Short Abstract

The present thesis emphasizes on the need for clean cooking fuel sources in developing countries where 2.8 billion people rely on solid fuels, posing health hazards due to indoor air pollution. Although liquefied petroleum gas (LPG) and biogas are cleaner alternatives, they face adoption barriers, including cost and availability. Methanol and ethanol have gained traction as a cleaner cooking source, and several countries have launched programs promoting their use. However, conventional methanol and ethanol cookstoves have drawbacks, such as low firepower and soot formation. In this regard, the thesis aims to evaluate the performance, safety, and sustainability of Free Flame Combustion based (FFC) methanol cookstoves, develop a Porous Media Combustion (PMC) based methanol cookstove, assess the feasibility of ethanol as a cooking fuel in FFC and PMC based cookstove, analyse indoor air quality due to use of PMC based cookstoves and compare it with the existing FFC based cookstove, and develop an Indian standard for the use of methanol and ethanol cookstoves.

The study assessed the performance of a FFC based methanol cookstove in terms of thermal efficiency, emission levels, usability, safety, and sustainability, and compared it with an LPG cookstove. The results showed that the methanol cookstove had a higher maximum efficiency (63.4%) than the LPG cookstove (59.1%), while combustion efficiency was similar for both (99.5%). The usability study revealed that the methanol stove was comparable to the LPG stove in terms of maintenance, comfort, and mechanical stability. A user survey indicated that the majority of users found the stove safe and clean, although around 30% had difficulty with frequent canister refilling and 16% expressed concerns about the longer cooking time. The study also demonstrated that the production of methanol from coal and biomass could be a cost-effective and sustainable option for India, with 10% methanol penetration potentially replacing 3.69 MMT of LPG by 2030.

Further, a PMC based methanol cookstove was developed and its performance was compared with the existing FFC based methanol cookstove. Comparison study on FFC and PMC based methanol cookstoves showed that there is increase in thermal efficiency and decrease in CO/CO2 ratio by 4.8% and 33.3% respectively, due to use of PMC based cookstove.

Further, the study compared the performance of FFC based fixed canister type and removable canister type ethanol cookstoves with PMC based ethanol cookstoves, finding reveals that PMC based cookstoves had the highest maximum efficiency of 60.3% and a higher FP of 3.5 kW

compared to FFC-based cookstoves (limited to 2 kW). They also found that using an ethanol/water blend with 93% ethanol and 7% water resulted in optimum visible soot reduction.

Another aspect of the present research work was to study the emission mitigation ability of a PMC based cookstove (CS_{PMC}) and compared to a FFC based cookstove (CS_{FFC}). The results emphasized that the utilization of CS_{PMC} would help in improving the IAQ of the kitchen area by decreasing the concentrations of $PM_{2.5}$, PM_{10} and CO. For 2 hr duration measurements, the methanol cookstove based on PMC reduced the concentrations of $PM_{2.5}$, PM_{10} and CO by 7.7%, 8.1% and 17.2%, respectively, compared to FFC cookstove. Similarly, in the case of PMC based LPG cookstove (CS_{PMC}^{LPG}) and kerosene cookstove ($CS_{PMC}^{Kerosene}$), the respective values were 11.7%, 20.4% and 41.6% and 55.3%, 62.6% and 66.6%, respectively. Further, the research work was also extended for the development of Indian standards for the FFC based methanol/ethanol cookstoves