Effect of Peralite-Spiritus Blend Fuel on Performance of Single Cylinder Spark Ignition Engine

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Abstract. This work aims to experimentally investigate an effect of Spiritus and Peralite blend on engine’s performance (brake horsepower and torque, specific fuel consumption rate, and exhaust gas emission). The tests are conducted at 3000-7000 rpm for four different fuels, i.e., peparalite, 95%P-5%S, 90%P-10%S, and 85%P-15%S to obtain an optimum ratio of the Peralite-Spiritus blend. The blend ratios of Peralite (P) and Spiritus (S) are measured by volume. The result shows that addition of 15% Spiritus (by volume) on Peralilte can enhance the combustion process of the blend hence increasing engine’s brake horsepower and decreasing specific fuel consumption rate. However, engine’s torque is lower when using the blend 85%P-15%S if compared with using Peralite.

1. Introduction
In recent years, fuel fossil depletion and global warming issues have been a serious problem worldwide. Many renewable fuels have been tried for fossil fuel substitution as well as additional fuel. Alcohol fuels (methanol and ethanol) have a potential for internal combustion engine fuel due to its high antiknock and ability for reducing CO and UHC emission [1]. Bioethanol is also attractive renewable bio-based fuel and its oxygenated characteristics able to reduce particulate emission in CI engine [2]. The use alternate fuels also have been proposed for reducing combustion-related pollution [3].

Due to the advantages of alcohol fuel, i.e., methanol and ethanol, many researchers work intensively in the area of alcohol fuel for internal combustion engine. Vapour pressure of gasoline-alcohol blend increases as alcohol composition in the blend increases, but the pressure decreases after optimum quantity of alcohol added [4]. The ethanol addition increases torque output and fuel consumption, CO and HC dramatically reduced [1]. Emission of CO₂ increases with the use of ethanol-gasoline blends which indicates combustion improvement. Meanwhile, engine performance and exhaust gas emission of ethanol-gasoline blend fueled engine could be affected by ignition timing [5]. The same tendency of CO, HC, and CO₂ in exhaust gas was also found for the use of ethanol-unleaded gasoline [6]. Exhaust gas emission as a function of compression ratio from engine fueled by Ethanol-Gasoline blend [7].

Some works were also performed specifically on ethanol-gasoline combustion. Flame propagation of gasoline-ethanol blend in SI engine has been investigated by [8]. Flame speed accelerated when 25% ethanol is added to gasoline. Spray characteristics of the ethanol-gasoline blend were also studied by Gao [9]. In the case of swirl type injector, the spray pattern development is not significantly changing when using ethanol gasoline with a different fraction. However, the use of alcohol as a fuel addition is a required modification on engine carburetor [10]. The effect of ethanol and unleaded
gasoline blends on engine performance which the ethanol amount was in the range 0-25% [6]. The results showed the engine performance was improved and the engine power was increased significantly.

In this work, the effect of Spiritus addition on Pentalite on engine’s performance (brake horsepower and torque, specific fuel consumption rate, and exhaust gas emission) is experimentally investigated. The tests are conducted at 3000-7000 rpm for four different fuels, i.e., pertalite, 95%P-5%S, 90%P-10%S, and 85%P-15%S. The blend ratios of Pentalite (P) and Spiritus (S) are measured by volume. The experiment purposes to obtain an optimum ratio of the Pentalite-Spiritus blend.

2. Experimental Setup

2.1. Fuel characterization

Spiritus is a blend of Ethanol and Methanol and has a high octane number (HON). The Spiritus has a potential to be used as additional fuel of low octane number (LON) fuel, i.e., Pentalite. Properties of Pentalite and Spiritus are shown in Table 1.

| Properties                        | Pentalite       | Spiritus        |
|-----------------------------------|-----------------|-----------------|
| Lower Heating Value               | 83.84 MJ/kg     | 26.90 MJ/kg     |
| Research Octane Number            | 90 (LON)        | 123 (HON)       |
| Specific gravity                  | 0.77            | NA              |
| Heat of vaporization              | 343 kJ/kg       | NA              |
| Laminar burning velocity (at λ = 1) | 0.5 m/s    | NA              |

2.2. Engine performance setup

Figure 1 shows engine performance setup in this work. Engine test is single cylinder 125 cc gasoline engine. Engine performance is measured in terms of brake horsepower (BHP) and torque, specific fuel consumption rate (SFCR), and exhaust gas emission. The brake horsepower and torque are measured using Dyno test, the specific fuel consumption is determined using the amount of fuel consumed in the buret within particular testing time, and exhaust gas emission is detected with the use of exhaust gas analyzer. The tests are conducted at 3000-7000 rpm for four different fuels, i.e., pertalite, 95%P-5%S, 90%P-10%S, and 85%P-15%S. The blend ratios of Pentalite (P) and Spiritus (S) are measured by volume. For each test, the data taken at interval engine speed of 1000 rpm, i.e., 3000 rpm, 4000 rpm, 5000 rpm, 6000 rpm, and 7000 rpm. The collected data are compared to each blend.

![Figure 1. Engine performance setup.](image-url)
3. Results and Discussion

Figure 2 shows the effect of the fuel blend on Engine’s Brake Horse Power (BHP) and Torque base on rpm. When Spiritus content in the blended fuel was increased, the BHP slightly increased for all engine speeds. Engine power was increased gradually as a percentage of ethanol increased in blended fuels (up to 10% [11]) [6,11]. The optimum BHP obtained when 15% Spiritus is added on Pentalite for all engine speed variation. On the other hand, the addition of 15% Spiritus also decreases engine’s torque. Increasing methanol content in blended fuel (30-50%) will decrease the engine power for all engine speeds [11].

![Figure 2](image)

**Figure 2.** Characterize of engine’s BHP and Torque with fuel blend variations.

Specific fuel consumption rate (SFCR) is affected by Spiritus addition on Pentalite as shown in Figure 3. The SFCR reduces when 10% and 15% by volume Spiritus are added on Pentalite but the SFCR increases for a blend of 95% Pentalite-5% Spiritus by volume. This result was not in line with Iliev [11] that SFCR increased as the ethanol (methanol) percentage increased. Increased ethanol up to 20% will reduce the SFCR, similar with the result of this study [6].

![Figure 3](image)

**Figure 3.** Effect of fuel blend on SFCR.

Meanwhile, Figure 4 presents an average value of CO, CO₂, and HC in exhaust gas emission. The value is engine speed averaging. The graph shows comparison of exhaust gas emission of the blends that a complete combustion occurs when using the blend 85%-P-15%S if compared with the use of
95%P-5%S and 90%P-10%S blends. A complete combustion is indicated by higher CO\textsubscript{2} and lower HC in exhaust gas emission as shown by 85%P-15%S blend.

![Figure 4. Concentration of CO, CO\textsubscript{2}, and HC in exhaust gas emission.](image)

### 4. Conclusion
Increasing the Spiritus content in the blended fuel will slightly increase the BHP for all engine speeds. The addition of 15% Spiritus (by volume) on Pentalite can enhance the blend combustion hence improve engine’s brake horsepower and decrease specific fuel consumption rate. However, engine’s torque is lower when using the blend 85%P-15%S if compared with using Pentalite.

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