

Magnetic zeolites from wastes and natural sources

Claudia BELVISO - Institute of Methodologies for Environmental Analysis - CNR, Tito Scalo, Italy

This work aims to briefly summarize the results on the use of waste materials, such as fly ash (FA), red mud (RM) or volcanic ash (VA), and natural phases, such as obsidian (OS) and bauxite (BAx), as precursors for the synthesis of magnetic zeolites for applications in environmental remediation, cement industry or medical field, just to name a few sectors.

Fly ash is a by-product of thermal power plants to be deposited of in landfill due to the potential presence of toxic elements. However, FA is composed of amorphous aluminosilicate; minerals, such as quartz, mullite, hematite and magnetite are also present. Red mud is a waste material formed during the production of alumina when the bauxite ores are subjected to caustic leaching. It is mineralogically characterized by the presence of iron oxyhydroxides (i.e., mainly hematite and goethite) with a minor aluminum hydroxide (i.e., boehmite). The risk associated with RM wastes is primarily due to its high pH. Volcanic ash is a natural product of volcanic eruption activity. Beside the potential presence of natural toxic elements, when VA is deposited on the roads it becomes a waste according to the European Waste Catalogue (EWC). However, VA is characterized by the presence of pyroxene, plagioclase, olivine, hematite and magnetite, and, above all, by a large amount of amorphous silica. Obsidian is a type of volcanic glass which mineralogical composition is dominated by the presence of amorphous material. OS chemical composition generally includes high percentage of iron. Finally, bauxites are aluminum rocks mainly characterized by the presence of boehmite and kaolinite, making them as natural sources of Si and Al.

Based on the type of the aforementioned raw materials used, different type of zeolites formed: zeolite A (LTA topology), zeolite X (FAU-topology), zeolite P (GIS-topology) and sodalite/cancrinite zeolite (SOD and CAN-topology). Zeolites are hydrated aluminosilicate minerals consisting of a three-dimensional open structure with excellent ion exchange and sorption properties, which makes them notably useful for resolving the mobility of toxic elements in polluted soil and water.

The synthesis is carried out by pre-fused hydrothermal process at low temperature using distilled water or seawater as solution. Besides the common properties, all the synthetic products possess sufficiently high magnetic moments to enable their easy separation from a solution using an external magnet. Therefore, the time consuming and expensive high performance centrifugation processes, which are typically employed to recover zeolites, can be eliminated. This makes the use of these synthetic products more advantageous in several environmental applications.