

# Arsenic removal by the iron oxide sorbent with quaternary ammonium groups modified with lanthanum(III) ions

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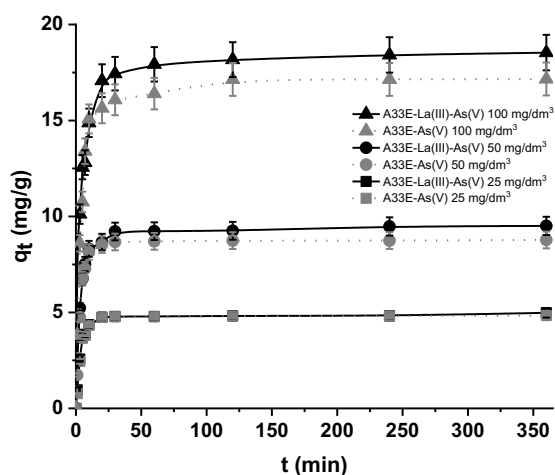
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Removal of arsenic compounds from the groundwater is an important issue of environmental protection. Several methods such as precipitation, oxidation, coagulation, ion exchange, adsorption and membrane filtration have been elaborated for arsenic removal from water. Unfortunately, many of these technologies are not sufficient to meet drinking water requirements. They are simply expensive or too complicated to handle. Adsorption seems to be the most appropriate way to combat the problem of arsenic contaminated aquatic systems. In recent years considerable work has been done on developing novel composite materials containing binary iron-metal oxides.

In this research, the commercially available iron oxide sorbent with quaternary ammonium groups (Ferrix A33E) was successfully modified with lanthanum(III) ions for removing arsenate(V) from water. This was confirmed by the scanning electron microscopy SEM, Fourier-transform infrared spectroscopy FTIR and X-ray photoelectron spectroscopy XPS. After the La(III) modification the surface area and the total pore volume increased. Moreover, the maximum sorption capacity towards As(V) ions increased from 34.41 to 53.33 mg/g. A33E-La(III) was characterized by better sorption capacities at the initial As(V) concentrations 25, 50 and 100 mg/dm<sup>3</sup>. The time needed to reach equilibrium was practically identical.



**Figure 1.** Comparison of time and initial concentration effects on the As(V) adsorption onto the modified (black) and unmodified (grey) sorbents.

The Freundlich and Halsey isotherms described arsenic(V) sorption behaviour the best and this process was mainly chemisorption due to the energy larger than 8 kJ/mol. Moreover, thermodynamic studies revealed spontaneous and exothermic nature of the As(V) adsorption. As for the sorption mechanism, at optimal pH 6 the arsenate(V) ions were adsorbed through the formation of inner-sphere monodentate or bidentate complexes as well as lanthanum arsenate precipitation. However, in the alkaline environment the adsorption could still proceed due to the inner-sphere complexation with lanthanum hydroxide. Moreover, even after 3 cycles of adsorption-desorption, A33E-La(III) had still larger As(V) adsorption capacity than that of A33E.

It was found that the presence of lanthanum on the surface of the ion exchanger plays a great role in the adsorption of As(V) from the contaminated water due to changing the mechanism of the process.

The exceptional As(V) removal capability of lanthanum-modified A33E-La(III) leads to its potential application for not expensive treatment of arsenic-contaminated water.