DESIGN, FABRICATION AND TESTING OF A DOWN DRAFT STOVE FOR SMALL SCALE INDUSTRIAL APPLICATIONS

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BACKGROUND

Biomass represents the largest share of primary energy supply in Sri Lanka. For household cooking as well as large industry applications, there have been a growing trend in the development of high efficiency technologies. However, the small scale industrial sector is yet to find efficient combustion solutions.

Biomass stoves work on either up draft or down draft system. In updraft stoves, the air enters below the wood and the flame moves up. A major problem in this system is that, as the hot gases move away from the burning wood, it will loose there temperature causing incomplete combustion. This problem has been addressed in down draft stoves. Down draft combustion can produce high temperatures high power output and a complete combustion. This is seen as a versatile solution for small scale industrial applications.

OBJECTIVES AND METHODOLOGY

The objectives of the investigation are; to design a down draft stove, to optimize its dimensions to achieve the best operating conditions, and to determine the firewood batch size for optimum combustion.

The methodology was;

1. Gathering of information on thermal power requirement and the existing downdraft burners in the industry, and estimate the heat output expected from a stove.
2. Changing the dimensions and scaling up of the existing downdraft cook stove to suit a small scale industrial stove.
3. Construction of a downdraft stove with clay & brick, according to calculated parameters.
4. Testing of the constructed downdraft stove, observing performances and taking measurements.
5. Modifying the downdraft stove until the optimum dimensions were reached.
6. A metal stove was constructed according to optimized dimensions and measurements were obtained.

RESULTS

Base on the information collected a downdraft stove with a maximum power output of 15 kW was designed, fabricated and tested. Firewood in batch sizes of 300g, 500g and 750g were fed. The temperature profiles were obtained and it was found that the temperature variation was cyclic and the maximum temperature occurred at the middle of the cycle. For Gliricidia firewood, the maximum temperature was recorded as 900°C.

In contrast to what were published in the literature, it was found that a small air leakage did not affect the combustion of the stove. It was also found that, in subsequent start-ups, there was no need for a blower as reported elsewhere. The stove was tested for the optimized batch size according to the CO emissions produced by the stove. Figure shows a section of experimental results. It can be seen from the graph that CO level in exhaust gas is quit varying with time. But it can be found that some points are very low carbon percentage. It should be possible to minimize the CO emissions to that level. And to optimize the batch size other exhaust gases should be considered at the same time. These testings will be carried out in future.