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Volatile Organic Compound concentrations in the exhaust of a natural gas, a gasoline, and a diesel passenger car under various driving conditions

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To reduce the primary emissions of traffic and therefore the harm caused to humans and the environment, alternative fuels, for example Compressed Natural Gas (CNG), have been developed. However, the amount of secondary particles, that are formed in the atmosphere from gaseous precursors such as Volatile Organic Compounds (VOC), can even exceed primary particle emissions. Their emissions and formation mechanisms remain poorly understood.

As a part of a larger project, the primary and secondary emissions of seven passenger cars were measured. In this study, three cars are compared: a Euro 6d-TEMP CNG (model year 2020, gasoline as a backup fuel), a Euro 6b gasoline (2015) and a Euro 4 diesel (2006) vehicle. All the vehicles had an oxidation catalyst, but no particulate filter. The measurements were done on a chassis dynamometer, which was in a temperature-controlled test cell with test temperatures of -9, 23, and 35 ˚C. The test cycle simulated Real Driving Emissions (RDE) and was 72 min and 47 km long.

The raw exhaust was diluted with a porous tube diluter (PTD) and an ejector diluter (ED), and then characterized physically and chemically. For example, the VOC spectra of the fresh exhaust was measured with a Proton Transfer Reaction Time of Flight mass spectrometer PTR-ToF-CIMS (VOCUS, Aerodyne Research, US). This instrument allows high time and mass resolution analysis of the spectra.

Based on the preliminary results, the VOC composition in the CNG and the diesel car exhaust was similar, with emphasis on oxygenated VOCs. In contrast, the gasoline car emitted more aromatic, polyaromatic and aliphatic hydrocarbons. The VOC concentrations from the CNG car were on average lower than from the diesel car, but the CNG car emitted higher concentrations at cold start and at highway. The VOC concentrations from the gasoline vehicle were also highest at cold start and at highway during the cycle.

In summary, the CNG vehicle seems to emit low VOC concentrations, and the emitted compounds have low secondary aerosol formation potential. However, at cold start and during high engine load, the concentrations increase greatly, potentially due to gasoline usage. This study provided new information about the VOC composition in a CNG car exhaust and supported previous studies in terms of diesel and gasoline cars.

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