

COPPER HEAP LEACH DESIGN – HIT OR MISS?

Heap leaching has become increasingly popular in the copper industry for treating oxide and secondary sulphide ores. The ability to use heap leaching, together with solvent extraction and electrowinning (SX/EW), to go from ore to high grade metal at the mine-site makes it particularly attractive to aspiring juniors. However, it is not without its pitfalls, and a number of projects have suffered from slow ramp-up times and not lived up to expectations, highlighting the need for improvements in testwork, scale-up and system design procedures. Although progress has been made, procedures are still in a state of flux, with no universally recognised standards. This is reflected in the number of heap leach modelling and scale-up papers at this month's ALTA Copper 2002 Conference.

If you are thinking about having a go, here are some practical pointers to help you towards a successful project:

Build a Good Foundation with Well Planned Drilling and Sampling

- Metallurgical testwork is a **big consumer** of diamond drill core, and the drilling program must be designed accordingly. Some drill chips can be used for the initial testwork phase, but core is needed for most of the program.
- Maximise the diamond drill diameter. Far better to pay the extra cost than to find out too late that you can't test a coarse enough crush size.
- Assay for leachable copper as well as total copper. Leachable copper is the **true head grade** for heap leaching, and the orebody should be modelled accordingly.
- Select the appropriate leachable copper assay procedure. Better to start correctly than be faced later with a major re-assaying effort.
- For oxide ore, use the hot acid soluble procedure. The cold acid soluble method has been proven to be **unreliable**, and often understates the leachable copper assay.
- For leachable copper assay for sulphides, best to use hot acid soluble with cyanide soluble on the residue from the hot acid procedure, especially in the early stages. The cyanide soluble assay alone does not always work (for example it does not pick up chrysocolla). The cyanide soluble assay can be considered later when more is known about the orebody.
- Talk to the metallurgist early about the assay procedure to avoid later backtracking. It may be worthwhile tracking other key elements.
- Use recent core wherever possible for metallurgical samples. Consider older core only when there is limited oxidation. Protect your investment by keeping sulphide core in a freezer.
- Carry out **thorough mineralogical work** to identify potential metallurgical issues early.

- Define potential metallurgical ore types for testing based on detailed chemical analyses, mineralogical information, physical characteristics and core logging data. **Be inclusive**; the number of ore types can be reduced as testwork progresses.

Systematic Testwork is Essential

- Being **systematic** is the name of the game. Avoid taking apparent short-cuts; you will usually live to regret it!
- Adopt a phased approach, with increasing levels of detail and increasingly large column tests.
- Carry out parallel economic studies and risk analyses, covering other aspects of the project also.
- Use tap water for initial work, but switch to site water as soon as possible. Track quality of potential site water. Watch out as the supply and/or quality can be seasonable.
- Test a range of crush sizes and select the optimum as early as possible.
- Always use **realistic** commercial leach conditions for column tests, such as acid level and irrigation rate.
- Test alternative acid addition strategies early, including strong acid cure. Be aware of the difference between gross and net acid consumption. The net figure takes account of acid regenerated in SX/EW.
- Ambient temperature, pressure and even humidity can affect leaching testwork, especially with sulphides. Therefore pay attention any difference between ambient conditions between the testwork location and the proposed mine site. Sometimes it may be necessary do testwork in enclosure under controlled conditions or at proposed mine-site itself.
- Consider using controlled aeration for sulphide leach column tests-it is increasingly used in commercial operations.
- If fines and/or clays are present, carry out percolation tests before committing to column tests. You may need to adopt agglomeration with strong acid and/or polymer. If agglomeration is adopted, stability of agglomerates during handling and leaching is an issue to watch.
- Build-up of impurities during leaching is not easy to simulate. You may have to do supplementary work if this is an issue. High impurity levels can cause viscosity problems in SX during very cold weather.
- Final column tests must be at the **full** projected lift height. This can lead to long test duration, especially for sulphides. For example, a 6 m high sulphide column test can take close to a year to complete!
- Final testwork phase should include composites related to mine plan.

- The question of pilot scale tests is always a thorny issue. It may be determined by corporate policy or financial institution requirements. In fact, a well designed tall column program with comprehensive orebody coverage may provide more security than larger scale pilot work, which is usually limited to only a portion of the ore.
- Consider looking at leaching ROM material for part or all of the ore zones. This requires a specially designed test program, which can be a challenge if only core is available.

Be Conservative in Scale-Up

- You **must** apply adequate safety factors to testwork figures for copper recovery and leach kinetics.
- The SX circuit has an overriding effect on the leaching curve, and must be taken into account. Don't be too optimistic when projecting the copper level in the SX feed solution. Allow for dilution with rain or snow when appropriate.
- Include an allowance for "catch-up" in the SX/EW design, especially for the EW **rectifier**, which is the ultimate bottleneck.



Girilambone Copper Company Heap Leaching Operation, NSW

Winning or Losing can Depend on Commissioning and Ramp-Up

- **Don't** change the mine-plan unless supported by testwork. If you drop the grade, you **can't expect** make the same SX feed copper level without putting production in serious jeopardy.
- Don't skimp on pre-production mining and heap building. You may need extra leach area in a hurry.
- Have people available to monitor the leaching performance during commissioning, no matter what. Leaching is your future, even though initial problems occur around the SX/EW plant. Hire extra people for commissioning if needed.
- Recalibrate the leaching model with actual data on ongoing basis. Do supporting column tests to predict leaching behaviour in advance of mining.
- If you use a contract crusher and heap builder, provide close supervision, especially in the early stages. His priorities may be different from yours.
- Locate the heads of your geological, mining and metallurgical groups in adjoining offices, and insist they talk to each other daily. Successful heap leaching has to be a **team effort**.

Don't try to re-invent the wheel. Learn from other's mistakes and hopefully you will have a hit and not a miss!

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