CFD ANALYSIS ON A SIMPLE CARBURETOR FOR DIFFERENT POSITIONS OF THROTTLE VALVE AND FUEL NOZZLE VALVE

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ABSTRACT

Carburetor plays a crucialrole in SI engine performance which supplies correct mixture of fuel airat the right time. One of the important factors that affect the fuel consumption is the design of the carburetor. The throat of the carburetor provides required pressure drop in the venturi tube of the carburetor device. Currently, alternative fuels like LPG, CNG, etc. are gaining attention all over the world because of their ecofriendly nature. So the design of the carburetor is important. To get a better economy and uniform distribution of fuel air mixture, it required to design the carburetor with an effective analytical tool or software. In this work,CFD (FLUENT 14) analysis was carried out on a simple carburetor to find pressure drop and velocity profile for different throttle valve angle (30^0,40^0,50^0,60^0,70^0,$80^0$and 90^0) and fuel discharge nozzle angle(33^0,36^0 and 39^0). The results obtained from the analysisare analyzed for optimum design of a carburetor. Maximum pressure drop was observed at the throttle angle of 90^0. Pressure distribution was observed more uniform atfuel discharge nozzle angle of 33^0.

***Keywords* - Carburetor, Throttle valve, Nozzle angle, Pressure Drop, and Velocity distribution**

I. INTRODUCTION

SI engines generally use volatile liquids. The preparation of the air fuel 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[1]. 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 is known as a carburetor. The flow through these internal passages may be quite complexand passages is short length[2].

1.1 Working principal of simple carburetor

All carburetors work on the Bernoulli'sPrinciple which states that the velocity of afluid increases, when the pressure drops. Within a certain range of velocity and pressure, the velocity increases with the drop in pressure. However, this linear relationship only holds within a certain range. Carburetor has to accelerate from rest, to some speed. It depends upon the air flow demanded by the engine speed and the throttle butterfly valve setting. According to Bernoulli theorem, air flowing through the throat of the carburetor will be at a pressure less than atmospheric pressure, and related to the velocity[3].

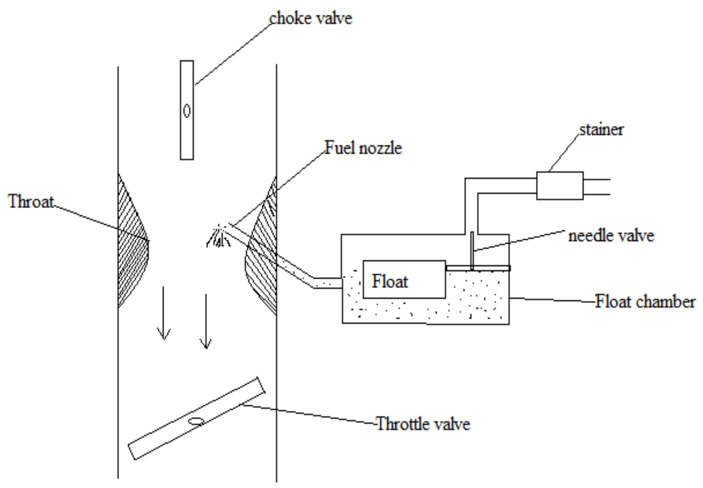

Fig.1. 1 Simple carburetor [1]

II. METHODOLOGY

2.1 Specifications of Simple Carburetor

Table 2.1 shows important geometry conditions used for the construction of simple carburetor.

Table 2.1 Geometry dimensions [4]

Sl No.	Name of the part	Dimensions	Unit
1	Inlet diameter	42	mm
2	Throat diameter	27	mm
3	Outlet diameter	37	mm
4	Length of the throat	5	mm
5	Length of the inlet section	51	mm
6	Length of the outlet section	51	mm
7	Fuel nozzle diameter	2	mm
8	Total length of carburetor	122	mm

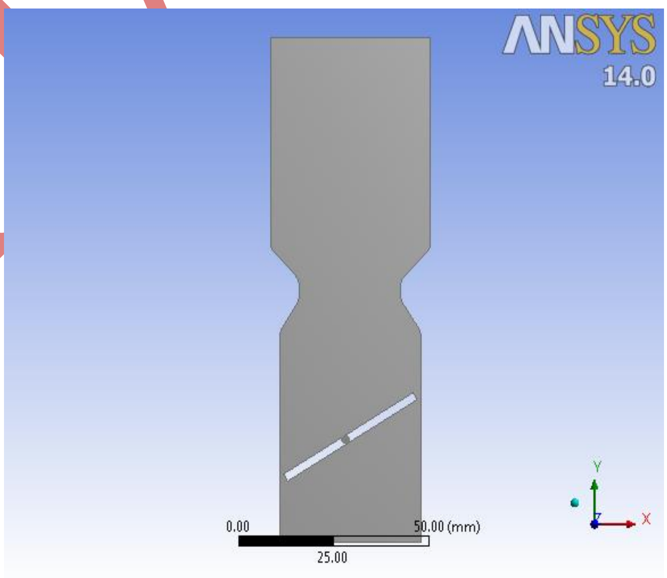

Fig. 2.1 A simple carburetor model

2.2 Creation of 2D model and Procedure

Fig. 2.1 shows a simple carburetor model generated by usingANSYS-14 workbench software.Meshing of the model was carried out inANSYS 14 software. Table 2.2 shows specifications of meshed model. Fig. 2.2 shows the meshed model of a simple carburetor. In order to carry the analysis, the meshed model is introduced to the CFD tool (ANSYS FLUENT 14). Proper boundary conditions were applied to the model. In this case, the effect of the variation of throttle valve and fuel discharge nozzle angle on the flow across the carburetor is studied. The analysis were carried out for various nozzle anglesi.e., θ =33º, 36º and 39^0 where θ is the angle between fuel discharge nozzle and the vertical axis of the carburetor. An attempt has also made to study the effect of different orientation of the throttle valve i.e., ϕ = 30º, 40º, 50º, 60º, 70º, 80º, and 90º.

Table 2.2 Meshed geometry specification

Element type	Quadrilateral
Number of nodes	65680
Number of elements	65180
Refinement	Up to 3 degree

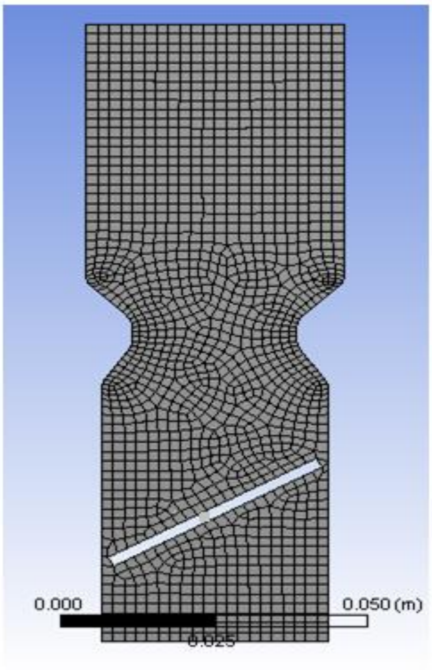

Fig. 2.2 Simple carburetor meshed geometry

III. RESULTS

3.1 Effect of throttle valve position on air pressure at the throat section

In this work, air is assumed to enter at atmospheric temperature and pressure. Results were obtained for pressure variation when air is flowing through the carburetor for different throttle valve angles. The analysis was done for 30º, 40º, 50º, 60º, 70º, 80º and 90º respectively.

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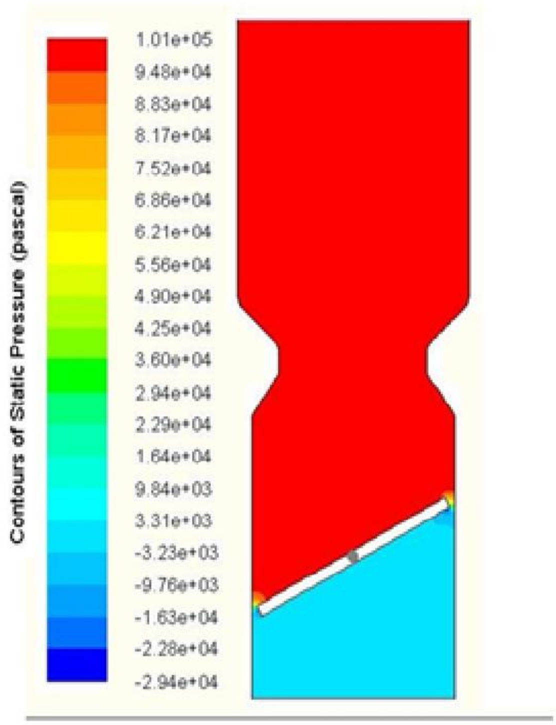


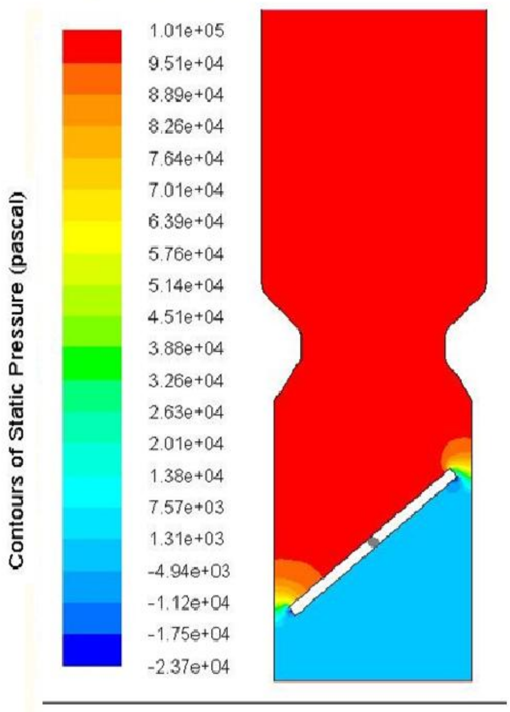
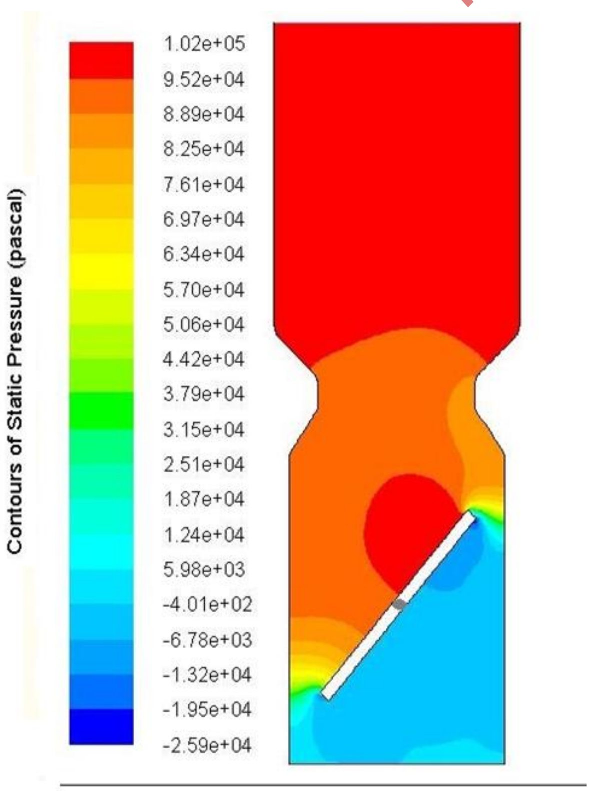


Fig. 3.1 Pressure contour at an angle of Fig. 3.2 Pressure contour at an angle of Throttle valve 30^{0}Throttle valve 40^0



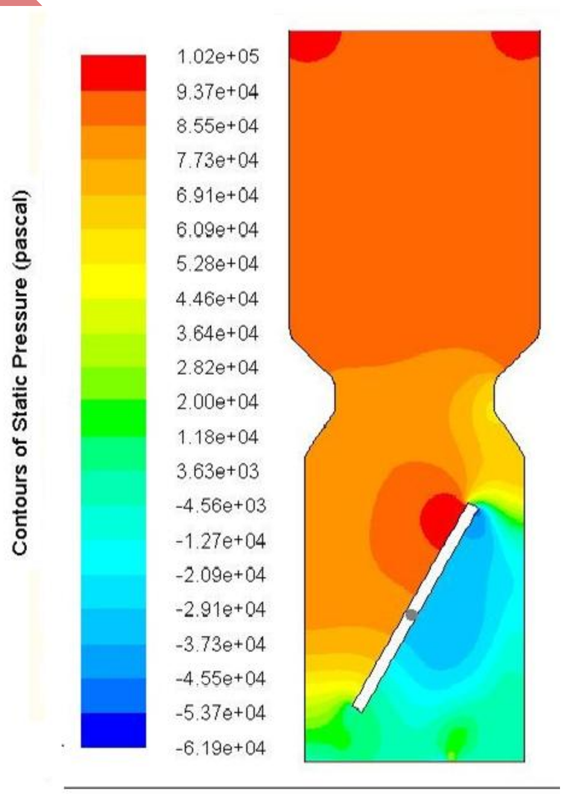
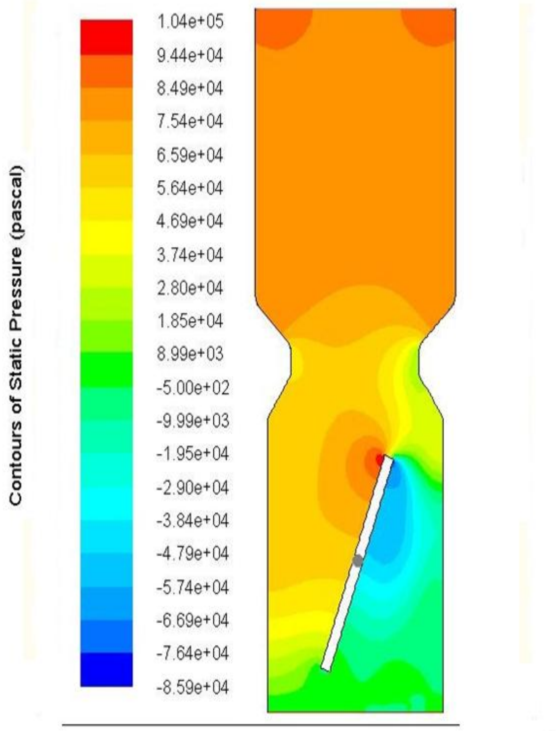


Fig. 3.1 Pressure contour at an angle of Fig. 3.2 Pressure contour at an angle of Throttle valve 50^{0}Throttle valve 60^0



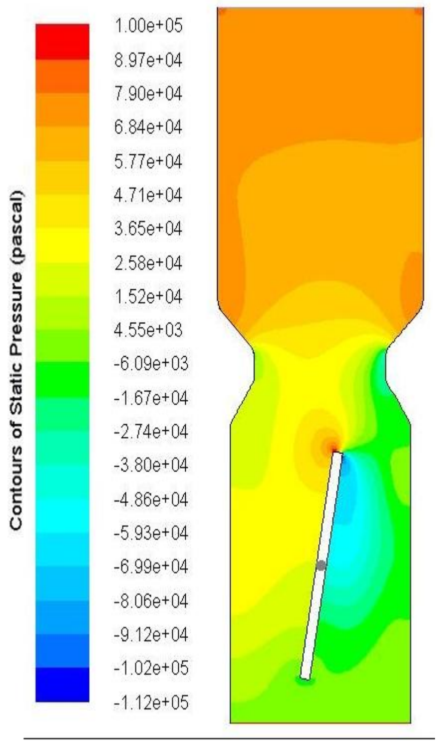


Fig. 3.1 Pressure contour at an angle of an angle of Throttle valve 70^{0}Throttle valve 80^0 **Fig. 3.2 Pressure contour at**

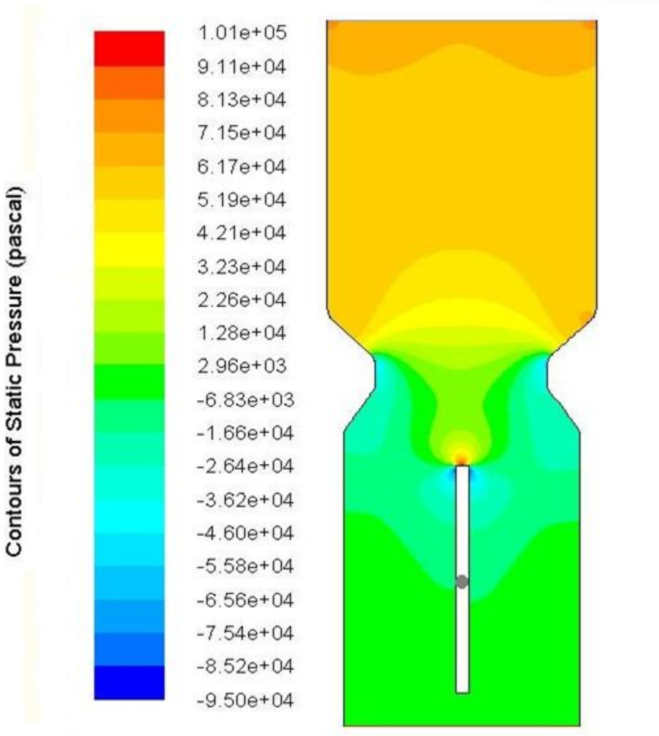


Fig. 3.7 Pressure contour at an angle of Throttle valve 90^0

Fig. 3.1 to 3.7 indicatesthe pressure at the throat of the venturi when the throttle valve is30º, 40º, 50º, 60º, 70º, 80º and 90º respectively. It is seen from Fig. 3.1 to 3.7 shows that the pressure at the throat section has decreased gradually with the increase in the throttle valve angle. It is minimum (32.3kPa) at 90º and maximum (101.1kPa) at 30º throttle valve position. With the increase in the throttle valve angle from 30º to 90º, the air velocity has increased, consequently the pressure at the throat section has decreased. This has a greater effect on the mixture strength. With the increase in pressure drop at the throat section, amount fuel entering into the throat section increases and makes the mixture progressively rich. This happens when load increases from zero to 100%. But, this phenomena is undesirable for practical SI engine when it is fitted with a simple carburetor. To avoid this problem, simple carburetor is needed extra attachments such as mixture enrichment circuit, idling circuits.

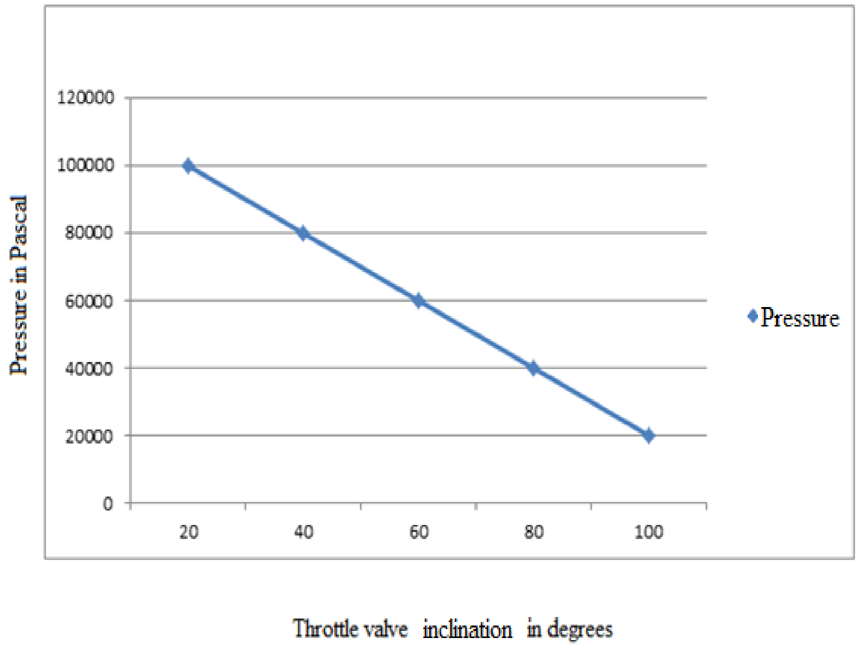
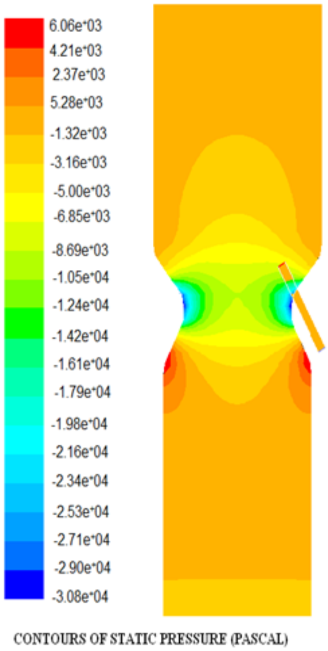


Fig.3.8Effect of Throttle plate angle on static pressure

Fig 3.8shows the effect of throttle plate angle on static pressure. Fig. 3.8 indicates that with the increase in throttle valve angle, the pressure drops.Maximum pressuredrop (32.3 kPa)occurs at full opening of throttle valve i.e., 90^0.

3.2Effect of Fuel Discharge Nozzle Angle on air pressure at the throat section

To study the effect of the fuel nozzle inlet angle on air , it is assumed that air enters the carburettor at atmopheric temperature and the pressure is taken as 32.3 kPa. Throttle plate is assumed to be kept in a vertival position.



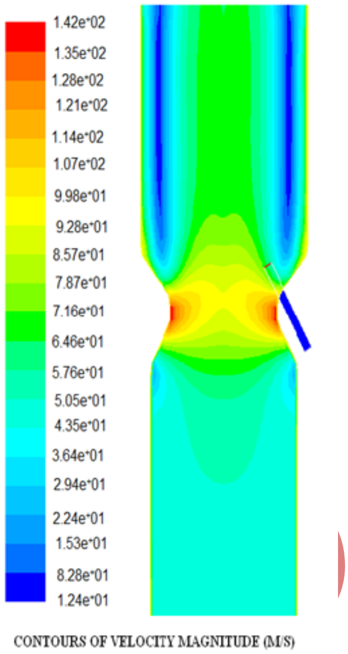
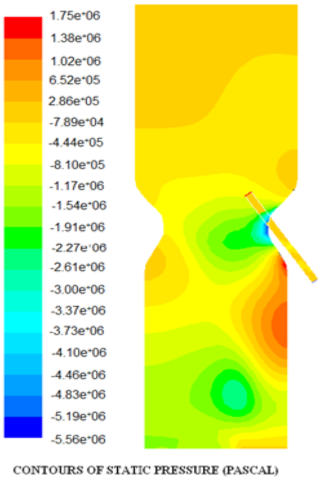


Fig.3.9Pressure contour at an nozzle angle of 33^{0}Fig.3.10Velocity contour at an nozzle of angle 33^0

Fig. 3.9 shows the static pressure contour and Fig. 3.10 shows the velocity contour for fuel discharge nozzle angle of 33^0. Fig. 3.9to 3.14 shows pressure and velocity distribution of air when it is flowing through the venturi tube for the nozzle angle of 33^0 , 36^0,and 39^0. Fig.3.9 shows the pressure distribution for nozzle angle of *33^0* . From Fig.3.9, it is clear that the pressure distribuation is uniform throughout the venturi section. Fig.3.10 shows that velocity is distributed uniformly from the inlet of the carburetor towards the throat. Fuel will be atomized and vaporised easily due to uniform distribution of pressure and velocity throught the venturi section.



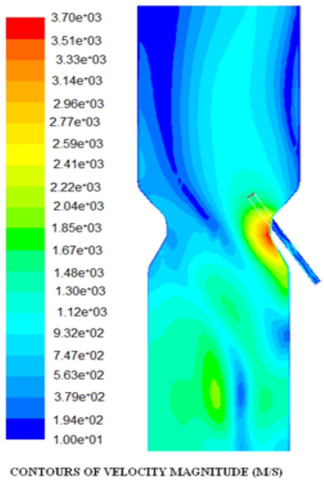
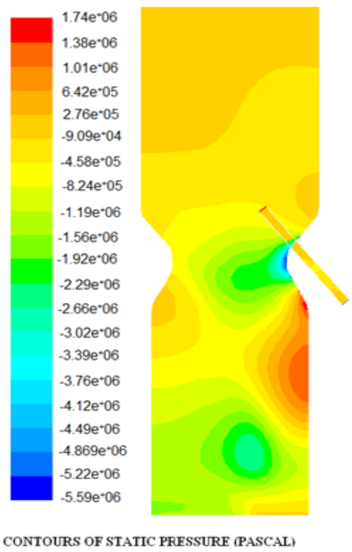


Fig.3.11 Pressure contour at an nozzle angle of 36^0 Fig.3.12 Velocity contour at an nozzle of angle 36^0

Fig. 3.11 and 3.12 show the static pressure and velocity contour for fuel discharge nozzle angle of 36^0. It is clear from Fig. 3.11 and 3.12, the velocity is maximum whereas the pressure is the minimum at the throat section of the venturi of the carburetor. Pressure contour shows that the pressure is not distributed uniformly throughout the body of the carburetorand the velocity distribution is also not uniform. It may lead to improper atomization and vaporization of fuel inside the body of the simple carburetor at nozzle of 36^0.



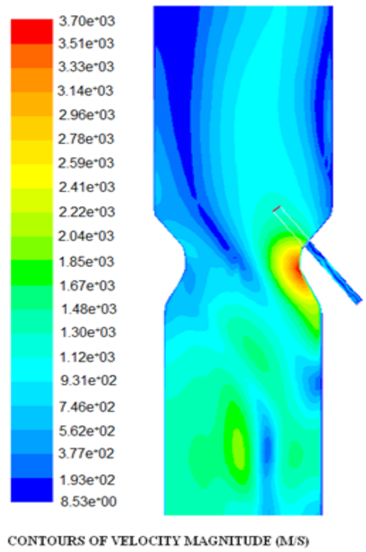


Fig.3.13 Pressure contour at an nozzle angle of 39^0

Fig.3.14 Velocity contour at an nozzle of angle 39^0

Fig. 3.13 and 3.14 show the static pressure and velocity contour for fuel discharge nozzle angle of 39^0. It is clear from Fig. 3.13 and 3.14, the velocity is maximum whereas the pressure is the minimum at the throat section of the venturi of the carburetor. Pressure contour shows that the pressure is not distributed uniformly throughout the body of the carburetorand the velocity distribution is also not uniform. It may lead to improper atomization and vaporization of fuel inside the body of the simple carburetor at nozzle of 39^0.

IV. CONCLUSION

Following conclusions are obtained by CFD analysison simple carburetor for different throttle plate valve angle and fuel nozzle angle.

1. For various throttle plate valve angles such as 30^0,40^0,50^0,60^0,70^0,80^0 and 90^0, it was found that the pressure at the throat of the venturi has decreased with the increase in the throttle plate angle. It is due to the fact that with the increase in throttle angle, the air velocity increases with the drop in air pressure at the throat section. The amount of air flowing through the throat section remains same but, more amount of fuel will be sucked into the throat section due to increase in pressure drop.

2. With the increase in nozzle angles from 33^{0}to 36^0, and from 36^0 to 39^0, it was observed that the pressure and velocity distribution became more non-uniform. At fuel discharge nozzle angle of 33^0, it is observed that the pressure and velocity distribution is uniform which leads to a better atomization and vaporization of the fuel inside the body of the carburetor. So, it can be concluded that optimum fuel discharge nozzle angle must be kept at 33^0.

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