



Project Proposal for Ph. D.

Project Details	
Project Title	Design and Demonstration of Clean Combustion for Jaggery Production and Impact of Pollutants on Environment and Climate
Project Summary	More than 600 million tons of biomass is generated in India every year, out of which around 130 million tons including stubbles are burnt in the open field after crop harvesting. This is energy equivalent to 40 million tons of gasoline and has a very strong possibility of generating clean and green energy with the right combustion equipment after converting the waste biomass into a processed (pellets) fuel. Also due to increasing usage of mechanized harvesting, the wastes of crop residues is increasing annually which requires time to clean the field, while the farmer are busy to prepare for the next crop. As a result, the stubble and crop residues are burnt in the opened field creating huge environmental and health hazardous in the entire northern region of the country. However, this waste can be converted into wealth by utilizing it for clean and green energy generation for rural industries like Jaggery & Khandsari plants and other small-scale enterprises which also pollute the environment. The proposed project would address these issues by constructing a clean and efficient furnace that will use processed (biomass pellets) fuel on par with the LPG burner. Some impediments have already been identified, and a breakthrough in the shape of a miniature clean combustion device has been demonstrated at IIT Delhi at different occasions including the outreach program at Sonapat Campus in August, 2022. It has received compliments and appreciations from visitors including school students and invited speakers. Some visitors are seeking for scalable and feasible field demonstrations with respect to the existing traditional medium scale rural industry, namely the traditional jaggery and khandsari plants. Apart from the clean jaggery production, there are other environmental issues with traditional jaggery production which releases the product of incomplete combustion in the form of air pollutants. These pollutants are heterogeneous mixture of fines and ultra-fines and are responsible for various disorders in humans as well as in plants. However, there is no study which quantifies the impact of air pollutants on the environment and severity with respect to the type, size, source, and levels of pollutants and vice-versa. Therefore, the student will be responsible for performing the following activities: ➤ Measurements of fine and ultra-fine particulate matter from different jaggery and Khandsari plants in the western Uttar Pradesh with varying fuel i.e. bagasse, agro-wastes, agro-processing wastes, etc. ➤ Complete heat and mass transfer analysis of existing jaggery and khandsari plants and their thermal performance. ➤ Design, simulation and possible interventions for clean combustion in jaggery and khandsari plants and their comparative performance analysis with respect to the existing traditional plants.

	➤ Field demonstration of modified clean combustion furnace/burner and its social and economical impact in the rural sector. ➤ Chemical analysis of fine and ultrafine particulate matters and its potential impact on human health. Since this project requires a detailed understanding of the physical, chemical and thermal aspects of solid fuels, the impacts of particulate matter on human health and the environment including the carbon saving potentials under CDM, this project's scope is inherently interdisciplinary. The student's admittance suits the core nature of the SIRE.
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PhD Supervisors

Role	Faculty	Academic Unit in IITD/Institute/University	Email ID
Supervisor 1	Prof. S. K. Tyagi	Energy Science and Engineering, IITD	tyagisk@iitd.ac.in
Supervisor 2	Prof. K. K. Agrawal	Mechanical Engineering, IITD	kkant@iitd.ac.in

Project requirements (Student publications, experience required, etc)

Qualification:

B Tech Chemical Engineering/Mechanical or related discipline (1st division)

M Tech in Mechanical Engineering or related discipline from reputed Institutes (1st division)

Experience required (Mandatory skills)

1. Experience in Thermal Analysis of Jaggery/Khandsari Plants
2. Prior experience in collecting the data from the field for thermal performance
3. Handling the data and preparation of manuscript for publication
4. Having prior experience of publication in referred Journals

Source of funding (IRD/FITT Project details, if any)

Institute funding

Role of Faculty Members involved:

Supervisor-1: S. K. Tyagi – Evaluation of fine and ultra-fine particulate matter ($\leq$ PM_{2.5}) from Jaggery/Khandsari plants with varying fuel and their impacts on environment and climate, fuel savings and potential for carbon credits under clean development mechanics (CDM), etc.

Supervisor-2: K. K. Agrawal – Design and simulation for underground furnace and its thermal performance and combustion characteristics, heat and mass transfer analysis, etc.

Supervisor-3: K. K. Dubey – Chemical analysis of fine and ultrafine particulate matter and its potential impact on human health.