EXPERIMENTAL OPERATION OF DIESEL

by Fajri Vidian

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EXPERIMENTAL OPERATION OF DIESEL AND GASOLINE ENGINE IN DUAL FUEL MODE USING PRODUCER GAS FROM WOOD CHARCOAL GASIFICATION

Fajri Vidian*, Ady Harianto Aritonang, Stevanus Jan Sipa Pinem, Qomarul Hadi
Department of Mechanical Engineering, Faculty of Engineering, Universitas Sriwijaya, Jalan Raya Palembang-Prabumulih km 32, Indralaya, Ogan Ilir, Sumatera Selatan, 30662, Indonesia

ABSTRACT

Wood charcoal gasification can produce low tar content in its producer gas. The producer gas is suitable to use in gasoline and diesel engine as fuel. This research aims to get the stability of producer gas from wood charcoal gasification and the savings of diesel and gasoline fuel in operating dual fuel engine. Tests were carried out on each electric load of 0 kW, 0.3 kW, 0.5 kW, 0.7 kW, 1 kW for diesel engines and 0 kW, 0.3 kW, 0.5 kW, 0.7 kW for gasoline engine. The test results showed that the wood charcoal gasification process took place at a air-fuel ratio were 1.7 – 2. The range of combustible gas stability was 91 – 105 min. Diesel and gasoline fuel consumption rate in dual fuel operation were 0.1 l/h to 0.2 l/h and 0.2 l/h to 0.37 l/h respectively. The average of diesel and gasoline fuel savings were each of 65.8 % and 19.8 % respectively.

Keywords: Gasification, Downdraft, Wood charcoal, Diesel, Gasoline, Engine.

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1. INTRODUCTION

Gasification is the most efficient and environmental technology used for biomass conversion. [1,2]. This efficient technology is limited by the high of tar produced [2]. Tar will inhibit the application of gas to generate power or electricity, especially for internal combustion engine application [3]. Tar in the gasification process is produced at the pyrolysis zone [4]. The use of solid fuels that has a potential to produce low tar is very necessary and beneficial in the gasification process.

Charcoal is a solid fuel that has produced through a devolatization process (pyrolysis) from biomass such as wood and coconut shell. After the pyrolysis process, the volatile content of the fuel will reduce, the amount of reduction will depend on the temperature of pyrolysis and resident time. Fassinou et al. [5] conducted pyrolysis of wood at temperatures between of 450 to 750 ^{0}C and the fuel rate of 10 kg/h and the resident time of 30 min where the volatile content would decrease from the wood condition of 81% to in the range of 4.5 % to 28.5%. This volatile content is not much different from the results of wood pyrolysis research by Gilbert et al. [6]. The volatile content of Indonesian rubber wood is about 71.8 % as reported by Surjosatyo et al. [7]. The low volatile content in wood charcoal gives an indicator of the low tar could be produced from the charcoal gasification. The use of wood charcoal as fuel in the gasification will avoid the utilization of the gas cleaners [8]. The stability of the flame and the CO composition are produced by charcoal gasification could be compared to corn pith and coal gasification [9].

Several studies have been conducted on the charcoal gasification to drive the engine, Homdoung et al. [10] utilized the gas produced by the gasification of wood charcoal to drive the gasoline engine. Ayutaya et al. [11] conducted an experiment wood charcoal gasification on the gasoline engine. As explained earlier, the use of producer gas from charcoal gasification continues to be developed. In this study carried out the utilization of producer gas from charcoal gasification in diesel and gasoline engines.

2. METHODOLOGY

The wood charcoal gasification process was done in imbert downdraft gasifier [12]. The size of wood charcoal used was about 2 x 2 x 2 cm as shown in Figure 1. Initial testing of the wood charcoal gasification was carried out to investigate the stability of the producer gas and the air-fuel ratio of wood charcoal gasification.

Figure 1 Wood charcoal

After the stability of combustible gas could be reached on gasification process, furthermore, the utilization of producer gas in diesel and gasoline engines was carried out on various of electrical loads. The diesel engine used has a maximum electric load capacity of 3 kW with the name commercial of daihong as in Figure 2 (a), while the gasoline engine used has a maximum load of 1 kW with the commercial name of captain as shown in Figure 2 (b). The experimental setup was used as shown in Figure 3.

Figure 2 Diesel (a) and Gasoline Engine (b)

Figure 3 The Experimental Set-Up

Tests were done with the variations of electric load of 0; 0.3; 0,5; 0.7 and 1 kW for diesel engine and each of 0; 0;3; 0.5 and 0,7 for gasoline engine. Each of loads were tested in single fuel and dual fuel operation for calculating of the fuel savings. The fuel savings was determined by using equation (1) [13,14].

$$Fuel\ Savings\ = \frac{Vs - Vd}{Vd} \times 100\% \quad (1)$$

Where Vs is flow rate of fuel in operation single fuel and Vd is flow rate of fuel in operation dual fuel.

3. RESULTS AND DISCUSSION

3.1. Gasification Operation

The results of gasification air-fuel ratio were, at interval of 1.7 – 2 kg of air/kg of fuel, as shown in Figure 4. The testing of combustible gas stability was repeatedly carried out at the gasification air mass flow rate constant. The time stability of combustible gas was, at interval of 91 – 105 min as shown in Figure 5. The appearing of combustible gas flame at daylight was redder than at night as shown in Figure 6. It caused by less volatile content.

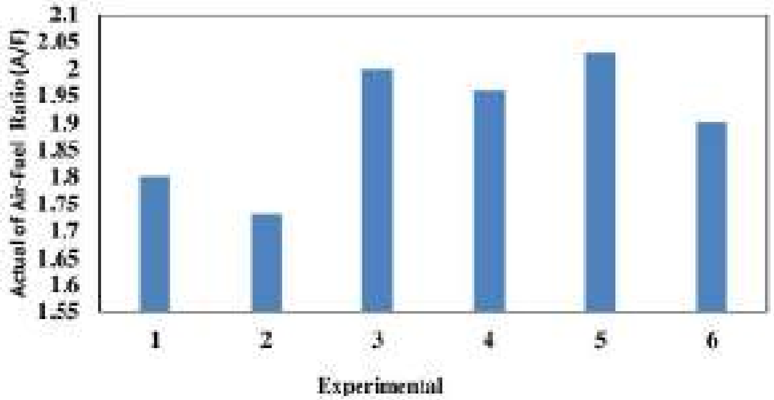

Figure 4 Actual Air Fuel Ratio

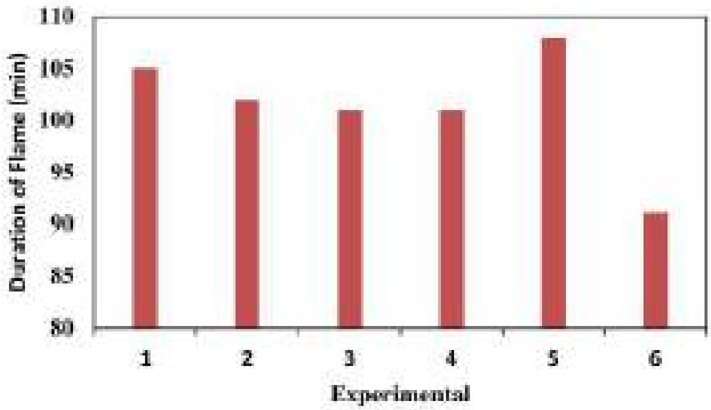

Figure 5 Duration of Flame.

Figure 6 Combustible Gas Flame

3.2. Application of Producer Gas in Diesel Engine

Figure 7 shows the effect of an increasing the electric load on consumption of diesel oil in operating single fuel and dual fuel. In single fuel operation when the load was increased from 0 to 1 kW would increase the rate of volumetric consumption of diesel fuel from 0.32 l/h to 0.6 l/h. In dual fuel operations when the load was increased from 0 to 1 kW would increase diesel fuel consumption from 0.1 to 0.2 l/h. Diesel fuel consumption rate in dual fuel operation were lower than single fuel operation for various electrical loads. The amount of diesel fuel savings was average of 65.8 % in dual fuel operation, as shown in Figure 8.

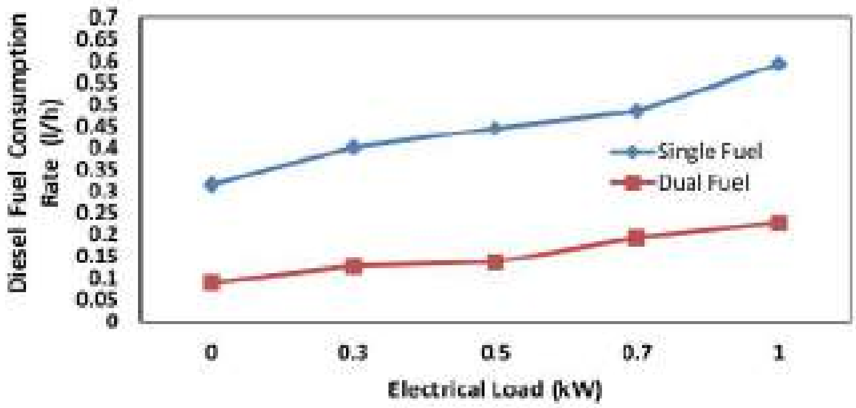

Figure 7 Diesel Fuel Consumption Rate

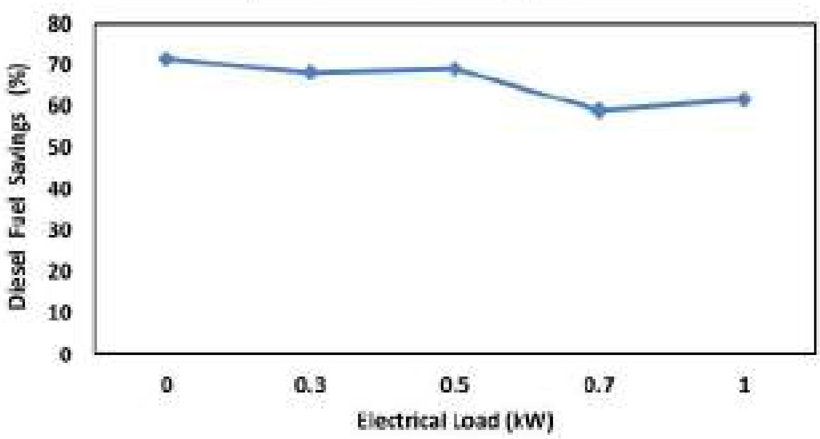

Figure 8 Diesel Fuel Savings

3.3. Application of Producer Gas in Gasoline Engine

Figure 9 shows the effect of an increasing the electrical load on the gasoline consumption in the operation of single fuel and dual fuel. In single fuel operation when the electrical load was increased from 0 to 0.7 kW would increase the volumetric rate of the gasoline fuel consumption from 0.25 to 0.46 l/h. In dual fuel operations when the load was increased from 0 to 0.7 kW would increase the gasoline fuel consumption from 0.2 to 0.37 l/h. At every electrical load, the gasoline fuel consumption rate in dual fuel operation was lower compared to single fuel operation. The amount of the gasoline fuel savings for increasing of the electrical loads from 0 to 0.7 kW was average of 19.8 %, as shown in Figure 10.

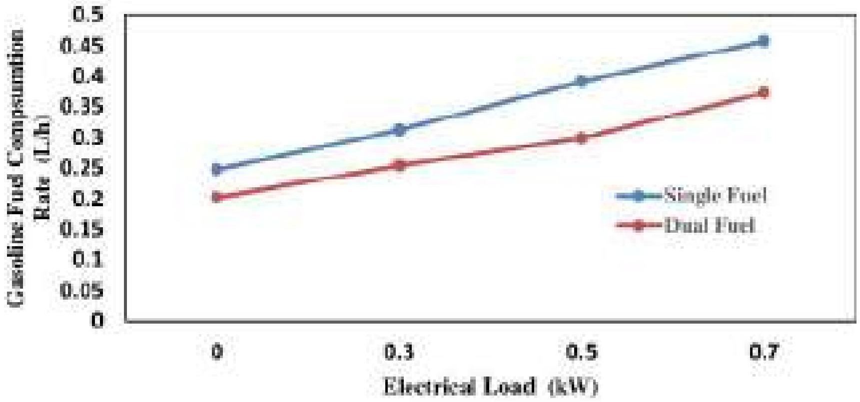

Figure 9 Gasoline Fuel Consumption Rate

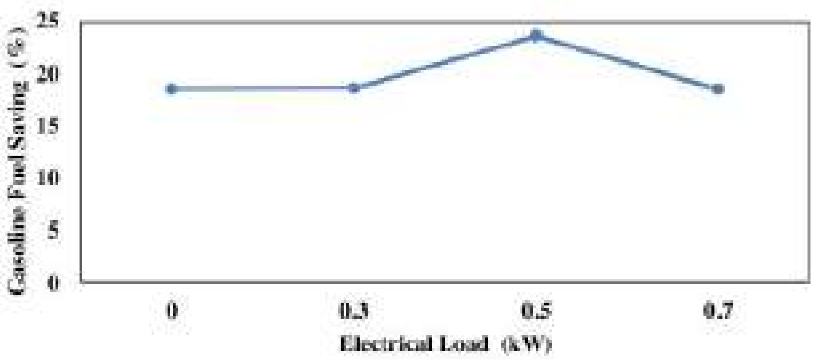

Figure 10 Gasoline Fuel Savings

4. CONCLUSIONS

Gasification of wood charcoal successfully has been done to produced a stability of combustible gas within in the range of 1.7 - 2 of actual air-fuel ratio. The applications of the producer gas in diesel engines could save more fuel than in gasoline engine each average of 65.8% and 19.8 % respectively.

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