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Potential of on-board FTIR as a single instrument for simultaneous measurement of all gaseous pollutants of interest under real-driving conditions.

Hannu Kuutti[1], **Michal Vojtisek**[2], Michal Vojtisek[3], Lubos Dittrich[4], Lubos Dittrich[5], and Martin Pechout[2]

[1]VTT Technical Research Centre of Finland Ltd, Espoo, Finland (hannu.kuutti@vtt.fi)
[2]Department of Vehicles and Ground Transport, Czech University of Life Sciences in Prague, Czech Republic
[3]Institute of Experimental Medicine of the Czech Academy of Sciences, Prague, Czech Republic (michal.vojtisek@iem.cas.cz)
[4]Technical University of Liberec, Liberec, Czech Republic
[5]Createch, Pardubice, Czech Republic

Responding to the outdoor air pollution being one of the gravest environmental hazards to human health, emissions from mobile sources have been subject to scrutiny and emissions reduction efforts through improved fuels, engine design, combustion control, exhaust aftertreatment, and traffic management. Assessment of the effects of various improvements has gradually extended from basic laboratory measurements to testing under real-world (real-driving) conditions and to additional pollutants.

Fourier-transform infra-red (FTIR) spectrometers have the potential to acquire spectra at high optical and time resolution. The absorption spectra are a convolution of absorption spectra of individual compounds and can be, with varying success, interpreted to obtain the concentrations of the pollutants of interest. To date, several FTIR have been adopted for the use in moving vehicles, which is challenging due to the effects of vibrations on precision multipath low-volume optical cells used to achieve a fast response time. The validation of on-road FTIR instruments typically consists of parallel measurement with reference instruments in the laboratory for all measured pollutants and on the road for those pollutants that can be reliably measured on the road.

In this work, two FTIR analyzers adapted for on-road use, an A&D BOB-1000FT vacuum sampling system operating at 5 Hz and a 35-kg Bruker Matrix extensively modified by Czech University of Life Sciences operating at 2.5 Hz, both with a 5-meter multipath cell and 0.5 cm-1 optical resolution, were used to sample the exhaust from diesel, gasoline and natural gas vehicles with and without exhaust aftertreatment. Concentrations and emissions of all pollutants set to be regulated under Euro 7, health and environment relevant reactive species reactive nitrogen species NO, NO2, NH3, CO and formaldehyde, and greenhouse gases CO2, CH4 and N2O were measured during dynamic driving cycles at -9 C, +23 C and + 35 C ambient temperatures.

The results show a reasonable correlation with reference instruments for all evaluated pollutants, suggesting on-board FTIR, which is not much larger than other instruments used to measure real driving emissions, can be potentially used to measure all gaseous pollutants regulated under Euro VII/7 on the road. FTIR spectra can be, even ex-post, interpreted for additional pollutants of interest.

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