INVESTIGATING THE COMBUSTION BEHAVIOUR OF SELECTED AGRICULTURAL RESIDUES AVAILABLE IN KENYA IN A FLUIDIZED BED COMBUSTOR

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ABSTRACT

The world's attention is increasing towards 'green energy'. Biomass, which is being seen as a '*green*' energy resource with a potential for partial substitution of fossil fuel is considered to be a CO_2 – *neutral* fuel and can be utilized to help meet the requirements of the Kyoto Protocol on the reduction of Greenhouse Gas (GHG) emissions.

Despite the high-energy potential of biomass and the advantages associated with their use for energy generation, their utilization is still very low, due to some of their peculiar properties such as high volatile matter contents, lower bulk densities, low ash melting temperatures and high chlorine content which, greatly influence their combustion behaviour. In the light of their energy potential the search for effective combustion techniques for agricultural residues with high alkali contents is justified.

This study was aimed at generating technical and scientific information necessary to promote increased utilization of the residue for energy generation. The objectives of this thesis were to establish the availability and potential of agricultural residues as sources of fuel, study their combustion characteristics as well as the agglomeration and sintering problems associated with their combustion.

The study involved literature review on the availability, energy potential and combustion characteristics of selected agricultural residues available in Kenya. A semi-pilot scale fluidized bed test facility available in the department of Production Engineering was used to study the influence of alkali compounds present in the ash of agricultural residues on their combustion behaviour through monitoring of temperature fluctuations, pressure drops and root mean square values of pressure drops.

It was established that over 81,000,000 tonnes of the main agricultural residues are produced annually in Africa with an energy potential of over 1,000,00 TJ of heat and over 35,000 MW of electrical energy. Kenya produces over 6,400,000 tonnes of residues annually with an energy potential of over 51,000 TJ of heat and 1642 MW of electricity. Through the study, it was understood that the combustion characteristics of the residues are different from those of conventional fuels such as coal and oil, mainly due to the high volatile matter and low fixed carbon content of the residues. In the tests carried out the problems of bed agglomeration and sintering were encountered and found to be the most challenging. Of the residues studied, coffee husks were found to be the most problematic to handle due to the presence of high contents of alkali oxides (mainly K_2O) in the fuel. For this fuel, agglomeration was manifested after three to four hours of operation depending on the firing temperature.

Based on their availability, high potential and attendant advantages, it is recommended that agricultural residues be seriously considered for utilization as fuel for energy generation. It is also recommended that studies be carried out to adequately address the problems associated with agglomeration in view of finding solutions, and develop methods of predicting and analysing the agglomeration process during the combustion of agricultural residues.