ZEOLITES AS ALTERNATIVE ADSORBENTS FOR WATER POLLUTANTS REMOVAL

LIAPUN VIKTORIIA, *PhD student, Faculty of Natural Sciences*
Comenius University in Bratislava
Mlynská dolina, Ilkovičova 6842 15 Bratislava 4 Slovakia

Rational use of water resources and water pollutants removal is one of the most actual problems in many countries. Human activities are the main cause of water pollution and it has rendered drinking water a competitive resource in many parts of the world.

Natural nanocomposites can be used as alternative adsorbents for water pollutants removal. Nanocomposite materials are contributed an active role in water purification, such as zeolites. Natural zeolites are being evaluated as the most progressive functional and nanosized materials in the last few decades because of their properties and extensive possibilities [1].

Zeolites occur in rocks of diverse age, lithology, and geologic setting. It was reported that, of the 40 naturally occurring zeolites studied by research groups, the most well-known ones are clinoptilolite, erionite, chabazite, heulandite, mordenite, stilbite, and phillipsite [2].

Pores and voids are essential characteristics of zeolite materials. The pores and voids are occupied by cations and water molecules. The internal surface area of these channels can reach about several hundred square meters per gram of zeolite, making zeolites an effective ion exchanger [3].

Zeolites can be classified as natural and synthetic zeolites. Natural zeolites are produced by the force of volcanic ash. The layers of volcanic ash were exposed to high temperatures and pressures and this established the physical and chemical change which created a diverse group of zeolites, including the clinoptilolite. Clinoptilolite is the most common natural zeolite belongs to a large zeolite group called heulandite. Grid structure allows clinoptilolite to operate as an ion exchanger and selective adsorbent [4].

Synthetic zeolites, also called molecular sieves, are crystalline aluminosilicates manufactured in a thermal process. Controlling the composition of the ingredient materials and the temperature of this process somewhat allows control of the structure and some characteristics of the adsorbent. Therefore, this provides a much more uniform product than natural zeolites [5].

The ability to release beneficial elements while capturing and binding others, often less desirable ones, makes zeolite an ideal media for the selective adsorption of certain elements and compounds from soil, water and air [6].

Natural and modified zeolites are usually used to remove ammonium ions and metal contaminants, such as iron, manganese, calcium, and heavy metals. In addition, modified zeolites are also used to remove viruses, bacteria, and organic contaminants. The efficiency of zeolites in removing contaminants mainly depends on several factors: the composition of the zeolite material and the nature of water [7].

Physicochemical zeolite properties: ion exchange selectivity, reversible hydration and dehydration, high gas sorption capacity, high thermostability and resistance to aggressive media. [4]

Zeolites are present in our everyday life, being widely employed as sorbents, as ion exchangers in detergents, or as catalysts in industrial processes. Many different zeolite structures have been described, leading to a wide versatility in terms of their pore dimensions, channel systems' dimensionality, or composition. Zeolites in wastewater treatment are quite effective in comparison, especially with the other methods not only because of their functionality, but also according to their environmentally 'green' character, due to their nontoxicity and safe operation [8].

The most important applications of zeolites are among the following:

- Buildings: zeolites have excellent mechanical properties that include this material in the group of building materials for structural elements. Another use of zeolite is as an additive in cement, as an active mineral supplement [9].
- Medical applications: zeolites are promising materials for creating biosensors, and also systems for harvesting and detecting biomarkers of serious diseases, particularly tumors. In addition to environmental decontamination, animal and human organisms can also be decontaminated from toxic agents [10].
- Toxic heavy metal cations may also be removed from the environment by cation-exchange into zeolites [11].
- Agriculture: Natural and synthetic zeolites due to their unique physicochemical properties, have found wide application in many fields related to agriculture. They are being increasingly used in the production of mineral fertilizers with slow release and as carriers of active ingredients of herbicides, fungicides and pesticides [12].

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