Study of urban roadside dirt reveals potentially toxic mix of metals

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A truck idles at a stoplight; when the light turns green, it roars away in a cloud of dirt and exhaust.

For many years, researchers have studied tailpipe emissions as they correlate to human exposure and adverse health effects. Recently, however, scientists at the University of Wisconsin-Madison learned that there's more to that cloud of roadway dirt than meets the eye: What looks like ordinary dirt actually is a potentially toxic mixture of non-tailpipe vehicle emissions, including microscopic metal particles from brake and tire wear.

Epidemiologists link roadway emissions to a higher incidence of chronic conditions such as asthma or lung disease, particularly in people living near roadways. "We know that metals can be important in toxicity and adverse health," says James Schauer, an associate professor of civil and environmental engineering at UW-Madison.

Schauer, former doctoral student Glynis Lough and other researchers studied the composition of "re-suspended" road dust — material made airborne by moving traffic. Their results showed that, in addition to platinum-group metals from catalytic converters, high levels of metals in re-suspended road dust come from brake and tire wear and fragments of the lead weights used to balance tires.

Published in a report available through the Health Effects Institute, the group's findings might help epidemiologists correlate adverse health effects with exposure to specific pollutants — and specific levels of pollutants.

Traditionally, researchers and epidemiologists have focused on tailpipe emissions as key to health concerns, says Schauer. "The broader picture of this is that these metals need to be thought of in the context of adverse health effects from roadways," he says. "It doesn't necessarily mean the metals are a part of that, but it gives us a basis that would need to be investigated."

Schauer's group conducted much of its study in the Milwaukee area. "To get representative samples was not a trivial thing," he says.

To measure pollutants at the entrances and exits of Milwaukee's Howell Street and Kilborn tunnels, the researchers set up air samplers and collected hundreds of filters, which they analyzed using unique techniques developed at UW-Madison for measuring very low metal levels. They counted the number of cars that passed through each tunnel and tracked their speed. They calculated the airflow through each tunnel, which helped them determine the difference in emissions at the entrances versus the exits.

The researchers "vacuumed" the roadways, re-suspended the dirt samples in the lab, collected them on filters and analyzed them. Every sixth day for a year, they collected ambient air samples in Milwaukee and Waukesha, Wis., as well as in Denver, to contrast and compare metal concentrations they observed in the air with the metals they found on the roadway.

In addition, to identify non-tailpipe auto emissions, they ran vehicle tests in a sealed room on a California Air Resources Board running-loss-shed dynamometer. "Historically, this has been used to look at gasoline vapors leaking out of a car, but we actually looked at how the brake dust and tire wear came out and built up in this room," says Schauer. "So with all of these profiles, we get 'fingerprints' for each source, and then we can reconstruct where the emissions come from."

His group also developed a synthetic fluid similar to human lung fluid, then leached metals off samples of particulate matter to see what fraction of metals was dissolved in the fluid. "A high percentage of the metals that are in these particles actually are liquid-soluble or soluble in this surrogate lung fluid, which again could be important to the health community to begin to understand what's important," says Schauer.

Re-suspended road dust generally falls into what researchers classify as the "coarse" particle category — meaning that it is larger than 2.5 microns, or 40 times smaller than the diameter of a human hair. Recently, the U.S. Environmental Protection Agency (EPA) proposed new regulatory standards for urban particles that fall into this category, says Schauer. "Our data would suggest that the reason we see adverse health effects is because of all of these metals that are present in these materials — which makes it different from rural dirt," he says.

Auto-industry decision-makers could use his group's findings to devise ways to reduce the environmental impacts of their products, while EPA officials can draw on the knowledge to assess current or establish new emissions regulations. "It's very difficult to say what are healthy levels," says Schauer.

He and other researchers recently began similar studies in large cities, including Los Angeles. They are collaborating with epidemiologists to try to correlate metal concentrations with observed health effects.

Source: University of Wisconsin, by Renee Meiller