TECHNICAL NOTE

Developments in gold leaching using hydrogen peroxide

J. Loroesch, H. Knorre, and A. Griffiths

Introduction

Hydrogen peroxide is known to the mining industry as a powerful oxidant, able to attack and to destroy cyanide, the most important leaching reagent (Knorre and Griffiths, 1984; Griffiths, 1988; Griffiths, 1988).

$$CN^- + H_2O_2 \Rightarrow OCN^- + H_2O$$

The most recent development, however, is the use of H_2O_2 as an oxidant in the cyanidation of precious metals.

This application may appear to be a contradiction to the above mentioned detoxification process. This can, indeed, be the case if certain conditions are not considered carefully. Degussa has developed a new process to enable the application of H_2O_2 in this field without having any detrimental effect on the cyanide.

The incentive to seek an oxygen supplier like H_2O_2 instead of air was the fact that one of the most important conditions for the fast dissolution of gold is the presence of physically dissolved oxygen in the pulp (Kydryk and Kellog, 1954; Warstell, 1987).

$$2\ Au + 4CN^- + 1/2\ O_2 + H_2O \Rightarrow 2\ [Au(CN)_2]^- + 2\ OH^-$$

Complete gold recovery within a reasonable leaching time may only be achieved if the pulp is saturated with dissolved oxygen. Gold losses in leach operations mainly occur due to the following reasons:

- In some cases, the saturation of oxygen in the pulp cannot be achieved by aeration due to the difficulty to transfer oxygen from the gaseous into the liquid phase. This happens, for example, in pulps with a high viscosity. In such cases, even violent aeration only results in a low concentration of dissolved oxygen in the pulp.
- In any case, the starting phase of leaching requires the highest amount of oxygen. Therefore, it is especially important to raise the dissolved oxygen level to saturation in the starting phase.

Peroxide assisted leach process (PAL)

The intention of the process is to introduce oxygen in a liquid form. As a result of intensive research work, it could be shown that hydrogen peroxide can be used as a source of oxygen in the leaching of gold ores. To avoid side reactions, the following conditions must be applied:

- Hydrogen peroxide must be diluted before it is added to the pulp.
- The dosage of H_2O_2 must be properly regulated based on the oxygen level of the pulp.
- An important part of the continuous O_2-control is a special oxygen electrode, which resists the extremely abrasive action of the pulp.

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Process efficiency

To compare the efficiency of H_2O_2 with common oxidants used in cyanidation, the authors have investigated the oxygen profiles in the pulp using H_2O_2, pure oxygen, and violent aeration with compressed air. The experiments were carried out with a typical air-rejective pulp that is processed at a South African gold mine. Each of the three tests was performed on the basis that the oxidant cost per ton of ore was equal.

The final O_2-level of 12 ppm was reached already after 14 minutes using H_2O_2 while a level of 8 ppm was obtained only after three hours with pure oxygen. With violent aeration, a maximum O_2-level of only 4.3 ppm was obtained after one hour (Fig. 1). This illustrates that the active oxygen in H_2O_2 can be used much more efficiently. Even the addition of six times the amount of active oxygen as pure oxygen or more than 800 times the amount of oxygen in compressed air did not allow the achievement of the same performance as hydrogen peroxide. It is also easy to exceed the oxygen saturation limit of the pulp (about 9 ppm at sea level) by more than 100% using H_2O_2 as an oxygen supplier.

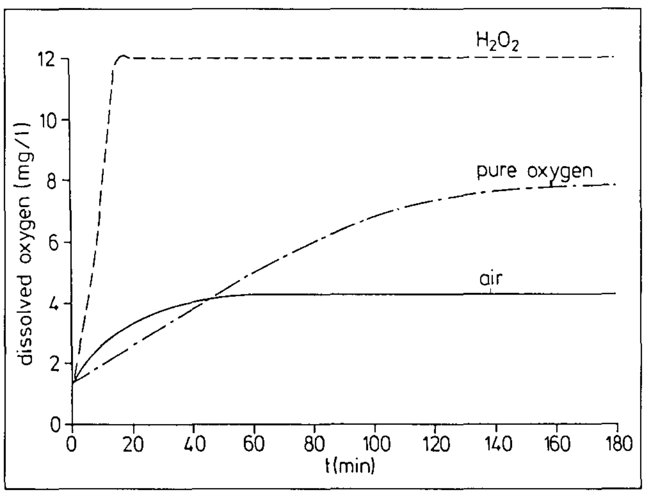

Fig. 1 — Dissolved oxygen concentration as a function of reaction time.

The dissolution rate of precious metals in the cyanidation process is directly related to the concentration of dissolved oxygen in the pulp. This was also confirmed in our leaching tests. In Table 1, the gold extraction rates on the same South African gold ore, obtained with H_2O_2 and compressed air as oxidants, are compared. It is obvious that the kinetics of the gold extraction are greatly accelerated when using H_2O_2.

Table 1 — Average values of the gold extraction rate by cyanidation of a typical South African ore using H_2O_2 (adjusted to different O_2 levels) and compressed air as oxidants.

		Gold extraction rates after					
Oxidants	max. O_2-level	1h	2h	3h	4h	24h	48h
H_2O_2	10 ppm	91%	91%	93%	95%	95%	95%
H_2O_2	18 ppm	94%	96%	96%	96%	96%	96%
Air	4 - 5 ppm	74%	82%	83%	85%	92%	96%

The final gold extraction rate (95% to 96%) is already reached after two to four hours when hydrogen peroxide is used. And, even more important, it is more than 10% higher than in the case of the aeration after the same time. The final extraction of the cyanide accessible gold was not reached before 48 hours when the simple aeration was used.

Scaling-up of the PAL process

The first steps in the scale-up of the process were performed in South Africa where Degussa operated the peroxide assisted leach system under pilot scale and full scale conditions. The full scale trials were carried out at Gencor's Fairview mine in the Eastern Transvaal/South Africa. The plant processes a flotation residue. At its full capacity of 750 t/d (827 stpd) and at a retention time of 24 hours, only about 62% of the gold was extracted (head grade about 2.8 ppm).

The testwork at Fairview mine proved the efficiency of H_2O_2 as an oxidant (Fig. 2). The gold extraction rate is very slow when H_2O_2 is not applied, a significant amount of cyanide accessible gold being left in the residue, even after 24 hours. However, final gold extraction is already achieved after 6 hours when the PAL process is applied.

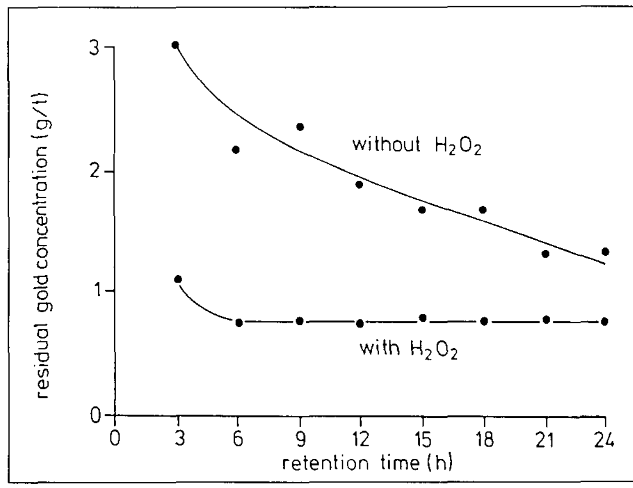

Fig. 2 — Residual gold concentration in the Fairview ore as a function of the leaching time.

During the 17 week testwork period, the PAL process enabled the extraction of all cyanide accessible gold, increasing the average gold extraction by 11.6%. This corresponds to a decrease in the average gold concentration in the washed residue of 0.3 g/t (0.01 oz per st) gold ore (Fig. 3). The results also proved the good economics of the PAL process. The value of the additional gold recovered exceeds the costs for H_2O_2 and for the payback of the equipment by a factor of five. Furthermore, the testwork showed that the cyanide consumption was at its lowest during the period of the H_2O_2 addition.

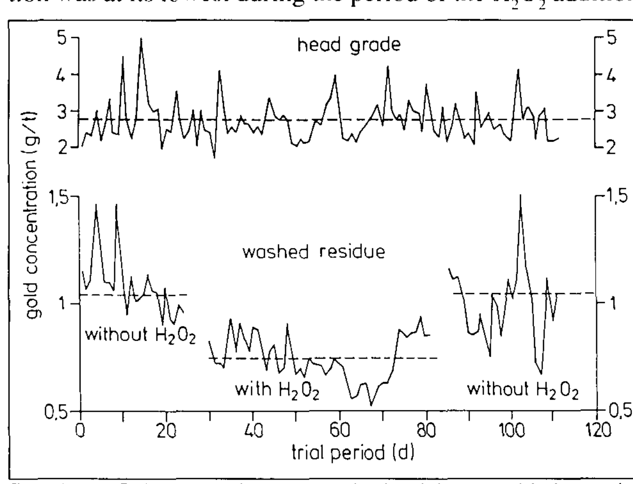

Fig. 3 — Gold extraction rates obtained by cyanidation using compressed air and H_2O_2.

Conclusion

The peroxide assisted leach process has been developed to introduce the oxygen necessary for cyanidation in a liquid form. The process has the following characteristics:

- The gold extraction is greatly accelerated. The final gold extraction is already reached after two to six hours while the current cyanidation process requires 24 to 48 hours.
- H_2O_2 does not attack the cyanide at all when the PAL process is used.
- The additional gold recovered easily pays for the supplementary reagent and investment costs for the implementation of the PAL process.
- Future plants can be designed much smaller than plants using the conventional cyanidation technique for a given throughput. This leads to considerable savings in the investment costs.

The first scale-up studies of the process have been completed. In the meantime, Gencor's Fairview mine is considering using the PAL process on a permanent basis. ♦

References

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DISCUSSION

Two case histories of subsidence in the Warrior coalfield

by D.W. Park

Technical Papers, MINING ENGINEERING, Vol. 40, No. 3
March 1988, pp. 185-191

by G.B. Johnston, Jr.

I was very interested in Professor Park's data on subsidence over longwall panels. His paragraph labeled "Conclusion," however, does not seem appropriate for the article. Nothing in the article gives any discussion of how knowledge of subsidence characteristics can be used in mine design to minimize damage. That thought may have been a reason for undertaking this study, but not a conclusion of it.

From his article, I would conclude that subsidence movements last considerably longer at great depth. And the National Coal Board's subsidence prediction model represents this area reasonably accurately, though most literature claims their model predicts far greater disturbances than actually occur in most areas of the United States.

Also, I would like to know, is the method used to determine angle of draw? The criterion used can make a significant difference in the value obtained. With 30 m (100 ft) spacing and a 122-m (400-ft) depth the angle between stations can be up to 14°. ♦