



Characterization of the leaching properties of a uranium leaching pulp

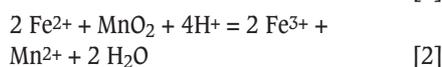
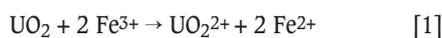
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Synopsis

This work was done to characterize the leaching of a uranium containing pulp processed by a South African producer to identify parameters that could be adjusted to increase the extraction of uranium in the existing circuit. Batch leach tests were used to characterize the leach properties and especially the influence of the oxidant concentration on the leaching achieved. It was found that relatively high extraction could be obtained even at room temperature by using a high liquid-to-solids ratio and that increasing the oxidant concentration significantly improved the leaching of the uranium minerals.

Introduction

Uranium typically occurs in Witwatersrand ores predominantly as uraninite, with compositions ranging from UO_2 to UO_3 , and less frequently as the more refractory minerals brannerite, thucolite and coffinite (Pinkney, *et al.*, 1962). Uraninite can be leached in acid solution as the uranyl (UO_2^{2+}) species, using an oxidant, such as manganese dioxide, to oxidize the tetravalent uranium in the mineral to the hexavalent uranyl species (Nicol, *et al.* 1975). The leaching process is electrochemical in nature and is catalysed by the presence of iron in solution, which facilitates the charge transfer between the manganese dioxide and the uranium minerals. Sufficient iron for this is typically introduced into solution by the leaching of the iron present in the ore and the manganese dioxide. The stoichiometry of the reactions involved are given as Equations 1 and 2.



The aim with the present work was to characterize the uranium leaching properties of a South African gold ore to optimize the leach. This is however a complex issue as the overall returns will also be determined by factors such as the cost of heating, reagent consumption and also the effect of the uranium leaching on

the gold extraction obtained. Only the work done to characterize the leach in terms of leaching time and oxidant addition is reported in the present paper.

Experimental

The experimental work involved the investigation of parameters such as time and oxidant concentration on the leaching of a uranium containing pulp sample in dilute sulphuric acid, using batch leach tests. A representative sample was collected over a period of one month using a sampler in the milled pulp stream with a grinding of 70%–75 μm . To simplify analysis of the results a high liquid-to-solids ratio was used to limit changes in reagent concentrations. 30 g of ore was suspended in 1 l of an aqueous solution containing 4 g/l sulphuric acid in an unbaffled reactor with a magnetic stirrer rotating at 800 r.p.m., which was the minimum speed required to suspend the solids. The oxidant was added as a powder with a nominal analysis of 85–90% MnO_2 . To ensure that enough iron was present in the initial stages of the leach 10 g/l $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$ was added to the solution. The temperature of the reactor was maintained at 20°C. The pulp potential was measured using a platinum sensing electrode and a silver-silver chloride reference electrode connected through a high impedance volt meter.

Results

Kinetics of uranium leaching

The typical leach curve shown in Figure 1 indicates that the initial leaching rate is fast but that it decreases with time, and that some of the uranium is very slow leaching or

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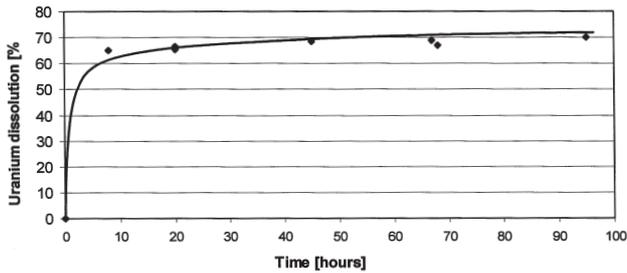


Figure 1—Influence of time on the leaching of an uranium containing pulp in 4 g// H₂SO₄, 0.5 g// MnO₂, 10 g FeSO₄·7H₂O at 800 rpm and 20°C

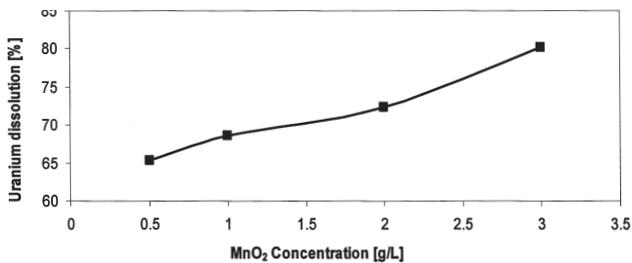


Figure 2—Influence of MnO₂ concentration on uranium dissolution at a residence time of 25 hours at 20°C, 10 g FeSO₄·7H₂O, 4 g// H₂SO₄ and 800 rpm

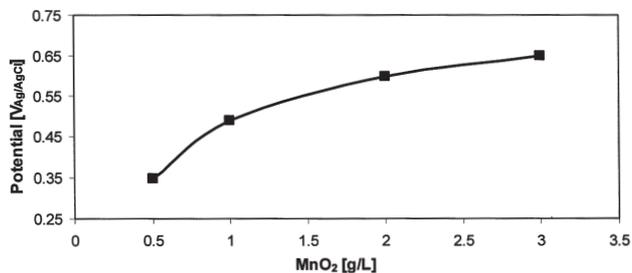


Figure 3—Pulp potential as a function of MnO₂ concentration at 25 hours residence time, 20°C, 800 rpm, 10 g FeSO₄·7H₂O and 4 g// H₂SO₄

occluded as indicated by the extraction of just above 70% that is achieved even after long times for the specific conditions used. The high extraction achieved after 25h, 94% of that achieved after 95h, indicates that it would probably not be economical to leach for longer times and further

analysis of the data is based on the extractions obtained after 25h.

Influence of MnO₂ concentration on uranium dissolution

Increasing the concentration of the oxidant (MnO₂) increased the rate and total amount of uranium leached significantly as indicated in Figure 2. This is probably due to increasing the pulp potential to more positive values as indicated in Figure 3. These results indicate that it may be feasible to increase the oxidant concentration, rather than the temperature, to achieve higher extractions, provided that the higher residual oxidant concentration does not complicate downstream processing. Maintaining the iron in the ferric form, as would be done at higher oxidant concentrations, would indeed help to maintain passivity in the stainless steel elution columns and would also favour the de-activation of the iron species prior to cyanidation.

Conclusions

The results obtained in this investigation indicate that the uranium leaching attainable for this ore is significantly higher than that presently obtained in practice and that the leaching of the uranium may be significantly improved by maintaining the reagent tenors and especially by increasing and maintaining oxidizing conditions in the pulp. Maintenance of oxidizing conditions may also have downstream benefits such as the maintenance of passivity of the stainless steel elution columns and the more efficient inactivation of the iron species prior to cyanidation. The results also indicate that the uranium minerals are largely liberated at the grind used but that some minerals are only leached under more aggressive leaching conditions.

Acknowledgements

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