Dutch Section of the Combustion Institute
WEBINAR 17

Friday June 30, 2022, 13:00-14:00 (CET)
(This webinar has been rescheduled from June 9 to this new date and time)

Turbulent spray combustion at transcritical pressures. Numerical simulation using real-fluid multiphase thermodynamics

By Stefan Hickel, Delft University of Technology

Event link available at:
https://www.linkedin.com/events/turbulentspraycombustionattrans7073786882525917184/comments/

Abstract
Accurate simulations of high-pressure transcritical fuel sprays are essential for the design and optimization of next-generation gas turbines, internal combustion engines, and liquid propellant rocket engines. For these applications, the accurate modelling of complex real-gas effects in high-pressure environments, especially the hybrid subcritical-to-supercritical mode of evaporation during the mixing of fuel and oxidizer, is very important and challenging. In this webinar, we present a novel modeling framework for high-fidelity simulations of reacting and non-reacting transcritical fuel sprays. The high-pressure jet disintegration is modeled using a diffuse interface method with multiphase thermodynamics, which combines multi-component real-fluid volumetric and caloric state equations with vapor-liquid equilibrium calculations. The proposed method represents turbulent fluid flows at supercritical fluid states as well as condensation and evaporation at transcritical multiphase fluid states with very high accuracy and unprecedented computational efficiency without relying on any semi-empirical break-up and evaporation models. Combustion source terms are evaluated using a finite-rate chemistry model, including real-gas effects based on the fugacity of the species in the mixture. The adaptive local de-convolution method (ALDM) is used as a physically consistent turbulence model for large-eddy simulation (LES). LES results are validated by comparison with available experimental data for the reacting and non-reacting Engine Combustion Network (ECN) benchmark Spray A at transcritical operating conditions.

CV
Stefan Hickel is Full Professor of Computational Aerodynamics (since 2015) and Chair of the Section of Aerodynamics at the TU Delft Faculty of Aerospace Engineering. He holds leading positions in the European Research Community on Flow, Turbulence and Combustion (ERCOFTAC); he was chairman of the Scientific Program Committee for six years and is currently treasurer. He is currently also Editor of Computers & Fluids and the CEAS Aeronautical Journal. He has previously served TU Delft as Director of the Graduate School of Aerospace Engineering and on the Board of Directors of the J.M. Burgerscentrum.
He and his students develop models and numerical methods for direct numerical simulations and large eddy simulations with which they perform numerical experiments on a broad range of transitional and turbulent flows at all speeds, such as turbulence and waves in the atmosphere, fluid-structure interactions, interactions of turbulence with shock waves, gas-surface interactions in hypersonic flows, mixing and combustion in trans- and supercritical flows with strong real-gas effects, and the interaction of turbulence with phase change/cavitation in multiphase flows.
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