Master Thesis
Laminar flame speeds for alternative fuels: Calculations

Premixed or partially premixed turbulent combustion processes are widely used in ground transportation (e.g., car engines), aviation (e.g., aero-engine afterburners), and stationary power generation (e.g., gas turbines) worldwide and, in particular, in Sweden (e.g., Volvo Car, SAAB, Volvo Aero, Siemens, etc.). To satisfy stringent requirements for ultra low emission and highly efficient combustion technology and to secure the sustainable growth of the European industry under the conditions of the increasing instability of the oil market, new solutions are strongly needed. In particular, the use of alternative fuels is an important trend of the EU and Swedish energy strategies, aimed at securing the European and Swedish society from increasing economical and ecological risks associated with the usage of conventional hydrocarbons such as oil and natural gas.

To effectively burn alternative fuels and to assess the advantages and disadvantages of using them, the basic combustion characteristics of the fuels, such as the laminar flame speed and ignition delay should be determined. The knowledge of these quantities is also of paramount importance for developing and validating chemical mechanisms of combustion of alternative fuels.

The present project aims mainly at (i) calculating laminar flame speeds of some alternative fuels, e.g. mixtures of CH_4/CO/H_2, gasoline-ethanol blends, etc., and (ii) comparing results with available experimental data.

The following issues should be addressed within the framework of the project:

- What kinds of alternative fuels exist, what advantages/disadvantages are associated with using them?
- What methods of computing laminar flame speeds exist and what modifications of these methods are required to study alternative fuels?
- What kinds of physical data are required for such numerical studies and how can they be generated?
- How can experimental data on the laminar flame speeds be used to validate results of the numerical simulations?

Project description: More specifically,

- A literature survey will be performed to find experimental data on laminar flame speeds of various alternative fuels and fuel blends under various pressures and temperatures.
- Software CHEMKIN-PRO will be learnt.
- Several (e.g. three) advanced chemical mechanisms will be selected.
- These mechanisms will be tested by running CHEMKIN-PRO and using the aforementioned experimental data.
- After selection of the best-in-the-test mechanism, it will be used to compute laminar flame speeds for a wide set of elevated temperatures and pressures by running CHEMKIN-PRO.
- Subsequently, the computed laminar flame speeds will be tabulated or/and approximated.
- Finally, the obtained results will be summarized in a report and will be presented orally at a seminar.

Suitable background: Studying a master program related to thermodynamics, chemistry, internal combustion engines, or fluid mechanics from e.g. mechanical, chemical, or automotive engineering. Interest and knowledge in combustion chemistry and combustion engines is an advantage, but not a prerequisite. We will learn a lot about combustion chemistry and self-ignition during the project.

Thesis level: Master, 20 weeks (30 HP) per student.

Language: English

Starting date: Flexible

Number of students: Two or one.

Miscellaneous: Do not hesitate to contact us if you would like additional information. Please provide covering letter and CV in your application.

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