TECH NOTE - AMENABILITY OF POTASH ORE DEPOSITS FOR SOLUTION MINING

TESTWORK, MODELING AND GEOMETALLURGICAL PLATFORM

BACKGROUND

In its broadest sense, solution mining (also known as in-situ leaching) is defined as the extraction of the pay metals from ore deposits using aqueous leaching medium. The pay metals (i.e. copper, uranium, sodium, potassium, etc.) are commonly present in the form of a compound that is either readily soluble in water, or can be rendered as such by addition of specific reagents. Solution mining differs from heap and vat leaching as it does not involve conventional mining of the ore. Minerals such as potash, trona (raw soda ash), etc., are readily soluble in water thus they could be suitable for solution-mining. In case of these minerals, solution mining targets the dissolution of the so called “evaporates” fraction, which commonly consists of soluble rock material. Essentially, the process consists of pumping water (initially, followed by brine-solution at a later stage) into the deposit through borehole wells until saturation is reached. The resulting loaded-solution is directed to purification and final product recovery.

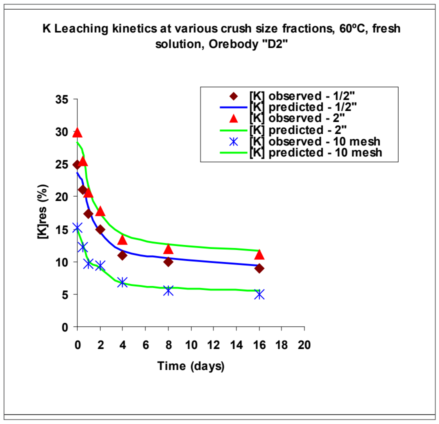
It is estimated that in the Canadian province of Saskatchewan there are some 8 billion short tons of recoverable KCl reserves using conventional underground techniques, but some 110 billion tons of recoverable KCl reserves by solution mining techniques. Expressed as potassium oxide, one ton of KCl is equivalent to 0.63 tons of K_2O. The potash deposit itself consists of sedimentary deposits containing primarily halite (NaCl), sylvite (KCl), carnallite ($MgCl2 \times 6H_2O$) as main soluble minerals. Insoluble species of relevance include clay, dolomite, and anhydrite.

SGS MINERALS SERVICES APPROACH OVERVIEW

SGS Minerals Services provides services necessary for ore deposit delineation and subsequent metallurgical-process characterization consistent with the National Instrument (NI) 43-101 guidelines, whereby the economic mineralization types are classified as Inferred, Indicated, and Measured Mineral Resources. Drill core data are needed to define the first two categories, whereas the measured resources definition requires completed engineering studies, including process-response, where the process in this case consist of solution mining.

The SGS approach addresses key aspects including:

- Provides certified laboratory drill-core chemical and analyses;
- Process mineralogy characterization of selected/representative drill-core samples;
- Metallurgical response of the said samples to testwork simulated solution mining;
- Real (test) data modeling (RDM) aiming to produce a geo-metallurgical mapping of the solution-mined deposit;
- Bankable NI 43-101-compliant report for engineering and project feasibility purposes.



SGS PROCESS RISK MITIGATION THROUGH TESTWORK AND SUBSEQUENT REAL DATA MODELING

SGS proposes a simple and direct approach for the metallurgical investigation aiming to determine the amenability of potash ore deposit samples for solution mining. The methodology is based on past project experience involving laboratory scale solution mining simulation for copper and trona ores. Related experience includes heap and vat leaching simulations for copper, nickel, gold, uranium and other deposits – despite of the dissimilarities between these technologies compared to solution mining, they also display certain common characteristics in terms of testing-operating procedures and subsequent data reduction and modeling.

Essentially, the SGS process risk mitigation approach to solution mining relies on producing leachability data on various feed samples originating from well-defined ore bodies within the deposit. A hydrometallurgical testwork matrix is designed and carried out aimed to investigate the effect of common parameters on leaching kinetics and final extraction values in case of each representative ore-deposit sample. In case of solution mining, those key parameters include size fraction, temperature and solution concentration.

The leaching model is provided below, along with an example (Figure 1) showing the comparative rates of reaction by plotting the residual K concentration profiles in the leached ore for a certain sample (within the orebody) at various size fractions. The underlying 10 mesh leach data are produced through agitated temperature-controlled-leaching tests. The coarse fractions leach data are produced through flowrate and temperature-controlled-flooded-column leaching tests. Feed and residue mineralogical examination results complete the leach data. The data produced are summarized and fed into a general leaching model that becomes the "logical feed" to the geometallurgical model.

The geometallurgical approach is perhaps the most omnivorous tool to achieve effective sample pre-definition. In our experience, about 6 to 12 representative samples should be defined and geochemically characterized. This number is determined primarily by deposit size and inherent geochemical complexity.

The rate equations can be used also to predict relative "in-situ" leaching rates based using a conventional parametric extrapolation – these results need to be confirmed by pilot scale full-feasibility testwork. This is necessary in order to estimate the metallurgical response of the ore deposit under real solution mining conditions characterized by increased pressures and possibly temperatures at the point of solution contact as well as to ascertain the effect of true permeability of the ore-body. Purification and separation testwork is carried out at this point in time using the large amounts of pilot-plant produced loaded solution. The data package produced by the pilot exercise is fed into the updated-overall geochemical model.

In addition to the above, the geometallurgical platform can integrate geological, mining, metallurgical, environmental, marketing and economic aspects of a mining project, as fundamental components of the project development process.

This framework allows SGS to define the optimal mineral processing flowsheet for the projected life of the mine, based on its process response in conjunction with the geological, geochemical, mineralogical, textural and metallurgical characteristics of the ore deposit.

$$[K]p,t = \frac{1}{k_P t + \left(\frac{1}{[K]p,o - [K]p,e}\right)} + [K]p,e$$

where

[K]p,t: concentration of K in ore @ time *t*

[K]p,o: Head

[K]p,e: concentration of K in ore @ infinite time

k_P: rate constant

t: time

CONTACT INFORMATION

Email us at minerals@sgs.com
www.sgs.com/mining