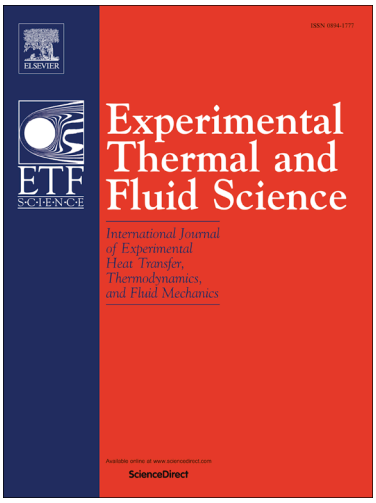

Wall-to-solid heat transfer coefficient in flighted rotary kilns: experimental determination and modeling

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Wall-to-solid heat transfer coefficient in flighted rotary kilns: experimental determination and modeling

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Abstract

A series of experiments were carried out on an indirectly heated pilot scale rotary kiln. These experiments aimed at recording, while the solids flow, the temperature profiles of the freeboard gas, the solid particle bulk and the wall, as well as the power supplied for heating, over a range of operating conditions. Based on these data, the experimental wall-to-solid heat transfer coefficient was determined through an energy balance. The effects of operating conditions, namely rotational speed, filling degree, lifter shape and controlled temperature, on the heat transfer coefficient are discussed. A model based on dimensional analysis is proposed to calculate the wall-to-solid heat transfer coefficient for low to medium heating temperatures (100-500°C). The experimental and calculated results are in good agreement. The experimental results are also compared to the predictions of some existing models. While the predictions are within a reasonable order of magnitude with regard to the experimental results, these models fail to represent actual variations with operating conditions satisfactorily

Keywords: rotary kiln, heat transfer coefficient, wall-to-solid heat transfer, dimensional analysis, lifter, bed depth profile

1. Introduction

Indirectly heated rotary kilns are widely used as heat exchangers, calciners, incinerators, coolers or dryers. They are usually designed for applications needing tight control and clean heating of materials. Possible applications include [1]: calcination [2, 3, 4], reduction [5, 6], controlled oxidation, carburization, solid-state reaction [7, 8], drying [9, 10] or waste disposal [11, 12]. When operated at atmospheric pressure, these units consist of a cylindrical shell that can be slightly inclined, into which the solid burden is fed continuously at one end and discharged at the other. They are usually equipped with lifting flights or lifters, and/or an exit dam at the kiln outlet end. These units can be classified in two main heating modes, namely directly heated [13] or indirectly heated [14], depending on the location of the heating source with respect to the kiln tube wall. They are very useful reactors with relatively intense heat and mass transfer, capable

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