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Influence of Flight Design on Discharging Profiles of Granular Material in Rotary Dryer

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Abstract : During the manufacture of fertilizer, it is necessary to add water for granulation purposes. The water content is then removed or reduced using rotary dryers. They are commonly used to dry wet granular materials and they are usually fitted with lifting flights. The transport of granular materials occurs when particles cascade from the lifting flights and fall into the air stream. Each cascade consists of a lifting and a falling cycle. Lifting flights are thus of great importance for the transport of granular materials along the dryer. They also enhance the contact between solid particles and the air stream. Optimization of the drying process needs an understanding of the behavior of granular materials inside a rotary dryer. Different approaches exist to study the movement of granular materials inside the dryer. Most common of them are based on empirical formulations or on study the movement of the bulk material. In the present work, we are interested in the behavior of each particle in the cross section of the dryer using Discrete Element Method (DEM) to understand. In this paper, we focus on studying the hold-up, the cascade patterns, the falling time and the falling length of the particles leaving the flights. We will be using two segment flights. Three different profiles are used: a straight flight (180° between both segments), an angled flight (with an angle of 150°), and a right-angled flight (90°). The profile of the flight affects significantly the movement of the particles in the dryer. Changing the flight angle changes the flight capacity which leads to different discharging profile of the flight, thus affecting the hold-up in the flight. When the angle of the flight is reduced, the range of the discharge angle increases leading to a more uniformed cascade pattern in time. The falling length and the falling time of the particles also increase up to a maximum value then they start decreasing. Moreover, the results show an increase in the falling length and the falling time up to 70% and 50%, respectively, when using a right-angled flight instead of a straight one.

Keywords : discrete element method, granular materials, lifting flight, rotary dryer
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