Proposal for an Open Invited Session at the IFAC World Congress 2023

The State of the Art in Flotation Modelling and Control

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Call for Papers

Abstract

Flotation is one of the key unit operations in mineral processing. While progress has been made in the modelling, control and optimisation of flotation processes, there remain many opportunities to improve the efficiency and economics of flotation circuits. Model predictive control for flotation is an area of current research both in academia and the industry. This invited session will provide the opportunity for both academic and industrial researchers to exchange their ideas and thoughts to find common problems and solutions.

IFAC Technical Committee: 6.2 - Mining, Mineral and Metal Processing.

Detailed Description

Flotation remains one of the most important mineral processing unit operations for upgrading ores and is widely used in copper, platinum, iron, coal, etc. processing flowsheets. The process is complex and in turn, its control has many challenges. There is little consensus on the best methods to model, monitor, control and optimize flotation circuits and their constituent banks. Much effort has been devoted to the modelling of the flotation process, with models ranging from simple scale-up to equations that can only be solved using computational fluid dynamic tools. Recent papers by the group at Imperial College (Quintanilla et al, 2021a, 20021b, 2021c) and the University of Pretoria (Oosthuizen et al, 2021, Le Roux et al, 2017). While having promise, the suitability of these models for the design of multi-variable control systems has not yet been demonstrated. The published work on model predictive control in the industry focuses on the use of empirical dynamic models derived from plant testing (Brooks & Koorts, 2017, Brooks & Munalula, 2017).

New sensing techniques have been developed for flotation, with increasing use of image analysis systems (Horn et. al, 2017, Horn et.al, 2022). Froth cameras have been in commercial operation for some time, but pulp sensing is a new field.

From a purely control perspective flotation banks have the unusual property that there are more inputs to manipulate than variables to control. As an example, a rougher bank of five cells with three reagent additions has 13 manipulated variables (air and level per cell and the reagents) with essentially three controlled variables (concentrate and tail grades and recovery). Practically this under specification is managed by specifying air and level profiles, but this is scientifically unappealing. The concept of peak air recovery (Hadler et al, 2010) provides an intuitively appealing answer to how to employ one of these degrees of freedom. Existing methods for operating a system “at the top of a hill” are however not as appealing (Wepener et al, 2022).

This session aims to bring together experts in the field of both flotation modelling (largely an academic focus) and model predictive control (largely an industrial perspective) to answer the question as to what common ground there is between these two efforts. The hot topics currently include:

- Froth and pulp sensing
- Forth and pulp modelling
- Image sensing – can we see the grade?
- Peak air recovery – controlling at the top of a hill
- Reagent responses – from lab to models or data to models?
- Monitoring versus control – the rule of the digital twin
- Datasets for model validation
- Can assay data be used to build soft sensors for grade and recovery
- Machine learning tools for dynamic modelling
- Economic optimization

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