Wang F-J, M.E.Sc., "Pressure Gradient and Particle Adhesion in the Pneumatic Transportation of Fine Particles", The University of Western Ontario, May 1997 (co-supervisor: JM Beeckmans).

Abstract

Group C powders, characterized by strong interparticle forces, are known to be very hard to fluidize or transport. However, it is of great importance of studying the conveying of group C particles, as the application of group C particles can significantly increase the plant efficiency due to their large volume-surface area and revolutionize certain processes such as surface coating and fine powder handling.

In the present study, the vertical pneumatic transport of 20 m m glass beads was systematically studied for the first time through a pneumatic transport system, employing a fluidized bed as solids feeder. Additional tests were carried out with the 66 m m glass beads for the comparison of flow characteristics between group C and A particles. The feasibility of pneumatic transport for this type of group C particles was determined. The pressure gradient along the transport line was found to increase linearly with solids flux. The Zenz type phase diagrams for both types of particles were constructed and were found applicable to group C particles as well as to group A particles. For 20 m m glass beads, the minimum pressure gradient point in the Zenz plot was found at 11.0 m/s, which is much higher than the 6.5 m/s for the 66 m m glass beads. This indicates that for the traditional dilute phase transport, much higher air velocity is required to convey 20 m m glass beads than to convey 66 m m glass beads, in order to conserve energy and lessen the attrition and particle degradation.

While larger electrostatics charging prevailed along the transport line during the transport of 66 m m glass beads, only minor electrostatics phenomena were observed in the conveying of 20 m m glass beads. After "Larostat 519â ", a quaternary ammonium anti-electrostatics compound with a diameter of 20 m m, were added into the transport system at a weight percentage of 0.5%, the pressure gradients for both types of particles were reduced with more dramatic decrease for 66 m m glass beads, and only minute reduction for 20 m m glass beads. It is believed that the particles adhering on the wall contributed to lessen the electrostatic charging for 20 m m glass beads as a result of prohibiting the flowing solids from contacting the pipe material directly.

The particle adhesion phenomena on a pneumatic transport pipe was also investigated for both 20 m m and 66 m m glass beads. The adhesion layer was divided into two parts: "tapped" and "brushed" layers, based on the methods of collecting the adhered particles. Results show that both the "tapped" and "brushed" layers formed by 20 m m glass beads are much thicker than those formed by 66 m m glass beads. The adhesion of 20 m m glass beads is independent of solids flux, but generally decreases with the air velocity, with an exception that the particle adhesion actually increases as the air velocity was raised from 3.5 m/s to 6.0 m/s probably due to the elimination of particle downflow at the wall. The quantity of particle adhesion for 66 m m glass beads to the wall increases with solids flux and air velocity. It was concluded that the particle adhesion of 20 m m glass beads can also affect the suspension-wall friction loss, resulting from the thick adhesion layer covering the entire inner surface of the pipe. The thickness of these layers range from several to more than 10 particle diameters. In contrast, the adhered 66 m m glass beads can only partially

cover the pipe wall and thus has less impact on the gas-solids flow in the transport line.