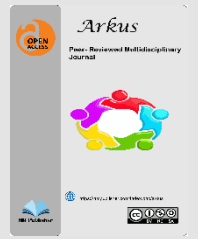




ARKUS

Journal Homepage:

<https://hmpublisher.com/index.php/arkus>



Differences of Fuel and Capacitor Discharge Ignition in Energy Output of Motorcycle

Muhammad Khumaedi^{1*}, Wahyudi¹, Muhammad Burhan¹

¹ Department of Mechanical Engineering, Faculty of Engineering, Universitas Negeri Semarang, Semarang, Indonesia

ARTICLE INFO

Keywords:

Ignition system
Gasoline
Engine performance
Engine fuel
Capacitor

Corresponding author:

Muhammad Khumaedi

E-mail address:

m_khumaedi@gmail.com

All authors have reviewed and approved the final version of the manuscript.

<https://doi.org/10.37275/arkus.v6i2.83>

ABSTRACT

The combustion engine is one of the internal combustion engines or often referred to as an internal combustion engine, namely a machine that converts energy thermal energy into mechanical energy. The energy itself can be obtained from the combustion process. One of the simple motorized vehicle transportation tools that are widely used by society today is the motorcycle. The ability of a motorcycle is influenced by several factors, including the quality of the fuel and the ignition system. The use of poor quality fuel can result in a decrease in motorcycle engine performance. Therefore, the selection of the right fuel refers to the compression ratio of each motorcycle. The higher the compression ratio of a motorcycle, the better the quality of fuel it must use.

1. Introduction

The motorcycle is a means of transportation that is driven by a gasoline engine. The type of gasoline can be divided into three types, namely premium, pertamax, and pertamax plus. The difference between these three types of fuel is in the octane number, where the octane number usually indicates the quality of the fuel. The higher the octane number, the more expensive the price per liter. Motorcycle engines require the type of fuel according to the engine's design to work correctly and produce optimal performance.

The low octane number allows the fuel to

detonate. Fuel that is easy to detonate will reduce motor performance because it will experience power losses due to fuel-burning prematurely and making fuel consumption more wasteful. After all, the combustion is not perfect, while the higher the octane number allows the fuel not to detonate to increase fuel consumption. Motor performance and make combustion more perfect so that fuel consumption becomes efficient. The ignition system is one of the many components of a motorcycle that is most often developed. Obtaining good engine performance required a good ignition system as well. The ignition



<https://hmpublisher.com/index.php/arkus>

system is a critical system on a motorcycle.¹

Capasitor discharge ignition-DC system

The CDI-DC ignition system uses current from the battery, in contrast to the CDI-AC, which comes from the source coil. CDI-DC (direct current) also has several advantages and disadvantages. The advantages of CDI-DC are that the voltage-current is sourced from the battery to be stable, the spool rarely dies, and at low rpm, the ignition remains maximal. The weakness of CDI-DC is that if the battery is weak, it can cause damage to the CDI, is sensitive to short circuits, and is relatively more expensive than CDI-AC.^{2,3}

According to Jama et al., the current will flow from the battery to the switch when the ignition is on. When the switch is on, the current will flow to the current amplifier coil in the CDI, increasing the voltage from the DC Volt battery to 220 Volt AC. Next, the current is rectified through the diode and then supplied to the condenser for temporary storage. Due to engine rotation, the pulse coil generates current, activating the SCR, thus triggering the condenser/capacitor to flow current to the primary coil of the ignition coil. When there is a cut in the current flowing in the primary coil of the ignition coil, an induced voltage arises in the two coils, namely the primary coil and the secondary coil, and produces a spark jump on the spark plug to burn the fuel and air mixture.

CDI limiter

This CDI limiter is a CDI given from the factory that produces the motorcycle, used by the Honda Beat 110 cc motorcycle. CDI limiter is a CDI whose ignition is limited to a certain rpm; usually, the CDI limiter is limited to a rotation of approximately 9000 rpm. When the motorcycle goes fast, and the engine speed has reached the limit on the CDI limiter, the engine power will automatically be lowered by the CDI so that the power will drop and fuel consumption will

be wasted. This is because in the electronic diode circuit, there is a Zener diode whose function is to limit the rotation of the motorcycle engine.⁴

CDI unlimiter

CDI unlimiter is a CDI that is usually used by racing motorbikes because the CDI unlimiter has a Zener diode whose breakdown voltage is more significant than that used in the CDI limiter. CDI unlimiter is a CDI that works; there is a limit on its rotation, but the limit is higher at approximately 20,000 rpm than because in the CDI limiter it is approximately 9000 rpm depending on motor specifications. This CDI limiter is made to get maximum power from an engine without any obstacles from the limiter.

Spark plug

According to research conducted by Machmud et al., a component that plays an essential role in the combustion process in a gasoline motor is the spark plug (spark plug). This spark plug is mounted on top of the cylinder in an internal combustion engine. In the spark plug's center, an electrode is connected by wires to the ignition coil on the outside of the spark plug and the ground at the bottom of the spark plug. This spark plug serves to produce electric sparks using the high voltage generated by the ignition coil. The sparks are then used to ignite a mixture of fuel and air, compressed in the cylinder.^{5,6}

The spark plug consists of several parts: the positive electrode, negative electrode, insulator, and the spark plug terminal. The process of the occurrence of an electric spark at the spark plug can be described as follows: the spark plug is connected to a voltage of up to 20,000 Volts generated by the ignition coil. The electrons that are pushed in from the windings produce a voltage difference between the electrodes in the center of the spark plug and those in the camping section. Current cannot flow because the gasoline and air in the gap are



insulators, but the more significant the voltage difference, the gas structure between the two electrodes changes.

Ionization is when the voltage exceeds the dielectric strength of the gas present, which was an insulator, turns into a conductor. Once this happens, a current of electrons can flow, and bypassing electrons, the temperature in the spark gap of the spark plug rises dramatically, up to 60,000 K. This very high temperature causes the ionized gas to expand rapidly, like a small explosion. This is the spark of a spark plug, which in principle is similar to lightning or mini lightning.

The spark plug gap is measured between the distance of the positive electrode and the negative electrode, and the size of the gap on the spark plug will affect the electrical resistance of the spark plug. Besides being affected by the size of the spark plug gap, the electrical resistance is also affected by the compression of the fuel and air mixture. This gap will determine the intensity of the eruption of electric sparks. When a high-voltage current flows from the coil, there is a high voltage between the two spark plug electrodes, resulting in a spark jump.

Spark plugs have a distance between the positive and negative electrodes. The greater the distance between the positive and negative electrodes, the more significant the difference in voltage required to obtain the same intensity of the electric fire. So it can be concluded that the spark plug gap determines the intensity of the electric spark, but to achieve the same electrical spark intensity with a large spark plug gap, a high voltage is also required. Generally, the ignition system provides the voltage needed to ensure that there is always an electric spark in all circumstances, which is between 10,000 - 20,000 volts. Therefore, to achieve an excellent electric spark, the size of the spark plug gap used by the motor needs to be limited and is usually determined according to the technical standards of each motor specification and the tool used to measure the spark plug electrode gap is a

feeler gauge.

Standard spark plug

Standard spark plugs are the default spark plugs from the manufacturer. The electrode tip material is nickel, and the center electrode diameter is 2.5 mm on average. The standard spark plug usage distance can reach 20 thousand km when the combustion conditions are normal and not influenced by other factors, such as engine oil and excessive fuel consumption.

Iridium spark plug

Iridium spark plugs are a new generation with a 0.7 mm diameter positive electrode tip for everyday use with long service life. While the diameter of 0.4 mm is the smallest in the world used for high speed or racing. Spark plug manufacturers have standardized iridium spark plugs with the condition of the motor and the character of the motor, and its use. The electrode core tip material is a mixture of iridium and rhodium (iridium alloy) developed by Japanese Denso technology with a very high melting point. IR spark plugs are designed to require a small working voltage, so there is no need to replace them with others. With a 0.4 mm tapered tip, the resulting fire will be focused on a single point and is more stable. Unlike the 0.7 mm spark plug, in which sparks will rotate. So with iridium spark plugs will get complete combustion.

Gasoline fuel

Gasoline is a saturated compound of hydrocarbons processed from petroleum. The octane number or octane number expresses the quality of gasoline. Gasoline contains hydrocarbons distilled from crude oil production. Gasoline contains flammable gas; generally, this fuel is used for engines with spark ignition. The properties of gasoline include being volatile at normal temperatures, low flash point (-10° to -15°C), low specific gravity (0.60 to 0.78), can



dissolve oil and rubber, produce large amounts of heat. (9,500 to 10,500 kcal/kg). Moreover, after burning a little, leaving carbon.

The octane number, also known as the octane number, indicates the ability of a fuel to withstand. The use of fuel with a higher octane allows for detonation to be avoided, so the mixture of fuel and air compressed by the piston becomes better. The motor power will be more significant, and fuel consumption will be more efficient. There are several types of gasoline, namely: Premium, Pertamina, and Pertamina plus. Each type of fuel has a different octane number. The octane number of a fuel is usually represented by ON (octane number).

Types of fuels and their properties

The types of gasoline available in Indonesia are Premium, Pertamina, and Pertamina Plus. Premium is a gasoline-type fuel produced by Pertamina, which is yellow and has an octane value of 88. Premium gasoline is usually used in motorcycle engines with a compression ratio of 7:1 to 9:1. However, it is not good if used on gasoline engines with high compression because it can cause detonation. A low octane number causes detonation and, if used continuously, can cause damage to motorcycle components.

Pertamax is a gasoline-type fuel produced by Pertamina, which is dark blue and has an octane value of 92. Pertamina gasoline is recommended for gasoline-fueled vehicles with a compression ratio of 9:1 to 10:1. Pertamina plus is a gasoline product from Pertamina that is recommended for gasoline-fueled vehicles with a compression ratio of 10:1 to 11:1.

According to Supraptono, the physical properties of fuel that need to be known are specific gravity, viscosity, calorific value, boiling point, flash point, and combustion process. Specific gravity is a ratio of the weight of fuel oil to the weight of water with the same volume and the same temperature. Fuel oil generally has a specific gravity between 0.82-0.96.

Viscosity is a measure of the resistance of a liquid to flow. The calorific value is the amount of heat produced when 1 kg of fuel is completely burned. The boiling point of oil varies according to its gravity. The boiling point is high for areas with low API gravity because it has a high specific gravity. Meanwhile, for high API gravity, the boiling point is low. The flashpoint is the lowest temperature of fuel oil that can cause a fire in an instant if a spark is sparked on the surface of the fuel.¹⁻⁴

Combustion process

Combustion is a chemical compounding of fuel elements with acids that produce heat and is called heat energy. According to Jama et al., the conditions for good combustion in a motor are sufficient compression pressure, sufficient fuel, and air mixture, high enough temperature for combustion. Combustion begins with a spark from the spark plug at the end of the compression stroke. The spark jump occurs before the piston reaches the top dead center (TDC) during the compression stroke and is usually expressed in degrees of crank angle before the piston reaches TDC. A good combustion process is when the mixture of fuel and compressed air is completely burned. Two possibilities occur in gasoline engine combustion, namely normal combustion, and abnormal combustion.

Normal combustion occurs when the fuel can burn entirely at the desired time and condition. The average combustion mechanism in a gasoline engine starts when the spark jumps on the spark plug a few degrees before TDC; then, the fire burns the surrounding combustion gases until all the particles are burned out. The heat energy that arises causes the pressure and temperature to rise suddenly so that the piston is pushed towards the TMB.

Abnormal combustion occurs when the fuel burns before the specified time. This abnormal combustion causes an explosion that produces a shock wave in the form of a knocking noise that allows disturbances



to the combustion process in the gasoline engine. Detonation occurs when the fuel burns before the spark's ignition from the spark plug because the pressure and temperature in the engine are very high, causing the temperature in the combustion chamber to rise and making the fuel very easy to burn. Detonation that is repeated over a long period can cause damage to the engine components of a motorcycle. Detonation in gasoline motors is very detrimental because this can reduce power and heat efficiency, which will impact lowering engine performance.³⁻⁶

The processor stage of combustion in an engine is divided into three separate periods. According to Suyanto, these periods are delays in combustion (delay period), the spread of fire, and the peak of combustion. The combustion delay period starts from points 1-2 when the spark plug starts to spark. This delay in combustion is due to the time to start the reaction between the fuel and oxygen.⁷

The period of spread of fire indicated in points (2-3) is the time at which combustion begins, and the spread of flame continues throughout the cylinder. In this phase, the pressure in the cylinder will rise drastically. The increase in pressure in the cylinder is due to the compression stroke as well as combustion.

The final combustion peak in the combustion process begins at point (3-4). The peak combustion pressure occurs at this phase point. Combustion pressure occurs some time after the piston has passed TDC, about ten degrees after TDC. This is done so that the power generated by the motor due to this combustion is maximum pushing the piston.

Motor performance calculation

Parameters used in calculating motor performance include torque, power, and specific fuel consumption (SFC). Torque is a measure of an engine's ability to do work. Torque is a derived quantity commonly used to calculate the energy

produced by an object rotating on its axis. The unit of torque is usually expressed in N.m (Newton meter). According to Arends et al., the formulation is as follows: power is the amount of motor work per unit of time. The unit of power is hp (horsepower). Torque on a motorcycle can be measured using a dynamometer, so to calculate the shaft power, it can be determined using the formula:⁸

$$N_e = T \times \omega$$

N_e = shaft power Nm/s (Watt)

T = torque (N.m)

ω = angular speed (rpm)

Specific fuel consumption

Specific fuel consumption (SFC) is the fuel per time to produce 1 HP of power. So SFC is a measure of fuel economy.⁹⁻¹¹

$$SFC = M_f / N_e \dots\dots\dots 3$$

$$M_f = v \times \rho \text{ fuel} / t \dots\dots\dots 4$$

SFC = specific fuel consumption (kg/hours. KW)

M_f = amount of fuel/time (kg/jam)

N_e = generated power (KW)

v = fuel volume used

ρ = specific gravity of the fuel used

t = time required for fuel consumption

Chassis Dynamometer

A dynamometer is a tool used to measure the engine's power, torsional force (torque). The working principle of this tool is to give a load that is opposite to the direction of rotation until it is close to zero rpm; the maximum load that can be read is the braking force which is equal to the rotational force of the engine shaft. In the chassis type, the dynamometer test uses the engine, and the entire chassis of the vehicle is fully installed.



2. Conclusion

The torque generated in the ignition system using CDI racing curve two and standard spark plugs with the use of premium fuel shows the highest of each variation of the ignition system, while the torque generated in the ignition system using CDI racing curve one and iridium spark plugs with the use of fuel premium shows the lowest of each variation of the ignition system.

3. References

1. Arends., BPM dan H. Berenschot. Motor Bensin. Jakarta : Erlangga Arismunandar, Wiranto. 2002. Penggerak Mula Motor Bakar Torak. Bandung: ITB. 1980.
2. Haryono, G. Uraian Praktis Mengenal Motor Bakar. Semarang: Aneka Ilmu. 1989
3. Hidayat, Wahyu. Motor Bensin Modern. Jakarta: Rineka Cipta. 2012.
4. Jama., Jalius., Wagino. Teknik Sepeda Motor Jilid 2. Jakarta: Direktorat Pembinaan Sekolah Menengah Kejuruan, Direktorat Jenderal Manajemen Pendidikan Dasar dan Menengah, Departemen Pendidikan Nasional. 2008.
5. Keputusan Direktur Jendral Minyak dan Gas Bumi. Nomor : 3674K/24/DJM/2006. tentang Standar dan Mutu (Spesifikasi) Bahan Bakar Minyak Jenis Bensin yang Dipasarkan di dalam Negeri.
6. Machmud, Syachril., Yokie Gendro Irawan. Dampak Kerenggangan Celah Elektrode Busi terhadap Kinerja Motor Bensin 4 Tak. Jurnal. 2011; 1(2).
7. Machmud, Syachril, Untoro Budi Surono dan Leydon Sitorus. Pengaruh Variasi Unjuk Derajat Pengapian terhadap Kerja Mesin. Jurnal Teknik. 2013; 3(1): 58-64.
8. Raharjo, Winarno Dwi., Karnowo. Mesin Konversi Energi. Universitas Negeri Semarang : Semarang. 2008.
9. Rajagukguk, Jenniria. Analisis Performa Mesin Bensin dengan Pengujian Angka Oktan Berbeda. Jurnal Teknokris. 2012. ;10/1: 4-11
10. Suprptono. Bahan Bakar dan Pelumas. Buku Ajar. Jurusan Teknik Mesin UNNES : Semarang. 2004.
11. Suyanto., Wardan. Teori Motor Bensin. Jakarta : Direktorat Jendral Pendidikan Tinggi. 1989.

