COMBUSTION WEBINAR

Modeling and Numerical Simulations of Turbulent Multi-Species High-Pressure Flows

Speaker: Josette Bellan, NASA JPL/CalTech

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Biography: Josette Bellan received her PhD from Princeton University and shortly thereafter began doing research at the Jet Propulsion Laboratory (JPL)/Caltech where she has remained her entire career. She has developed accurate numerical simulations of both high-pressure and multi-phase turbulent reactive flows, and has derived reduced chemical kinetic mechanisms of complex fuels. Josette is an AIAA Fellow, an ASME Fellow, a Combustion Institute Fellow and an Amelia Earhart Fellow. She is the recipient of the AIAA Pendray Literature Award and of the JPL Magellan Award. Josette has been twice sponsored by NATO's Research and Technology Agency to lecture at several institutions in Europe. She served for six years as Associate Editor for the AIAA Journal, was for twenty years on the Editorial Board of Atomization and Sprays, and was Deputy Editor of Progress in Energy and Combustion Science for nine years. She has published papers in twenty-two different journals.

Abstract: High-pressure turbulent reactive flows occur in numerous combustion devices. These flows have been experimentally shown to display features unlike those of atmospheric-pressure flows, namely high density-gradient magnitude regions. To reproduce these features, the mathematical models necessary to describe these flows are succinctly reviewed and explained with emphasis on the new aspects compared to atmospheric–pressure flows. Results are presented from Direct Numerical Simulations of turbulent mixing of several chemical species and from Direct Numerical Simulations of turbulent combustion using a simplified reaction model. These results show the existence of the high density-gradient magnitude regions and, additionally, identify uphill – diffusion, which had not been described in this context prior to these studies, although it is well-known in chemical engineering extraction industry. Unlike regular diffusion, uphill diffusion occurs against the gradient and concentrates the species for which it occurs, a fact which impacts turbulent flow aspects. The importance of using the complete diffusion matrix is addressed and emphasized. Further aspects of these turbulent high-pressure studies are briefly discussed.

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