INVESTIGATION OF ASPECTS OF COMBUSTION OF BIOMASS IN A FLUIDISED BED COMBUSTOR

By

Joaz Kiptanui Korir

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ABSTRACT

Adequate and affordable energy is a basic requirement for the economic development of any country. Over the years, the countries of the world have been developing many diverse sources of energy in an effort to achieve a well-balanced mix of these sources (at affordable costs) so that there is no over-dependency on any one of them. Biomass and biomass wastes are energy sources that still have a lot of potential for further improvement in terms of conversion and use. Sawdust is a biomass waste of the saw-milling industry that can be converted in suitable devices to more useable forms of energy but is not being done to any appreciable scale in Kenya. One of these conversion methods is the combustion in a fluidised bed combustor and then utilising the energy in the combustion products in appropriate devices.

The objective of the work presented in this thesis was therefore to evaluate the combustion of sawdust in a fluidised bed combustor. This involved experimental investigation and the development of a mathematical model for the thermodynamics of the combustion process. The model gives an indication of the quantity of the useful energy that can be extracted from the system and serves both as a modelling tool and as a basis for the design and implementation of an improved system of energy recovery/conversion from sawdust. The model can also form a basis of designing combustors that can utilise other biomass wastes.

In developing the model, it was realised that some of the effects taking place in a fluidised bed are still insufficiently investigated and their physical modelling not possible and so empirical parameters had to be included in the model. The combination of empirical approach and theoretical sub-models finally led to an overall

mathematical model that sufficiently described the phenomena occurring in bubbling fluidised bed combustion of sawdust. Model calculations were compared with data obtained from a pilot-scale fluidised bed combustor installed at Moi University.

It was found that sawdust can burn in a fluidised bed combustor with an efficiency of up to 70%, which is much better than that found in conventional combustors. However, it was found that the height of the fluidised bed does not have much influence on combustion efficiency but affects greatly the rate of heat transfer to any equipment installed internally in the combustor.

It was also found that the air/fuel ratio in the combustor had a lot of influence on combustion efficiency with efficiency ranging from a low of about 24% at an air/fuel ratio (by mass) of 16, rising to a high of about 70% at an air fuel ratio of 6, then falling thereafter. The air/fuel ratio also had a lot of influence on the temperature of the flue gas in that at an air/fuel ratio of 16 the flue gas temperature was about 1000 K while at an air/fuel ratio of about 6 it was about 2000 K.