

Executive Summary



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1. Title of the project: Design, Development, Testing and Commercialization of Porous Radiant Burners for Domestic Cooking and Industrial Applications.

2. Date awarded and tenure: 1st Oct 2022, 3 yrs.

3. Proposed aims and Objectives

- Design and fabrication of 200 units of LPG cooking stoves with PRB at various capacities having 30-40 % fuel saving and 80 % reduction in CO emissions.
- Organization of technical cum product demonstration workshops in various parts of India for the market penetration.
- Organizing user feedback survey and fine – tuning of the product specifications.
- Large – scale market penetration of PRB based products (around 1000 units at the completion of the project) in collaboration with professional bodies and industrial partner.
- Techno-economic and life cycle assessments of the developed products.

4. Significant Achievements

- Fabricated and successfully installed several LPG/CNG operated PRB of 5-7 kW, 8-12 kW, 12-24 kW and 20-35 kW for cooking and industrial applications. Real time kitchen performance tests have been conducted over a period of one year at various educational institutes such as IITs, NITs and other reputed research organizations / educational institutes.

- Newly developed Porous Radiant Burners (PRB) with improved material specification showed fuel saving up to **58 % with up to 85 % reduction in CO and NOx.**
- The newly developed PRBs provides better taste to the food by eliminating the over burnt due to non-uniform heating.
- PRB completely eliminates the soot formation over the surface of the cooking vessel.
- Developed thermal model for the design of the PRBs.
- Transferred the technology of fabrication and testing of LPG cooking stove with PRBs of various capacity to industrial partners.
- Exhibited the developed PRBs in several workshops, and national science exhibitions across India.
- Three product patents have been granted and two more are in pipeline
- Published 10 research articles in reputed Int Journals and conference proceedings.

The following table provides the details PBR developed and their respective kitchen performance tests carried out at actual cooking environment.

	
	<p><u>Installed at IIT Madras</u></p> <p>Stove: <i>Seven PRB Kadai; Five PRB Kadai and Four PRB Stove</i></p> <p>Fuel : LPG/ PNG ; Power out : 20-35 kW; 15-25 kW, 12-20 kW.</p> <p>Fuel saving in actual cooking environment: 40-50%. Reduction in CO and NOX emission : up to 85%</p> <p>Other features: No soot formation, up to 15 % save in cooking time, no clogging for burners when the food/milk/oil spills over the burner, can be operated at lower pressure (down to 30 mbar) and easily cleanable. Kitchen performance tests carried out at IIT Madras hostel. Reported fuel saving while preparing several food menu such as rice, sambar, etc is about 40-50 %.</p>

Stove: Seven PRB Kadai with SS Protection Cover and Five PRB Kadai with SS Protection Cover
Fuel : LPG/ PNG

Power out : **20-35 kW (for seven PRB) and 15-25 kW**

Fuel saving in actual cooking environment: **40-55%**

Reduction in CO and NOX emissions : up to **85%**

Other features: No soot formation, no clogging for burners when the food/milk/oil spills over the burner, can be operated at lower pressure (down to 30 mbar) and easily cleanable. No leakage of heat to surrounding while cooking.



Installed at MIT-Anna University

Stove: Seven PRB Kadai with SS Protection Cover
Fuel : LPG/ PNG

Power out : **20-35 kW**

Fuel saving in actual cooking environment: **60%**

Reduction in CO and NOX emissions : up to **85%**

Other features: No soot formation, no clogging for burners when the food/milk/oil spills over the burner, can be operated at lower pressure (down to 30 mbar) and easily cleanable. No leakage of heat to surrounding while in operation



Installed at M/s Oxenvet Neutaceuticals, Kadapa, Andhra Pradesh

Stove: Five cluster PRB with MS Cover installed at IIT Tirupati kitchen.

Fuel : LPG/ PNG

Power out : **15 to 25 kW**

Fuel saving in actual cooking environment: **40-45%**

Reduction in CO and NOX emission : up to **85%**

Other features: No soot formation, no clogging for burners when the food/milk/oil spills over the burner, can be operated at lower pressure (down to 30 mbar) and easily cleanable.

PRB has been effectively used to cooking rice, preparation of sambar and other food items.

Reported fuel saving was up to 42 %.



- We have installed over 75 PRBs of various power outputs and configurations across South India in many premier educational institutes, hotels and industries. We are continuously monitoring the performances and providing all possible technical and service assistance.

5. Publications, patents or similar knowledge generation during the period (a chronological list with complete list of authors and archival reference is needed):

Journal Publications

- Sofia Rani Shaik, **Muthukumar P** and Pratul Chandra Kalita. Life Cycle assessment of LPG Cook-stove with Porous Radiant Burner and Conventional Burner – A comparative study. *Sustainable Energy Technologies and Assessments (2022), Vol.52, Part C, 102255.*
- Pratibha Maurya, **Muthukumar P** and Anandalakshmi R. Assessment of indoor air quality of porous media combustion based cookstoves. *Environmental Science and Pollution Research (Under review).*
- Sofia Rani Shaik, **Muthukumar P** and Pratul Chandra Kalita. Life Cycle assessment Biogas operated Porous Radiant Burner and Conventional Burner for cooking applications. *Environmental Science and Pollution Research (Under review).*
- Arun Kumar Mahalingam, Lav Kumar Kaushik and **Muthukumar P**. Experimental investigation on performance characteristics of a naturally-aspirating Porous Radiant Burner. *Sustainable Energy Technologies and Assessments (Under review).*
- **Muthukumar P**, Lav Kumar K, Arun Kumar M, Sunita Deb, Pratibha M, Sofia Rani S, Muhammad A M (2023). Evolutions in Gaseous and Liquid Fuel Cook-stove Technologies, *Energies* 2023, 16, 763.

We have presented 5 conferences papers in various reported Int National Conferences

Granted Patents

- **Muthukumar P**, Pratibha Maurya, Self-Aspirated Pressurized Methanol Cookstove with a Porous Radiant Burner. Patent No: 399210 Granted with effect from 9-11-2021.
- **Muthukumar P**, Arun Kumar M, LPG-Operated Fuel-Efficient and Clean Porous Radiant Burner, Patent No. 434432 Granted effect from 14/05/2022..
- **Muthukumar P**, L K Kaushik, Sangjukta Devi, Arun Kumar M. Biogas Operated Domestic Cook Stove with Naturally Aspirated Porous Radiant Burner. Patent No. 437518 Granted effect from 14/12/2019.