IMPROVEMENT OF DRUM MIXER ABILITY FOR THE BETTER AGGLOMERATION OF RAW MATERIALS[1]

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Abstract
The granulation process in the drum mixer of POSCO No 2 sintering plant was investigated to improve the productivity of sinter products. The retention time, sticking, and agglomeration of raw materials were estimated by laboratory scale tests. We found that the increase of retention time and the minimize of sticking of raw materials were effective factors for an optimum granulation process in the drum mixer. The lifter of triangle type and the blade with -15 degree of the drum mixer showed very low sticking. Air blowing of 100 m/s into the drum mixer increased the size of quasi-particles with the reduction of the sticking of raw materials. In addition, the moisture spray by a flat-type nozzle improved granulation properties of raw materials.
Key words: Drum mixer; Lifter; Blade; Air blowing.

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1 INTRODUCTION

A granulation process for the treatment of raw materials has an important factor which has an effect on the productivity of sinter products in a sinter machine. In the granulation process by a drum mixer which is conventionally used at the sintering process, the blending, mixing, and agglomerating of raw materials contribute significantly to improve sintering operation including the permeability of gas in sintering bed. There are three zones of slip, normal cascade, and cataract defined by particle movements of raw materials in the drum mixer. The physical and mechanical properties of pseudo-particles, which have been usually granulated in the normal cascade zone, can be used to determine a condition suitable for the high productivity of sinter products[1~3]. The Froud number is defined by the following Equation (1).

$$N_{FR} = D \cdot N^2 / g \qquad (1)$$

N_{FR} is Froud number, D is the diameter of drum, N is revolution of drum, and g is gravity acceleration.

The retention time is defined by the following Equation (2).

$$T = (L \cdot \sin\theta) / (\pi \cdot D \cdot N \cdot \phi)^4 \qquad (2)$$

T is retention time, L is length of drum, θ is angle of repose of sinter mix, and φ is drum inclination angle.

In this study, we report an optimum condition suitable for the drum mixer of POSCO (Pohang) No 2 sintering plant through lab-scale tests. Several factors such as retention time, sticking, and agglomeration of raw materials for the granulation process in the drum mixer were investigated.

2 EXPERIMENTAL METHODS

Table 1 shows the specification for the lab-scale tests of a drum mixer in No. 2 sinter. It designed to easily modify drum mixer functions including rpm, inclination angle, feeding rate and angle of blade. For the sticking tests, an air blowing unit was connected to the drum mixer which is 1/7 size of the drum mixer in No. 2 sinter.

Table 1. Specification of 1/7 scale drum mixer

Item	Specification
Size of Drum	Dia. 550mm, Length 1700mm
Inclination Angle	0~5 degree
Revolution of Drum	0~30 rpm
Feeding Rate	110 liter hopper, 0~30kg/min feeding
Moisture Spray Rate	40 liter tank, 0~1L/min spray
Air Blowing Unit	Air receiver tank, constant pressure

Using the 1/7 scale drum mixer we investigated retention time according to the rpm, inclination angle and feeding rate and also monitored sticking procedure of raw materials in the drum mixer. Sticking test with various type lifters was performed in order to seek proper lifter shape for reduction of sticking. Agglomeration property was evaluated by change of the angle of blade. To understand the effect of moisture content, water injection nozzle, spraying angle and positions in the drum mixer were also investigated. Feeding rate, moisture content and inclination of drum mixer were somewhat changed for the purpose of experiments.

3 RESULTS AND DISCUSSION

3.1 Retention Time of Drum Mixer

Figure 1 shows that the retention time decreased with the increase of RPM and the inclination angle. Raw materials were discharged without proper mixing and granulating in case of extremely high RPM and tilt angle of drum mixer. However, the feeding rate was not a function of the retention time.

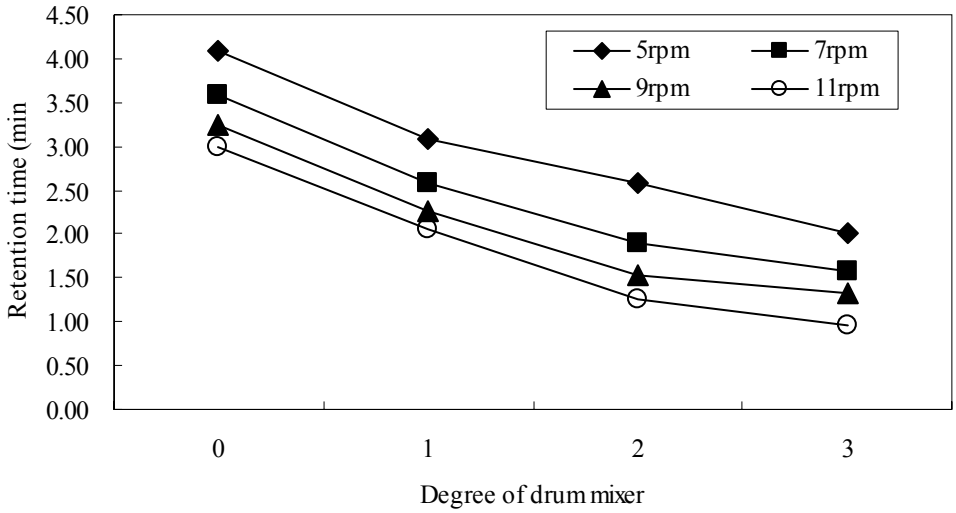

Figure 1. Retention time with various rpm, inclination angle of drum mixer

3.2 The Procedure of Sticking of Raw Materials in the Drum Mixer

The sticking procedure in the drum mixer was observed with the feeding rate of 12.5kg/min and moisture of 10%. Small sized particles with the moisture adhered to lifter in drum mixer and then the sticking prolonged to the intermediated area between lifters. During the sticking test, the adhesive weight at the wall of drum mixer increased. After 45min, the extremely adhesive parts were locally observed in the drum mixer, in which adhesive materials were dropped by gravity force. Cyclical pattern of adhesion and fall off was gradually progressed time goes by and sticking was concreted near lifter with triangle shape. Using this mechanism of sticking progress, it is possible to design of lifter which produces minimum sticking property.

3.3 Sticking Tests by Lifter-type of the Drum Mixer

Under same feeding rate and moisture condition, adhesive weight was calculated according to the revolution time of drum mixer equipped with 4 types of lifter which are plate type, curved type, triangle type and trapezoid type. Adhesive weight was measured by weighing of total adhesive materials between lifters. Triangle type lifter had the smallest adhesive weight among all lifter types as shown in the Figure 2. The less adhesive weight in the drum mixer has larger space for granulation process. The retention time of raw materials relatively increased. Therefore, granulation effect in the drum mixer was enhanced.

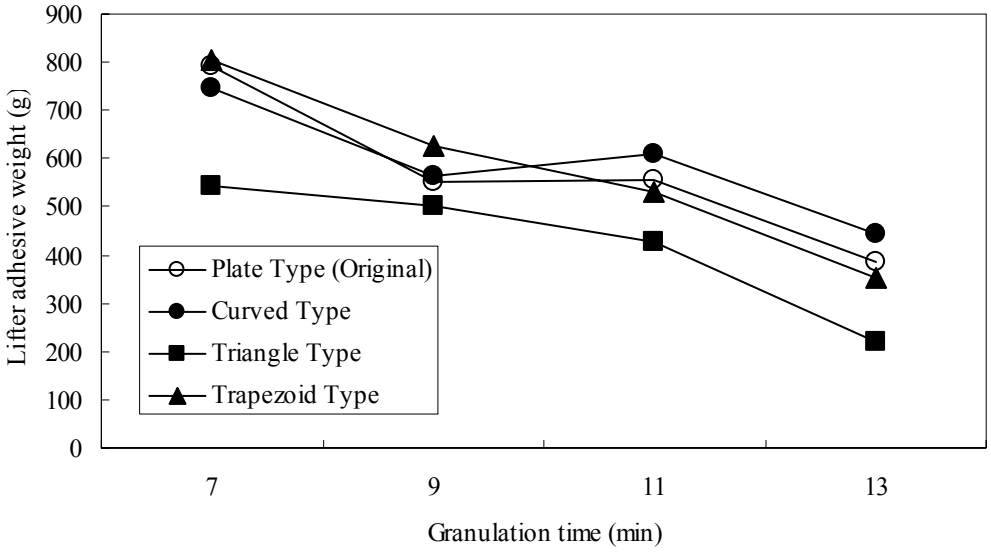

Figure 2. Change of sticking by various lifter types

3.4 Agglomeration Property of Drum Mixer by Air Blowing

The experiment was performed to evaluate the air blowing effect about the granulation property. A feeding rate of 12.5kg/min, a 10 rpm, and a 0 inclination angle was maintained during tests. Air flow rate was varied from 0 to 150 liter/min. The optimum granulation process was at the air flow rate of 50 liter/min, where the mean size of quasi-particles and the granulation index increased (Figure 3).

When air flow rate was over 50 liter/min, granulation property abruptly decreased. As total sprayed moisture content was constant, if air flow rate was increased over 50 liter/min, moisture which directly usage to agglomeration of raw materials was reduced because moisture was evaporated during air blowing so practical moisture content for granulation was lowered.

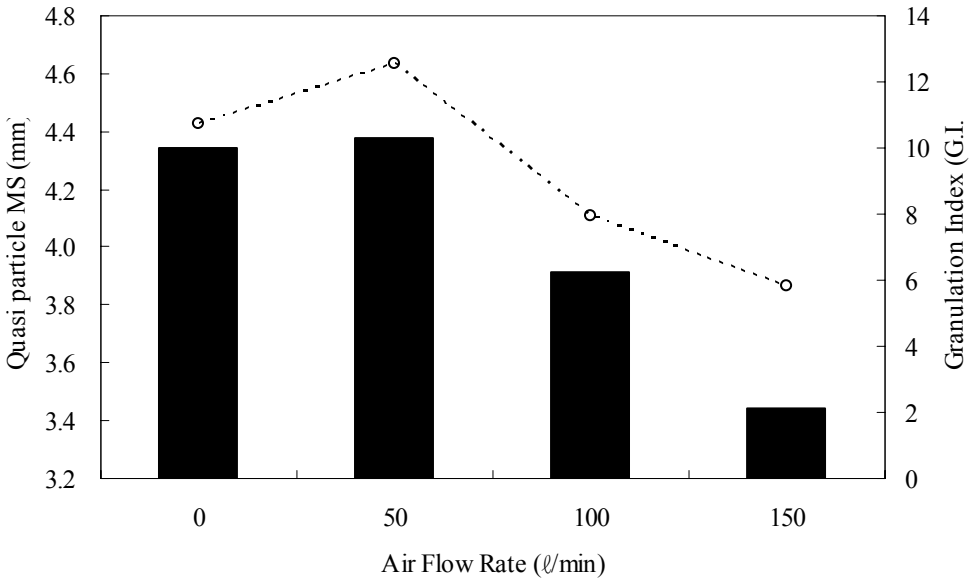

Figure 3. Granulation property by various air flow rate

3.5 Agglomeration Property by the Blade Angle in Drum Mixer

Agglomeration property of drum mixer with change of blade angle was evaluated using specially designed drum mixer which easily changed blade angle. Blade angle which located from entrance to 1/3 position of total length was intentionally changed with various angles to evaluate granulating property with blade angle. When the blade located at the entrance of the drum mixer was set to -15 degrees against material flow, the retention time in the drum mixer increased with the sufficiently mixing of burnt lime. The mean size of quasi-particles was the highest value (Figure 4).

If angle of blade was over -15 degrees, the blade's ability to lift raw materials was decrease so that the mixing effect at the entrance was deteriorated. The granulation property was somewhat lower over -15 degrees of blade.

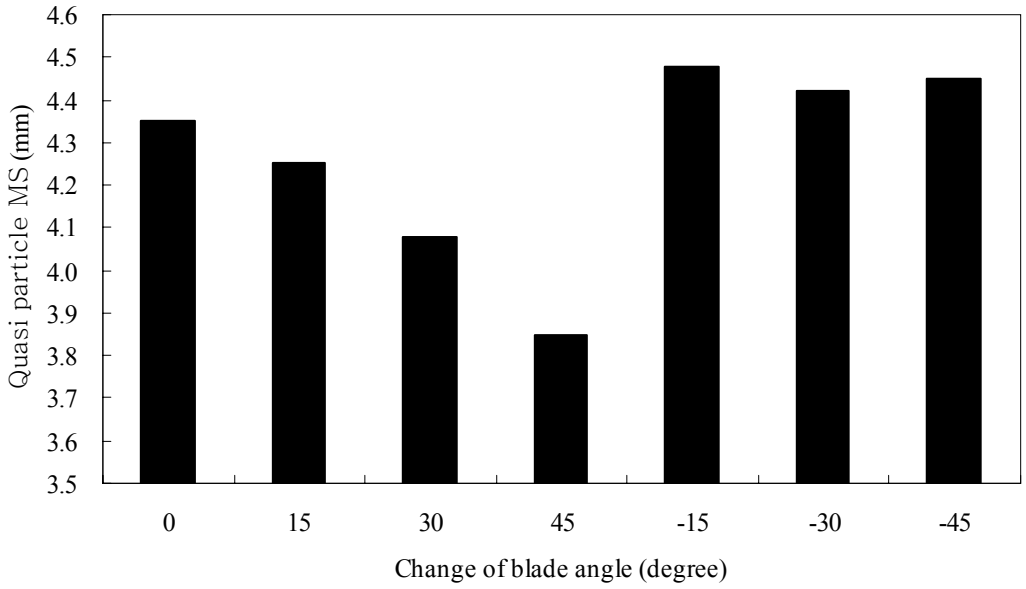

Figure 4. Granulation property by the blade angle

3.6 Agglomeration Property by Spray Nozzle Type

Figure 5 shows that the agglomeration property of the drum mixer with the change of spray nozzle type at the same moisture, charging rate, rpm and inclination degree of the drum mixer. In the granulation process, the spray nozzle of a flat type was more effective than that of a circle type. In case of the circle type, the moisture sprayed all directions including the wall of the drum mixer. The moisture was not enough to use agglomeration of raw materials.

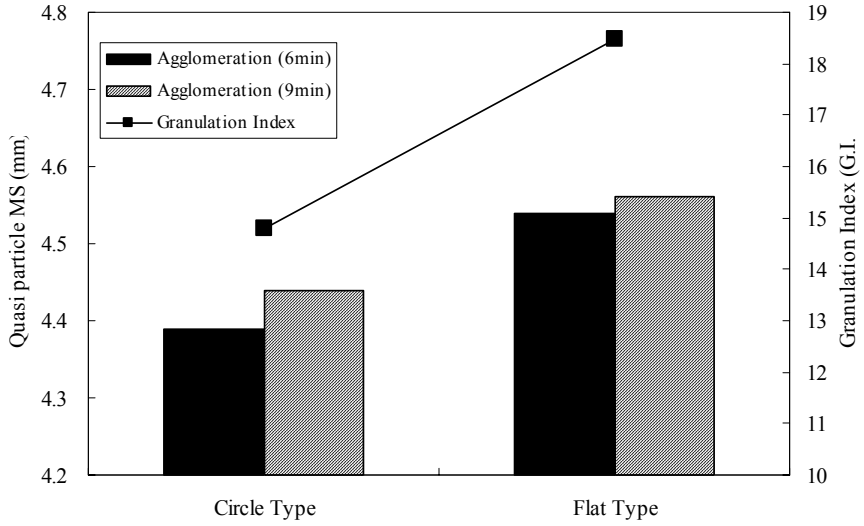

Figure 5. Granulation property by spray nozzle type

3.7 Agglomeration Property by the Position of Moisture Spray

In all cases the position of tip of spray nozzle focused on the center part of sediment materials in the drum mixer for the best granulation of raw materials. Granulation characteristics were changed by the setting of a nozzle at the same moisture contents of the drum mixer. The moisture was generally sprayed over the whole range of the drum mixer. However, if the moisture was locally sprayed, the spray nozzle should be arranged at the rear of drum mixer. For the better agglomeration, a combination of spray nozzles at the middle and the rear of the drum mixer improved the granulation property (Figure 6).

We found that the combination type of spray nozzles is an optimum for the drum mixer of POSCO No 2 sintering plant. For the better granulation process, the front area of the drum mixer should be only for a blending of raw materials. The middle and the rear of the drum mixer should be with the moisture spray for the enhanced agglomeration of raw materials.

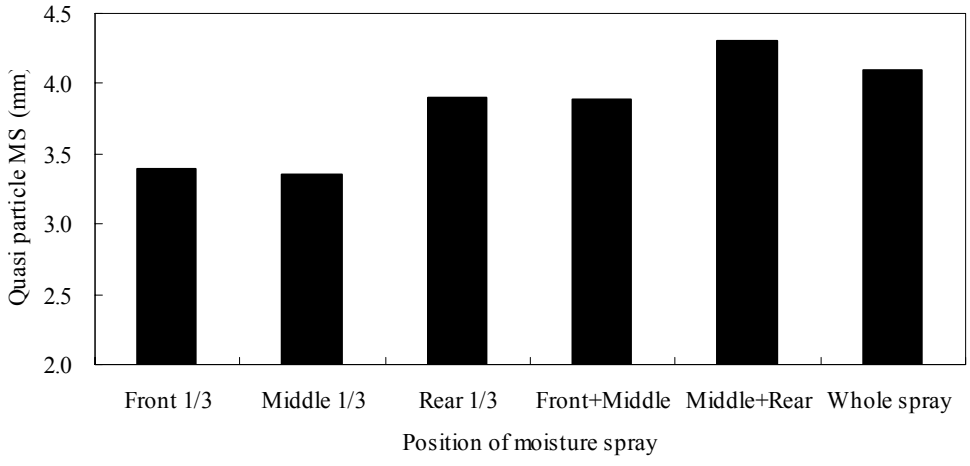

Figure 6. Granulation property by the position of moisture spray

4 CONCLUSIONS

The granulation process in the drum mixer of POSCO No 2 sintering plant was investigated to improve the productivity of sinter products through laboratory scale tests.

A triangle-type lifter of a drum mixer showed less sticking of raw materials so that the granulating effect of raw materials in the drum mixer was enhanced. A blade angle of the drum mixer was set -15 degrees against a flow direction from an entrance to a 1/3 position. It is very effective for agglomeration because of the sufficient mixing of a burnt lime and the increase of retention time in the drum mixer.

The installation of an air blowing unit was very effective for the improvement of granulation process with less sticking of raw materials in the drum mixer.

The change of a spray nozzle to a flat type increased an agglomeration of raw materials due to the increase of available moisture contents. For the granulation process, it was more effective to spay the moisture after 2/3 position of the flow direction.

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