

An Indian-Australian research partnership

Project Title:

Project Number

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IITB Department:

Research Academy Themes:

Highlight which of the Academy's Theme(s) this project will address?

(Feel free to nominate more than one. For more information, see www.iitbmonash.org)

3. Clean Energy

The research problem

Low-rank coals represent almost 30% of the world's coal reserves, and contribute significantly to power generation in several countries, such as India, Bulgaria, China, Poland and South Africa. Current power generation processes based on conventional pulverised coal combustion result in low efficiency and high CO₂ emissions when used with low-rank coals of high ash or moderate ash contents. A more efficient way to utilise these coals is to gasify them first into combustible fuel gases and then use the gases for production of chemicals, liquid fuels or power generation. Among the three major gasification technologies – entrained flow gasification, fixed bed gasification and fluidized bed gasification - the last two are problematic for use with even moderate ash coals, which have not been explored for entrained flow gasification. Information on the gasification characteristics of (eg. extent of conversion of coal into fuel gas, gas composition, pollutant formation, and how these are affected by fouling/slugging problems due to high levels of ash) low-rank coals are non-existent. Such information is essential for the development of the gasification-based technologies using these coals. At the same time, co-use of biomass with these coals is one way to mitigate the ash-related problems during gasification. Again information on co-gasification of biomass and moderate to high-ash coal is non-existent. With the information generated on fuel gas quality and gaseous pollutants, strategies for catalytic synthesis of chemicals and/or liquid fuels can be devised. For India, which has over 50 billion tonne of low-rank coal and produces almost 400 million tonne of ligno-cellulosic biomass, there is a large potential for efficient utilization of these resources through gasification. This project will address this problem.

Project aims

Define the aims of the project

The project will involve experimental work on gasification of coal/biomass/coal-biomass mix, analysis including electron microscopy and mathematical modelling. By generating fundamental information, the project will serve two major aims: advance the understanding of gasification characteristics of low-rank coals and coal-biomass mix, and development of the gasification-based technologies using these lignites for power generation or chemicals/liquid fuels production.

Expected outcomes

Highlight the expected outcomes of the project

Major outcomes will include a comprehensive set of information useful for technology developers, and detailed scientific mechanistic insight into biomass-coal gasification. These include:

- Optimized process conditions to maximize the yield of combustible gases
- Composition of the combustible gas, unconverted char and pollutants over a range of process conditions and coal/biomass quality
- Quality of two target chemicals following catalytic synthesis of the fuel gas from gasification
- Development of a mathematical model for an entrained flow gasifier
- Development of a process model combining gasification with catalytic synthesis

Details will be available in consultation with industry collaborator.

How will the project address the Goals of the above Themes?

Describe how the project will address the goals of one or more of the 6 Themes listed above.

High efficiency is a pre-requisite to reduction of coal consumption and CO₂ emission from any coal conversion process. This project addresses the issue of cleaner utilization of two large resources in several emerging economies – low-rank coals and biomass – through gasification. It is also expected that the project will result in persons trained in the fundamental and practical aspects of gasification, and catalysis. Shortage of such trained manpower is felt by the gradually expanding gasification industries in several countries.

Capabilities and Degrees Required

List the ideal set of capabilities that a student should have for this project. Feel free to be as specific or as general as you like. These capabilities will be input into the online application form and students who opt for this project will be required to show that they can demonstrate these capabilities.

This project will have the opportunity to train at least two students – one on gasification and another one on catalytic synthesis of fuel gas to chemicals. The students are expected to have degree in any of the following disciplines - Chemical Engineering or Chemistry or Environmental Engineering. Also some experience with modelling is desirable. Any junior employee (s) with the above qualification of potential collaborating organization can also be considered.

Potential Collaborators

Please visit the IITB website www.iitb.ac.in OR Monash Website www.monash.edu to highlight some potential collaborators that would be best suited for the area of research you are intending to float.

National Metallurgical Laboratory-Jamshedpur, BHEL, NTPC, Thermax, JSW

Please provide a few key words relating to this project to make it easier for the students to apply.

Biomass, coal, gasification, catalysis, chemicals