Full scale design of bioleaching pond concept through numerical simulation

Céline Loubière[1], Anne-Gwénaëlle Guezennec[1*], Agathe Hubau[1], Douglas Pino Herrera[1], Eric Olmos[2]

[1] Water, Environment and Process Development and Analysis Division, BRGM, Orleans, France

[2] Laboratoire Réactions et Génie des Procédés, Université de Lorraine, CNRS, LRGP, 54000 Nancy, France

*Correspondence: a.guezennec@brgm.fr (Anne-Gwénaëlle Guezennec).

Abstract: New bioreactor technology was recently developed for bioleaching applications. It consists of ponds where pulp suspension and gas-liquid mass transfer are achieved with floating agitators. Bioleaching reactions are significantly exothermic with high oxygen requirements. Temperature regulation is usually required in bioleaching reactors to maintain biological activity. Contrary to conventional stirred tank reactors, the temperature in ponds cannot be easily regulated through heat exchangers. A numerical strategy was developed to design an industrial application of the concept and to select suitable operating parameters. First, computational fluid dynamics (CFD) was used to model the hydrodynamics of the system and to define the volume of influence of one single agitator, the number of floating agitators and the mechanical power dissipated into the fluid. Then, a numerical model was developed using MatLab to quantify the contribution of the operating and environmental conditions to the heat balance and their influence on temperature regulation. Various scenarios were simulated (equatorial and sub-arctic climates, sulfide concentration, pond geometries). At industrial scale, the environmental conditions have little influence on the heat balance, which is mainly dominated by the reaction enthalpy. It was demonstrated that the temperature could be maintained in a suitable range (40 to 50°C) by controlling the fresh pulp inlet conditions (flow rate, temperature) and the aeration (flow rate, oxygen partial pressure), even at low sulfide concentration (between 5 and 10%).

Keywords: bioleaching, computational fluid dynamics, floating agitator, heat transfer, mixing, numerical model, pond, reactor,

Acknowledgements: This work is part of the European collaborative research project NEMO (Near-zero-waste recycling of low-grade sulfidic mining waste for critical-metal, mineral and construction raw-material production in a circular economy), funded by the European Union's Hori-zon2020 research and innovation programme under grant agreement No 776846.