KAMPALA INTERNATIONAL UNIVERSITY

EXPLORING THE HEIGHTS

MEC4111: REFREGERATION AND AIRCONDITION I

STUDY 1: THERMOSTATIC EXPANSION VALVE

1.0 INTRODUCTION

Thermostatic Expansion Valve

The thermal expansion valve usually abbreviated as TEV or TXV is used for refrigerant flow control and operates at varying pressures resulting from varying temperatures. This valve maintains constant superheat in the ac evaporator.

1.1 PRINCIPLE OF TEV/TXV

The thermostatic expansion valve **REQUIRES** a capillary tube and thermal element (bulb) for its operation. The capillary tube links the heating element to the top of the TXV diaphragm as shown below:

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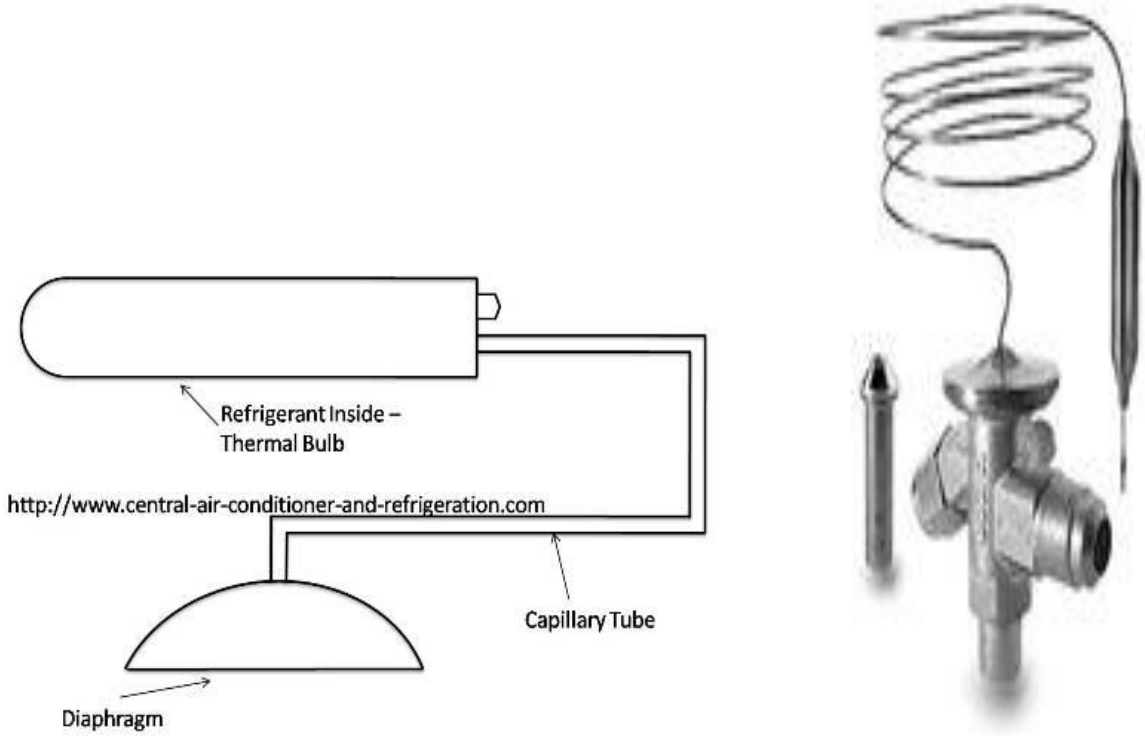
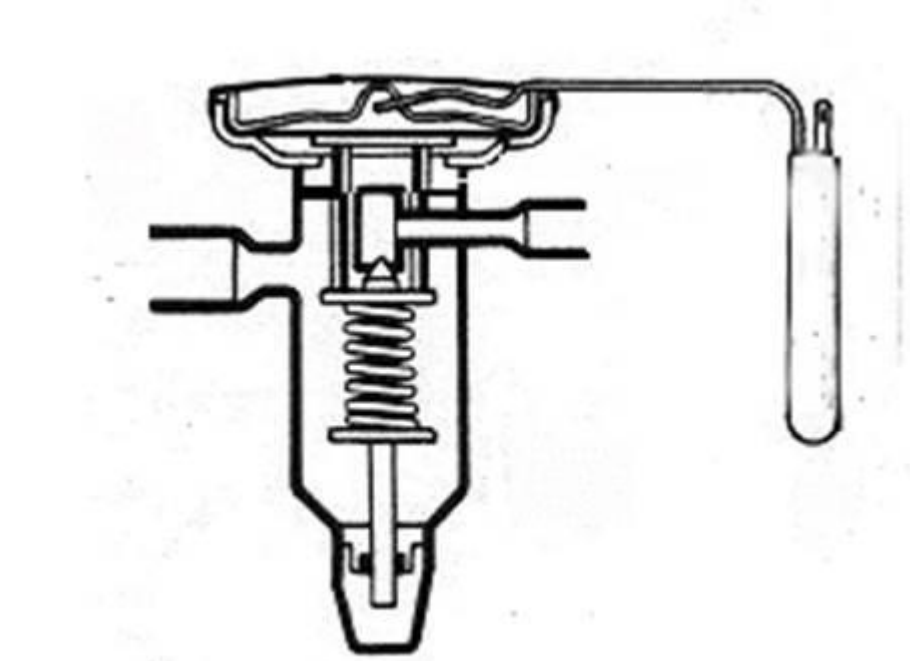


Fig. 1: TEV

The element (sensing bulb or thermal bulb) is partly filled with a liquid refrigerant (usually the same refrigerant used in the system) and maintains some liquid under all conditions of temperature and load.

A cross-section of a thermostatic expansion valve components and the operation principle is showing below.



Courtesy Singer Controls Division

The three forces which control the operation of the thermal expansion valve are:

P1 – The vapor pressure of the thermostatic element (a reaction to the bulb temperature) which acts to open the valve.

P2 – The evaporator pressure which acts in a closing direction below the diaphragm.

P3 – The pressure equivalent of the superheat spring force which is also applied underneath the diaphragm in a closing force.

At any constant operating condition, these forces are balanced. Therefore, P1=P2+P3

When a change in temperature in the suction line occurs, the pressure in the thermal bulb also changes similarly. With an increased heat load, the refrigerant in the evaporator coil boils fast.

This results in a rise in temperature at the thermal bulb because of superheating. The higher temperature produces an increase in pressure within the thermal bulb due to superheating.

The higher temperature produces an increase in pressure within the thermal bulb which increases the pressure at P1. The pressure in the evaporator at P2 and the spring pressure in the TEV at P3 remains constant.

Therefore, with the increased pressure at P1, the bellows (diaphragm) expands to force a wider valve opening. As a result, more refrigerant is allowed to enter the evaporator to compensate for the increased heat load.

The increase in flow rate increases to evaporator pressure P2, which establishes a balance control once again. With a decreased load the reverse cycle takes place.

Thermostatic expansion valve or TEV is one of the most commonly used throttling devices in the refrigerator and air conditioning systems. The thermostatic expansion valve is the automatic valve that maintains the proper flow of the refrigerant in the evaporator as per the load inside the evaporator. If the load inside the evaporator is higher it allows the increased inflow of the refrigerant and when the load reduces it allows the reduction in the flow of the refrigerant. This leads to the highly efficient working of the compressor and the whole refrigeration and the air conditioning plant.

The thermostatic expansion valve also prevents the flooding of the refrigerant to the compressor ensuring that the plant would run safely without any risk of breakage of the compressor due to compression of the liquid. The thermostatic expansion valve does not control the temperature inside the evaporator and it does not vary the temperature inside the evaporator as its name may suggest.

Beside the capillary tube, the thermostatic expansion valve is used widely in the refrigeration and air conditioning systems. While the capillary tube is used in the small domestic systems, the thermostatic expansion valve is used in the systems of higher capacities. It is commonly used in industrial refrigeration plants, high-capacity split air conditioners, packaged air conditioners, central air conditioners, and many other systems.

1.2 THE CAPACITY OF TEV

The capacity of a TXV differs due to orifice size, the pressure difference between the high and low side, and the temperature and condition of the refrigerant in the liquid line.

The amount of liquid that will flash to vapor will increase with a rise in liquid line temperature. The capacity of most valves, however, may be determined by the orifice size and needle assembly. The body size remains the same for many capacities.

Thermostatic expansion valves are rated in a ton of refrigeration. However, three different tonnage capacities are usually provided for the same orifice. The range of capacity depends on the difference in pressure between the high and the low side of the system.

Using the appropriate capacity valve is very important. If the valve orifice is too small, the evaporator will be starved regardless of the superheat setting. The full capacity of the evaporator will never be obtained.

If the valve orifice is oversized, too much refrigerant will pass into the evaporator and the suction line will sweat or frost before the thermal element can close the valve.

The thermostatic expansion valve is one of the most commonly used throttling devices in refrigeration and air conditioning systems. Let us see the details of this valve that automatically maintains the flow of the refrigerant inside the evaporator.

1.3 FUNCTIONS OF TEV

The thermostatic expansion valve performs the following functions:

1) Reduce the pressure of the refrigerant: The first and foremost function of the thermostatic expansion valve is to reduce the pressure of the refrigerant from the condenser pressure to the evaporator pressure. In the condenser, the refrigerant is very high pressure. The thermostatic expansion valve has a constriction or orifice due to which the pressure of the refrigerant passing through it drops down suddenly to the level of the evaporator pressure. Due to this the temperature of the refrigerant also drops down suddenly and it produces a cooling effect inside the evaporator.

2) Keep the evaporator active: The thermostatic expansion valve allows the flow of the refrigerant as per the cooling load inside it. At higher loads, the flow of the refrigerant is increased and at the lower loads, the flow is reduced. It won't happen that the load on the evaporator is high and the flow of the refrigerant is low thereby reducing the capacity of the evaporator. The thermostatic expansion valve allows the evaporator to run as per the requirements and there won't be any wastage of the capacity of the evaporator. The TEV constantly modulates the flow to maintain the superheat for which it has been adjusted.

3) Allow the flow of the refrigerant as per the requirements: This is another important function of the thermostatic expansion valve. It allows the flow of the refrigerant to the evaporator as per the load on it. This prevents the flooding of the liquid refrigerant to the compressor and efficient working of the evaporator and the compressor and the whole refrigeration plant.

1.4 ADVANTAGES OF TEV

As it is obvious from the above discussion the advantages of the thermostatic expansion valve are:

1) The TEV maintains the flow of the refrigerant to the evaporator as per the load inside. Thus the refrigeration or the air conditioning plant can run to the optimum capacity as per the requirements.

2) The TEV keeps the evaporator fully active and helps to get the optimum cooling effect from it.

3) Since the entire refrigerant in the evaporator gets vaporized the chances of the liquid refrigerant particles going to the compressor are reduced. This reduces the chances of the breakdown of the compressor due to compression of the liquid.

4) The compressor can also work at the optimum capacity as per the refrigeration load on the system. If the load is lesser it has to compress the refrigerant and work on lesser capacity thus absorbing lesser electric power. If the load is higher it can work at higher capacities.

1.5 TYPES OF TEV

There are two types of thermostatic expansion valves:

1) Internally equalized thermostatic expansion valves
2) Externally equalized thermostatic expansion valves

1.6 THE DIFFERENCES BETWEEN THE TWO TPYEPS OF TEV

1. Internally equalized valves can be used on a single current evaporator coil having low-pressure drops while externally equalized valves must be utilized on a single circuit evaporator with refrigerant distributors

2. Internally equalized valves can be replaced by externally equalized valve while externally equalized valve cannot be substituted; however, can be used on all applications.

3. In internally equalized valves, the pressure of the evaporator against the diaphragm is the same as the pressure at the inlet of the evaporator while in externally equalized the evaporator pressure against the diagraphm is the pressure at the outlet of the evaporator

REFERENCE

1) Book: Basic Refrigeration and Air Conditioning by P. N. Ananthanarayanan, Second Edition, Tata Mc-Graw-Hill Publishing Company Limited

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