



Ph.D. Position: Auto-Ignition characteristics of ammonia/air premixture for high compression spark ignited engine

Subject :

One way for the storage of the renewable energy excess is what is commonly named 'electro-fuels' (*e-fuels*), feasible if users develop adapted technical solutions to use them in energy converters and/or in transport systems. Ammonia can be considered as a mere hydrogen carrier (as recognized by IEA, 2018) due to some advantages over hydrogen as 1) its lower cost per unit of stored energy; its higher volumetric energy density; 2) easier and more widespread production, handling and distribution capacity, and better commercial viability; 4) its liquid phase by compression to 0.9 MPa at ambient temperature; 5) a well-established, reliable infrastructure already exists for both ammonia storage and distribution (including pipeline, rail, road, ship). By considering global efficiency, it will be better to consider NH₃ directly as a fuel combusted in gas turbines, industrial furnaces or internal combustion engines, most likely after partial or complete thermal cracking into nitrogen and hydrogen to balance out its high ignition temperature – a positive safety feature. The limited knowledge of the combustion process (ignition, flame stabilization, combustion propagation, pollutant emissions...) limits for the moment to generate power with high-efficiency and low emission impacts from small to utility-scale power units.

PRISME have done, since 7 years, different studies to consider ammonia as fuel for internal combustion engine, by studying fundamental combustion processes to engine performances. Even if recent results clearly pointed out the possibility to run engine with pure NH₃, a first step is required to heat up the system or to ignite up thanks to ignition promoter as hydrogen and increase the compression ratio in comparison to 'current' spark ignition engine.

This phd thesis is part of a project financed by German consortium to enhance the accuracy of knock modelling not only for ammonia but also for other synthetic fuel candidates (as Hydrogen and Methanol, which all strongly differ in their combustion properties and application range, as the modelling of engine knock as one key limiting factor for peak efficiencies for the use of gasoline-like fuels. Knock modeling has proven to be extremely difficult to predict and has been a challenge for the past decades of engine development.

During the phd, dedicated studies for Ammonia (incl. Hydrogen dosing) using thermodynamic testing on a single cylinder engine with a focus on knocking combustion will carry out. To support kinetic mechanism selection, ignition delay times are measured on a rapid compression machine. This project will feature a documentation of thermodynamic investigations at knock limit for a very broad application range, which itself will provide great insights for SMEs and enable them for validation of their own models based on this data. The models done by the other partners will be calibrated and validated with the experimental data.

The interactions between the different teams involved in the project will be numerous and essential to progress on this important subject. This project will enable a very systematic analysis of the involved processes and will provide baseline data. The long-term goal of this project is to provide the obtained knowledge gain with respect to ammonia combustion for the scientific environment in the form of publications and scientific repositories but also for SME to provide accurate predictive simulations. Aspired publications are intended to provide



auspicious and innovative approaches that would have a multiplier effect on the research and development of novel alternative fuels.

Keywords : e-fuels, combustion, ammonia, auto-ignition, flame speed, SI engine

Education required : Master or Engineering diploma in Fluid mechanics and Energetics, experience or internship on combustion

Skills : enjoy experimental works, Matlab tools

Conditions

Start : October 2022

Duration: 3 years

Location: Orléans with several meeting in Germany

Net Salary: 1800€ / month

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