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# CASE STUDY ON SIMPLE CARBURETTOR

**Harshad Nawale[1]**

[1]*Mechanical Department of Engineering, VIT Pune*
[2]*Guide:* ***Prof. Nitin Borse,*** *Dept. of Mechanical Engineering, VIT Pune, Maharashtra, India*

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**Abstract -** *Modern passenger vehicles with gasoline(petrol) engines are provided with different compensating devices for fuel air mixture supply. Even then there is a high fuel consumption because of many factors. One of the important factors that affect the fuel consumption is that design of carburetor. The venturi of the carburetor is important that provides a necessary pressure drop in the carburetor device. The Venturi effect is that the reduction in atmospheric pressure and thus the rise in air velocity when filtered air flows through the throat section of an easy carburetor. The reduction in atmospheric pressure and thus the rise in air velocity within the throat section of a carburetor is restricted by the choked flow condition at Mach number unity. The fuel mass flow entering the throat area are often treated as an incompressible fluid using Bernoulli's equation.*

***Key Words*****: Carburettor, Carburetion, A/F ratio, Air-Fuel Mixture.**

## 1. INTRODUCTION

The process of formal ion of a combustible fuel-air mixture by mixing the right amount of fuel with air before admission to engine cylinder is named carburetion and therefore the device which does this job is called carburettor.

### 1.1 FACTORS INFLUENCING CARBURETION:

**THE ENGINE SPEED:** The time available for the preparation of the mixture. In case of recent high speed engines, the time duration available for the formation of mixture is extremely small and limited. The time duration for mixture formation and induction could also be of the order of 10 to 5 milliseconds.
**THE VAPORISATION CHARACTERISTICS OF FUEL:** Atomisation, mixing and vaporisation are the processes which require a finite time to occur. The time available for mixture formation is very small in high speed engines. For completion of those processes in such a little period an excellent ingenuity is required in designing the carburettor system. In order to achieve high quality carburetion within such a short time requires good vaporisation characteristics of the fuel which are ensured by presence of high volatile hydrocarbons within the fuel.
**THE TEMPERATURE :.** The temperature may be a factor which effectively controls vaporisation process of the fuel. If the temperature of the incoming air is high, it leads to higher rates of vaporisation. The mixture temperature are often increased by heating the induction manifold but it'll end in reducing power thanks to reduction in mass flow.
**THE DESIGN OF THE CARBURETTOR:** The design of carburetion system is very complicated owing to the fact that the air-fuel ratio required by it varies widely over its range of operation, particularly for an automotive engine. For idling also as for max power rich mixture is required.

### 1.2 AIR-FUEL MIXTURES:

For proper running of the engine under different loads and speeds a proper mixture of air and fuel is required. Fuel and air are mixed to make three differing types of mixtures. Generally 3 types of fuel mixtures are:

1. Chemically Correct Mixture
2. Rich Mixture And
3. Lean Mixture

The mixture during which there's only enough air for the entire combustion of the fuel is named ***stoichiometric mixture.*** For Example, to burn one kg of octane (C8H18) completely 15.12 kg of air is required. Hence chemically correct A/F ratio for C8H18 is 15.12:1; usually approximated to 15:1.

The mixture which contains less air than the air required for stoichiometric mixture is called ***rich mixture***.(For Example, A/F ratio of 12:1, 10:1 etc.). The mixture containing more air than the stoichiometric mixture is called ***lean mixture.*** (For Example, A/F ratio of 17:1, 20:1 etc.). The carburettor should provide the air-fuel mixture according to engine requirement and that must be under combustible range.

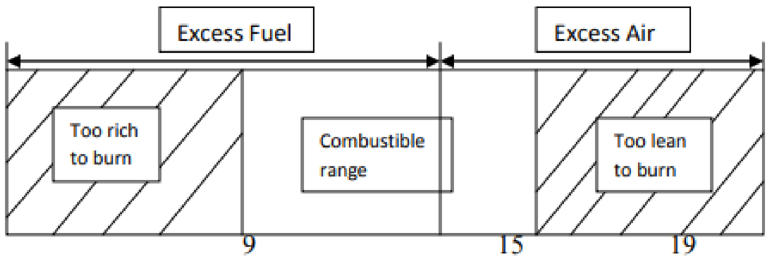


Fig no.1

**1.3 MIXTURE REQUIREMENTS AT DIFFERENT LOADS AND SPEEDS:**

The performance of an engine generally suffering from the air-fuel ratio under which it's operating. The power output and therefore the brake specific fuel consumption are suffering from the air-fuel ratio as shown within the Fig no.2

The mixture like the utmost point on the facility output curve is named *best power mixture* and therefore the air-fuel ratio at now is approximately 12:1.

The mixture like rock bottom point on the brake specific fuel consumption curve is named the *economy mixture* and therefore the air-fuel ratio at now is about 16:1.

The best power mixture is usually richer than the stoichiometric mixture whereas the economy mixture is leaner than the stoichiometric mixture.

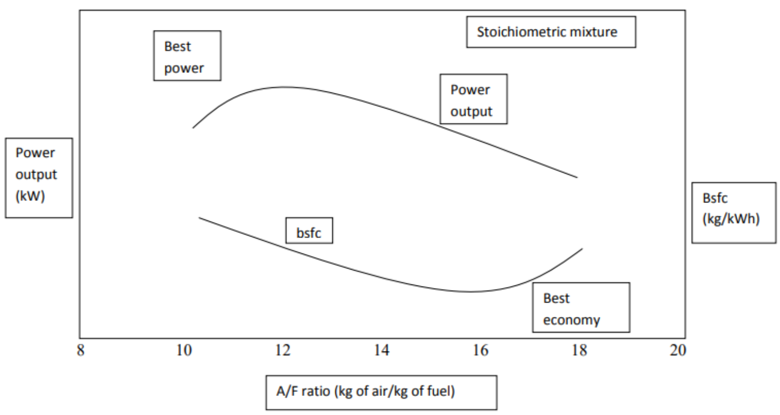


Fig no.2

## 2. AUTOMOTIVE ENGINE AIR-FUEL MIXTURE REQUIREMENTS:

### 2.1 IDLING AND LOW SPEED:

In idling range the mixture must be enriched as the engine operates at no load about 20% of rated power and with nearly closed throttle. It is indicated by the point A in the Fig no.3

Due to constant volume of the clearance volume the mass of the exhaust gas tends to stay constant throughout the idling range. The amount of fresh charge that's drawn during the intake stroke is far but that of during full throttle condition which tends to mixing of larger proportion of exhausts gas with the fresh charge under idling conditions.

During the opening of the intake valve the pressure difference between combustion chamber and the intake manifold results in a backward flow of the fresh charge. But as soon because the piston starts moving downwards the mixture is again sucked into the combustion chamber. Inside the combustion chamber as there's much amount of exhaust gas than the fresh charge, the exhaust gas prevents the touching of the air and fuel molecules with each other which is far necessary for the method of combustion to require place. Therefore it is essential to provide more fuel particles by richening the air-fuel mixture. As the throttle moves from A towards B the pressure difference between the combustion chamber and the manifold decreases and the exhaust gas dilution of the fresh charge decreases.

### 2.2 CRUISING OR NORMAL POWER:

From about 25% to about 75% of rated power. In cruising range from position B to C of the throttle valve the exhaust gas dilution is insignificant. The primary aim lies to obtain a much better fuel economy. Because mixture of fuel and air is never completely homogeneous the stoichiometric mixture of fuel and air will not burn completely and some fuel will be wasted. For this reason an excess of air, say 10% above theoretically correct (16.5:1), is supplied in order to ensure complete burning of the fuel.

### 2.3 MAXIMUM POWER:

From 75% to 100% of rated power. Maximum power is obtained when all the air supplied is fully utilized. In the peak power operation the engine requires a much richer mixture as indicated in the Fig no.3 by the line C to D because of:

1. During peak power operation some parts of the cylinder gets heated up. So enriching the mixture reduces the flame temperature and the cylinder temperature and the cooling problem is solved.
2. Since high power is required the cruising setting must be transferred to a setting in which the mixture will deliver maximum power or to a setting in which air-fuel ration lies in the range of 12:1.

As the mixture is not completely homogeneous a rich mixture must be supplied to assure utilization of air. Running on the weakest mixture. This results in high efficiency and there is fuel economy. On normal loads engines work on weak mixture.

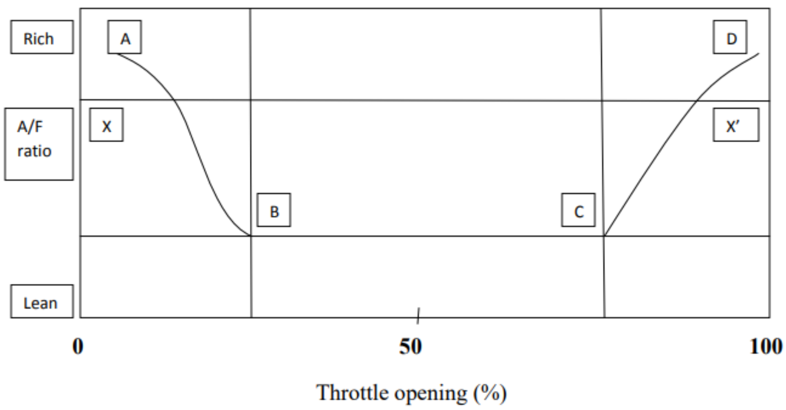


Fig no.3

**3. PRINCIPLE OF CARBURETION:**

Until air and gasoline(petrol) are drawn through the carburettor and into the engine cylinders by the suction created by the downward movement of the piston. This suction is due to a rise within the volume of the cylinder and a consequent decrease in the gas pressure in this chamber. The difference in pressure between the atmosphere and cylinder that causes the air to flow into the chamber.

In the carburettor, air passing into the combustion chamber picks up fuel discharged from a tube. This tube features a fine orifice called *carburettor jet* which is exposed to the air path.

The rate at which fuel is discharged into the air depends on the pressure difference or pressure head between the float chamber and the throat of the venturi and on the area of the outlet of the tube. So as that the fuel drawn from the nozzle could also be thoroughly atomized, the suction effect must be strong and therefore the nozzle outlet is comparatively small. So as to supply a robust suction, the pipe within the carburettor carrying air to the engine is formed to possess a restriction. At this restriction called throat due to increase in velocity of flow, a suction effect is made.

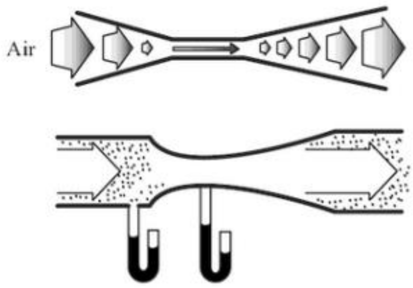


Fig no.4

The end of the fuel jet is found at the venturi or throat of the carburettor. Normally, this is often slightly below the narrowest section of the Venturi tube . The spray of gasoline(petrol) from the nozzle and therefore the air entering through the Venturi tube are mixed together during this region and a combustible mixture is made which passes through the manifold into the cylinders. Most of the fuel gets atomized and simultaneously a little part are going to be vapourized.

**4. THE SIMPLE CARBURETTOR:**

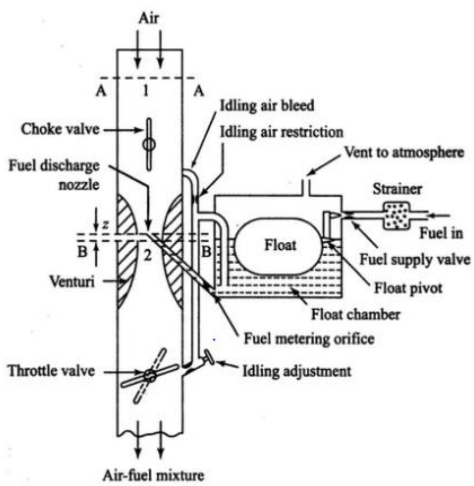


Fig no.5

The simple carburettor consists of the subsequent basic parts:

- Float chamber

- Venturi
- Fuel discharge nozzle
- Metering orifice
- Choke
- Throttle valve

The float and a needle valve system maintains a continuing level of gasoline within the float chamber. If the quantity of fuel within the float chamber falls below the designed level, the float goes down, thereby opening the fuel supply valve and admitting fuel. When the designed level has been reached, the float closes the fuel supply valve, thus stopping additional fuel supply.

During suction stroke air is drawn through the venturi. Because the air passes through the venturi the speed increases reaching a maximum at the venturi throat. Correspondingly, the pressure decreases reaching a minimum. From the float chamber, the fuel is fed to a discharge jet, the tip of which is found within the throat of the venturi. Due to the difference in pressure between the float chamber and the throat of the venturi, referred to as carburettor depression. The pressure at the throat at the fully open throttle condition lies between 4 to 5cm of Hg, and rarely exceeds 8 cm Hg.

To avoid overflow of fuel through the jet, the extent of the liquid within the float chamber is maintained at a level slightly below the tip of the discharge jet. This is often called the tip of the *nozzle.* The internal-combustion engine is quantity governed, which suggests that when power output is to be varied at a specific speed, the quantity of charge delivered to the cylinder is varied. This is often achieved by means of a accelerator usually of the butterfly type which is situated after the Venturi tube . Because the throttle is closed less air flows through the Venturi tube and fewer is that the quantity of air-fuel mixture delivered to the cylinder and hence power output is reduced. Because the throttle is opened, more air flows through the choke tube leading to increased quantity of mixture being delivered to the engine. This increases the engine power output.

A simple carburettor of the sort described above suffers from a fundamental drawback therein it provides the specified A/F ratio only at one throttle position. At the opposite throttle positions the mixture is either leaner or richer counting on whether the throttle is opened less or more. Because the throttle opening is varied, the air flow varies and creates a particular pressure difference between the float chamber and the venturi throat. The same pressure difference regulates the flow of fuel through the nozzle. At an equivalent time, the density of air decreases because the pressure at the venturi throat decreases with increasing air flow whereas that of the fuel remains unchanged. This leads to an easy carburettor producing a progressively rich mixture with increasing throttle opening.

**5. COMPLETE CARBURETTOR:**

For meeting the demand of the engine under all conditions of operation, the subsequent additional devices/systems are added to the simple carburettor:

- Idling system
- Power enrichment or economiser system
- Acceleration pump system
- Choke

**5.1 MAIN METERING SYSTEM:**

The main metering system of a carburettor should be so designed to supply almost constant fuel-air ratio over a good range of operation. This F/A ratio is approximately adequate to 0.064 (A/ F ratio = 15.6) for best economy at full throttle so as to correct the tendency of the simple carburettor to offer progressively richer mixtures with load speed, the subsequent automatic compensating devices are incorporated within the main metering system:

- Compensating jet device.
- Emulsion tube or air bleeding device.
- Back suction control or pressure reduction method.
- Auxiliary valve carburettor.
- Auxiliary port carburettor.

### 5.2 EMULSION TUBE OR AIR BLEEDING DEVICE:

The mixture correction in modern carburettor is completed by air bleeding alone.

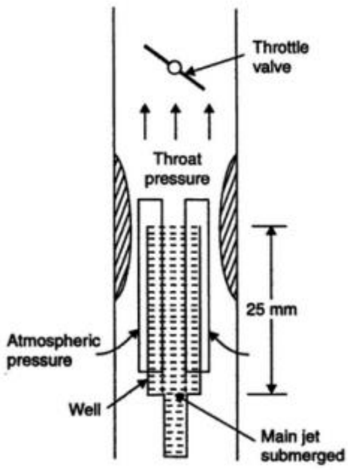


Fig No.6

A main metering jet is fitted 25 mm below the gasoline(petrol) level within the float chamber and thus it is called submerged jet. The jet is situated at rock bottom of a well, the edges of which have holes which are in communication with the atmosphere. Air is drawn through the holes and therefore the gasoline(petrol) is emulsified; the pressure difference across the gasoline(petrol) column isn't as great as that within the simple carburettor. Initially the extent of gasoline(petrol) within the float chamber and the well is same. When throttle is opened the pressure at the venturi decreases and therefore the gasoline(petrol) is drawn into the air stream. This leads to progressively uncovering the holes within the central tube resulting in decreasing F/A ratio or decreasing richness of the mixture. Normal flow then takes place from the most jet.

### 5.3 IDLING SYSTEM:

At idling and low load an engine requires an upscale mixture having about air-fuel ratio 12 :1. the most metering system not only fails to provide enrich mixture at low air flows but also cannot supply any fuel during idling operation. It is due to this reason that a separate idling jet must be incorporated within the simple carburettor. Fig no.7 shows an idling jet. It consists of a little gas line from the float chamber to some extent on the engine side of the throttle ; this line contains a hard and fast fuel orifice. When throttle is practically closed, the complete manifold suction operates on the outlet to the present jet.Besides local suction is increased due to very high velocity past the throttle valve. Fuel therefore are often lifted by the extra height upto the discharge point, but this happens only at very low rates of air flow.

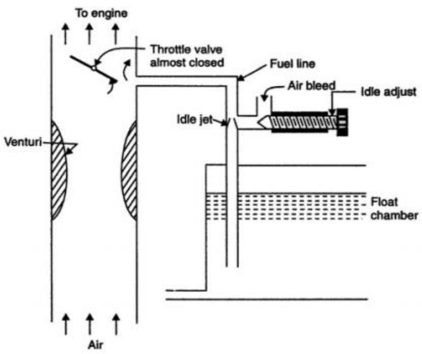


Fig no.7

When the throttle is opened, the most jet gradually takes over and therefore the idle jet eventually becomes ineffective.

**5.4 POWER ENRICHMENT ECONOMISER SYSTEM:**

At the utmost power range of operation from 75% to 100% load, a tool should be available to permit richer mixture F/A about 0.08 to be supplied despite the compensating leanness. Meter rod economiser shown in following Fig no.8 is such a tool . It simply provides an outsized orifice opening to the most jet when the throttle is opened beyond specified limit.

An economiser may be a valve which remains closed at normal cruise operation and gets opened to provide enriched mixture at full throttle operation. It regulates the extra fuel supply for the above operation. The term economiser is quite misleading. It stems from the very fact that such a tool provides an upscale uneconomical mixture at high load demand without interfering with economical operation within the normal power range.

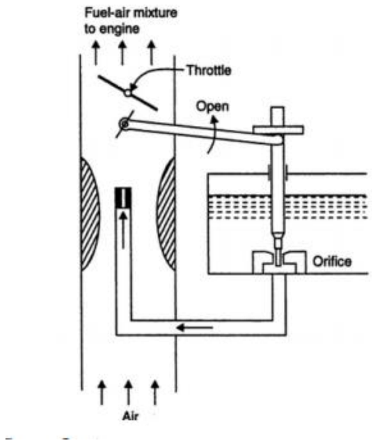


Fig no.8

**5.5 ACCELERATION PUMP SYSTEM :**

Acceleration may be a transient phenomenon lasting a really short time. So as to accelerate the engine rapidly, a really rich mixture is required which an simple carburettor might not be ready to supply. Rapid opening of throttle are going to be immediately followed by an increased air flow, but the inertia of liquid fuel (gasoline) will give momentarily lean mixture. Thus acceleration mixture required might not be met with in practice. To beat this difficult situation an acceleration pump is incorporated.

Acceleration pump consists of a spring-load plunger. Is also provided a linkage mechanism in order to when throttle is rapidly opened the plunger moves into the cylinder and forces a further jet of fuel into the venturi. An is additionally provided which ensures that when throttle is opened slowly, the fuel within the pump cylinder isn't forced into the venturi but leaks past plunger or some holes into the float chamber.

**5.6 The Choke and the Throttle:**

When the vehicle is kept stationary for an extended period during cool winter seasons, could also be overnight, starting becomes more difficult. At low cranking speeds and intake temperatures a really rich mixture is required to initiate combustion. Sometimes air-fuel ratio as rich as 9:1 is required. The main reason is that very large fraction of the fuel may remain as liquid suspended in air even within the cylinder. The foremost popular method of providing such mixture is by the utilization of choke valve. This is often simple valve located between the doorway to the carburettor and the venturi throat as shown in Fig no.9

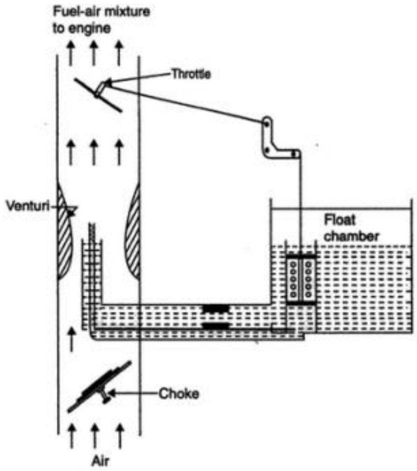


Fig no.9

**6. MULTIJET CARBURETTORS:**

A single barrel carburettor has just one barrel, whereas a dual carburettor has two barrels. Each of those two barrels during a dual carburettor contains a fuel jet, a Venturi tube , an idling system, a choke and a throttle. The float chamber and therefore the accelerating pump are common to both the barrels Passenger cars with six or more cylinders, are given dual carburettor. Each venturi supplies the air-fuel mixture to half the cylinders.
Certain advantages of a dual carburettor over one barrel carburettor are:

- The dual carburettor supplies a charge of the mixture to the cylinders which is uniform in quality.
- Volumetric efficiency is higher just in case of a dual carburettor.
- The charge of the air-fuel mixture is distributed to every cylinder during a better manner.
- The dual carburettor Ls compact in its design.

**7. Drawbacks of Modern Carburettors:**

The modern carburettors have the subsequent drawbacks:

- The mixture supplied to varied cylinders of a multi-cylinder engine varies in quality and quantity. Also, thanks to fuel condensation in induction manifold, the mixture proportion is affected.
- Due to presence of several wearing parts, the carburettors operate at a lower efficiency.
- Reduced volumetric efficiency due to non availability of a free flow passage for the mixture due to the presence of choke tubes, throttle valves, jets, bends etc.
- At low temperatures, freezing can occur.
- When the carburettor is tilted or during acrobatics in aircraft surging can occur.
- In the absence of flame traps, backfiring may occur which can cause ignition of fuel outside the carburettor.

**8. Conclusion:**

- When the flow inside the carburettor was analysed for a particular angles of throttle plate opening, it was found that the pressure at the throat of the venturi decreased with the increase in opening of the throttle plate. Because when the throttle plate opening increases then the flow of air through the carburettor increases but the fuel flow remains constant. So the mixture becomes leaner. But as the pressure at the throat also decreases with increase in opening of the throttle plate so the flow of fuel from the float chamber into the throat increases and hence the quality of the mixture tends to remain constant.
- When analysed for fuel discharge nozzle, it was observed that the pressure distribution inside the body of the carburettor is quite uniform which leads to a better atomization and vaporization of the fuel inside the carburettor body. The considered angle gives optimum fuel discharge nozzle for gasoline operated engine.

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