Emissions of an agricultural tractor with experimental e-diesel and commercial diesels

Järvinen Anssi[1], Kuutti Hannu[1], Aakko-Saksa Päivi[1], Lehtonen Juha[1], Vilenius Topi[2], Kouva Sonja[3], Lehto Kalle[3]

1 VTT Technical Research Centre of Finland, Espoo, Finland
2 AGCO Power, Nokia, Finland
3 Neste Corporation, Espoo, Finland

anssi.jarvinen@vtt.fi

INTRODUCTION

Electrofuels synthetized from CO_2 and H_2O with renewable or nuclear energy could be used to replace fossil fuels. Diesel engines will remain dominating in some transport sectors, particularly in the heavy-duty transport and shipping resulting that diesel fuel will be needed in the future. Sustainable alternatives for fossil diesel exist, such as diesel produced from waste materials, but also new ones are studies to fill the large demand. One of the new alternatives is the e-diesel (electrofuel), see e.g. [1].

In this work, carbon capture and high-temperature water electrolysis techniques as well as the reverse water-gas shift reaction were used to produce CO and H_2, which acted as feedstocks of Fischer-Tropsch (FT) synthesis. The FT synthesis produced a mixture of hydrocarbons with different chain lengths. Oil refining techniques such as isomerization and distillation were utilized to produce e-diesel from the FT synthesis product. The e-diesel consisted mostly of alkane hydrocarbons and its cetane number (IQT) was 66.1.

METHODS

Emissions of an agricultural tractor (Valtra 235D) running with the e-diesel were studied in a dynamometer and in on-road measurements. Measurements were conducted before and after the aftertreatment system (ATS). The before aftertreatment measurement provided information on the combustion behaviour of the fuel and after aftertreatment provided tailpipe emissions of the tractor. To see differences in the emissions, several different fuels were tested: fossil EN590 diesel, HVO-type renewable diesel, e-diesel and blend of fossil and e-diesel (appr. 35 % of e-diesel).

Emissions of gaseous compounds were measured with AVL PEMS system (Before ATS) and A&D FTIR-spectrometer (After ATS)). Particle number emissions (PN) were measured with the AVL PEMS system (Before ATS) and Dekati MPEC+ (After ATS). AVL Micro Soot sensor was used to study black carbon (BC) concentrations before the ATS.

RESULTS

The fuel affected significantly on the before ATS emissions. For instance, the BC concentrations varied in the order of tens of percent between the fuels as seen from the time series presented in Figure 1. The e-diesel produced the lowest BC concentrations, HVO produced slightly higher than e-diesel and the fossil

EN590 diesel clearly the highest BC concentrations. Blending of EN590 with e-diesel reduced BC emissions by -16 %.

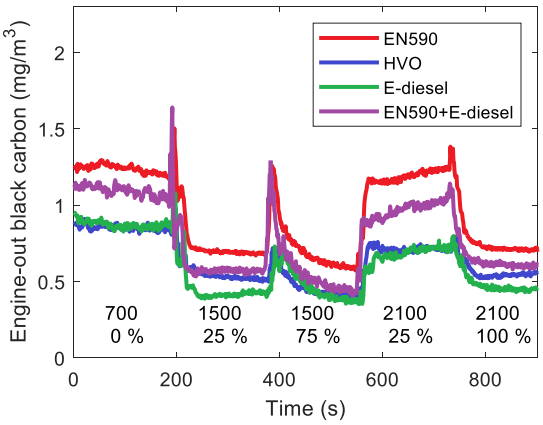

Figure 1 Engine-out black carbon concentrations with different fuels over the dynamometer cycle. The engine rpm and load (%) are marked into the lower section of the figure.

Although fuel affected before ATS concentrations, exhaust exiting from the tailpipe had very low PN concentrations with all fuels and differences between the fuels were not seen. PN concentrations after ATS were not systematic and probably depended mostly on the operation of the diesel particulate filter.

CONCLUSIONS

Experimental e-diesel was manufactured from CO_2 and H_2O and electrical energy. The produced e-diesel proved out to burn well with low black carbon (soot) emissions. In the future, if e-diesels are manufactured commercially, they or their blends with conventional diesel could be used to power the oldest vehicles with the lowest level emission control technology to minimize emission. With the newest engine technology, e-diesels could reduce regeneration needs of the diesel particulate filter.

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REFERENCES

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