DEVELOPMENT OF A PADDY HUSK GASIFIER AND EFFECTS OF DESIGN PARAMETERS ON PERFORMANCE OF THE GASIFIER

by

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ABSTRACT

Approximately 0.4 million tons of paddy husk are being produced in Sri Lanka, annually. With the implementation of Mahaweli Development Programme, an increased production of paddy husk is anticipated. It has been found that the paddy husk could be converted into energy, by several ways and the gasification is one of the conversion techniques which can be adopted.

The aim of this research study was to develop a suitable gasifier to gasify paddy husk and to evaluate its' performance against the design parameters.

The other researchers work on paddy husk gasification is discussed here critically, since it has led to some understanding on potential problems of this process.

The properties of paddy husk are discussed in detail, since this is vital when paddy husk is considered as a gasifier fuel.

As the paddy husk is being used for various energy applications at present, although in limited manner, those energy systems were investigated. But there are few other alternative processes available for derivation of energy from paddy husk. They too are discussed.

The basic principles and the chemistry of gasification are examined together with different gasifier designs and their relative applications, to select an appropriate mode of operation and to understand important design features, for the gasification of paddy husk. It was decided to design

and develop a throatless, rotating grate, down draft gasifier having a hopper capacity of 25kg/Hr, and useful thermal output of 25 kw.

The various essential components of this type of gasifier are identified and analysed together with different alternatives available. Different types of ash/char removal mechanisms are considered and a rotating grate with a fuel bed agitator has been selected for further studies. The mode of operation of the gasifier was studied with respect to paddy husk feeding arrangements. A hopper having a simple lid, a double door feeder and a star feeder were taken for detailed study.

The ash pit of the gasifier was sealed hydraulically first and with a metal plate, later on. The problems associated with the water seal are discussed.

Paddy husk conveying, gas cleaning and gas burning aspects also are discussed.

Determination of the right rotational speed and the correct orifice size were obtained experimentally, since there is no straightforward method to determine them. The experimental methodalogy as well, is explained.

Basic design calculations, design considerations salient features of the gasifier, gasifier construction and the operating procedures are also discussed.

The measures of the performance of the gasifier were considered as, the combustibility, flame temperature and CO content of the producer gas. The performance of the gasifier was estimated by varying the design parameters, firstly, against the gasification air flow rates and air inlet configurations. The radial and the longitudinal temperature profiles were obtained and from which different reaction zones of the gasifier were determined.

Some amount of "promoter air" was used to obtain enhanced gasification performance. The "promoter air" was introduced directly into the gasifier hearth zone. The results were very encouraging. Here the performance of the gasifier was measured against varying promoter air flow, air nozzle diameter and the location of the promoter air nozzle plane.

Different particulate fuels were gasified in the same gasifier and performance results obtained.

The material balance and the energy balance were carried out with the help of experimentally obtained data and the data extracted from the available literature, from which the efficiency of the gasifier and the chemical energy output were determined.