Module 3: Air-Conditioning Components

- AIR-CONDITIONING COMPRESSORS
- CONDENSERS AND EVAPORATORS
- RECEIVER DRIER
- LINES, OR PIPES, AND HOSES
- THERMAL EXPANSION (TX) VALVE CONSTRUCTION
- TEMPERATURE-MONITORING THERMOSTAT
- REFRIGERANTS
- PRESSURE SWITCHES
- HEATING ELEMENTS

Air-Conditioning Compressors

READY FOR REVIEW

- Function of the compressor
  - Circulates refrigerant through the air-conditioning system
  - Normally driven by a belt from the engine crankshaft
- Four basic types
  - Reciprocating piston
  - Rotary vane
  - Scroll
  - Axial piston
- Axial piston type
  - One of the most common types used
- Cylinders
  - Placed around the drive shaft and parallel to the axis
  - Each cylinder has a doubled-ended piston.
  - Allows a separate pumping chamber at each end of the cylinder
- Pumping chambers and valves
  - Each pumping chamber has a set of inlet and discharge valves.
  - Inlet reed valves are connected to the inlet port of the compressor by drillings.
  - Discharge valves are connected to the discharge port by drillings.
- Swash plate
  - Attached to the drive plate at an angle
  - Rotation of the drive shaft causes the outer edge of the swash plate to constantly change its linear position.
- Pistons
  - Connected to the outer edge of the swash plate by swiveling ball joints
  - The action of the plate and ball joints continually moves the pistons back and forth in the cylinder.
- Inlet reed valves
  - The volume above the piston increases.
    - Refrigerant is drawn into the cylinder through the inlet reed valves.
  - The volume above the piston reduces.
    - Refrigerant is forced out of the cylinder through the discharge reed valves.
- Intake and discharge strokes
  - One end of the cylinder is on an intake stroke.
  - The other end is on a discharge stroke.
  - Dual pumping action
  - Occurs in each cylinder during each revolution of the crankshaft

Condensers and Evaporators

READY FOR REVIEW

- Condenser function
  - Transfers heat from the high-pressure, high-temperature refrigerant to the outside air
- Condenser positioning
  - Normally positioned in front of the radiator
  - Exposed to maximum ram air flow when the vehicle is in motion
- Assisted air flow
  - Air flow is assisted by the engine cooling fan or by the auxiliary electric fan.
  - Needed to create sufficient air flow when the vehicle is stationary
- Condenser construction
  - Usually made as a continuous coil of thin tube
  - Meshed with a compact series of fins surrounding it
- Purpose of the fins
  - Fins increase the surface area available.
  - Maximize the amount of heat transferred from refrigerant to the outside air
- Evaporator mounting
  - Mounted in the passenger compartment
  - Positioned so air from the cabin interior passes across the external surface
- Evaporator construction
  - Normally constructed of an aluminum tube
  - Fins are attached to increase the surface area.
  - Maximizes the rate of heat removal from the air

Receiver Drier

READY FOR REVIEW

- Sealed metal canister containing:
  - Filters to remove impurities
  - Desiccants to absorb moisture
- Flow in the receiver dryer
  - High-pressure liquid enters the receiver drier.
  - Passes down through the filter and desiccant material
  - Exits via the pick-up tube at the bottom of the canister
  - Moves on to the expansion valve

Lines, or Pipes, and Hoses

READY FOR REVIEW

- Role in the system
  - To carry refrigerant between the air-conditioning system components
  - Special types of hoses and pipes are needed.
- Why special types of hoses and lines?
  - Can withstand high pressures and temperatures found inside the system
  - Able to flex and withstand vibrations and movement of the engine
- Hoses
  - Used to connect the inlet and outlet ports of the compressor to the air-conditioning system
- Hose connections
  - Crimped to the hose
  - Use special unions
  - Must be carefully assembled to avoid leaks
- Pipes or lines
  - Rigid tubes of metal
  - Often found connecting components fixed to the body of the vehicle
- Pipe bends
  - All pipes must have properly formed bends.
  - Must be secured to the vehicle body to prevent fatigue cracks
- Pipe connections
  - Flared flanges
  - Threaded unions are welded to the pipe.

Thermal Expansion (TX) Valve Construction

READY FOR REVIEW

- TX valve
  - Controls the amount of refrigerant entering the evaporator coils
  - Causes a drop in pressure without causing a change of state
  - Constructed of cadmium-plated steel or aluminum
  - Three commonly used types:
    - Internally equalized
    - Externally equalized
    - H block

Temperature-Monitoring Thermostat

READY FOR REVIEW

- Warm air and cooling action
  - Warm air passes across the evaporator fins.
  - The cooling action causes water vapor in the air to condense.
  - Adheres to the fins in the form of water droplets
- Drop in temperature
  - If the temperature of the fins drops to 32°F (0°C) or lower, ice forms on the fins.
  - Restricts air flow
  - Prevents heat transfer to the refrigerant
- Temperature monitoring
  - A thermostat is used to monitor the temperature of the evaporator fins.
  - Controls the system operation within set limits
- Bellows type
  - The capillary tube is placed about 1 inch (25 mm) into the evaporator core.
  - Contacts the fins
- Capillary tube, bellows, and pressure
  - The capillary tube and bellows are sealed and filled with temperature-sensitive fluid.
  - The fluid expands and contracts with the temperature changes.
  - Increases or decreases pressure in the bellows
- Bellows and electrical circuit
  - The bellows is positioned to open and close the set of contacts.
  - The contacts form part of the electrical circuit to the compressor clutch.

- Springs and thermostat housing
  - Springs connect the bellows contact frame and thermostat housing.
  - Try to keep the contacts open.
  - Pressure in the bellows tries to force the contacts closed.
- The temperature falls below the minimum setting.
  - The temperature at the evaporator fins falls below the minimum setting.
  - The fluid in the capillary tube contracts.
  - Reduces the size of the bellows
- Springs move to open the contacts.
  - Springs are mounted on the pivoted frame.
  - Move the frame to open the contacts.
  - Break the electrical supply to the compressor clutch.
- Refrigerant stops circulating.
  - The compressor stops circulating refrigerant around the system.
  - The temperature of the evaporator fins begins to rise.
- Increased temperature and pressure
  - Increased temperature is applied to the fluid in the capillary tube.
  - Causes an increase in pressure at the bellows
- The bellows acts to close the contacts.
  - The bellows pushes on the pivoted frame against the spring force.
  - Closes the contact points
  - Completes the circuit to the compressor clutch once more
- Refrigerant circulation is resumed.
  - The circulation of refrigerant is resumed.
  - System operation recommences.
  - The thermostat usually cycles the system between a minimum of 35.6°F (2°C) and a maximum of 46.4°F (8°C).
  - Maintains the evaporator at the required temperature

Refrigerants

READY FOR REVIEW

- About R-12
  - Used for many years in automotive air-conditioning systems
  - Known as dichlorodifluoromethane
  - Commonly referred to as freon or R-12
  - Group of gases called CFCs (chlorofluorocarbons)
  - Properties:
    - Nonflammable
    - Nontoxic
    - Chemically stable
    - Soluble in mineral oils
- R-12: boiling point and vaporization point
  - Has a low boiling point
  - Vaporizes at 3.6°F (-30°C)
- R-12 is harmful to the environment.
  - Harmful to the environment
  - A number of alternative refrigerants are considered replacements.
  - The most practical is a R-134-A liquid.
- R-134-A
  - Refrigerant suitable for use in automotive air-conditioning systems
  - An HFC or hydrofluorocarbon
  - Does not contain an ozone-depleting chlorine atom
- R-134-A compared to R-12
  - The boiling point is 10.4°F (-26.2°C).
  - All other refrigerant characteristics are similar to R-12.
  - Only difference: operating pressures and temperatures in the evaporator and condenser are slightly higher than R-12.
- Important differences
  - Unlike R-12, R-134-A is not soluble in mineral oils.
  - New compressor lubricating oils are developed.
- Change in service ports
  - It is important to prevent the wrong lubricant or refrigerant from being installed during servicing.
  - Service ports on the air-conditioning systems are changed.
  - Service equipment for the R-12 system cannot be connected to the R-134-A system.

Pressure Switches

READY FOR REVIEW

- Severe damage potential
  - High pressures and low pressures can cause severe damage to air-conditioning system components.
- High-pressure switches
  - Mounted in the high-pressure side of the system
  - Switch the contacts in the series with the compressor clutch circuit.
- How the high-pressure switch works
  - If the pressure exceeds the switch setting:
    - The switch opens the circuit.
    - The compressor clutch and the compressor stop circulating refrigerant.
- Low-pressure switches
  - Mounted in the low pressure side of the system
  - Connected in a series with the compressor clutch
- Low pressures
  - Can occur in air-conditioning systems when refrigerant has escaped
  - If no refrigerant is flowing, lubricating oil flow is also reduced.
  - Can damage the compressor
- How the low-pressure switch works
  - Low pressure causes contacts in the low-pressure switch to open.
  - Breaks the electrical supply to the compressor clutch
  - Stops its operation

Heating Elements

READY FOR REVIEW

- Heated rear window
  - The heating element is almost invisible when viewed from the driver's seat.
  - Small resistance wires are embedded within the glass, crossing from one side to the other.
  - When the rear defrost switch is turned on, electrical current flows through the wire.
  - The wire heats up, gradually clearing the fogged glass.
- Exterior mirrors
  - The heating elements are fitted to the exterior mirrors.
  - Keep mirrors free of frosting and fogging
- Embedded wire as an antenna
  - Similar wire is embedded within the fixed glass as a radio antenna.
  - Usually separate from the resistance wire
  - Can be located in any fixed window, including the windshield
  - May be fit in more than one window