ECONOMIC AND ENVIRONMENTAL ASSESSMENT OF UNDERGROUND IN-SITU LEACHING PROCESSES UTILISING DRILL AND BLAST TO ACHIEVE HIGH PERMEABILITY

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ABSTRACT

In-Place Recovery (IPR) involves blasting a stope, dissolving the metal-bearing minerals within the stope using an appropriate leach solution, and pumping the pregnant leach solution (PLS) to the surface for further processing. While the IPR concept is applicable to various metals, this study was focused on copper extraction mainly to address the future challenge of accessing lower grade and more complex ore bodies in a sustainable manner. In this work, an economic assessment and an environmental impact assessment were conducted to compare copper extraction via IPR with that of conventional mining methods and extraction routes.

A high level economic assessment was completed for a hypothetical 50,000 tonnes per annum copper operation with a head grade of 1% copper from a deposit 500 m deep. Capital investment and the operating cost of the sublevel open stoping (SLOS) method was compared against IPR with three different blast design methodologies. The results showed that both mining and processing capital costs of an IPR operation are significantly lower than that of SLOS. IPR benefits from lower direct operating cost, despite lower recoveries and a higher number of stopes in operation to equate the production rate of SLOS. Lowered haulage and the reduced amount of development were the main contributing factors to the cash cost saving. A sensitivity analysis was performed to assess the response of net present values to copper grade, operating cost, initial capital cost, and copper price. The results showed that SLOS is more sensitive to all four parameters. Hence, for an increase in head grade or copper price SLOS is more profitable, while at lower grades and copper prices IPR is more profitable. While an optimum technology choice can only be made upon detailed consideration of the relevant facts for each specific project, the economic assessment in this work revealed that at low grades of copper an IPR operation is more profitable than conventional SLOS method due to the reduced operational cost and initial capital investment. As the stope configuration in IPR can be aligned with conventional mining methods, there is scope to run a hybrid operation where high-grade ore is mined and processed conventionally, and the low-grade ore is recovered through IPR. This allows the IPR technology to be an addition to an existing operation.

Environmental concerns such as greenhouse gas emissions, energy consumption, water consumption, and land disturbance play a governing role in restricting future operations. The environmental impacts of IPR were compared to conventional underground (UG) and open-pit operations combined with either pyro- or hydro-metallurgical processing. When comparing the CO_2 per tonne of Cu for a range of mining-processing streams, IPR with solvent extraction/electrowinning (SX/EW) is significantly less polluting than a surface mining operation with heap leach pads and SX/EW or an UG operation with concentrators, smelter, and electro refining. Technologies such as IPR allow the targeted extraction of metals from the ground resulting in significantly reduced land disturbance and other environmental impacts. The technology could be a significant contributor in underground operations achieving a net zero target by 2050.

Keywords: UG mining, Copper, In-Place Recovery, Cash Flow analysis, Environmental impact