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A study on Optimization of Flow through Venturi of a Carburettor.

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Abstract— **Modern passenger vehicles with gasoline 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 carburettor. The venturi of the carburettor is important as it provides a necessary pressure drop in the carburettor device. Since different SI engine use alternative fuels such as LPG, CNG in the present day to reduce the pollution and fuel consumption. Still for a better economy and uniform fuel air supply there is a need to design the carburettor with an effective analytical tool or software. In this work two parameters namely pressure drop and fuel discharge nozzle angle of the carburettor will be analyzed using computational fluid dynamics.CFD analysis of the carburettor has been done by solid works and results obtained are used for optimum design of a carburettor.**

Keywords— **Pressure Drop, Fuel discharge, Nozzle angle, CFD analysis.**

I. Introduction

Engine is a device that transforms one form of energy into another form. Heat energy is a device that transforms the chemical energy contained in a fuel to another form of energy and utilizes that energy for some useful work [i]. Internal combustion engine is a device in which the combustion of the working fluid takes place inside the engine e.g. gasoline or diesel engine. SI engines generally use volatile liquids. The preparation of the fuel-air mixture is done outside the engine cylinder. The fuel droplets that remain in suspension also continue to evaporate and mix with air during suction and compression processes also. So carburetion is required to provide a combustible mixture of fuel and air in required quantity and quality [ii]. The process of forming a combustible fuel-air mixture by mixing the right amount of fuel with air before admission to the cylinder of the engine is called carburetion and the device doing this job is called carburettor.

Principle of Carburetion

Both air and gasoline are drawn into the cylinder due to suction pressure created by the downward movement of the piston [iii]. In the carburettor, the air passing into the combustion chamber picks up the fuel discharged by a fine orifice in a tube called the carburettor jet [iv].The rate of discharge of the fuel depends on the pressure difference between the float chamber and the throat of the venturi of the carburettor and the area of the outlet of the tube. In order that the fuel is strongly atomized the suction effect must be strong and the nozzle outlet must be comparatively small. To produce a strong suction, a restriction is generally provided in the pipe in the carburettor carrying air to the engine. This restriction is called throat. In this throat due to increase in the velocity of the air the pressure is decreased and suction is created. The venturi tube has a narrower path at the centre so that the path through air is going to travel is reduced. As same amount of air must travel must travel through the path of the tube so the velocity of the air at the venturi is increased and suction is created [v].Usually the fuel discharge jet is located at the point where the suction is maximum, so this is positioned just below the throat of the venturi. The spray of the fuel from the fuel discharge jet and the air are mixed at this point of the throat and a combustible mixture is formed, maximum amount of fuel gets atomized and some part gets vaporized [vi]. Due to increase in the velocity of the air at the throat the vaporization of the fuel becomes easier. The operation of the venturi in a carburettor is show in Figure1.

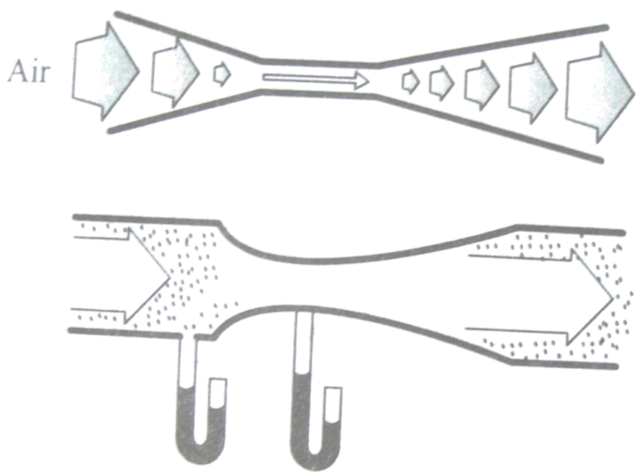

Figure 1: Operation of Venturi in a Carburettor

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II. Methodology

Specifications of the Model Carburettor

The model of the carburettor used is shown in Figure 2 and the various dimensions of the carburettor are mentioned below.

- Total length of Carburettor = 122 mm
- Inlet Diameter = 42mm
- Throat Diameter = 27mm
- Outlet Diameter = 37mm
- Length of Throat = 5mm
- Length of Inlet Part =51mm
- Length of the outlet part = 51 mm
- Nozzle inlet diameter = 2 mm
- Angle of fuel discharge nozzle with the vertical axis of carburettor = ϴ

Procedure and Simulation

For the analysis a simple carburettor meshed structure as shown Figure3 was taken and its various dimensions were measured. Then according to the measured dimensions a geometrical structure of the venturi of a carburettor was drawn with the help of Solid works software. Then the structure was analyzed with proper boundary conditions using the CFD tool of Solid Works and the results of this analysis were studied. There are so many parameters to vary but in this case only the effect of the variation of the fuel discharge nozzle angle on the flow across the carburettor is studied. The analysis was done for ϴ = 30^0, 35^0, 40^0, 45^0 where ϴ is the angle between the axis of the fuel discharge nozzle and the vertical axis of the body of the carburettor. Another analysis was done to calculate the throat pressure for different angles of the throttle plate. The analysis was done for ϴ = 45^0, 60^0, 75^0, 90^0.

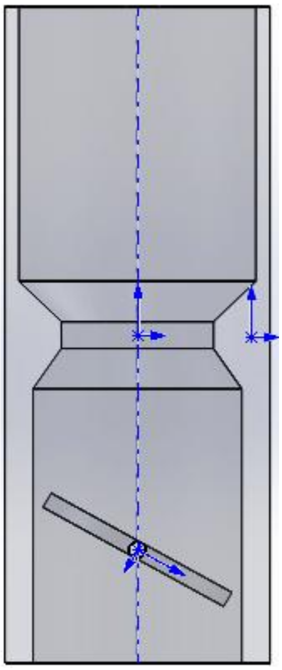

Figure 2: Model of a simple Carburettor

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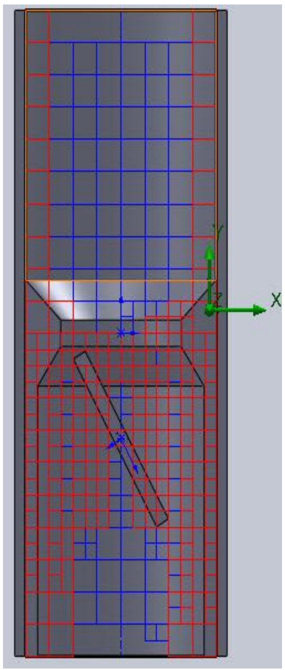

Figure 3:Meshed Structure of a Carburettor.

III. Results and Discussions

Throttle Plate Variation

The inlet air was assumed to enter the carburettor at normal temperature and the pressure was taken to be 1 atm.Results were obtained for pressure variation of the throttle plate of the carburettor. The analysis was done for ϴ = 45^0, 60^0, 75^0, 90^0 respectively.

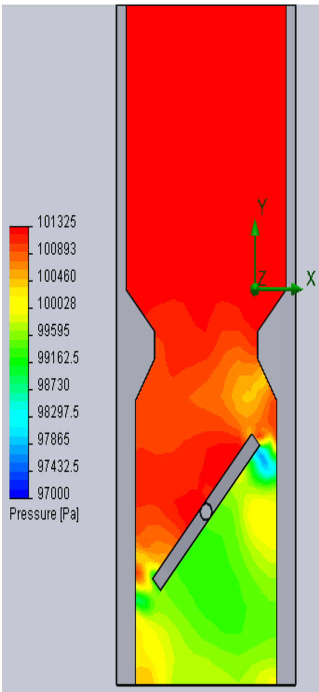

Figure 4: 45 Degrees Throttle Plate Angle.

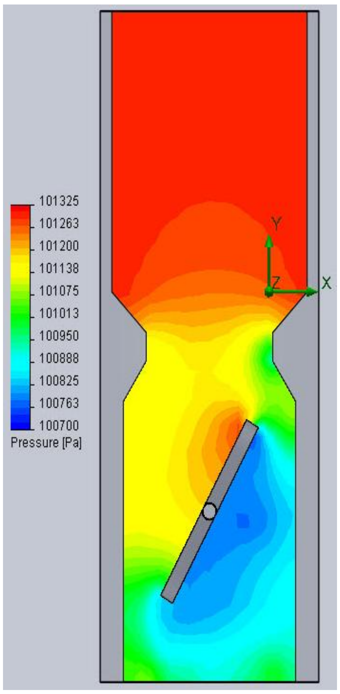

Figure 5: 60 Degrees Throttle Plate Angle.

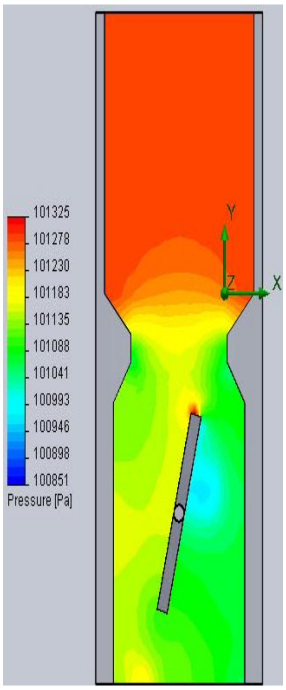

Figure 6: 75 Degrees Throttle Plate Angle.

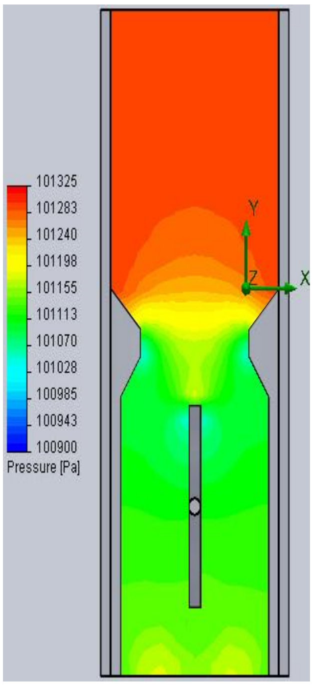

Figure 7: 90 Degrees Throttle Plate Angle.

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From Figure 4 it is evident that when the throttle plate is 45^0 open, there is less amount of air flow through the inlet valve and hence the mixture is rich. In this case the pressure at the throat of the venturi is around 101300 Pascal. In figure 5 when the throttle plate is 60^0 open, the mixture is slightly leaner than in case of 45^0 opened throttle plate condition. In this case the pressure at the throat of the venturi is found to be around 101200 Pascal. From Figure 6, when the throttle plate is 75^0 open, there is be more amount of air flow through the inlet of the carburettor. So the mixture will be leaner. In this case the pressure at the throat is found to be 101150 Pascal. From figure 7, when the throttle plate is 90^0 open, there will be maximum amount of air flow through the inlet of the carburettor but the fuel flow remains same so the mixture will be leaned in this case. In this case the pressure at the throat is found to be 101050 Pascal. From the analysis done the throat pressure was found to be 101200 Pascal.

Fuel Discharge Nozzle Angle Variation

The same sets of conditions were taken, inlet air was assumed to enter the carburettor at normal temperature and the pressure was taken to be 1 atm. The results shows pressure and velocity contours of the fuel discharge nozzle angle of the carburettor. The nozzle angle was varied by 30, 35 and 40 degree angles.

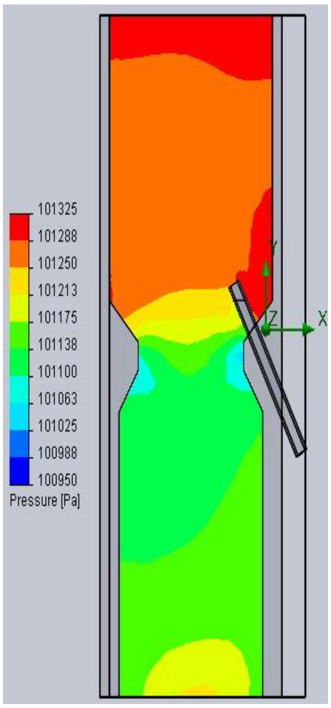

Figure 8(a): Pressure contour for 30 degree variation.

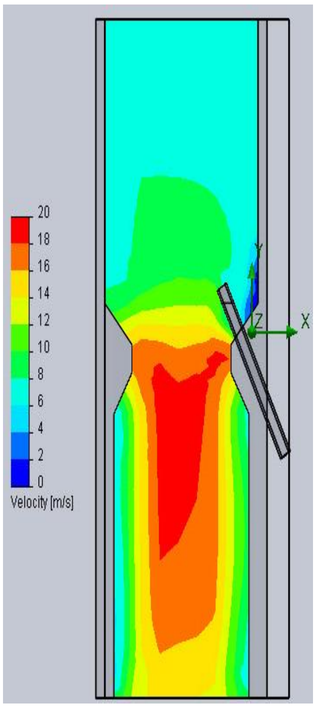

Figure 8(b): Velocity contour for 30 degree variation.

Fig 8(a) shows a uniform distribution of pressure and Fig 8(b) shows that velocity increases uniformly from the inlet of the carburettor towards the throat. Since there is uniform distribution of pressure throughout the body of the carburettor, in this case the fuel will be easily atomized and will also be properly vaporized. The velocity is maximum at the throat of the venturi, while pressure is minimum at the venturi.

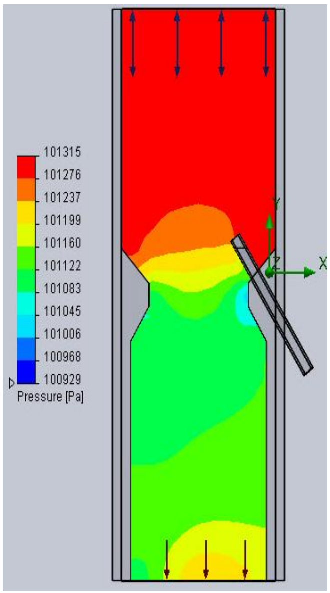

Figure 9(a): Pressure contour for 35 degree variation.

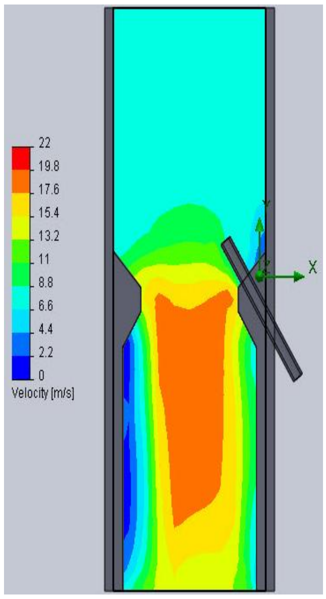

Figure 9(b): Velocity contour for 35 degree variation.

From figures 9(a & b) it is evident that the velocity is maximum at the throat of the venturi, whereas the pressure is the minimum at the venturi of the carburettor. It shows that the pressure is not distributed uniformly throughout the body of the carburettor and the distribution is also same in case of velocity. So, there will not be proper atomization and vaporization of fuel inside the body of the carburettor.

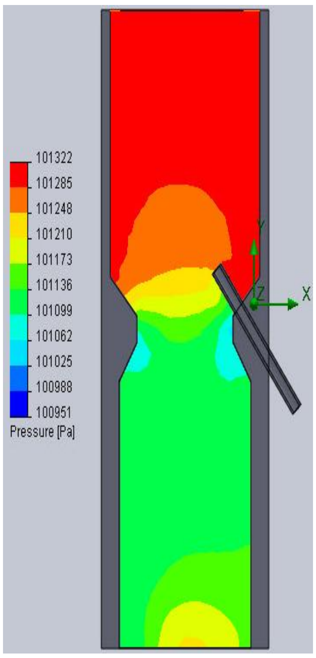

Figure 10(a): Pressure contour for 40 degree variation.

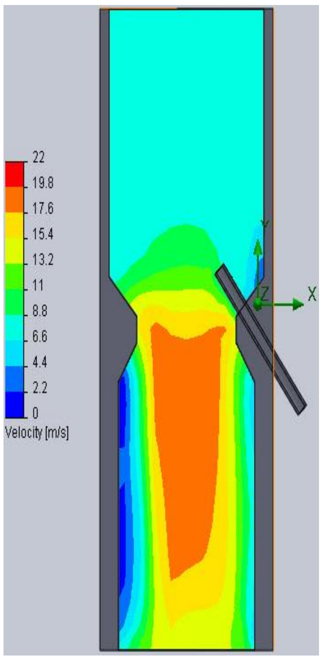

Figure 10(b): Velocity contou for 40 degree variation

From figures 10(a & b) it is evident that the velocity is maximum at the throat of the venturi, whereas the pressure is the minimum at the venturi of the carburettor. It shows that the pressure is not distributed uniformly throughout the body of the carburettor and the distribution is also same in case of velocity. So, there will not be proper atomization and vaporization of fuel inside the body of the carburettor.

IV. Conclusion

From the above analysis the conclusions obtained are

1. When the flow inside the carburettor was analyzed for different 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 obtained from the analysis above 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.

2. When analyzed for fuel discharge nozzle angle of 30^0, 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. But in other cases like where the fuel discharge nozzle angle was 35^0 or 40^0, the pressure distribution is quite non-uniform inside the body of the carburettor. So it is concluded that for gasoline operated engine the optimum fuel discharge nozzle angle is 30^0.

V. FUTURE SCOPE

In the present scenario the four wheeler is installed with the petrol injection system where carburettor system have got obsolete. So by bringing the change in the design of the carburettor we can attain the high level of efficiency which could match up the efficiency level of petrol injection system or may even exceed it. In the two wheelers the carburettor system is still in use so our changes in design of carburettor will help in uplifting the efficiency of these carburettors also.

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