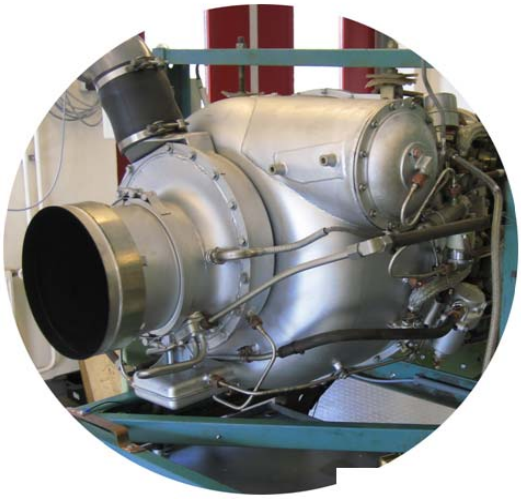
Pyrolysis oil combustion in gas turbines



The concept of using liquid fuels produced from biomass for energy generation encounters problems resulting from an incompatibility between properties of bio-oils and the designed for fossil fuels gas turbines. Pyrolysis oil has several major advantages over the conventional biomass and fossil fuels. Since the pyrolysis oil is biomass in the liquid form it can be easily transported to a place of destination (the available network and logistics for petroleum might be employed) or use in the small CHP installations built nearby the place where the feedstock for pyrolysis oil is produced (or in the vicinity of housing districts). Power and heat obtained from these units is utilized then to cover local needs of householders, hospitals, schools etc. Pyrolysis oil can be also stored to cover the shortage of other fossil fuels for emergency situations. Solid and gashouse fuels, due to economical and logistical reasons cannot be used for this purpose. Other advantages of the pyrolysis oil are high energy density (by factor 5-8 higher than the feedstock from which it was produced), it does not compete or interfere food chain (second generation of biofuels), the minerals left from the pyrolysis oil burning might be re-used for soil enrichment. Pyrolysis oil is also neutral for the environment with respect to CO_2 emission and it follows the climate policy of the Netherlands government about the use of renewable sources for energy production at level of 20 % in 2020.

All the aforementioned benefits make the pyrolysis oil a new desired source for energy production. However, pyrolysis oil cannot be applied directly in present gas turbines. The chemical and physical properties of any pyrolysis oil differ significantly from those of diesel oils. High viscosity, delayed ignition time, low heating value, corrosion effect and solid content make pyrolysis oil a challenging fuel for utilization in modern gas turbines. To utilize the enormous potential of pyrolysis oil as a fuel of the future, an additional work on its combustion behaviour and interaction with gas turbine elements must be done.

The experimental study will be performed on the full scale, 50 kWe gas turbine (also tests at small test rig for checking atomization quality will be performed). Experiments will be focused first on a feeding line, where the influence of temperature and pressure on the spray behaviour will be studied. Then, pyrolysis oil mixed at different ratios with methanol or ethanol will be investigated, followed by study of corrosion effect in the feeding line. These investigations will provide information about the effect of pyrolysis oil on the feeding line and atomization process quality. In the second part of the study, ignition of pyrolysis oil alone and pyrolysis oil mixtures will be done. Here, the ignition process together with stability of the flame will be taken into account. Combustion behaviour at different operating conditions (power, pressure ratio, preheating temperature, air factor, etc.) and exhaust gas composition will be studied as well. After combustion examination, a corrosion, erosion and deposit formation at the liner walls will be evaluated.

The results of this project will give guidelines for further utilization of the pyrolysis oil in gas turbines.

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