Nanoparticle emissions rise 30 percent when flex-fuel cars switch from bio to fossil

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Levels of ultrafine particulate matter in São Paulo City, Brazil, increased by up to 30% at times when ethanol prices rose and consumption fell. Credit: Léo Ramos Chaves / Pesquisa FAPESP magazine

When ethanol prices at the pump rise for whatever reason, it becomes economically advantageous for drivers of dual-fuel vehicles to fill up with gasoline. However, the health of the entire population pays a high price. Substitution of gasoline for ethanol leads to a 30 percent increase in the atmospheric concentration of ultrafine particles with a diameter of less than 50 nanometers.

The phenomenon was detected in São Paulo City, Brazil, in a study supported by the São Paulo Reserch Foundation (FAPESP) and published in *Nature Communications*.

"These polluting nanoparticles are so tiny that they behave like gas molecules. When inhaled, they can penetrate the respiratory system's defensive barriers and reach the pulmonary alveoli, so that potentially toxic substances enter the bloodstream and may increase the incidence of respiratory and cardiovascular problems," said Professor Paulo Artaxo at the University of São Paulo's Physics Institute (IF-USP) and a co-author of the study.

He says that between 75 percent and 80 percent of the mass of nanoparticles measured in this study corresponds to organic compounds emitted by motor vehicles. Levels of ultrafine particulate matter in the atmosphere are neither monitored nor regulated by environmental agencies anywhere in the world, Artaxo says.

"What these compounds are, exactly, and how they affect health are questions that require further research." The São Paulo State Environmental Corporation (CETESB), for example, routinely monitors only solid particles with diameters of 10,000 nm (PM10) and 2,500 nm (PM2.5), as well as other gaseous pollutants such as ozone (O3), carbon monoxide (CO) and nitrogen dioxide (NO2).

Nonetheless, he explains that a consensus is forming in the United States and Europe based on recent research indicating that these emissions are a potential health hazard and should be regulated. Several U.S. states, such as California, have laws requiring a 20 percent-30 percent ethanol blend in gasoline, which also reduces emissions of ultrafine particulate matter.

Data collection was performed from January to May 2011, and the

analyses took place before, during and after a sharp fluctuation in ethanol prices—owing to macroeconomic factors such as the international price of sugar (Brazilian ethanol is made from sugarcane)—leading consumers to switch motor fuels in São Paulo City.

While no significant changes were detected in levels of inhalable fine particulate matter (PM2.5 and PM10), the study proved in a real, day-to-day situation that choosing ethanol reduces emissions of ultrafine particles. To date, this phenomenon had only been observed in the laboratory. "These results reinforce the need for public policies to encourage the use of biofuels, as they clearly show that the public loses in health what they save at the pump when opting for gasoline," Artaxo said.

According to Artaxo, the research included innovative approaches so that the study could focus on known aerosols that had already interacted with other substances present in the atmosphere. Thus, collection was performed in a site relatively distant from main traffic thoroughfares—the top of a 10-story building belonging to IF-USP in the western part of São Paulo. "The pollution we inhale every day at home or at work isn't what comes out of vehicular exhaust pipes, but particles already processed in the atmosphere" he explained.

The research used data analysis techniques adapted from a model developed by Brazilian economist Alberto Salvo, first author of the article. The method meticulously integrates a large number of variables. "We adapted a sophisticated statistical model originally developed for economic analysis and used here for the first time to analyze the chemistry of atmospheric nanoparticles," Artaxo said. "The main strength of this tool is that it enables us to work with all these variables, such as the presence or absence of rainfall, wind direction, traffic intensity, and levels of ozone, carbon monoxide, and other pollutants."

Perspectives on low carbon emissions

In São Paulo, a city with 7 million motor vehicles and the largest urban fleet of flexible-fuel cars, it would be feasible to run all buses on biofuel. "We have the technology for this in Brazil—and at a competitive price," he said.

The fact that the city's bus fleet still depends on diesel, Artaxo warned, creates an even worse health hazard—emissions of black carbon, one of the main components of soot and a pollutant that contributes to global warming. Alongside electricity generation, the transportation sector is the largest emitter of pollutants produced by the burning of fossil fuels.

For Artaxo, incentives for electric, hybrid or biofuel vehicles are vital to reducing greenhouse gas emissions. "By incentivizing biofuels, we could solve several problems at once," he said. "We could combat climate change, reduce harm to health and foster advances in automotive technology by offering a stimulus for auto makers to develop more economical and efficient cars fueled by ethanol."

More information: Alberto Salvo et al. Reduced ultrafine particle levels in São Paulo's atmosphere during shifts from gasoline to ethanol use, *Nature Communications* (2017). DOI: 10.1038/s41467-017-00041-5

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