Geology, Geophysics & Environment 2016, vol. 42 (1): 114–115

Adsorption efficiency of selected natural and synthetic sorbents

Henrieta Pavolová, Tomáš Bakalár, Štefan Sabo, Petra Puškárová

Technical University of Košice, Faculty of Mining, Ecology, Process Control and Geotechnologies; Letná 9, 042 00 Košice, Slovakia; e-mail: tomas.bakalar@tuke.sk

Sorbents are substances binding other substances on their surface. Effective sorbents have a porous surface. The adsorption activity of the surface is closely related to the local radius of curvature of surface irregularities. Suitable sorbents are natural and synthetic solids of amorphous or microcrystalline structure (Kyncl et al. 2008). Globally, the following adsorbents are the most used: activated carbon, zeolites, silica gel, activated alumina (Bakalár et al. 2005). A characteristic of effective adsorbents is large surface area of hundreds of square meters multiply by gram to the power of minus one [$m^2 \cdot g^{-1}$]. Other important features of adsorbents include specific volume, porosity, average pore diameter, pore distribution, etc.

Some natural materials or industrial waste with high adsorption capacity, which naturally reduces the overall cost of their disposal, can be used for adsorption of heavy metal cations. Some of low-cost sorbents are: lignin, chitin, seaweed/algae, zeolites, clays, fly-ash, peat, sand grains coated with iron oxide, modified cotton and wool (Pavolová et al 2006).

In experiments of Cu and Zn removal from wastewater the following adsorbents were used (Bakalár et al. 2005):

- Lewatit S100, which is strongly acidic, gel-like cationic ion exchange resin with particles of equal size based on styrene-divinylbenzene copolymers. Monodisperse beads are chemically and osmotically highly stable.
- Chitosan, which is prepared from chitin, naturally occurring in the shells of crustaceans, by deacetylation using strongly alkaline solution. Chitin is a homopolymer composed of β-(1-4)--N-acetyl-D-glucosamine. The ability of crustaceans shells to bind metal ions is assigned to the presence of exoskeleton in the molecule of chitin and chitosan.
- Synthetic zeolite, which is included in the group of aluminosilicates, was prepared by zeolitization of fly-ash from energy industry.
- Bentonite, which is included in the group of hydrated aluminosilicates, the main ingredient is mineral montmorillonite.
- Slovakit, which is an inorganic composite sorbent made from pure natural ingredients. Its composition is a subject of patent protection.

The aspect of time, i.e. the time the specific sorbent reaches the maximum adsorption capacity for the heavy metal removed, is also important in removal of Cu^{2+}, Zn^{2+} and Pb^{2+} cations. The experimental measurements of cations adsorption using the above mentioned sorbents are made at the initial concentration of 10 $mg \cdot L^{-1}$ of heavy metal.

The time to reach the equilibrium for all sorbent during separation of Cu^{2+} cations from model solutions of wastewater was about 60 seconds except for chitosan for which it was almost 2 minutes. This is relatively very good result.

The equilibrium of Zn^{2+} cations adsorption at the experimental measurements for all the selected sorbents was reached in about 80 seconds except for chitosan for which this time was 2 minutes 5 seconds. This time was on average around 20 minutes longer compared to the adsorption of Cu^{2+} ions.

http://dx.doi.org/10.7494/geol.2016.42.1.114 ISSN 299-8004 | e-ISSN 2353-0790 | Wydawnictwa AGH

The adsorption of Pb^{2+} cations was carried out at the experimental measurements in about 83 seconds for all the selected sorbents, except for synthetic zeolite for which the time was 1 min 15 seconds. The adsorption of Pb^{2+} cations compared to the cations of Cu^{2+} was 23 seconds faster and compared to the cations of Zn^{2+} was 3 seconds longer.

The most appropriate for the removal of Cu^{2+}, Zn^{2+}, and Pb^{2+} is Lewatit S100 among the used sorbents; the equilibrium was reached in approximately 35 seconds, 45 seconds, and 83 seconds for Zn^{2+}, Cu^{2+}, and Pb^{2+}, respectively. According to the experimental measurements the longest adsorption time was for chitosan – about 2 minutes for Cu^{2+} and Zn^{2+}, and about 1.5 minutes for Pb^{2+}.

REFERENCES

Kyncl M., Pavolová H. & Kyseľová K., 2008. Using untraditional sorbents for sorption of certain heavy metals from waste water. *GeoScience Engineering*, 54, 2, 26–31.

Bakalár T., Búgel M., Schlosser Š. & Onderková B., 2005. Odstraňovanie ťažkých kovov z vodných roztokov. *Acta Montanistica Slovaca*, 10, 1, 275–279.

Pavolová H., Bakalár T. & Kyseľová K., 2006. Efficiency of copper removal from wastewater using selected adsorbents. *Acta Metallurgica Slovaca*, 12, 3, 275–281.