UNIVERSITY OF THE
WITWATERSRAND,
JOHANNESBURG

The Effect of Operating Conditions on the Kinetics of Density Stratification in a Batch Jig

Anil Kumar Tripathy

The Faculty of Engineering and the Built Environment, University of the Witwatersrand, Johannesburg,

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Supervisor(s): Lorenzo Woollacott, Herman Potgieter

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Abstract

King's stratification model is a prominent and elegant model of stratification in a jig once an equilibrium condition has been reached. It has been well validated for synthetic systems of mono sized particles. However, it does not account for (1) kinetic effects, (2) the effect of operating conditions on jigging performance, or (3) differences in particle size and shape. Very little work has been done to investigate how the King model can account for the first two of these shortcomings. The focus of the investigation reported in this thesis was therefore to enhance the predictive ability of the King model with regard to accounting for the effect of kinetics and operating conditions.

Jigging performance has been found to be a function of both (1) jig operating conditions and (2) feed characteristics such as feed composition, density distribution, the size and shape of the particles. Hence, tests were conducted in a batch jig using 8mm artificial particles (glass beads) of different colour and density. The effect of key operating conditions such as pulsion time, hold time, bed depth, and water displacement (stroke) on density stratification and stratification kinetics has been investigated.

The results showed that, provided the bed depth was 100mm or less and the stroke was not excessive, the operating conditions did not affect the stratification pattern at equilibrium but did affect the kinetics of stratification. This has the important implication that kinetic and equilibrium effects can be decoupled. The key operating variables that were found to influence stratification kinetics were the density difference between the particles being stratified, the stroke, and the hold time after the pulsion stroke.

It was found that the effect of operating conditions on stratification kinetics could be modelled by means of an 'approach-to-equilibrium' metric. The approach of the stratification pattern asa whole to the equilibrium was essentially first order and could be described in terms of a time constant, $\boldsymbol{\Theta}$, and a delay time of $\boldsymbol{t_o}$. A multi-linear regression model was then developed to

describe the effect of density difference, stroke, pulsion time, and pulsion hold time on the time constant $\boldsymbol{\Theta}$. From this a kinetic model for stratification was developed in which the equilibrium stratification profile is described by the King model, and the kinetics are described by the regression model. The quality of fit of this model to the kinetic data generated in the study is variable and more work is required to improve its predictive ability.