

The composition of diesel exhaust particles in different size fractions from 10 μ m to <10nm using comprehensive 2D-GCMS

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Despite intensive research over the last 20 years, major questions remain concerning the composition of primary vehicle exhaust aerosol and its contribution to secondary organic aerosol (SOA) formation. These uncertainties relate especially to the semi-volatile component of the particles. Semi-Volatile Organic Compounds (SVOC) are compounds which partition directly between the gas and aerosol phases under ambient conditions. In engine exhaust the SVOC are typically hydrocarbons in the C15-C35 range and are largely uncharacterised, other than the homologous series of the n-alkanes. This is due to the drawbacks of monitoring techniques available, as the SVOC are unresolved by traditional gas chromatography and form a large hump in the chromatogram referred to as Unresolved Complex Mixture (UCM).

In this study, thermal desorption coupled to comprehensive two dimensional Gas-Chromatography Time-of-Flight Mass-Spectrometry (TD-GC \times GC-ToF-MS) was exploited to characterise and quantify the composition of SVOC from the exhaust emission. Samples were collected from the exhaust of a diesel engine, investigating the effect of testing different speed/load conditions and sampling before and after different abatement devices. Engine exhaust was diluted with air and collected using both filter and impaction (nano-MOUDI, size fractions of 10 μ m to <10nm), to resolve total mass and size resolved mass respectively. Adsorption tubes were utilised to collect SVOC in the gas phase and analysed using thermal desorption.

Analyses indicate the separation of \sim 8,000 peaks, of which many homologous series are identified. These include the homologous series such as straight and branched chain alkanes, monocyclic, bicyclic, tricyclic alkanes, monocyclic aromatics, oxygenated compounds and PAH; similar to both fresh lubricating oil and fuel. Lubricating oil and diesel fuel account for a substantial amount of the mass fraction that is emitted in the exhaust emissions. Thus both lubricating oil and diesel fuel have been comprehensively analysed observing mass fractions of 75 and 90%, respectively. The compounds identified in diesel fuel are mostly present in the gas phase, although some SVOC are also present in the particulate phase; while the compounds identified in the lubricating oil are present in the particulate phase only. Results are presented illustrating differences in the SVOC composition for different size fractions from 10 μ m to <10nm when varying the speed/load and collecting samples with and without abatement devices fitted. Measurements of the same range of compounds in both the condensed and vapour phases in ambient urban air will also be presented.