

## Organic analysis of aircraft engine smoke number filter samples with thermal-optical carbon analysis and thermal desorption-gas chromatography/mass spectrometry

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From atmospheric measurement near an airport runway [1], we have recently found that jet engine lubrication oil [2] is a key component of aircraft exhaust nanoparticles [3]. However, it is uncertain where oil nanoparticles are emitted or formed in aircraft jet engine exhaust. In this study, we aimed to examine the organic composition of jet engine exhaust bulk particulate matter (PM) collected with a smoke meter, especially to see whether those PM samples have lubrication oil signature. The smoke number (SN) paper filter samples, collected at SR Technics, Zürich Airport, Switzerland in 2019–2020, were used. From carbon analysis, the volatile organic carbon (OC) concentrations ( $\mu\text{gC cm}^{-2}\text{-filter}$ ) in the gray-colored SN filter samples were very low but significantly higher than the blank filters. The roughly estimated volatile OC concentrations in the undiluted exhaust was  $1,200 \mu\text{gC m}^{-3}$  for the gray-colored samples. In the chromatograms of thermal-desorption gas chromatography/mass spectrometry (TD-GC/MS), oil marker compounds (tricresyl phosphate and likely fatty acid esters of pentaerythritol) were clearly and consistently detected from the gray-colored samples, and were not detected from the blank filters (Fig. 1). The mass spectra of the oil marker compounds in the gray-colored samples matched well with those of the jet engine lubrication oil. From the gray-colored samples, strong signals of  $\text{C}_{24}\text{--C}_{30}$  *n*-alkanes and some polycyclic aromatic hydrocarbons (PAHs) were also detected.

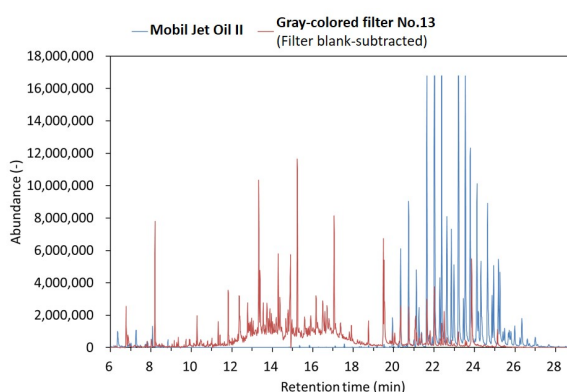


Fig. 1 Overlapped TD-GC/MS mass chromatograms ( $m/z$  85: major ions of hydrocarbons) of the gray-colored SN filter sample and jet engine lubrication oil.

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