Effects on air quality of semi-volatile engine emissions

EASVOLEE

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Special Interest Articles

About EASVOLEE

The **EASVOLEE (Effects on Air quality of Semi-VOLatile Engine Emissions)** project aims to help improve air quality in Europe, focusing on the effects of organic atmospheric pollutants on our health.

This collaborative project involving 8 partners (FORTH, CNRS, TNO, Weizmann, Met.Norway, CRMT, PSI and BFH) in 6 countries is developing and identifying health-related metrics, mitigation strategies, and policies to improve air quality in Europe limiting the concentrations of aerosol due to vehicle exhaust.

The EASVOLEE project (GA-101095457—HORIZON-CL5-2022-D5-01/HORIZON-CL5-2022-D5-01-07) has started on February 2023 under the EU- Horizon Europe Research and Innovation Action.

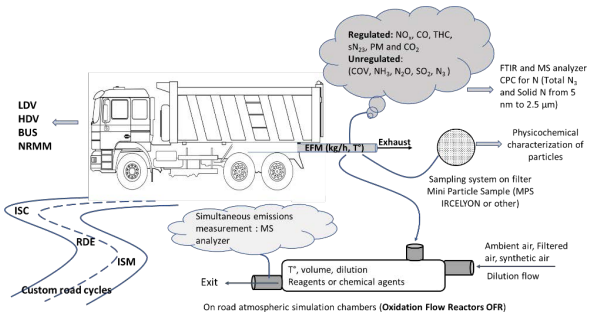

Figure 1. *Schematic of the on-road measurement approach in EASVOLEE.*

Real Driving Emission (RDE) Measurements by CRMT and CNRS

Targeted investigation of key processes associated with the current emissions of organic vapors most relevant to secondary aerosol formation from cars/trucks/ scooters /off-road engines in Europe under real driving conditions is ongoing. As an example, studies of emissions' under real driving conditions of different type of vehicles have started on certified trajectories in the metropolitan area of Lyon (lead by CRMT). The RDE measurements are carried out by CRMT in partnership with CNRS-IRCELyon.

These measurements will continue for several months employing the latest measurement technologies including Portable Emissions Measurement System (PEMS). The results of the measurements will assist in the development of the EASVOLEE emission inventory.

Figure 2. *The CRMT team prepares for on-board measurements on a vehicle during the EASVOLEE project.*

Figure 3. *FTIR Exhaust Gas Analyzer device, Horiba FTX-ONE-CS (modified for on road measurement) and PEMS installed in a car.*

EASVOLEE has received funding from the European Union's Horizon Europe (2021-2027) research and innovation programme under grant agreement No 101095457.

"EASVOLEE will allow, for the first time, the simulation and monitoring, under real driving conditions, of the potential aerosol formation induced by the vehicle emissions"

Dynamometer Experiments in Biel

Emission measurements of gasoline and diesel passenger cars, scooters, and off-road vehicles have started in dedicated dynamometer tests in Biel, Switzerland by the BFH, PSI, and FORTH teams. Both an oxidation flow reactor (OFR) and a smog chamber are used in these experiments to age the emissions and quantify the secondary organic aerosol (SOA) formation. One smog chamber experiment is performed per test focusing on the cold start period while the OFR can be used for multiple measurements during the driving cycle. The experiments are performed using the latest driving Worldwide harmonized Light-duty vehicles Test Cycles (WLTC) and World Motorcycle Test Cycles (WMTC).

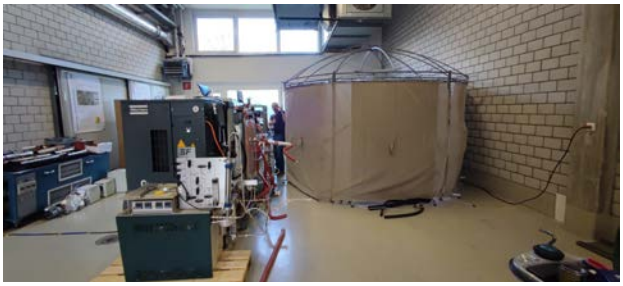

Figure 4. *Experimental setup by PSI and FORTH for dynamometer emission measurements in the BFH facility.*

Meeting of EASVOLEE team in Lyon

On July 17 2023, the EASVOLEE team visited the CRMT Powertrain facility in Lyon and the Frejus tunnel at the French/Italian border.

Figure 5. *EASVOLEE group visit in CRMT SA.*

The 13 km Fréjus road tunnel is located at the junction of two major national and international trade routes between France and Italy.

The Fréjus tunnel is designed for heavy goods traffic with a maximum height of 4.3 m. A single tube accommodates two 3.55 m lanes of traffic.

Figure 6. *An inside view of the Fréjus tunnel.*

The concentrations of gas and particulate pollutants will be measured (effort led by PSI) in the Frejus tunnel at the French/Italian border during a month-long period next June. In a tunnel the VOC emissions of gasoline vehicles are expected to be quite low with 3-way catalyst operating, while diesel emissions should substantially contribute to both VOCs and IVOCs.

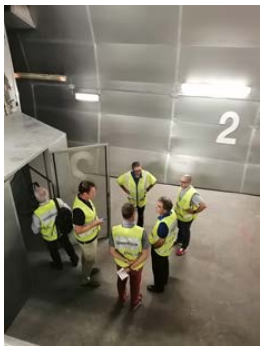

Figure 7. *EASVOLEE group visit in the Fréjus tunnel.*

These measurements will be combined with tunnel traffic data (number of vehicles, type and average speed) and ventilation data to estimate the corresponding average emission rates. The measurements will include both continuous automatic techniques and collection of gas and aerosol samples for subsequent off-line analysis.

"EASVOLEE studies will allow us to quantify the actual effects of fresh and aged transportation PM on actual cells"

Health effects of Secondary Organic Aerosol (SOA)

Analysis of the filter samples collected in WPs 1 and 2 will take place within WP3 (Health effects). Efforts to measure an array of chemical components and their association with the oxidative potential (OP) are ongoing and on a good track. Extracts from the same filter samples analyzed for OP are used to expose lung epithelial and liver cells to assess, using flow cytometry: the degree of cell death (using live/dead stains), generation of reactive oxygen species (ROS), actual oxidative damage and lipid oxidation, and DNA damage. This effort is led by the Weizmann Institute.

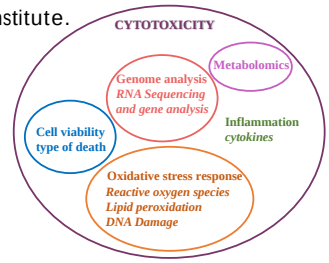

Figure 8. *Biological endpoints to determine toxicity.*

The extent to which each analysis is carried out depends on the toxicity of each sample and the amount of sample mass available for exposure. The toxicity of both the fresh and the processed emissions will be quantified.

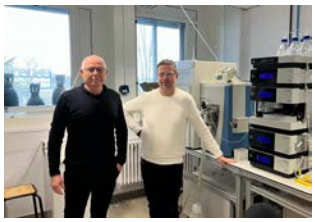

Figure 9. *Prof. Rudich visited Christian George's research group and gave a talk about the Weizmann Institute's research to students, post-docs and Faculty in the CNRS-IRCELYON lab.*

Figure 10. *Prof. Nenes visit at Weizmann Institute of Science, Tel Aviv in the framework of FORTH collaboration with Prof. Rudich research team in the EASVOLEE project.*

Emission inventories for SOA precursors

TNO is integrating the information regarding emissions of SOA precursors combining the results of the EASVOLEE measurements and results of other relevant studies. This information will be used by the EASVOLEE modelling teams in order to simulate organic particle concentrations over Europe. The TNO team working on the EASVOLEE emission inventory consists of Marya el Malki, Tilman Hohenberger, Antoon Visschedijk and Jeroen Kuenen.

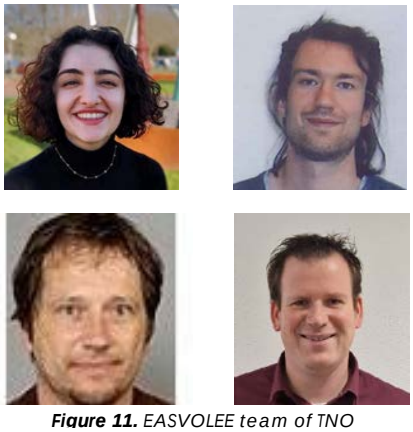

Figure 11. *EASVOLEE team of TNO*

Given the variety of formation and removal pathways in the atmosphere the TNO work involves the preparation of emission inventories for both organic and inorganic gases and particles as a function of size and composition. The emissions include not only particle mass but also particle number.

As a first step, available information on emissions from earlier studies has been collected and is currently being interpreted.

The results emerging from this first assessment will be subsequently improved based on the results obtained by the various measurements of EASVOLEE. The information on emissions per vehicle will be combined with information on the structure of the fleet in each European country to compile an emission inventory for the most recent available year. It has been found that the total VOC and $PM_{2.5}$ emissions in 33 European countries in 2019 have changed dramatically due to the use of emission reduction technologies. Such emission distributions are now being modelled as well for ultra-fine particles (UFP) and semi-volatile organic compounds.

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Dissemination activities during the first year

During the first year, 6 peer-reviewed EASVOLEE articles were published. The corresponding results have been presented in a series of international conferences (including the AGU Fall Meeting 2023; European Aerosol Conference 2023; EGU 2023, etc.). Furthermore, EASVOLEE coordinator Spyros Pandis presented an overview of the project in the kick off meeting of MI-TRAP "Mitigating Traceability of Pollutants from Transport Emissions" project at NCSR DEMOKRITOS in Athens on February 6, 2024. Potential areas for collaboration between EASVOLEE and MI-TRAP were discussed. Moreover, the management aspects of EASVOLEE have been running smoothly during the first year. Internal reporting requests have been promptly responded to and generally, the partners have shown an excellent degree of engagement and accountability in all activities.

Figure 12. *Prof. Pandis' presentation of the EASVOLEE project overview in the KoM of MI-TRAP project at NCSR DEMOKRITOS in Athens, Greece.*

EASVOLEE Annual Meeting 2024

The first EASVOLEE Annual Meeting took place in person at the Foundation for Research and Technology HELLAS/Institute of Chemical Engineering Sciences in Patras (FORTH/ICE-HT) between March 7 and 8, 2024.

The first day of the meeting focused on project updates from WPs 1-2: Emissions of Organic and Other Pollutants (WP1) and Atmospheric Processing of Emissions (WP2) and includes the second EASVOLEE General Assembly meeting. The sessions included presentations of the contents of the different WPs, objectives and milestones, methodological approach, activities, and partners' roles. The second day of the meeting was devoted to the Health Effects of SOA (WP3), New Simulation Tools and Emission Metrics (WP4) and Impacts and Policy (WP5) sessions, followed by the project management presentation (WP6) by the project coordinator. The day ended with the Executive Board (EB) meeting which focused on project management and the initiatives agreed upon during the annual meeting. The collection of specific input from partners on the observational data sets used and produced, model experiments planned and process descriptions within EASVOLEE project were summarized. The meeting was attended by more than 25 participants.

Figure 13. *Group photo of the EASVOLEE Annual Meeting 2024 participants.*