19th ETH-Conference on Combustion Generated Nanoparticles

Brake Wear Particles Emissions using a Dynamometer System under Driving Cycles

Hiroyuki HAGINO

Motoaki OYAMA, Yoshio TONEGAWA, Sousuke SASAKI / Japan Automobile Research Institute

1. Introduction

The relative contribution of non-exhaust sources will become increasingly more important for total traffic related PM emissions, as the relative contribution of brake wear particles emission to total traffic-related PM is expected to rise with time. Current brake wear particles emissions do not be assessed under transient driving cycles according to the tailpipe emission test method.

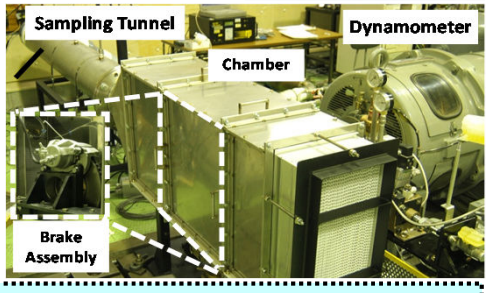
To determine emission factors for brake wear, this study developed a brake wear dynamometer with a constant-volume sampling system to measure the emissions of airborne brake wear particles under transient driving cycles in conformity with the tailpipe emission test method.

2. Brake Dynamometer Test

Vehicle I (Disc) | **Vehicle II (Disc)** | **Vehicle III (Drum)**

Driving Cycles

Passenger Car (Disc)
JC08 mode
(10 times× 5days)
Truck (Drum)
JE05 mode
(10 times× 5days)



Emission Factor (EF) per Wheel

$$EF_{wheel} = PM_{tunnel} \times \text{Flow Rate}_{tunnel} \times \text{Time}_{test} / \text{Distance}_{JC08\ or\ JE05}$$

EF per Vehicle (mg/km/vehicle)

$$EF_{vehicle} = EF_{wheel} \times \text{Number}_{front} + EF_{wheel} \times \text{Force Distribution} \times \text{Number}_{rear}$$

3. Decision of Braking Pattern & Temperatures

Oval Track Test | **Cockpit in the Car** | **Brake &Thermocouple**

Vehicle I (Disc) | **Vehicle II (Disc)** | **Vehicle III (Drum)**

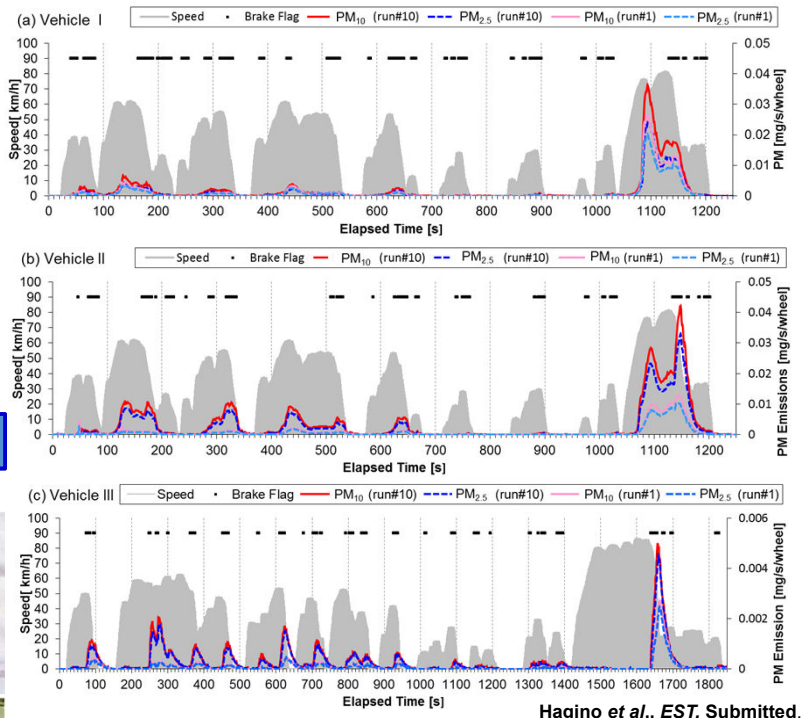
The braking patterns and brake temperatures recorded.

Max Temp. during driving cycles

Vehicle I 102–113ºC, Vehicle II 72–74ºC, Vehicle III 97–133ºC

Consequently, the behavior of the actual vehicle was enabled corresponding to the driving operation performed by dynamometer test.

4. Time Series Mass Emissions



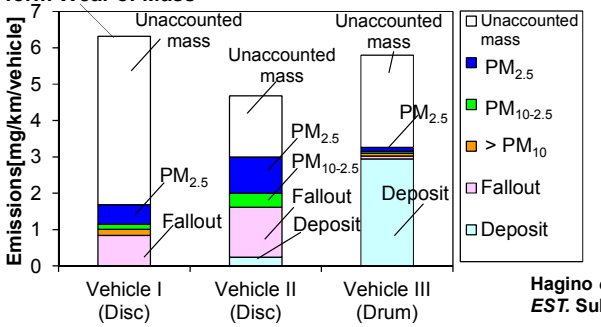
Hagino *et al.*, *EST.* Submitted.

The brake wear particles can be released by brake abrasion and the swirling airflow resulting from the rotor or drum after prior braking events.

Emission Level：0.04～1.21 mg/km/vehicles@$PM_{2.5}$

5. Wear vs. Emissions

Estimated form Wear of Mass



Hagino *et al.*, *EST.* Submitted.

Not all brake wear particles are emitted as airborne particles.

airborne $PM_{2.5}$: 8% (vehicle I), 21% (vehicle II), 2% (vehicle III)

6. Conclusion

To measure driving-distance-based mass emission factors of airborne brake wear particulate matter (PM), a brake wear dynamometer with a constant-volume sampling system was developed.

The brake wear particles can be released by brake abrasion and the swirling airflow, and the emission level was 0.04～1.21 mg/km/vehicles for $PM_{2.5}$.

Not all brake wear particles are emitted as airborne particles.

Detailed Information

Hagino *et al.*, Airborne brake wear particle emission due to braking and accelerating, *Wear*, 334-335, 44-48.

Hagino *et al.*, Evaluation of Airborne Brake Dust Emissions using a Dynamometer System under Transient Driving Cycles, *Environ. Sci. Technol., Submitted.*