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Analyzing the Characteristics of Particle Matters through the Development of a Fine Dust Collection System Generated by Tire and Brake Pad Wear

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Automobile exhaust gas is one of the main causes of fine dust generation, and it increases mortality due to environmental pollution, respiratory, and cardiovascular diseases[(1)-(3)]. In this context, electric vehicles (EVs) and hydrogen fuel cell vehicles (FCEVs) that do not emit exhaust gas safe? However, since tires and brake systems, which are essential for all vehicles, are worn out parts, even an eco-friendly car without any exhaust gas cannot represent a complete solution to fine dust prevention[(4),(5)]

In this paper, an optimal collection and analysis system was developed by devising a suction device for the fine dust generating area to precisely understand the state of fine particles generated during tire and brake pad wear[(6)-(8)]. It was therefore, possible to quantitatively determine the level of fine dust generated by tire and brake pad wear through indoor and actual vehicle tests.

The collection and measurement of fine dust was conduct using indoor tire performance test equipment, brake dynamometer, and an actual driving vehicle. In an actual vehicle, a shield cover was installed to minimize the inflow of fine dust from the outside. This shield cover not only blocks external polluted air, but it also serves to simultaneously send fine dust generated from tires to the indoor collection system. As a result of the simulation, the PM2.5 fine dust collection efficiency is very good with values of 99.59% tires and 99.52% brakes.

We have obtained the following main results.

First, fine dust is generated due to wear of tires and brakes. Brakes (0.3~3.0 ㎛) generate a lot of ultrafine dust, which is 10 times smaller than that generated by tires (1~10 ㎛).

Second, fine dust from tire wear showed a larger emission factor in the actual vehicle test than indoors using flat track equipment. In the case of the indoor test, it was confirmed that when the tire tread continuously rubs and wears in contact with the loor, the tread compound (rubber) particles agglomerate due to the increase in the contact surface temperature, thereby reducing the generation of fine dust. As a result, it was confirmed that, to accurately measure tire wear and fine dust in the indoor test equipment, it is necessary to secure a test device similar to a real road.

Third, although the reason for fine dust in the brake system is different from that for fine dust in the tire, it was found that the amount of fine dust generated was higher in the actual vehicle test than in the indoor test (maintaining the brake temperature of 230℃). It can be seen that braking deceleration, atmospheric temperature (-2℃ level), and high load (+100kgf) are more unfavorable conditions than indoors.

In the future, if the level of fine dust generated from many tires and brake systems is quantified using the experience of the actual vehicle fine dust collection and analysis system developed in this paper, then it will be possible to actively respond to fine dust reduction technologies and global fine dust regulations.

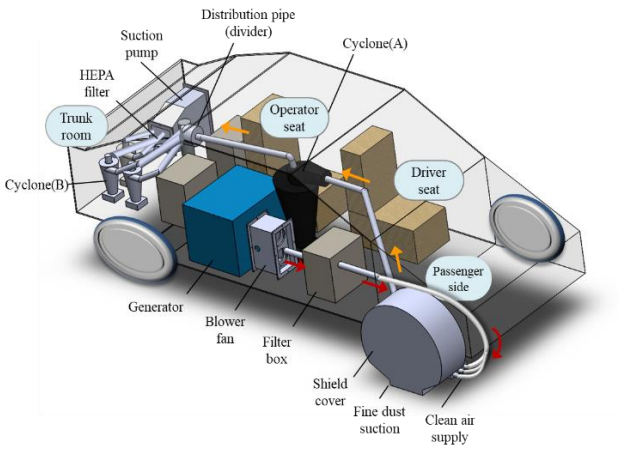

Fig. 1 Fine dust measurement equipment setting in a vehicle