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Original Research Paper

Effect of binder properties on the strength, porosity and leaching behaviour of single nickel laterite pellet

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ABSTRACT

Nickel laterite pellets with controlled mass, porosity and binder were made by using a pellet press. Both water and sulphuric acid solution were used as binders. The wet pellets were then dried at different conditions and their mechanical strength was measured. Leaching tests were also conducted on single pellet with irrigation of sulphuric acid solution from the top of the pellet. The leached out solutions were collected and nickel recoveries were analysed. The time taken for the pellets to disintegrate during leaching test was also recorded. It was found that the mechanical strength of the pellets was directly related to their dryness, with completely dried pellets having much higher strength. The dry pellet strength was found to increase with increasing binder content and decreasing pellet porosity. The time taken for the pellets to disintegrate during leaching test increased with increasing pellet strength. In comparison to sulphuric acid solution-bound pellets at the same condition, water-bound pellets exhibited higher mechanical strength. Although the nickel leaching rate for water-bound pellets was low at the beginning of the leaching test, the pellets lasted for more than 200 h without disintegration, with 70% of nickel recovered.

1. Introduction

Heap leaching is a process employed in the minerals industry to recover valuable metals from low-grade ores at relatively low capital and operational cost. Agglomeration of mineral particles as a precursor to heap leaching can eliminate the migration of fine grained particles throughout a heap leach [1] and therefore makes the leaching process more efficient.

Numerous studies of agglomeration of copper ore heap leaching have been reported (e.g. [2,3]) and to a lesser extent on gold ore (e.g. Polizzotti et al. [4]). For nickel laterite agglomeration and heap leaching, few studies have been reported to date. Readett and Fox [5] reported the commercialisation of nickel laterite heap leaching process, although the heap height was limited by the agglomerate strength. Bouffard [6] has provided a comprehensive review on the agglomeration processes and fundamentals for heap leaching and its geotechnical stability. However, progress in this area has been significantly hampered by the lack of quantitative measurements for optimisation of agglomerate quality [1,7], particularly at single agglomerate level. Ideal agglomerates in a heap should not only withstand the aggressive acid leaching conditions without disintegration over 200–300 days, but also be able to leach out more than 80% of the targeted metal. If the majority of the targeted value metal can be leached out without disintegration, this establishes the optimum conditions with high permeability in the robust heap. On single agglomerate level, it indicates that an ideal agglomerate for heap leaching should be both strong and porous at the same time. It should be pointed out that the total mass loss during nickel laterite agglomerate leaching is higher than copper leaching which means that the agglomerate porosity and strength will change significantly during leaching process.

In this work, nickel laterite pellets with controlled mass, porosity and binder (sulphuric acid solution and water) were made to study the effect of binder properties on the strength and leaching behaviour. The objective of this study were to: (1) relate pellet strength to variables such as binder type (acid solution and water), binder content and (2) relate the binder properties and drying conditions of the pellets to its leaching behaviour so that the best pellet attributes can be identified. The knowledge obtained from single agglomerate performance can then be used to inform industry for producing agglomerates with optimum properties for enhanced heap leaching.

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