Fluidized powder conveying in a horizontal rectangular channel using fluidizing air

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1. Introduction

Pneumatic conveying of particles is widely used in various industries. Dense phase pneumatic conveying in a pipeline is often applied to avoid disadvantages such as high power consumption, particle breakage and pipeline abrasion [1]. There have been many investigations of the flow characteristics of dense phase pneumatic transportation of powder, many focusing on the minimum transportation of particles and the flow pattern in a pipeline [2–5]. Wypych and Yi [2] experimentally and theoretically examined the capacity limitation and the mechanism for the formation of the unstable region in dense phase pneumatic conveying in a horizontal pipeline. Pan [3] observed three flow patterns in a pipeline during dense phase pneumatic conveying that could be classified into three groups according to loose-poured bulk density and median particle diameter. Tomita et al. [4,5] discussed that two types of slug flow were found in the lower and higher air velocity region when the coarse particles were transported in a horizontal pipe. We recognize from these studies that the minimum transport boundary and the flow pattern are significant in dense phase pneumatic conveying of powder in a horizontal pipeline. However, we also recognize that dense phase pneumatic conveying has disadvantages such as the generation of pipe blockages, the intermittent conveying of powder and the increased power consumption due to the effect of the wall compared with mechanical conveying [1,6]. Therefore, it is necessary to examine how to reduce these disadvantages.

Using fluidized gravity conveyors known as air slides is one method for dense phase pneumatic conveying. This type of conveyor consists of an inclined channel in which powder flows under the influence of gravity. Powders such as Geldart A and B particles [7] are fluidized in the channel for powder conveying by air flow through a suitable distributor [8]. In this system, the particle–particle force and the frictional force between the particle and the channel surface can be reduced by the fluidizing air [9], giving the fluidized gravity conveyor the advantages of low solid velocity with little attrition loss, high mass flow rate and low specific power consumption [8]. In addition, this conveyor can be avoided from disadvantages such as pipe blockage and intermittent conveying. Therefore, the flow properties of fluidized gravity conveyors have also been investigated. Ishida et al. [10] experimentally examined the flow characteristics of fluidized powder in a downward-inclined open channel. They indicated that five types of flow pattern were found depending on the air velocity and the slope of the channel surface can be reduced by the fluidizing air [9], giving the fluidized gravity conveyor the advantages of low solid velocity with little attrition loss, high mass flow rate and low specific power consumption [8]. In addition, this conveyor can be avoided from disadvantages such as pipe blockage and intermittent conveying. Therefore, the flow properties of fluidized gravity conveyors have also been investigated. Ishida et al. [10] experimentally examined the flow characteristics of fluidized powder in a downward-inclined open channel. They indicated that five types of flow pattern were found depending on the air velocity and the slope of the channel surface can be reduced by the fluidizing air [9], giving the fluidized gravity conveyor the advantages of low solid velocity with little attrition loss, high mass flow rate and low specific power consumption [8]. In addition, this conveyor can be avoided from disadvantages such as pipe blockage and intermittent conveying. Therefore, the flow properties of fluidized gravity conveyors have also been investigated. Ishida et al. [10] experimentally examined the flow characteristics of fluidized powder in a downward-inclined open channel. They indicated that five types of flow pattern were found depending on the air velocity and the slope of the