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# The Effect of Excessive Oil – Gasoline Mixture on the Acceleration of Bajaj Rickshaw Vehicles

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**Abstract:** In this research paper, a Bajaj rickshaw vehicle was tested under variable loads and five different oil – fuel mixture ratios ranging between 2% and 12.5%. Three readings of each experiment were taken and average values were extracted.

It was found that oil – fuel mixture ratios which lie between 2% and 5% are the most suitable ratios that could be used by rickshaw drivers and technician mechanics. These ratios are recommended to be used because they give the vehicle's engine higher acceleration, longer operation period life, diverge the overhaul maintenance period intervals, and that they cause less impact to the surrounding environment.

**Keywords:** Excessive oil; Acceleration; Bajaj Rickshaw; Experimental results; Pollution impact

## 1. Introduction

Rickshaw began as a two or three – wheeled passenger cart, called a pulled rickshaw, generally pulled by one man with one passenger. The first known use of the term was in 1887. Over time, cycle rickshaws, auto rickshaws, and electric rickshaws were invented [1]. Pulled rickshaws created a popular means of transportation, and a source of employment for male laborers, within Asian cities in the 19$^{th}$ century. Their appearance was related to newly acquired knowledge of ball bearing systems. Their popularity declined as cars, trains and other means of transportation became widely available. Auto rickshaws are becoming more popular in some cities in the twenty first century as an alternative to taxis because of their low cost of fuel and maintenance.

The word rickshaw originates from the Japanese word Jinrikisha, which literally means human powered vehicle [2]. There are several theories about its invention, which may be summarized into the following points:

i. It was invented in Japan in 1869 by Izumi Yosube,who formed a partnership with Suzuki Tokujiro and Taka Yama Kousbe to build the vehicles, having being inspired by the horse carriages that had been introduced to the streets of Tokyo a few years earlier {[3] – [8]} .

ii. An American missionary to Japan called Jonathan Scobie is also said to have invented the rickshaw around 1869 to transport his wife through the streets of Yokohama{[9] – [11]} .

iii. An American blacksmith called Albert Tolman is said to have invented the rickshaw in 1846 in Worcester, Massachusetts for a South American bound missionary [12].

iv. In New Jersey, the Burlington County Historical Society claims an invention in 1869 by carriage maker James Birch, and exhibits a Birch rickshaw in its museum [13].

Though the origins of rickshaw are not entirely clear, they seem to be Japanese, and of Tokyo specifically. The most widely accepted theory offers the name of the past mentioned four inventors, and gives the year of 1869 as the date of invention [3].

In the last quarter of the 19$^{th}$ century the rickshaw was spread all over Asia to Singapore (1880), China (1873) [4], and {[14] – [16]}. In the 20$^{th}$ century, the rickshaws were introduced To Durban city in South Africa, Kenya, Tanzania, Sudan and other areas of East Africa for short distance trips{[17] – [22]} . The 21$^{st}$ century has seen resurgence in rickshaws, because they are about 1/3 to 1/2 the cost of regular taxis. Therefore, they were spread all over the world to Asia, Africa, America, and Europe {[23] – [26]} .

India is home to three quarters of the world's auto – rickshaws, which are three – wheeled engine vehicles that are hired to move both people and goods .These vehicles play an important role in urban transport in the country, being used for a wide range of trip purposes, often for trips that cannot be practically undertaken on the other types of public transport, at a considerably lower cost that would be incurred in a taxi.

## 2. Safety Risks in Riding Rickshaws

Auto – rickshaws are perceived to be unsafe, first because the vehicle itself is seen as hazardous and the drivers as poor vehicle operators, who are willing to overload their vehicles and at the same time make many trips in short periods of time.

Auto –rickshaws are seen as unstable and liable to turn turtle, due to a shunt from another vehicle, a bump in the road, or overly rapid speeds caused by the drivers, with the passengers being thrown against the sparse, hard metal interior, whose sole soft surfaces are the rear passenger bench and the driver's seat. The lack of doors means that the occupants could be thrown onto the road, with the potential for serious injury, even at low speed.

## 3. Air Pollution and Environmental Impacts

Auto – rickshaws have been seen as significant contributors to urban air pollution, and regrettably it is not included in policy making circles in Sudan. The rates of pollutants leaving the exhaust pipe including carbon dioxide, carbon monoxide and unburned hydrocarbons contribute negatively in human beings health in different forms of diseases ranging from chest infections to cancer {[27] – [28]} .

Auto – rickshaws are thought to cause congestion in near future due to the impact of their increasing numbers and therefore, major cities would be prone to lungs related diseases and other dangerous impacts related to animals and natural environment surrounding these cities. Therefore, major cities must strictly regulate and rationalize the number of auto – rickshaws through a permit system, based on the belief that auto – rickshaw numbers would otherwise reach a level that would cause intolerable congestion which leads to serious human and environmental impacts.

The perceptions of auto – rickshaws amongst the middle classes, media, consumer organizations and policy makers are largely negative. The vehicles are seen as polluting, unsafe, and a significant cause of congestion and environment degradation. Auto – rickshaws are perceived as an intrusion into organized urban space and therefore, they should be tamed and controlled with strict policies and punitive penalties.

As stated above the two stroke gasoline engine driven vehicles are major source of air pollution by their smoky emissions particularly in Asia and Africa. An immediate ban on gasoline –powered two stroke engine vehicles would be extremely difficult and costly because these vehicles are numerous and popular. Two immediate simple solution proposals which include use of correct mixture of lubricant oil to fuel and regular vehicle preventive and corrective maintenance, which ultimately will improve air quality and increase the operation life of the vehicle [29] and [30].

## 4. The Usage of Auto – Rickshaw in Sudan

Auto – rickshaw which also called tuk tuk is used extensively in different parts of Sudan (i.e. urban and non – urban regions) as a mean of transport for short distance trips. These small size vehicles constitute about one – third of all transport population in Sudan according to the statistical records of Sudan National Statistical Bureau.

In Sudan there is a high misunderstanding of the correct mixture of oil to fuel among technicians and vehicles' mechanics and vehicles' drivers as they think that the engine will give its highest performance due to the increase of oil – fuel ratio. The oil – fuel proportion recommended by those technicians and/ or mechanics may reach more than 12%. That means they do not abide with the operation instructions of the manufacture's manual. The manufacturer always recommends that for every liter of gasoline (i.e. Benzene) charged, a lubrication oil proportion of about 2% or 3% should be added to the fuel and should be agitated and mixed perfectly before engine's operation. To do this job, always the rickshaw is equipped with a calibration cup which has two graduated scales engraved on the outside surface of the cup. One of the graduated scales represents the proportion of 3% oil to Benzene, which ought to be used in summer season when the atmospheric temperature is high and therefore, the evaporation rate of the mixture is elevated. The other graduated scale of 2% is recommended to be used during winter when the atmospheric temperature is low and so the evaporation rate. Often, the incorrect mixture of oil to fuel (i.e. more than 5%) is detriment on the performance of the engine due to the increase and accumulation of carbon deposits inside the combustion chamber which minimize the size of the chamber and consequently cause a considerable drop in pressure and power of the engine. The carbon deposits formed during combustion may be inserted and consequently reciprocate between the piston and cylinder. This action causes scratches on the surface of the cylinder and leads repeatedly to engine overhaul maintenance.

Also, the increase of lubrication oil in the oil – fuel mixture causes major defects in spark plug terminal gap which in turn needs repeated and continuous maintenance or replacement of the defected plugs. Another limitation of excessive oil in the mixture is the formation of layers of carbon particles which blocks the exit of exhaust gases through the exhaust pipe, and this problem leads to a considerable drop in exhaust gases pressure and consequently, the exhaust gases are imprisoned inside the cylinder.

## 5. The Experimental Results on Bajaj Rickshaw Engine

Some experiments on Bajaj Rickshaw engine have been performed using a wide spectrum of oil/ fuel ratios ranging between 2% and 12.5%.

A Bajaj Rickshaw engine of the following technical specifications has been used in the experiments. The specifications are tabulated in table (1) below:

**Table (1) Technical Specifications of Bajaj Rickshaw used in Experiments**

| | |
|---|---|
| Engine | Gasoline engine, 1 cylinder, capacity 400cc |
| Speed Transmitter | Manual , 4 speeds |
| Battery | 12 volt |
| Output power | 5.5 hp at 500 rev/min |
| Maximum torsional torque | 12.17 N.m at 3500 rev/min |
| Fuel system | Carburetor system |
| Ignition system | Electronic ignition (CDI) |
| Engine cooling | Air cooling |
| Transmission | 4 Forward gears and 1 reverse gear |
| Brake system | Hydraulic expansion shoe brake front and rear |
| Fuel tank capacity | 8 Liter including 0.75 Liter for the reservoir tank |
| Vehicle length | 2.62 m |
| Vehicle breadth | 1.3 m |
| Height above ground | 20 cm |
| Diameter of rotation | 2.3 m |
| Maximum load | 610 kg |
| Fuel consumption | 1 Liter per 25 to 28 km |
| Front wheel and rear wheel tire pressures | 2.1 kg/ $cm^2$<br>2.4 kg/ $cm^2$ |
| Distance from ground to center of wheel | 0.2 m |
| Vehicle mass | 295 kg |
| Maximum speed | 68 kg/hr |

### 5.1 Oil Fuel Mixture of 2%

Table (1) and Fig. (1) Show the variation of velocity against time. Three tests were performed and average values were taken as they are shown in table (1). It has been observed that the average time taken to reach the maximum speed (i.e. 25 kg/hr) for the second gear is 7.01 seconds, and the time taken to reach the speed (40 km/hr) for the third gear is 14.49 seconds, and for the fourth gear the time taken is 84.61 seconds for speed of 58.67 km/hr.

**Table (1) Oil – Fuel Mixture of 2%**

| Variables / Gear change | Speed (km/ hr) | Time (seconds) |
|---|---|---|
| Second gear | 25 | 7.01 |
| Third gear | 40 | 14.49 |
| Fourth gear | 58.67 | 84.61 |

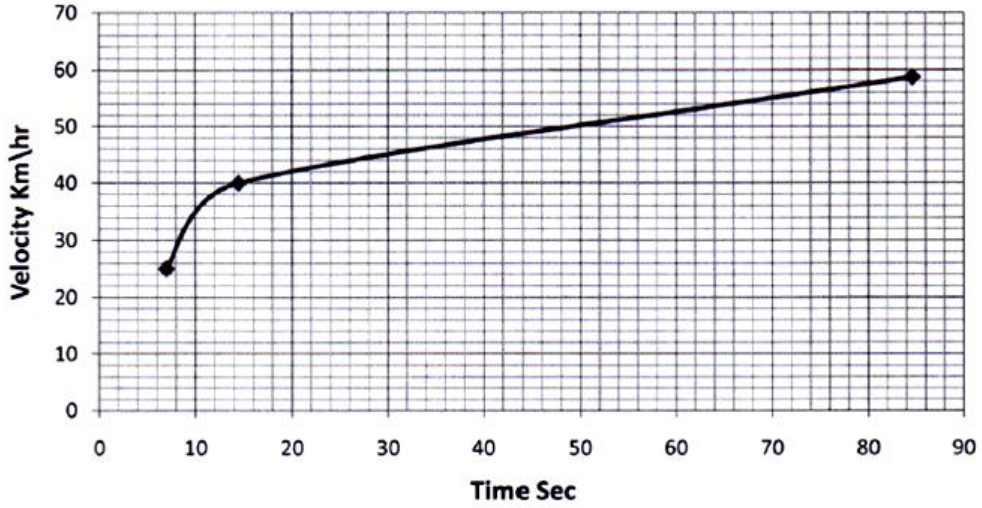


Fig. (1) Velocity against time for oil – fuel mixture of 2%

**5.2 Oil Fuel Mixture of 3%**

Table (2) and Fig. (2) Show the variation of velocity against time. The average values of velocity and time were taken from three tests. It has been observed that the average time taken to reach the maximum speed (i.e. 25 kg/hr) for the second gear is 7.4 seconds, and the average time to reach the maximum speed (i.e. 40 km/hr) for the third gear is 19.76 seconds, and for the fourth gear the time taken is 88.36 seconds for speed of 60 km/hr.

**Table (2) Oil – Fuel Mixture of 3%**

| Variables / Gear change | Speed (km/ hr) | Time (seconds) |
|---|---|---|
| Second gear | 25 | 7.4 |
| Third gear | 40 | 19.76 |
| Fourth gear | 60 | 88.36 |

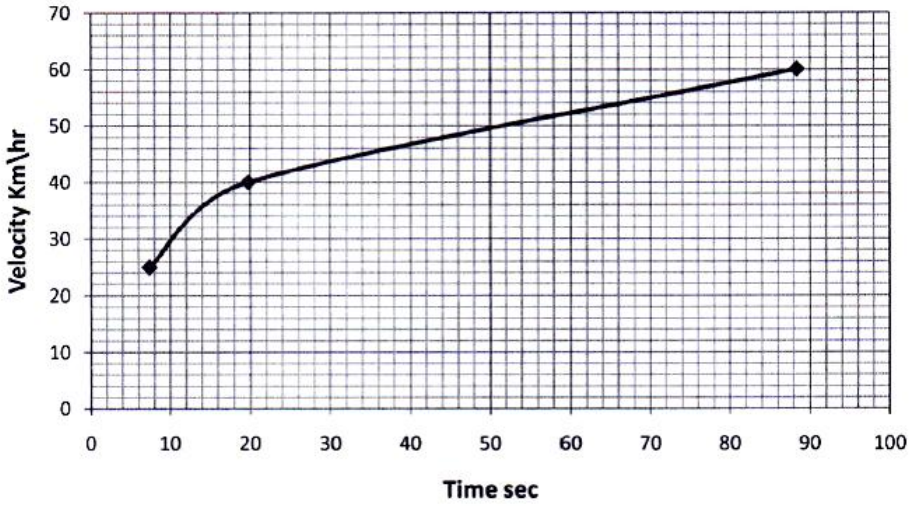


Fig. (2) Velocity against time for oil fuel mixture of 3%

**5.3 Oil Fuel Mixture of 6.25%**

Table (3) and Fig. (3) Show the variation of velocity against time for three consecutive gear changes (i.e. second, third and fourth gears) and their corresponding averaged time taken.

**Table (3) Oil – Fuel Mixture of 6.25%**

| Variables / Gear change | Speed (km/ hr) | Time (seconds) |
|---|---|---|
| Second gear | 27 | 7.5 |
| Third gear | 40 | 16.9 |
| Fourth gear | 60 | 89.26 |

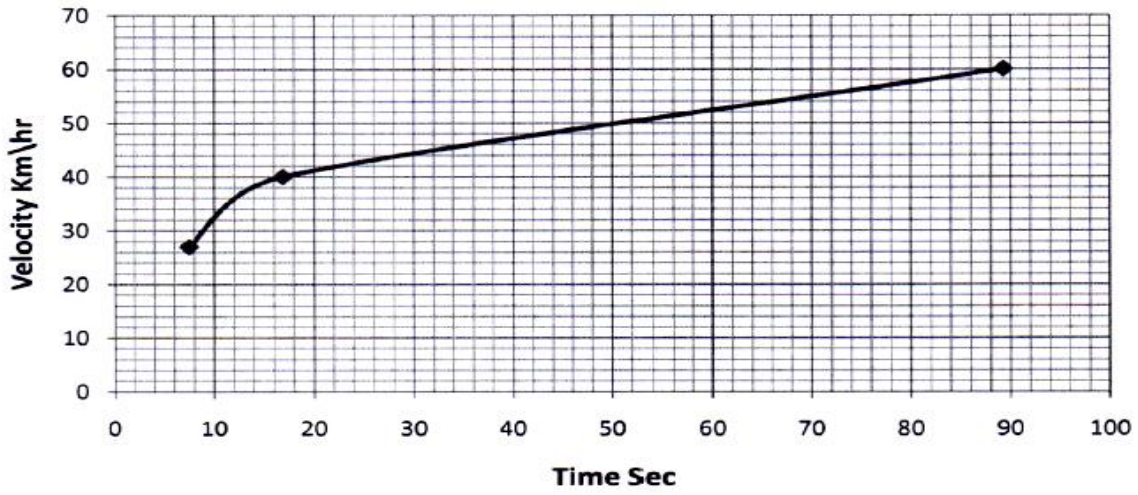


Fig. (3) Velocity against time for oil fuel mixture of 6.25%

**5.4 Oil Fuel Mixture of 10%**

Table (4) and Fig. (4) Show the variation of velocity against time for three consecutive gear changes (i.e. second, third and fourth gears) and their corresponding averaged time taken.

**Table (4) Oil – Fuel Mixture of 10%**

| Variables / Gear change | Speed (km/ hr) | Time (seconds) |
|---|---|---|
| Second gear | 30 | 7.6 |
| Third gear | 40 | 19.38 |
| Fourth gear | 58 | 90.3 |

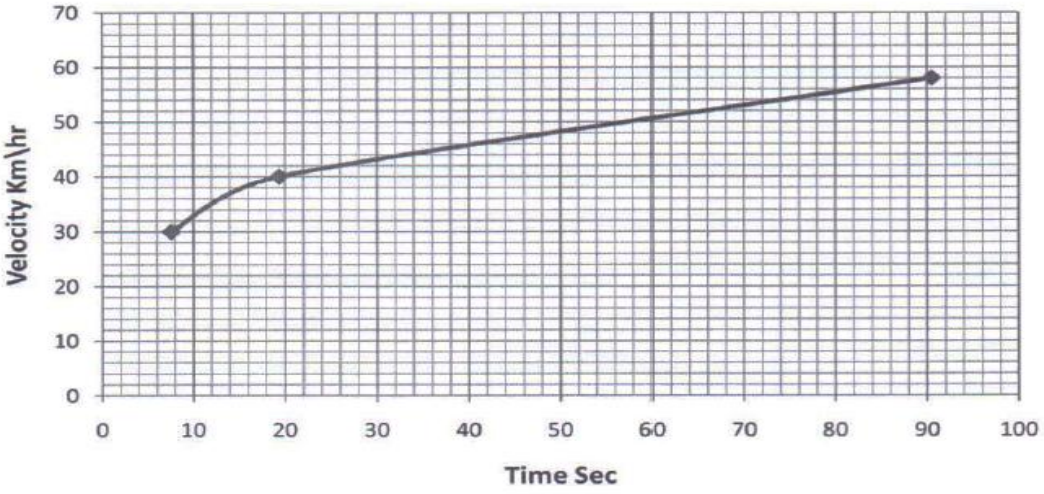


Fig. (4) Velocity against time for oil fuel mixture of 10%

**5.5 Oil Fuel Mixture of 12.5%**

Table (5) and Fig. (5) Show the variation of velocity against time for three consecutive gear changes (i.e. second, third and fourth gears) and their corresponding averaged time taken.

**Table (5) Oil – Fuel Mixture of 12.5%**

| Variables / Gear change | Speed (km/ hr) | Time (seconds) |
|---|---|---|
| Second gear | 28 | 8.24 |
| Third gear | 40 | 20.64 |
| Fourth gear | 60 | 92.3 |

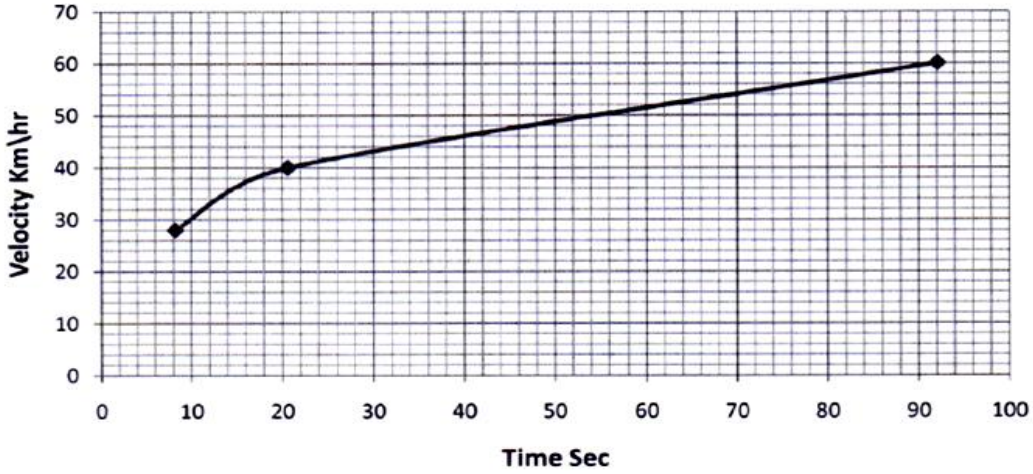


Fig. (5) Velocity against time for oil fuel mixture of 12.5%

## 6. Discussion of Results

From the previous tables and diagrams it is observed that the speed is directly proportional to time taken in approximately all the mixtures (i.e. 2%, 3%, 6.25%, 10%, and 12.5%) for all gear changes (i.e. second, third and fourth gear). As an example, when a mixture ratio of 2% is used the time taken to reach maximum velocity at the second gear change which is 25 kg/hr is 7.01 seconds, and when using a mixture ratio of 3% the time taken to reach the same speed is 7.4 seconds, and when using a mixture ratio of 6.25% the time taken to reach the same speed is 7.5 seconds. When a mixture ratio of 10% is used, the time taken to reach the maximum velocity (i.e. 25 kg/hr) is 7.6 seconds and when using oil – fuel mixture of 12.5% the time taken to reach the same maximum speed is 8.4 seconds. This means that as the oil – fuel mixture ratio increases, the time taken to access the maximum speed for every gear change also increases. In other words, the acceleration of the vehicles increases as the oil – fuel mixture ratio decreases.

In Sudan, the rickshaw drivers and mechanics (i.e. maintenance technicians) always use incorrect oil – fuel mixture ratio (i.e. above 5% up to 12.5%) which causes slow acceleration of engine rotation.

The out of proportion of oil – fuel mixture ratio could cause many problems due to different factors which can be summarized as follows:

1. The unburned fuel – oil mixture and small particles of carbon deposits contribute in blocking the ports of passing exhaust gases inside the silencer. This in turn increases pressure and therefore, slows down the exit of exhaust gases outside the combustion chamber.
2. The small particles of carbon deposits which form during combustion are accumulated inside the combustion chamber and therefore, minimize its size and consequently cause drop in pressure inside the cylinder. Also, these small and fine particles of carbon deposits may be inserted between the cylinder and piston and subsequently reciprocates with the piston inside the cylinder. This action causes scratches on the surfaces of cylinder and piston and possibly leads to engine overhaul.

## 7. Conclusions

From the experiments that were obtained in paragraph 5, it was found that the manufacturers' recommended oil – fuel mixture ratios of 2% in winter season and 3% in summer season are the suitable and optimum ratios that could be used by rickshaw drivers. The advantages of using these ratios could be summarized as follows: (1) longer life of engine, (2) divergence of overhaul maintenance periods, (3) less impact to the surrounding environment.

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