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Velocity Performance Analysis of Slider-Style Valve in Engine

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Abstract:

The design of the engine intake and exhaust system has a direct impact on the engine power play, the power and economy of the vehicle has a direct impact, and the design of the intake and exhaust system has a great impact on the vehicle noise level. This article from the fuel engine into the role of the exhaust valve in the supply system, and its effect on the performance of the engine inlet and exhaust system, this paper in view of the traditional engine mushroom valve caused due to size and quality of engine inlet and exhaust system of low transmission efficiency, energy loss is bigger, and the valve switch caused by excessive motion inertia on the sexual problem, Taking S195 diesel engine as the research object, a new sliding block valve is designed. By referring to the relevant parameters of S195 diesel engine and based on the valve structure of the slider engine, the speed characteristic curves of the slider valve at different speeds were obtained by using the method of dynamics simulation. The velocity characteristics lay a foundation for the dynamic performance analysis of the sliding block valve and provide a certain possibility for the research of the sliding block engine valve.

Keywords*: Intake and exhaust system; Mushroom valve; Sliding block valve; Speed characteristic*.

I. INTRODUCTION

The fuel supply system is an important part of the fuel engine, similar to the digestive system of the human body. It undertakes the task of energy and material entering, transforming and then discharging the engine Function of fuel supply system: according to the different requirements of various working conditions of the engine, it supplies the engine cylinder with a certain concentration and quantity of combustible mixture, and discharges the exhaust gas generated by engine combustion and power stroke into the atmosphere [1].

The intake and exhaust system is the core part of the fuel supply system. The design of the engine intake and exhaust system has a direct impact on the engine power play, the power and economy of the vehicle has a direct impact, and the design of the intake and exhaust system has a great impact on the vehicle noise level.

1.1 Functions of the Intake System [2]

(1) The main function of the intake system is to transport clean, dry, sufficient and stable air for the

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engine to meet the needs of the engine, to avoid impurities and large particle dust in the air into the engine combustion chamber, causing abnormal engine wear;

(2) Another important function of the intake system is to reduce the intake noise. The intake noise not only affects the noise of the vehicle, but also affects the noise inside the vehicle, which has a great influence on the ride comfort. Proper design of Noise eliminators can reduce intake system Noise and improve vehicle NVH performance (Noise, Vibration, Harshness).

(3) The quality of the intake system design directly affects the power of the engine, related to the vehicle's dynamic performance and ride comfort.

1.2 Functions of Exhaust System

(1) The exhaust gas from each cylinder is discharged through the exhaust pipe.

(2) The exhaust system is equipped with muffler device, which can reduce engine noise.

(3) Now in order to protect the environment, the exhaust system is equipped with sewage purification devices, such as ternary catalysis.

1.3 Working Process and Principle of Diesel Engine Intake and Exhaust System [3]

Air with ambient temperature through the air filter cleaner, into the turbocharger inlet, pressurized from the turbocharger outlet into the intake pipe, air density increases, temperature rises, the air temperature at the turbocharger outlet is about 170℃ (different engine values vary). Through the intake pipe, the temperature of the pressurized high temperature and high pressure air flow to the intercooler inlet is about 165℃. After the intercooler cooling, the air comes out of the intercooler outlet, the temperature drops to about 55℃, and then enters the engine inlet pipe. When the air in the intake port to the cylinder head, air temperature slightly higher, approximately 60 ℃, fresh air, the inlet valve intake valve, compressed, air temperature, density, surge, reach before the check point on crankshaft Angle of fuel injection advance Angle, injection diesel to meet the required natural temperature and pressure, air and fuel mixture combustion after expanding power, into the exhaust stroke, the exhaust valve opens, The exhaust gas temperature as it passes through the cylinder head airway is up to 600℃, through the exhaust manifold, and into the turbocharger and exhaust pipe. The high-temperature exhaust gas pushes the turbine to rotate at a high speed and is discharged from the turbine outlet. The temperature drops to about 500℃. It enters the muffler through the exhaust pipe path, exhaust brake valve and exhaust bellows, and enters the atmosphere after muffling.

Intake and exhaust valve as a valve, through opening and closing to control the combustion material into the cylinder, as well as the exhaust gas and exhaust cylinder after combustion, to ensure the normal operation of the engine intake and exhaust system, plays a decisive role. The role of the intake valve is to

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open the air into the engine, mixed with fuel combustion; The function of the exhaust valve is to expel the exhaust gas after combustion and dissipate heat. From the perspective of power transmission, capacity loss and motion inertia, the size and quality of the intake and exhaust valves have a great impact on the power and economy of the vehicle.

II. FACTORS INFLUENCING THE SIZE OF INTAKE AND EXHAUST VALVES

The size of the intake valve and exhaust valve is determined by the volume of charge and discharge. It is mainly determined by the following three factors:

(1) Influence of airflow resistance

Theoretically speaking, the charging volume and the exhaust volume are equal, and the opening and closing time of the exhaust valve and the opening and closing time of the intake valve are equal. But this is not the case, because the throttle determines the speed, and the throttle opens and closes large and small, the cylinder should be filled with a mixture equal to the atmospheric pressure at the end of the inhalation.[4] But when the gas passes through the intake pipe and the intake valve, there is resistance, and to overcome this resistance and allow the mixture to flow at a certain speed, some of the pressure must be dissipated, so that the pressure in the cylinder is always below the atmospheric pressure. As the gas density varies with pressure, the pressure low density decreases and the actual weight of the inhaled mixture decreases. To solve and reduce the impact of airflow resistance, we must increase the cross-sectional area of airflow path at the inlet valve, that is, increase the valve area. In the thin air of the highlands, the area of the intake channel must be enlarged, otherwise the engine will not reach its rated power in these areas [5].

(2) Influence of engine speed:

In the case of constant engine airway size, the suction pressure also varies with the speed and load. The speed varies with load when the throttle remains fully open. When the engine speed increases rapidly, the air flow cannot keep up with the demand for filling. Because when you triple the RPM, the piston moves three times as fast, and the flow has to go three times as fast to get the same amount of gas into the cylinder. But because the resistance in the airway increases at high speed, the airflow cannot increase by the same proportion [6]. In this way, when the engine decelerates, the inflation effect is better, resulting in a higher average effective pressure and torque (torque is proportional to the average

(3) Comparative factors of inlet and exhaust flow speed

The mixture enters the cylinder when the piston moves from top TDC to bottom TDC and the piston stroke volume forms a vacuum (that is, the pressure difference), so the piston moves first, the air flow moves later, and the piston moves faster than the air flow. In theory, the more fresh mixture enters the cylinder, the better, but the speed of the flow cannot keep up with the speed of the piston's action. In this case, the solution is to expand the intake valve to accommodate the volume of air.

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Exhaust is the exhaust gas in the cylinder. Free exhaust under the working stroke piston XingYao 120 °, 180 ° after piston upward, at this time in before the pistons in the exhaust, and the speed of the waste gas discharge is the speed of the piston upward, exhaust gas in the role of external forces were forced to discharge, to say the upstroke velocity and exhaust velocity are equal, this is the reason why the exhaust valve smaller than inlet valve. Generally, the exhaust valve caliber is two-thirds of the inlet valve caliber. The diameter of the exhaust valve is designed without affecting the exhaust effective pressure) [7].

It can be seen that the design of the engine intake and exhaust system has a direct impact on the engine power, power and economy of the vehicle, and the design of the intake and exhaust system also has a great impact on the noise level of the vehicle. This article from the fuel engine into the role of the exhaust valve in the supply system, and its effect on the performance of the engine inlet and exhaust system, this paper in view of the traditional engine mushroom valve caused due to size and quality of engine inlet and exhaust system of low transmission efficiency, energy loss is bigger, and the valve switch caused by excessive motion inertia on the sexual problem [8]. Taking S195 diesel engine as the research object, a new sliding block valve is designed. By referring to the relevant parameters of S195 diesel engine and based on the valve structure of the slider engine, the speed characteristic curves of the slider valve at different speeds were obtained by using the method of dynamics simulation. This speed characteristic lays the foundation for the dynamic performance analysis of the sliding block valve, provides a certain possibility for the research of the sliding block engine valve, and puts forward feasible innovative measures and methods for the engine valve structure.

III. BRIEF INTRODUCTION OF SLIDER ENGINE VALVE STRUCTURE

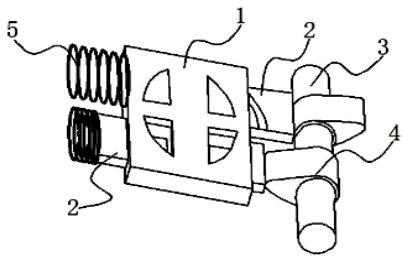

Fig 1: Schematic diagram of structure design of the slider valve
1-valve seat 2-slider valve 3-camshaft 4-cam 5-return spring

The structure features of slider engine valve, as shown in Figure 1, contains:

1) Valve seat with vent holes and slider, the camshaft and cam with drive slider cooperating with the valve seat traction are arranged on both sides. The valve seat has a hollow structure. The slider is inserted from the end face opening of the valve seat to support traction.

2) One end of the valve seat is provided with a camshaft, and a cam with position corresponding to the slider is installed on the camshaft. The other end of the valve seat is provided with a return spring, and one

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end of the return spring is pressed against the end surface of the slider valve.

3) Both sides of the slider valve are provided with valve holes with the same position and size as the vent holes on both sides of the valve seat. A longitudinal baffle is arranged inside the valve seat, which divides the internal space into two separate spaces, each of which is closely matched with the slider valve. The upper and lower sides of each independent space of the valve seat are provided with two left and right mirrored vent holes, and the slider valve is provided with a valve hole with position corresponding to the vent hole.

IV. SPEED CHARACTERISTICS ANALYSIS OF SLIDER VALVE

4.1 Mass Center Location and Speed Analysis of Intake and Exhaust Valves

Perform dynamics simulation on the valve mechanism, input the valve mechanism speed, the number of cycles and the name of the output file. After ADAMS simulation, click the post-processing icon, select simulation filter, add the curve. Then, we can get the dynamic parameter curve of S195 engine valve mechanism at the rated speed of 2000r/min:

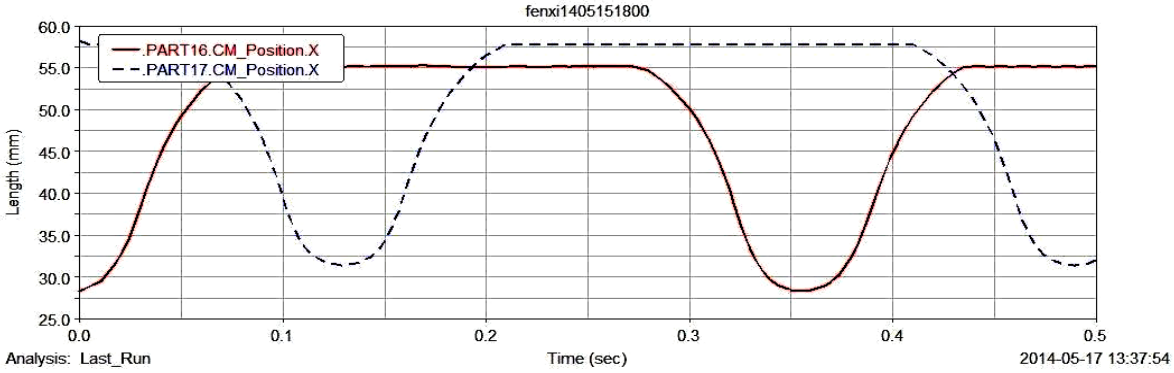

Fig 2: Centroid position curves of inlet and exhaust valves

It can be seen from the curve in Figure 2 that at rated speed, the exhaust valve has a lift of about 26mm, the intake valve has a lift of about 26.5mm, which approaches the spring deformation of 26mm at spring selection, so the design is reasonable. The valve lift curve is smooth, indicating that the valve mechanism runs smoothly and there is no fly-off phenomenon. [9].

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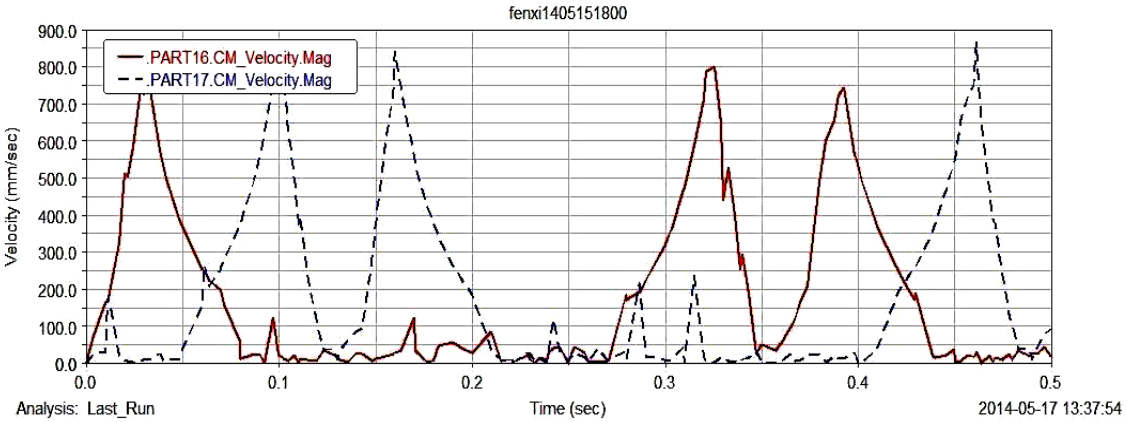

Fig 3: Inlet and exhaust valve centroid velocity curve

It can be seen from the curve in Figure 3 that at the rated speed, the exhaust valve has a maximum speed of about 860mm/s, and the intake valve has a maximum speed of about 800mm/s, which meets the design requirements.

4.2 Speed Curves of Intake and Exhaust Valves at Different Speeds

Through mass center location and speed analysis of intake and exhaust valves, further simulation under ADAMS is performed, and the intake and exhaust valve acceleration parameter curves of S195 engine valve mechanism at the rated speed of 2000r/min are as follows:[10].

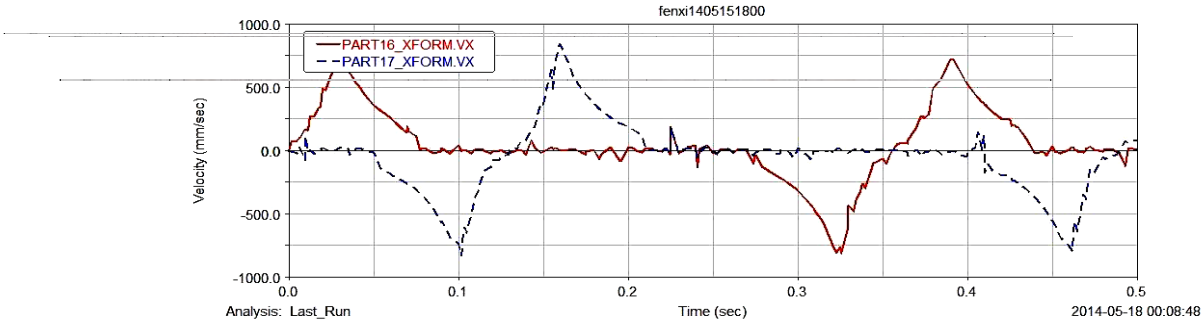

Fig 4: Inlet and exhaust valve velocity curves at 2000r/min

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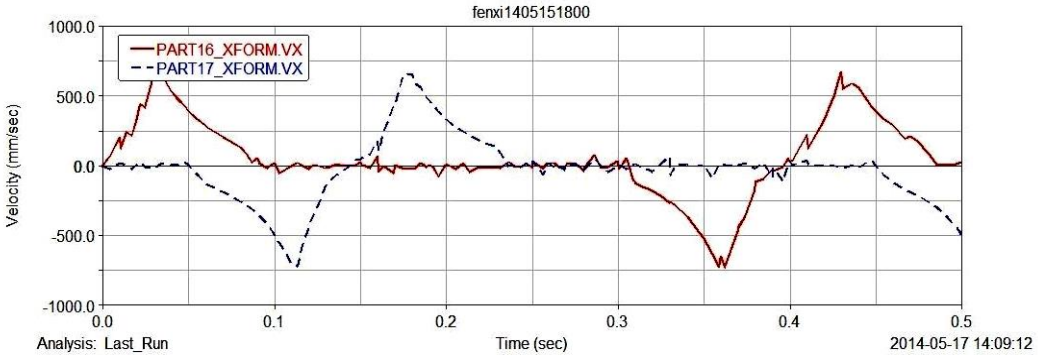

Fig 5: Inlet and exhaust valve velocity curves at 1800r/min

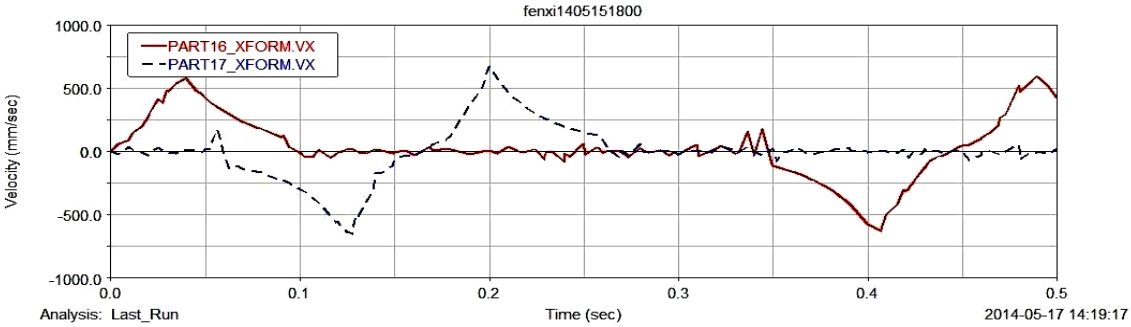

Fig 6: Inlet and exhaust valve velocity curves at 1600r/min

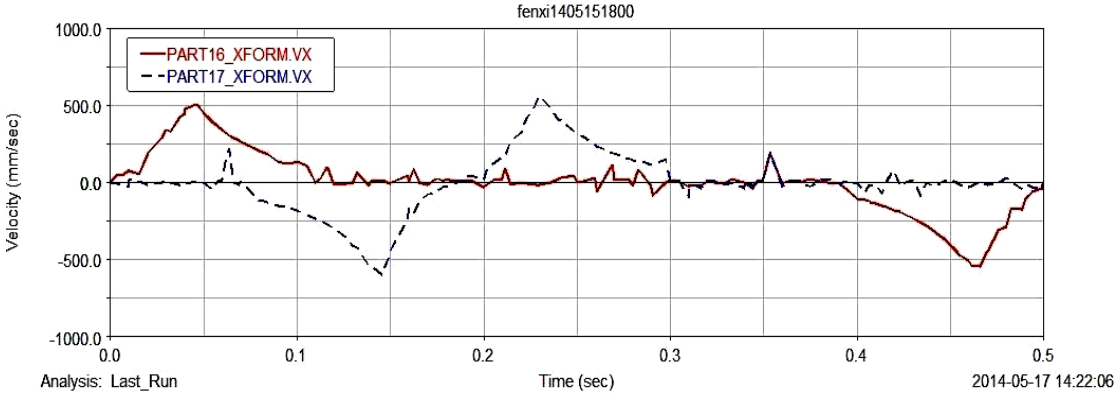

Fig 7: Inlet and exhaust valve velocity curves at 1400r/min

It can be seen from Figures 4~7 that at different engine speeds, the valve has vibration at the instant of opening and return stroke. The vibration amplitude is small under low speed, but higher under high speed. At the end of the valve return stroke of the valve mechanism, the speed increases with the increase of the engine speed.

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V. CONCLUSIONS AND PROSPECTS

5.1 Summary of Speed Simulation Analysis

According to the multi-body dynamics simulation curve conducted by ADAMS, it can be seen that in the engine running process, due to its smaller structure size and mass, the motion inertia is smaller and the motion smoothness is improved. [11] It can be seen from the analysis results that the sliding block valve structure can correctly reflect the actual motion law and dynamic characteristics of the engine valve mechanism. The conclusions are as follows:

(1) Good exercise regularity

Simulation analysis shows that the motion law of each moving part and the interaction force and contact force between the moving parts are very uniform, which meets the requirements of engine intake and exhaust.

(2) The valve force is good

The simulation results show that the force and lubrication characteristics of all parts of the valve mechanism are good, indicating that the CAM profile design of the valve mechanism is reasonable.

By comparing the simulation results of different valve mechanisms, it can be found that on the basis of ensuring the continuous valve acceleration, increasing the valve lift has a significant effect on improving the engine ventilation and lubrication conditions of the valve mechanism, so that the performance of the engine valve mechanism is significantly improved.

5.2 Research Prospects

In this paper, the inlet and exhaust velocity characteristics of diesel engine are simply analyzed from the Angle of inlet and exhaust valve structure and quality change. In the following research, more detailed analysis and research will be carried out on the assembly accuracy of the slider valve, the acceleration characteristics of the intake and exhaust valve, so as to improve the engine performance of the new structure of the engine valve.

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