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Modelling and Analysis of Spark Ignition Carburettor

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ABSTRACT
Modern passenger vehicles with gasoline engines are provided with different compensating devices for fuel air mixture supply. Even there is a high fuel consumption because of many factors. One of the important factors that affects the fuel consumption is carburettor. The venturi of the carburettor is important that provides a necessary pressure drop in the carburettor device. For a better economy and uniform air fuel supply there is a need to design the carburettor with an effective analytical tool or software. In this work three parameters namely, pressure drop and fuel discharge nozzle angle and the throttle angle will be analysed using the computational fluid dynamics. For this analysis two soft-wares are used namely CATIA and ANSYS. Whereas CATIA for designing of carburettor and ANSYS for analysis of the carburettor. The results obtained from the soft-wares will be analysed for optimum design of a carburettor and also find out the exact pressure at various throttle angles and choke valve for a proper homogenous air-fuel mixture.

KEYWORDS: *Carburettor, pressure drop, Nozzle angle, analysis, CATIA.ANSYS.*

1. INTRODUCTION

The process of forming a combustible mixture of air and fuel in a proper ratio in the carburettor for combustion process is called as carburetion process. SI engines generally use the volatile liquids. Carburetion process takes place outside the engine cylinder. Various factors affect the combustible mixture of air-fuel ratio like engine speed, Temperature of incoming air, Design of carburettor, in case of high-speed engines less time is available for mixture preparation. In order to achieve the Good quality of air fuel mixture the velocity at the injection has to be increased. To achieve this increase in various angles of throttle angle of different pressures and velocity angles can be measured. Presence of highly volatile hydrocarbons in the fuel also ensures the high quality of carburetion. The atmospheric conditions and temperature also affect the process of carburetion. Higher atmospheric air temperature increases the vaporisation of the fuel and hence an optimum quantity of homogenous mixture is produced.

2. METHODOLOGY

Carburetor is designed by using CATIA and the model is generated by using ANSYS software for analysis. To carry the analysis various, it is introduced. Proper boundary conditions are applied to the model which is designed and various changes in throttle valve and fuel discharge nozzle is observed according to the flow in various conditions and various conditions are been studied. The analysis has been carried at various angles like 30 degrees,40 degrees,45 degrees, 50 degrees, 55degrees, 60 degrees, 65 degrees, 70 degrees, 75 degrees, 80 degrees, 85 degrees.

S. 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

Table 1: Specifications of Carburettor

A carburettor is used designed according to the specifications given in a CATIA soft-ware.

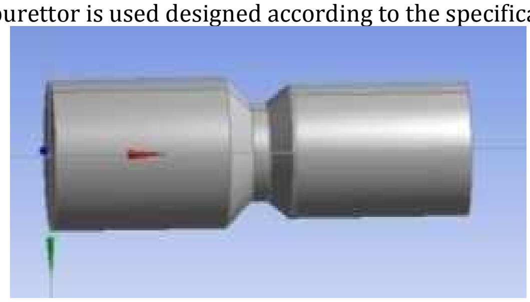


Fig. 1: Venturi considering Choke

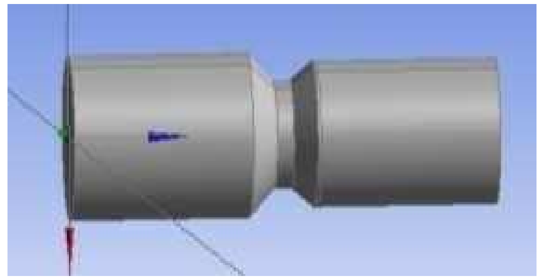


Fig. 2: Venturi considering Throttle

In next stage, meshing of was carried out. Following figure shows the meshed venturi sections.

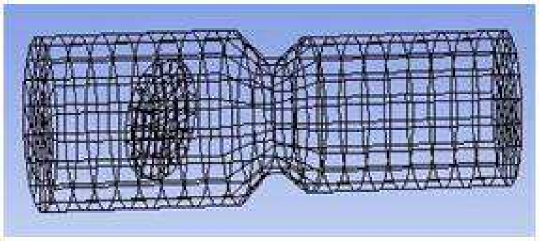


Fig 3: Venturi considering Choke

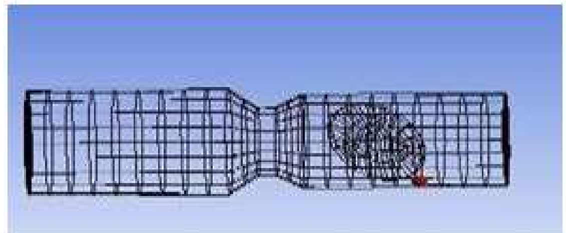


Fig 4: Venturi considering Throttle

Following are the details of meshing parameters.

S. No.	Parameter	Venturi considering Choke	Venturi Considering Throttle
1.	Nodes	1866	1874
2.	Elements	1463	1467
3.	Mesh Element Type	Coarse	Coarse

Table 2: Various Parameters Observed

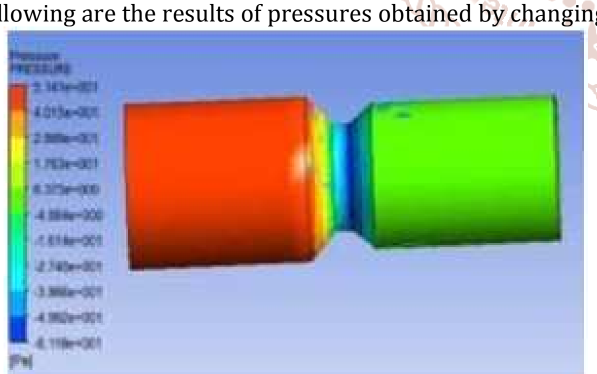
In next stage, CFD analysis for different models was carried out, under which pressures and velocities at the exit of throat section and after throttle were investigated.

3. RESULTS AND DISCUSSION

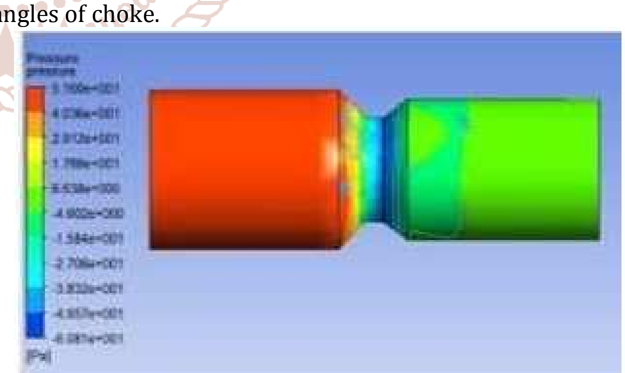
Present section is devoted to results of the research work and associated discussion made, the details of which are present in upcoming sections

A. Results

Following are the results of pressures obtained by changing angles of choke.



(a)



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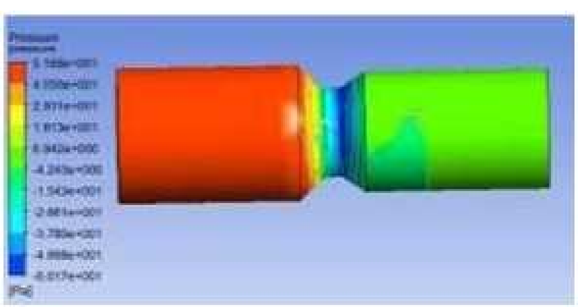
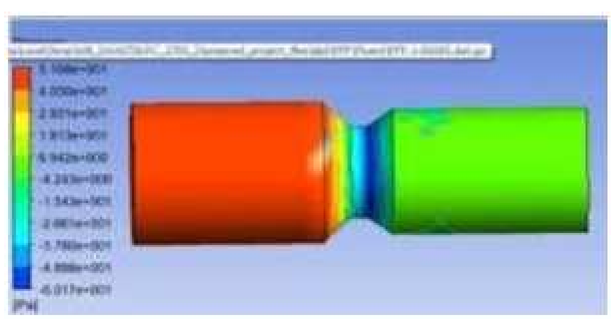
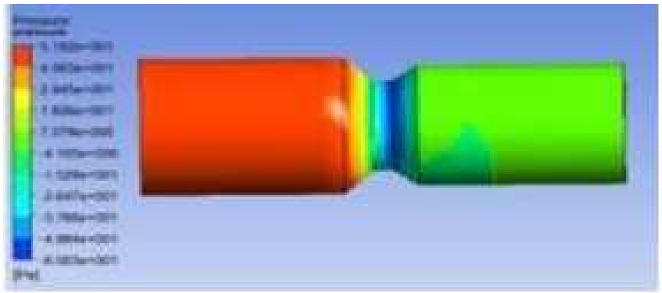


(c)

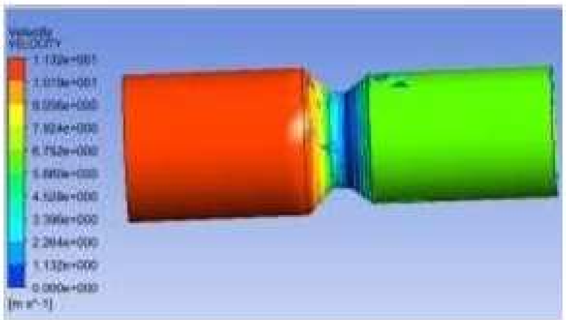


(d)



(e)

Fig. 5: Pressure at Different Choke Angles



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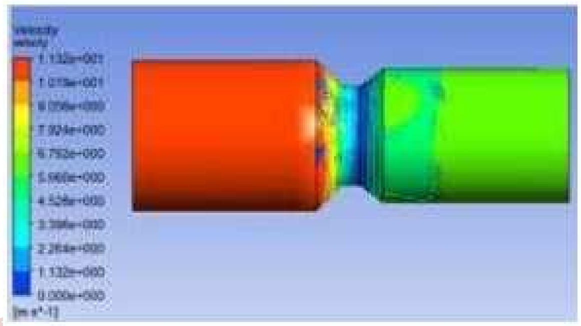

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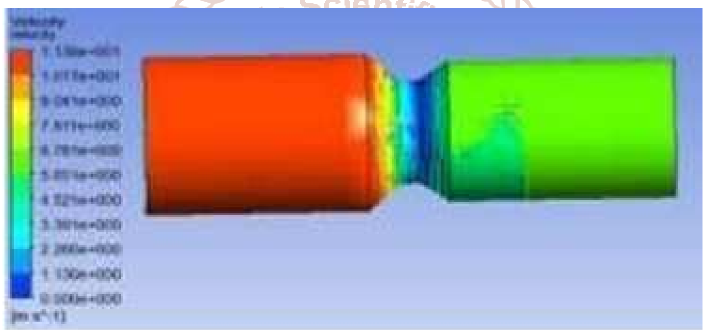

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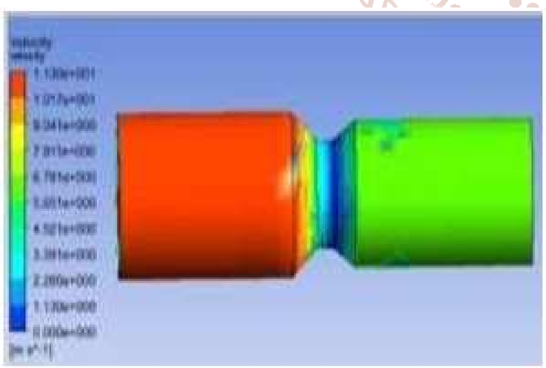

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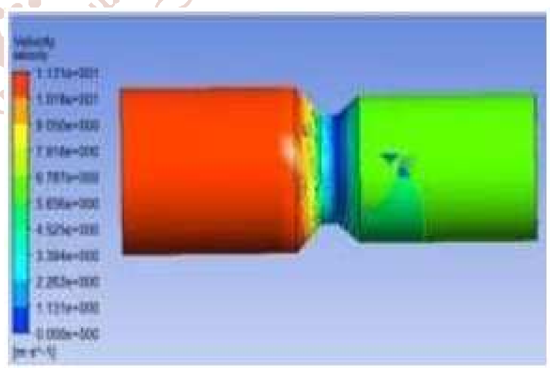


(e)

Fig. 6: Velocities at Different Choke Angles

S. No	Choke Angle (degrees)	Pressure (at throat) (Pa)	Velocity (at throat) (m/s)
1.	30	-4.992E+001	1.132E+000
2.	45	-4.957E+001	1.132E+000
3.	60	-4.896E+001	1.130E+000
4.	75	-4.896E+001	1.130E+000
5.	90	-4.884E+001	1.131E+000

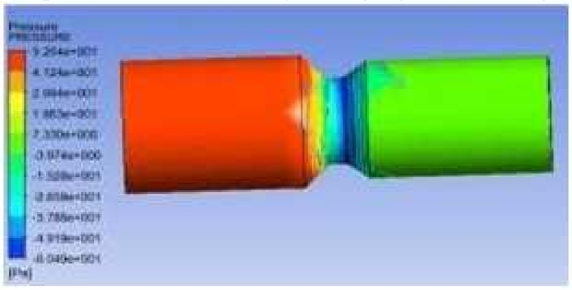
Table 3: Summary of Results for Variation in Choke Angles

Negative signs in pressure column show that the gauge pressures are less than operating pressure (101325 Pa). Therefore, in order to get static pressure or absolute pressure, these values were added with operating pressure, and following results were obtained.

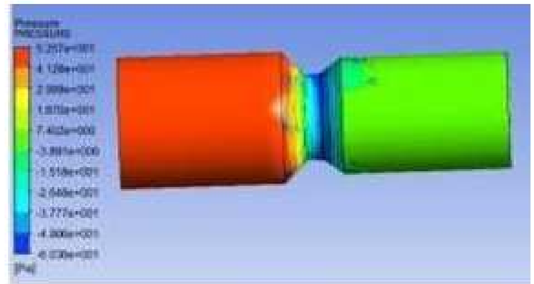
S. No	Choke Angle (degrees)	Static Pressure (at throat) (Pa)
1.	30	101275.1
2.	45	101275.4
3.	60	101276
4.	75	101276
5.	90	101276.2

Table 4: Static Pressure for different Choke angles

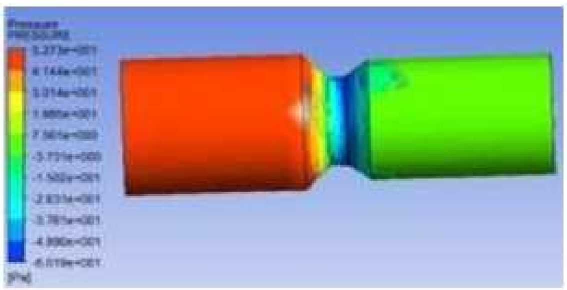
Results of pressures obtained by changing throttle angles



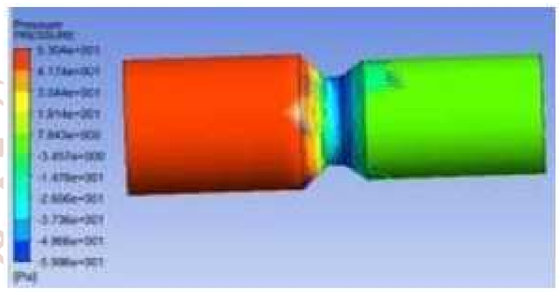
(a) 30Degrees



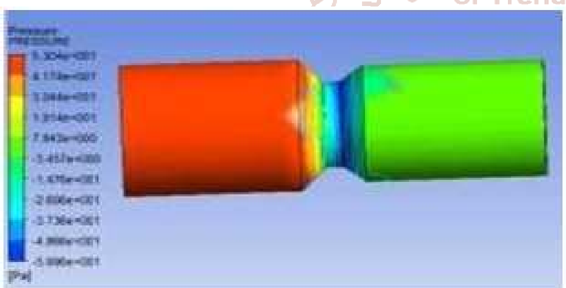
(b) 35Degrees



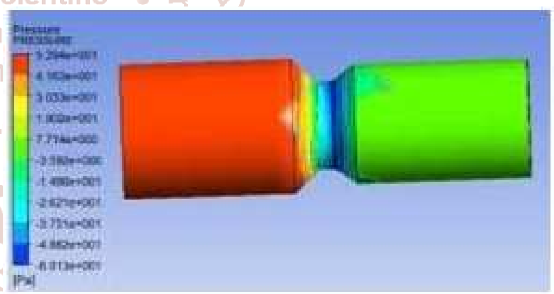
(c) 40Degrees



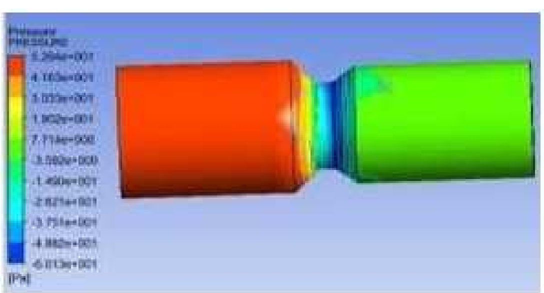
(d) 45Degrees



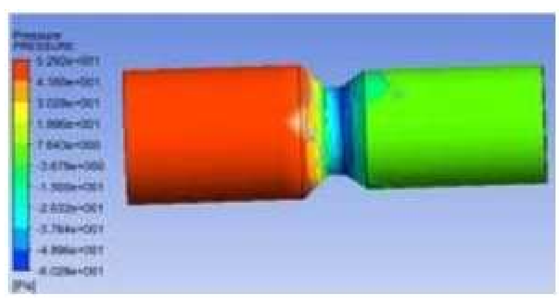
(e) 50Degrees



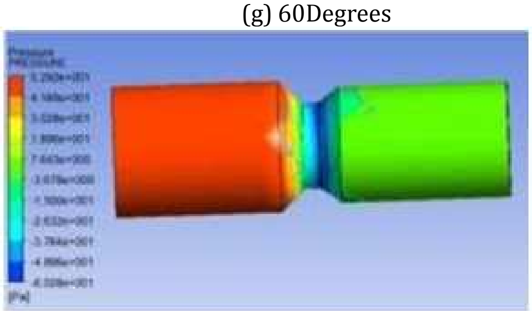
(f)55Degrees



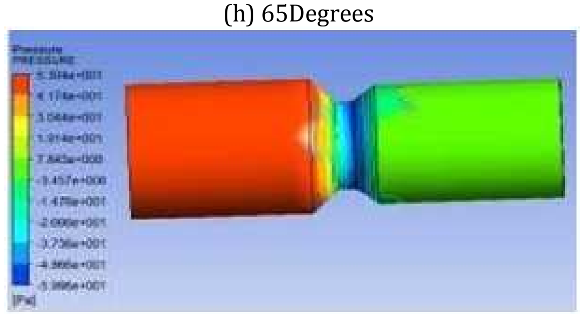
(g) 60Degrees



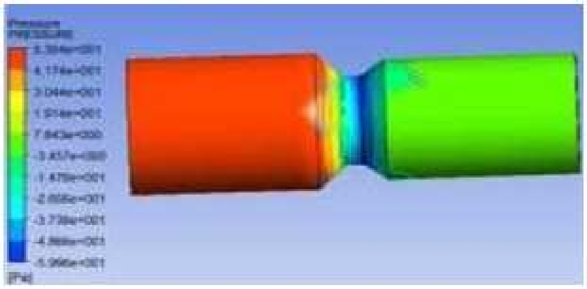
(h) 65Degrees

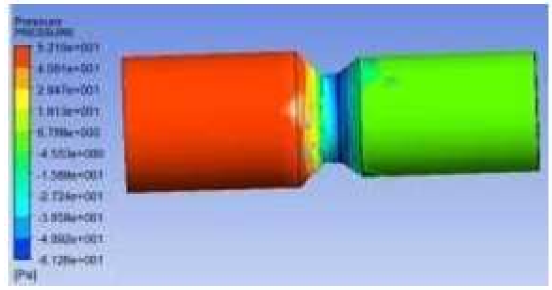


(i) 70Degrees



(j) 75Degrees


(k) 80Degrees


(l) 85Degrees

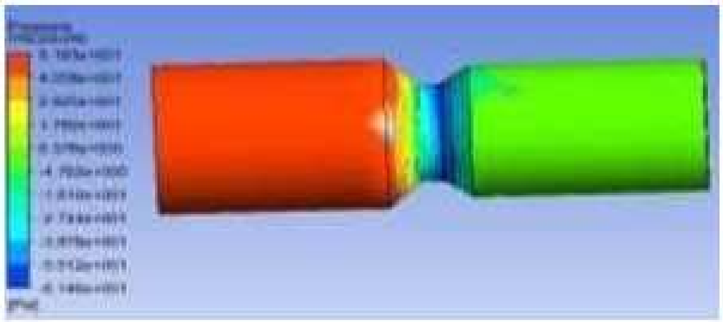
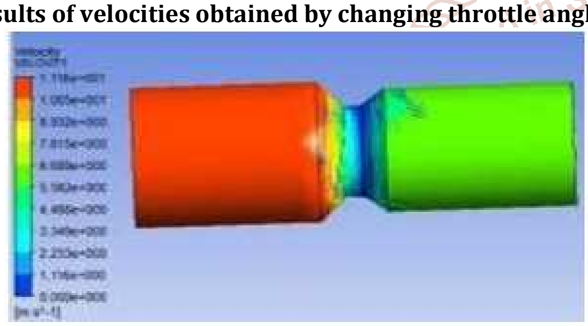
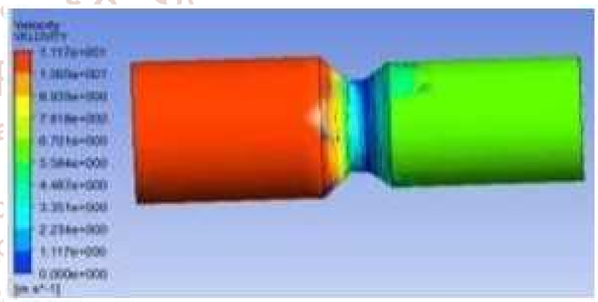
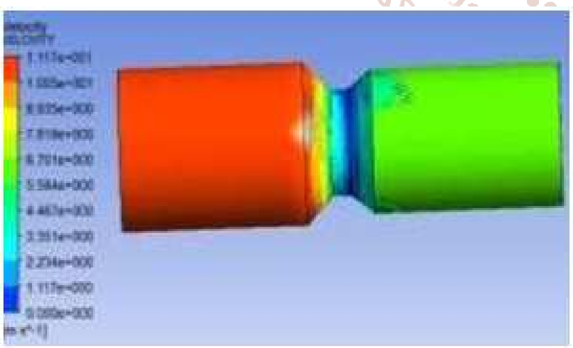

90Degrees

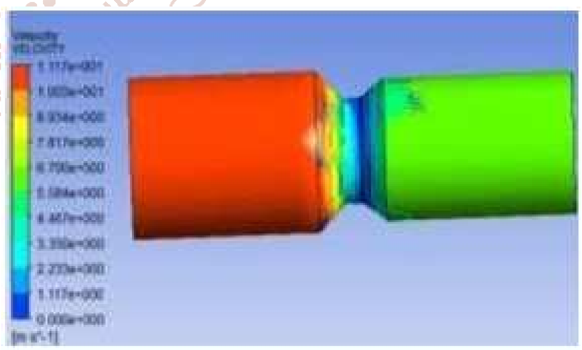
Fig.7: Pressure at different Throttle Angles

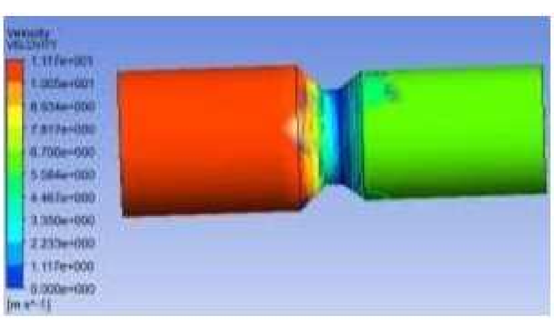
Results of velocities obtained by changing throttle angles

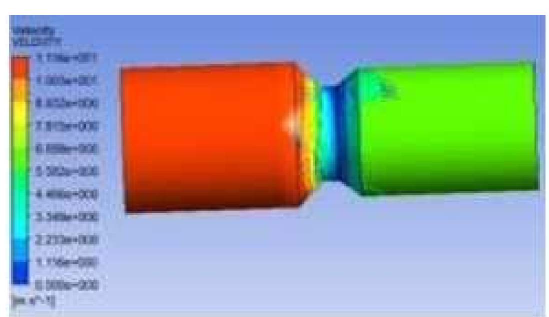

(a) 30Degrees

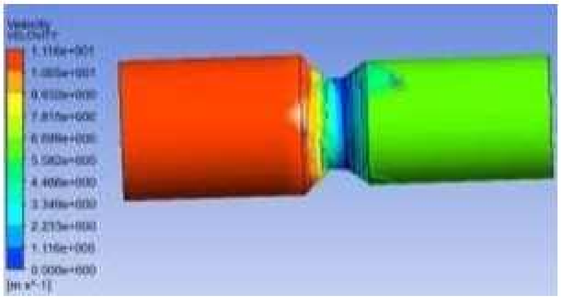

(b)35Degrees


(c) 40Degrees

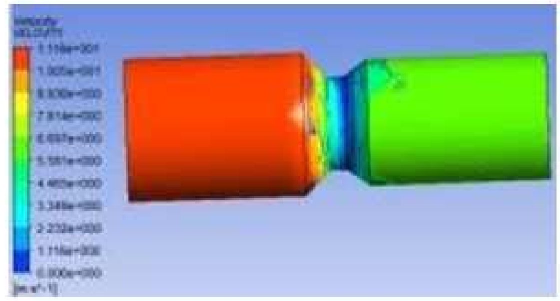

(d) 45Degrees


(e) 50Degrees

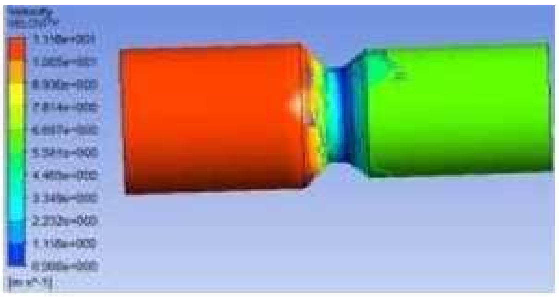

(f) 55Degrees



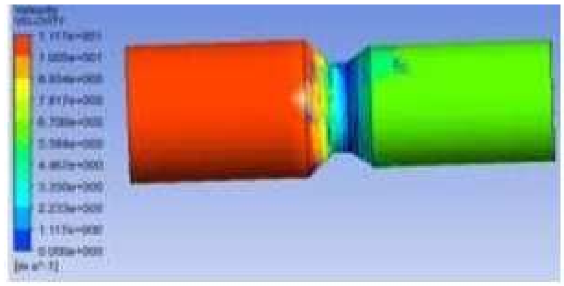
(g) 60Degrees



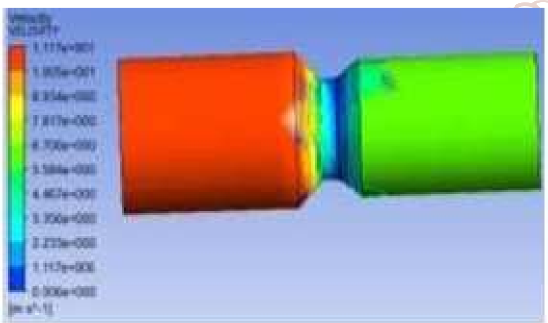
(h) 65Degrees



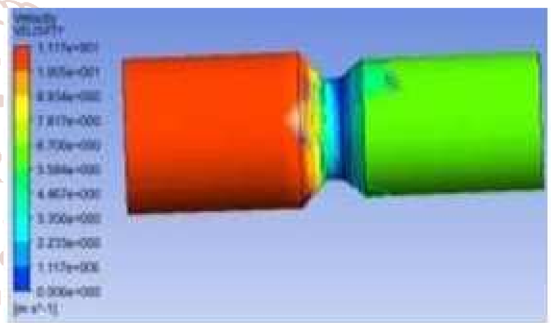
(i) 70Degrees



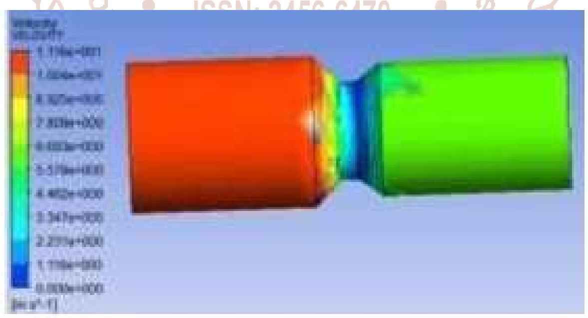
(j) 75Degrees



(k) 80Degrees



(l) 85Degrees



(m) 90 Degrees

Fig.8: Velocities at different Throttle angles

S. No	Throttle Angle (degrees)	Pressure (after throttle) (Pa)	Velocity (after throttle) (m/s)
1.	30	-3.974E+000	5.582E+000
2.	35	-3.891E+000	5.584E+000
3.	40	-3.371E+000	5.584E+000
4.	45	-3.457E+000	5.584E+000
5.	50	-3.457E+000	5.584E+000
6.	55	-3.592E+000	5.582E+000
7.	60	-3.592E+000	5.582E+000
8.	65	-3.678E+000	5.581E+000
9.	70	-3.678E+000	5.581E+000
10.	75	-3.457E+000	5.584E+000
11.	80	-3.457E+000	5.584E+000
12.	85	-4.533E+000	5.579E+000
13.	90	-4.762E+000	5.578E+000

Table 5: Variations of pressure and velocity with respect to Throttle Angles

In this case also negative signs in pressure column show that the gauge pressures are less than operating pressure (101325 Pa). Therefore, in order to get static pressure or absolute pressure, these values were added with operating pressure, and following results were obtained.

S. No	Throttle Angle (degrees)	Static Pressure (after throttle) (Pa)
1.	30	101321.026
2.	35	101321.109
3.	40	101321.629
4.	45	101321.543
5.	50	101321.543
6.	55	101321.408
7.	60	101321.408
8.	65	101321.322
9.	70	101321.322
10.	75	101321.543
11.	80	101321.543
12.	85	101320.467
13.	90	101320.238

Table 6: Static pressure for different throttle angles

B. Discussion

We know that at throat section of the venturi, a requirement of minimum pressure and maximum velocity exists. This is because, at throat section due to lower pressure fuel reaches, and if the velocity of air at this section is higher, rapid formation along with rapid removal of air fuel mixture from that vicinity will take place. Considering this fact, chock angle which offers lowest pressure with greatest velocity should be considered. In research analysis, chock angles 30 degree shows the least value of static pressure as compared to other angles. In case of velocity value for this angle, greatest values out of all combinations, is obtained. Second best option is 45-degree chock angle, because at this choke angle, velocity is same as that of 30-degree choke angle and pressure is somewhat higher than previous case. Above this angle, one can find considerable deviations the values of static pressure and velocity of air.

Considering trend line also, one can analyze that out of the available options best choke angle is 30 degree. Below figures shows hypothetical and actual Otto cycles.

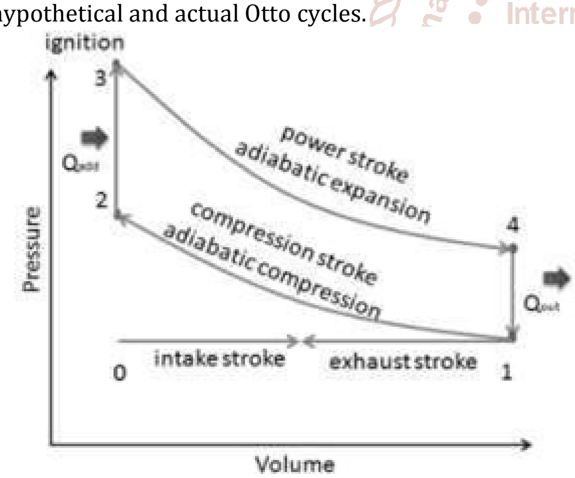


Fig. 9: Hypothetical Cycle

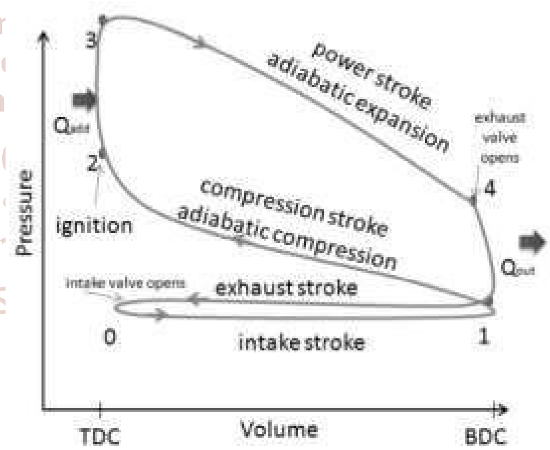


Fig. 10: Actual Otto Cycle

4. CONCLUSION

Present conclusion tells about conclusions drawn, limitations and future scope of the research, the details of which are presented in upcoming sections. Following conclusions are being drawn from the research work.

- At throat section, static pressure increases and velocity decreases with increase in choke angle;
- After throttle valve, both static pressure and velocity decrease with increase in throttle angle;
- Out of analyzed options, best angles for choke valve are 30 degree and 45 degree, respectively and Out of analyzed options, best angles for throttle valve are 40-degree, 45 degree and 50 degree respectively.

5. FUTURE SCOPE

Based on limitations, future scope of the research can be dictated through following points.

- A vast research considering complete assembly of carburetor can be initiated;
- A detailed research involving a broader set of properties can be undertaken and
- A more detailed research considering all the possible combinations of angles, length ratios, diameters, and other parameters can be initiated.

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