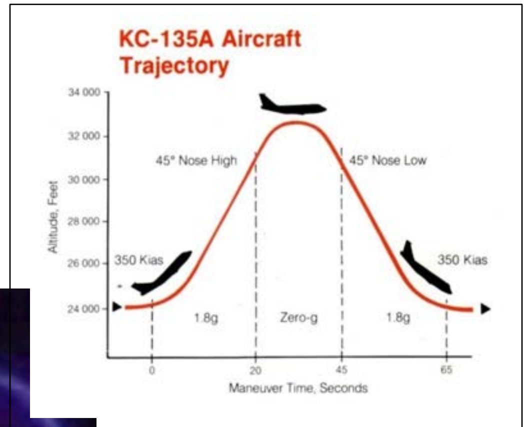

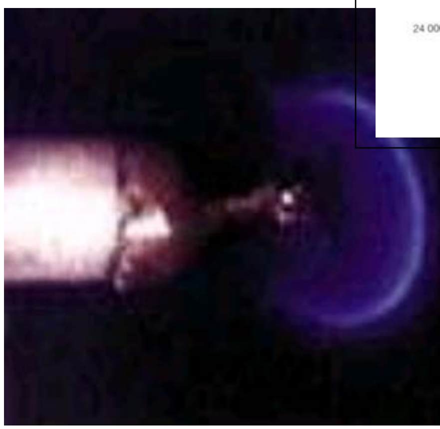

Our primary research interests are in the area of theoretical and experimental combustion, with emphasis on understanding the fundamental interactions between fluid dynamics and finite-rate chemistry. In the applied arena, we are focused on developing highly optimized combined heat and power systems using a range of renewable biofuels. A list of currently and recently funded research projects are described below.

Combustion Research Group

Harsha Chelliah

Professor
harsha@virginia.edu
www.mae.virginia.edu/NewMAE/harsha-k-chelliah/

Dept. of Mechanical & Aerospace Engineering
University of Virginia
Charlottesville, VA
434.924.6037

"Working to increase the efficiency of jet engines while reducing their environmental impact."

University of Virginia Engineering

Development of Reduced Kinetic Models

Elementary reaction pathways that describe the pyrolysis and oxidation hydrocarbon fuels typically consist of 100s of species in over 1000 reaction steps. The objective of this work is to derive systematically developed reduced reaction models for engineering applications based on characteristic physical time scales. In particular, efficient implementation of reduced reaction models in time dependent, multi-dimensional hypersonic reacting flow simulations is the key focus of this work. Reduced reaction models developed to date include hydrogen-air, methane-air, ethylene-air, heptane-air, and JP10-air.

Development and Validation of Soot Kinetic Models

Combustors of mid-to-large size gas-turbine engines operate under high-pressure conditions, ranging from 25-50 atm. While modern gas-turbine engines have significantly reduced the formation of pollutants, very fine soot particles (10-100 nm) can still be formed in these engines. The objective of this project is to collect high-quality soot particle formation and oxidation data under more realistic high-pressure conditions to validate soot kinetic models. The models developed will be implemented and validated in several laboratory scale reacting flow configurations (tube reactors and counterflow flames) and subsequently implemented in simulation of complex multi-dimensional reacting flow simulations.

Combined Heat and Power Using Renewable Biomass

With current energy costs, combined heat and power concept can yield an immediate impact on the energy cost of many industries. The objective of this project is to explore the utilization of renewable fuels derived from biomass in combined heat and power mode. Two Capstone Microturbines have been installed and tested at UVa in grid connected mode.

Fire Suppression by Condense Phase Agents and Search for Alternatives

The goal of this project was to understand the basic physical, thermal and chemical fire suppression mechanism for several gaseous and condensed-phase agents. Both experimental and theoretical/computational methods were employed. Experiments were performed using an enclosed counterflow burner with two opposed fuel and air streams. The condensed-phase fire suppressing agent was introduced with the advantage of this flow field has the ability to accurately simulate the two-phase reacting flow field and identify the rate controlling physical, thermal and chemical effects of fire suppressing agents. With the knowledge gained, effective replacements for the now banned halogenated fire suppressants are being pursued.

Combustion of Porous Graphite and Magnesium Particles under Microgravity

The focus of this project is to develop a detailed model that takes into account the interaction between heterogeneous combustion of a porous char particle with the external homogeneous combustion. The heterogeneous model developed includes the transport and combustion within a porous particle; hence the model can effectively decouple the physical fluid dynamical effects from the intrinsic surface reaction rates. The supporting experiments to validate the model were performed using the NASA Reduced Gravity Aircraft. Simplified models developed based on this comprehensive study can be applied to simulation of porous coal particle combustion on earth as well as combustion of Mg particles in Martian atmospheric conditions.

RECENT RESEARCH DEVELOPMENTS

- Development of reduced-reaction models for high-speed reacting flow simulations, validation of models in collaboration with NIST.
- Development of reduced reaction models for soot formation and oxidation for CFD applications.

RECENT GRANTS

- DOD/Air Force – Merging Hyperspectral Imagery and Multi-Scale Modeling for Laser Lethality
- DOD/Air Force – Center for Hypersonic Combined Cycle Flow Physics
- Rolls Royce – Mechanism of Soot Particle Formation Under High Pressure Conditions

SEAS Research Information
Pamela M. Norris, Associate Dean
University of Virginia
Box 400242
Charlottesville, VA 22903
pamela@virginia.edu
434.243.7683

University of Virginia Engineering