Module 2: Fixed Orifice Tube and Thermal Expansion Valve Air Conditioning

Fixed Orifice Tube Air-Conditioning System

READY FOR REVIEW

- Fixed orifice tube system components
  - Condenser
  - Evaporator
  - Compressor
  - Orifice tube
  - Accumulator
  - Connecting pipes and hoses
  - Thermostat
  - Blower fans
  - Pressure switches
- Orifice tube
  - Located between the condenser and the evaporator
  - Provides the restriction to flow necessary for system operation
- Switching on the air-conditioning system
  - The electromagnetic clutch is energized on the compressor drive plate.
  - The compressor is driven by the engine crankshaft.
- Flow of vaporized refrigerant
  - Drawn from the low-pressure side of the system by the compressor
- From the compressor to the condenser
  - Discharged from the compressor as high-pressure, high-temperature vapor
  - Flows to the condenser
  - Cooled by air flowing across the condenser coils and fins
- Condensation
  - A reduction in temperature causes the refrigerant vapor to condense.
  - Turns into liquid, which flows to the filter and then to the orifice tube
- Loss of pressure
  - Liquid refrigerant loses pressure by flowing through the fine tube.
  - Forced to expand suddenly by passing through the nozzle
  - Enters a larger volume of the evaporator
- Boiling and evaporating
  - A drop in pressure causes the low-pressure, low-temperature liquid to boil.
  - Liquid mist evaporates rapidly in the evaporator coils.
  - Absorbs heat from air passing across the external fins
- Cooled air to the vehicle interior
  - Cooled air is directed to the interior of the vehicle by blower fans.
  - Refrigerant in the evaporator flows on to the accumulator.
- Accumulator
  - Acts as a storage volume for the refrigerant
  - Separates the liquid from the vapor
- Refrigerant vapor enters the accumulator.
  - Enters at the top of the accumulator
  - Any liquid refrigerant falls to the bottom.
- Final evaporation
  - The accumulator is made from aluminum and has a large surface area.
  - Assists the final evaporation of any liquid refrigerant leaving the evaporator
- Drawn through the outlet tube
  - Refrigerant vapor is drawn off from the top of the accumulator through the outlet tube by the compressor.
- Hole in the outlet tube
  - Small hole at the bottom of the outlet tube
  - For small amounts of lubricating oil that settle at the bottom of the accumulator
  - Drawn to the compressor
- Accumulator filters and desiccants
  - The accumulator contains filters and desiccants.
  - Removes impurities and moisture from refrigerant passing through

Control Devices

READY FOR REVIEW

- Purpose of control devices
  - To ensure maximum efficiency
  - To protect components from damage
- Thermostat
  - Used to sense the temperature of evaporator fins
  - Helps ensure that the temperature does not drop below 33.8°F (1°C)
  - If it drops to 32°F (0°C) or less, moisture condensing out of the air will freeze on the unit.
  - Will block the flow through the evaporator
- When the temperature of the fins drops
  - The fins of the evaporator drop to 33.8°F (1°C).
  - The thermostat contacts open.
  - Breaks the electrical circuit to the compressor clutch
  - Stops the compressor from circulating refrigerant
- When the temperature rises
  - The evaporator temperature rises to about 39.2°F (4°C).
  - The thermostat contacts close.
  - The electrical circuit to the compressor clutch is restored.
- Heat load increases.
  - The fixed orifice tube cannot alter the amount of refrigerant entering the evaporator.
  - Therefore, extra cooling is required and heat load on the system increases.
  - The compressor cycles on for longer periods.
- Heat load decreases.
  - As heat load decreases, the compressor cycles off for longer.
- Cycling
  - Cycling adjusts the system to the heat load.
- High-pressure switch system protection
  - System protection is needed against high pressures.
  - Provided by the high-pressure switch
  - Mounted in the high-pressure line between the condenser and the orifice tube
- High temperatures and pressures
  - May develop if the condenser is unable to transfer its heat effectively to the outside air
  - May be due to blockage of the condenser fins or an inoperative electric fan
- High-pressure switch
  - If this occurs, the high-pressure switch open-circuits the compressor clutch.
  - Prevents the compressor from circulating refrigerant
- If a leak develops
  - A leak may develop and refrigerant is low in charge.
  - The system pressure falls below a set value.
  - The low-pressure switch on the low-pressure side of the system turns the compressor off.
- Lubricating oil
  - A lack of lubricating oil can damage the compressor.
  - Carried around the system by refrigerant
  - Prevents damage to the compressor

Thermostatic Expansion Valve System

READY FOR REVIEW

- Components of the system
  - Condenser
  - Evaporator
  - Compressor
  - Receiver drier
  - Thermostatic expansion valve
  - Connecting pipes and hoses
  - Thermostat
  - Blower fans
  - Pressure switches
- Thermostatic expansion valve
  - Also called a TX valve
  - Located at the entry to the evaporator
  - Provides a throttling or restricting function to control the quantity of refrigerant entering the evaporator
  - Also provides for the complete vaporization of all liquid refrigerant entering the evaporator
- Refrigerant and lubricating oil
  - The system is charged with refrigerant.
  - Also charged with lubricating oil
  - Circulates with refrigerant at all times
- The air-conditioning system is switched on.
  - The electromagnetic clutch is energized on the compressor drive plate.
  - The compressor is driven by the engine crankshaft.
- Vaporized refrigerant is drawn in.
  - Drawn in from the low-pressure side of the system by the intake side of the compressor
- Discharged from the compressor
  - Discharged from the compressor as high-pressure, high-temperature vapor

- Flows to the condenser
- Cooled by air flowing across the condenser coils and fins

- Condensation and flow to the receiver drier
  - A reduction in temperature causes refrigerant vapor to condense.
  - Turns into liquid, which flows to the receiver drier
- Receiver drier
  - Acts as a storage volume for liquid refrigerant
  - Contains a filter and desiccant (drying material)
- Flow to reach the pick-up tube and TX valve
  - Liquid refrigerant passes through the filter and desiccant.
  - Reaches the pick-up tube
  - Flows on to the TX valve

Thermal Expansion Valves

READY FOR REVIEW

- TX valve
  - Determines the amount of liquid refrigerant flow
  - A spring-loaded valve is controlled by different pressures on each side of the connecting diaphragm.
- Pressure in the chamber "A" side of the valve
  - Determined by the temperature sensing bulb
  - The bulb is taped to the evaporator outlet.
  - Insulated from air temperatures
- Sensing bulb
  - Filled with refrigerant
  - Connected to chamber "A" by the capillary tube
  - The temperature at the evaporator outlet determines the pressure in the bulb.
- Higher temperatures
  - Will give higher pressures
  - Will tend to open the TX valve wider
  - Allow more refrigerant to flow through
- Lower temperatures
  - Will give lower pressures
  - Will tend to close the TX valve
  - Reduce the flow of refrigerant
- Pressure in the chamber "B" side of the valve
  - Determined by the refrigerant pressure in the evaporator
  - Also determined by the force supplied from the valve spring
  - The spring is often called the superheat spring.
- Superheat spring
  - Designed to ensure that the temperature of refrigerant leaving the evaporator is between 35.6°F to 48.2°F (2°C to 9°C) higher than the boiling point of refrigerant at the current operating pressure
- Superheat
  - The difference in temperature is called "superheat."
  - Ensures that all liquid refrigerant entering the evaporator is vaporized before leaving
- When the compressor switches on
  - Suction from the compressor removes refrigerant vapor from the evaporator.
  - Lowers its pressure
- Changes in pressure
  - Reduces pressure in chamber "B"
  - Allows pressure in chamber "A" to move the valve away from its seat by action of the diaphragm
  - High-pressure liquid flows through the orifice.
  - Enters the evaporator as low-pressure liquid
- Liquid expansion and then vaporization
  - Liquid expands into the larger volume of the evaporator.
  - Causes a reduction in its pressure
  - Heat from the air passes over the evaporator fins.
  - Both actions cause liquid to vaporize.
- Low temperature of refrigerant leaving the evaporator
  - Interpreted by a sensing bulb attached to the outlet
  - If the temperature is low, refrigerant in the sensing bulb will contract.
  - Pressure in chamber "A" of the TX valve will reduce.
- Diaphragm movement
  - The diaphragm moves and the valve moves towards the valve seat.
  - Reduces the quantity of refrigerant entering the evaporator
- High temperature of refrigerant leaving the evaporator
  - Refrigerant in the sensing bulb expands.
  - Exerts more pressure in chamber "A"
  - Causes the valve to move away from its seat
  - Allows more refrigerant to enter the evaporator
- Amount of refrigerant flow
  - Depends on the quantity of heat to be removed from air passing over the evaporator fins
  - More heat means more refrigerant is required to remove it.
  - Less heat means less refrigerant is required.
- Control devices
  - Fitted into the system
  - Ensure maximum efficiency
  - Operate as described in the section on the fixed orifice system