

Pabitra Badhuk

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PRESENT POSITION

July 2024 - now Assistant Professor, IIT Kharagpur, Dept. of Mechanical Engineering
My research focuses on mitigating the environmental impact of the aviation sector as well as ensuring safe operation of novel propulsion/battery technologies. I am currently studying vortex breakdown phenomenon in swirl stabilized combustors, flashback phenomenon in Hydrogen combustors, and risk mitigation strategies associated with hydrogen detonation using chemically active flame inhibitors.

PREVIOUS POSITIONS

2023-2024 Lead Engineer, **GE Aerospace**, Bengaluru
Developing lean-burn micromixer designs operating with 100% H₂ through CFD.
Developed semi-automated process for end-to-end CFD: Design to post-processing.
Expertise gained in ANSYS Fluent, Siemens NX, Spaceclaim, Enight, Tecplot
Filed 4 patents around improvement of the mixing technology between fuel and air.

2022-2023 Engineer, **GE Aerospace**, Bengaluru
Developed rich-burn combustor architecture for engine support to Airbus ZEROe program.
Filed 6 patents around technologies for containment of H₂ flame to improve hardware durability.

2015-2016 Officer, **Bharat Petroleum Corporation Limited (BPCL)**, Mumbai
Responsible for smooth operation of machine shop at BPCL Mumbai refinery, managed 40+ people.
Oversaw overhauling of pumps, turbines, heat exchangers, and safety valves.

EDUCATION

2016-2022 **Indian Institute of Science**, Bengaluru, Karnataka
PhD, Mechanical Engineering, CGPA: 9.3/10
Thesis advisor: Prof. RV Ravikrishna
Thesis title: Experimental and Numerical Studies on Chemically Active Flame Inhibitors

2011-2015 **Jadavpur University**, Kolkata, West Bengal
B.E., Mechanical Engineering, CGPA: 9.29/10
Graduated with first class honours.
Final year project on numerical modelling of a fixed displacement vane pump.

GRANTED PATENTS

Disclosure title	Sponsoring agency	Year	Link
4. Gas turbine engine combustor with dilution passages	GE Aerospace	2024	link
3. Gas turbine engine combustor with a set of dilution passages	GE Aerospace	2024	link
2. Gas turbine engine combustor with a set of dilution passages	GE Aerospace	2024	link
1. Gas turbine engine combustor with openings	GE Aerospace	2024	link

INDUSTRY PROJECTS

Development of lean-burn 100% H₂ Combustor for aviation (GE Aerospace) **2023-Present**

- Conceptualized and evaluated 30+ pre-mixer designs. The challenge of pre-mixer design is how to ensure mixing without incurring excessive pressure loss, while at the same time abate risks associated with flame flashback and autoignition.
- The proposed design abates flashback by ensuring sufficient velocity at mixer exit. Autoignition risk is abated by ensuring a small residence time of fuel inside the pre-mixer. Pressure loss in the pre-mixer has been kept to acceptable levels (about 4%).
- Multiple novel pre-mixer designs have been proposed that improve the state-of-the-art mixing technology. 4 patents have been filed around these, whereas multiple others are in process.

- Conceptualized and evaluated 50+ combustor designs through CFD to identify optimal design parameters suitable for hydrogen combustion in aviation applications.
- Conducted 0D and 1D reactor analysis to understand flame speed, ignition delay, and extinction strain rate characteristics of pure hydrogen and blends.
- Proposed novel methods to control the shape of H₂ flame. The work has led to the filing of 6 patents.

Evaluation of the EDC-PSR model for H₂ applications (GE Aerospace)**Jul-Dec, 2022**

- Identified that the species transport with EDC overpredicts flame length, whereas flamelet-based models underpredict flame length compared to experimental measurements.
- Conducted parametric study by tweaking the modeling constants for EDC and observed that these constants have minimal effect on flame length, whereas the influence of underlying turbulence model is more significant.

JOURNAL PUBLICATIONS

8. **Badhuk, P.**, Verma, N., Ravikrishna R.V. (2024), 'Optimizing Chemical Reaction Mechanisms: Evaluating Parameter-Free Metaheuristic Algorithms and Gradient-Based Optimization' **Combustion Science and Technology**. ([link](#))
7. Dolai A., **Badhuk P.**, Ravikrishna R. V. (2023), 'Effect of Swirl on the Combustion & Emission Characteristics in an Ultralow Emission 20-kW Two-stage Combustor' **Fuel** 340, 127497. ([link](#))
6. **Badhuk P.**, Ravikrishna, R. V. (2022), 'Development and Validation of Skeletal/Global Mechanisms Describing TMP-based Flame Inhibition' – **Combustion Theory and Modelling** 26 (5), 968-987. ([link](#))
5. **Badhuk, P.**, Ravikrishna, R.V. (2022), 'Flame Inhibition by Aqueous Solution of Alkali Salts in Methane and LPG Laminar Diffusion Flames.' **Fire Safety Journal** 130, 103586. ([link](#))
4. **Badhuk, P.**, Ravikrishna, R.V. (2022), 'A Study on the Extinction Condition in Counterflow Diffusion Flames of Methane and LPG Under the Influence of Polydisperse Water Mist.' **Fuel** 318, 123620. ([link](#))
3. Dolai A., Pramanik S., **Badhuk P.**, Ravikrishna, R. V. (2022), 'Nonlinear Dynamic Analysis of the Transition from MILD Regime to Thermoacoustic Instability in a Reverse Flow Combustor' **Combustion Science and Technology**. ([link](#))
2. **Badhuk, P.**, Ravikrishna, R. V. (2021), 'A Numerical Study on the Response of Chemically Active Flame Inhibitors to Strain Rate Variations', **Proceedings of the Combustion Institute** 38 (3), 4615-4623. ([link](#))
1. Sahu, A. B. Markandeya, S., **Badhuk, P.**, Ravikrishna, R. V. (2020), 'Experiments and Kinetic Modeling of Diffusion Flame Extinction of 2-Methylfuran, 2,5-Dimethylfuran, and Binary Mixtures with Isooctane', **Energy Fuels** 34 (2), 2293-2303. ([link](#))

FELLOWSHIPS & AWARDS

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|---------|---|
| 2024 | Received prestigious Young Engineer Award 2024 given by GE Aerospace in the Engineering Recognition Day event. |
| 2023 | Awarded by GE Aerospace for showing leadership behaviour under categories ' Lead with transparency ' and ' Deliver with focus '. |
| 2023 | Recipient of the First Time Inventor award for filing the first patent while at GE Aerospace. |
| 2016-21 | Recipient of the PhD fellowship sponsored by the Ministry of Human Resources Dept. (MHRD), Govt. of India. |
| 2020 | Won first prize and the people's choice award in the Three Minute Video (TMV) competition. Communicated the essence of thesis work to general audience. (link) |
| 2019 | Received the Young Investigator Award – India Section presented by 2019 ASPACC (Asia- Pacific Conference on Combustion). |

TECHNICAL SKILLS**Programming** – Matlab, Python, Bash, Scheme**CFD** – ANSYS Fluent, Converge CFD, OpenFOAM**Chemical Kinetics** – ANSYS Chemkin, Cantera**CAD** – Unigraphics NX, ANSYS Spaceclaim, Solidworks, Ansys Design Modeler**Experiments** – High-speed imaging, Shadowgraphy, PIV, PLIF, Rayleigh thermometry, Hot wire anemometry