

Development of Tire Dust Emission Measurement for Passenger Vehicle

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1. Introduction

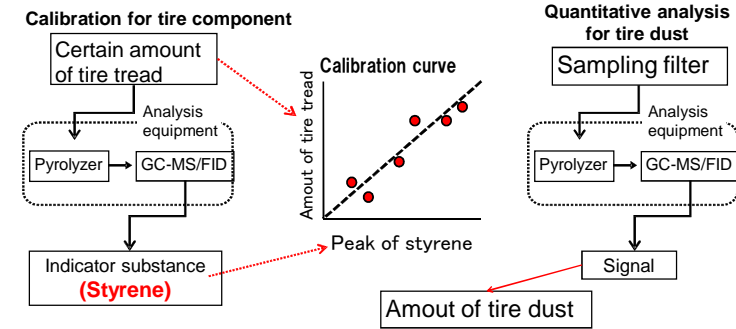
Non-tailpipe emission is relatively important, since particle matter in exhaust gas have been decreasing with the development of advanced engine technologies including after-treatment system. Therefore, development of emission factor of tire wear particle is necessary to evaluate contribution to atmospheric environment.

This study investigated following items to develop a method for emission factor of tire wear by using a testing vehicle.

- (1) Difference of tire wear particles by a laboratory and on-road test
- (2) Particle measurement and estimation of emission factor (EF)
- (3) Measurement of amount of tire wear and contribution of tire dust to atmospheric environment

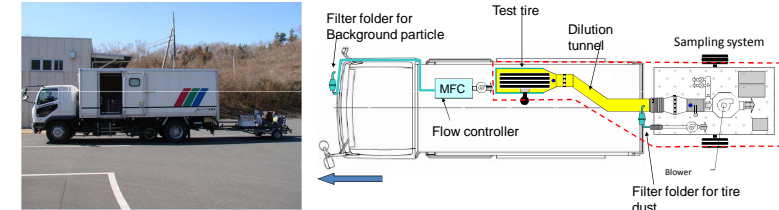
2. Experimental

Analytical quantification for tire dust



Tire dust weight was separated by analytical technique with thermal-decomposition of tire tread on the filter collected tire and road wear particle. Indicator substance for tire tread was Styrene generated by thermal decomposition in this research.

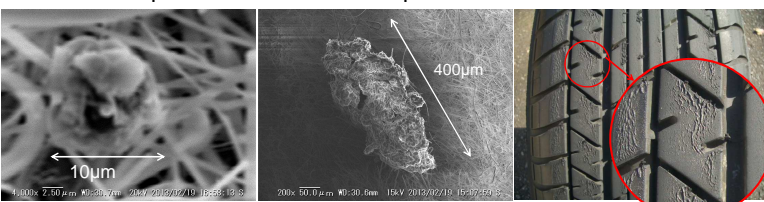
On-road test: Test truck for tire dust measurement



Tire testing vehicle with 6-component force measuring system was used. Sampling system for PM2.5, 10 from tire dust was constructed.

3. Differences in particle shapes and sizes between laboratory test and on-road test

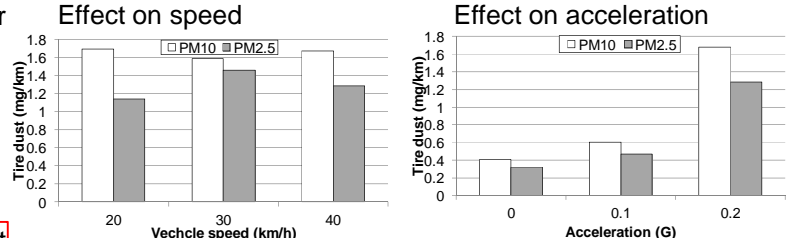
The road test particle The lab test particle Tire surface after lab test



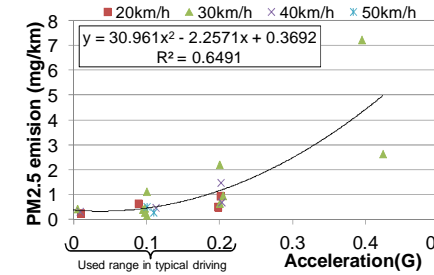
Particle of Road test is spherical, the size is about 10µm. In Laboratory test, the shape and size are much different compared to the road test ones. Tire surface was rough after laboratory testing, because tire dust should be re-attached during test. Tire dust is generated by interaction with the road surface.

Therefore, real environment testing is required in order to evaluate tire dust emission.

4. On-road test results and emission factor



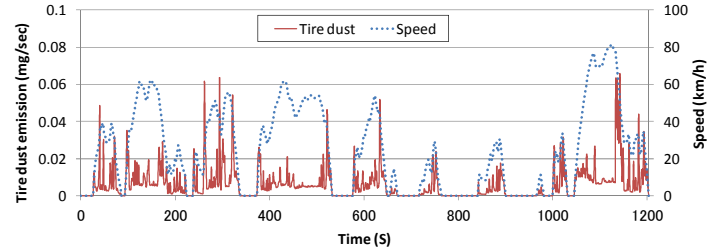
Relationships between Tire dust emission and vehicle acceleration



$$EF = \int \frac{v(t) \cdot f(a_i)}{d} dt$$

EF: Emission factor
v(t): Vehicle speed
f(a_i): Tire dust emission at each acceleration
d: Distance of vehicle driving

Emission estimation applied to test cycle



PM2.5 emission from tire dust was calculated as 3.7 mg/km/vehicle

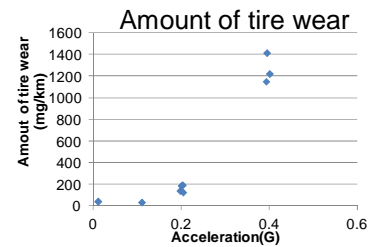
Emission of tire dust was shown by a quadratic function on acceleration. Instantaneous tire dust emission was calculated applied to JC08 test cycle (Japan's test cycle for type approval of exhaust emission).

5. Measurement method of amount of tire wear

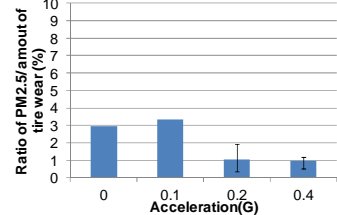
Electronic weight scale for tire weight (readability 10mg)



Weight of tire wear was possible to accurately evaluate the amount of at approx. 5km driving.



Contribution to PM2.5



Contribution of tire wear particle to atmospheric environment was less than 3% (PM2.5) in experimentally evaluation.

Almost tire dust should be remained on road surface.

6. Future work

- (1) This research used only one type of tire. Therefore, it is necessary to consider using various types of tires.
- (2) To examine more accurate measurement, it is necessary to examine under various conditions.