Research Activities on Experimental and Numerical High-Pressure Spray Combustion and Flame Kernel Development in Michigan Tech's Combustion Vessel

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Abstract: In the transportation fuel matrix for the United States biofuels, alternative, and renewable fuels hold a prominent position in the future. Due to concerns of energy independence, national security, and greenhouse gas emissions, and resource depletion, several novel engine technologies are being evaluated to reduce emissions and reduce fuel consumption. Of these technologies, low temperature combustion engines offer significant promise with extremely high efficiency along with concurrent low-emissions.

The talk will cover the current research activities at the Alternative Fuels Combustion Laboratory (AFCL) in Michigan Tech. The AFCL houses the optically accessible combustion vessel (CV) which has been successfully operating since 2009. The main objective of utilizing the facility (P_{max} = 350 bar and T_{max} = 2000 K) is to characterize combustion processes representative of advanced engine operating conditions. This unique CV facility is used to study for high-pressure spray dynamics of biofuels, and alternative fuels, spark ignition engine fundamentals, emissions/soot formation, and develop necessary laser diagnostics to characterize fundamental spray and combustion processes.

The talk will present recent results from high-pressure diesel spray combustion including split injection and spray modeling, flame kernel development by spark ignition under turbulence including simulation, recent development of non-intrusive diagnostic techniques along with relevant images. In addition, we will discuss on-going project of di-methyl ether (DME) combustion supported by the NSF-DOE and new project of spray impingement on the wall interaction supported by the DOE program. Finally, we will discuss the potential cooperative research between the Istituto Motori and Michigan Tech including the experimental and numerical simulation program development, characterization of spray impingement, and advanced optical diagnostics for mutual benefits.