Automotive Swirl Generate Inlet Valve Mechanism

Y. Lethwala[1], J. Surti[2]
[1] UG Student, Automobile Engineering, BMCET, Surat, India
[2] UG Student, Mechanical Engineering, MGIT, Navsari, India

***Abstract-* Generally In Automobile industries the role of inlet pressure is significant for Engines. Inlet pressure is propositional to Engine's power. Generally whenever we inlet high pressurized air in the inlet valve the pressure is decreased due to impact of valve under head. To resolve this problem we have created the new design of swirl Inlet valve. Pressure of inlet air will be 15-20% more efficient due to impact of air on helix teeth. This will help to increase the pressure of combustion chamber as well as power of engine (hp).**

***Index Terms-* Swirl intake valve, Self generate swirl intake valve, Swirl valve, New self pressure increase valve**

I. INTRODUCTION

Today, more than 70% of passenger cars utilize Gasoline (petrol) as their prime chemical energy source. The major attractions of these spark ignition engines are their high specific power (power/weight ratio) and the rate at which they accelerate the vehicle. The performance of these engines is largely determined by proper operation of their valve train Arrangement. The engine valve trains control the gas flow to and from cylinders. The most commonly used valve train is shown in Fig. 1.

Fig. 1 shows a number of friction interfaces such as cam/pushrod, pushrod/rocker-arm, rocker/rocker-arm shaft, rocker-arm/valve and valve/valve-guide. Due to many friction interfaces, approximately 25% of total engine friction losses are attributed to the valve train sub-system.

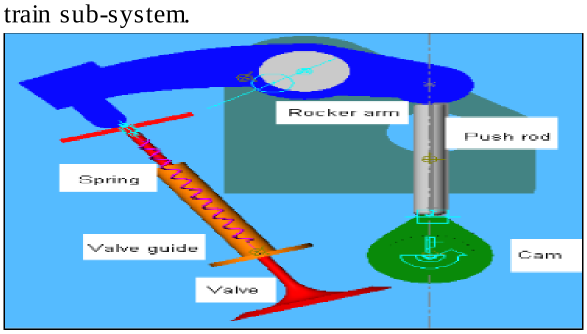


Fig 1: *Cam with pushrod valve train mechanism*

The valves used in the IC engines are of three types: Poppet, mushroom valve, Sleeve valve or Rotary valve. Of these three types, Poppet valve is most commonly used. Since both the inlet and exhaust valves are subjected to high temperatures of 1930°C to 2200°C during the power stroke, therefore, it is necessary that the materials of the valves should with stand these temperatures. The temperature at the inlet valve is less compared to exhaust valve. Thus the inlet valve is generally made of nickel chromium alloy steel and exhaust valve is made of silichrome steel. Engine Valve is one of the main parts which are used in all IC Engines.

A. *Inlet Valve Design And Function*

The inlet which operates by the action of Tappet movement, allows air and fuel mixture into the cylinder.

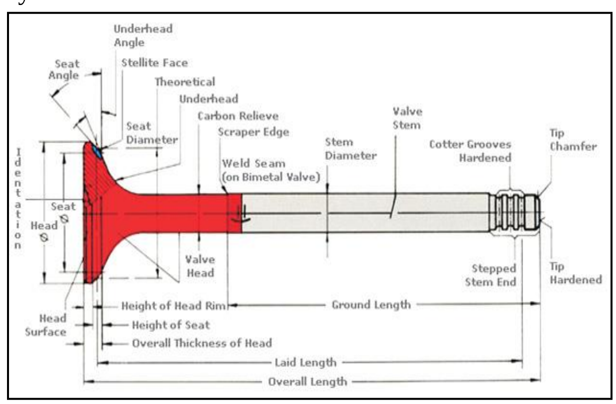


Fig 2: *valve notation*

As the refer some literature papers S. M. Muzakkir, M. G. Patil and Harish Hirani [1] this is part one of the paper on conceptual design of an engine valve. This paper describes the background and the need of an engine valve for an internal combustion engine. The present state of the engine valve technology and the innovations incorporated in its design has been described. The paper presents the conceptualization of an innovative valve train aiming at lesser number of components, reduction in friction and wear, proper sealing, and trimming down pumping losses. The need of these objectives have been identified and established. The next part of this paper describes the various geometric designs of valve trains that have been conceptualized and compared by using the Magneto rheological and electromagnets. Teodorescu et al.[2] The turbulent intensity of the working fluid in an SI engine can be increased at the end of the compression stroke by inducing intake generated in-cylinder swirl flow [4] Intake generated in-cylinder swirl flow is a structured rotation in the horizontal plane of an engine cylinder, which can be created by Using a shrouded intake valve [5-6] the main advantage of using a shrouded intake valve is that it can be manufactured with ease, and it permits to find the desired level of swirl ratio by only varying the shroud angle of a shrouded intake valve. However, the real disadvantage is that for generating a high degree of swirl, a shrouded intake valve of greater shroud angle is required. These results in substantial reduction in mean flow coefficient of an engine and as a consequence of it, the volumetric efficiency of an engine decreases. Performed experiments to study the contribution of different components such as rocker arm, push rod and cams in the total friction losses occurred in the valve train having geometry similar to that shown in Fig. 1. They measured friction components of valve train directly from a fired single cylinder engine and concluded that the friction in the rocker arm bearing is dominated by boundary friction mechanism.

II. NEW MODIFIED SWIRL INTAKE VALVE

This is the new design of inlet valve of engine:

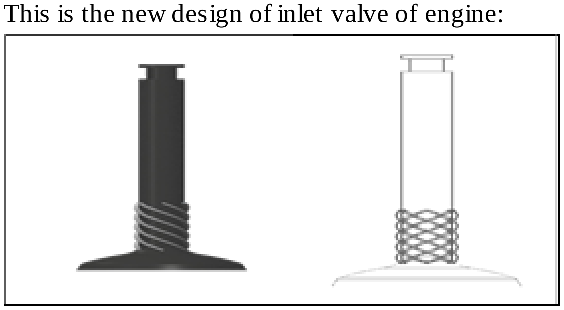


Fig 3: *design of self swirl generate inlet valve*

1) *Design:*

In this new design of self generate swirl inlet valve, we have created the helix teeth on the valve head. There are total eight helix teeth and each have 35° angle with respect to center line of the valve. Due to impact on valve under head, the pressurized inlet air lost some amount of the pressure energy in stamp type inlet valve.

In the self generate swirl inlet valve, the helix teeth create the swirl which actually increase 15-20% pressure of inlet air instead of losing it. The Swirling inlet air which has created in inlet port will continue swirling in cylinder of the Engine which is beneficial for hp of engine.

a. Size of valve port,

$$a_p\ v_p = aV$$

$$V = 90\ {}^{m}/_{s} = 90000\ {}^{mm}/_{s}$$

$$a_p = \frac{3302.66 \times 10933.33}{90000} = 462mm$$

$$a_p = \frac{\pi}{4}(d_p)2$$

$$d_p^2 = \frac{462 \times 4}{\pi} = 588.53mm$$

$$d_p = 24.25mm$$

b. Thickness of valve disc:

$$t = K \times d_p\sqrt{\frac{p}{\sigma_p}}$$

$$t = 0.42 \times 24.25\sqrt{\frac{10.96}{100}} = 3.36mm$$

c. Maximum lift of the valve:

h = lift of the valve

$$h = \frac{\sigma_f}{4\cos 30°} = \frac{24.25}{3.46} = 7.008mm$$

d. Valve steam diameter:

$$d_s - 3.03 + 6.35$$

$$d_s - 9.38\ (or)1403\ mm$$

$$\tan\alpha \ -\frac{2(h+t)}{d_p}-\frac{2(h+t)}{d_p}$$

$$\tan 30=\frac{2(3.36+7)}{d_p}$$

$$d_p=\frac{20.72}{0.577}=35.9mm\cong 36mm$$

Fig 4: *Swirl generated inlet valve*

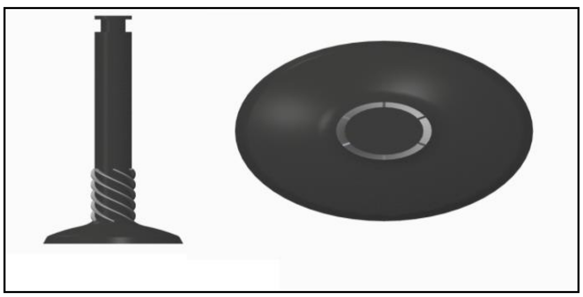


Fig 5: *Swirl generated inlet valve*

III. CALCULATION FOR SWIRL INTAKE VALVE

A. *Measuring Parameter:*

The restrictions to the flow offered by the intake valves are characterized by flow coefficient and mean flow coefficient.

Flow coefficient is defined as the measure of actual mass flow rate to theoretical mass flow rate and is given by,

$$c_f=\frac{\dot{m}}{\rho v_{bA_v}} \qquad (1)$$

Where, the Bernoulli velocity is given by,

$$v_b=\sqrt{\frac{2\Delta p}{\rho}} \qquad (2)$$

And the representative area is given by,

$$A_v=\frac{\pi}{4}iDv \qquad (3)$$

Mean flow coefficient is the average of flow coefficient over the crank angle between intake valve opening and intake valve closing and is given by,

$$C_{f(mean)}=\frac{\int_{IVO}^{IVC}C_f d\theta}{(\theta_{IVC}-\theta_{IVO})} \qquad (4)$$

Swirl generated by the intake valves are characterized by swirl coefficient and swirl ratio Swirl coefficient is defined as the ratio of angular momentum of flow with its axial momentum and is given by,

$$c_s=\frac{\omega_s}{v_b} \qquad (5)$$

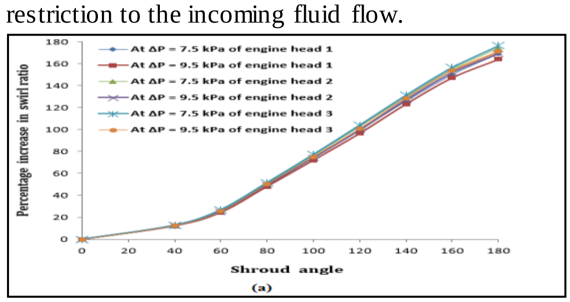
Swirl ratio as a global swirl generation parameter for the entire intake process of the engine is defined as,

$$R_s=\frac{BS\int_{\theta IVO}^{\theta IVC}c_f c_s d\theta}{iD_v^2\left(\int_{\theta IVO}^{\theta IVC}c_f d\theta\right)2} \qquad (6)$$

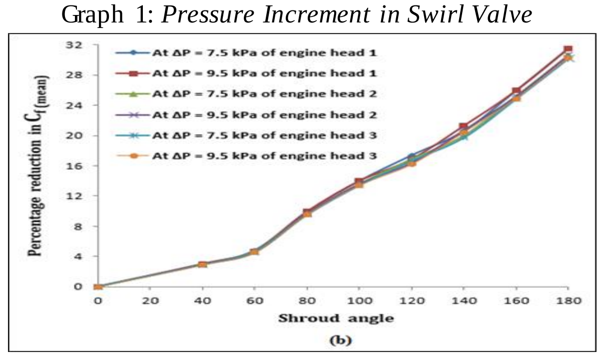
B. *Mean Flow Coefficient:*

Shows the mean flow coefficient of all the considered engine heads with different shrouded intake valve at *P* = 7.5kPa and 9.5 kPa. Flow coefficients for non-dimensional valve lift (*LV/DV*) of 0.05, 0.1, 0.15, 0.2, and 0.25 are used for determining the mean flow coefficient for all the considered cases in the study. Flow coefficient for any of the non-dimensional valve lift is calculated as per Eq. (1) by making use of the air mass flow rate obtained from the experiment.

It can also be seen that the mean flow coefficient of all the considered engine heads has decreased on using shrouded intake valve of higher shroud angle. It emphasizes the fact that an SI engine with shrouded intake valve of larger shroud angle provides a greater restriction to the incoming fluid flow.



Graph 1: *Pressure Increment in Swirl Valve*



Graph 2: *Pressure Increment in Poppet Valve*

IV. CONCLUSION

From the calculation we conclude that the compression and combustion process of inlet air become more economical. Instead of using stamp type valve, the self generate swirl inlet valve will be more beneficial which is one step towards to gain more power in automobile industry.

REFERENCES

[1] B Seshagiri Rao and D Gopi Chandu, 2014(Petrol Engine Exhaust Valve Design, Analysis And Manufacturing Processes)

[2] S. M. Muzakkir*, M. G. Patil and Harish Hirani, Volume No.4 Issue No.3, pp : 178-181, (Design of Innovative Engine Valve: Background and Need)

[3] Hirt C W, Amsden A A and Cock J L (1974), “Journal of Computational Physics”, Vol. 14**.**

[4] Heywood J B. (2011).Internal Combustion Engine Fundamentals. New Delhi, Tata McGraw-Hill.

[5] Gunasekaran, J, Ganesan V. (2011). Effect of Swirl and Tumble on the Stratified Combustion of a DISI Engine - A CFD Study.SAE Paper No. 2011-01-1214.

[6] Heim D, Gandhi J. A (2011).Detailed Study of In-Cylinder Flow and Turbulence using PIV. SAE Paper No. 2011-01-1287**.**