

## Performance comparison between electronic expansion valve and thermal expansion valve

Electronic expansion valve and thermal expansion valve have the same basic purpose, diverse structures, but there are great differences in performance.

### 1. Adjustment range:

At present, the adjustment range of thermal expansion valve is generally narrow. The heat pump unit should not only cool, but also heat, and the applicable environment temperature range is from  $-15^{\circ}\text{C}$  to  $+43^{\circ}\text{C}$ , and the corresponding refrigerant evaporation temperature will work in the range of  $-25^{\circ}\text{C}$  to  $5^{\circ}\text{C}$ . Moreover, if there are multiple compressors in the refrigeration circuit, the number of compressors in operation will change with the change of user load, resulting in drastic changes in refrigerant flow.

Therefore, a single thermal expansion valve is far from being competent for the operation of large heat pump units. At present, many large-scale heat pump products adopt a single-loop design system with a single compressor, and adopt an expansion valve system with independent cooling mode and heating mode, which will inevitably increase the complexity and manufacturing cost of the system.

The electronic expansion valve can be accurately adjusted within the range of 15%~100%, as shown in Figure 1. As far as the current use effect is concerned, a single electronic expansion valve can meet the adjustment of the heat pump unit under the above working conditions. And the adjustment range can be set according to the characteristics of different products, which increases the flexibility.

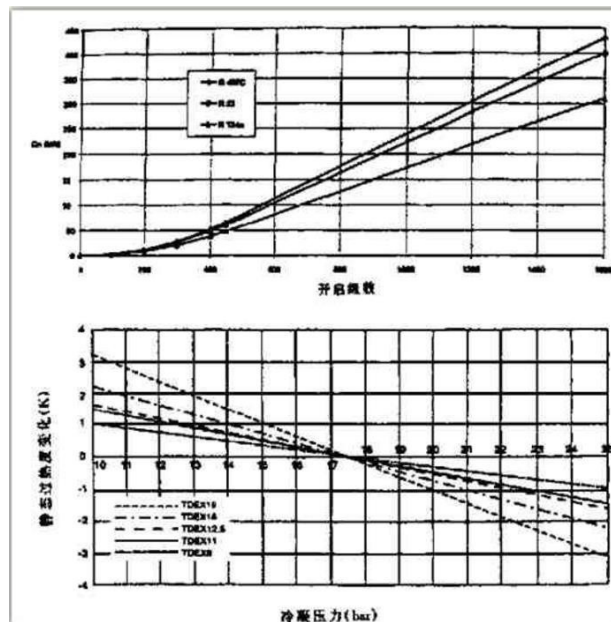


Fig.1 Curve between the capacity of electronic expansion valve and the number of opening stages  
2 Static superheat change (one-way orifice type)

### 2. Control of superheat

(1) **Control point of superheat:** For thermal expansion valves, generally only the superheat at the evaporator outlet can be controlled. The electronic expansion valve shows its advantages. In semi-closed and fully-closed compressor systems, its control point can be set not only at the evaporator outlet, but also at the compressor suction port, which can control the suction superheat of the compressor and ensure the efficiency of the compressor.

(2) **Setting value of superheat:** For thermal expansion valves, the setting value of superheat is generally set by the manufacturer during the manufacturing process.

, usually 5°C, 6°C or 8°C. The superheat of electronic expansion valve can be set artificially according to the different characteristics of products, such as the superheat of evaporator outlet is set to 6°C, and the superheat of compressor suction can be set to 15°C, which is very flexible.

(3) **Stability of superheat control under non-standard working conditions:** the superheat setting values of thermal expansion valves are all set under standard working conditions. However, due to the characteristics of filling working medium, when the system deviates from the standard working conditions, its superheat often deviates from the set values with the change of condensation pressure, which will not only lead to the decline of system efficiency, but also cause the fluctuation of the system. As shown in figure 2. However, the superheat degree of the electronic expansion valve is set artificially by the controller, and the actual superheat degree of the system is calculated by the parameters of the control point collected by the sensor, so this kind of problem does not occur.

(4) **Intelligent regulation of the system:** the control of superheat by the thermal expansion valve is based on the current state of the control point and is determined by the characteristics of the charged working medium, so it cannot judge the changing trend of the system. The control logic of electronic expansion valve can adopt all kinds of intelligent control systems according to the design and manufacturing characteristics of different products. It can not only adjust the current state of the system, but also judge the characteristics of the system according to the parameters such as the change rate of superheat, and adopt corresponding control means for different system change trends. Therefore, its response speed and pertinence to system changes are superior to those of thermal expansion valves.

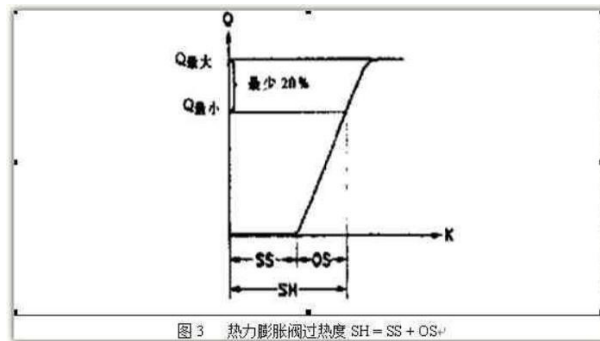
### 3. reaction rate

The thermal expansion valve is driven by using the thermal characteristics of the charged working medium, so its opening and closing properties have the following characteristics:

(1) The sensitivity of reaction and the speed of opening and closing action are slow.

(2) Generally speaking, the opening and closing speed of thermal expansion valve is relatively consistent (ALCO company has newly introduced a thermal expansion valve for heat pump, and its opening and closing characteristics are slow opening and fast closing).

(3) During the start-up of the unit, there is static superheat, as shown in Figure 3. The superheat (shh) of the thermal expansion valve is composed of static superheat (stainless steel) and opening superheat (operating system). Due to the existence of static superheat, there will be a tendency to delay the opening of the expansion valve during the start-up.



The driving mode of the electronic expansion valve is that the controller calculates the parameters collected by the sensor, sends an adjustment instruction to the driving board, and the driving board outputs an electrical signal to the electronic expansion valve to drive the electronic expansion valve, as shown in Figure 4. The electronic expansion valve takes only a few seconds from fully closed to fully open, with fast reaction and action, no static overheating, and the opening and closing characteristics and speed can be set artificially, which is especially suitable for heat pump units with severe working conditions.

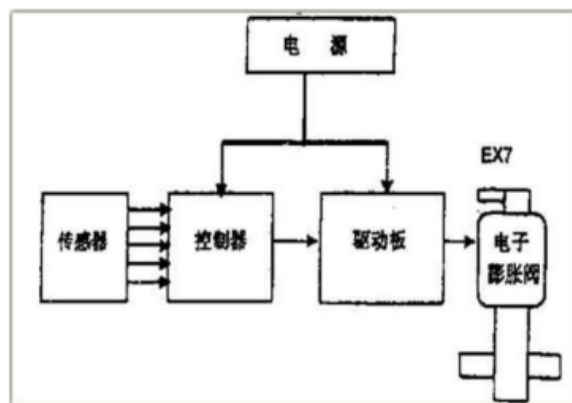


Fig.4 composition of electronic expansion valve control system

#### 4. Diversity of control functions

In order to prevent the compressor from being overloaded due to excessive refrigerant pressure and flow at the evaporation side when the unit is initially started, the general thermal expansion valve is equipped with mop function, that is, the expansion valve is opened only when the evaporation pressure is lower than the set value. However, compared with the electronic expansion valve, its function is still monotonous. The electronic expansion valve can be regarded as an organic combination of throttle mechanism and solenoid valve in structure, and it is adjusted by controller. Therefore, according to different product characteristics, it shows the diversity and superiority of its control function in the cases of unit start-up, load change, defrosting, shutdown and fault protection. For example, the electronic expansion valve can not only control the evaporator, but also adjust the condenser. When the evaporation condition permits, if the condensation pressure is too high, the expansion valve can be properly closed to reduce the refrigerant flow in the system and the condenser load, thus reducing the condensation pressure and realizing the high-efficiency and reliable operation of the unit.

## **Structure and working**

### **principle of thermal expansion**

#### **valve 1. Structure of thermal**

##### **1.expansion valve:**

The top of the expansion valve consists of a sealed box cover corrugated film temperature sensor and a capillary tube, which is filled with freon, which is called an induction mechanism. The refrigerant filled in the induction mechanism can be the same as or different from that in the refrigeration system. The temperature sensing bulb is used to sense the superheated steam temperature at the outlet of the evaporator. As the connecting pipe between the sealed box and the temperature sensing bulb, the capillary tube transmits pressure to the diaphragm.

The wave diaphragm is formed by stamping a thin alloy sheet of about 0.2 mm, and its cross section is wavy. After being stressed, the elastic deformation performance is very good. The adjusting rod is used to adjust the opening superheat of the expansion valve, and it is used to adjust the elasticity of the spring during debugging. When the adjusting rod rotates inward, the spring is compressed, and when the adjusting rod rotates outward, the spring is relaxed. The transmission rod pushes against the valve needle seat and the transmission disc to transmit pressure. The valve needle is installed on the valve needle seat to open or close the valve hole.

##### **2. Working principle of thermal expansion valve**

The expansion valve senses the change of superheat at the outlet end of the evaporator through the temperature sensing bag, which causes the pressure change of the charge in the temperature sensing system and acts on the transmission diaphragm, prompting the diaphragm to move up and down, and then transmits this force to the transmission rod through the transmission diaphragm to push the valve needle to move up and down, so that the valve can be turned down or up, which plays the role of reducing pressure and throttling, automatically adjusts the refrigerant supply of the evaporator and keeps the evaporator outlet end with a certain superheat, thus ensuring the full utilization of the heat transfer area of the evaporator and reducing the phenomenon of liquid hitting the cylinder.

##### **3. Types of expansion valves: (internal balance, external balance)**

The pressure acting on the lower part of the transmission diaphragm in the thermal expansion valve body is the evaporation pressure after throttling, and this structure is called internal balanced expansion valve.

The pressure acting on the lower part of the transmission diaphragm in the thermal expansion valve body is not the evaporation pressure after throttling, but the pressure at the outlet end of the evaporator is introduced into the valve of the lower space structure of the transmission diaphragm through the external balance pipe, which is called the external balance thermal expansion valve.

Compared with the internal balanced expansion valve, the superheat of the external balanced thermal expansion valve is much smaller, so when the external balanced thermal expansion valve is adopted, the heat transfer area of the evaporator can be fully exerted and the effect of the refrigeration device can be improved.

**In the case of small evaporator resistance and small pressure loss, the internal balance thermal expansion valve can be selected; When the evaporation resistance is large, the pressure loss is large or there is a liquid distributor, the external balanced thermal expansion valve should be selected. External balance expansion valve is generally used for distributors.**

**The external balance thermal expansion valve is usually used in special air conditioners. Although the thermal expansion valve is only a small component, it plays an essential role in the refrigeration system, so it is called the four major components of the refrigeration system together with the refrigeration compressor, evaporator and condenser.**