Effect of performance generator set 1.5 PK 4 stroke with variations in load and type of spark plugs

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Abstract. Energy is one of the most important needs for humans, and electricity is one of the energy needs needed to support various human activities both day and night. One source of electrical energy is obtained by using a generator as a power plant. The generator set is used as a backup when the electricity supply from PLN is cut off. Efforts to get a good performance generator set are made by improving the combustion quality to increase efficiency. Tests carried out on a four-stroke one cylinder generator capacity of 1.5 PK with variations in load and type of spark plugs are standard, platinum, and iridium, which at 3000 rpm engine speed with a load of 350, 700 and 1050 Watt pentalite fuel with a volume of 10 ml. The value of Torque and power has increased along with the increased engine load. The optimum generator performance is obtained at a load of 700 watts when using this type of platinum spark plug. The maximum engine power generated is 1,092 HP. Torque of 2.59 Nm and the lowest fuel consumption (SFC) of 0.484 kg/hp.hour.

Keywords: spark plugs, generator set, four-stroke

1. Introduction
A generator or what is also called a Generator Set is a device capable of producing electrical power, which consists of a combination of a generator or alternator with the engine. Where the machine is the driving force, and the generator produces electricity [1]. Based on the type of fuel used, the generator set consists of gasoline, Liquid Petroleum Gas (LPG), and diesel fuel. Based on how to turn it on, pull, use a spin (crank), and use an electric starter[2]. Gasoline generator sets require spark plugs as a primary source of ignition for the combustion process. This type of ignition is called the Spark Ignition (SI). A spark plug’s function is to provide a high-voltage spark jump between two electrodes that triggers an air-fuel mixture in the combustion chamber[3].

According to the type, there are two spark plugs, namely hot spark plugs and cold spark plugs. Hot spark plugs absorb and dissipate or release heat slowly. This type is only used for engines with low combustion chamber temperatures. Meanwhile, cold spark plugs absorb and remove or
release heat quickly and are commonly used for engines with high combustion chamber temperatures [4]. These types of spark plugs are known as standard spark plugs, platinum spark plugs, and iridium spark plugs. The standard spark plug is a spark plug built into the motorbike, the manufacturer. It can be used for normal combustion conditions up to a distance of 20 thousand km[5].

While iridium spark plugs are designed for large motors above 150 cc, the electrodes are made of nickel, this type of spark plug can last 50-70 thousand km. And for this type of platinum spark plugs are very suitable for long trips. The platinum spark plug can reach 30 thousand km. The electrodes are made of nickel, and the center electrodes are made of platinum.

In a study conducted[5] using four types of spark plugs namely standard spark plugs, iridium spark plugs, platinum spark plugs, and Splitfire V. spark plugs The results of the research conducted showed that the use of spark plug variations affects the performance of a four-stroke 115 cc motorcycle engine.

By using Standard Spark Plug, Platinum, Double Iridium. Tests carried out on 110 cc motorbikes with variations of spark plugs and the fuel used to affect increasing the power and Torque produced[6]. Compared to standard and platinum spark plugs, the Duration double Iridium type produces relatively constant sparks and the color of flashes that are dark blue, according to the color temperature in the temperature range of 8000-9000 Kelvin.

It also carried out the same study using iridium spark plugs for two different brands of Bosch and Denso with LPG fuel[7]. Higher engine performance is achieved when using a Denso spark plug while the lowest fuel consumption is achieved when using a Bosch spark plug. Nevertheless, this research concludes there is no significant difference in power and engine performance.

For this reason, based on the background above, of the many studies conducted, no research has been done on Generator Sets (Genset). In this study, a load test was performed on a 1.5 PK 4 stroke 1 Cylinder Over Head Valve (OHV) generator with variations of standard spark plugs, platinum, and iridium, to see its performance, both power, Torque and the use of fuel used. In this study, the fuel used was Pentalite, with an octane number of 90. The equation used to calculate power:

\[ P = V \cdot I \]  
Where:
- \( P \) = Power (Watt)
- \( V \) = Voltage (Volt)
- \( I \) = Current (Ampere)

Power (load) is converted to Horse Power to get Torque:

\[ HP = \frac{P}{746} \]  
So that Torque is obtained by using the equation [8]

\[ T = \frac{5250 \cdot HP}{n} \]  
Where:
- \( T \) = Rotating body torque (lb.ft)
- \( HP \) = Motor horse power
\( n \) = Engine speed (Rpm)

To calculate fuel consumption with an equation:

\[
M_f = \frac{V_f}{t} \cdot \frac{3600}{1000} \cdot \rho_{bb}
\]

(4)

Where:
- \( M_f \) = Fuel consumption (kg/hour)
- \( t \) = Time (s)
- \( V_f \) = consumption volume (ml)

Calculation of specific fuel consumption (SFC) using the equation:

\[
Sfc = \frac{M_f}{P}
\]

(5)

Where:
- \( Sfc \) = Fuel consumption Specific (kg/hp.hour)
- \( M_f \) = fuel consumption (kg/hour)
- \( P \) = Power (HP)

2. Materials and methods

2.1. Materials

Equipment and materials used, first the Genset Hirochi NC2800 in standard conditions. Second, standard spark plugs, iridium spark plugs, and platinum spark plugs. Third, Heater 350 Watt as much as three units as a generator load. Fourth, stopwatch, fifth digital tachometer. Sixth, ammeters and voltmeters to measure current and voltage. Seventh, artificial fuel tanks as fuel containers. Eighth, a measuring cup used to measure fuel capacity (pertalite).

2.2. Methods

The study was conducted experimentally involving several independent and dependent variables. The independent variable uses standard spark plugs, iridium spark plugs, and platinum spark plugs installed in the engine. In comparison, the study’s dependent variable was to determine differences in power, Torque, and the amount of fuel consumption of 1.5 PK generators with variations of standard spark plugs, platinum, and iridium spark plugs.

To retrieve test data, the steps are as follows. First, take volt meter voltage and current data with an ampere meter on the generator with a constant rotation of 3000 Rpm at 350, 700, and 1,050 watts with a standard spark plug. Second, to test fuel consumption and calculate the SFC value of fuel using standard spark plugs. With the same steps, replacements for Iridium and Platinum spark plugs are carried out. After the data is finished, it is done through analysis.
3. Results and discussion

3.1. Research result

Performance testing of gasoline generators with pertalite fuel under engine conditions using standard spark plugs, iridium spark plugs, and platinum spark plugs at 3000 rpm rotation with a load of 350, 700 and 1050 watts. The data obtained are:

Table 1. Comparison of variations in load and type of spark plug vs. voltage and electric current

| Load (Watt) | Standard | | | Iridium | | | Platinum | | |
|-------------|----------|------|------|----------|------|------|----------|------|------|
|             | Voltage (V) | Current (A) | Voltage (V) | Current (A) | Voltage (V) | Current (A) | Voltage (V) | Current (A) |
| 350         | 208      | 2.1  | 209  | 2.1      | 210.4      | 2.1       |            |           |
| 700         | 207      | 3.86 | 207.5| 3.88     | 209        | 3.90      |            |           |
| 1050        | 185      | 4.1  | 187.9| 4.1      | 188        | 4.1       |            |           |

Figure 1. Power relationship with load variation and spark plug type at 3000 rpm
Figure 2. Torque relationship with load variation and spark plug type

Figure 3. Specific fuel consumption relationship with load variations and spark plugs type
3.2. Discussion

Based on the test results above, the 1.5 PK 4 stroke agile engine's performance with variations in load using three different types of spark plugs are standard, iridium, and platinum at 3000 rpm motor shaft rotation. Figure 1 the lowest engine power when using standard and iridium spark plugs at a load of 300 watts is 0.58 HP, while the maximum engine power when using platinum spark plugs at 700 watts load is 1,092 HP.

A platinum spark plug gives the maximum Torque at a 700-watt load of 2.59 N.m (Figure 2). While the lowest specific fuel consumption (SFC) when the engine uses platinum spark plugs at a load of 700 watts is 0.484 kg / hp.hour. The highest fuel consumption when the engine uses platinum spark plugs is 350 watts of a load equal to 0.793 kg / hp.hour (Figure 3).

The engine uses a platinum spark plug when loading 700 watts consumes the lowest fuel based on the picture above. While the power or Torque produced is also higher than standard and iridium spark plugs, this shows that the optimum 1.5 Hp generator's performance at 700-watt loads uses platinum spark plugs with the lowest fuel consumption. Overall, Genset's performance by looking at figure 4. Along with the increasing generator load, the power generated is higher. Likewise with the Torque produced also increased. In comparison, the fuel consumed by the generator in each loading phase fluctuates.

4. Conclusion

The highest power obtained at platinum spark plugs reaches 1,092 hp at 3000 rpm rotation and a 700 Watt load, while the lowest energy is received at standard spark plugs and 0.58 hp iridium with a 350-watt load at 3000 rpm rotation.

While the highest Torque is obtained at the platinum spark plug, which reaches 2.59 Nm with a load of 700 Watt, while the lowest Torque is received at the standard spark plug and iridium at 1.37 Nm at 3000 rpm rotation at 350 watts.

The lowest specific fuel consumption (SFC) is found in platinum spark plugs 0.484 kg hp$^{-1}$ hour$^{-1}$ at 3000 rpm and a load of 700 watts. While the highest specific fuel consumption obtained at iridium spark plugs reached 0.57 kg/hp—hours at 3000 rpm with a 350 Watt load.

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