Remote sensing technology reduces urban air pollution

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Car exhaust fumes contain poisonous gasses. Credit: Pixabay / Alexei_other

Cities that adopt roadside emissions sensors to detect high polluting vehicles, together with an enforcement program to inspect and repair these vehicles, could significantly improve urban air quality, new research shows.

Vehicle emissions are the most significant source of air pollution in the

urban environment worldwide, impacting the climate and the health of millions of people. Reducing air pollution is a key target of the United Nations sustainable development goals.

"Car exhaust fumes contain poisonous gasses such as carbon monoxide, nitrogen oxides, and particulate matter that cause lung cancer, heart failure, asthma and other diseases," says research co-author, Professor John Zhou from the University of Technology Sydney (UTS).

"Remote sensing equipment uses a sensor and light beam to measure chemical concentrations in the exhaust as a vehicle drives past. A camera records the license plate, so vehicles can be identified for inspection and repair," he says.

Although new cars are required to meet emissions standards, older cars, those with high kilometers and cars that have been modified, or not well maintained, can malfunction and have significantly higher emission levels, leading to high levels of air pollution.

Researchers from UTS partnered with the Hong Kong Environmental Protection Department (HKEPD) and the Hong Kong Vocational Training Council to evaluate the accuracy and effectiveness of Hong Kong's remote sensing enforcement program.

They examined data from the start of the program in September 2014 to December 2018, which included around 2.9 million vehicle counts from over 150 monitoring sites. They also looked at air quality monitoring and chassis dynamometer testing data.

In total, 16,365 high-emitting LPG and petrol vehicles were identified by remote sensing and issued with emission test notices. Among them, 96.3% of the high emitters were successfully repaired and subsequently passed the Hong Kong Transient Emission Test (HKTET).

Only 1.4% of vehicles failed the HKTET, and 2.3% of vehicles did not take the test, causing the cancelation of 558 vehicle licenses.

The study, published in the journal *Science Advances*, found that Hong Kong's remote sensing enforcement program led to a significant and continuing reduction in the level of harmful chemicals at the roadside and in the wider atmospheric environment.

"This is the first study of its kind to link on-site measurement of vehicle emissions with follow-up actions for repair of the high polluting vehicles. It provides insights for policymakers not just on monitoring but also implementing enforcement programs," says first author Yuhan Huang.

"Targeting the small portion of high emitters for vehicle emission control significantly reduces the repair cost and time for both the government and vehicle owners, compared to passive sampling or periodic inspection," he says.

The researchers estimate that total hydrocarbons, carbon monoxide and nitric oxide can be reduced by 22%, 47%, and 39% respectively when all high-emitters are repaired.

Baseline testing undertaken by the HKEPD showed the overall failure rates for petrol and LPG vehicles were 13% and 63%, respectively. The percentages of high emitters in the taxi and light bus fleets were much higher than for private cars.

The worst high emitters were more than 10 times over the limit for carbon monoxide and nitrogen oxides. Older vehicles were more likely to fail the emissions standards, although some newer vehicles also failed.

A pilot repair demonstration program was carried out on 600 selected

LPG taxis. After repair, the emissions failure rate reduced from 63% to 7%. Nearly 90% of the repairs needed were related to three-way catalytic converters (TWCs) and oxygen sensors.

The Hong Kong government subsequently provided $150 million in funding to the HKEPD to subsidize the replacement of TWCs and oxygen sensors in taxi and light bus fleets. Repairing engine faults not only reduced emissions but also improved fuel consumption.

The researchers note that training workshops established for automotive industry and repair associations, including both technical seminars and laboratory demonstrations, were an important part of the implementation program.

They also highlight current challenges, including conservative setting of emission cut points, the need for single-lane measurement sites, and the lack of application in diesel vehicles. Developing more sensitive remote sensing systems, and vertical systems, will help address these issues.

More information: Yuhan Huang et al, Rapid detection of high-emitting vehicles by on-road remote sensing technology improves urban air quality, *Science Advances* (2022). DOI: 10.1126/sciadv.abl7575. www.science.org/doi/10.1126/sciadv.abl7575

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