TREATMENT OF GRANULAR PHOSPHATE WITH A MULTI-STAGE FLUID-BED COOLER

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Heat-exchange equipment is known to play a very important role in chemical industry. Two processes are used to produce phosphate fertilizers: run-of-pile and granular. The granular process uses lower-strength phosphoric acid (40%, compared with 50% for run-of-pile). The reaction mixture, a slurry, is sprayed onto recycled fertilizer fines in a granulator. Granules grow and are then discharged to the screen, crusher, cooler and sent to storage. Thus, the multistage fluidized bed can be used for granular solids cooling. But the solid particles do not reach the thermal equilibrium due to relatively short residence time in a cooler.

So, first of all a rational perforated plate construction and an optimal regime is needed to establish. Second, we have to propose some method for energy saving.

When an air stream is passed through a permeable support (perforated plate) on which the free flowing material rests, the bed starts to expand when a certain velocity is reached. The superficial velocity of the air at the onset of fluidization is the minimum fluidization velocity. With a further increase in air velocity, bed reaches a stage where the pressure-drop across fluid bed drops rapidly and the product is carried away by the air. The velocity at this stage is known as terminal velocity and an important parameter in fluidization operations. The operational velocity must remain between these two velocities.

All fluidization regime experiments were conducted in a bath type flexi-glass fluidizing column of 185 mm inside diameter and length 1 m. The cooling air was taken from a ventilator system and directed to the fluidizing column by flexible ducts. Air entered the material bed through a perforated plate with circular holes of 1 mm diameter (18 holes/cm^2). Wall effects, slugging and channeling behaviour can be of concern in small-scale experiments. They have been given sufficient consideration during planning of experimentation. In this study initial ratio of bed diameter to effective particle diameter was 18. It was mentioned that if this ratio is greater than 16 there is no effect from the walls. Therefore, wall effect was considered insignificant in the working range.

Real process exhibits a wide range of random factors, the most important of which are turbulent eddies of different scales, non-uniformity of the concentration fields and agglomeration of particles within the flow.

These phenomena are easily observed with high-speed cinematography or photography under stroboscopic lighting. Airflow entering the fluidization column was varied by means of varying the incoming rate with the manual valves in the system. Differential pressure of incoming air was read from a digital manometer connected to a flow sensor of the Pitot tube through transparent vinyl tubes.

Flow rates entering the fluidizing column were calculated and average air velocity of air passing through the material was determined. Resolution of air velocity measurement was 0.05m/s, minimum fluidization velocity was 1.2 m/s, terminal velocity was 2.0 m/s. Pressure drop across the bed was measured by a U-tube manometer connected to the fluidizing column below the air perforated plate, and above the bed of samples. Bed height was measured from a scale attached to the column. The change of bed pressure drop was measured while increasing the velocity through the bed for each height. In order to determine the optimum bed height for improved fluidization, bed heights of 100, 80, 60 and 40 mm were used. Measurements of pressure drop for each bed height took less than 3 min.

The use of fluidization is one of the technologies commonly used in granular particles and other materials. It is commonly used in freezing and cooling systems. Fluid bed cooling has been recognized as a gentle method with a high degree of efficiency. In the proposed apparatus a fluidized bed has an perforated plate which is inclined to the horizontal so that excessively sized or dense particles migrate to a collection point from which they may be removed, such as by a gate in the side of the bed

A full three-dimensional discrete particle simulation method was performed to study the formation of a stable regime fluidized bed. The course and behavior of particles that formed a dense and stable fluidized bed are discussed. Both the experimental and simulation results of this study show that the process of forming a suspension bed can be categorized into an induced stage, a growing stage, and a stable stage. The velocity of gas through the orifice directly controls the formation of the bed while the solid flow rate over a considerable range maintains a balanced hold-up in the suspension bed system without downcomers.

The existence of a multiplicity of steady states corresponding to different gas flow rates, for the same feed rate and perforated plate type and slope, was observed. Results show that the design of the plate, the particle feed rate and the gas velocity distribution through the holes affect the stability of the fluidized bed. The simulated results agree qualitatively well with experimental observations.

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