Preferential flow behaviour in unsaturated packed beds and heaps: Incorporating into a CFD model

D. McBride, I.M.S.K. Ilankoon, S.J. Neethling, J.E. Gebhardt, M. Cross

PII: S0304-386X(16)30546-1
DOI: doi: 10.1016/j.hydromet.2017.06.008
Reference: HYDROM 4600

To appear in: *Hydrometallurgy*

Received date: 12 August 2016
Revised date: 26 April 2017
Accepted date: 3 June 2017

Please cite this article as: D. McBride, I.M.S.K. Ilankoon, S.J. Neethling, J.E. Gebhardt, M. Cross , Preferential flow behaviour in unsaturated packed beds and heaps: Incorporating into a CFD model, *Hydrometallurgy* (2017), doi: 10.1016/j.hydromet.2017.06.008

Preferential flow behaviour in unsaturated packed beds and heaps: Incorporating into a CFD model

*D. McBride[1], I.M.S.K. Ilankoon[2], S.J. Neethling[3], J.E.Gebhardt[4], M.Cross[1]

[1] College of Engineering
Swansea University, Bay Campus, Swansea SA1 8EN, Wales UK
(*Corresponding author: d.mcbride@swansea.ac.uk)

[2] Discipline of Chemical Engineering, School of Engineering
Monash University, Jalan Lagoon Selatan
47500 Bandar Sunway, Selangor Darul Ehsan, Malaysia

[3] Department of Earth Science and Engineering,
Royal School of Mines, Imperial College London, London SW7 2AZ, UK

[4] FLSmidth Inc., Salt Lake City, Utah USA

ABSTRACT

Heap leach stockpiles inevitably contain local voidage heterogeneities due to non-uniform particle size distributions of the ore and other factors that lead to preferential flow paths and solution channelling. The stockpile can also encounter diverse flow conditions due to a number of factors, including storm events, infiltration into dry ore material, cyclic drain down, compaction, migration of fines, all contributing to large variations in local ore permeability and the creation of preferential flow pathways. Non-uniform and adverse flow behaviour within the heap reduces the leaching efficiency which can lead to lower metal recoveries. Therefore, capturing the local flow variations that affect the transport of leach solution within the heap is critical to accurately predicting the leaching kinetics. Experimental data shows how channelling develops due to local heterogeneities that cannot be eliminated by packing alone. Thus, effective modelling of heap leach stockpiles should account for these channelling affects. This paper utilises a robust computational fluid dynamics (CFD) framework that incorporates techniques to account for local preferential flow paths in the heap leach system. The results are compared against liquid flow behaviour in a pseudo two-dimensional column of narrowly sized particles and a more realistic particle size distribution. The methods are then applied to a hypothetical leach to assess the impact of accounting for the flow variability in the heap.

KEYWORDS
Heap leaching, preferential flow, channelling, Computational fluid dynamics (CFD), Hydrodynamics

1. INTRODUCTION

Heap leaching is often the preferred method for the extraction of base and precious metals from large volumes of low grade mineral deposits. This method provides a cost effective technique for the recovery of a range of metals, such as copper, gold, zinc and uranium from low grade ores. However, the efficiency of recovery can be quite variable with recovery rates typically ranging from 50% – 80%, with the more complex sulphide deposits providing lower