Module 7: Air Supply System

Terms and Definitions

- **Build-up time** is the period required for the air compressor to fully pressurize the air brake system.
- **To charge** means to load or fill to capacity, or to bring an air system up to its operational pressure.
- **Compressor output** is the rate at which a compressor produces pressurized air, which is usually measured as air flow in cubic feet per minute (cfm).
- **Cut-in pressure** is the pressure level in the air system supply reservoir that triggers the compressor load cycle.
- **Cut-out pressure** is the pressure level in the air system supply reservoir that triggers the compressor unload cycle.
- **Desiccant** is the granular substance used to remove moisture from the air stream flowing through the air dryer.
- **Integral** is formed as a unit with another part.
- **Load cycle** is the time during which the air compressor is building air pressure in the air system.
- **Particulate** is small solid contaminant such as dust and road grit.
- **Purge** is the initial blast of air (decompression) from the air dryer purge valve at the beginning of the unload cycle of the air compressor.
- **Regeneration** is the backflow of air from the air system and through the air dryer to remove moisture and to ready the air dryer for the next compressor load cycle.
- **Remote** is one part operating at some distance removed from the other part(s).
- **A sump** is the pit or reservoir serving as a drain or receptacle for liquids.
- **Unload cycle** is the time during which the air compressor is idling and is not building air pressure in the air system.
- **A valve** is the mechanical device that starts, stops, or regulates the flow of fluid products (air or liquid).

Components of the Air Supply System

- Air dryer
- Check valve
- Compressor
- Governor
- Low pressure switch
- **Air lines and fittings**
- **Safety valve**
- **Supply reservoir**
- **Drain valve (automatic)**
Basic Functions of the Air Supply System

The compressor pumps air to and builds air pressure in an air system.

The governor controls the operation of the compressor so that air pressure is maintained between a maximum and minimum pressure level. It also controls operation of the air dryer.

The air dryer cools, filters, and removes moisture, oil, and other contaminants from the air delivered by the compressor.

The supply reservoir holds pressurized air for transfer to the service reservoirs.

Valves and switches direct, control, and monitor various qualities of the air in the supply system such as pressure level and flow direction.

Air brake lines and fittings connect brake components so that air is not lost from the system.

Parts of a Compressor

The cylinder head is iron casting that houses the inlet, discharge, and unloader valve.

The crankcase houses the cylinder bores, pistons, crankshaft and main bearings, and mounting surface.

Characteristics of Compressors

Compressors supply and maintain pressurized (compressed) air to the air brake system and/or auxiliary air systems.

Compressors are driven by the vehicle's engine using a belt (medium-duty) or a gear (heavy-duty).

Compressors operate continuously while the engine is running, but only compress air when actuated by the governor.

Compressors typically use the vehicle's lubrication and cooling systems, but large units may also have self-lubrication mechanisms and combination water and air cooling systems.

Compressors may be base mounted or flange mounted with various flange configurations for different vehicle engine designs.

Loading and Unloading Process

The loading process (intake and compression of air)

- During the down stroke of the piston, the inlet valve opens and atmospheric air is drawn into the cylinder.
- As the piston begins its upward stroke, the air that was drawn into the cylinder is compressed.
- Then the inlet valve closes and the discharge valve opens, which allows air to flow into the discharge line and to the reservoirs.
- As the piston starts down, the discharge valve closes, which prevents the compressed air from returning.

The unloading process (noncompression of air)

- As the unloader pistons move down and hold the inlet valves off their seats, air is pumped back and forth between the two cylinders, and the discharge valves remain closed.
- When air pressure from the reservoir drops to the cut-in setting of the governor, the governor closes and exhausts the air from above the unloader pistons.
- The unloader springs force the pistons upward, and the inlet valves return to their seats. Compression can then resume.
Characteristics of Governors

Governors constantly monitor the air pressure in the supply reservoir and automatically control the operation of the air compressor.

Governors initiate the compressor load cycle when cut-in pressure is realized, and initiate the compressor unload cycle when the cut-out pressure is reached.

Governors also control the air dryer by sending an air signal (at the beginning of the compressor unload cycle) to the control port of the air dryer, initiating the purge cycle.

Methods of Providing Clean Air to the Compressor

There are three methods of providing clean air to the compressor; two are naturally aspirated and one uses pressurized induction.

Naturally aspirated (method 1)—the compressor uses its own attached air strainer, which is typically made of polyurethane sponge or pleated paper dry element.

Naturally aspirated (method 2)—the compressor inlet is connected to the engine air cleaner or the vacuum side of the supercharger or turbocharger.

Pressurized induction—the compressor inlet is connected to the pressure side of the supercharger or turbocharger.

Parts and Ports of an Air Dryer (Desiccant Type)

The upper housing includes the outer shell, inner desiccant cartridge, oil separator, and brackets.

The lower base assembly includes the check valve, safety valve, purge valve, sump, and threaded air connections (ports), which include:

- Control port for purge valve control and turbo cut-off
- Supply port for air inlet
- Delivery port for air outlet

Characteristics of Air Dryers

Provides clean, dry air to reservoirs, valves, and other components.

One common design is the desiccant type, which uses a replaceable desiccant cartridge to remove water vapor from the pressurized air, and also has an oil separator and may have additional filters depending on the model.

Another common design is the heat exchanger type, which uses external fins for cooling and condensing the pressurized air, and also has a wire filter for removing microscopic carbon and other particulates from the air.

Many designs also include a replaceable heater and thermostat assembly to prevent freezing of the accumulated condensate prior to its exhaust.

Extended purge models are available for applications where heavy air usage is the norm, such as with city buses.
Cycles That Occur in the Operation of the Air Dryer

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- **Drying cycle**
  - When the air system reaches the governor cut-in setting, the compressor is loaded (compressing air), and the air dryer operates in the drying cycle.
  - Compressed air, oil, water, and vapors enter the supply port.
  - As air travels through the base, air temperature is reduced, vapors condense, and liquids drop to the bottom or sump of the air dryer base.
  - Air enters the oil separator where water, oil, vapors, and solid contaminants are removed.
  - Air enters the desiccant drying bed, and then becomes progressively drier as water vapor adheres to the desiccant material.
  - Dry air exits the desiccant cartridge through the check valve or orifice to enter the purge volume area.
  - Dry air flows through the check valve and out the delivery port to the supply reservoir.

- **Purge cycle**
  - When the air system reaches the governor cut-out setting, the compressor unloads (air compression stops), and the air dryer begins the purge cycle.
  - The purge piston moves, causing the purge valve to open to the atmosphere and partially closing off the air supply from the compressor.
  - Contaminants in the base sump are expelled immediately when the purge valve opens.
  - Air flowing through the desiccant cartridge changes direction and begins to flow toward the open purge valve.
  - Oil and solid contaminants in the oil separator flow out the purge valve.
  - The purge valve closes when air pressure is reduced and the governor signals the compressor to charge.

Optional Devices That May Be Used on Supply Systems

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- **Alcohol evaporator**
  - May be used on some systems that do not have an air dryer
  - Is installed in the compressor discharge line between the compressor and the supply reservoir
  - Operates by injecting alcohol mist into the air flow to reduce the risk of freeze-up by lowering the freezing temperature of water

- **Aftercooler**
  - May be used on some systems that do not have an air dryer
  - Is installed between the compressor and the supply reservoir
  - Condenses and eliminates water from pressurized (compressed) air

Characteristics of Supply Reservoirs

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- Holds pressurized and conditioned air (heated and dried)
- As the air in the reservoir cools, water and contaminants collect in the reservoir.
- This water must be drained at least once a day, unless the vehicle is equipped with an automatic drain valve, which operates each time the brakes are applied.
- The supply reservoir is the first tank after the compressor.
- The supply reservoir is sometimes called the “wet tank” because it is where water and oil are most likely to accumulate, especially in systems without a functional air dryer.

Valves and Switches Used On the Air Supply System

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- Single check valve (one way)
- Safety valve (pressure relief)
- Drain valve (manual—pull chain)
- Drain valve (manual—drain cock)
- Automatic drain valve
- Low pressure switch (double terminal)
Functions of Supply System Valves and Switches

- The single check valve (one way) allows air to flow in only one direction (from the air dryer to the supply reservoir).
- The safety valve releases air at excessive pressures, and “pops off” when the limit is reached.
- The drain valve permits removal of condensate from the reservoir, it may be manual or automatic, and it may also be electrically heated to prevent the valve from freezing open or closed.
  Note: Automatic drain valves are often referred to as spitter valves.

- The low pressure switch (double terminal) senses pressure in the reservoir and actuates an in-cab buzzer and warning light when the pressure falls below a specified level (typically 60 pounds per square inch [psi]).

Basic Characteristics of Air Brake Valves

- All air brake valves have air passages and internal moving parts.
- As the valve’s internal parts move, they direct the compressed air to the desired location.
- Each air valve has at least one supply port to allow air to enter the valve and one delivery port to allow air to exit the valve.
  Note: Many valves have more than one supply and/or delivery ports.
- Some air valves may have a control port that allows an air pressure source to control when air can flow through the valve and an exhaust port that allows air to vent to the atmosphere.
- Some valves have special function control ports, such as balance or reservoir ports.
- Air brake valves operate either manually or automatically. Manual valves require the driver to move a knob, handle, or pedal to work the valve, and automatic valves use control ports or internal regulating parts to work.

Types of Lines Used On the Air Supply System

- Reinforced hose
  - Commonly made of fabric and rubber, reinforced hose may be lined with Teflon or covered with steel braid. A hose with a fabric-braided exterior has replaceable ends, and a hose with a rubber-coated exterior has nonreplaceable ends.
  - Typically, reinforced hose is used where more flexibility is needed, such as when going to the air brake chambers or for trailer connections.
- Metal tubing
  - Used for high heat applications
  - Commonly found between the compressor and the next component (the dryer or supply reservoir)
  - Require compression fittings
- Nylon tubing
  - Commonly used for standard service and supply lines to connect components throughout the system
  - Should not be used in high heat areas
  - Use special fittings designed for nylon tubing
- Color coding—nylon tubing may be color-coded for system identification.
  - Black—accessory equipment
  - Blue—front system
  - Green—rear system
  - Red—parking system
  - Yellow—trailer system
  - Blue—trailer supply