Title: Errors in determination of VPR's Particle Concentration Reduction Factor

Abstract: (min. 300 – max. 500 words)
We investigated sources of errors in determination of the particle concentration reduction factor ($f_r$) of the volatile particle remover (VPR) used in legislated vehicle emission measurement. Sodium chloride and soot are two of the most frequently used materials of particles used in the $f_r$ evaluation. We identified two sources of errors that are associated with the use of these materials: One is the variation of the detection efficiency of condensation particle counters (CPCs) against sodium chloride particles, which was found to depend on the preheated temperature of the particles. The other is the size shrinkage of soot particles generated with a propane flame burner that are not thermally pre-treated, when the particles were heated at temperatures typically set at the evaporation tube of VPRs. These two sources of errors have presumably caused disagreement of $f_r$ values obtained with particles of the two materials. We found that, by selecting appropriate CPCs and also by sufficiently pre-heating the particles, disagreement due to these errors could be eliminated. As a result, consistent $f_r$ values were obtained between measurements with the two different particle materials, i.e., sodium chloride and soot.

Short CV:

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Errors in determination of VPR’s Particle Concentration Reduction Factor

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Purpose of the study

- Particle concentration reduction factor (PCRF: \( \frac{f_r}{f} \)) will be used in legislated vehicle emission measurement, we must be able to evaluate the performance of the volatile particle remover (VPR) accurately.
- Investigated the sources of errors in determination of the PCRF with the use of NaCl and CAST.

Investigation of NaCl

The detection efficiency of CPCs depend on the preheated temperature of the particles.

![Detection efficiency of CPCs against NaCl particles preheated at various temperatures.](image)

- The detection efficiency of CPCs at 30 nm that were obtained with the aerosol electrometer (AE) used as the reference.
- It is obvious in the plot that the detection efficiency of the two CPCs behaved differently against the heating temperature.
- The size distribution curve had the mode diameter at ~30 nm at room temperature.

Comparison of PCRF

Consistent results would be obtained in the \( \frac{f_r}{f} \) evaluation either with NaCl or soot particles.

![Comparison of PCRF](image)

- The experimental observations in this study suggest that consistent results would be obtained in \( \frac{f_r}{f} \) measurement for VPRs, while the particles used in the measurement were either NaCl or soot, if the particles were pre-heated properly and if CPCs of sufficiently small \( d_{50} \) were used.
- We hope these results help developing better \( \frac{f_r}{f} \) evaluation techniques and improving reproducibility of the \( \frac{f_r}{f} \) measurement.

Conclusions

- The authors acknowledge Dr. Masaaki Tsuji, Ms. Emiko Ohnuma, and other technical staff of AIST for their assistance during the course of this study.
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