CFD with OpenSource software

A course at Chalmers University of Technology
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Study questions and answers for:

Project work:

An FGMFoam tutorial

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Study questions and answers

1. How is flame-turbulence interaction modelled in the EDC combustion model, one of the combustion models available in reactingFoam?

   Answer: The eddy dissipation concept (EDC) combustion model considers that reactions take place in the region where the dissipation of turbulence kinetic energy occurs, hence the name. The mass fraction of these dissipation regions and the average residence time are provided by the energy cascade submodel.

2. How are reaction kinetics incorporated into the solution process of reactingFoam?

   Answer: The species transport equation contains the source term 'reaction->R(Yi)'. $R(Yi)$ is the reaction source term calculated in the combustion model. The progress variable source term *reaction->SourcePV()* is passed from the FGM combustion model as a tabulated value from the look-up table.

3. What is the purpose of tabulated chemistry models?

   Answer: Solving the transport equations for a large number of species can be computationally expensive when investigating detailed chemistry effects in turbulent reacting flows. Instead of solving the species transport equations for a reduced set of species and/or reactions, a tabulated chemistry model can be used to resolve detailed chemistry at lower computational cost.

4. What are the limitations for flamelet-based combustion models?

   Answer: Flamelet models are based on the flamelet assumption for turbulent combustion. The turbulent flame is modelled locally as a laminar flame. At high Karlovitz number, thin flamelets do not accurately represent the highly curved or even broken flame.

5. Which libraries need to be changed in order to successfully compile the combustion model library for the FGMFoam solver?

   Answer: Limited changes of the libraries

   - CompressibleTurbulenceModels and
   - TurbulenceModels

   and minor modifications of

   - ChemistryModel

6. How is the viscosity modelled in the FGMFoam reactive flow solver?

   Answer: The viscosity is tabulated as a function of the scaled progress variable, the mixture fraction, and the variance of these two control parameters. The viscosity of the mixture is therefore based on the transport data file used to calculate the 1D flamelets. During runtime, the viscosity is simply retrieved for the 4D table as a function of the current value of the 4 control variables.