Optimization of Biomass Use and Performance as an Industrial Fuel: Experimental Study

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ABSTRACT

The main focus of this research is to evaluate the combustion characteristics of biomass fuel, macadamia nut shells. It seeks to determine its optimum combustion by designing a biomass burner with provision for measurement and then evaluating the combustion behaviour of the macadamia shells using the burner. The research also sought to determine the physical and chemical properties of the macadamia shells as factors that may a_ect combustion.

The analysis for the properties of the macadamia nut shells, determined that it has a higher heating value of 21.12 MJ/kg, 72.1% volatile matter, 13.1% moisture content, 1.6% ash and 13.1% _xed carbon. In addition, further analysis evaluated the carbon, hydrogen, nitrogen, sulphur and oxygen compositions as 54.5%, 5%, 0.36%, 0.02% and 39.8%, respectively. These analyses show that macadamia shells has a high heating value with low ash content which are suitable qualities for an industrial fuel.

An experimental rig was designed, constructed with a special fuel feeding screw and used in this research to enable the combustion of the macadamia nut shells. The instruments connected to the rig included thermocouples, ori_ce-meter, and emission gas analyzer. An Adventest TR2724 multichannel temperature recorder was used to acquire and record temperature data from the thermocouples to and accuracy of _ $0.5^{o}C$ in the system.

The combustion parameters, viz, combustion chamber temperature and gaseous

emissions, were determined by varying the rate of fuel feed rate and the amount of combustion air per unit time. It was found that an air fuel ratio of 2.4 kg of air for a unit kg of fuel gives the optimal combustion chamber temperature of 800 ^{o}C, with acceptable gaseous emissions of; Carbon monoxide (CO), Nitrogen monoxide (NO), Nitrogen dioxide (NO_2) , and Sulphur dioxide (SO_2). The results of this study provides an insight for future design of biomass systems to be used in small scale industries locally.