Improvement in Thermal Efficiency and Emission Control of Domestic Cook Stoves

A THESIS

submitted by

Ankur Kaundal (Roll No. S15008)

for the award of the degree

of

MASTER OF SCIENCE

(by Research)

School of Engineering

INDIAN INSTITUTE OF TECHNOLOGY MANDI

Mandi, Himachal Pradesh- 175005

June 2019

Dedicated to the

Countryside

who always wishes to be better off

DECLARATION

This is to certify that the thesis titled "**Improvement in Thermal Efficiency and Emission Control of Domestic Cook Stoves**" submitted by me, to Indian Institute of Technology Mandi for the award of the degree of **Master of Science (by research)**, is a bona fide record of the research work carried out by me in the School of Engineering, Indian Institute of Technology Mandi, under the supervision of Dr. Satvasheel Powar and Dr. Atul Dhar. The contents of this thesis, in full or in parts, have not been submitted to any other Institute or University for the award of any degree or diploma.

IIT Mandi
June 2019

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THESIS CERTIFICATE

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ABSTRACT

Biomass holds substantial importance to cater day to day energy demands of people worldwide. Around three billion people globally rely on biomass viz. wood, crop residue, etc. to meet their energy requirements. Utilization of biomass as a source of energy started a long back when our ancestors learned the secret of fire. They started it with open fires and three-stone methods of cooking. These conventional methods were poor in terms of thermal efficiency and pollutants' emission. Pollutants emitted from these cook stoves pose serious threats to the health of people working nearby. However, as the time progressed subsequent modifications kept on taking place and various cook stove designs have evolved since their inception in domestic use.

After mid of the twentieth century, intensive research has been carried out to improve the performance of cook stoves. The new concepts like provision of primary and secondary air, natural and forced draft establishment in the chimney, etc. sprung up. Significant improvements in thermal efficiency and pollutants emissions have been recorded in these cook stoves. Presented work in this thesis is an extension of these advancements. A design of cook stove well-equipped with the provision of primary and secondary air has been proposed. Multiple cook stove prototypes based on this design have been fabricated and an experimental test facility as per Bureau of Indian Standards has been set up. These prototypes have been tested in this test facility for thermal efficiency and emissions' measurement. A comparison has been made on the performance parameters of these prototypes. Furthermore, these prototypes have been compared with the existing cook stoves in literature.

Results have shown good performance parameters for thermal efficiency and pollutants' emission in fabricated cook stoves. The highest thermal efficiency of 32.04% has been achieved, which falls in reasonably impressive range among existing cook stoves. Simulation techniques have been used to optimize certain parameters, whose analysis through experiments was challenging. Cook stove combustion chamber has been simulated for varying air supplies distributed between primary and secondary air inlets. The thesis concludes with the optimization of air supplies and primary to secondary air ratio of 50:50 has yielded best results for the proposed design.

Keywords: Cook stove, species transport, wood volatiles, thermal draft, primary air, secondary air, mass-depreciation, Adiabatic Flame Temperature, de-volatilization, computational domain, heat of formation, eddy-dissipation.

ACKNOWLEDGEMENT

At the outset, I would like to express sincere appreciation to my thesis supervisors Dr. Satvasheel Powar and Dr. Atul Dhar, who encouraged me to work on a socio-technical project. Ample facilities and consistent support by them have paved the way to conduct research conveniently. I would also like to express profound gratitude to all the APC members and instructors at Indian Institute of Technology Mandi. Their timely comments and valuable suggestions have guided me through qualitative research. Apart from this, I feel grateful to Mr. Stephan Marchal for inception of the idea and handing over his prototype for studying. Also, I would like to acknowledge all the friends, lab assistants and workshop staff who stood by me during the project work. Needful assistance from time to time has put everything at ease. Short-hikes, recreational hangouts, informative discussions with friends made me stay sane throughout the project duration.

A debt of gratitude is also owed to my family members. Their consistent support and understanding patience have contributed a lot to the successful completion of the project.

Finally, thanks a bunch to Almighty!

Ankur Kaundal

June 2019 IIT Mandi

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