ENERGY GENERATION, STORAGE & CONVERSION

ROYDON FRASER, PH.D.

BACKGROUND

Roydon Fraser is currently an assistant professor of Mechanical & Mechatronics Engineering as well as the associate chair of Undergraduate Studies at the University of Waterloo. He received a bachelor's degree in engineering at Queen's University then obtained his master's degree and doctorate in mechanical and aerospace engineering from Princeton University. Fraser is a member of the Society of Automotive Engineers, the American Society of Mechanical Engineers and the Ontario Society of Professional Engineers, and is a lifetime member of the Sandford Fleming Foundation. He has served on the Ontario Engineering Competition Advisory Board since 1996 and on PEO's Academic Requirements and Discipline committees, both since 1999.

Professor Fraser's main focus of research is in energy analysis of energy conversion systems, and alternative fuels. His work includes characterization of spark ignition engine combustion, the integration and control of alternative fuels powertrains into vehicles, and the application of energy and the second law of thermodynamics to the characterization and optimization complex thermodynamic systems.

Professor Fraser also has an expertise in turbulent combustion and non-intrusive combustion diagnostics as applied to internal combustion engines, in alternative fuel vehicle development with particular emphasis on natural gas, ethanol, hydrogen fuel cells and hybrid vehicles. As such, he has knowledge on Alternative Transportation fuel use and storage, and on the application of fuel cells, with practical demonstration projects.

IMPROVING THE UTILIZATION OF ALTERNATIVE TRANSPORTATION FUELS

Work is done to provide ways to help better analyse the environmental impact of alternative fuel technologies. This work involved five primary projects and currently three primary fuels (natural gas, ethanol, and gasoline).

Project 1: The "craddle-to-grave" life-cycle analysis (LCA) decision making tool has been modified to include economic value in addition to measures of environmental impact. This new tool is termed life-cycle value assessment (LCVA). LCVA is being applied to various production methods for various alternative fuels. Gasoline is the reference case.

Project 2: On a production vehicle converted to dedicated ethanol (E85) emissions, engine power, and other engine control parameters are being monitored. This project will hopefully lead to new engine control strategies specifically designed for dedicated ethanol vehicles. The investigation into various smart cold start strategies is very relevant in Canada.

Project 3: In cooperation with Pohang University, S. Korea, an improved auto ignition model (conditional moment closure method) is being applied to the modelling the auto ignition of natural gas in diesel engines. With the improved auto ignition model a more appropriate global low-temperature kinetics scheme will be sought.

Project 4: In cooperation with National Research Canada (NRC) and Prof. E.J. Weckman, laser-Doppler velocimetry (LDV), planar laser-induced fluorescence (PLIF), laser-induced incandescence (LII), and other advanced diagnostic techniques are being developed for flame structure, reaction kinetics, and soot formation in natural gas combustion.

Project 5: Investigations into the interpretation of LDV in-cylinder velocity measurements continue.

Alternative Fuel Vehicles

From 1997 to 2004 Professor Fraser has supervised the UW Alternative Fuels Team, competing against teams from across North America to three 1st, two 2nd, and two 4th place finishes in propane and ethanol fuels competitions. The team is participating in the EcoCar challenge and Challenge X, partnering with General Motors, the Department of Energy, Hydrogenics Corporation, and received sponsorship from Natural Resources Canada. Currently the only Canadian team invited to participate in Challenge X , the team finished first in the competition of 2005 using its fuel-cell powered design.

Research relating to the Challenge X competition involves automotive power module modeling (hybrid platform), using a 65 kW Hydrogenics fuel cell power module system on a GM equinox and fuel cell system control.

Determination of Local Window Heat Transfer Coefficients

This work seeks to determine local heat transfer coefficients.

Project 1: Model local window surface temperatures to contribute to our ability to improve the validation of window system models by admitting code validation based on thermo-graphic imaging. Accurate surface temperature modeling also permits contributions to the classification of window system condensation resistance.

Project 2: Improve confidence in our ability to model more complex window systems' (e.g., skylights, bay windows, inter-glazing blind systems) thermal performance.

Project 3: It is speculated that local heat transfer coefficient determination may help better characterize laboratories used in the thermal performance rating of windows.