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Comparative toxicological evaluation of SI and CI engine exhausts in an in vitro model of rat lung slices

In Europe and especially in France, diesel cars represent up to 50% of the vehicles while in California USA they represent less than 5%. In California, gasoline engine PM contribution may represent up to 50% to 70% ambient air PM according to the studies and thus may represent a health concern.

Gasoline exhaust PM mass is much lower (by a factor 100 to 1000) than in diesel exhaust however, they may reach significant numbers such as 2 to 5 10^5 particles per cm^3 . Due to their smaller size, and according to the lung models PM deposition described by the IRCC 1996, they may very efficiently deposit in the alveolar region of the respiratory tract.

Rat lung slices were exposed to continuous flows of controlled diluted exhausts from either gasoline and diesel engines. Gasoline exhaust were untreated or catalysed (3ways) and/or filtered while diesel exhausts were either untreated or filtered. Particle size distributions and numbers were measured by SMPS and ELPI. Cell viability, oxidative stress, inflammatory reaction and DNA alterations were assessed as biological toxicity endpoints.

Particle size distribution showed a clearly bi-modal distribution for untreated gasoline exhausts, with peaks centred on 30 and 80 nm, the 30nm peak representing ca.80% of PM. The use of a cordierite particulate trap allowed to remove at least 95% of gasoline exhaust PM. Catalysed exhausts showed a marked reduction of the 30nm peak without significant reduction of the 80nm peak, while diesel exhausts showed as expected a clear single peak centred on 90-100 nm.

Cell viability remained unaffected by diesel exhausts while a marked loss of viability was observed after untreated or filtered gasoline exhausts. This loss of viability did not occur after 3way catalysis treatment of gasoline exhausts. Similar oxidative stress was observed after gasoline and diesel untreated exhaust exposures. However, while filtration of diesel exhaust partially protected from oxidative stress, no impact of gasoline exhaust filtration could be evidenced. No oxidative stress was observed after 3way catalysis of gasoline exhausts. DNA alterations were solely observed with diesel exhausts and partially reduced by exhaust filtration. These alterations are modulated by engine type and running conditions. Inflammatory reaction induced by diesel exhaust was almost absent after gasoline exhaust exposure (untreated, 3way catalysis and filtration).

In conclusion, in the view of the lack of filtration effect, gasoline exhaust toxicity appears to be mainly due to the gaseous phase of the exhaust while in the presence of diesel exhausts both PM and gaseous phases may exert some oxidant and inflammatory reactions.

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