AUTOMOBILE CARBON MONOXIDE (CO) EMISSION INVENTORY USING REMOTE SENSING

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With a light source on one side of a single lane of highway, such as a freeway on-ramp, infrared detectors and a PC on the other, we are able to determine remotely the exhaust %CO of passing cars in less than one second per vehicle (1). Briefly, the remote sensor measures the increase in IR absorption by CO and CO_2, compared with the air in front of the car. If these observed increases of CO and CO_2 are well correlated, the computer determines their ratio, and calculates the %CO equivalent to a tailpipe measurement of CO at that same instant. The system is calibrated from the computer by means of a half second puff of a certified gas calibration mixture.

The CO/CO_2 ratio measured can also be directly converted to the fuel specific vehicle emissions which, in the USA, is calculated in grams of CO emitted per gallon of fuel used. If a representative fleet of vehicles is measured, then the total emissions can be determined by multiplication of the measurements by the total gallons of fuel sold in the region for which the inventory is required.

The conventional method of determining motor vehicle fleet emissions consists of testing vehicles in highly controlled dynamometer tests, determining their emissions (usually in grams per mile), then attempting to extrapolate the observations to the region of interest using data on vehicle miles travelled, and correction factors to get from the dynamometer conditions to the real on road conditions.

With a database of 10,000 %CO snapshot readings for each week of operation, we have examined our data to categorize the emissions of the fleet we observe. We find that 10% of the vehicles produce more than 50% of the CO. These few gross polluters are not new, and not well maintained. On the rare occasions when we were on site, calibrating the instrument, we observed some of the gross polluters passing by. Several were observed to be taxis, mobile wreckers, and even State Highway Vehicles.

Evaluation of the Colorado Oxygenated Fuels Program

According to Hollman (2), the world's first mandated oxygenated fuels program which took place in Colorado for two months in early 1988..."Resulted in an 8 - 11% reduction in ambient carbon monoxide levels". According to his slides, this reduction was actually modelled. From Colorado Department of Health (CDH) data reports, (3) it can be determined that the basis is FTP measurements of 156 vehicles and Mobile3 modelling of the results, which predicted a 12 - 16% improvement of the mobile source term.

Hollman did not mention that the results of Mobile3 CO emissions modelling have been shown to be wrong by more than a factor of two in recent studies (4,5,6), and that the particular model used for the oxygenated fuels program depends critically on the slopes of two lines which claim to be related to the fuel dependent increase in CO emissions with vehicle age. The deterioration rate data are shown in a CDH report (7). The two least squares lines are plotted, however when the standard deviations are plotted, they overlap each other and most of the rest of the data.

With the remote sensing system at a single on-ramp we obtained 20,000 CO emissions measurements during the 1988 oxygenated fuels program, and 20,000 measurements after its termination. The results showed a 6 $\pm$2% CO improvement possibly arising from the fuel switch (8). The results would be scaled downward by any loss in average gas mileage (estimated at 2%). The costs to the public of the two month program were estimated to lie between 3 and 14 million dollars (5,9). According to Hollman (4) ...."Due to the success of Colorado's Oxygenated Fuels program, other states are now following our lead and implementing Oxygenated Fuels programs. These include Arizona, New Mexico and Nevada."..... It is an interesting situation when the same state agency which mandates a program also gets to evaluate it and to set its own criteria for success.

Evaluating the Colorado Inspection and Maintenance Program

A second program which was evaluated with the remote sensor was the Colorado State annual automobile inspection and maintenance program. We observed a fleet of three thousand vehicles which had never been tested, randomly interspersed with a fleet of 1,100 vehicles which had always been subject to the test. The State and Federal models predicted a greater than 30% difference. We measured 4 $\pm$ 4% difference between the fleets when corrected for average vehicle age.

These conclusions about the efficacy of the program do not differ with other independent literature on the subject. A study of the idle emissions of over 600 vehicles in Colorado showed no correlation between emissions, and how recently the I/M sticker had been obtained (10). A study in Michigan showed that of 600 vehicles which had failed their annual test, the process of driving around the block and retesting them allowed over 200 to pass (11).

There are a few gross polluters out on the roads; we have the technology to identify those vehicles in proportion to how much they drive. It is a long road from identification to enforcement (12). I invite readers to consider how they might devise enforcement strategies, given our new high-technology remote sensing identification capability. Certainly the need to obtain accurate inventories of the emissions from automobiles can best be met by remote sensing studies of a representative fleet of vehicles, preferably using an advanced remote sensor with NO and Hydrocarbon capability.

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