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Effect of moisture content on conveying characteristics of pulverized coal for pressurized entrained flow gasification

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ABSTRACT

During the pneumatic conveying, pulverized coal with different moisture contents may develop substantial difference in flow characteristics, whose cause is not fully understood. This study focused on influence of moisture content on conveying characteristics in an experimental test facility with the conveying pressure up to 4 MPa. The experiments included soft coal and lignite with similar density and particle size. With the increase in moisture content, the mass flow rate decreased for lignite ($3.24\% < M < 8.18\%$) but increased at first and then decreased for soft coal ($0.4\% < M < 6.18\%$) at same operating parameters. The flowability of soft coal was worse than that of lignite at similar operating parameters and external moisture content. The extremal conveying moisture contents of two coal types were obtained. The particle charge and surface moisture content were investigated to indicate influence mechanism of moisture content on mass flow rate in pneumatic conveying at high pressure. Pressure drop of soft coal was greater than that of lignite for same test section. The conveying phase diagram of dense-phase pulverized coal at high pressure was obtained and the pressure drops through different test sections were compared and analyzed. The bend loss factor rose with the increase in moisture content and was independent of conveying velocity and solid–gas ratio in dense-phase pneumatic conveying at high pressure.

1. Introduction

Due to global economic growth, there is an increasing need for energy. Fossil fuels will continue to dominate the world energy supplies in the future and coal will play a significant role [1,2]. Since coal is one of the most important fossil fuels in the world, coal gasification technology appears to be an inevitable choice for power and chemicals production and has a leading place in clean coal technology. Dense-phase pneumatic conveying of pulverized coal at high pressure is one of the key technologies in it. In the pressurized gasification system, pulverized coal is conveyed into a gasifier using high pressure inert gases. Because of low velocity and high solid concentration in transportation, the gas–solid two-phase flow becomes very unsteady and complicated, and unsteadiness of flows often cause blockage and pipe vibration. Experimental and theoretical studies to understand the flow characteristics of conveying on powder is needed so that the processing parameters and the pneumatic conveying systems can be optimized to avoid problems at the large scale. There is a great interest to study effect of material property on conveying characteristics.

Understanding the flow characteristics of pneumatic conveying therefore offers a rich topic for research. Recent work on pneumatic conveying concentrates on the influence of powder properties on flow characteristics. Cowell et al. [3] used test work in conjunction with a mathematical model to generate conveying characteristics for coal. Yao and Wang [4] examined the effects of particle size and shape distributions on electrostatics in conveying systems. Hyder et al. [5] carried out an investigation using five plastic materials of similar shape and density, but with different particle sizes. Vasquez et al. [6] used a high-speed video camera and pressure transmitters to study the dynamic behavior of the particles and its influence on pressure drop during conveying. Pahk and Klinzing [7] applied two different types of plastic pellets to the determination and development of distinguishing flow characteristics. Laouar and Molodtsof [8] studied pressure drop characteristics in pneumatic conveying line at a very low velocity and a general differential pressure law was obtained which proves to be independent of both flow regimes and pipe diameter. As related topics, there are velocity measurement using electrostatic charge [9] and numerical simulations of particles behavior [10], attrition of granules [11,12] and pressure drop [13]. Generally, many of those researchers mainly worked at the low pressure and dilute-phase pneumatic conveying. The high pressure to transport these materials can be substantially different. The particle behavior of

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