

COMBUSTION OF SOLID FUEL ON DOMESTIC STOVE

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*DEDICATED TO
MY LOVING DAUGHTER
SHRAMANA*

CERTIFICATE

This is to certify that the thesis entitled COMBUSTION OF SOLID FUEL ON DOMESTIC STOVE being submitted by Anubha Mandal for award of the degree of Doctor of Philosophy in Chemical Engineering of the Indian Institute of Technology, Delhi, is a record of bonafide research work carried out by her under our guidance and supervision. To our knowledge, it has reached the standard of fulfilling the requirements of the degree. The matter embodied in this thesis has not been submitted for the award of any degree/ diploma of any other university or institute.



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ABSTRACT

In India, soft coke and wood are the major solid fuels used for cooking purposes. Soft coke is used mainly in urban areas, whereas, wood is used in the rural areas.

The coke is burnt in a household appliance, commonly known in India, as a sigri or a chulha. Intense smoke pollution, generated during the lighting up operation is the single largest drawback of using such an appliance in populated areas. A systematic study of combustion in a household model of a chulha was conducted primarily to discern the mechanism of smoke generation in such combustion process, so that possible solution to this problem could be obtained. It was observed that the major cause of smoke formation was the incomplete combustion of volatile matter. This was due to initial large difference of temperature between the top and bottom of the fuel bed and low oxygen concentration in flue gas. In order to eliminate this deficiency of initial large temperature difference, experimental studies were conducted in a simulated appliance where the temperature at various sections were controlled by external heating. The results of the study showed that if the initial smoke laden gases could be passed through a hot zone kept around 500°C , the smoke could be completely eliminated due to combustion with secondary air. This was confirmed in field trials with a prototype of a chulha designed and developed for this purpose.

Experiments were also conducted to study the combustion characteristics of single coke particle using thermogravimetric analysis. This study was mainly to ascertain the physico-chemical characteristics of the raw material, so that a detailed theoretical simulation of a chulha operation could be undertaken later on.

The effect of bed temperature conditions on the thermal efficiency of chulha is quite evident from the fact that radiational heat transfer rate between the fire place and pot is dependent on the fourth power of this temperature. An experimental study was initiated to determine the effect of various fuels in the bed on the temperature distribution across the bed. It was found that very little axial and radial dispersion of heat occurred in these chulhas under normal conditions of operation. Different fuels showed quite varied temperature profile depending on the burning characteristic of them.

Wood is the main solid fuel in rural India. It is burnt in home made simple wood fired stoves. But the efficiency of these stoves is very low. There have been lot of developmental activities in improving the basic design of a wood fired stove resulting in a number of models. Very few of these models developed appear to have been based on any theoretical understanding. The present work on wood fired stoves attempted to make a theoretical

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analysis of heat transfer from the fire to the pot for the simplest conventional design available. These predicted results were confirmed with field data obtained from a proto-type chulha. Based on the information obtained from the study a modified wood fired chulha has been developed.

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