ABSTRACT

The cyanidation process of refractory gold ores has been the subject of numerous investigations aimed at improving the gold recovery and the leaching kinetics. Many pretreatments methods have been developed in this regard and numerous new leaching configurations have been introduced in the process. However, even after many improvements, the leaching of refractory gold ore remains a process of some duration (24 hours or more to reach acceptable gold recoveries). From recent literature investigations, hydrodynamic cavitation has been found to be a promising new approach which may advantageously enhance the cyanidation process. This approach results in the enhancement of mass transfer kinetics of multiphase streams due to impacting two pulp streams against one another in a vessel called the "Jetleach reactor (Jetleach)''.

In this work the Jetleach reactor was applied to three different refractory gold ores. Two rougher flotation concentrates from West Africa (DIO and MVO) and one flotation concentrate from the Ergo plant in South Africa. Results from a comparative cyanidation test between the Jetleach process and conventional methods, here represented by the normal leaching in agitated vessel and bottle rolling methods, have shown impressive results. On the DIO sample, the Jetleach reactor has shown an improvement of almost 8% and 19% gold recovery compared to the normal leaching and bottle rolling method, respectively, while on the MVO sample, the improvement was about 10% compared to the normal leaching method and 17% compared to the bottle rolling tests. On the Ergo sample, the improvement of gold recovery was over 12% compared to both two conventional methods.

Cyanidation using one factor at a time (OFAT) experiment revealed that the pump pressure, the feed pulp solid percentage and the oxygen flowrate are the parameters significantly influencing the gold recovery. However, cyanidation, using design of experiments (DOE) and response surface methodology strategy, has shown that, in addition to these three significant parameters, three other interactions between parameters also have a significant effect on the gold recovery.

The analysis done on the Jetleach residues, using the Scanning Electron Microscope (SEM), have revealed the presence of cavities and cracks on the surface on some particles which could

explain one reason for the faster leaching kinetics and higher gold recoveries. The particle size analysis, undertaken on the feed and the residue of the Jetleach reactor, revealed a size reduction of particles after passing through the reactor. This size reduction can also be one of the elements contributing to faster leaching kinetics.

In pursuing the understanding of the generation of cavitation in the Jetleach reactor, a visualization test using a high-speed camera was conducted on a transparent tube reactor, operating with water to simulate the process in the Jetleach. Images collected from the high-speed camera have shown the presence of cavities generated in the water and the collapsing process of same. These images also revealed that cavitation was directly connected to the pump pressure. The higher the pressure of the pump, the larger the resulting cavitation zone.

This work has shown that the Jetleach reactor is able to improve the leaching kinetics and the gold recovery of all three refractory gold ores involved in this project. The reactor was also able to reduce the cyanide and oxygen consumption on the Ergo sample. Therefore, an integration of this reactor in the cyanidation process, will result in benefits in terms of both metal recovery improvement and reagent consumption reduction.