

The MAAPHRI Project:

Multidisciplinary approach to airborne pollutant health related issues: modelisation with combustion engine exhausts

Among hazardous airborne pollutants, engine emissions are claimed to make major contributions especially in urban areas. Further reductions of regulated emissions may lead to the unexpected production of chemical species capable of causing diminished cardiorespiratory functioning. A global multidisciplinary approach of combustion emitted aerosol was developed in this project.

Objectives

The objectives were as follows:

- Assessment of the potential benefit of reformulated fuels and engine technologies on combustion engine emission safety in respect to health-related modelled endpoints;



- To address the impact of particle size distribution and soluble organic fraction on the toxicity response profile;
- To deliver biological *in vitro* and *in vivo* safety screening tools allowing to assess industrial engine exhaust depollution strategies based on the quantification of actual health benefits;
- To provide inputs to policy makers for elaborating future “no regret” regulatory decisions based on actual scientific experimental data rather than on the use of the precautionary principle.

Key findings and conclusions

- *In vitro* experimental models showed that with high sulphur fuel in the absence of oxidation catalysis, particulate matter was the main toxic component triggering DNA damage and systemic inflammation. At the opposite, with ultra-low sulphur fuel and lubricant, in the presence of strong diesel oxidation catalysis, the role of particulate matter was no more evidenced and the gas phase became the major component triggering strong oxidant stress highly correlated to emission NO₂ concentrations;
- A selective particle sizer (SPS) was designed allowing continuously sampling combustion aerosols and delivering a flow of aerosol with selected particle sizes;
- Cytokine reporter gene cell lines were exposed to combustion aerosols using bi-phasic air/liquid exposure design. Cytokine expression patterns were variable according to aerosol particle size downstream of the SPS;

- There was no evidence of occurrence of mutation with two strains of Salmonella up to high emission concentrations of combustion aerosols while the system was responsive to benzylchloride vapours used as a positive control. These observations question the bioavailability of combustion emitted airborne pollutants for exerting their known genotoxic potential;
- The results from both *in vitro* and *in vivo* studies indicate that increased NO₂ emissions raise a new health safety concern that should be addressed by regulatory authorities, since recent epidemiological studies point out to an important role of NO₂ for triggering acute cardiorespiratory impacts.

Relevance and contribution to EU policy

A question of relevance for regulators: Is it worth further reducing engine emissions (CO, HC and ultra-fine particles with the use of a technology that increases the level of oxidant pollutants such as NO₂ and might bring deeper health concerns? A suggestion: Relevant public authorities should encourage systematic biological safety studies of combustion engine emissions: HCCI, Diesel IDI, DI, Common rail, 2 stroke engines (2-wheelers, gardening tools, etc.) after-treatment systems (DOC, DPF, SCR, DeNOx), biofuels.

The projects aimed to provide policy-makers with pertinent tools to globally assess complex combustion aerosols safety, to improve health-related impact based knowledge for elaborating future regulatory decisions based more on scientific experimental data than on the precautionary principle. To meet the target of both emission and health effects reduction, the screening of health-related issues of combustion emissions should consider global aerosol, particulate matter, gas phase component preservation and multidisciplinary approaches.

Future regulations should:

- Consider system interactions as well as single component;
- Anticipate the complex and the unexpected by a holistic approach of complex aerosols.



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