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Treatment of underground water in open flow and closed-loop fixed bed systems by utilizing the natural minerals clinoptilolite and vermiculite

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ABSTRACT

Iron and manganese are found naturally in several soil and rock minerals while in the same time they are used as raw material in steel manufacture and products. Both metals can reach ground water reserves easily by rain or other means and while surface water does not usually contain high concentrations of iron or manganese because the oxygen-rich water enables both minerals to settle out as sediments, in anaerobic conditions, like in ground water deposits, iron and manganese are reduced to their soluble oxidation states Fe^{2+} and Mn^{2+}. The problem of groundwater contaminated with these metals has become evident the last decades and several methods have been tested in the related literature. Ion exchange and adsorption are inexpensive and simple methods, especially when natural minerals are used, as zeolites and clays, however, the relevant studies of simultaneous removal of Fe and Mn from natural samples in the literature are few. In the present study natural clinoptilolite (zeolite) and vermiculite (clay) are utilized for simultaneous removal of Fe and Mn from underground water samples in open flow and closed loop fixed bed systems. A closed loop fixed bed system is a fixed bed with recycling of liquid phase and thus, is a type of batch process. Vermiculite exhibited higher removal levels than clinoptilolite for both Fe and Mn. For both materials Fe removal is higher than Mn. In the closed loop fixed bed system after 24 h of treatment and 2 g/100 ml solid to liquid ratio, Fe and Mn removal levels reach 100% and 75% for vermiculite and 82% and 30% for clinoptilolite, respectively. Pretreatment of groundwater by precipitation increases removal of Fe and the system could reach 100% removal for clinoptilolite as well. Finally, results show that under the same operational conditions, closed loop fixed bed system is more promising for groundwater treatment than batch system.

Keywords: Drinking water; Manganese; Iron; Clinoptilolite; Vermiculite; Closed loop; Fixed beds

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