Application of ABS Regulator Solenoid Valve Control

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Abstract: In the air brake system of the vehicle, the electromagnetic valve of the brake regulator belongs to the anti-lock brake system. In case of an emergency, the wheel is prevented from being locked and slipped during braking, and the most suitable braking force is applied to each wheel, so that the adhesion force \(^1\) of the tire to the ground is fully utilized, which plays a vital role in improving the safety of the vehicle. In ABS anti-lock system, the regulation of solenoid valve plays an important role. This paper analyzes and applies a kind of solenoid valve control.

1. Introduction

With the increase of vehicle speed, the increase of road traffic density and the increasing demand for vehicle safety, ABS has become an important safety device in automobiles. With the development of high speed, the current vehicles are equipped with ABS anti-lock system, which can improve the safety of driving. Anti-lock braking system can avoid the wheel is locked to cause slippage in case of sudden emergency, also can shorten the vehicle braking distance, maintain good adhesion and steering performance, improve the safety of vehicle braking. At present, air braking is widely used in various commercial vehicles. The ABS anti-lock braking system controls the rotation speed of the wheels within a certain range \(^2\) to realize anti-lock braking. At this time, the vehicle reaches the maximum parking braking force to control the braking force of the wheels \(^3\). It is mainly composed of wheel speed sensor, controller (ECU) and ABS solenoid valve. Solenoid valve is a kind of precise control valve, which can be accurately controlled by ECU.

2. Structural logic:

2.1 Working principle of solenoid valve:

As shown in the structure of ABS solenoid valve (the left figure in Fig. 1), the solenoid valve mainly consists of three parts: Main valve body 1, air guide valve body 2 and exhaust valve body 8. The main valve is equipped with an intake diaphragm assembly (3, 4, 5), and the exhaust valve body is equipped with an exhaust diaphragm assembly (3, 5, 6). The ABS solenoid valve is a two-position three-way
valve with three states. 1. Boost 2. Hold pressure 3. Depressurization. As shown in the coil assembly of ABS solenoid valve (the right figure in Fig. 1), when both ends of the solenoid valve coil (12) are not energized (Fig. 2), when compressed air comes in A1, corresponding A2 has air out. Under normal conditions, A1 and A2 are connected, which is called booster. When the intake end coil is energized, the air pressure of the air guide valve body increases gradually, so that the intake diaphragm 4 moves down into contact with the main valve 1, and the air pressure between A1 and A2 is closed, which is called holding pressure. When the pressure of A2 is to be reduced, the exhaust end coil is then energized, the A1 of the exhaust valve body 8 is compressed and the exhaust diaphragm 6 is closed, the pressure of the exhaust valve body 8 in the mold cavity overcomes the spring force, so that the intake diaphragm 4 is separated from the exhaust valve body 8, and the A2 and A3 communicate with the exhaust gas, referred to as depressurization. When A2 pressure is to be increased again, the intake end coil and the exhaust end coil are de-energized at the same time, and the air pressure is controlled through the ABS solenoid valve, such as pressure boosting, pressure holding and pressure depressurization, which is the same as that in the circulation to achieve the final anti-lock brake purpose.

2.2 Coil principle of solenoid valve:

The solenoid valve coil is of DC design, which is made of round copper enamelled wire wound on the insulating frame. Its electrical characteristics are basically consistent with the inductance, which can suppress the change of current in the coil. The solenoid valve has compact structure, few parts and simple composition, so it is very convenient to maintain and widely used in [4]. The solenoid valve coil 12, the stationary core assembly 11, the movable core 13, and the springs 13 and 14 constitute an integral body, and are the core of the ABS solenoid valve. When energized, the electrical energy is converted into magnetic energy, the stationary core assembly 11 generates a constant magnetic field, and the movable core 13 acts to engage the stationary core assembly 11 against the spring force 14. When the solenoid valve coil 12 is de-energized, the electric energy can not be supplied again, the solenoid coil is de-energized, the current drops rapidly, the magnetic field loses the energy source, the magnetic field disappears, and the movable iron core 13 closes the valve port under the action of the spring 14. When the electric current is applied, the electromagnetic force is generated by the current of the coil [5], which causes the static characteristic assembly to drive the moving core 13 to open the valve port against the spring force and the medium pressure, thereby enabling the electromagnetic valve to open and close the & x201c;
Figure 1 Schematic diagram 1
Figure 2 Schematic diagram 2
1. Main valve body 2. Air guide valve body 3. Spring 4. Intake diaphragm 5. Diaphragm positioning plate 6. Exhaust diaphragm 7. Filter 8. Exhaust valve body 9. Solenoid valve coil 10. Intake spring 11. Static core assembly 12. Solenoid valve coil 13. Moving core assembly 14. Exhaust spring

Figure 3 Schematic diagram of gas circuit
A1: Intake  A2: Outlet  A3: Exhaust
a: Exhaust coil b: Intake coil
A1: Intake  A2: Outlet  A3: Exhaust
a: Exhaust coil b: Intake coil
3. **Basic requirements for solenoid valve performance:**

   (1) Pressure characteristics (boost, hold, depressurize)
   (2) Electrical performance (normal operation at 18 V~32 V)
   (3) Insulation (>100 MΩ at DC500V)
   (4) Pressure resistance (more than one minute at DC1200V, not broken down)
   (5) Resistance (at 20 ℃, resistance 15.5±5 %Ω)
   (6) Tightness (in case of power-on or power-off, its tightness can be guaranteed)
   (7) Durability (normal function after 5 million operations)
   (8) Protection (protection against external dust and rain)
   (9) High and low temperature (normal operation under high and low temperature and normal sealing performance)
   (10) Performance requirements meet the requirements of QC/T1006 -2015 Performance Requirements and Bench Test Method for Air Pressure Electromagnetic Adjustment of Automobile Anti-lock Braking System [6]

4. **Application of solenoid valves:**

   The solenoid valve is the basic component of the ABS anti-lock control system. ABS solenoid valve internal pressurizing valve and reducing valve in the continuous operation (pressurizing-depressurizing-holding) to adjust the air pressure [7] to achieve the final anti-lock purpose. So the faster the solenoid coil response time, the more obvious the anti-lock effect will be. If the response time of the valve is delayed, the pressure in the brake cylinder cannot be rapidly depressurized and boosted in an emergency shutdown. Finally can not get the effective anti-lock effect, the occurrence of unnecessary safety accidents. Therefore, the importance of magnetic property, coercivity and cutting property should be considered when reasonably selecting the voltage, current, power and response time of the solenoid valve coil, and selecting the moving iron core and static iron core materials.

5. **Solenoid valve precautions:**

   In the process of application of solenoid valve, the fault of solenoid valve will directly affect the action of shutoff valve or control valve.

   If the solenoid valve terminal is loose or the terminal falls off, the solenoid valve shall not be electrically connected, and the terminal shall be tightened.

   If the solenoid valve coil is burnt, the wiring of the solenoid valve can be removed and measured with a multimeter. If the circuit is open, the solenoid valve burns; It may cause magnetic leakage due to poor insulation caused by moisture in the coil, causing excessive current in the coil and burnout, so prevent rainwater from entering the solenoid valve. In addition, the value of the spring force is too large, the reaction force is too large, the number of turns of the coil is too small, and the suction force is not enough to burn the coil.

   The solenoid valve is stuck. One reason: For long-term use, the clearance between the inner hole of the static iron core assembly 11 of the solenoid valve and the outer circle of the movable iron core 13 is too large, and it is easy to be stuck under the high-speed operation of the solenoid valve. Another reason: There are mechanical impurities sticking to the moving iron core and into the static iron core sleeve, resulting in friction jam. Solution: Remove the solenoid valve, replace the parts with excessive clearance between the static iron assembly and the movable iron core, and regularly clean them to keep the static iron core assembly 11 and the movable iron core 13 clean and move flexibly.

6. **Conclusion:**

   To sum up, when selecting solenoid valve: on the one hand, it should be based on the process needs, on the other hand, it also needs to consider the reliability and economy of solenoid valve. The ABS anti-lock braking system is an important way to improve the braking performance of automobile. It can improve the braking performance of automobile and satisfy the driving safety. Solenoid valve is
the actuator of ABS anti-lock system. Its response, sensitivity, stability and reliability are particularly important.

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