Magnetic Modification of Ion Exchange in Water Treatment Processes

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Abstract. At present intensification of ion exchange processes in water treatment systems is widespread. Mainly technological and constructive methods are used. It is proposed to apply a magnetic field to modify the processes of ion exchange when adjusting the mineral composition of water. The study evaluates the method of magnetic modification of ion exchange processes on changes in the working dynamic capacity of the ionite, the amount of sorbed salts, the duration of the filter cycle and the flow rate of the regeneration solution. Results of method application were obtained. For the qualitative and quantitative analysis of the investigated water, cationite KU-2x8 and anionite AN-22 were used. Proposed method of modification of the ion exchange process due to simultaneous influence of magnetic field on the ion exchanger and purified water.

Introduction

Environmental protection is one of the most important issues of our time. The rational use of water resources and the treatment of natural and wastewater are of particular relevance due to their inextricable link with the protection of natural waters from pollution [1]. Modern approaches to water treatment in water treatment systems include the use of physical, chemical and physicochemical methods. One of the methods of rational use of natural water resources is ion exchange [2].

Ion exchange is a reversible physicochemical process whereby ions of a dissolved substance are exchanged for an equivalent number of ions that are fixed on a fixed solid carrier, namely ionite [3].

This is a purification method commonly used to remove unwanted ions such as calcium, magnesium and other heavy metals by introducing more desirable ions or simply neutralising the liquid.

Ions can be classified into two main groups, depending on their charge: cations, which are positively charged, and anions, which are negatively charged.

In the process of cation exchange, positively charged ions such as calcium (Ca^{2+}) and magnesium (Mg^{2+}) are replaced by similarly charged ions, usually sodium (Na^{+}) or hydrogen (H^{+}). When water passes through the ion exchange resin, it binds the unwanted cations and releases an equivalent amount of sodium or hydrogen ions back into the water. Anion exchange targets negatively charged ions such as chloride (Cl^{-}) and sulfate (SO_4^{2-}). It uses anion exchange resins that attract and exchange the target anions for more harmless ones, such as hydroxide (OH^{-}) or chloride (Cl^{-}), depending on the resin used [4].

There are four basic categories of industrial water treatment resins:

- Strong Acid Cation (SAC) Resins;
- Strong Base Anion (SBA) Resins;
- Weak Acid Cation (WAC) Resins;
- Weak Base Anion (WBA) Resins.

SAC resins neutralize strong bases and convert the salts into corresponding acids. They can remove all cations, replacing them with hydrogen ions. SAC resins are used over all pH ranges.

SBA resins neutralize strong acids and convert the salts into corresponding bases. These are common in water softening and demineralization processes.

Conclusions

The following conclusions were made from represented research:

1. The methodology of the study of the magnetic modification of the ion-exchange processes of the ionites KU-2x8 and AN-22 is proposed.

2. Using the magnetic modification of ionite, the duration of the filter cycle is increased by 20–25 % and the necessary volume of regeneration solution is reduced by 5–10 %.

3. The influence of the multiplicity of regeneration solution on the quantity of sorbed salts and the working dynamic exchange capacity of ionite has been studied - at a similar ionite equivalent the quantity of sorbed salts and the working dynamic exchange capacity increases by 20–25 %, if the maximum saving of regeneration solution is set at the basic efficiency of ionite (effect of water treatment without modification of the ion exchange process), its saving will be 25–35 %.

It should be noted that the use of physical methods for intensification of ion exchange processes in water treatment systems requires further research.

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