Establishment of X-ray Measurement System for On-line Monitoring of Water Content in Powder

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1. Introduction

On-line process monitoring is of critical importance in many industries, and therefore a variety of the state-of-the-art physical and chemical measurement techniques have been proposed [1-4]. But, these techniques have their own pros and cons under the field process environments. Because the field process environments are very different from the well-organized chemical laboratories, many factors should be considered in order to optimize the process monitoring system. However, there have been few studies on the on-line measurement of water content in powder materials. For that reason, the X-ray measurement system based on the X-ray scattering technique, which was first proposed in 2011 as a new method for the determination of water content in powder, has been improved [5]. In the present study, our original X-ray measurement system has been modified for more rapid, simple, and adequate for maximizing the field applicability of the on-line monitoring system.

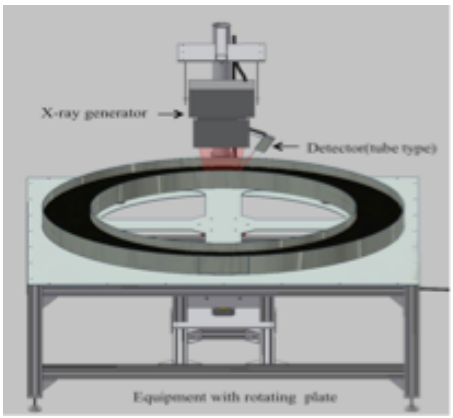

Fig. 1. X-ray measurement system for the analysis of powders moving with a sample plate

2. Experimental

X-ray measurement system is composed of an X-ray tube with a power in range of 30W to 1kW equipped with cooling system, a cadmium telluride (CdTe) diode detector mounted on a two-stage thermoelectric cooler temperature, a data acquisition system, and a rotating sample plate with a width of 200 mm as depicted in Figure 1. Rotation speed of the sample plate can be controlled from 1 rpm to 60 rpm.

In our present work, the sample on the plate was rotating at 3 rpm. The effect of the output powder of X-ray tube on the X-ray scattering by the powder samples containing the water was examined in range of 30 W to 60W.

3. Results

Figure 2 shows the effect of X-ray output of 30 keV and 60 keV on the total X-ray scattered intensities. X-ray scattered intensities increased with an increase of X-ray output power, and it showed a linear dependence on X-ray output in the range of 30 W to 50 W. The maximum X-ray output power was 50 W because the total X-ray scattered intensities did not increase at 60W. In addition, the total X-ray intensities of the 30-mm-thick samples were slightly higher than those of the 10-mm-thick samples. However, the effect of sample thickness on the total X-ray intensities was disappeared at 60 W.

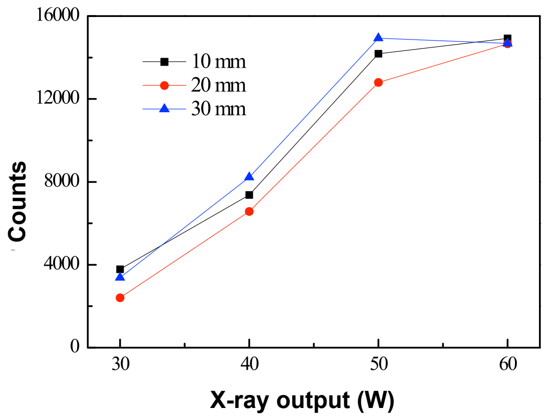

Fig. 2. Effect of X-ray power and the sample thickness on the total scattered X-ray intensities

Figure 3 shows total scattered X-ray intensities of the powder samples on a sample plate with time. The X-ray beam was most stable at 30 W.

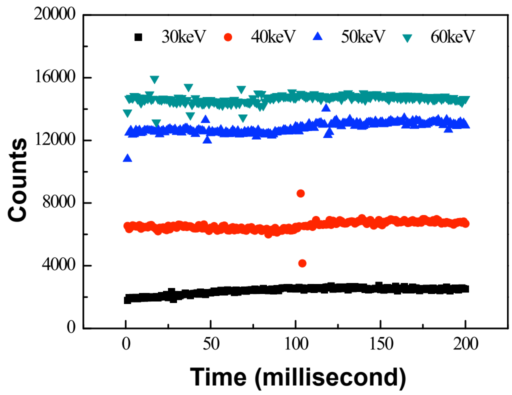

Fig. 3. Total scattered X-ray intensities of the powder samples moving on a sample plate

4. Conclusions

In this work, optimum conditions of the X-ray scattering system have been examined for the on-line monitoring of the water content in powder samples on a conveyor belt. Instead of using conveyor belt, the sample rotation system has been established based on the in-house design equipped with X-ray source and detector. The performance of the X-ray measurement system was evaluated with the thickness of samples and the output power of X-ray.

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