Development of Tire Dust Emission Measurement for Passenger Vehicle

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Topics of this research

1. Tire wear particle emission measurement with speciation of tire and road wear on road vehicle test

2. High sensitive (0.01g/test) measurement of tire wear mass
Introduction of measurement method for tire wear particle at JARI

- Tire testing vehicle with 6-component force measuring system was used for tire dust test. Sampling system similar to CVS system was constructed to collect tire wear particle.

![Diagram of sampling system]

- Test tire
- Mixing tunnel
- Flow controller
- MFC
- Blower
- Filter folder for Background particle
- Filter folder for tire dust
- Sampling system
(1) Road testing for tire dust
   - Tire dust collection with constant lateral acceleration.

(2) Correlation equation for tire dust emission
   - Correlation equation between tire dust emission and acceleration should be built.

(3) Calculation of emission factor
   - The emission factor is calculated with driving pattern from the result of correlation equation.
Quantification for tire dust

- Tire dust was quantified by Pyrolyzer-GC-MS/FID.
  - Evaluation for the correlation between amount of tire tread and signal of organic marker (Styrene)
  - Quantification for amount of tire wear by analyzing the styrene signal on the sampling filter

Other method: polymer fragments analysis in ISO/TS 21396:2017
Test result

- Emission of tire dust was increased with an increase of the lateral acceleration.
- Emission of dust was shown by a quadratic function on acceleration.

**Road dust**

\[ y = 377.99x^2 - 46.112x + 12.072 \]

\[ R^2 = 0.9078 \]

**Tire dust**

\[ y = 30.961x^2 - 2.2571x + 0.3692 \]

\[ R^2 = 0.6491 \]

Test tire: 175/65R17 82S
Estimation of tire dust emission applied to driving pattern.

- Instantaneous tire dust emission was calculated applied to JC08 test cycle.
- Tire dust should be significantly emitted when acceleration is changed at high speed.
- PM2.5 emission from tire dust was calculated as 3.7 mg/km-vehicle.
Evaluation method of accurate tire wear mass

◆ Weighting of tire wear was measured by electric weighting scale (readability: 0.01 g)
  - (Custom made balance for measuring the amount of hydrogen filled in the gas cylinder)

◆ Tire wear quantity could be evaluate by traveling for several kilometers.
Experimental result of tire wear and PM2.5 contribution

- Contribution of tire wear particle to atmospheric environment was conformed about 3% (PM2.5) in experimentally evaluation. Therefore, Almost tire dust should be remained on road surface.

![Graph showing the relationship between amount of tire wear and PM2.5 contributions of tire wear.](image)

Test tire: 175/65R17 82S
Summary

1. Evaluation methods for tire wear were investigated.
   - Test vehicle was used to evaluate relationships between lateral acceleration and tire dust emission for emission estimation.
   - Quantitative method for tire dust was developed with thermal decomposition and GC analysis of tire rubber. As a result, it become possible to quantify the tire component in TWRP.

⇒ Emission factor of tire wear particle could be estimated.

2. High sensitive measurement of tire wear mass
   - We developed a method that can evaluate the amount of tire wear in a short run by measuring the weight of each tire rim assembly using a precise balance.

⇒ The contribution of airborne tire wear particle was less than 3% to tire wear quantity.

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