- IDEALFUEL -

Lignin as a feedstock for renewable marine fuels

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Deliverable Report

D5.4

2-Stroke engine – Spray and combustion behaviour

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Publishable summary

Within the IDEAFUEL project, information on the drop-in capability/compatibility of the Bio-HFO and the related blend with a conventional HFO under large two-stroke engine like conditions should be obtained and benchmarked with conventional fossil fuel products.
This includes test at WinGD's spray combustion chamber. This unique facility is enabling engine-like investigation of the injection, spray formation and combustion behaviour at relevant conditions in terms of pressure, temperature, and swirl at start of fuel injection. The setup with real-size injection system parts and configurations together with the application of (optical) measurement systems allow for detailed investigations to assess the underlying phenomena related to the spray and combustion. During the project the spray combustion chamber has been further developed and the measurement toolbox was further extended to generate a high-fidelity database to validate and calibrate (CFD) simulations and further develop the numerical models, accordingly.
The heat release rate characteristics have been improved substantially by the application of a non-return flap between the regenerator and the combustion chamber to minimize accuracy losses due to the large crevice volume of the heating system attached. Furthermore, an exhaust gas sampling system has been developed and applied to gather information about the emission formation which is of high value for the combustion process development. The optical diagnostic capabilities have been extended by designing an ultra-wide angle visualization setup consisting of a self-designed sapphire dome window, a cooling holder for the relay optics and lens which can be connected to a (high-speed) camera system. It enables gathering an optical insight with a view of the entire combustion chamber enabling visualization of the flame propagation through the combustion chamber as well as on spray-to-spray interactions. All the mentioned improvements of the SCC test facility further advance this unique reference experiment for the combustion system developments and alternative fuel validation. Moreover, it enables further developments for the simulation tools and applications.
A reference measurement campaign with a diesel-like (MGO) fuel has been performed. Important parameter variations such as gas and injection pressures data have been obtained and analyzed with regard to the combustion characteristics and emissions. Furthermore, experiments under a non-reactive nitrogen atmosphere have been conducted to assess the spray formation and morphology. The results have been postprocessed and analyzed and the results were used for the extensive spray and combustion modeling activities within this work package.
WinGD has designed and developed a single cylinder test engine that allows for cost- and fuel-efficient measurements of the engine performance such as efficiency and emission formation (CO_2, NO_x, PM, etc.). During the course project, the engine has been shipped from China to Winterthur for installation in the Engine Research and Innovation Center. After the build-up at the new location, application of control and measurement systems, the engine was commissioned and taken into operation for its purpose for fuel testing as well as development platform in the landscape of engine technology.
Regarding the fuel compatibility activities in WP4, especially the procedure and methodologies have been discussed among the experts. WinGD offers the opportunity to test the fuel on a hydraulic injection test rig where 100000 of injection cycles with an engine fuel system arrangement can be measured. Besides the actual injection performance data also the component and parts can be analyzed in terms of wear, deposits etc.

The lack of Biofuel produced in the predecessor work packages WP2 and WP4 affects the last step of the validation process in a critical way. For the SCC tests, no Bio-HFO testing could be performed and the comparison with conventional fossil fuels was not possible. Unfortunately, also the small quantities requests for such testing (ca. 10 liters) were not available. This also includes the amount after blending with HFO. The missing detailed fuel specifications did also not allow for mitigation action with surrogate fuel and the mimic of the composition which would yield similar chemical characteristics is seen as very unlikely due to costs and efforts.
Therefore, also the planned SCE tests were not possible as the scale-up to amounts in the range of several tons was not doable within the project. Hence, also the activities related to the fuel compatibility could not be performed.

All preparatory work and activities have been successfully completed, and all facilities would have been ready to test the Bio-HFO with regard to its drop-in capabilities and compatibility under large two-stroke engine conditions. Therefore, certain reference experiment activities at the SCC for the simulation and validation of the newly developed CFD modelling approach for such engines have been emphasized.

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Project partners:

#	Partner short name	Partner Full Name
1	TUE	Technische Universiteit Eindhoven
2	VERT	Vertoro BV
3	T4F	Tec4Fuels
4	BLOOM	Bloom Biorenewables Ltd
5	UNR	Uniresearch B.V.
6	WinGD	Winterthur Gas & Diesel AG
7		(Formerly SeaNRG, is now GOODFUELS #12)
8	TKMS	Thyssenkrupp Marine Systems GMBH
9	OWI	OWI – Science for Fuels gGmbH
10	CSIC	Agencia Estatal Consejo Superior De Investigaciones Cientificas
11	VARO	Varo Energy Netherlands BV
12	GOOD	GoodFuels B.V.

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