Advanced Powder Technology 23 (2012) 761–770

Contents lists available at SciVerse ScienceDirect

Advanced Powder Technology

journal homepage: www.elsevier.com/locate/apt

Original Research Paper

Fluidized powder conveying in a horizontal rectangular channel using fluidizing air

Koichiro Ogata *, Tomoya Furukawa, Yusuke Yamamoto

Department of Electronic and Mechanical Engineering, Oshima College of Maritime Technology, 1090-1 Komatsu, Suo-Oshima, Yamaguchi 742-2193, Japan

ARTICLE INFO

Article history:
Received 30 June 2011
Received in revised form 11 October 2011
Accepted 12 October 2011
Available online 3 November 2011

Keywords:
Fluidized powder conveying
Air supply
Minimum fluidizing velocity
Flow pattern
Mass flow rate

ABSTRACT

In this study we experimentally investigated powder conveyance in a horizontal rectangular channel using fluidizing air. The conveying system consisted of a powder discharge vessel and a horizontal rectangular channel at the side of the vessel. The air velocities at the bottom of the vessel and the horizontal channel were changed experimentally. The powder was glass beads that are Geldart A particles, with a mean diameter of 53 μm, a particle density of 2523 kg/m^3 and a minimum fluidizing velocity of 4.329 mm/s. We measured the mass of the transported powder, the bed height of the powder in the vessel, the air pressures at the bottom of the vessel and the horizontal channel, and the flow pattern during powder conveying. Sufficient powder conveying could not be obtained when air was not supplied to the bottom of the vessel. On the other hand, the powder could be transported smoothly when air was supplied to the bottom of the vessel and the air velocity at the bottom of the horizontal channel exceeded the minimum fluidizing velocity. In this case, the powder was discharged smoothly from the vessel to the horizontal channel, and then the powder flowed easily toward the exit of the horizontal channel. The mass flow rate of the powder was in proportion to the falling velocity of the powder in the vessel, where that velocity was related to the discharge of the powder from the vessel. Therefore, it is found that the discharge of the powder from the vessel had significant effect on the horizontal conveying of fluidized powder in this system.

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

* Corresponding author.
E-mail address: ogata@oshima-k.ac.jp (K. Ogata).

0921-8831/$ - see front matter © 2011 The Society of Powder Technology Japan. Published by Elsevier B.V. and The Society of Powder Technology Japan. All rights reserved.
doi:10.1016/j.apt.2011.10.005