified materials in terms of the residual content of total iron.

The use of tested materials makes it possible to significantly reduce the volume (layer height) of filter medium and enhance the treatment efficiency during the first start-up of filters after regeneration on condition of the positive feasibility study of the production and application of these materials in underground water deironing plants.

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