



Chapter Four

Expansion Devices

1. Introduction

Expansion devices is the one of the basic element in the refrigerant cycle. The purpose of expansion devise is reducing the pressure of the liquid refrigerant, and regulating the flow of it to the evaporator. The common types of expansion devices are :

- The capillary tube
- The constant-pressure expansion valve
- The superheat-controlled expansion valve
- The float valve

The most commonly used are: the capillary tube, the constant expansion valve, and the superheat-controlled expansion valve.

13-1 Purpose and types of expansion devices The last of the basic elements in the vapor-compression cycle, after the compressor, condenser, and evaporator, is the expansion device. The purpose of the expansion device is twofold: it must reduce the pressure of the liquid refrigerant, and it must regulate the flow of refrigerant to the evaporator.

This chapter explains the operation of the common types of expansion devices, the *capillary tube*, the *superheat-controlled expansion valve*, the *float valve*, and the *constant-pressure expansion valve*. Operation of a refrigeration system using these devices will be discussed, with special emphasis on balanced and unbalanced flow conditions occurring between the expansion device and the compressor. The two most commonly used expansion devices, the capillary tube and the superheat-controlled expansion valve, are singled out for a more thorough study of their operating characteristics.

Let us illustrates each expansion devices

Constant-pressure expansion valve:

- The constant-pressure expansion valve maintains a constant pressure at its outlet, the entrance to the evaporator.
- It senses the evaporator pressure, and when that pressure drops below the control point, the valve opens wider. When the evaporator pressure rises above the control point, the valve partially closes

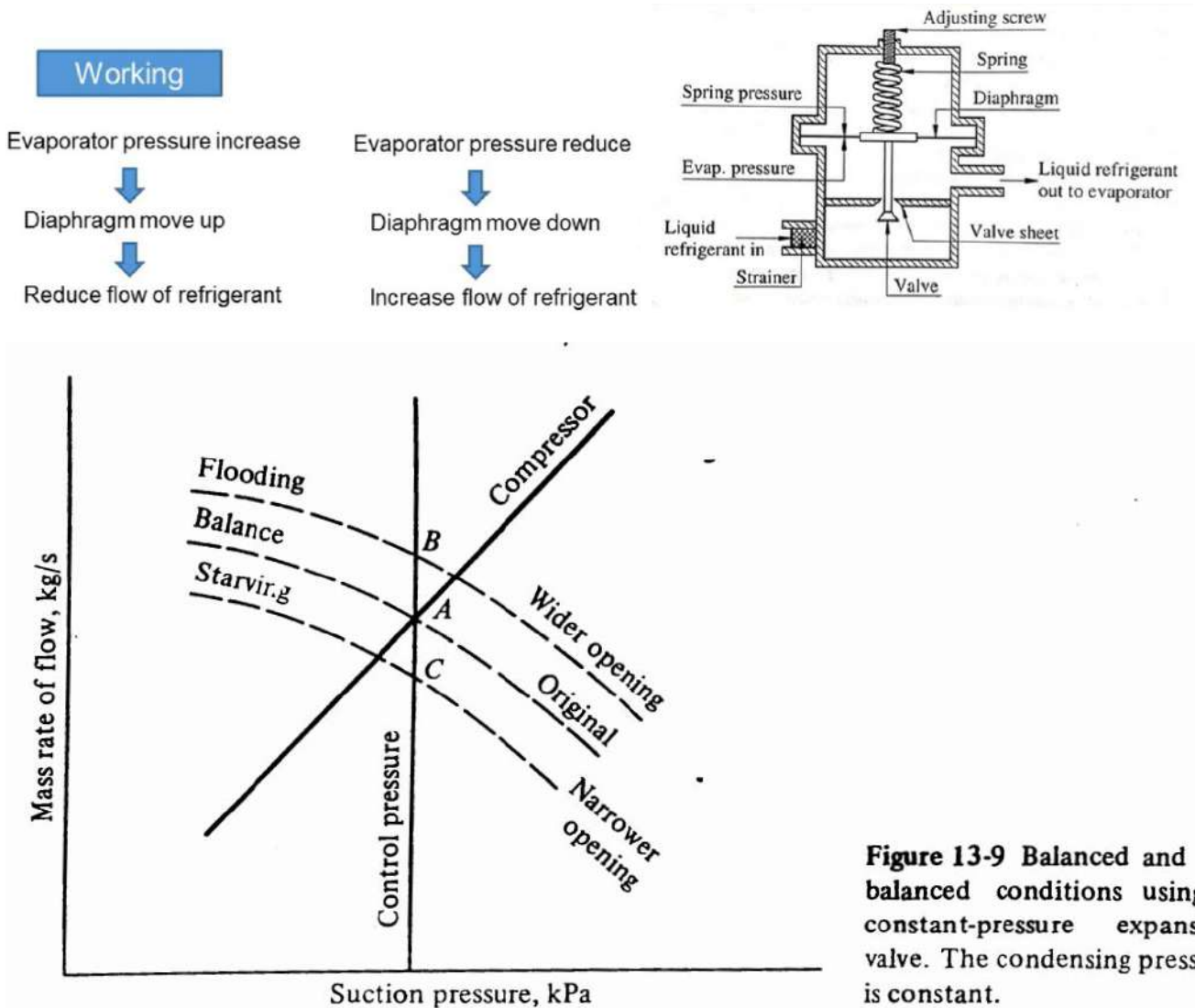


Figure 13-9 Balanced and unbalanced conditions using a constant-pressure expansion valve. The condensing pressure is constant.



The effect of the valve operation on the performance of the system is charted in Fig. 13-9. At a constant condensing pressure the compressor capacity and the feeding capacity of the expansion valve at several degrees of opening of the valve are shown. Point *A* is the balance point, where the expansion valve feeds as much as the compressor pumps from the evaporator. If the refrigeration load drops off, the suction temperature and pressure attempt to drop but the valve resists the drop in pressure by opening wider. Under the new condition the compressor capacity remains at *A*, but the feed rate of the valve changes to *B*. The evaporator will then flood under this unbalanced-flow condition. Starving of the evaporator can occur if the refrigeration load increased and the valve operated at point *C*.

Use of the constant-pressure expansion valve has been limited to systems of refrigerating capacity less than about 30 kW, in which a critical charge of refrigerant is feasible to prevent liquid from flooding out of the evaporator. Its primary use is where the evaporating temperature should be maintained at a certain point to control humidity or to prevent freezing in water coolers. The pressure-limiting characteristic can be used to advantage when protection is required against overload of the compressor due to high suction pressure.

Float valves

- The float valve is a type of expansion valve which maintains the liquid at a constant level in a vessel or an evaporator.
- A float switch which opens completely when the liquid level drops below the control point and closes completely when the level reaches the control point will give the same net performance as a modulating type of float control.
- By maintaining a constant liquid level in the evaporator the float valve always establishes balanced conditions of flow between the compressor and itself. Figure 13-10 shows an original balance point at *A*. If the refrigeration load should increase, the evaporating temperature and pressure rise, which momentarily allows the compressor to pump a greater rate of flow than the valve is feeding. The valve reacts to keep the level constant by widening its average opening. A new balance point occurs at point *B*. If the refrigeration load decreases, the suction pressure drops and the level rises, prompting the valve to close somewhat and give a balance point at *C*. Float valves and float-switch-solenoid combinations are used primarily in large installations. They can regulate the flow to flooded evaporators in response to the level of liquid refrigerant in the shell of the evaporator or in a chamber connected to the evaporator.

They should not be used in continuous-tube evaporators, where it is impossible to establish a level of liquid refrigerant by which they can be controlled.

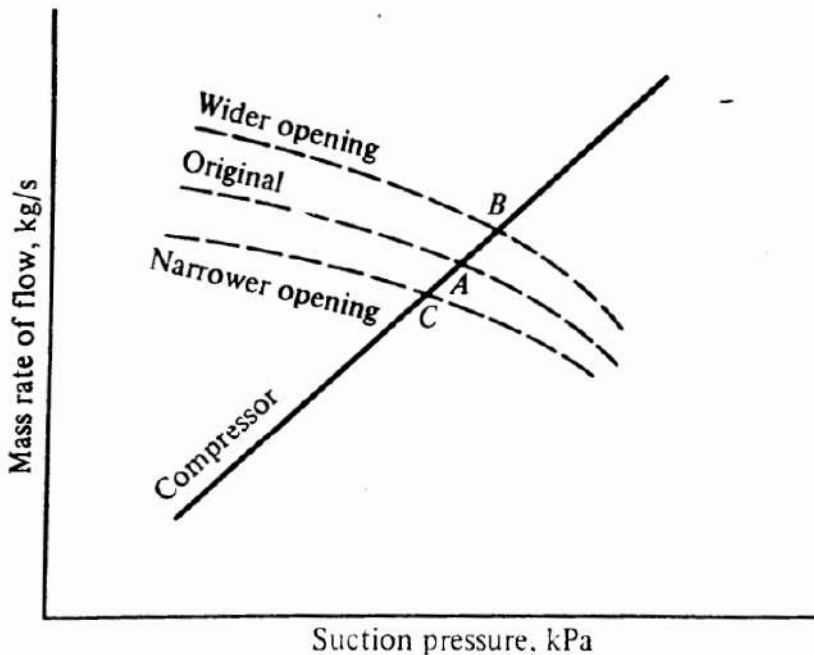


Figure 13-10 Balance points with various load conditions using a float valve. The condensing pressure is constant.

Superheat-controlled (thermostatic) expansion valve

- The most popular type of expansion device for moderate-sized refrigeration systems is the superheat-controlled valve, usually called a thermostatic expansion valve.
- The name may be misleading because control is actuated not by the temperature in the evaporator but by the magnitude of superheat of the suction gas leaving the evaporator.
- The superheat expansion valve regulates the rate of flow of liquid refrigerant in proportion to the rate of evaporation in the evaporator.
- The balances of the flow rate between the compressor and superheat-controlled expansion valve are therefore practically identical to those shown for the float valve in Fig. 13-10. Figure 13-11 is a photograph of a thermostatic expansion valve.
- The superheat of the suction gas operates the thermostatic expansion valve as follows. A feeler bulb (Fig. 13-12) is partially filled with liquid of the same refrigerant as that used in the system. The fluid in the bulb is called the power fluid. The feeler bulb is clamped to the outlet of the evaporator so that the bulb and the power fluid closely

assume the temperature of the suction gas. The pressure of the power fluid bears on the top of the diaphragm, and the evaporator pressure pushes on the bottom of the diaphragm. A slight force exerted by the spring on the valve stem keeps the valve closed until the pressure above the diaphragm overcomes the spring force plus the force of the evaporator pressure. For the pressure above the diaphragm to be higher than the pressure below the diaphragm, the power fluid must be at a temperature higher than the saturation temperature in the evaporator. The suction gas must therefore be superheated in order to bring the power fluid up to the pressure which opens the valve.

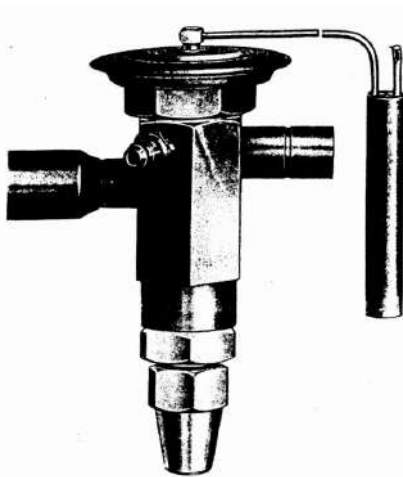


Figure 13-11 A thermostatic expansion valve. (Sporlan Valve Co.)

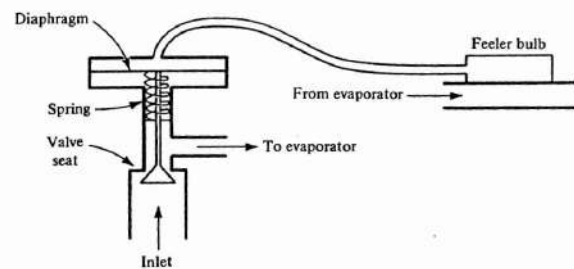
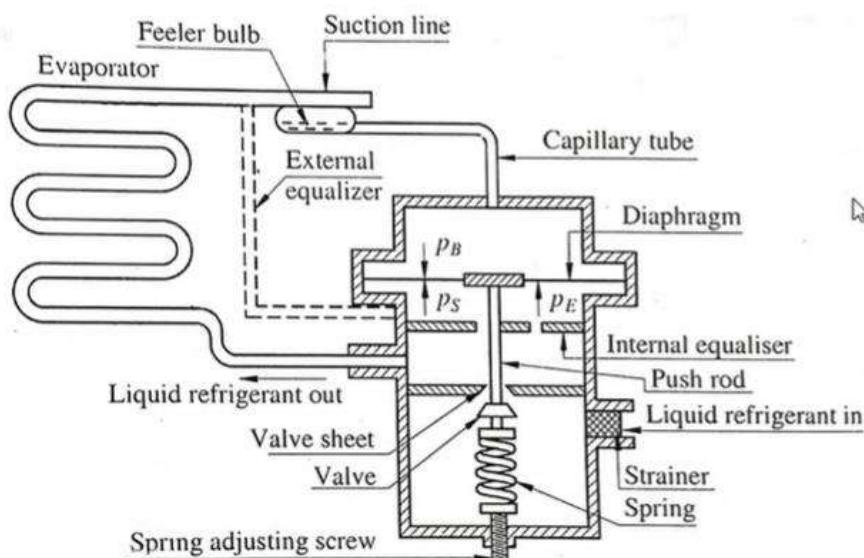


Figure 13-12 A schematic diagram of the basic superheat-controlled expansion valve.



Electric expansion valves

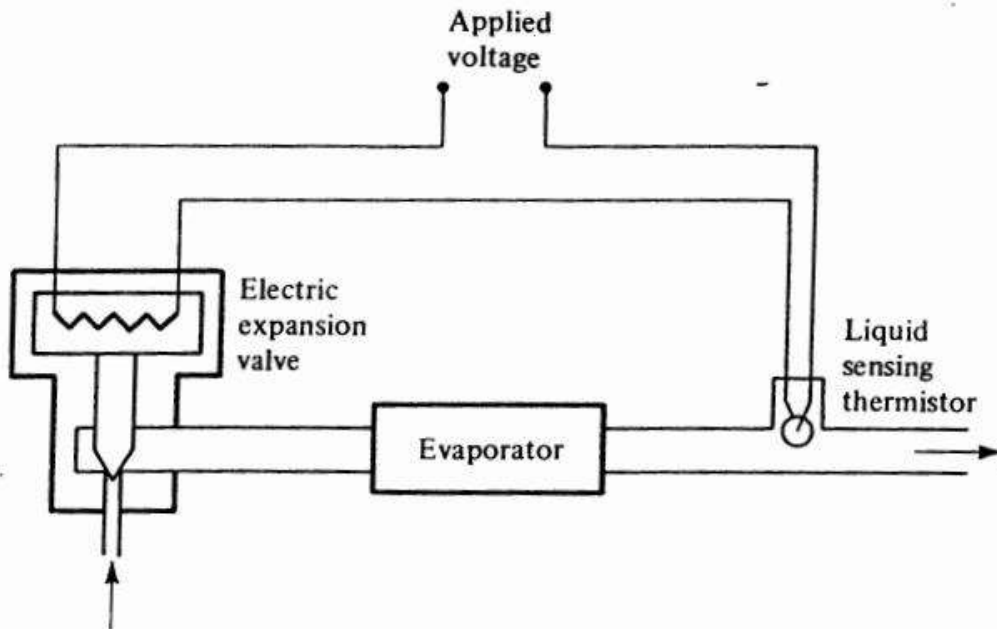


Figure 13-17 An electric expansion valve.

13-12 Electric expansion valves The electric expansion valve, shown schematically in Fig. 13-17, uses a thermistor to sense the presence of liquid in the outlet stream of the evaporator. When no liquid is present, the temperature of the thermistor increases, which drops its resistance and permits a greater current flow through the heater at the valve. The valve is thereby opened, allowing an increased refrigerant flow rate. One of the applications of the electric expansion valve is for heat pumps (Chap. 18), where the flow rate of refrigerant is reversed in order to change from heating to cooling. Since its control is independent of refrigerant pressures, the electric expansion valve can function with flow through the valve in either direction.