Recommendations and Points of Interest

Though this year's design was not successful in meeting all of the customer's needs and specifications, it certainly took the project in a new direction, and significant insights were gained with regard to improving the design for next year. The design showed great promise in overcoming the issues faced by previous groups, which struggled to provide a consistent and uniform temperature gradient across the thermoelectric module. By incorporating convective heat transfer as the primary means of providing thermal energy to the TEM, a consistent temperature gradient of 200 C was achieved for prolonged periods of time. Despite having the requisite design temperature difference, the TEM was unable to produce an output voltage large enough to power the MPPT circuit.

A key issue with the convective heat transfer system was that throttling the fan to control the boil or simmer phase of the test resulted in very different convective heat transfer coefficients. This caused significant design issues, as the TEM was vulnerable to being damaged if the system was designed for a steady-state convective system, and if the system was designed so that the TEM would survive the pre-boil phase then it wouldn't generate the requisite voltage during the simmering portion of the cooking process. In this iteration of the project, the stove was designed to operate at the pre-boil temperatures, and was therefore not adjustable down to a simmer. The results show that the stove and the thermoelectric system meet the required temperature difference of 200 C across the TEM, however the voltage output does not meet expectations.

In order to remedy the TEM issues, a couple of practical solutions exist. The simplest solution to implement would be to select a new TEM with a more appropriate operating range and design operating point, that would allow the TEM to operate continuously during both the pre-boil and post-boil stages of the cooking process. The current TEM is severely limited because in order to get the appropriate temperature difference of 200 C across the module, the hot side of the module must be kept at nearly 350 C, the maximum operating temperature for the module. Operating the TEM at lower temperature ranges is impossible given the available cooling system, which relies upon ambient air to cool the cold side of the TEM. A second solution is to install a bypass system into the stove, which allows the hot exhaust from the combustion chamber to bypass the thermoelectric portion of the system in the pre-boil stage, and that could be switched to the thermoelectric portion of the system in the post-boil, steady state stage.

Over the course of the design process, it was decided to focus primarily on the thermoelectric component of the system, because it had proven to be the most problematic system throughout the previous iterations of the project. As a result, little attention was paid to the impact of design decisions on reducing emissions and fuel usage. Furthermore, additional effort was put into troubleshooting the thermoelectric system, so emission and fuel usage data was not collected for a controlled-cook test. In order to improve upon the current design in future project iterations, it is strongly recommended that the project scope should be trimmed back to focus exclusively on either the environmental aspect of the stove design or on the thermoelectric component of the design. Once the first of these two goals is attained, a second project can focus on altering the design so as to meet the second set of goals. It is the recommendation of this group that primary focus be given to the design of a fully functional thermoelectric cook stove, and that subsequent projects focus on improving the fuel efficiency and emissions of the working thermoelectric stove.

In looking at efficiency of the stove, thermal mass should be the main concern. The larger the stove, the more fuel it will take to heat up the stove. This idea was mostly neglected during this year's design process and adversely affected the amount of fuel used. If the stove design could be made smaller for just enough space to fit 1 kilogram of charcoal within the combustion chamber, that would be ideal.

Along with decreasing the size of the stove, additional air access to the combustion chamber would be favorable. Forced air must be used to speed up combustion, but the current stove design might be limiting the amount of air that can reach the charcoal. If air could be more uniformly distributed, better combustion may be possible. Additionally, it should be determined whether forced draft technology truly increases the efficiency of burning charcoal, especially with regards to emissions.