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### Effect of chloride ions on dissolution of ilmenite in acid solutions

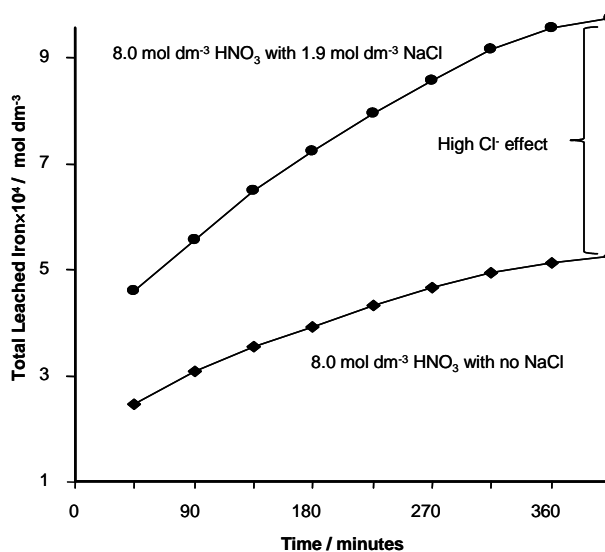
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Ilmenite ( $\text{FeTiO}_3$ ) is a naturally occurring mineral and it is extensively used for the production of titanium dioxide ( $\text{TiO}_2$ ). Synthetic rutile is a chemically upgraded form of ilmenite containing lower amounts of non titanium components.  $\text{TiO}_2$  is an important material with several industrial applications such as a pigment, semiconducting material, filler, and photocatalyst. Two major processes have been reported for production of  $\text{TiO}_2$  from ilmenite, the sulphate process and the chloride process. The sulphate process is the major process due to its low operating cost. One drawback of this method is the environmental burden due to the high amount of acidic waste. Several studies have been reported on enhancing the dissolution rate of ilmenite with different acids under different working conditions. In general, the order of rate of dissolution is  $\text{HCl} > \text{H}_2\text{SO}_4 > \text{HNO}_3$ . In this study we have

found that the rate of dissolution of ilmenite is greatly enhanced in nitric acid solutions in the presence of background chloride ions. The effect of cation ( $\text{Na}^+$ ,  $\text{K}^+$  and  $\text{Li}^+$ ) was found to be negligible. The  $\text{Cl}^-$  induced enhancement of the rate of dissolution achieved a level which corresponds to a similar dissolution rate under the same  $\text{H}^+$  concentration for  $\text{H}_2\text{SO}_4$  and  $\text{HCl}$ . The effect of chloride ions could be explained by the formation of iron(III) nitrate complex in nitric acid solutions, readily converting to more stable iron(III) chloride complexes in the presences of excess chloride ions. Some of the possible iron and titanium complexes are:  $\text{FeCl}(\text{H}_2\text{O})_5^{2+}$ ,  $\text{trans-FeCl}_2(\text{H}_2\text{O})_4^+$ ,  $\text{cis-FeCl}_2(\text{H}_2\text{O})_4^+$ ,  $\text{FeCl}_3(\text{H}_2\text{O})_2$ ,  $\text{FeCl}_3(\text{H}_2\text{O})_3$ ,  $\text{FeCl}_4^-$ ,  $\text{TiO}^+$ ,  $\text{TiOCl}$ ,  $\text{TiOCl}_2$  and  $\text{TiOCl}_4^-$ . Addition of chloride ions into the  $\text{H}_2\text{SO}_4$  acid medium did not show any enhancement of the rate, presumably due to stable nature of ferricopiapite, coquimbite, rhomboclase, and  $\text{Fe}_2(\text{SO}_4)_3(\text{H}_2\text{O})_5$ .

Keywords: Ilmenite, acid dissolution, salt effect



Enhanced dissolution in the presence of background  $1.9 \text{ mol dm}^{-3} [\text{Cl}^-]$  at  $8.0 \text{ mol dm}^{-3} [\text{HNO}_3]$ .  
 $T = 30 \text{ }^\circ\text{C}$