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Research Paper :

Performance study of a diesel engine by using producer gas from selected agricultural residues on dual-fuel mode of diesel-cum-producer gas

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ABSTRACT

Producer gas through gasification of biomass can be used as an alternate fuel in rural areas due to high potential of biomass resources in India. Experiments were conducted to study the performance of a diesel engine (four stroke, single cylinder, 5.25 kW) with respect to its thermal efficiency, specific fuel consumption and diesel substitution by use of diesel alone and producer gas-cum-diesel (dual fuel mode). Three types of biomass *i.e.*, wood chips (Acacia; scientific name, *Acacia abyssinica*), pigeonpea stalks (scientific name, *Cajanus cajan*) and corn cobs (scientific name, *Dracaena fragrans*) were used in this study for generation of producer gas. A producer gas system consisting of a downdraft gasifier, a cooling cum cleaning unit, a filtering unit and a gas air mixing device was designed, fabricated and used to power a 5.25 kW diesel engine on dual fuel mode. Performance of the engine was reported by keeping biomass moisture contents as 8%, 12%, 16%, and 21%, engine speed as 1600 rpm and with variable engine loads. The average value of thermal efficiency on dual fuel mode was found slightly lower than that of diesel mode. The specific diesel consumption was found to be 60 to 64 % less in dual fuel mode than that in diesel mode for same amount of energy output. The average diesel substitution of 64% was observed with pigeonpea stalks followed by corn cobs (63%) and wood chips (62%). Based on the performance studied, the producer gas may be used as a substitute or as supplementary fuel for diesel conservation, particularly for stationary engines in agricultural operations in the farm.

Key words : Biomass gasification, Producer gas, Downdraft gasifier, Diesel engine

The escalating oil prices and scarcity of fuel oils coupled with exploding population have resulted in serious energy crisis. There is thus a pressing need to develop technology for utilizing the renewable energy sources that can make significant contribution to the economy and the well being of the rural people.

Of all the alternative sources of energy for rural areas, producer gas from biomass appears to have the greatest potential. As an agricultural country, India has large supply of biomass resources. It is estimated that about 40 to 60 per cent of agricultural residues are either lost or put to inefficient use. This calls for better utilization of these resources by thermo-chemically converting into producer gas in the current context of limitedness of petroleum based fuels for use in internal combustion engines.

Producer gas is generated from solid carbonaceous fuels such as wood, charcoal, coal, agricultural and forest residues and also animal wastes by gasification process (Hindsgaul *et al.*, 2000; Dogru *et al.*, 2000; Bhattacharya *et al.,* 2001, Maniatis, 1989, Naksitte, 1989; Sridhar *et al.*, 2001; Das and Pandey, 1993 and Pathak and Jain, 2004). Gasification is an irreversible thermo-chemical process by which feed stock is thermally decomposed and the end products are principally in gaseous form, the main combustible components being carbon monoxide and hydrogen. The main advantages of gases as a fuel over liquid or solid fuels are that (i) gases burns with higher efficiency than the solid or liquid fuels, (ii) they have a higher rate of heat release (iii) the rate of energy output is easily controlled and adjustable, and (iv) gaseous fuels with good energy utilization can be used for power sources. A good quality producer gas has an energy content of about 5200 kJ/Nm^3. A gas producer requires 2.5 to 3 kg of wood to generate about the same energy as 1 liter of diesel (Tiwari and Ghosal, 2007).

Diesel engines are widely used in Indian agricultural farms for a variety of stationary and mobile operations. The usual approach of producer gas utilization in diesel engines consists of operating existing compression ignition engines on producer gas cum diesel dual-fuel mode. The thermal efficiency of gasifiers in which producer gas is produced has been found to be 70-80 per cent and that of the gasifier-engine system to be 16-20 per cent (Stout, 1986). The problem is more acute and serious in nature when producer gas is used to run motor vehicles