Partially Premixed Combustion - Pre-Analysis & Start-Up

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Pre-Analysis & Start-Up

In this tutorial, you will learn how to set up and solve a turbulent reactive flow - particularly, a partially premixed combustion case, in which there are both premixed and non premixed conditions. You will:

1. Use the probability density function (PDF) method to track the mixture fraction and modeling the chemistry in the system (used for non-premixed, mixing combustion cases).
2. Learn the appropriate inputs and solver techniques using the turbulent Zimont Flame Speed model to close the turbulent quantities, typically used for premixed combustion cases.
3. Analyze the results of the system

The non-premixed combustion model solves transport equations for conserved scalars and mixture fractions. The amounts of chemical species present are derived from the predicted mixture fraction distribution, present in the precomputed PDF tables. These tables are generated by knowing the species that can be present, as well as the inflow conditions and properties of the mixture.

For the premixed combustion component which will be solved at simulation runtime, the Zimont turbulent flame speed model includes the laminar flame speed (which determines the chemistry of the system) and the flame front evolution due to turbulence. The assumption to use this model is that the turbulence lengthscale in the flame is smaller than the flame thickness (Karlovitz number Ka > 1) where

$$Ka = \frac{(u')^{1.5}}{(U_{laminar flame speed})^2}$$

Combining these two models is straightforward. The reaction progress variable c is used to track the location of the flame, called the flame front. Before (to the left of) the flame front at c=0, the mixture is unburnt, and the mass fractions and other variables are computed using mixture the precomputed mixture fraction PDFs. Inside the flame, a combination of the two models is used. In the burnt area (to the right of the flame at c=1), the equilibrium mixture fraction is computed.

This method is typically limited to combustion systems that only contain 2 inflow streams. Using swirl conditions on one of the streams is useful as it promotes mixing of the two streams; reducing problems with flame initialization and extinction.

The turbulence model that will be used is the 2 equation k- model, described in detail in the Turbulent Jet tutorial pre-analysis.

Go to Step 2. Geometry

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