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INVESTIGATION THE EFFECT OF SPARKPLUG GAP ON VIBRATION, FLAME AND HC EMISSION FOR SINGLE CYLINDER ENGINE

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Abstract: This study has been undertaken to investigate and analyze the effect of sparkplug flame if we increase the electrode gap in single cylinder 125CC vertical engine. The performance of automobile engines is impacted by a variety of factors. One of the world's primary sources of fuel consumption today is the gasoline spark ignition mechanism in automobiles. The spark plug is one of the crucial parts of a petrol engine during the combustion process. An engine's performance declines when it isn't running consistently, but it also increases fuel consumption, vibration and HC emissions. There are numerous causes of pollution. The improper gap of electrode in the sparkplug is one of the causes. Spark plugs play a critical role in the combustion process in a gasoline engine. The combustion engine's backfire and banging are brought on by an incompatibility between the fuel utilized and the width of the spark plug gap. Consequently, the spark plug gap was investigated with an emphasis on managing the combustion process to enhance engine performance. The parameters of spark plug gap when the gap increased have been explored in this study. The standard gap of 125CC single cylinder engine is 0.7mm. In experiments, it has been found that the vibration and noise increase correspondingly as the spark plug gap increase; on the other hand, the exhaust emission (HC) value increases.

Keywords – Sparkplug gap, Emission, Engine performance

I. INTRODUCTION

The advancement of automotive technology has boosted manufacturer competitiveness and, as a result, raised vehicle comfort and safety standards. The company which will provide more safety with comfort. People will move more towards that company. Along with safety, customers now also pay attention to the average of the vehicle. The comfort and safety of the vehicle are impacted by a variety of things. The most crucial variables can be categorized as vibration, noise, and emission. Basic sources of vibration and noise in vehicles are vehicle engine, road surface and aerodynamic effects.(Nurullah Gültekin1, 2018) . Those who are exposed to these impacts are seen to exhibit signs of distraction, stress, irritation, and weariness. It raises the driver's chance of an accident in this instance. By exposing the vehicle's systems to impact, material fatigue, friction, and thermal stress, vibrations may result in system failure. It is possible to considerably lower the noise level by reducing vibration.(Nurullah Gültekin1, 2018).The main causes of vibrations in motors for vehicles are centrifugal forces produced by the flywheel, combustion forces coming from combustion, irregularities of engine parts with rapid motion, Irregular gap in sparkplug between both electrodes and movements in valve mechanisms. The elasticity of the parts, the space between the parts, and the non-continuous contact are additional causes of motor vibrations. If there is too much noise in the vehicle, it will be difficult to drive the vehicle and it can also increase the pollution. The cylinder walls and flank walls of the engine vibrate as a result of the quick pressure surge brought on by combustion in the cylinder. These vibrations in different parts of the engine

cause the pressure fluctuation and produce noise.(Nurullah Gültekin1, 2018). It is impossible to eliminate vibration as well as emission in internal combustion engines with today's technology, but it is possible to reduce it.

Many investigations have been conducted to identify the primary sources of this phenomenon. Over the past few decades, numerous studies have been conducted to understand the effects of spark plug design on the performance of spark-ignition engines in various aspects. The main parameters under investigation include the number of electrodes, shape, size, material, gap projection, and orientation.(Abdel-Rehim A. a., 2013). Early in the combustion process, the ignition process and its subsequent combustion will be significantly impacted by the spark plugs design. Vehicle exhaust emissions, fuel-oil vapor, lead compounds, asbestos and rubber particles, as well as corrosion, corrosion, and more corrosion cause motor vehicles to contaminate the environment. Certain substances, such as partially burned hydrocarbons including aldehydes, ketones, carboxylic acids, CO, NOx, lead compounds, and particulates, make up 75% of the overall pollution from motor vehicles. if the hydrocarbons are exhausted, they are either emissions that are partially burned because of an improper air-to-fuel ratio, low compression, valve thrust, and an uneven temperature distribution inside the cylinder, or they are emissions that are released into the atmosphere without engaging in combustion.(Nurullah Gültekin1, 2018). The amount of intake and breathing time affect emissions in a way that is harmful to human health. Three different concentrations have been discovered in this regard, and hazard limits have been provided. The businesses are conducting extensive research to lower the value of the emulsion. These technologies include stepped filler motors and the directly sprung engine design, which results in poorly mixed combustion in gasoline engines.(Nurullah Gültekin1, 2018).Yet, the cost of the vehicle goes up as a result of these technological studies that are done to lower emissions. Improper Sparkplug gap creates more emission.

For compressed fuel and air to be ignited by an electric spark while maintaining engine pressure, a spark plug is a part that transports electric current from an ignition system to an engine's combustion chamber. The spark plug serves a variety of important functions in engines, including starting the car, enhancing engine performance, removing heat from the combustion chamber, and more(Ahmad Shahril Daut, 2019).According to study conducted by(Abdel-Rehim A. a., 2013) The impact of the spark plug design on the efficiency of spark ignition engines is being studied primarily in terms of a variety of factors, including the number of components, electrode, gap projection, gap, size, and orientation. The center and floor electrodes' design has made it the primary indicator of a spark plugs effectiveness. A ceramic insulator separates a spark plugs metal threaded shell from its center

There are many causes of pollution caused by vehicles. One of the reasons is the irregular gap of the sparkplug. Generally, combustion in spark-ignition engines varies considerably from cycle to cycle(A. K. Singh, 2014).

electrode electrically. Sparkplug has two electrodes; one is center electrode and second is ground electrode. A substantially insulated wire connects the central electrode, which may include a resistor to the output terminal of a magneto or ignition coil. The spark plug's metal casing is grounded electrically when it is placed into the engine's cylinder head. As the central electrode emerges from the combustion chamber through the porcelain insulator, the inner end of the center electrode and typically one or more protuberances form one or more spark gaps, or structures attached to the inner end of the threaded shell and known as the side, earth, or ground electrodes..(Abdel-Rehim A. a., 2013). The clearance between center electrode and ground electrode is called spark plug gap. There are two different types of spark plug. One is hot spark plug and Cold spark plug.

Different parts of Spark plug.

- Insulator: It serves as an insulator and is constructed of ceramic aluminum oxide. It creates a 40000 volt gap between the earth and the center electrode. To avoid flash, it can be produced in simple form or with profiles.
- Metal Body: Precision rolled threads are used to make the steel shell, ensuring a tight fit and simple installation and removal. By transmitting heat to the cylinder head, this serves as the cylinder head's electrical ground and aids in cooling the plug.
- Centre Electrode: It is constructed from alloys containing nickel and has a copper core linked to it. Depending on the kind, the central electrode could be constructed of platinum or iridium. Ground Electrode: A spark path is created along the middle electrode as a result. Alloys based on nickel are used to make it.
- Electrode Gap: It is a clearance between Centre electrode and ground electrode. The plug may not produce enough sparks to ignite the gasoline and may misfire if the necessary space is not provided.
- Plating: Mostly typically, the shell is plated. Durability is improved, and corrosion and corrosion resistance are provided.
- Threads: Typically, spark plug threads are rolled rather than cut. It satisfies the requirements set forth by SAE and the International Standards Organization.
- Ribs: Further defense against secondary voltages or spark arcs is provided by the insulator ribs, and the rubber electrical device against the plug body at the joint helps to improve the boot's grip.

Fig: 1 Sparkplug (125CC engine)

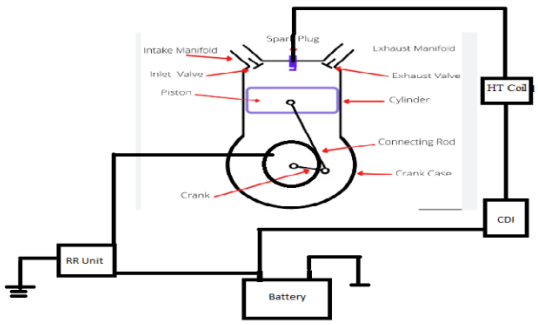


Fig: 2 Process of Spark

Fig.2 shows the process of spark in the engine. The ignition system is one of the most important components utilized in I.C. engines. To ignite the compressed air-fuel mixture in a spark-ignition engine, a device is required. The ignition system accomplishes this by igniting the fuel inside the cylinder at the conclusion of the compression stroke. A current plug is reached by it, which is a component of the electrical system. It provides the spark needed to properly ignite the air-fuel mixture. As show in fig (2), the ignition and combustion processes are started by a CDI Unit, which regulates the ignition system on motorcycles. The spark plug is ignited by a pulse of electricity from the motorcycle battery that travels through the CDI unit. The sparkplug sparks from Ignition Coil (HT coil) through CDI unit. The ignition coil functions similarly to a transformer. The ignition coil uses two coils, one inside the other, to convert the electrical energy from the car battery to high voltage, which it then temporarily stores before releasing as a high voltage current pulse to the spark plug. The main objectives in this study are:

- To study the impact on sparkplug when electrode gap increased.
- To track the vehicle's (125CC) emissions while utilizing this form of spark plug gapping.
- To track the engine's performance both before and after switching to gap increased in spark plugs.

There are two possibilities for the sparkplug gap; one is too large gap and too small gap or no gap. In this paper we increase the spark plug gap.

II. METHODOLOGY

- We used sparkplug gap gauge for increasing the sparkplug gap as shown as fig.3.

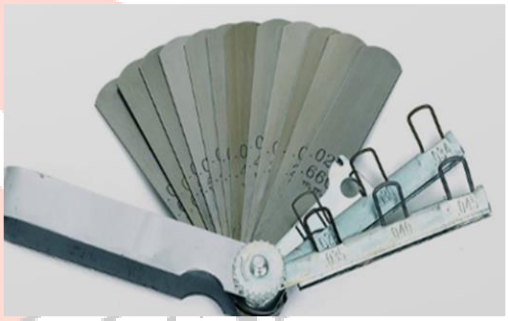


Fig: 3 Sparkplug gap gauge

We can obtain the precise measurement advised by the manufacturer by using a spark plug gap gauge. By ensuring that the spark plug is producing the right spark to ignite the air and fuel mixture and power your vehicle, this improves the spark plug's efficiency (Ahmad Shahril Daut, 2019).The amount of voltage required to jump a gap increases with its size. Most skilled tuners are conscious of the fact that increasing the gap size increases the spark area exposed to the air-fuel mixture, maximizing burn efficiency. The majority of racers therefore install high-energy ignition systems. We increase the spark plug gap with this gauge. The ideal gap between two electrodes in the 125cc vehicle is 0.7mm.We increase this gap from 0.7mm to 0.8mm and from 0.8mm to 0.9mm, and sees the results of change in flame and the changes of HC emission. When we increase the sparkplug gap we are aware of the effects that raising the sparkplug gap has on both the sparkplug flame and the amount of HC emissions.

- We used sparkplug tester for testing the sparkplug after increasing the sparkplug gap as shown in fig4.

Fig: 4 Sparkplug Cleaner and Tester

In order to determine whether to replace the spark plug, the spark tester primarily checks the performance of the spark plug by simulating the ignition of the Vehicle. You can check if an electrical current is getting to your engine's spark plug with an ignition spark tester. In order to generate power, that current is used to ignite the mixture of gasoline and air inside the engine's cylinder. A spark plug cleaner and tester is a tool used in petrol, petrol, and kerosene engines to thoroughly clean and test an old, used spark plug.A modern workshop or garage must have a spark plug cleaner in order to restore the functionality of a used spark plug to that of a brand-new one. First we increase the spark plug gap from 0.7mm to 0.8mm and then we fix the sparkplug in this tester. There are two dial gauges in this tester. One is for pressure and other for the gap. We set the dial gauge according to the pressure. After that we press the green button for testing the sparkplug. Different flames will appear inside the glass at different pressures. If we increase the sparkplug from 0.7mm to 0.8mm, it will appear that the flame is reduced a little. Again, the flame will be lowered more at different pressures if we increase the gap to 0.8mm to 0.9mm.

This demonstrates that the sparkplug flame will diminish as the gap is increased. An engine may run poorly or not at all if the spark plug gap is too great because the spark is unlikely to regularly "jump" over the wide space between electrodes. Many people believe that the better the gap, the wider it should be. A spark plug very slightly shortens the electrodes each time it produces an electrical arc. The distance between the electrodes widens over time. When this distance increases, more power is needed to ignite the air/fuel mixture. Misfires will occur if the gap is too great and the ignition system is unable to supply the necessary voltage to spark across the gap or if combustion chamber turbulence blows out the spark.

- The study's emission measurements were carried out using the exhaust gas emissions monitoring apparatus seen in Figure 5.

Today, catalytic converters exhaust gas recirculation (EGR), sump ventilation, fuel evaporation, and thermal exhaust reactors are used to reduce the exhaust emissions of internal combustion engines. Automotive Exhaust Gas Analyzers are typically employed to identify and resolve issues with engine emissions and to enhance engine performance.

Although the development of automotive technologies has reduced the emission of dangerous gases, it is still not at an appropriate level.(Nurullah Gültekin1, 2018). Gas analyzers provide instantaneous, accurate, and reliable measurements to help with emission compliance. They are used to calculate gas concentrations, such as carbon monoxide.(Nurullah Gültekin1, 2018).

An exhaust gas analyzer, also known as an exhaust carbon monoxide analyzer, is a device used to measure carbon monoxide, HC and other gases released into the atmosphere as a result of improper combustion; the Lambda coefficient measurement is the most widely employed.

Exhaust gas analyzers can efficiently collect and measure the different gases present and give the operator an end reading in their most basic configuration. Exhaust gas analyzers can find carbon monoxide in exhaust pipe systems and pinpoint sources that could catch fire if fuel were accidentally discharged. Engine efficiency can also be greatly influenced by more complicated models. Engine efficiency is affected if gasoline is not provided to the engine in the necessary ratios to air or if fuel is not burned properly, and the engine will either consume a lot more fuel or stop working altogether due to a lack of power.

Fig: 5 Exhaust gas analyzer

III. RESULTS AND DISCUSSION

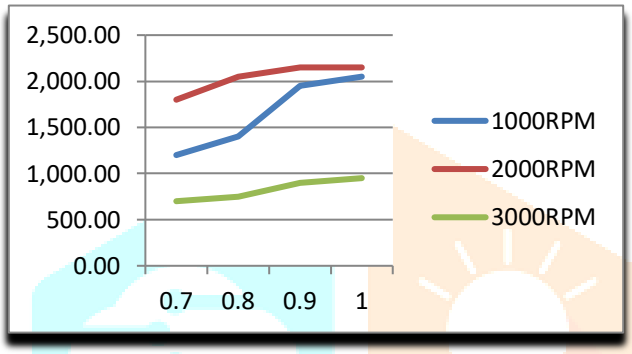
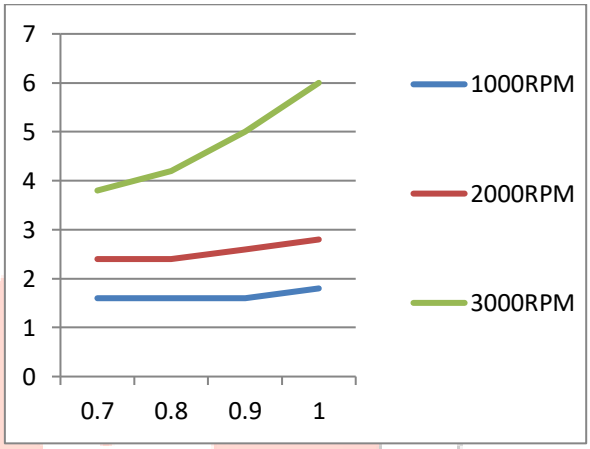


Fig.6 HC Chart With different Gap

The ideal sparkplug gap of 125CC engine is 0.7mm-0.8mm. As shown in the graph, first we set the ideal sparkplug gap of the engine. We measured HC value in ppm.And we see that in the gap of 0.7 mm -0.8 mm the emission is slightly lower than that of 0.9 mm and 1. As we increase the spark plug gap from 0.8 mm to 0.9 mm, the HC emission will increase. Because if the gap increases then proper spark will not occur. And if the spark will not occur properly the burning process will not happen properly. As the result, pollution will increase. Although a greater spark plug gap will have more contact with the fuel mixture for ignition, it takes too much voltage to generate a spark and is an inefficient technique of spark ignition in the engine. . The length of the electric arc's journey will be more than necessary. . Spark plug ignition is still ineffective at this wide separation. If the electric arc must travel a greater distance, it will require more voltage. As appropriate contact is sufficient for efficient ignition, the increased contact with the fuel mixture offers no further benefits.

When we increase the gap from 0.7mm to 0.8mm and 0.8mm to 0.9mm we fix the spark plug in the vehicle, and with using exhaust gas analyzer we found that when we increase the sparkplug gap fuel not burn properly, for that reason the amount of HC and other gases is increase. Gap of sparkplug is also one of the causes of pollution. If the gap of the spark plug is too higher, then it will be difficult to burn the mixture or air and fuel. Due to which the unburned mixture will go out with the help of exhaust valve and spread pollution. If we increase the gap of the sparkplug, then the pollution will spread more.



Above diagram shows vibration will increase when we increase the spark plug gap. The lowest value was found at 0.7 mm spark plug gap. Which means at the ideal gap. . If the electric arc must travel a greater distance, it will require more voltage. Due to this when we increase the gap the vibration level also increase. Uneven spark plug gaps might cause engine to run irregularly, reduced performance, and higher fuel consumption. Variation in idle revolution and engine vibration are regarded to be clear signs of an engine failure.

IV. CONCLUSION

The effects of spark plug gap on vibration, flame and HC emission in a 125 CC engine have been examined in this study. In this experiment we found when we increase the sparkplug gap and revolution, the vibration and rate of HC is increased. The spark flame is decrease when we increase the sparkplug gap, because if the gap is too large, it will take a long time to generate the spark. On the other hand, the value of the exhaust emission (HC) varies according to the spark plug spacing. It is an ineffective method of spark ignition in the engine because it requires too much voltage to produce a spark. The journey of the electric arc will take longer than is required. At this large gap, spark plug ignition is still unsuccessful. It will need more voltage to move an electric

arc over longer distances. As effective ignition only requires appropriate contact. The use of the proper spark plug with proper spark gap for a vehicle is the most crucial aspect of automotive maintenance. Otherwise the engine will not run properly at ideal speed. And also we see that the amount of HC emission rate will increased when sparkplug gap is too large compare to ideal gap (0.7mm). Wider spark plug gaps increase the likelihood of misfiring. Higher spark plug gaps, however, will lessen the likelihood that low injection pressure will cause the fuel to ignite. Increased the overall amount of HC. A rise in HC indicates that combustion is either incomplete or deteriorating. Poor combustion causes more dangerous compounds to spread into the atmosphere and increases fuel usage. For that reason, every automobile company advises to inspect the sparkplug during service. And at the time of servicing, if the gap is not proper, it is also advised to adjust properly. Because if the sparkplug gap in not proper, it can be harmful to both the vehicle and the environment.

Fig: 7 Vibration Chart With different Gap

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