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Discussion

Comment on "Statistical modelling of vehicle emissions from inspection/maintenance testing data: an explanatory analysis"

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A recent article describing a method to predict in-use emissions of motor vehicles (Washburn et al., 2001) included an important error regarding emissions when a vehicle is idling. The article also omitted previous and on-going research into predicting real world emissions of in-use vehicles.

First the error. The authors justify their use of loaded idle emission test data from a vehicle inspection and maintenance (I/M) program by stating that "CO and HC emissions are at their highest when vehicles are idling". This mis-statement is supported by a reference to a figure that shows CO emissions in grams-per-mile as a function of driving speed (Sturm et al., 1997), with gram-per-mile emissions increasing as average speed decreases. However, the figure does not show emissions at idle, because gram-per-mile emissions at idle are essentially infinite, as the vehicle is not moving. The same reference includes another figure indicating that CO emissions in terms of grams-per-second are lowest under idle conditions. One reason EPA originally recommended that states use a more representative emissions test, such as the IM240, was because of the limitations of the idle test in predicting a vehicle's on-road emission performance. (Another reason is that NO_x emissions, even on cars with malfunctioning emission controls, are very low during idling.) We recently published an article alerting researchers to this and other common statistical errors made when analyzing vehicle emissions data (Wenzel et al., 2000).

Next the omissions. The authors develop statistical models to predict emissions of each of the three pollutants (HC, CO and CO_2), based on vehicle parameters and measured emissions of the other two gasses. However, nearly all of the variance in the statistical models developed by the authors is explained by the levels of emission of the other pollutants, which are included as independent variables in each model. This should not surprise anybody familiar with the

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fundamentals of combustion chemistry. What is of more interest is a method of predicting emissions of a pollutant from a vehicle, based solely on the vehicle's parameters (and without knowledge of its emissions of the other pollutants).

Readers may be interested in two efforts to develop models to predict in-use emissions for vehicle fleets. The Comprehensive Modal Emissions Model (CMEM) developed by a team of researchers led by the College of Engineering, Center for Environmental Research and Technology (CE-CERT) at the University of California at Riverside uses fundamental combustion chemistry and detailed vehicle parameters to estimate second-by-second emissions of groups of vehicles under transient driving conditions (Barth et al., 1999; Schulz et al., 2000). The mobile emissions assessment system for urban and regional evaluations (MEASURE) model developed by the Georgia Institute of Technology is essentially a large statistical model that uses a large database of dynamometer emissions measurements to predict average emissions based on vehicle parameters and driving mode (Guensler et al., 1998; Bachman et al., 2000; Fomunung et al., 2000).

The authors find that their statistical models indicate that I/M emissions vary by vehicle manufacturer, and cite this as confirmation of results we obtained earlier using remote sensing emissions measurements (Ross et al., 1998). In our study we emphasized that emissions of a given manufacturer's vehicles also can vary substantially by model or engine family, with each manufacturer exhibiting some models with high emissions and some models with low emissions. Subsequent research using emissions data from IM240 programs in three states indicates similar wide ranges in emissions by vehicle model for a given model year (Wenzel and Gumerman, 1999), and that average emissions of the same year/make/model vary by I/M station location (Wenzel et al., 1998). This suggests that socioeconomic characteristics of the vehicle owners directly or indirectly account for emissions variability across vehicles. (For example, low income vehicle owners may spend less money on maintaining their vehicles' emission controls.) In their current research, the authors also find that I/M station location explains some of the variation in HC and CO emissions in their statistical models.

Finally, the authors suggest that their exploratory research may be used as a basis for developing a tool to predict on-road emissions based on vehicle parameters such as age and make/model. Readers may be interested to know that Eastern Research Group (ERG; previously Radian International) has been doing just that for the last several years. ERG has developed a high emitter profile (HEP), which predicts a vehicle's emissions based on three pieces of information: the historical average emissions and I/M failure rates of a given year/make/model vehicle; the I/M history of a particular vehicle; and any remote sensing measurements of the particular vehicle (Radian International, 1996a,b, 1997). California uses the HEP to identify suspected high emitting vehicles, and directs them to be tested at test-only stations for their next scheduled I/M test.

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