The Department of Mechanical Engineering/College of Engineering and Applied Sciences
Stony Brook University

Mechanical Engineering Seminar

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Lecture Title: Investigation of Nano-Particle Transport in Non-Isothermal Internal Turbulent Flows

Friday, February 10, 2012, 2PM, Room 173 Light Engineering

Abstract

Deposition of nano-particles occurs in many applications; to name a few: gas cleaning, electronic devices packaging, pharmaceutical applications, and heat exchanger industry. Depending on the purpose of the application, particle deposition is desired or unwanted. This presentation shows modeling and experimental approaches to study the physics of nano-particle transport with the aim of preventing/mitigating particle deposition and/or enhancing removal mechanisms. One of the major applications of this study is in IC engine exhaust gas recirculation (EGR) coolers used to reduce intake charge temperature and thus reduce emissions of nitrogen oxides. Exhaust flow passing through the EGR cooler carries submicron soot particles ranging from 10 to a few hundred nanometers with an average diameter of 57 nm. The thermal performance (effectiveness) of the EGR cooler has been shown to significantly degrade with particle deposition generally followed by a stabilization trend (no more degradation) for longer exposure times. This reduction results in higher level of emission from engine. To investigate the initial sharp reduction in cooler effectiveness, Eulerian CFD models are developed to quantify the deposition rate and the overall heat transfer reduction in coolers. The models are validated against experimental data. To address the stabilization trend of cooler effectiveness and particle removal mechanisms, a unique visualization test rig is designed and constructed to track the dynamics of particle deposition and removal in-situ, and a digital microscope records any events. Interesting results are observed for flaking/removal of the deposit layer at various boundary conditions. Despite the good agreement between the models and short exposure experiments, there are observed discrepancies for long exposure data. The discrepancies can be attributed to the assumptions that are made to estimate the deposited layer properties employed into the models as their effects are important. Therefore, further improvements of the models are necessary to address long exposure experiments as well. The outcome of this study can be a potential solution for the auto-industry in order to solve the challenging problem of soot particle deposition in the emission reduction devices.

Biography

Dr. Abarham received his Ph.D. in Mechanical Engineering and M.SE. in Aerospace Engineering in 2011 from the University of Michigan. He also received his M.Sc. in Mechanical Engineering in 2003 from Sharif University of Technology. He is currently a research engineer at Ford Motor Company-Research and Innovation Center.

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