



Project Proposal for Ph.D.

Project Details (The research problem must clearly indicate the need for an interdisciplinary approach)

Project Title	Experimental and numerical Study of Soot Formation in syngas from solid-Fuel Gasification
Project Summary (Minimum 500 and maximum 2000 characters)	Gasification converts biomass, coal, and their blends into syngas, a flexible feedstock for power, hydrogen, and chemicals. How well a gasifier performs depends on its temperature field, how the fuel breaks down, and how much of the carbon ends up in the syngas rather than in tar. Although syngas has been used over many decades in burners/combustion devices, most of the modeling focuses on a predefined mixture of CO+H₂ whereas the syngas obtained from a practical gasifier contains many heavier hydrocarbons and aromatics (including tar) which serve as the precursors for soot formation. Both tar from the gasifier and soot formation in syngas flames are not yet fully understood. There is a need for their reduction as they lower carbon conversion, foul downstream equipment, and alters the temperature field through radiation. A step towards this is gaining a predictive capability from numerical modeling of these phenomena. This project proposes experimental and numerical studies on a realistic gasifier and burner configuration and the process of gasification and soot produced during the flame generated from the syngas produced by it. The student will run experiments an existing laboratory-scale downdraft gasifier in the Department of Mechanical Engineering under controlled conditions (fuel type, equivalence ratio, steam-to-oxygen ratio) and measure temperature profiles, major syngas species (H₂, CO, CO₂, CH₄), tar using gas chromatography. This will be complemented by simplified one-dimensional reactor network models using detailed chemistry. In parallel, the student will also work on developing a laboratory scale burner and soot measurement (through light extinction) for the syngas produced from the gasifier. The data generated from this will be used to build CFD models for soot modeling in turbulent combustion to study syngas flames.

Ph.D. Supervisors* (Supervisor 1 and Supervisor 2 cannot be from the same department of IITD)				
Role	Name of Faculty	Date of Superannuation [§] (DD/MM/YYYY)	Academic Unit in IITD/Institute/University	Email ID (Official) & Contact Number
Supervisor 1*	Sujeet Yadav	31-07-2057	Department of Energy Science and Engineering	syadav@iitd.ac.in
Supervisor 2	Pavan Prakash Duvvuri	07-08-2053	Department of Mechanical Engineering	duvvuripp@iitd.ac.in

*Supervisor 1 must be from IIT, Delhi.

+All cells in this table are mandatory fields that need to be filled by faculty for consideration of proposal.

§The date of superannuation of supervisors should be at least three years from the date of registration of selected candidates.

Project requirements (Student qualifications, experience required, etc)
*The candidate will be shortlisted based on common shortlisting criteria decided by ScRC (SIRe)

- Qualifications:** B.Tech./M.Tech. in Mechanical Engineering, Energy Engineering, Chemical Engineering, or related disciplines.
- Skills desired:** Basic understanding of Thermodynamics, heat transfer, fluid mechanics, and numerical modeling

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

Institute fellowship (MoE). DRC approvals of both parent departments (DESE and ME) will be provided at the time of selection.

Role of Faculty Members involved:	
Supervisor-1	CFD of reacting flows; development and validation of the gasifier CFD model; detailed soot modeling
Supervisor-2	Design and operation of the lab-scale test gasifier; measurement of temperature, syngas composition, tar and soot; reaction kinetics, soot modeling

Note :-

1. Approval from the respective DRC/CRC/ScRC of your Department/Centre/School will be required for using the "Full-time Institute Assistantship (Category-wise) (FIA)" for selecting the students in SRe.
2. Declaration:- Faculty members, please ensure that you have at least 3 years of service left before superannuation along with adequate sitting space & lab facilities for the SRe student.
3. PI/s are also encouraged to submit joint proposals with AIIMS, NII, JNU and institutes with which IITD has an existing MoU. If the Co-PI (Supervisor 2) is from outside IITD, kindly share his/her detailed CV.
4. If a research scholar is to be considered for selection under the project fellowship, then the project should have a minimum of two-year duration remaining.
5. A candidate applying with a valid JRF/INSPIRE/any national level fellowship should have at least two-year validity from the date of joining the Ph.D. program.
6. The third supervisor’s name (if required) can be added only after the formation of Student Research Committee (SRC) subject to a strong recommendation of SRC and subsequent approval from the competent authority.
7. If institute fellowship is being sought then the DRC approval of the parent departments of both supervisors is required at the time of selection.