IITB-Monash Research Academy

Indian Institute of Technology Bombay | MONASH University

An Indian-Australian research partnership

Project Title:	On the joint investigation of flow and thermal fields during vortex induced heat transfer enhancement	
Project Number	**IMURA0959**	
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Research Clusters:

Highlight which of the Academy's CLUSTERS this project will address? *(Please nominate JUST **one**. For more information, see www.iitbmonash.org)*	
1√	*Material Science/Engineering (including Nano, Metallurgy)*
2	*Energy, Green Chem, Chemistry, Catalysis, Reaction Eng*
3	*Math, CFD, Modelling, Manufacturing*
4	*CSE, IT, Optimisation, Data, Sensors, Systems, Signal Processing, Control*
5	*Earth Sciences and Civil Engineering (Geo, Water, Climate)*
6	*Bio, Stem Cells, Bio Chem, Pharma, Food*
7	*Semi-Conductors, Optics, Photonics, Networks, Telecomm, Power Eng*
8	*HSS, Design, Management*

Research 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)*	
1√	*Advanced computational engineering, simulation and manufacture*
2	*Infrastructure Engineering*
3	*Clean Energy*
4	*Water*
5	*Nanotechnology*
6	*Biotechnology and Stem Cell Research*
7	*Humanities and social sciences*
8	Design

The research problem

Define the problem

Importance of high heat flux management systems has been realized in a wide range of applications including efficient energy converters, heat exchangers, electronic equipment, aircraft pumps etc. Of the possible options available, passive modes of heat transfer enhancement have found considerable attention for such applications. In this direction, heat transfer augmentation through vortex-induced disruptions of otherwise stratified thermal boundary layer has been found to be one of the effective approaches. Periodic interaction of wake vortices with the boundary layer formed in the vicinity of the thermally active surfaces leads to significant enhancement in heat transfer rates. For optimizing the performance of such systems, a detailed understanding of flow and thermal fields from a fundamental point of view is important. With this background, the present project is concerned with the joint investigation of flow and transported properties (temperature field) during vortex-induced heat transfer enhancement in the context of internal flows. Both experiments as well as numerical simulations are proposed. As one of the definite advancements over the existing literature, simultaneous measurements of the flow velocity and temperature fields using thermographic-PIV technique would be made. Dependence of heat transfer characteristics (for instance, thermal boundary layer profiles, Nusselt number etc.) on flow features (vortex shedding frequency etc.) would be investigated through experiments and numerical simulations.

Keywords: Heat transfer enhancement; Vortex induced wake instabilities; Boundary layer disruptions; Internal flows; Coupled flow and heat transfer measurements; Thermographic-PIV

Project aims

Define the aims of the project

The project proposal is aimed towards:

Investigating passive methods-based cooling solutions for high heat flux systems, for instance efficient energy converters, heat exchangers, electronic equipment, aircraft pumps etc. In this direction, joint flow and thermal (temperature) measurements would be made to understand the phenomena of vortex-induced heat transfer enhancement in the context of internal flows. Vortex-induced periodic disruptions of boundary layer would be quantified to determine the temporal and spatial distribution of flow features and heat transfer rates. Optimization of process parameters (range of vortex generators, Reynolds number, Stouhal number etc.) would be based on the detailed experimental as well as numerical investigation of flow and transported properties. As a definite advancement over the conventional approaches, the whole field experimental measurements would be made in a complete non-intrusive manner using Thermographic-PIV technique.

Expected outcomes

Highlight the expected outcomes of the project

1) Passive cooling solutions for managing high heat flux applications.
2) Whole field measurements of coupled flow and thermal characteristics in the context of internal flows.
3) Fundamental understanding of the phenomena of vortex-induced heat transfer enhancement.
4) Optimized set of process parameters.
5) Real time experimental data recorded in a complete non-intrusive manner for benchmarking of numerical models.

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.

Successful completion of the project objectives would lead to effectives solutions for the management of high heat flux systems based on the concept of passive heat transfer enhancement principles. Outcomes of the project have direct applications in areas ranging from efficient energy converters, heat exchangers, electronic equipment to aircraft pumps.

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.

The potential PhD candidate is expected to have the following capabilities:

1) Fundamental understanding of fluid mechanics and heat transfer concepts.
2) Capability to plan and design experiments.
3) Candidates with prior experience on non-intrusive optical measurement techniques (for instance, PIV, interferometry etc.) would be preferred.
4) Exposure to numerical modelling.
5) Basics of computational methods (discretization schemes etc.).

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.