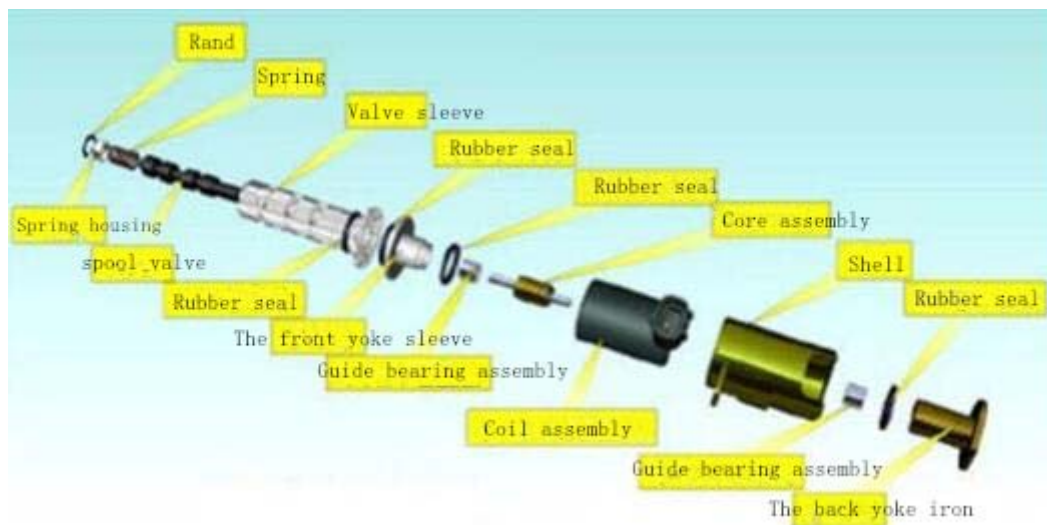


OCV Instructions

VVT system mainly consist of cam phaser and oil control valve(oil control valve is short for OCV).Cam phaser is the actuator for the system ,and OCV is the controller for the system .

1. OCV structure



OCV is a proportional valve , it means the moving position of valve core is proportional to the PWM duty ratio that the engine ECU supplied to the OCV coil . When the duty ratio is gradually increasing , the electromagnetic force of coil also become bigger, the core assembly is moving inside the coil assembly , and overcome the spring force to push the valve core move forward. When the duty ratio is smaller, the electromagnetic force also become smaller , the valve core will back to the position under the action of the spring . The valve core cooperate with the valve sleeve during the moving process to accomplish the oil circuit changing , so it can control the direction and flow of engine oil

that get in and out of the OCV , and control the engine oil flow that go in/out of the cam phaser.

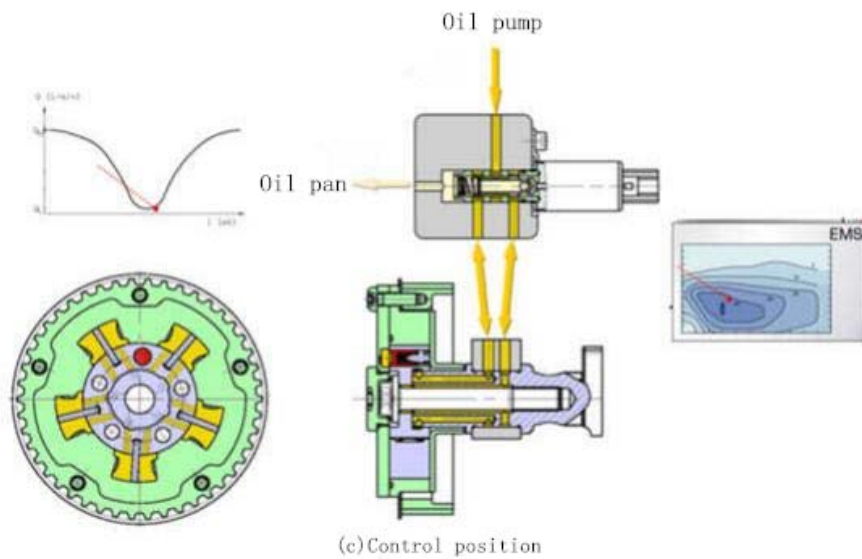
2. OCV working process

In order to have a better explanation for the working process of VVT system, below we will take the intake VVT as an example to explain the three mainly working process.

(1)Reference position : The PWM duty ratio of OCV is usually 0%, and the valve core don't move. The oil pressure of the cam phaser's right part is bigger than the left part. The left part of vane is next to the stator, there is no relative rotation between the stator and rotor , it means the camshaft is without adjustment for the crankshaft timing . Usually the reference position of intake VVT is the lag position of port timing , the intake valve will open and close later.

(2)Working position :The PWM duty ratio of OCV is gradually increasing , and the valve core move to the farthest position ,the oil pressure of cam phaser's left part become bigger, after unlocking, when the left part's oil pressure is bigger than the right part's pressure, and overcome the friction torque of the camshaft and cam phaser, the rotor has a relatively clockwise rotation for the stator.The camshaft adjust to the timing advance , the intake valve will open and close in advance.

(3)Control position: The rotor has a relatively clockwise rotation to the



VVT system working process

The final purpose of the VVT system is to accomplish the adjustment and controlling for the camshaft timing . Like other control systems ,the critical technical features are the three points.

(1)Response speed : The adjustment speed of VVT system , the rotating angle of camshaft that adjusted by the VVT system in unit time. The configuration parameter of the cam phaser has the biggest influence on it, we can measure it in the torque pressure ratio parameter,this parameter is only in relation to the structure of cam phaser . In addition ,the installation position of the OCV in oil ducts also have influences on the VVT response speed.

(2) Control accuracy :The conformity degree between the actual phase

angle of VVT and the setted target angle by ECU. In the function test of VVT system ,usually use the follower curve to indicate .

(3) The stability of control : When the external condition changing (like the changes of oil pressure of engine oil and the changes of temperature,etc.) , if the closed cycle control system can work stability . Usually use the adjusted angle fluctuations to measure in a certain controlled position .

In a word , the three points are in relation to the cam phaser, the structure and property of OCV , the installation way of the system and the control algorithm.

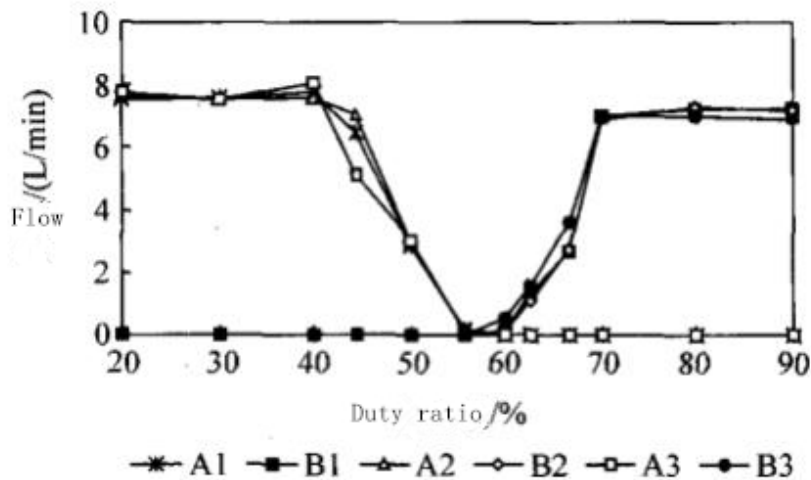
3. Performance and test

Now there is no systematic and deeper research on the VVT system inside China ,and also we can't purchash the matching and ready-made test system .The following test is tested by our own testing system .

OCV performance parameter:

Coil impedance:(7.4 ± 0.5) Ω 20 $^{\circ}\text{C}$; Coil inductance:18 mH@1kHz;
valve core electric current : (100~1000) mA ; Input voltage (through the coil): rated voltage (12 ± 0.5) V; the start-up response under the input volate:<50m s .

Testing condition : oil model 10W-30 ,oil temperature : (80 ± 3) $^{\circ}\text{C}$,oil pressure:(300 ± 10) kPa.



The above picture is the test result of 3 times testing for one OCV. We can know from the picture, the changes of duty ratio let the valve core of OCV in a certain position, it will change the connection situation of all the interface, so we can get through the working medium flow performance test: When the duty ratio is changing between 20%~40%, the flow of exit A is the biggest, the flow of B is zero, and the flow of every exit will not change because of the change of duty ratio; The duty ratio goes on increasing, the flow of exit A gradually decreases, the flow of B still be zero. When the duty ratio is about 56%, except the flow that leakage into it, the flow of every exit will be zero; The duty ratio goes on increasing, the flow of A is zero, the flow of B is gradually increasing. When the duty ratio is about 70%, the flow of B reach the maximum value and it will not change if the duty ratio goes on increasing. Through getting the OCV's working medium flow in different duty ratio, to accomplish the accurately control to OCV's working medium

flow by impulsing power source.

We can make a conclusion through a large number of tests by our workers:

(1) The pressure and temperature of engine oil have a big influence in the cam phaser's response speed. Through the proper design of every exits' parameters of OCV, it can improve the actual oil supply pressure of cam phaser, and improve the adjustment of speed.

(2) The rotation speed has a main influence on the changes of cam phaser's load, in the range of cam phaser's actual working rotation speed, the cam phaser's actual load can be the average value of torsional moment, and it also be the target load when designing the cam phaser.

(3) Through influencing the cam phaser's oil supply pressure and back pressure, the OCV and oil conduit will influence the cam phaser's effective oil supply pressure. The exits' flow performance of OCV should try to be the same, so it can make the exits' opening degree have more influence on the response speed.

(4) Because of the limit of current oil supply flow, the increasing of cam phaser's displacement has small influence on improving the response speed.

4. Maintenance

In the engine's production and using time , it will have some scrap . In order to prevent the scrap to block the VVT system's engine oil conduit and OCV, it need to clean the engine oil conduit every time in the driving time , it can try to take the scrap away through the oil belt,to prevent the block , so it is called preventive cleaning. It is mainly to prevent the block ,considering that changes of the camshaft's position has big influence on the engine's performance ,so the cleaning times is limited in one driving .Through the quick changes of setted value of the camshaft's target postion , and improve the engine oil's pressure and flow in short time , to take the scrap away from the oil conduit through the fast flowing oil .

5. The reasons of engine's difficult start and idle speed because of the breakdown of OCV

(1)The engine start and stop , the position of OCV should be in the latest (In order to prevent the exhaust gas back to the intake manifold, it should shorten the throttle valve position's overlap section and improve the start ability .)

(2)When the engine is in idle working, the position of OCV also in the latest (In order to prevent the exhaust gas back to the intake manifold, it should shorten the throttle valve position's overlap section and let the engine more stable .)

(3) If it has the things in the oil conduit such as metal particles come into the OCV, it leads to the slide valve in the advance position. Under this situation start the engine, because the exhaust gas upstream, the intake gas is short, so it will lead to the appearance of difficult start and idle speed.

6. The treatment of engine's difficult start and idle speed because of the breakdown of OCV

(1) When it can't start, step on the gas, usually it can start the engine. (usually it is hard to start without stepping on the gas and after starting it has big idle wobbling.)

(2) Can beat and vibrate the oil control valve.

(3) Disassemble the oil control valve, inspect and clean it.

(4) Replace the oil control valve.

7. The treatment method

(1) Beat and vibrate it gently. (under the guidance of the professional person)

(2) Clean (Use the engine oil to lubricate it, and switch on the current for 5 times to see if can remove the slide valve normally, the practice shows that the diesel oil is better than the detergent.)

8. Assemble the OCV

It is convenient , the steps as below:

- (1) Pull out the control cable.
- (2) Take apart the fastened bolt of OCV and the engine shell .
- (3) Replace the new OCV , fasten the bolt well ,and assemble the control cable.