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# Engine performance using vaporizing carburetor

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**Abstract**

A simple device for mixture preparation in a spark ignition engine (vaporizing carburetor) with the ability to provide the engine with a homogeneous and correctly proportioned combustible mixture for different operating conditions has been tested in this study. This carburetor works on the principle of adiabatic vaporization of liquid gasoline fuel before introduction into the engine cylinder. This vaporization is achieved by passing atmospheric air, induced by engine suction, through the fuel.

The performance and exhaust gas emissions of the engine were studied using different percentages of methanol–gasoline blends as well as pure gasoline, using both conventional and vaporizing carburetors. Results have shown that the vaporizing carburetor has numerous advantages over conventional carburetors. The advantages include improvement in fuel economy and exhaust emission, which can be attributed to the leaning out of the mixture that could be prepared by using the vaporizing carburetor. The vaporizing carburetor was found to be suitable for use with fuel blends. This is due to the high quality of mixture preparation and mixing of different fuels. 

*Keywords:* Vaporizing carburetor; Fuel blends; Mixture preparation; Engine performance; Exhaust gas emissions

## 1. Introduction

Spark ignition engine performance is greatly affected by the quality of air–fuel mixture through the intake system, so the good design of the mixture preparation system will enable the engine to operate at its best performance. Metering of fuel and air in suitable proportions, mixing and distributing the fuel across the air stream and leading the mixture to the intake manifolds is usually accomplished through a mechanically controlled device which may be a carburetor. For

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the air–fuel mixture to be combustible, the fuel should be atomized, mixed with air and vaporized as it flows through the induction manifold to the combustion chamber. Atomization, mixing, vaporization, homogeneity and correct proportionality are very important parameters that make an air–fuel mixture suitable for engine operation. Also, these processes require a finite time to occur, therefore, speed is quite important.

Most conventional carburetors do not deliver optimum, uniform mixtures to every cylinder at different operating conditions. Optimum fuel–air ratio at any given speed is that which will develop the required torque, or brake mean effective pressure, with the lowest fuel consumption consistent with smooth and reliable operation. Mixture strength varies from cylinder to cylinder and from cycle to cycle. This is due to insufficient mixing and vaporization of fuel in air in the intake manifold [1,2]. In summary, a conventional carburetor under normal operating conditions supplies the engine with a nonhomogeneous mixture containing part of the fuel in a liquid form which, if not completely evaporated before combustion, can cause cyclic variation, increase the concentration of unburned hydrocarbons [3] and ruin lubricating oil quality by oil dilution [4]. Many attempts have been made to improve mixture quality to supply the engine with a well vaporized and mixed charge, such that engines will run reliably with best economy [2,5]. Attempts include:

- using gaseous fuels, e.g. methane,
- increasing the rate of turbulence to improve mixing of fuel vapour with air,
- Developing other types of venturi carburetors that are more suitable for efficient engine operation.

One of the attempts for improving mixture quality is to use the vaporizing carburetor which was invented by Asfar [6]. This carburetor supplies the engine with a well vaporized fuel–air mixture that would alleviate most of the problems associated with conventional carburetors. The performance characteristics of this system were investigated by Asfar et al. [7]. They used a constant speed blower to simulate engine suction and studied vaporization and the air–fuel ratios produced.

In the present work, the actual performance of the vaporizing carburetor is evaluated with an engine test bed. The engine performance and its exhaust emissions using different percentages of methanol–gasoline blended fuels as well as pure gasoline were studied.

## 2. Vaporizing carburetor

A schematic diagram of the vaporizing carburetor used in this study is shown in Fig. 1. It is made of a transparent plexiglass cylinder of 150 mm diameter and 350 mm long. A 32 mm diameter intake central tube penetrates the top cover and leads the air to the bottom of the cylinder through holes distributed at the circumference of the tube. The lower end of the tube is closed and rests against the bottom cover of the cylinder. An opening in the bottom of the cylinder is made for fuel inlet from the tank. A float chamber is used to maintain a constant level of fuel in the cylinder. By varying the float chamber height, the fuel height inside the cylinder will change in the same amount.

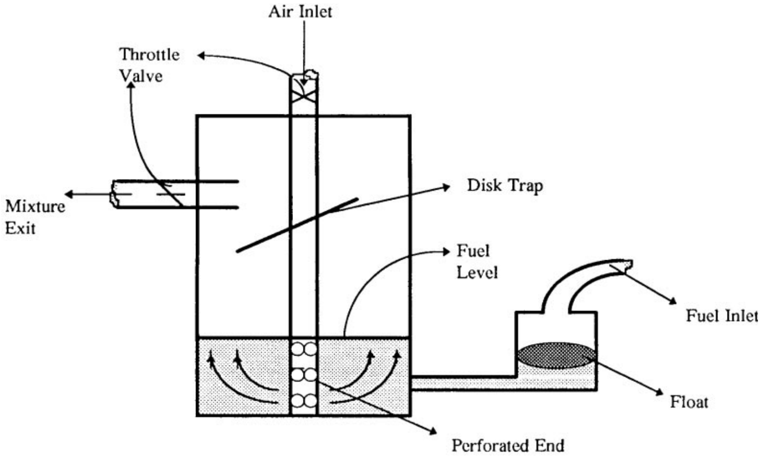


Fig. 1. Schematic diagram of vaporizing carburetor.

Air leaves the central tube through small holes in its wall and passes through the liquid fuel, causing bubbling. The air bubbles mix with the fuel and an exchange of heat and mass occurs, causing vaporization of the liquid fuel. When the air bubbles leave the fuel surface, they carry fuel vapor. The vaporized fuel–air mixture is led through an opening in the cylinder upper wall to the engine inlet tube. The mixture flow to the engine is controlled by a butterfly valve located at the engine inlet tube. To ensure that the *n*-fixture leaving the carburetor to the intake of the engine is completely dry, a circular disk trap is fitted into the central tube near the outlet of the cylinder.

## 3. Experimental equipment and method

A variable compression ratio (TecQuipment TD43), single cylinder gasoline engine, with a swept volume of 582 $cm^3$ was used as the test engine. The engine was coupled to an electrical generator through which load was applied by increasing the field voltage.

At each condition, the engine was allowed to run for approximately 20 min so as to achieve a steady state before taking measurements. A fixed spark timing, 120, and compression ratio, 8, were used throughout the experiments. Indicators on the test bed show the following quantities which are measured electrically: engine speed, torque, brake power and various temperatures. The fuel for test is a combination of a commercially available gasoline and industrial methanol (99.5% pure). Several fuel mixtures were used in this experiment. Pure gasoline and with methanol at different percentages. An exhaust gas analyzer (Sun model SGA 9000) was used to measure the exhaust gas concentrations of CO and HC in the exhaust. A continuous sample was drawn 80 cm downstream of the exhaust port.

The experimental work was divided into:

1. Investigation into engine performance and exhaust gas emissions using pure gasoline fuel with:

   - conventional carburetor,
   - vaporizing carburetor.

2. Investigation into engine performance and exhaust gas emissions using gasoline–methanol blended fuels at different percentages 5%, 10%, 20% with:

- conventional carburetor,
- vaporizing carburetor.

Tests were conducted for a speed range between 1000–2000 rpm and for different air–fuel ratios. The engine torque, fuel consumption, densities of CO and HC in the exhaust and exhaust temperature were measured at each operating condition.

## 4. Results and discussion

Fig. 2 shows the variation of brake power output from the engine with air–fuel ratio by using the vaporizing carburetor and engine conventional carburetor. For the same developed power by the engine and at full throttle condition, the air–fuel ratio produced by the conventional carburetor is less than that produced by the vaporizing carburetor. So, the carburetor extends the lean bum range of the engine.

Fig. 3 shows an improvement in the engine thermal efficiency of about 10–13% as a result of the presence of 20% methanol in the fuel blend. This is due to the fact that methanol has a higher flame speed compared to gasoline which ensures complete combustion with minimum time loss. Also, the engine has a higher efficiency by using the vaporizing carburetor as opposed to a conventional carburetor, where the fuel economy was improved by 20–25%.

Figs. 4 and 5 show the variation of exhaust emissions of CO and HC with engine speed for 0% and 20% methanol in the mixture. At low speed, a rich mixture is present and less turbulence, so

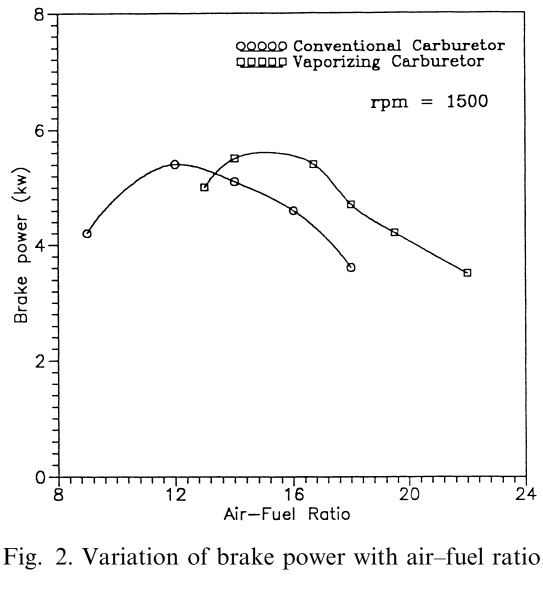


Fig. 2. Variation of brake power with air–fuel ratio.

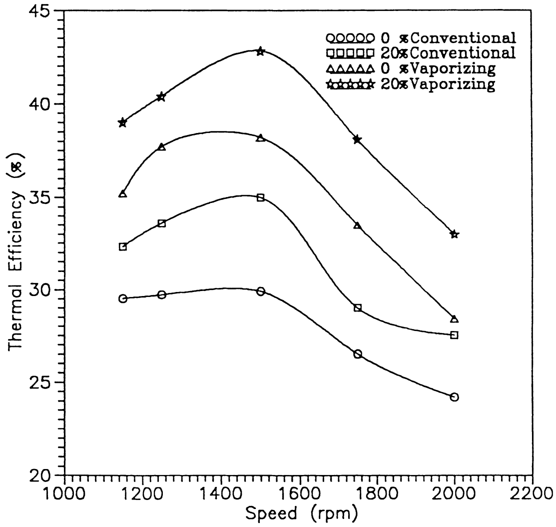


Fig. 3. Effect of engine speed on thermal efficiency.

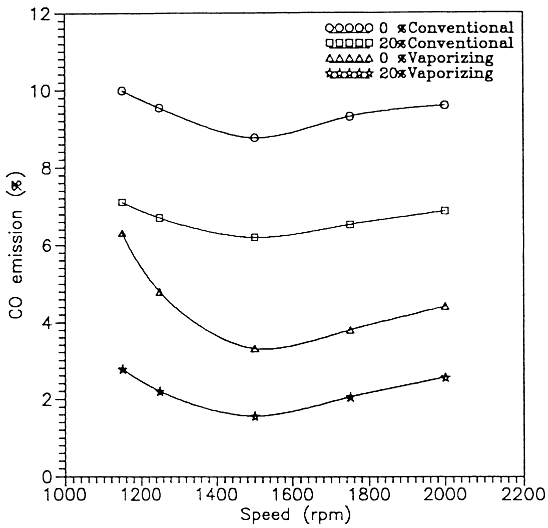


Fig. 4. Effect of engine speed on CO emission.

CO and HC emissions are expected to be high. At high speed, good turbulence is obtained, but there is insufficient time for combustion due to high speed. This will affect combustion and, thus, results in incomplete combustion, so increased emissions. Also, it can be seen that at 20% methanol, a reduction of 42–56% in CO emission occurs, while a reduction of 40–60% in HC emission is achieved. For the same percentage of methanol in the mixture, the vaporizing carburetor has less exhaust emission compared to the conventional carburetor.

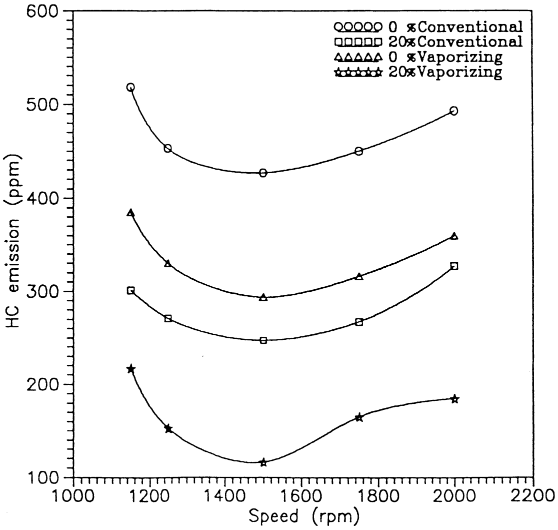


Fig. 5. Effect of engine speed on HC emission.

The improvement in the engine efficiency and the reduction in exhaust emissions when the vaporizing carburetor is used can be attributed to the following:

- The degree of turbulence which improves vaporization and mixing of fuel vapor with air. Turbulence formed in the vaporizing carburetor is due to air penetration through the central holes which increases the air velocity to enter the fuel layer and begin the process of atomization and vaporizing of fuel droplets. The degree of turbulence is directly related to engine speed.
- Elimination of fuel droplets in the mixture. This will obtain a higher air–fuel ratio and better distribution of fresh charge to each cylinder which, in turn, reduces cyclic and cylinder to cylinder variation and exhaust emissions.

## 5. Conclusions

The current investigation shows through the results that the vaporizing carburetor offers a simple device for mixture preparation in a spark ignition engine capable of supplying the desired air–fuel ratios. The following conclusions have been made:

- A wide range of air–fuel ratios can be obtained under different operating conditions by the vaporizing carburetor.
- For the same power output, an engine can operate with leaner mixtures by using the vaporizing carburetor as opposed to a conventional carburetor, so the fuel consumption is considerably reduced, and the amount of exhaust emissions are reduced.
- The vaporizing carburetor proves to be well suited to the use of blends in spark ignition engines, so the use of blends can be extended for different percentages of blends due to the high quality of mixture preparation and mixing of different fuels.

- The construction of the vaporizing carburetor is very simple, so its manufacturing cost is low when compared with conventional carburetors or fuel injection systems, and its maintenance is easier.

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