National Center for Sustainable Transportation

RESEARCH BRIEF

Real-World Brake Activity Testing in Heavy-Duty Vehicles to Inform Emissions Inventories

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Issue

Studies have shown that long-term exposure to ambient air pollution endangers human health. Regulations targeting internal combustion engines have proven effective in reducing their particulate matter (PM) emissions over the years. However, PM from non-tailpipe sources such as brake and tire wear are not currently regulated and are expected to eventually become the dominant source of traffic-related PM emissions. During vehicle deceleration, brake wear PM is produced through the contact abrasion between the brake pad and the rotor or disk. The airborne emissions produced by brake wear are composed of particles with different sizes, physical properties, and chemical compositions, depending on factors such as friction material, vehicle weight, braking intensity, and braking temperature.

To begin measuring these non-tailpipe emissions, some researchers have used laboratory tests to simulate real-world driving under a controlled environment while others have conducted on-track tests with sampling instruments integrated into a test vehicle. Although these studies have produced a greater understanding of brake wear, laboratory tests are an imperfect substitute for real-world activity. For example, the braking profile of heavy-duty vehicles (transit buses, refuse trucks, tractors, etc.) is unlike that of a light-duty vehicles (SUVs, vans, pickup trucks, etc.), and the frequency and extent of braking activity varies dynamically in the real world. Therefore, it is necessary to investigate brake activity for diverse vehicle classes and sizes under in-use conditions. In addition, the same vehicle can experience different braking activity based on its use (such as goods movement, refuse, or people transit) and on route differences.

Researchers at the University of California, Riverside aimed to establish a test method to determine brake activity of a heavy-duty vehicle under both dynamometer tests and on-road tests. Their study was designed to quantify heavy-duty vehicle brake pad activity during chassis and in-use on-road testing. The results advance the research methodology, ultimately contributing to a more accurate determination of brake activity and informing efforts to improve non-tailpipe PM emissions inventories.

Key Research Findings

Brake activity during standard laboratory test cycles differed significantly from brake activity during real-world driving conditions. This finding highlights the importance of collecting brake activity data from a wide range of vehicle types and driving routes to improve future emissions inventories.

Brake line pressure measurement can be used to identify the beginning and end of brake events. The researchers found it complicated to distinguish real-world brake activity solely based on vehicle speed, highlighting the need for other measurements.

Brake temperature measurement is sensitive to air flow, vehicle speed, sensor location, and sensor geometry. Since brake temperature is an important factor in determining emissions, care must be taken to standardize the sensor

construction, installation, and location to ensure accurate measurements.

More Information

This policy brief is drawn from "Real World Brake Activity of Heavy-Duty Vehicles," a report from the National Center for Sustainable Transportation, authored by Heejung Jung, Kent Johnson, and Brenda Lopez of the University of California, Riverside. The full report can be found on the NCST website at https://ncst.ucdavis.edu/project/real-world-brake-activity-heavy-duty-vehicles.

For more information about the findings presented in this brief, contact Heejung Jung at heejung@engr.ucr.edu.

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