

An Indian-Australian research partnership

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| <b>Project Title:</b>                                  | Direct aromatization of methane - theoretical and experimental studies   |                  |
| <b>Project Number</b>                                  | IMURA0890  |                  |
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**Research Clusters:**
**Research Themes:**

| <b>Highlight which of the Academy's CLUSTERS this project will address?</b><br>(Please nominate JUST <u>one</u> . For more information, see <a href="http://www.iitbmonash.org">www.iitbmonash.org</a> ) |   | <b>Highlight which of the Academy's Theme(s) this project will address?</b><br>(Feel free to nominate more than one. For more information, see <a href="http://www.iitbmonash.org">www.iitbmonash.org</a> ) |  |
|--|---|---|--|
| 1  | Material Science/Engineering (including Nano, Metallurgy)                 | 1   | Advanced computational engineering, simulation and manufacture |
| 2  | Energy, Green Chem, Chemistry, Catalysis, Reaction Eng                    | 2   | Infrastructure Engineering                                     |
| 3  | Math, CFD, Modelling, Manufacturing                                       | 3   | Clean Energy   |
| 4  | CSE, IT, Optimisation, Data, Sensors, Systems, Signal Processing, Control | 4   | Water  |
| 5  | Earth Sciences and Civil Engineering (Geo, Water, Climate)                | 5   | Nanotechnology   |
| 6  | Bio, Stem Cells, Bio Chem, Pharma, Food                                   | 6   | Biotechnology and Stem Cell Research                           |
| 7  | Semi-Conductors, Optics, Photonics, Networks, Telecomm, Power Eng         | 7   | Humanities and social sciences                                 |

|   |                         |   |        |
|---|-------------------------|---|--------|
| 8 | HSS, Design, Management | 8 | Design |
|---|-------------------------|---|--------|

## The research problem

*Define the problem*

Enormous amounts of natural gas are flared every year, causing a loss of potential hydrocarbon resources and emitting hundreds of million tons of CO<sub>2</sub> in the earth's atmosphere. If this methane were to be captured and converted into a useful liquid fuel this would be a beneficial product and also help to reduce CO<sub>2</sub> emissions associated with natural gas processing.

It is known that Mo/ZSM-5 is an effective catalyst for converting methane to aromatic products – but, unfortunately, this catalyst also deactivates readily due to coke formation. The process needs to be developed further with a view to reducing coke formation at the same time as improving reaction kinetics and maximising aromatic products, especially monoaromatics such as benzene, and alkylaromatics which are useful as fuel additives and/or as chemical precursors.

## Project aims

*Define the aims of the project*

The broad objective would be to understand the mechanism of catalyst activation and deactivation, so as to be able to determine the optimal operating window for the reaction in terms of temperature, GHSV, duration of cycles of activation, reaction, reactivation etc.

## Expected outcomes

*Highlight the expected outcomes of the project including likelihood of patents*

- a) Methodologies will be optimized and scope will be evaluated
- b) Results will be published in peer-reviewed journals.
- c) Effective catalysts may be patented following the guidelines.
- d) Application of catalyst in industrial and academic settings.
- e) Further evaluation of existing methodology in the context of our findings.

## 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.*

Enormous amounts of natural gas are flared every year, causing a loss of potential hydrocarbon resources and emitting hundreds of million tons of CO<sub>2</sub> in the earth's atmosphere. If this methane were to be captured and converted into a useful liquid fuel this would be a beneficial product and also help to reduce CO<sub>2</sub> emissions associated with natural gas processing. This project will help develop technologies for conversion of methane to aromatic products.

## Capabilities and Degrees Required

*List the ideal set of capabilities that a student should have for this project. 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.*

M. Sc. (Chemistry) or M. Tech. (Chemical Engineering)

Select up to **(4)** keywords from the Academy's approved keyword list (**available at <http://www.iitbmonash.org/becoming-a-research-supervisor/>**) relating to this project to make it easier for the students to apply.

Energy, Energy Storage, Energy Materials  
Water, climate change (Carbon Capture and Sequestration)  
Waste to Wealth  
Green Chemistry and Renewable Energy  
Computational and Theoretical Chemistry  
Modelling and Simulation