



# Heat balance modelling of a stirred aerated industrial bioleaching pond reactor for design and operation optimization

Céline Loubière, Olmos Eric, Yannick Ménard, Anne-Gwenaëlle Guezennec

## ► To cite this version:

Céline Loubière, Olmos Eric, Yannick Ménard, Anne-Gwenaëlle Guezennec. Heat balance modelling of a stirred aerated industrial bioleaching pond reactor for design and operation optimization. 2020. hal-02495700

**HAL Id: hal-02495700**

**<https://brgm.hal.science/hal-02495700>**

Preprint submitted on 2 Mar 2020

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

## **Heat balance modelling of a stirred aerated industrial bioleaching pond reactor for design and operation optimization**

*LOUBIERE Céline<sup>1</sup>, OLMOS Eric<sup>2</sup>, MENARD Yannick<sup>1</sup>, GUEZENNEC Anne-Gwenaëlle<sup>1</sup>.*

*<sup>1</sup> Bureau de Recherches Géologiques et Minières, BRGM, 45100 Orléans, France*

*<sup>2</sup> Laboratoire Réactions et Génie des Procédés, Université de Lorraine, CNRS, LRGP, 54000 Nancy, France*

*Email: c.loubiere@brgm.fr*

The global metal demand is steadily growing for both industrial and domestic applications, and is anticipated to increase by 30% by 2050<sup>1</sup>. Combined to high-grade deposits exhaustion, it motivates the exploitation of low-grade ores. Within this context, bioleaching represents an alternative when traditional processes are not economically viable.

An innovative bioleaching concept was recently developed, using floating agitators to inject gases and to mix solids in ponds instead of costly tanks<sup>2,3</sup>. Based on an oxygen-enriched air, the gas-liquid transfer is improved, and the temperature, crucial to "regulate" the exothermic biological reactions ( $\Delta rH^0 = -12.9 \text{ MJ kg}^{-1}$  for pyrite oxidation), can be controlled without heat exchanger<sup>4</sup>. This system was validated at pilot scale (2 m<sup>3</sup> reactor with mini-floating agitator 1:4-scale at a culture temperature of 40 °C using a moderate thermophilic consortium)<sup>5</sup>, and a scale-up method was elaborated for the industrial scale (>10<sup>3</sup> m<sup>3</sup>). The process design was based on a complete heat balance, including bio-chemical reactions, agitator power input and both solar and atmospheric radiation for heat gains. For heat losses, radiative emission, aeration, pond wall convection, pond surface convection and evaporation were considered. A dynamic integration was performed using weather data near the Sotkamo mine (Finland), regarding day / night and season impacts. Impacts of pond dimensions and gas inlet flowrates were finally investigated in order to propose enhanced geometries and operating conditions, regarding efficiency of the bioleaching reactions.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 776846<sup>6</sup>.

### Literature

1. Johnson, B.: *The Evolution, Current Status, and Future Prospects of Using Biotechnologies in the Mineral Extraction and Metal Recovery Sectors*, 2018, *Minerals*, 8(8), 343.
2. Guezennec, A.-G., et al.: *Bioleaching method and facility*, 2017. Patent US20170175223A1.
3. Guezennec, A.G., et al.: *The Use of Bioleaching Methods for the Recovery of Metals Contained in Sulfidic Mining Wastes*, 2014, *Hydrometallurgy 2014*, Victoria, Canada. 7 p. ([hal-00988746](https://hal.archives-ouvertes.fr/hal-00988746)).
4. Guezennec, A.G., et al.: *Influence of dissolved oxygen on the bioleaching efficiency under oxygen enriched atmosphere*, 2017, *Minerals Engineering*, 106, 64-70.
5. Guezennec, A.-G., et al.: *The use of oxygen instead of air in bioleaching operations at medium temperature*, 2016a, *8th International Mineral Processing Congress : IMPC 2016*, Sep 2016, Quebec, Canada.
6. <https://h2020-nemo.eu>

- ☒ Oral contribution
- ☒ Poster contribution

### Stream:

- ☒ Industrial-scale bioprocess operation
- ☐ Bioprocesses for a circular economy
- ☐ High-throughput bioprocessing and automation
- ☐ Single-use bioreactors and their applications
- ☐ Process analytical technologies (PAT)
- ☐ Population balances
- ☐ Microtechnologies for bioprocesses
- ☐ Special session: Biotechnology in Latin America

Upload your application including abstract at <https://biotechnologie.ifgb.de/bioproscale2020/cfp>