G-CSC Kolloquium

Predicting Complex Turbulent Flames Using Large Eddy Simulation and Flamelet-Based Tabulated Chemistry.

Prof. Dr.-Ing. J. Janicka, TU Darmstadt

Abstract:

Understanding mixing and combustion dynamics has become increasingly important, particularly for achieving high efficiency and low emissions in modern gas turbines and other technical combustion devices. Whenever turbulent non-premixed combustion takes place, the physical processes typically cover a wide range of time and length scales. Main geometrical features of technical flow systems, like swirl generators or bluff-bodies, induce recirculation zones to stabilize the flame and intensify the mixing of fuel and oxidizer. This frequently goes along with large-scale, coherent fluid motion. To capture those instationary motions the large eddy simulation (LES) technique is commonly used and becomes more and more important in industrial applications. It has great potential in predicting these flow properties, due to a direct simulation of large fluid structures while only nonresolved small scales are modeled. A promising approach for simulating such systems relies in progress variable approaches (PVA) where an additional scalar controls the progress of the reaction. Here, the chemistry is parameterized as a function of the mixture fraction and a progress variable.

LES and different flamelet-based combustion models were applied to four bluff body stabilized non-premixed and partially premixed flames selected from the Sydney flame series, based on Masri’s bluff-body test rig (University of Sydney). Three related non-reacting flow cases were also investigated to assess the performance of the LES solver. Both un-swirled and swirled cases were investigated, which exhibit different flow features, such as recirculation, jet precessing and vortex breakdownIt turned out that a reasonable spatial resolution in the vicinity of the flame together with TVD-based discretization and standard presumed probability density modeling is sufficient to capture accurately the complex flame lift mechanisms for reactive flows stabilized by hot gas recirculation.