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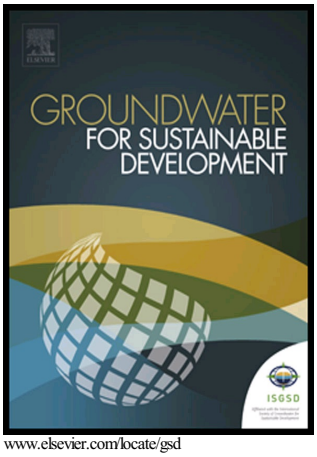
M.S. Podder, C.B. Majumder



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Biological detoxification of As(III) and As(V) using immobilized bacterial cells in fixed-bed bio-column reactor: Prediction of kinetic parameters

M. S. Podder, C. B. Majumder

Department of Chemical Engineering, Indian Institute of Technology, Roorkee.

Roorkee – 247667, India

Email: mou.chem11@gmail.com, cbmajumder@gmail.com

Abstract

The dynamic removal of As(III) and As(V) ions by biofilm of *Bacillus arsenicus* MTCC 4380 supported on Sawdust/$MnFe_2O_4$ composite was studied in a fixed-bed bio-column reactor. FT–IR analysis exhibited that functional groups involved in metal ions binding were hydroxyl, amide and carboxyl groups. Experiments were performed to investigate the effects of various parameters on the breakthrough and saturation time. The breakthrough and saturation time both increased with the increase in the bed height. Similar effects were found when both flow rate and initial arsenic concentration were increased. The breakthrough curve for the bed height showed that a longer bed column extended the life span of the column with a maximum capacity of 87.573 and 88.990 mg/g for the As(III) and As(V) column, respectively. The controlled rate step shifted from external to internal mass transfer limitations as the flow rate was increased. Column data acquired at various conditions were explained using Adams–Bohart, Wolborska, Yoon–Nelson, Thomas, Modified Dose–Response and Clark models. All models were found to be suitable to describe the whole or a definite part of the dynamic behaviour of the column with regard to the bed height, flow rate and initial arsenic concentration except Adams–Bohart and Wolborska models. On comparison of $\overline{R^2}$, χ^2 and RMSE values both Thomas and Clark models were found to have a better fit than other models and these two models can be used to predict the biosorption/bioaccumulation of As(III) and As(V) ions in fixed-bed bio-column reactor. It is also clarified that the present method is found to be much more efficient than that of biosorption alone. The whole study reveals that the biofilm tried is very capable to remove As(III) and As(V) ions from industrial wastewater.