

Comparison between Hybrid and Fuel Injection Motorbikes

N. Bano, T. Younas, U. A. Khan, A. T. Durrani, M. Huzaif, and M. R. Khalid

Abstract—As the technology is evolving and upgrading, more ways are being founded to tackle global warming and the emission of greenhouse gases. Introducing hybrid cars in 1997 was a milestone towards this initiative, which not only decreased fuel consumption but also lowered the on-road emission of harmful gases. However, in developing countries where masses are using motorbikes as a primary source for commuting. Industries are in process to manufacture hybrid motorbikes which are eco-friendly and light in build. This paper will be addressing the comparative analysis of both types of bikes i.e. the new hybrid bikes and fuel injection motorbikes with associated pros and cons.

Index Terms—Fuel consumption, fuel injection system, hybrid motorbike, greenhouse gas emission.

I. INTRODUCTION

As the industrial revolution gained strength, people used horse cart as a medium to travel around faster as there were no other means. Different steps were being taken to overcome this issue but the most important was the invention of a motorbike (a two-wheel vehicle). The first ever motorbike was a steam engine based, invented in 1867 by Pierre Michaux [1]. It was a paradigm shift for the engineers who worked hard to introduce an alternative mode of transportation. This instantly attracted everyone towards the idea of an engine-based vehicle and research started which resulted in the making of the first petroleum-based internal combustion engine in 1885 by Gottlieb Daimler [2]. Later, Heinrich Hildebrand in 1894 manufactured petroleum-based engine bikes in bulk quantity with modern design which gave birth to new revolutionary era [3].

With on-going modernization in transportation, vehicle industry got special attention and increasingly innovations took place to get something productive and efficient in comparison to the past machines [4], [5]. Later on, carburetor engines were introduced which consumed extensive fuel consumption and increased carbon emission. To overcome this, fuel injection method was introduced in the 1980s which quickly took the upper hand in versus to all other types of engine till date.

Many milestones were achieved in the history and easiest ways for traveling were introduced. With the increase in

population, demand for motor bikes also increased which in return required more consumption fuel. As studies progressed, it was realized that the main reason behind global warming was the carbon emission emitted by the vehicles. To sustain and protect future generations, there was a dire need to introduce measures against the effects of greenhouse gases. Carbon emission started since 1750, in 1900 there were around 2 billion tonnes of carbon dioxide emission, while in 2017 it was around 36 billion tonnes which shows an increase of around 34 billion tonnes in 117 years [6]. This rapid increase in emission was faster than it was expected. The world's overall temperature was vastly affected by the emission as the temperature had increased to 0.8 ° Celsius (1.4 ° Fahrenheit) since the 1880 baseline [7].

Thus, production of fuel barrels increases by a significant amount. In 2005 the Oil Depletion Analysis Centre (ODAC) in London provided a figure of 944 billion barrels which had been extracted since the beginning of commercial drilling, and counting from 1870 around 135 billion barrels of oil had been used [8].

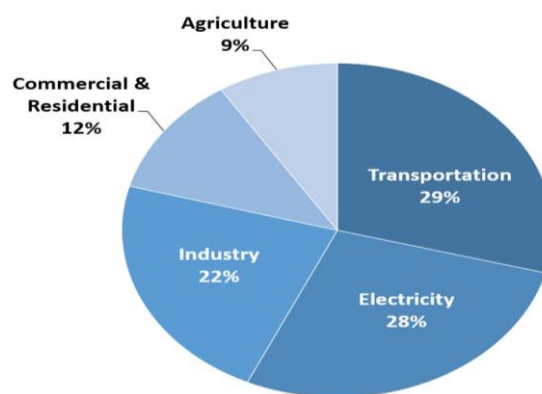


Fig. 1. Greenhouse gas emissions by different sectors in 2017 [9].

The greenhouse gases emission from different economic sectors of the United States during the year 2017 are shown in Fig. 1. The pie chart clearly demonstrates that the transportation sector was the highest contributor of greenhouse gases, accounting for around 29% of total harmful gases emission in 2017 due to the high usage of fossil fuels for energy in the transportation sector [9].

To resolve the emerging issues of fuel consumption and carbon emission, measures were taken along with discoveries that changed the history. The most important of all was the introduction of hybrid cars in 1997. The hybrid car was a magnificent invention as the carbon emission by the car decreased by more than 50%. The invention had a huge impact and it helped western countries to fight against greenhouse gases emission. However, developed countries used motorbikes as a primary source for travelling which

Manuscript received November 17, 2021; revised December 30, 2021.

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happened to be less effective. As a result, emitted carbon was not managed efficiently especially in Asia, where approximately 79% of the world's motorbikes were present. According to Dr Jawaid Abdul Ghani (professor at Karachi School of Business Leadership), in 2015 6% of the citizens owned cars in Pakistan and India, whereas 41% and 32% owned bikes [10]. The Daily Times also stated in their headlines that around 7,500 of new motorcycles daily hit roads in Pakistan. Further they also claimed that in 2017, around 2 million motorcycles were produced [11]. The above-stated fact shows that the number of people dependent on bikes is greater in Pakistan.

In order to reduce carbon emission from the planet and to decrease the use of carbon fuel, vast scale studies and inventions are required in the motorbike sector. The giants of the vehicle industry such as Honda, Kawasaki, Harley Davidson, etc. are working towards Hybrid motorbike and are likely to get success soon.

II. FUEL INJECTION MOTORBIKE

In a fuel injection system, fuel is directly introduced in an internal combustion engine, by using an injector. This method overtook the previously used carburettor engine of 1980s and is the most used engine to date. The basic difference between fuel injection and carburettor engine was of a nozzle, as in fuel injection the small nozzle atomizes the fuel using high pressure whereas in carburettor suction method was used for intake of fuel into the airstream.

The objectives behind the making of fuel injection engine were to:

- Increase output
- Increase fuel efficiency
- Decrease carbon emission
- Drivability and smooth operations
- Lesser initial/maintenance cost

This technology was first introduced in cars but it gradually took an important position in the motorbike industry. The injection system is controlled using an electronic circuit that allows the proper air mixture into the chamber. The fixed ratio is around 14.7:1, meaning that for every one part of fuel 14.7 parts of air are required for combustion to be effective [12]–[14]. Fig. 2 and 3 shows the working of a fuel injection system.

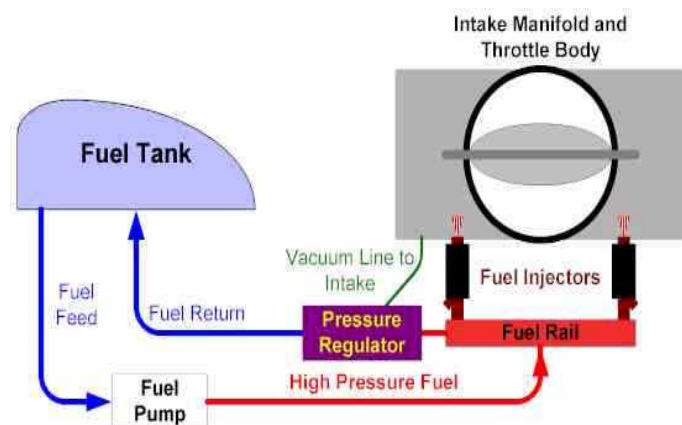


Fig. 2. Fuel flow inside EFI system [15].

Fig. 2 shows how fuel flows inside an EFI system. The fuel tank supplies gasoline to the fuel pump. The fuel pump is located in the fuel tank. A high-pressure feed is provided by a fuel pump to the fuel rail that is connected to the fuel injectors. The fuel pressure is maintained around 39-45 PSI by a pressure regulator on fuel rail. The pressure regulator is connected by a vacuum line to the intake manifold through which any extra fuel is returned back to the fuel tank [15].

Fig. 3 shows the working of an injection system in a motorbike. As the engine starts, the airflow creates a low-pressure area in the carburetor. The fuel in the fuel tank is at atmospheric pressure while the venturi pressure is lower. Fuel is forced into the venturi through metering jets from where it's taken by the airstream towards the combustion chamber. Fuel metering depends on the strength of the vacuum signal and the size of holes in jets. As it can be affected by many factors ranging from the engine's rpm/throttle position to the status of rings and exhaust [16].

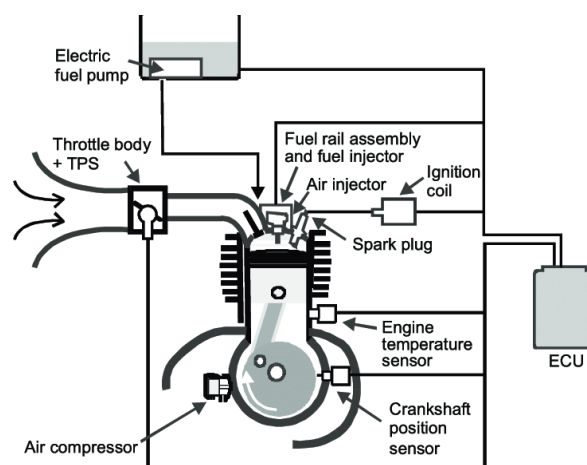


Fig. 3. Working of injection inside a bike [17].

A. Advantages

The Advantages are as follow:

- Cold starting of the engine is easier.
- It's more economical and requires less maintenance.
- Due to the smaller combustion space the thermal efficiency is better.
- Fix ration of fuel and air mixture allows cleaner and more efficient combustion.
- Fuel efficiency is better and more powerful than a carburetted system.

B. Disadvantages

The Disadvantages are as follow:

- It's very noisy compared to other systems.
- Blockage occurs frequently due to small injection holes.
- Once damaged, its fixing might require changing of the whole body.
- The swirling is slow, especially at low speeds.

III. HYBRID MOTORBIKE

A hybrid system is a mechanism that uses two distinct types of power to run an engine. Both electric and internal combustion engines are used in motorbikes. Different motors

work more efficiently on different engines, like electric motor efficiency is higher while producing torque or turning power, while the combustion engine is efficient at maintaining high speed. By doing this, a hybrid system decreases fuel consumption and saves fuel cost and increases efficiency. By decreasing fuel consumption, it decreases carbon emission and other greenhouse gases emission. The current also gives us the characteristics of its fuel injection system [18].

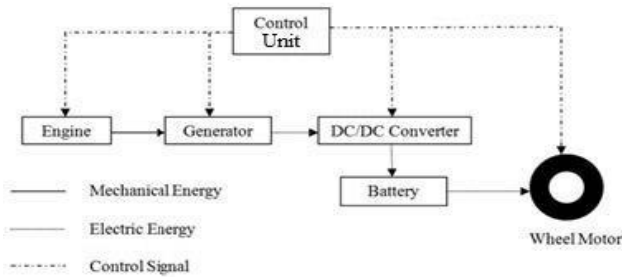


Fig. 4. Working of hybrid system [19].

Fig. 4 illustrates the way wheel gets energy in a hybrid. The energy is first stored in the battery and then moved to tires so that extra energy can be stored. There are two basic types of systems in hybrid.

A. Parallel System

These are commonly used systems and are currently used as well in hybrid cars. The system works as shown in Fig. 5 that both electric motor and internal combustion are connected to a mechanical transmission. Power steering and air conditioner are connected directly to an electric motor and are independent of the combustion engine, this increases the efficiency as the accessories keep working irrespective of the status of the combustion engine. Due to which a parallel system is preferred for highway drives [20].

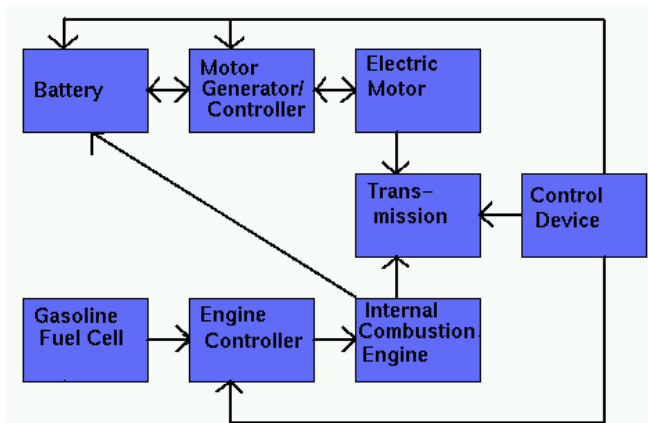


Fig. 5. Parallel system [21].

B. Series System

Series system working is similar to an electric vehicle. Fig. 6 shows the working of a series system, where the combustion engine directly drives electric generator instead of driving wheels. The generator is connected to the battery and the wheel by which it stores energy and operates wheels at the same time. When a huge amount of energy is required the energy is taken from both generator and battery. Transmission is not needed in series. The advantage of series

over parallel is the lack of a mechanical link between wheels and combustion engines. The combustion engine can operate efficiently and constantly. Due to this, it's better for in city traffic [16].

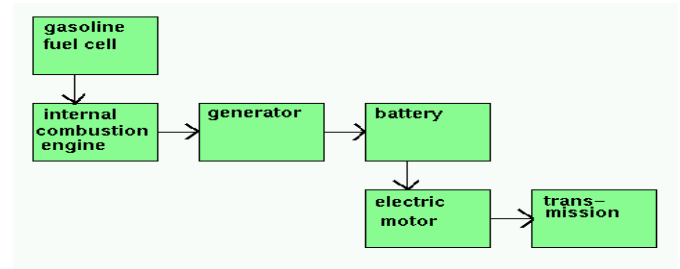


Fig. 6. Series system [21].

The hybrid technology in cars was first introduced in 1990s and the first mass production was done by Toyota Prius in 1997. Although hybrid motorbikes are under manufacturing but the research is still going on for the hybrid motorbikes.

C. Advantages and Disadvantages

The advantages of hybrid are as follow:

- Hybrid engines are environment friendly as they run cleaner and have better gas mileage.
- Hybrid engines are supported by many credits and incentives which make them financially cheap and economical.
- Hybrid vehicles are cleaner and have lesser fuel consumption, thus less fuel is required which in return decreases carbon and greenhouse gases emission.
- Brake systems are designed in such a way that whenever a brake is hit a current is produced which helps in charging the battery.
- Hybrid vehicles are usually made up of light materials thus decreases energy requirements.

The Disadvantages are as follow:

- It has lesser power than a single-engine bike, as the hybrid is twin powered where combustion engine is the primary source and has lesser space thus it's suitable for driving in city and not for speed racing.
- Maintenance of a hybrid car is expensive as two engines are present and expert mechanics are required for service.
- Presence of high voltage batteries can be dangerous and fatal in case of an accident [22].

IV. DISCUSSION

By comparing both motorbikes, it can be seen that the hybrid has more advantages over fuel injection motorbikes, as the hybrid is a green product and contributes less towards carbon and greenhouse gases emission [23]. The result is based on paperwork and not examined practically as hybrid motorbikes are still under process and haven't been fully produced or tested. The data and statistics of hybrid cars are used to conclude for hybrid motorbikes.

Fig. 7 compares the mpg (miles per gallon) of hybrid, diesel, and petrol-based cars. The figure clearly shows that hybrid mpg in city/town is twice of petrol and diesel-based

cars, whereas on the highway it's almost the same. This shows that hybrid engines are beneficial for city use only and not efficient for long drives. The motorbikes are usually used for in-city rides and small distances and people usually avoid using bikes for longer travel. In such a case, hybrid ride can be very effective as they are twice efficient for city travel in comparison on highways. So, the average mpg for hybrid motorbikes will surely be higher than the average mpg of hybrid cars.

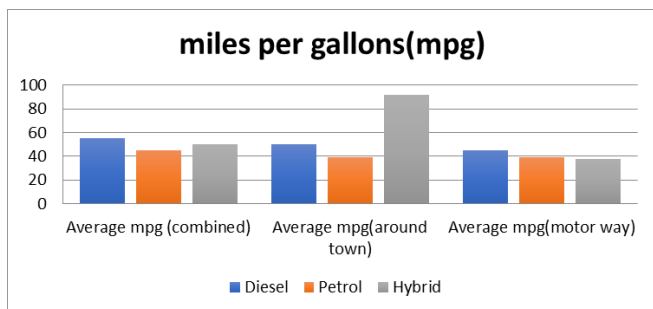


Fig. 7. Comparison of mpg of hybrid, petrol, and diesel car [24].

Same as fuel consumption the carbon emission of the hybrid motorbike can also be concluded on basis of the hybrid car. Fig. 8 shows the annual emission of different engine vehicles in the United States. The Fig. 8 shows a visible difference between hybrid and gasoline and it can be seen from the figure that emission from gasoline is twice what hybrid cars emit. To be precise, hybrid emits 6258 pounds of CO₂ equivalent whereas gasoline emits 11435 pounds of CO₂ equivalent [25]. Considering these results, we can assume that hybrid motorbikes will also have the same difference in carbon emission from fuel injection motorbikes. As bike's size and weight is lesser than cars, and it usually ranges between 70-300 CC, the carbon emission will surely decrease by a larger factor [26].

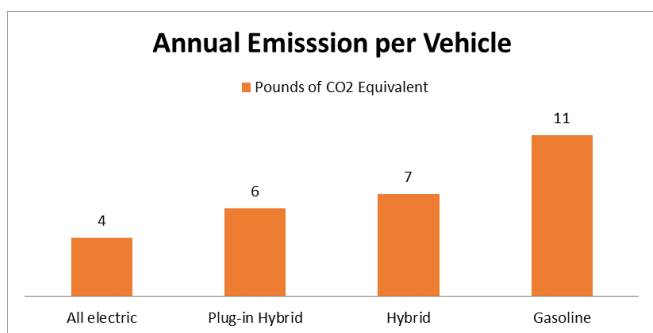


Fig. 8. Emissions per vehicle in the U.S. [25].

V. CONCLUSION

From the discussion, it is concluded that a hybrid motorbike is better than a fuel injection motorbike, the mechanical structure is efficient and fuel consumption is lesser. Less fuel consumption means both fuel requirement and carbon emission, both will decrease. Moreover, due to battery and storage of energy, hybrid engine can be very useful in case of an emergency, as when fuel exhausts, battery can play a vital role. Two different engines in hybrid vehicle can increase the efficiency and decrease the chances of car breakdown, as while one engine stops working the

other will cover its load.

Introducing and producing hybrid motorbikes would help fight against carbon emission and decreases the usage of fossil fuels as there's an urgent need of managing fuel and carbon-related issues to make our future sustainable. Fossil fuels are expected to finish by end of this century, after which the world has to switch to a renewable source of energy, so it's better to start shifting. Hybrid bikes would play an important role in the fight against carbon emission in Asia, as stated earlier handsome amount of people use bikes in Asia for traveling, and with the introduction of hybrid bikes the emission would drop by a huge factor and would surely support Asia towards a pollution-free continent.

CONFLICT OF INTEREST

The authors declared no conflict of interest.

AUTHOR CONTRIBUTION

The contribution of the authors' is this work is stated below

	Author 1	Author 2	Author 3	Author 4	Author 5	Author 6
Data Collection		✓		✓		✓
Designed the Analysis	✓	✓				
Contributed data or analysis tools	✓		✓		✓	
Interpretation of data	✓	✓		✓		
Drafting the article		✓			✓	
Critical revision of the article	✓		✓	✓		✓
Final revision	✓		✓			

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