

A combined experimental and modelling approach for the study of bioleaching kinetics as a function of the temperature

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Abstract: Bioleaching processes are highly impacted by the temperature due to the microorganisms' sensitivity to this parameter, particularly when mixed microbial consortia containing iron- and sulfur-oxidizing bacteria are involved. Various microorganisms may have different temperature ranges for optimal metabolisms. Therefore, it is crucial to understand the effect of temperature on bacterial activity and on the bioleaching reaction kinetics in processes in which this parameter is difficult to control (such as heap or pond bioleaching). In the H2020 NEMO project, a mixed experimental and modelling approach was developed to determine the relation between bioleaching kinetics and temperature. Firstly, a heat balance model, including the main heat transfer gains and losses, was developed for stirred tanks and pond bioleaching processes. This model included a biological sub-model that provides the heat contribution of the pyrite biooxidation reaction and that correlates the biological reaction kinetics as a function of the temperature. Then, the biological sub-model was calibrated using experimental data coming from the bioleaching of flotation tailings (Aitik mine, Sweden; 40% pyrite) in a 114-L continuous pilot composed of four stirred tank reactors in series. The microbial consortium was composed mainly of *Leptospirillum ferriphilum*, *Acidithiobacillus caldus* and *Sulfobacillus* spp. Test work showed that optimal temperature range for this consortium was between 42°C and 45°C and that temperature autoregulation of the process was possible at pilot scale. The calibrated model, including the bioleaching kinetics as a function of the temperature, agreed with the experimental results in terms of pyrite bioleaching yield. The model was then applied to estimate the heat balance of a pond bioleaching process treating Aitik and Luikonlahti tailings (Finland).

Keywords: bioleaching kinetics, heat transfer, modelling, pond, reactor

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