Mechanistic Modelling of Water Partitioning Behavior in Hydrocyclone

Chandranath Banerjee, Eric Climent, Arun Kumar Majumder

Chemical Engineering Science

www.elsevier.com/locate/ces

PII: S0009-2509(16)30331-1
DOI: http://dx.doi.org/10.1016/j.ces.2016.06.037
Reference: CES13017

To appear in: *Chemical Engineering Science*

Received date: 23 February 2016
Revised date: 17 May 2016
Accepted date: 16 June 2016

Cite this article as: Chandranath Banerjee, Eric Climent and Arun Kuma Majumder, Mechanistic Modelling of Water Partitioning Behavior ii Hydrocyclone, *Chemical Engineering Science* http://dx.doi.org/10.1016/j.ces.2016.06.037

Mechanistic Modelling of Water Partitioning Behavior in Hydrocyclone

Chandranath Banerjee[a], Eric Climent[b], Arun Kumar Majumder[a,*]

[a] *Department of Mining Engineering, Indian Institute of Technology Kharagpur, Kharagpur 721302, India*
[b] *Institute of Fluids Mechanics - UMR 5502 CNRS-INPT-UPS Allée Pr. Camille Soula - 31400 Toulouse, France*

Abstract

A new mechanistic model on water split behaviour in a hydrocyclone has been developed based on the convoluted hydrodynamics of swirling flows in a confined environment. A comprehensive study has been accomplished on the genesis and subsequent distribution of G force based on the characterisation of internal flow features of a two inch hydrocyclone through computational fluid dynamics (CFD) approach. The difference between the magnitude of G force in cylindrical and spigot regions is taken into account as a new hydrodynamic parameter to compute the water split behaviour. Specifically,our analysis reveals a semi empirical relationship between the water split with G force difference (ΔG),the vortex finder diameter (D_{vf})and the spigot diameter (D_{sp}).The developed model is validated against experimental data and show good prediction accuracy. Unique aspect of the developed empirical model is that the underlying mechanism of incipient flow peculiarity is implicitly accounted to rummage the separation characteristics in a quantifiable manner. In addition to rationalize the flow split behaviour of hydrocyclones, this new hydrodynamic indicator seems promising to be used as a scale-up parameter in envisaging the separation performance for a given application.

Keywords: Water split, Hydrodynamics, G force difference, CFD, Hydrocyclone

1. Introduction

Hydrocyclones have vast engineering applications in various sectors like mining, chemical, petroleum, nuclear,environment,food processing etc. Although the popularity of hydrocyclone is primarily attributable to its apparently simple design and operational features, imprecise particle separation remains a major drawback. In reality, the particle separation mechanism in a hydrocyclone is very complicated due to its cylindro-conical geometry and the presence of strong swirling flow (Ovalle and Concha, 2005; Gupta et al., 2008; Davailles et al., 2012; Swain and Mohanty, 2013; Banerjee et al., 2015) which results into turbulence. Probably due to this reason, a tailor-made design of hydrocyclone for a specific application is still non-existent. The solutions to those aforementioned problems associated with hydrocyclones can only be provided once the physics of particle separation in a centrifugal flow

*Corresponding author
Email address: akm@mining.iitkgp.ernet.in (Arun Kumar Majumder)