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Temperature Effects on Sylvinite Solution Mining

Robert Asch, Mazi Rejaee, Novopro Projects Inc., Montreal, Canada
Norbert Grüschow, NGConsulting, Sonderhausen, Germany
Micheal Rembe, W/T Geoingenieure GbR, Nordhausen; Germany

Abstract

Active solution mines are using a solvent at deposit temperatures or hot leaching methodology in order to extract KCl from potash deposits. The idea is simple; KCl (sylvite) dissolves faster with increased mass flux in hot solvent than in cold solvent. The deposits consist primarily of sylvinite, which is composed of halite and sylvite. Whereas halite hardly shows an endothermic dissolution behavior, sylvite dissolution benefits from elevated solvent temperatures. By taking advantage of this behavior, the solution mining process can gain an edge over conventional mining with regards to the following aspects:

- A number of the processing steps are outside of the processing plant and within the production caverns; the dissolution and clarifying process takes place within the cavern, dissolving the ore and reducing the insolubles brought to surface.
- The KCl content of the production brine can be increased using elevated temperatures.
- The elevated temperature of the production brine supports the evaporation processing stage at the plant.
- The water consumption can be reduced using hot solvent, as the tonnage of KCl transported within the brine to the plant is significantly increased.

A study was performed to estimate the optimum energy balance with respect to the recovered tonnage of KCl using cavern target temperatures of 60°C, 75°C, 100°C, and 125°C. The deposit temperature is assumed to be 40°C. The increase of the KCl content in the production brine with increasing cavern temperatures was estimated based on solubility equilibrium data and theoretical equations developed from dissolution test work. The quantity of steam required to preheat the solvent and the advantage of evaporating a pre-heated production brine was compared to the increased KCl content of the production brine.

Furthermore, the heat losses to the surrounding rocks of the cavern and from pipeline transport were incorporated to identify areas of optimization such as insulated and buried pipelines. As a result, the recommended cavern brine temperature should be approximately 20°C above the host rock temperature to support a balanced heat input and KCl output. The required solvent injection temperature to sustain this cavern temperature is calculated based upon borehole depth, formation losses and pipeline length. These assumptions and factors can be investigated using a CFD (computational fluid dynamics) model with a focus on the geometrical aspects of the caverns such as mining cut heights and volumes. The model considers cavern turbulent fluid flow, dissolution kinetics, mass and heat transport. This paper presents the thermodynamics of sylvinite leaching at elevated temperatures, and its effect on the resulting production brine and the processing steps within the evaporation plant. The potential of a CFD model is also discussed with respect to heat transfer.

Key words: Sylvinite, Temperature Effects, Solution Mining, Cavern Operation, Sylvinite Processing