NU Mechanical and Industrial Engineering Colloquium Series – Spring 07

Thursday, February 15, 2007
306 Egan Center
11:15 – 11:30am, Tea, Coffee & Lunch
11:30 – 12:15pm – Lecture (typical)
12:15pm – 12:30pm Q&A and Discussion

Seminar Title

"Case Studies of Combustion and Propulsion Research"

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1. **Sub- to Supercritical Mixing**

Supercritical mixing appears in several practical applications including diesel engines, rocket engines main combustion chambers, etc. The inverse problem of a supercritical fluid injected in subcritical conditions also is present, for example, in a supersonic combustion engine. The advancement of liquid propellant rocket technologies led to significant pressure increase in the combustion chamber and, in many applications, the pressure and temperature largely exceed the critical values of one of the propellants.
A study of liquid injected into a gaseous surrounding under subcritical, transcritical and supercritical conditions is presented here. Significant laminarization of the jet under supercritical conditions was observed. A linear stability analysis is performed to develop a distortion relation for the viscous jet in the inviscid gaseous surrounding. The results indicated that this describes well the subcritical mixing but is less successful at trans and supercritical conditions.

2. **Flameholding in Supersonic Flows**

Flameholding in supersonic flow depends on the local conditions in the recirculation region and the mass transfer into and out of this region. Large gradients in local gas composition and temperature exist in the recirculation region, hence, stability parameter correlations developed for premixed flames cannot be used to determine the blowout stability limits for non-premixed flames encountered in practical devices. In the study described here mixture samples have been extracted at different locations in the recirculation region and the shear layer formed behind a rearward-facing step and analyzed by a mass spectrometer to determine the distribution of species concentration in the region. Both non-reacting flow tests and combustion experiments were performed for a range of fuel related parameters such as injection location, injection pressure and fuel type. The difference between the local fuel mole fraction within the recirculation region determined from mass spectrometry (MS) and the global fuel mole fraction based on the total moles of air and fuel injected was identified. Planar laser induced fluorescence (PLIF) was used in non-reacting cases to provide a 2-d image of fuel distribution and complement the MS measurements.