

**Ihalainen M. / University of Kuopio, Finland**

**Biobased diesel fuels: particulate emissions and their inflammation response**

---

The aim of this study was to investigate the effects of biobased diesel fuels on diesel engine emissions. We concentrated on the differences of particle mass emission, particle emission toxicity (inflammation) and chemical composition (organic and elemental carbon, OC/EC), particle number size distributions, and regulated gaseous emissions between different fuels. The measurements were carried out also with a catalytic converter (DOC-POC) to see, how a diesel oxidation catalyst (DOC) and a particle oxidation catalyst (POC) affected the emissions.

Biofuels used in this study were a 1<sup>st</sup> generation biodiesel rapeseed methyl ester (RME) and a hydro-treated vegetable oil (HVO). Conventional diesel (EN590) was used as reference fuel. A non-road EURO II diesel engine coupled with an engine dynamometer was employed for this study and operated according to the international ISO standard C1 (ISO 8178-4:1996).

For measurements of particle size distribution, OC/EC and particulate mass, a partial flow from the exhaust gas was diluted using a system of porous-tube diluter, ageing chamber and ejector-type diluter assembled accordingly. A similar dilution method has been previously used, e.g. in studies on diesel engine emissions by Lyyrinen *et al.* (2004). Particle number size distributions were measured with a Fast Mobility Particle Sizer (FMPS), an Electrical Low Pressure Impactor (ELPI) with filter stage, and a Scanning Mobility Particle Sizer (SMPS) with a long and nano Differential Mobility Analyzer (DMA). The OC/EC contents of emitted particles were analyzed using a thermal optical method (Sunset laboratory Inc).

Particulate samples for the toxicological analyses were collected from a Constant Volume Dilution tunnel (ISO 8178) with a High Volume Cascade Impactor (HVICI) (Sillanpää *et al.* 2003). They were collected and pooled together from four previously chosen steady states. Mouse macrophage cells (RAW264.7) were exposed for 24 hrs to the particulate samples in a dose-related manner. The production of the proinflammatory cytokine TNF $\alpha$  was measured by Enzyme Linked Immunosorbent Assay (ELISA).

Preliminary results show that RME decreased the particle mass emission by 10% and HVO by 20%, when compared to EN590. In contrast, the particle number emission increased by about 20%, when RME was used instead of EN590. These findings were explained by a smaller geometric mean diameter of the emitted particles with RME compared to EN590. There was no clear difference in particle number emission between HVO and EN590, but, like with RME, the geometric mean diameter of particles was lower with HVO than with EN590. With the catalytic converter, both the particle number concentration and the mass emission were notably decreased as expected.

The inflammatory (cytokine) response to the HVO particles was slightly higher than it was to the EN590 particles (fig. 1A). The responses to the EN590 and HVO particles also increased after a catalyst treatment of the emissions. The picture changed however, when the mass emission/kWh was taken into account (fig. 1B). The inflammatory potential of the particulate emission was assessed lower with the catalytic converter than without it and the inflammatory potential of the HVO particulate emission decreased below that of the EN590 particulate emission.