Dissolution kinetics of zirconium dioxide in nitric acid

R.R. Prajapati\textsuperscript{a}, T.G. Srinivasan\textsuperscript{b}, V. Chandramouli\textsuperscript{b}, S.S. Bhagwat\textsuperscript{a,*}

\textsuperscript{a}Department of Chemical Engineering, Institute of Chemical Technology (Deemed University), Matunga 400019, Mumbai, India
Tel. +91 22 3361 2001/1111; Fax: +91 22 3361 1020; email: ss.bhagwat@ictmumbai.edu.in
\textsuperscript{b}Chemistry Group, Indira Gandhi Centre for Atomic Research, Kalpakkam, Chennai 603 102, India

Received 6 March 2012; Accepted 14 March 2013

\textbf{ABSTRACT}

Dissolution kinetics of zirconium dioxide (ZrO\textsubscript{2}) in nitric acid was investigated as a function of time, temperature, acid concentration, stirring speed, solid to liquid ratio, and surface area. The dissolution appears to be a two-stage dissolution process that is related to the changes at the solid surface; the outer layer being more susceptible to dissolution than the inner layer. The initial rate of ZrO\textsubscript{2} dissolution was used for the comparison studies. The dissolution of zirconium dioxide follows a pseudo-first-order rate equation. An increase in the temperature of the dissolving medium enhances the initial dissolution rate of the ZrO\textsubscript{2}. The activation energy was found to be 43.3 kJ/mol. A probable dissolution mechanism consistent with the experimental data is suggested and the steps involved in the reaction are discussed. The results are explained in terms of a surface reaction mechanism. The effect of ultrasound on the rate of zirconium dioxide dissolution was also investigated.

\textit{Keywords:} Dissolution rate; Kinetics; Zirconium dioxide; Nitric acid; Ultrasound; Activation energy

\textsuperscript{*Corresponding author.

Presented at the DAE—BRNS Biennial Symposium on Emerging Trends in Separation Science and Technology (SESTEC 2012)
Mumbai, India, 27 February–1 March 2012

1944-3994/1944-3986 © 2013 Balaban Desalination Publications. All rights reserved.