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The Analysis of the Throttle Body of the Intake System in the Engine Through CFD

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ABSTRACT

In the Spark ignition engine, in order to improve the air intake power and intake fuel efficiency, we use the important device of the intake system is Throttle Body. The amount of the air entering the engine is controlled by the Throttle Body. However, the throttle body could control the air stream, restriction the air flow into the engine. We could through the device to control the air flow to make different Equivalent ratios in the Spark ignition engine. Through this method can find the best position of the throttle valve angle to improve the engine performance to decrease the exhaust emission. For this reason, we can find the best position of the throttle angle through the analysis program that is ANSYS Fluent.

Keywords: *Throttlebody; Throttle Valve Angle; ANSYS FLUENT; Air Flow; Air Intake System.*

1.0 Introduction

Recently, with the development of the automotive industry, cars can be seen everywhere, so the environmental pollution comes with the engine combustion, incomplete mixing air and fuel burning in the engine cylinder. Due to the incomplete mixing air and fuel, the combustion emissions including CO, NOX, CO2, HC and submicroscopic particulate generated. In order to improve the composition of the exhaust emissions, we change the air and fuel mixture ratio. However, we use the throttle device, to achieve the equivalent ratio changes.

In this paper, we analyze the mixing ratio of air and fuel into the engine cylinder by changing the angle of the throttle valve, that is, by changing the angle of the throttle and thus changing the amount of air entering the cylinder, we can find Optimize throttle angle that improving the exhaust emissions.

Main function of a throttle body assembly is to control the air flow into the engine based on vehicle demand. Throttle body is mounted between the air cleaner and the intake manifold. Following the angle of throttle valve changes, butterfly valve restricts the amount of airflow into the engine cylinder.

In this analysis process, we set the butterfly valve angle to 0, 25, 50, 75, 100% throttle opening conditions. At these conditions we can find the Optimize throttle angle for air and fuel ratio into the engine cylinder. In this study, three types of boundaries are involved including inlet, outlet, and wall. Inlet pressure boundary conditions are used to set the fluid pressure at the flow inlet. So we can set the pressure when the pressure is not known.

And outlet boundary conditions require the specification of static pressure at the outlet boundary. With the air flow inlet through the throttle valve,we can analysis the counter and vector of air stream in the different angles. We can find the effects of throttle valve opening on flow field in order to see the wake regions and velocity vectors in this analysis.

2.0 Experiment Analysis and Results

In order to compare the different results of the experiment by using CFD program, we set the experiment use the Optimization shape that Hexagonal shape throttle valve to analyze the air flow through throttle body into the engine cylinder. The flow rate of the air is adjusted by flow control valve and measured with the help of CFD. With the

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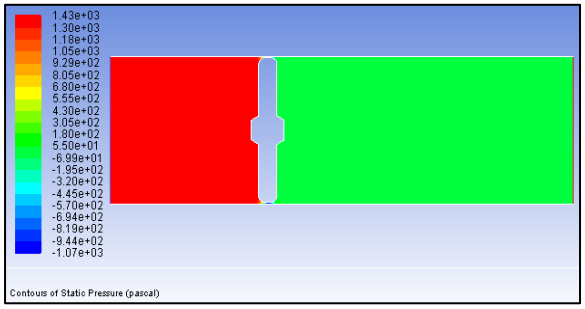
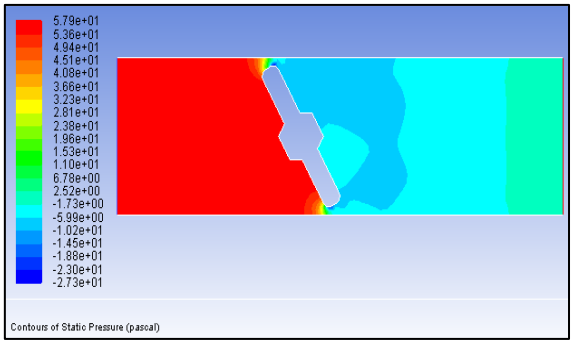
simulation of the throttle body, the experiment can show us the air flow image and fluid velocity, and initially the throttle opening is kept corresponding to engine idling conditions. The test pressure is set and flow through the throttle body is measured. So we set the angle for 25, 50, 75, and 100% throttle opening positions flow rates can be measured. During in these experiments, with find optimization angle of the throttle body for air and fuel equivalent ratio and engine speed, the exhaust emissions (consist of HC, CO, CO_2)can be measured. In this experiment process, in order to realize exhaust emission to reduce, and for reducing the environmental pollution of gas exhaust, we set the throttle valve angle for 0, 30, 45, 60, 90 degrees respectively to compare. With the pressure and velocity compare, find the angle of the throttle valve for optimization of exhaust emission. From this Fig.1 the pressure plots of the different throttle opening positions, shows the throttle opening positions as 0, 30, 45, 60, and 90degrees. Due to the relations about the velocity and the pressure, the pressure of the regional fluid speed slowly, the pressure of small regional fluid speed will be accelerated. Above figures show us the distribution of pressure, in order to make air and fuel well mixed, so the air into the engine at slow speeds, the outlet air regions make the pressure is a little larger. Such as this reason we can compare these images, find 0 degrees, 45 degrees and 60 degrees of the throttle valve are good angles for the air flow into engine. Because the 0 degrees no air through the throttle cause the energy waste and idling time also cause the exhaust emission generated. In another way, in order to reduce air flow noise, from these angles of the throttle opening positions, these images show us the throttle opening positions for reducing air flow noise are 60 degrees and 90 degrees.

Fig 1: Pressure Plots of the Different Throttle Opening Positions

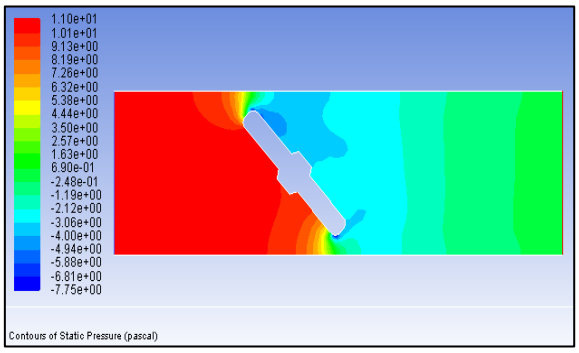
0 Degree



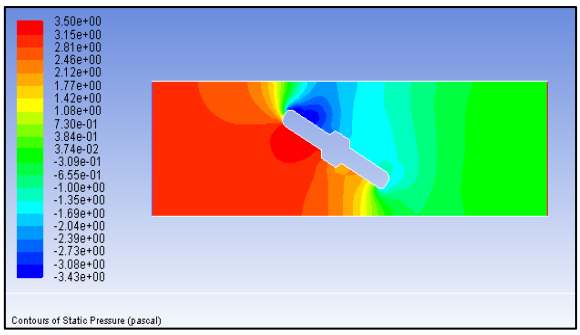
30 Degrees



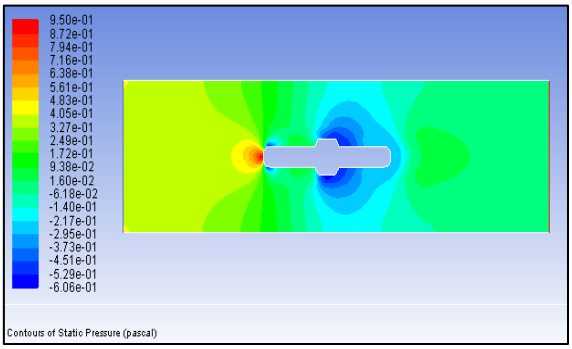
45 Degrees



60 Degrees



90 Degrees

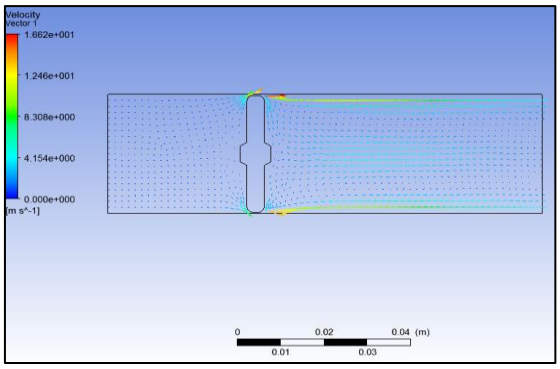


Comprehensive, these two aspects of the experimental comparison, I think the best angle of the throttle opening position is 60 degrees. Because the angel can make the air flow outlet the pipe with bigger pressure, and above the throttle valve, can be found the negative pressure regions, this regions can make air eddy generated reduce the air flow energy for noise reduction.

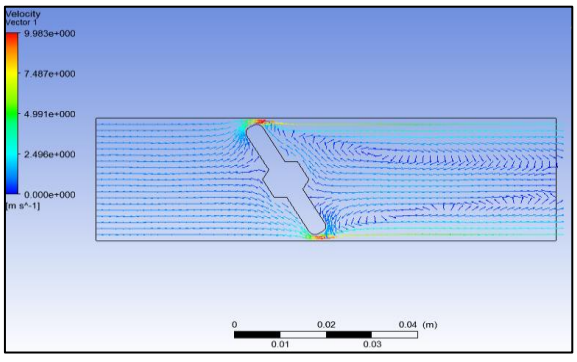
From Fig.2 the velocity of the different throttle opening positions, shows the velocity of air flow through the throttle valve, find the eddy of the air flow in the 30 degrees, 45 degrees and 60 degrees angle of the throttle opening. In order to the air into engine cylinder with Gentle speed, the eddy regions cannot be too large, otherwise it will cause the air and fuel mixture is not uniform. If the air and fuel not well mixed can cause the HC, CO exhaust emission generated. So in order to exhaust emission and air and fuel well mixed, I think the angle of the throttle opening position is 60 degrees.

Fig 2: Velocity Plots of the Different Throttle Opening Positions

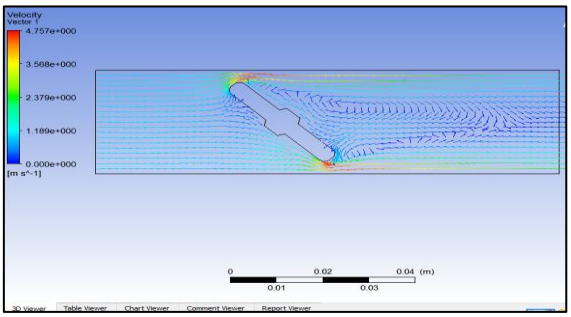
0 Degree



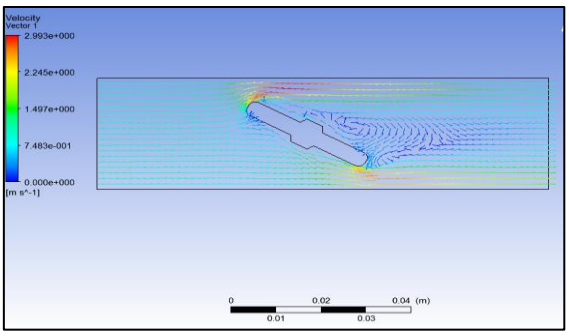
30 Degrees



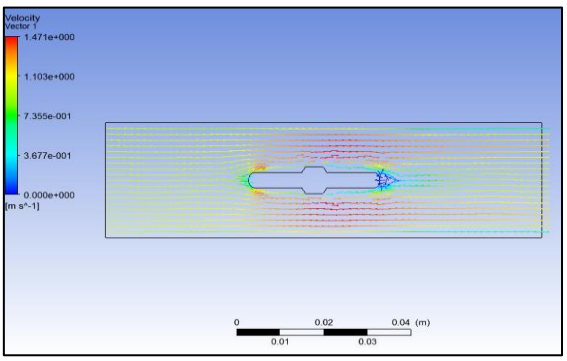
45 Degrees



60 Degrees



90 Degrees

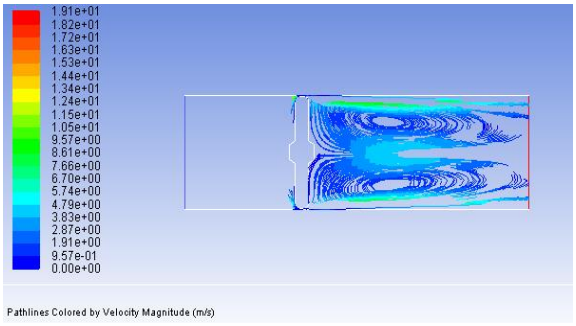


From above this Fig.3 the flow distribution of velocity of the different throttle opening positions, when the angles are 0, 30, 45 degrees, can find the weak regions generated, causing the air into the engine is very rare, resulting in uneven mixing of air and fuel, resulting in some incomplete oxidation of the product.

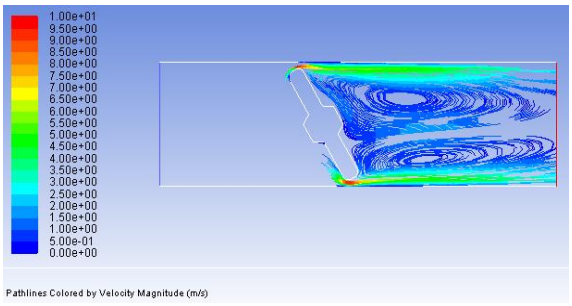
Although the 60-degree flow rate distribution, will have a wake region, but after a short period of time will soon return to normal. I do not think there is a significant impact on the air and fuel mix.

Fig 3: Flow Distribution of Velocity of the Different Throttle Opening Positions

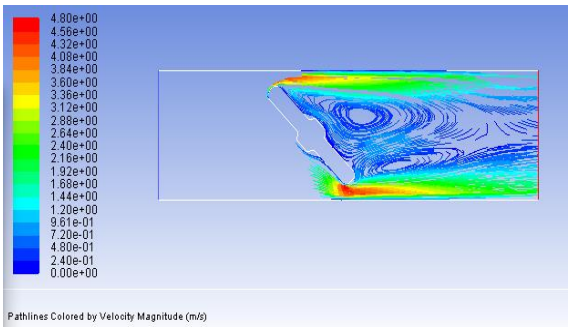
0 Degree



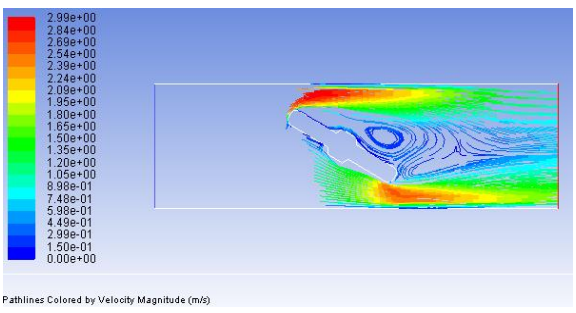
30 Degrees



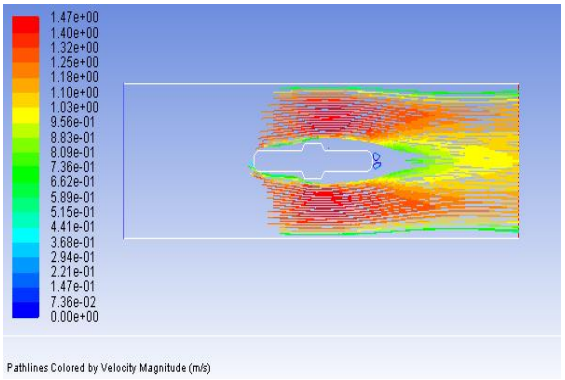
45 Degrees



60 Degrees



90 Degrees



3.0 Conclusions

With the different throttle opening positions as 0, 30, 45, 60, and 90 degrees are shown use the ANSYS FLUENT system. With the study of the angles of the throttle opening positions, to compare the different angles air flow velocity distributions and pressure distributions find the better angle of the throttle opening position is 60 degrees.

Not only make the air and fuel to mixture uniform but also find the 60 degrees can reduce the air flow noise into the engine cylinder, due to generate the negative pressure regions make the air energy to reduce cause the velocity slowly through the outlet .

In this paper, compare the angle of the throttle opening positions when air flow through the throttle valve, find the best angle of the throttle valve for reducing the exhaust emission, because the throttle body can control the air flow into the engine cylinder to mix with fuel (control the Equivalent ratio), control the air and fuel well mixed for HC, CO exhaust emission reducing.

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