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EFFECT OF USING IRIDIUM AND PLATINUM SPARK PLUGS ON FUEL CONSUMPTION AND EXHAUST EMISSION

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Abstract

This research analysed the effect of using iridium spark plugs and platinum spark plugs on fuel consumption and exhaust emissions on motorbikes with 50 C engine types. We analysed the experiments theoretically and empirically. The results showed different types of combustions and exhaust emissions. The platinum spark produced lower fuel consumption compared to iridium spark plugs. The empirical results were in good agreement with the theoretical analyses. The better combustion observed with certain spark plugs, like platinum, could be due to their ability to provide a more consistent spark, leading to a more efficient burn of the fuel-air mixture. In the analysis of exhaust emission, the lowest CO and HC values were obtained when using iridium spark plugs. For fuel efficiency, Platinum spark plugs are better, as they reduce fuel consumption. For exhaust emissions, Iridium spark plugs are preferable, as they result in lower CO and HC emissions. Platinum spark plugs are more efficient in terms of fuel consumption, but iridium spark plugs excel in reducing harmful emissions. This test provides information relating to the selection of spark plugs that are appropriate for their intended use. The impact of this research is to provide solutions to reduce fuel consumption and exhaust emissions following the provisions that have been set.

Keywords: Exhaust emissions, Fuel consumption, Iridium spark plugs, Platinum spark plugs.

1. Introduction

The increasing number of motorcycles requires special attention to fuel efficiency and emission reduction, especially through advances in ignition systems. Research shows that the type of spark plug significantly influences fuel consumption and exhaust emissions, which is critical to meeting environmental standards and performance demands [1-4].

A combustion engine is an energy conversion machine that converts chemical energy into heat and motion energy through the combustion process [5]. Data from the Central Statistics Agency shows that the number of motorbikes continues to increase every year, in 2021 the number of motorbikes was 120,042,298, and in 2022 it increased to 125,305,332.

Thus, the need for fuel will also increase, while fuel supplies are now very limited, therefore efforts are needed to save current fuel. Not only is there a problem with the need for fuel consumption, but this will also have an impact on the levels of exhaust emissions produced by vehicles. Excessive exhaust emissions caused by the incomplete combustion process in the cylinder produce residual gas and particles. These exhaust gas emissions are very dangerous for human health because they contain substances that are not good for health [6].

The use of iridium spark plugs shows superior fuel efficiency, consuming only 0.078 kg/h.hp at 6000 rpm, compared to 0.087 kg/h.hp for platinum spark plugs[5]. The use of iridium spark plugs can reduce CO emissions by 29% and HC by 61%, outperforming platinum spark plugs [7]. A powerful spark from a high-quality spark plug increases combustion efficiency, resulting in optimal power output and lower emissions [8]. Inefficient combustion produces harmful residual gases, emphasising the need for effective ignition systems to reduce health risks associated with tailpipe emissions [7].

The purpose of this study is to determine the fuel consumption and exhaust emissions produced by the use of iridium spark plugs and platinum spark plugs. The novelty of this study is to compare two spark plug materials in the efficiency of fuel consumption and exhaust emissions produced.

2. Literature Review

Four technological demands must be met by every vehicle, namely (i) must have high performance, (ii) save fuel, (iii) produce low vibration and sound, and (iv) low exhaust emissions [9]. Thus, several variations can be made to meet these demands. The ignition system is one of the many components that have an important role in an engine. The ignition system requires a spark plug to channel current into the combustion chamber by providing a spark to burn the compressed mixture of fuel and air [10].

Spark plugs can spark sparks which will then ignite the mixture of materials quickly, producing optimal power output [11]. A strong spark will increase engine efficiency, where engine performance will increase, and the resulting exhaust emissions will be almost perfect [12]. With this ability, spark plugs have the potential to save fuel and produce low exhaust emissions [11]. Influence of spark plug type on fuel consumption; platinum iron and iridium iron can improve the performance of the combustion process and increase fuel efficiency [13]. Iridium

spark plugs get the lowest fuel consumption, namely 0.078 kg/h.hP at 6,000 rpm rotation, while fuel consumption using platinum spark plugs is 0.087 at 6,000 rpm rotation [11], from these results it is known that fuel consumption Iridium spark plugs are more economical than platinum spark plugs.

The use of iridium and platinum spark plugs significantly affects fuel consumption and exhaust emissions in internal combustion engines. Research shows that while both types improve performance, the effects vary. Impact on fuel, the use of platinum spark plugs, shows superior fuel efficiency, consuming less fuel across a wide range of RPM compared to iridium spark plugs. For example, at 2,000 RPM, a platinum spark plug consumes 20 mL, while an iridium spark plug consumes 10 mL at lower RPM but 50 mL at higher RPM [12]. The use of iridium spark plugs, although providing better ignition and engine performance, can cause higher fuel consumption under certain conditions [13].

Effect on exhaust emissions: The use of iridium spark plugs, demonstrated a 13% reduction in nitrogen oxide emissions when used with alternative fuels, demonstrating their effectiveness in controlling emissions [14]. Meanwhile, platinum spark plugs reduce CO emissions by an average of 7% when paired with high-octane fuel, highlighting their efficiency in minimising the output of harmful exhaust gases [15].

The use of platinum spark plugs reduces CO emission levels by 20% and HC by 41%, while iridium spark plugs reduce CO emission levels by 29% and HC by 61%, and the fuel efficiency of iridium spark plugs shows the best efficiency compared to platinum spark plugs [16]. The use of this type of spark plug can affect exhaust emissions and fuel consumption [17].

Conversely, while iridium plugs improve ignition and performance, they may not always be the most fuel-efficient choice. The choice between spark plugs must take into account specific engine conditions and fuel types to optimise fuel consumption and emissions.

3. Method

This research uses experimental methods, using a dynamometer to determine torque and power, a tachometer, a 50 ml burette, a fuel hose, and a device to calculate and record time. Testing was carried out in 3 (three) conditions, namely 1) at idle (800-1,200) rpm, 2) at 4,000 rpm, and 3) at 8,000 rpm, empirical testing was carried out at a distance of 500 metres at a speed of 40 km, measuring material consumption burn using a burette tool connected to a carburettor.

4. Results and Discussion

4.1. Fuel consumption test results

Fuel consumption testing was carried out in three conditions, namely at idle, 4,000 rpm, and 8,000 rpm (Table 1). Platinum spark plugs in all conditions get the lowest results compared to iridium spark plugs, where platinum spark plugs produce 15.4 ml in the first test in idle conditions, 34 mL at 4,000 rpm, and 9 ml at 8,000 rpm in 30 seconds, this is in line with the results of calculations carried out theoretically. The calculation results prove that the thermal efficiency of iridium spark plugs is higher, namely 0.04474 kcal/kg, which causes the next cycle to require more fuel.

Table 1. Fuel consumption test results.

No	Spark Plug	RPM	Fuel consumption (mL)	Time
1	Platinum	800–1,200	15.40	5 min
			16.40	
			16.50	
		4,000	34.50	5 min
			34.00	
			36.50	
		8,000	9.00	3 s
			9.30	
			10.00	
2	Iridium	800–1,200	17.20	5 min
			15.90	
			16.20	
		4.000	16.30	5 min
			36.00	
			39.00	
		8,000	10.30	3 s
			10.70	
			10.70	

The use of iridium spark plug material shows an increase in fuel consumption of 3.0% during idle and 1.3% during city driving compared to spark plugs with platinum material [18]. Calculation of volumetric efficiency (the mixture of air and fuel that can be sucked into the cylinder) also affects fuel consumption, where iridium spark plugs have a volumetric efficiency value of 80.29% while platinum spark plugs are 74.68%. The greater the volumetric efficiency, the more air and fuel that enters the combustion chamber so that the power produced will be greater.

Table 2 shows the results of the performance calculation of two types of spark plugs, platinum spark plugs and iridium spark plugs, Iridium spark plugs have higher combustion efficiency (80.29%) compared to platinum spark plugs (74.68%). This means that more fuel is converted into useful energy. Iridium spark plugs produce greater effective power (14.54 PS) compared to platinum spark plugs (13.82 PS). Effective power indicates how well the engine converts fuel energy into power. Iridium spark plugs show higher indicator power (18.17 PS) compared to platinum spark plugs (17.28 PS).

Indicator power usually measures the total energy produced before taking losses into account. Iridium spark plugs have better heat conversion (0.04472 Kcal/cycle) compared to platinum spark plugs (0.04171 Kcal/cycle). This shows that iridium spark plugs are more efficient in converting heat into power. Iridium spark plugs consume more fuel (1.705 kg/hour) compared to platinum spark plugs (1.62 kg/hour). Although iridium spark plugs are more efficient in producing power, they require more fuel to achieve that performance. Overall, iridium spark plugs show superior performance in terms of efficiency and power, although with slightly higher fuel consumption.

Table 2. Calculation results.

Spark Plug	Volume Yield (%)	Power Effective (PS)	Power Indicator (PS)	Heat Converted to Power (Kcal/cycle)	Fuel Consumption (kg/hour)
Platinum	74.68	13.82	17.28	0.04171	1.62
Iridium	80.29	14.54	18.17	0.04472	1.705

Figure 1 shows that the lowest fuel consumption for iridium spark plugs was 12 ml in the first test, the same results were produced by platinum spark plugs in the second test, while the lowest fuel consumption produced by platinum spark plugs at the same distance and speed was 11.30 mL. In the empirical test, two factors can influence the results, when pulling the gas lever on the motorbike, the first test and subsequent tests will not get the same results and the speed indicator factor when testing with a distance of 500 m cannot be consistent at 40 km/hour.

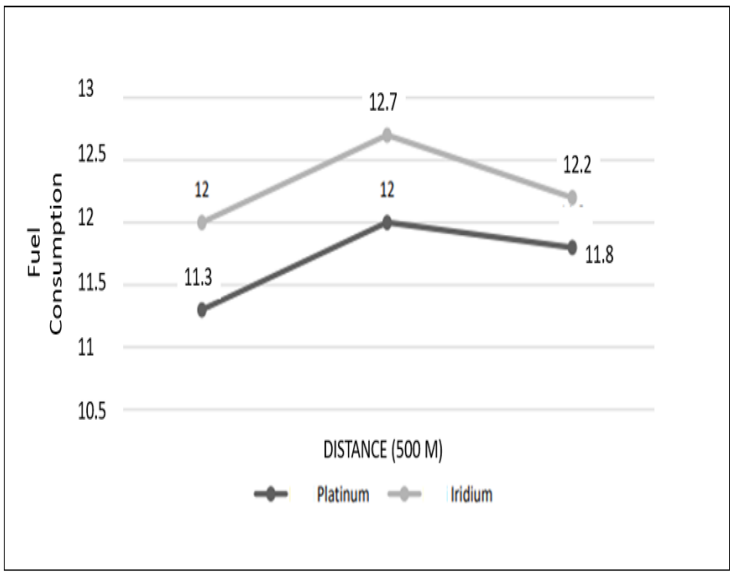

Fig. 1. Empirical test results.

4.2. Exhaust Gas Emission Test Results

Figure 2 shows the content of CO exhaust emissions from using iridium spark plugs and platinum spark plugs. The value of CO produced from using iridium spark plugs is 4.05%, while from using platinum spark plugs the CO produced is 4.62%.

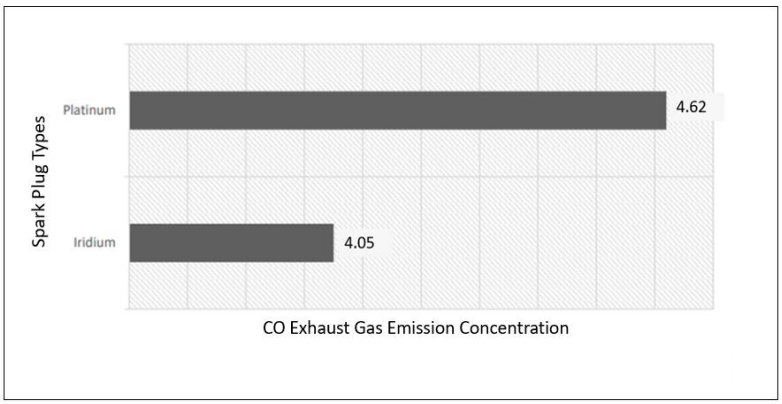

Fig. 2. CO exhaust gas emission test results.

The formation of CO can be influenced by the ratio between air and fuel that enters the combustion chamber, when the mixture is rich (lack of air), less oxygen is needed to bind atoms from the fuel through a chemical reaction and turns into CO resulting in the CO exhaust emissions. the resulting output will tend to increase [19]. Meanwhile, when the mixture is too poor (excess air), the resulting CO exhaust gas emissions tend to decrease because there is not enough oxygen from the air to fulfil the reaction with carbon to form CO_2. CO is a gas resulting from poor or incomplete combustion because during the combustion process, there is a lack of oxygen, this compound is very dangerous for the respiratory system if inhaled on a large scale [20].

Figure 3 presents data on HC exhaust emissions with the use of iridium and platinum spark plugs, the HC value tends to decrease when compared with the use of platinum spark plugs, namely 653 ppm, while the HC exhaust gas emission levels when using platinum spark plugs are much higher, namely around 1.508 ppm, almost doubled.

The formation of HC gas is caused by problems with the ignition system, namely incomplete combustion of the fuel. This is caused by inadequate compression, which results in only partial fuel combustion [21].

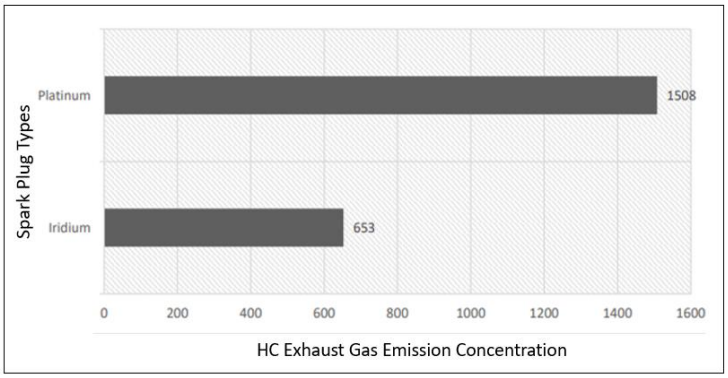

Fig. 3. HC emission test results.

5. Conclusion

This study investigated the effects of iridium and platinum spark plugs on fuel consumption and exhaust emissions in a 50 cc motorcycle engine, using experimental and theoretical analysis. The results showed that platinum spark plugs reduced fuel consumption more than iridium spark plugs, which had higher thermal efficiency and volumetric yield but required more fuel in the next cycle. However, iridium spark plugs produced lower CO and HC emissions. This study aims to offer an alternative spark plug option to optimise fuel efficiency and comply with emission standards.

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