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Influence of Air Humidity on Dust Control Using Ultrasound Atomization

超音波霧化を利用した湿度調整とその防塵特性

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1. Introduction

Dust control is an important factor which influences human health in our working field. The continuous exposure to harmful dust, such as fibrogenic dust and carcinogenic dust, increases the risk of disease. To control dust, we focused on ultrasonic atomization. In general, as humidity becomes higher, the amount of dust dispersion becomes lower[1]. The water particles generated by the ultrasonic atomization are very fine, and they can raise the humidity quickly without wetting the space. In addition, the water particles generated by the ultrasonic atomization absorb dust and precipitate due to their heavier weight compared to air. This study examined dust control using the regulation of humidity and water particles by ultrasonic atomization.

2. Experimental

A glove box (146 L; UNICO) was used as the contained space to adjust relative air humidity. Relative air humidity was adjusted using a vacuum blower, dry air, and water. The temperature in the glove box was maintained using an air conditioner. To confirm the sealing capacity of the glove box, the change of the relative air humidity of 22% was measured using relative humidity sensors for 2 weeks under the 0.105 MPa.

The ultrasonic atomization was performed with a submersible transducer (2.4 MHz; Honda electro. Co.) and 300 ml of ion-exchanged water (500 ml flask, 30 °C). The top of the beaker was covered with a plastic lid and the side of flask has an outlet port for the water particle generated by the ultrasound. The experimental apparatus is shown in **Fig.1**. The changes of the relative air humidity and the temperature by ultrasonic atomization in the glove box were recorded on two points using sensors (set on the bottom and middle of the glove box). The ultrasound atomization was performed for 20 min, followed by 20 min standing without the ultrasound atomization. After the ultrasound atomization, the weight of the flask was measured by an electronic scale to calculate the amount of the atomization.

Dust control experiments were performed using the ultrasonic atomization device, a dust sampler, a digital dust sampler (scattered light detection method), an acrylic box (61 L) as the experimental field, and green tuff particle (<0.24 mm) as dust. **Figure 2** shows the photograph of green tuff particles. Green tuff (1.7 g) was dropped from the top of the acrylic box to the floor of the box at various values of relative air humidity. 5 min after the drop of green tuff, the measurement of dust particle numbers was started using a digital dust sampler for 10 min.

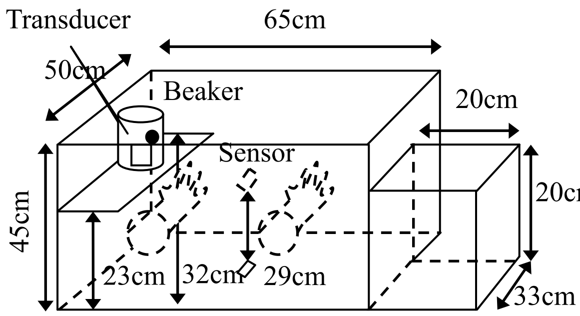

Fig.1 Schematic design of the experimental apparatus.

Fig.2 Photograph of green tuff particles.

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3. Results and Discussion

Figure 3 shows the sealing capacity of the glove box. The change of the relative air humidity was minimum during 2 days, as such, the sealing capacity was sufficient.

Figure 4 shows the change of the relative air humidity using the ultrasound atomization. The humidity at the bottom could be raised more quickly than that at the middle of the glove box. After the ultrasound atomization, the weight of the flask was measured. 0.40 g of ion-exchanged water was used as the ultrasound atomization. And, from the increase in the relative air humidity, 0.38 g of the water was used for raising the relative air humidity. Almost all of the water particles generated by the ultrasonic atomization became vapor in the glove box. **Figure 5** shows the change of the relative air humidity without the ultrasound atomization. The water (0.4 g) was put on the same place of the ultrasonic atomization device in the glove box. The humidity raising was very slow. As a result, it is clear that the ultrasonic atomization is effective in raising the humidity quickly. Also the water particles generated by the ultrasonic atomization are heavier than that of air. So, the ultrasound atomization is applied to rapidly increase the humidity near the ground.

Figure 6 shows the result of the dust control experiments at 50 and 80% of the relative air humidity. The higher humidity showed the higher capacity to suppress the dust dispersion. Green tuff was dropped in the glove box at 55% of the humidity, followed by the ultrasonic atomization for 15 min (after the 15 min, the humidity reached to 80%). It was shown to be more effective to suppress the dust dispersion than conditions without ultrasonic atomization. We are considering that the water particles generated by the ultrasonic atomization absorb dust and precipitate due to their heavier weight compared to air.

4. Conclusion

It was clear that the ultrasonic atomization is effective in raising the humidity quickly. We applied the ultrasound atomization to suppress the dust dispersion and succeeded in 50% dust reduction compared to without ultrasonic atomization at 80% of the humidity.

Reference

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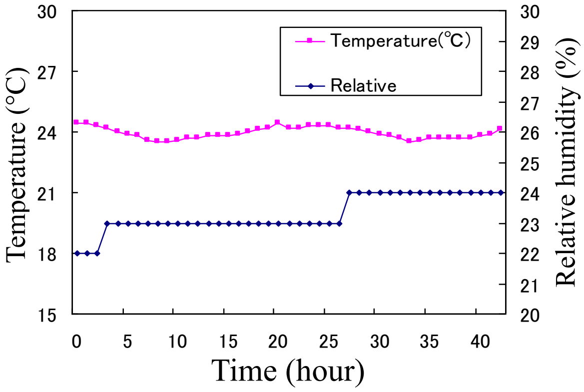

Fig.3 Variation of temperature and relative humidity in the globe box.

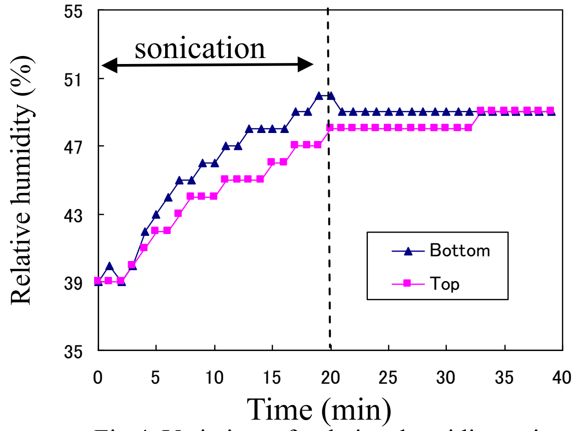

Fig.4 Variation of relative humidity using the ultrasonic atomization in the globe box.

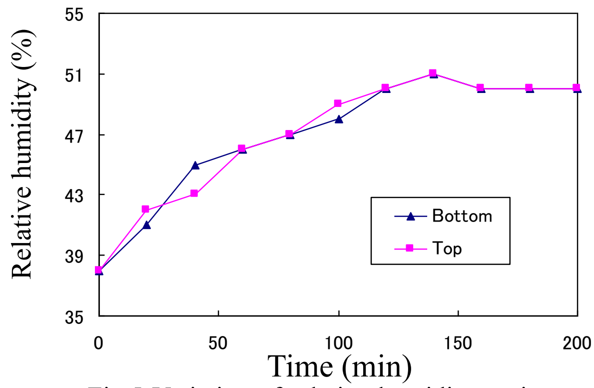

Fig.5 Variation of relative humidity setting water of 0.4 grams in the globe box.

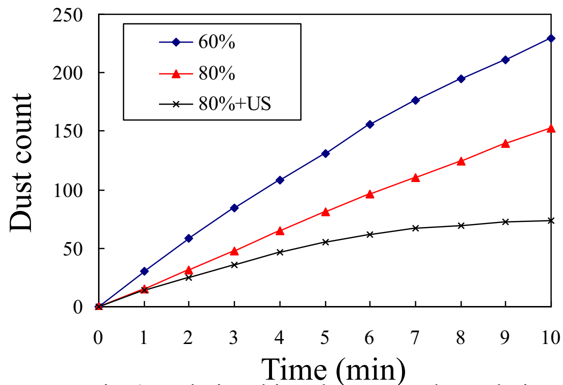

Fig.6 Relationships between the relative humidity and the dust dispersion.