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Application of FGM to a Marine-Size Constant Volume Chamber

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Introduction

The work presented is part of an European project called **IDEALFUEL** which aims at the production, on large scale, of a new bio-fuel, lignin based, to feed huge marine diesel engines. To reduce the amount of fuel needed, first tests will be performed on a marine-size constant volume chamber, so called Spray Combustion Chamber (SCC), Schmidt et al. [1]. A numerical model will be validated on the SCC to be used as bench test for the upcoming fuel.

Results

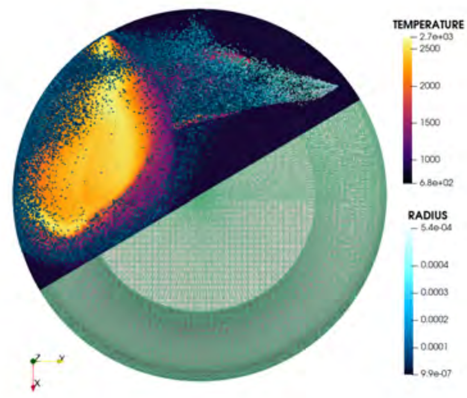

Fig. 1 Spray Combustion Chamber with high temperature threshold development and spray droplets mixing in the domain. Diameter is 500mm, Height (in z) is 36mm.

The domain is shown in Fig. 1. The aim of this study is to compare the results of the FGM (Flamelet Generated Manifold) method to the standard used CTC (Characteristic Time-scale Combustion) model. The injector consists of five nozzle of different diameters, ranging from 725μm to 825μm. Originally, the chemistry of the fuel was taken to be that of n-heptane (C_7H_{16}), currectly n-dodecane ($C_{12}H_{26}$) is used since more relevant data is available for that approach (Engine Combustion Network [2]). The tabulation for FGM is done using the utility provided by the CONVERGE software. The model of Yao et al. [3], a 54-species skeletal mechanism, is used. The control variables are Mixture Fraction (101 levels), Progress Variable (301 levels) and Enthalpy (40 levels), with Variance of Mixture fraction (10 levels) as passive control variable.

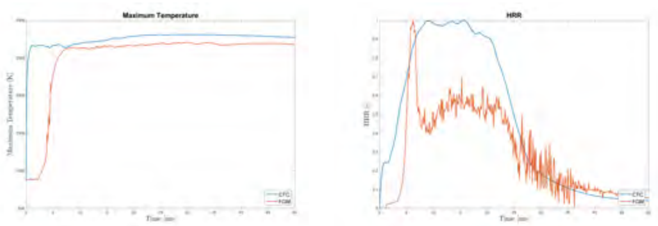

Fig. 2 Temperature (left) and normalized Heat Release Rate (right) temporal evolution of FGM and CTC.

The first results in Fig. 2 show a large difference between the two approaches, mainly due to the large difference in ignition delay (in CTC = 0.10ms, FGM = 3.8ms, considering as a threshold an increase of 400K with respect to the initial chamber temperature of 873K). For that reason the FGM model shows the characteristic pre-mixed peak followed by a mixing controlled phase of the heat release rate. This large difference needs further investigation. The experimental campaign that is currently performed will be used to validate the approach in the near future.

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References

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