Desalination and Water Treatment
www.deswater.com

doi: 10.5004/dwt.2017.20550

71 (2017) 182–190
April

Kinetics of divalent mercury reduction by zero-valent iron: the effects of pH, chloride, and dissolved organic carbon

Go-Un Nam[a], Seunghee Han[b], Yongseok Hong[a,*]

[a]*Department of Environmental Engineering, Daegu University, Gyeongsan-si, Gyeongsangbuk-do, Daegu, Korea, Tel. +82-53-850-6694; Fax: +82-53-550-6699; emails: yshong@daegu.ac.kr (Y. Shon), namgwo@gmail.com (G.-U. Nam)*
[b]*School of Environmental Science and Engineering, Gwangju Institute of Science and Technology (GIST), Gwangju, Korea, email: shan@gist.ac.kr*

Received 17 September 2016; Accepted 28 January 2017

ABSTRACT

The effects of pH, Cl^-, and dissolved organic carbon (DOC) on the kinetics of Hg^{2+} reduction to Hg^0 were investigated in anoxic Fe^0–H_2O system. A reaction kinetic model was developed to describe separately the surface-mediated and aqueous phase Hg reduction processes. The Hg^{2+} was rapidly reduced to Hg^0 in the presence of 2 g L^{-1} Fe^0 (0.42 m^2 L^{-1}) within 3 h although the presence of DOC significantly, about an order of magnitude, reduced the reduction kinetics. The zero-valent iron (ZVI) surface area normalized Hg^{2+} reduction rates varied between 0.5 and 2.74 m^{-2} min^{-1}. In the presence of 0.1–10 mg/L DOC, the rates varied between 0.026 and 0.1 m^{-2} min^{-1}. Modeling studies showed that the increase of pH and NaCl concentrations and the decrease of DOC levels increased surface-mediated Hg^{2+} reduction rate. Higher pH seemed to increase the reduction rates and this was attributed to the enhanced adsorption of Hg^{2+} to ZVI surface at higher pH. The Cl^- undergoes strong complexation with Hg^{2+} (i.e., $HgCl^+$, $HgCl_2$, and $HgCl_3^-$) and prevent the adsorption of Hg^{2+} to Fe^0 surface and subsequent reduction. However, the enhanced corrosion and greater release of Fe^{2+} by the pitting corrosion process in the presence of Cl^- affected the overall Hg^{2+} reduction far more significantly, hence, increased Hg^{2+} reduction was observed in the presence of Cl^- in solution. The DOC seemed not only to decrease the reactivity of Hg^{2+} by rendering strong complexation but also to prevent the adsorption of Hg^{2+} to the Fe^0 surfaces thus inhibiting surface reduction.

Keywords: Zero-valent iron; Mercury reduction kinetics; Mercury-contaminated wastewater; Groundwater pollution

* Corresponding author.