BIOclean

alternative fuels in shipping

Reduktion der Emissionen klimarelevanter Gase und Partikeln aus Diesel-Großmotoren für die Schifffahrt und für den stationären Einsatz durch den Einsatz regenerativer Treibstoffe

ABSCHLUSSBERICHT

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GEFÖRDERT VOM

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Project Summary

Study Objectives and Structure

The use of biofuels for stationary power generation or propulsion in shipping gains increasing importance in the framework of CO_2 reductions and the use of energy from renewable sources. The knowledge on emission characteristics of various biofuels and resulting climate impacts however is very limited. BIOCLEAN considers the quantification of all key climate-active exhaust constituents as a very important task not only for fossil fuels but also for fuels from renewable sources. The evaluation of the climate impact of biofuels requires precise knowledge on the differences in emission characteristics between conventional and biofuels.

BIOCLEAN investigated the emission of CO_2, NO_x, hydrocarbon compounds, SO_2, H_2SO_4 and particulate matter in terms of particle number, particle size, and chemical composition from medium-speed four-stroke large diesel engines for different fuel types. The selected fuel matrix included heavy fuel oil (HFO) with a fuel sulphur content of 2.17 weight-% (wt-%) as the fossil high-sulphur reference fuel, marine gas oil (MGO) with a fuel sulphur content of < 0.1 wt-% as a fossil low-sulphur fuel, and palm oil, soy bean oil, sunflower oil and waste edible fat as fuels from biogenic sources.

The simultaneous consideration of climate-active trace species like NO_x, particulates and sulphur-containing particle precursors on one hand and of the most important climate-active exhaust constituent CO_2 on the other hand allowed for the investigation of trade-off effects of CO_2 emissions reduction and potentially increasing emissions of other climate-active trace constituents. Accompanying model studies using a CO_2 response model for the treatment of the CO_2 emissions, and a coupled climate chemistry model for the treatment of direct and indirect aerosol effects on climate investigated the climate response in case of replacing heavy fuel oil by biofuels. The greenhouse gas emissions associated with the production and use of the biofuels were included by means of a fuel lifecycle analysis which also considered land use chances associated with the growth of energy plants for the production of biofuels.

This set of joint test rig studies and model studies forms the basis for recommendations of reasonable applications of biofuels in terms of climate protection. As a whole, BIOCLEAN provides decision guidance and guidance on technological realisation for a world-wide use of fuels from renewable sources in the investigated applications of large diesel engines.

Emission Properties

The investigated set of biofuels demonstrated good combustion properties in the single-cylinder four-stroke test engine. No significant increase in engine degradation and corrosion was observed for biofuel use. Fuel characteristics and emissions properties of the investigated fuels are summarised as follows:

Energy content and specific CO_2 emissions:

Energy content per mass:	HFO	40.4 MJ kg^{-1}
	MGO	43.0 MJ kg^{-1}
	Biofuels (av.)	37.3 MJ kg^{-1}
Specific CO_2 emissions (75% load)	HFO	679 g CO_2 kWh^{-1}
	MGO	639 g CO_2 kWh^{-1}
	Biofuels (av.)	655 g CO_2 kWh^{-1}