Experiment No: 04

Aim: ***To study different controls used in refrigeration and air conditioning equipments for better performance.***

Theory: For efficient and safe working of refrigeration and air conditioning systems different control devices are used these are listed as below.

1. Flow control devices.
2. Safety devices.
3. Air conditioning controls.

1. Flow Control devices:

The major devices under this category air the expansion devices. The purpose of the expansion devices is twofold: it must reduce the pressure of the liquid refrigerant, and it must regulate the flow of refrigerant to the Evaporator.

An expansion device offers a resistance to flow so that the pressure drops resulting in a throttling process. Basically there are two types of expansion devices these are:

1. Variable restriction type
2. Constant restriction type

In the variable restriction type the extent of opening or area of flow keeps on changing depending on the type of control. There are two common types of such control devices viz,

a) Thermostatic expansion valve. b) Automatic expansion valve.

a. Thermostatic Expansion value (TEV):

The name may give an impression that it is a temperature control device. It is not a temperature control device and it cannot be adjusted and used to vary evaporator temperature. Actually TEV is a throttling device which works automatically maintaining proper and correct liquid flow as per the dictates of the load on the evaporator. Because of automatic operation, high efficiency and ability to prevent liquid flood backs this value is extensively used.

P_1 = Thermostatic Elements Pressure

P_2 = Evaporator Pressure

P_3 = Pressure Equivalent of the Superheat Spring Force

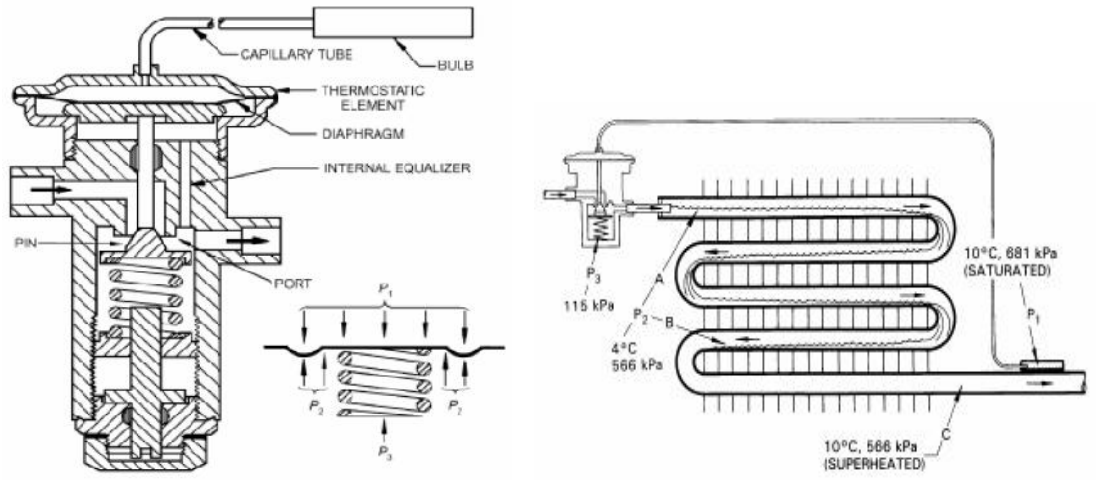

Fig.1 Thermostatic Expansion Valve

The functions of thermostatic expansion value are:

1. To reduce the pressure of the liquid from the condenser pressure to evaporator pressure.
2. To keep the evaporator fully active.
3. To modulate the flow of liquid to the evaporator according to the load requirement of the evaporator so as to prevent flood back of liquid refrigerant to the compressor.
4. Pressure P1 in the power element acts to open the valve i.e. to move the value needle away from its seat.
5. The evaporator pressure P2 acts an the bottom side of the diaphragm of the power element tending to close the value.
6. Pressure P3 of the superheat spring also assist in the closing action. Therefore if the power element pressure P1 is greater then the constrained pressure of P2 and P3, the value will open.

It does last two functions by maintaining a constant superheat of the refrigerant at the outlet of the evaporator it would be more appropriate to call it a "constant

superheat valve". The important parts of the valve are power element with feeler bulb, value seat, needle and a superheat adjustment spring. The power element is charged with a refrigerant.

The operation of the valve i.e. the closing and opening of the value is controlled by there basic forces. The force balance is shown in fig.

b. Automatic Expansion Valve:

AEV is also called as constant pressure expansion value. As name implies it maintains a constant pressure in the evaporator. It works on the same principle as the pressure reducing valves used in compressed air lines, oxyacetylene cylinders etc. A schematic diagram of the constant pressure Expansion. Valve is shown in fig.

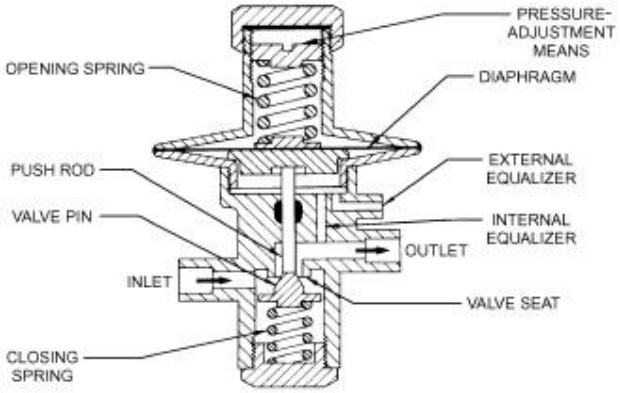

Fig.2 Automatic Expansion Valve

The valve consists of seat and needle- which forms the orifice, a metallic diaphragm or bellow, spring and an adjusting screw. The spring pressure and the atmospheric pressure acts on top of the diaphragm, thereby moving the needle a way from it seat that is moving the needle valve in the opening direction. The evaporator pressure acts below the diaphragm moving the needle valve towards the closing position. Thus the evaporator pressure and spring pressure oppose each other and whichever is greater will determine the position of the needle with respect to the seat.

When the plant is running the value maintain an evaporator pressure in equilibrium with the spring pressure plus atmospheric pressure. The tension of the spring can be varied by the spring adjusting screw. The value operates automatically to maintain a constant evaporator pressure as per the setting of the spring pressure.

By adjusting the tension of the spring, the evaporator pressure can be varied. Once a setting is made, the valve functions to maintain a constant evaporator pressure. Hence it is called the constant pressure expansion valve".

Once the plant stops, the evaporator pressure increases due to the vaporization of the liquid left in the evaporator. This increase in pressure acts on the diaphragm against the spring pressure and closes the valve tightly. It remains closed until the compressor start again and reduces the pressure in the evaporator. This is a big advantage.

2. Constant Restriction Type:

The capillary tube, a long tube with very small bore comes under constant restriction type expansion devices. The capillary tube is a fixed restriction type device. It is a long narrow tube connecting the condenser directly to the evaporator. The pressure drop through the capillary tube is due to the following reasons:

1. Friction due to fluid viscosity, resulting in frictional pressure drop.
2. Acceleration, due to the flashing of the liquid refrigerant into vapour resulting in momentum pressure drop.

The mass flow through the capillary tube will, therefore be adjusted so that the pressure drop through the tube just equals the difference in pressure between the condenser and evaporator. For a given state of the refrigerant, the pressure drop is directly proportioned to the length and inversely proportional to the bore diameter of the tube. A number of combinations of length and bore are possible for a capillary tube to obtain the desired flow and pressure drop. However, once a capillary tube has been selected, it will be suitable only for the designed pressure drop and flow. It cannot satisfy the flow requirements with changing condenser and evaporator pressures. Even then it is most commonly used

expansion device in small refrigeration units such as domestic refrigerators, window A/C, water coolers, etc. The advantages of a capillary tube are its quite working, simplicity, low cost and absence of any moving part. Also it is found most suitable with on-off control because of its unloading characteristics. Thus when compressor stops it allow high and low pressure to equalize, thereby enabling the compressor motor to restart on no load. Accordingly lower starting torque motors can be used.

2.SAFETY DEVICES:

1. High pressure and low pressure cut-out:

Refrigerant compressors are provided with high pressure (HP) and low pressure (LP) cut outs. High pressure cut-out is merely a safety control. When the head pressure increases beyond a set point, the HP cutout cycles off the compressor in order to avoid the possible damage to the compressor. When the head pressure subsequently drops, the circuit is one again closed and the compressor starts. Because of the possibility of scale formation in condenser tubes and the failure of water supply high pressure cutout are essential in the system with water cooled condensers. These cutouts require manual setting.

The low-pressure cutout is used both as safety control as well as temperature control. The evaporator governs the suction pressure. A low-pressure cutout is actuated by change in suction pressure and can be indirectly used to control the evaporator temperature.

3. Starting relays:

The relays are generally used in hermetic type units. It allows the flow of electricity through the starting winding of the motor and disconnects the starting winding or starting capacitor from the circuit when the motor reaches 75% of its rated speed.

There are two types starting relays.

- Current relay
- Voltage relay.

01. Current relay:

The current relay is used primarily with capacitor start induction motors for disconnecting the starting winding and starting capacitor from the circuit. It is a Magnetic

type relay and actuated by the change of current flow in running winding during starting and running periods of motor.

It consists of few turns of copper wire in which soft iron plunger is free to more up and down. This soft iron plunger is free to more up and down. This soft iron plunger may be called electronic net. It is connected in series with the running winding and the contact points, which are fitted near the electromagnet, are connected in series with the current relays with the starting winding.

When the motor is energized, the current flow through the relay in the running winding. In the starting, the magnetic field produces around the relay and attracts the plunger to close the contact thus energizing the stating winding. The speed of the motor increases gradually and when it reaches 75% of its rated speed, the motor current and magnetic field of the relay decreases. Permitting the contact points to open. Then motor runs on running winding alone.

2. Voltage Relay:

The voltage relay is growing in popularity, especially in the larger units. Its operation depends on the increase in voltage as a unit approaches and reaches its rated speed. In construction, the voltage coil made of many turns of wire as compared with current coil which is made of few turns of heavy wire and is connected parallel with starting winding. A set of content points are connected in series with the starting capacitor and closed when the motor is at rest.

When the supply is connected to the motor, the motor starts up and increases its speed then the voltage in the starting winding increases along the line voltage because of capacitor in service with this winding. The higher voltage creates more in magnetism in the relay coil, which attracts the plunger, the contact point opens and disconnect the starting capacitor from the circuit.