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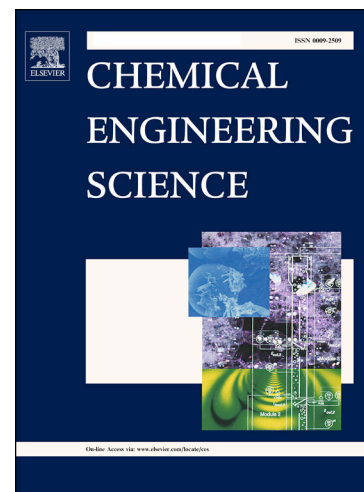
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Core-Annulus Radial Solids Concentration Distribution in Riser

Yiping Fan^a, Chen Li^{a,b}, Hanwen Fan^c, Miao Yu^a, Chunxi Lu^{a*}

^a State Key Laboratory of Heavy Oil, China University of Petroleum-Beijing, China, 102249

^b Department of Chemical and Biological Engineering, University of Saskatchewan, Saskatoon, SK, Canada, S7N5A9

^c State Key Laboratory of Multiphase flow, Xi'an Jiaotong University, Xi'an, China, 710049

*Corresponding authors. Tel.: +86 10 89733237; E-mail: lcx725@sina.com (Lu C)

ABSTRACT

The radial particle concentration distribution in riser is comparatively low in the central area and increases sharply near the wall. It is the so-called typical core-annulus structure. The occurrence of the core-annulus was usually contributed to the velocity gradient in the boundary layer or the drag force. In this paper, an aerodynamic theory is used in the two-phase flow analysis. A transverse force on the particles, the Kutta-Joukowski force, is introduced to explain and quantify the formation of the core-annulus in riser. This force is the function of the particle velocity curl, the slip velocity and the gas density. Based on the experimental results combining with the data proposed in the published literatures, the distribution of the Kutta-Joukowski transverse force in riser is discussed. The results show that this force is the main factor of the core-annulus occurrence.

Key Words: multi-phase flow; fluidization; riser; core-annulus; transverse force

1. Introduction

In the past decades, the circulating Fluidized Bed (CFB) riser has been achieved increasing attention in both the fields of academic investigation and industrial applications including fluid catalytic cracking (FCC), ore roasting, calcinations operations and circulating fluidized bed combustion (CFBC). However, the non-uniform radial distributions of the particle concentration and the solids velocity have been widely reported (e.g. Liu, 2001; Liu et al., 2003a; Liu et al., 2003b; Wei et al., 1998; Wang et al., 1998; Zhang et al., 2003; Yan et al., 2005a, 2005b; Zhang et al., 1998, 2001; Pärssinnen et al., 2001a, 2001b; Issangya et al., 1999, 2000; Nieuwland et al., 1996; Aguilon et al., 1996; Miller and Gidaspow, 1992; Zhu et al 1991; Bi et al., 1996a; Zhu et al., 2001; Werther et al., 1996; Martin et al., 1992; Wang et al., 2014a, 2014b, 2014c, 2015; Li et al., 2013; Bi and Zhu, 1993; Wang, 2013; Yan 2004). The particle concentration in a riser is generally

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