INTMET

INTEGRATED METALLURGY FOR POLYMETALLIC, COMPLEX AND LOW GRADE ORES AND CONCENTRATES

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WORK PACKAGE 5: DEVELOPMENT OF INTEGRATIVE BIOLEACHING PROCESS

OBJECTIVES

The main objective of WP5 is to:

Develop and test innovative bioleaching processes capable of efficiently dealing with Low Grade copper concentrates (<10-15% Cu), polymetallic concentrates (<10-15% Cu+Zn+Pb), and flotation middlings produced in existing flotation plants (WP2), to yield high quality and added value metal products.

This has been divided into the following sub-objectives:

- ✓ O5.1 To evaluate the bioleaching lab scale results for each of the BOR, CLC, KGHM and Somincor concentrates.
- ✓ O5.2 To confirm that each concentrate is amenable to bioleaching at that scale (current positive results at lab scale).
- ✓ O5.3 To perform the required bioleaching for a certain period of time (it is a slow process) aiming to optimize Cu and Zn released into solution.
- ✓ O5.4 To design and develop dedicated pilot plant circuits as required by tested concentrates.
- ✓ O5.5 To optimise the operational conditions (temperature, residence time, feed density etc).

The responsibility for the execution of this work package has been allocted to Mintek (South Africa) and IRM-Bor (Serbia).

MAIN RESULTS

LAB-SCALE BIOLEACHING AND AMENABILITY TESTING (ADDRESSING O5.1-O5.3)

Feed materials were received from the Bor-Institute (Serbia), Somincor (Portugal), KGHM (Poland) and Cobre Las Cruces (Spain). Each were subjected to small-scale bioleaching tests to firstly establish the regime within which material would need to be treated regarding bacterial culture (low, medium or high temperature), requirement for re-grinding, minimum leach residence time and maximum feed density (affecting reactor volume).

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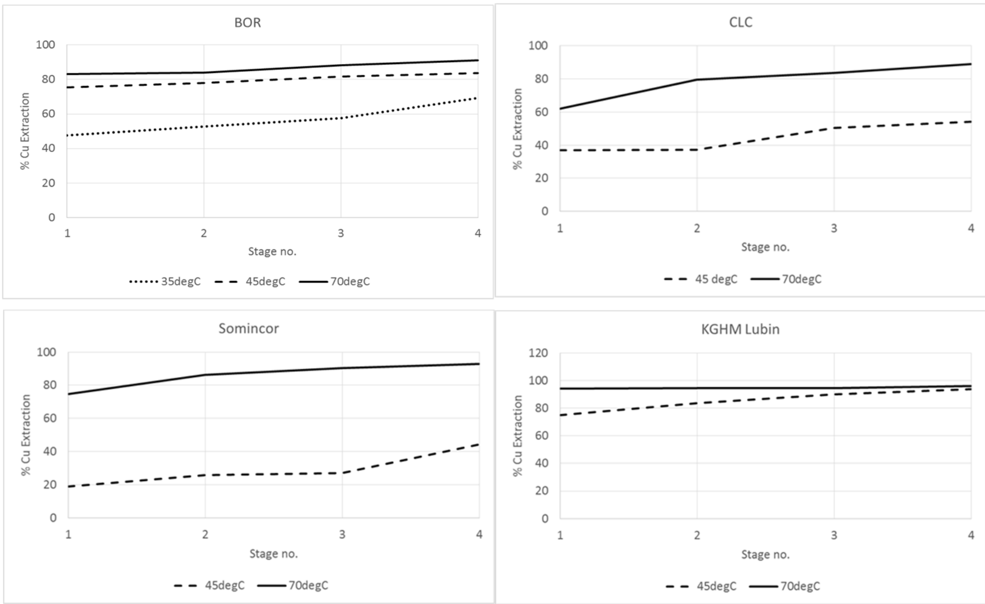

FIGURE 1. COPPER EXTRACTIONS ACHIEVED DURING CONTINUOUS BIOLEACHING

For economy of space, only the copper extraction results are shown in Figure 1 above, since this metal is a major (if not the primary) source of value in all cases and is typically the more difficult mineral to extract. For the sake of providing a readily implementable technological solution, it is recommended that the use of extreme thermophiles (operating at 70°C) be avoided if possible. On this basis, bioleaching (operating at 45°C) can be recommended for consideration only on the Bor and KGHM materials, while other technologies should firstly be considered for the CLC and Somincor materials.

TESTING OF PILOT PLANT CIRCUITS AND OPTIMISATION (ADDRESSING O5.4 AND O5.5)

To satisfy the constraints of budgetory and other resources, process integration and optimisation have been performed on the Bor material, which is the most complex by having its contained value spread over 6 elements (Cu, Zn, Pb, Ba, Ag and Au). It is anticipated that lessons learnt on the Bor material should be transferable to the treatment of any of the other three materials.

The most significant innovation that has been required to treat the Bor material, being unusual for its low grade, high pyrite content and multitude of value-elements, has been the adoption of resin-in-pulp adsorption instead of solvent-extraction for winning of the dissolved copper and zinc from solution. This overcomes the difficulties that would otherwise arise during the solid-liquid separation steps and the co-precipitation of the value-metals during precipitation from solution of the substantial iron content.

An integrated batch-continuous pilot plant has been operated at Mintek, while various options for re-covery of the other value-elements (lead, silver, gold and barium) have been tested at both Mintek and IRM-Bor. It has been established that at least 85% of the Cu, 75% of the Zn, 90% of the Pb, 90% of the Au and 80% of the Ag can be extracted from the ore. Technologies exist for refining all these elements to their metallic form. However, as a pragmatic initial approach, a flowsheet has been suggested where-by only the Cu is produced as LME-grade cathode. The Zn and Pb are to be produced as salts while the Ag is to be sold in adsorbed form on activated carbon.

A flow diagram appears in Figure 2. The red blocks indicate separation steps, with the existance of seven such steps indicating the relative complexity of the process, a simple process would have contained only one or two such steps. (This number would increase even further if each of the products were to be refined to metallic form). In Figure 2, products are indicated by green text and raw material inputs by red text.

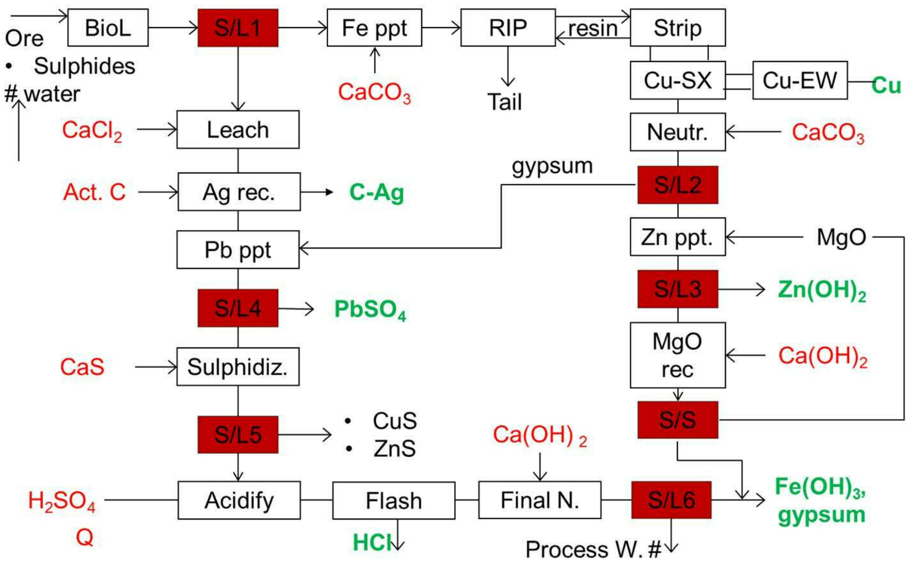

FIGURE 2. PROCESS BLOCK FLOW DIAGRAM SUGGESTED FOR EXPLOITATION OF THE BOR MATERIAL.

The production of intermediates opposed to refined metals will minimise the capital that needs to be raised for the plant, which would be consistent with the relatively small resource that is available of this material.

A study of the behaviour of the leach residue revealed that all of Cu, Ni, Pb, Sb, Se, Zn, Al, Ca and Fe could be leaching from it at levels that exceed effluent guidelines. The tailings storage facility would therefore need to be designed to contain any seepage to prevent these elements from spreading beyond the perimeter of the operation.

An economic analysis considered the case for the treatment of the Bor material at a rate of 880,000 tonnes per annum. Considering only Cu as a product, a pay-back period of less than 2 years was predicted which is very favourable. This economic model can now be expanded to consider the marginal cost and revenue of each additional element to be produced in turn, to decide which additional products (if not all) are to be incorporated into the ultimate process flow diagram.

Larger scale continuous pilot plants are under commissioning at IRM-Bor which will be instrumental in transferring the technology for application on-site at Bor, Serbia.