ABSTRACT

Energy plays a vital role in the industrialisation and contributes to the human welfare of the modern society. There is an immediate necessity to substitute present fossil fuels with alternative energy sources due to their limited availability and the increasing environmental constraints. Rice husk is a by-product in the rice milling industries. A part of the husk is used for parboiling purpose. The surplus husk can be used for generating power to meet the demand of milling machinery.

In the present work, the rice husk is gasified in a fluidized bed gasifier to generate power using dual fuelled diesel engine. The fluidization and mixing behaviours of rice husk are studied in a transparent fluidized bed column. Although it is difficult to fluidize the rice husk, its fluidization behaviour is improved when it is mixed with sand to form a multisolid system. When the weight percentage of husk is less than 3%, the mixture exhibits good aggregative fluidization behaviour. The mixing of rice husk with sand is more uniform in the into-bed feeding than that in the over-bed feeding. The mixing is also found to be quicker in the into-bed feeding. When the weight percentage of ash is less than 30%, good fluidization behaviour is exhibited by the mixture of sand and ash.

The agglomeration resistance of rice husk and bagasse are found to be high and of cane trash and olive flesh are poor by using the controlled fluidized bed agglomeration test. The ability of ASTM ash fusion test to predict the agglomeration behaviour of high ash fuels with high silica content is found to be poor.
A lab scale fluidized bed gasification (150 mm diameter) system is designed and fabricated to gasify the rice husk. The gasification experiments established that the bed temperature and fluidization behaviour are the two main parameters affecting the performance of the gasifier. The bed temperature can be controlled by adjusting the equivalence ratio. An isothermal bed condition can be achieved by controlling the equivalence ratio. A 150 mm reactor is found to gasify 12 to 20 kg/h, with optimum fuel flow rate of 16 kg/h. The lower heating value of the gas is found to increase with the temperature to reach a maximum of 5.6 MJ/Nm³ at 780°C. The producer gas yield is increased from 1.14 to 2.15 Nm³/kg and the tar content is decreased from 13.4 to 2.73 g/Nm³ when the temperature is increased from 700 to 950°C. A maximum carbon conversion efficiency and cold gas efficiency of 81.6% and 66% are achieved respectively.

The producer gas from the gasifier is cleaned and cooled and then used in a 7.5 kW diesel generator in dual fuel mode to generate power. The maximum diesel saving of 73% is achieved without making any major modifications. The maximum overall system efficiency on dual fuel mode is 17.8%. A pilot plant gasifier with 450 mm diameter is also designed and fabricated. It is found to gasify 100 to 130 kg/h with gas lower heating value of 4.7 to 5.8 MJ/Nm³ in the temperature range of 760 to 810°C. A maximum carbon conversion efficiency of 83% and cold gas efficiency of 68% are achieved.

The results of economic analysis demonstrate the favourable case for the installation of gasifier-engine system for generating power by utilising the surplus husk even in the rice mills connected to the grid. If the rice mill is operated by diesel engine, the producer gas form the gasifier can be used to operate the engine on dual fuel mode as it can result in the savings of 10 to 34% even in the absence of any financial incentives.