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Biodiesel (soy-bean FAME) effect on particulate and gaseous pollutants from a passenger car

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Diesel vehicles are an important source of pollutant emissions, some of which potentially toxic. Biodiesel (fatty acid methyl esters – FAME) use as an automotive fuel is expanding around the world and this calls for better characterization of its impact on diesel combustion, emissions, air quality and ultimately on human health (Kousoulidou, Fontaras et al. 2007).

In this study a neat soybean-oil derived biodiesel (B100) and its 50% vol. blend with petroleum diesel (B50) were used on a Euro 2 diesel passenger car. The aim was to investigate biodiesel effect on regulated and non regulated pollutants such as carbonyl compounds (aldehydes and ketones), particle number and size distribution. Additionally, exhaust particle samples were collected for toxicological analysis. Measurements were conducted over the (cold-start) NEDC and the Artemis cycles on a chassis dynamometer.

Emissions of CO and HC increased up to 50% over the certification test, particularly with the B100 fuel. NOx increased by up to 10%, only with the B100 blend. Fuel consumption also increased by 9% (B50) and 17% (B100) over the legislated cycle and by 4.5% and 10% over Artemis respectively.

Despite some evidence which reports reduction of particulate matter (PM) with use of biodiesel, our measurements showed that PM more than doubled with B100 over the cold-start NEDC. The reduced volatility of biodiesel and engine-fuel interactions are important parameters with regard to the cold-start engine emission performance. The presence of biodiesel only led to significant reductions of PM emissions over the (hot) Artemis cycles.

In all cases solid particle number emissions decreased with the use of biodiesel. The reduction in solid particle number is mainly linked to the oxygen content in the biodiesel and, as a result, the lower C-atom proportion in its composition than petrodiesel. On the other hand, the total particle number (including volatiles) was increased. In addition, nucleation mode particles appeared more often than with petrodiesel. This effect was stronger at higher biodiesel blending ratios (Fig, 1). The formation of nucleation mode particles should be linked to the higher semi-volatile emissions and the lower soot mode of biodiesel, which promotes homogeneous nucleation that condensation. A negative effect (increase in emissions) was also observed for certain carbonyl compound emissions.

The results of this study showed that biodiesel at high blending ratios may strongly impact emissions from passenger cars, in a rather non-uniform manner, with the actual effect being dependant on driving conditions and blending ratio. The fact that certain results of this study are not in line with the general trends reported in literature (Lapuerta, Armas et al. 2008) indicates that biodiesel use under certain conditions and from different feedstocks may have different impacts, some of which strongly relate to health issues. Therefore, the detailed characterisation of emissions with use of biodiesels is required to thoroughly assess their environmental and health effects.

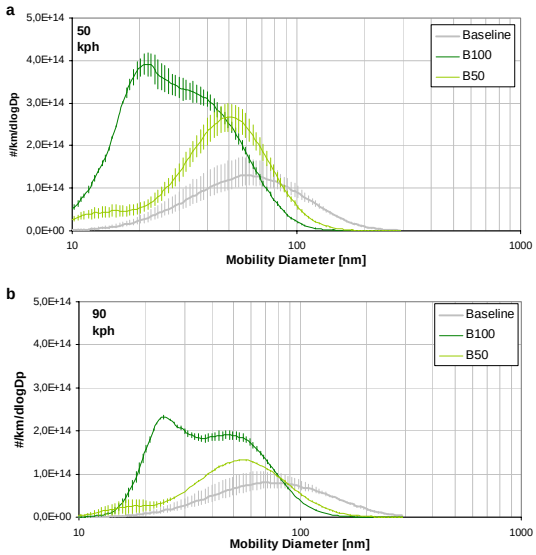

Figure 1 Particle mobility size distribution with use of petrodiesel (Baseline), neat biodiesel (B100), and a 50% blend (B50). (a) 50 km/h, and (b) 90 km/h.

Kousoulidou, M., G. Fontaras, et al. (2007). " Effect of biodiesel and bioethanol on exhaust emissions." ETC/ACC Technical Paper 2008/5.

Lapuerta, M., O. Armas, et al. (2008). "Effect of biodiesel fuels on diesel engine emissions." Progress in Energy and Combustion Science **34**: 198-223.