



Project Proposal for Ph.D.

Project Details	
Project Title	Development of cost-effective optical techniques to measure soot and temperature to assist surrogate development of sustainable fuels
Project Summary (Minimum 500 and maximum 2000 characters)	As the world moves towards sustainable fuels, there is a need to understand the combustion properties along with emission propensity of these new and upcoming fuels from a fundamental perspective. Although non-intrusive techniques exist to provide a detailed assessment of temperatures, species and soot concentration measurements in flames for fundamental and applied configurations ranging from flat premixed, coflow diffusion flames to practical combustors, these techniques often require expensive laser diagnostics. Recent studies have shown that a quantitative assessment of canonical laminar flame configurations can be obtained using some cost-effective optical techniques based on colour ratio pyrometry performed using consumer grade cameras. The proposed study involves the development of such a technique for the assessment of combustion and soot formation characteristics in some canonical flame configurations like flat premixed flames and coflow diffusion flames. The research would also try to extend this to turbulent non-premixed flames. Such experimental setups for said flame configurations already exist or are under development in the I C engine laboratory at IIT Delhi. The intent is to be able to quantitatively assess the soot volume fraction and temperature fields for certain hydrocarbons which are potential candidates for surrogate creation of sustainable aviation fuels (SAF). Recent studies have shown the difficulty in creating surrogates for said fuels due to the presence of a wide variety of alkanes, alkenes, cycloalkane and aromatics in SAF. The experiments would be complemented by simulations of detailed chemical kinetics and statistical soot models, coupled with computational fluid dynamics using inhouse and opensource codes. This exercise is expected to help create better surrogates representing the combustion and sooting properties of sustainable fuels. The PhD research in this project will mainly focus on the development of optical techniques, calibration and validation of temperature and soot measurements with well-known flames from literature for standard fuels like ethylene. This would be continued with measurements on potential surrogate candidates. The work would be predominantly experimental, but the PhD student would also be working on complementary simulations. The interdisciplinary aspect is due to the use of thermo-fluids and combustion knowledge (Mechanical Engineering) for creation of such flames, and the indigenous development of optical diagnostics (Sensors and Instrumentation) for aforementioned flames.

Ph.D. Supervisors			
Role	Name of Faculty	Academic Unit in IITD/Institute/University	Email ID (Official)
Supervisor 1	Pavan Prakash Duvvuri	Mechanical Engineering	duvvuripp@iitd.ac.in
Supervisor 2	Manish Singh	SeNSE	kmanish@iitd.ac.in

Project requirements (Student qualifications, experience required, etc) *The candidate will be shortlisted based on common shortlisting criteria decided by ScRC (SIRe)
- A good understanding of fundamentals of optics, thermodynamics, heat transfer is preferable. - Knowledge of chemical kinetics and numerical modeling desirable but not mandatory

Source of fellowship/funding (CSIR/UGC/DBT/ICMR/ICAR/NEET-PG/DST-INSPIRE/IRD/FITT Project details, if any)

Role of Faculty Members involved:	
Supervisor-1	Guidance for design, development and calibration of optical diagnostic system for color ratio pyrometry to measure temperature and soot
Supervisor-2	Guidance for design and development of experimental setup of coflow flames, design of experiments
Supervisor-3	Guidance for numerical modeling of detailed chemical kinetics, statistical soot models coupled with computational fluid dynamics for the flame configuration. Surrogate creation for sustainable aviation fuels.