Topic 3: Oxygenated fuels: development & demonstration of CHP

The use ofoxygenated fuels and fuel mixtures in diesel engines for CHP applications

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Background

The EC has set a target to increase the share of combined heat and power (CHP) in the European energy supply. One of the objectives is to develop energy systems for remote regions with a special emphasis on the integration of renewable energy. So far, the implementation of small-scale (50 to 1000 kW_e), direct biomass-to-electricity CHP-systems has been rather limited for various reasons. The Bioliquids-CHP project was set up to break down the technical barriers preventing the use of biomass-based fuels in engines and turbines. The aim of the research described in this paper is to develop and demonstrate a cost-effective biomass based combined heat and power (CHP) system by using biomass derived liquids.

Approach

The basis of the experimental set-up is a one-cylinder, 20 kW_e diesel engine, which has been adapted to enable the feeding of different fuels and the monitoring of its performance. Besides the complete stainless steel fuel injection system also specific measures have been implemented to overcome the difficult and slow ignition behavior of pyrolysis oil. At several locations in the set-up temperatures and pressures can be measured and logged. To monitor gas emissions two analyzers have been installed, one measuring the gas components (CO, NO_x, CO_2, O_2 and HC), and the other measuring soot/particles. A generator is connected to the engine to convert the mechanical power into electricity. The electrical load can be varied in the range from 0 to 12 kW_e. A Smart Power Analyser is installed to monitor the actual power output, frequency, etc.

Results

Test runs with the engine set-up have been carried out with diesel fuel to check all controls and measurements, and to characterize the engine with the original fuel. In a next step, both the fuel pump and injector have been replaced by a corrosion resistant version to enable pyrolysis oil as a fuel. Subsequently, the diesel engine has been fuelled with several oxygenated biofuels (biodiesel, sunflower oil, ethanol, pyrolysis oil, pyrolysis oil emulsions & blends as well as chemical treated pyrolysis oil). The performance (fuel consumption, efficiency) of the different liquids will be compared also with respect to the flue gas emissions (NO_x, CO, HC and soot). The paper will discuss in detail all experimental results obtained with this set-up with the different bioliquids.

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Keywords

Cooperation with Russia in the field of power generation from biomass; combustion, bio-liquids, engine, combined heat and power (CHP), cogeneration