Module 3: Lubrication Systems

Terms and Definitions

- **Additives** are chemicals added to the oil to provide extra performance.
- **Antidrain check valve** prevents oil from draining out of the filters and back into the oil pan when the engine is stopped.
- **American Petroleum Institute (API)** is an association that issues engine oil classifications based on performance during standardized tests.
- **American Society for Testing and Materials (ASTM)** is an association that establishes minimum performance standards for different classifications of engine lubricating oil.
- **Contaminant** is any unwanted material in a fluid or lubricant.
- **Filter** is a device that removes contaminants from fluids or lubricant.
- **Gallery** is the pipe or passageway in the engine used to carry engine oil from one area to another.
- **Inhibitor** is a chemical that dissolves in water to form a rustproof film on metal.
- **Military specifications (MIL)** are oil specifications prepared by the federal government for specific military applications.
- **Multigrade oil** is oil that has been modified to behave as a light oil in cold temperatures, while acting as a heavy oil when hot.
- **Oil pan** is the reservoir for engine oil, and the pan sides also provide a surface for heat transfer from the hot oil to the atmosphere.
- **Particulate** is a substance made up of minute separate particles.
- **Pressure gauge** indicates lubrication system pressure when the engine is running.
- **Society of Automotive Engineers (SAE)** is an association that developed a rating system for oil viscosity.
- **Strainer** is a coarse filter usually designed to prevent large items such as rocks and bolts from entering the system.
- **Temperature gauge** indicates the temperature of the oil in the oil pan.
- **Viscometer** is an instrument used to measure viscosity.
- **Viscosity** is a measure of a fluid's resistance to flow (at a given temperature).

Components and Their Functions

- A full flow filter bypass valve diverts oil flow around the oil filter and/or oil cooler when system pressure rises above a set point due to cold, thick oil, or a clogged component.
- **Full flow filter**
- **Bypass filter**
- An oil cooler (thermostat optional) is a heat exchanger that transfers heat from the oil to either ambient air or engine coolant.
- **Accessory drive/air compressor**
- **Idler gears**

- An oil pump pulls oil from the oil pan, pressurizes it, and sends it to the oil filter, oil cooler, and main supply galleries.
- A high pressure relief valve diverts some of the oil from the oil pump directly back to the oil pan when the system pressure rises above a set point.
- A differential pressure valve senses a pressure drop between the filter inlet and outlet, and when the difference reaches a certain level, the valve allows oil to bypass the dirty filter.
Oil galleries are passageways cast in the block that supply oil to the crankshaft main bearings, camshaft bearings, oil cooler, oil filter, cam followers, and rocker arms.

A thermostat is the automatic device for regulating temperature, and diverts cold, thick oil past the oil cooler.

Oil Filters

- Full flow
  - All engine oil travels directly from the pump to the filter, before being sent to the oil galleries.
  - A relief valve in the filter canister allows the filter element to unseat from its base if internal pressure gets too high, and unfiltered oil then flows directly out of the canister, preventing bursting.
  - A differential pressure valve bridges the inlet and outlet lines running to the filter, allowing oil to completely bypass a clogged filter.
  - Both the filter relief valve and the differential pressure valve act as system safeguards, ensuring adequate lubrication at all times. (Dirty oil is better than no oil.)

- Bypass
  - Unfiltered oil travels directly from the pump to the oil galleries.

  - Approximately 10% of the oil is diverted to the oil filter.
  - After filtering, the oil flows back to the crankcase.

- Combination full flow/bypass
  - Uses both a full flow filter and a bypass filter
  - The bypass filter extends the life of the full flow filter.
  - System filtering capacity is increased.

- Centrifugal bypass (spinner)
  - Ten percent of the unfiltered oil is bypassed to the prefilter (similar to the bypass filter).
  - Unfiltered oil enters the main cavity of the prefilter, which is spinning at about 4,000 revolutions per minute (RPM).
  - Centrifugal force settles out the sludge and sediment.
  - Filtered oil leaves the cavity through jets (maintaining the rotating speed) and flows back to the crankcase.

Oil Pumps

- Gear type
  - Oil is pulled into the pump and pressurized by the rotation of the gears.
  - The oil stream is carried by the gear teeth around to the outlet side of the pump.
  - Intermeshing teeth prevent backflow through the pump and loss of pressure.

- Rotor type
  - Offset rotation of the inner rotor pulls oil into the pump.

  - Oil is carried through the pump in the spaces between the inner rotor and the outer rotor ring.
  - At the outlet side of the pump, the spaces between the rotor and rotor ring are smaller, pressurizing the oil and forcing it out of the pump.
  - Intermeshing rotor lobes prevent backflow through the pump.
  - The rotor may be driven by an internal or external rotor or in combination with gears.

Oil Coolers

- Plate type
  - Mounted on the outside of the cylinder block
  - Oil flows through a series of flat plates, releasing heat to the plates.
  - Coolant flows around the plates, absorbing the heat and transferring it to the radiator.

- Bundle type
  - Mounted on the outside of the cylinder block
  - Oil flows around the tubes.
  - Coolant flows through the tubes, absorbing the heat and transferring it to the radiator.
Sources of Oil Contamination

- Dirt/dust in containers used to transfer lubricants from storage to the engine
- Water/condensation in storage container(s)
- Airborne dust ingested by the engine
- Improper engine warm-up
- Coolant leakage into the crankcase
- Oxidation
- Carbon particles
- Engine wear
- Fuel dilution

Monitor Operation

- Oil pressure alarm (Switchgage™)
  - If the oil pressure falls off, the sensor sends a low reading to the Switchgage™.
  - As the Switchgage™ indicator needle drops, it passes a preselected low pressure limit, triggering a magnetic switch inside the gauge.
  - The switch energizes a relay, closing the fuel shutoff valve.
  - Fuel flow to the injector pump stops, and so does the engine.

- Oil temperature indicator
  - The oil temperature sensor responds to oil temperature changes by varying the resistance in the circuit.
  - The oil temperature gauge reading varies as the resistance changes. High oil temperature causes high current flow, which causes a high reading on the gauge.
  - Coolant flows through the tubes, absorbing the heat and transferring it to the radiator.

API Use Codes

- API format
  - Letters are used to classify appropriate use.
  - The first alpha character designates the engine type: S = gasoline, C = diesel.
  - The second alpha character designates the level of protection offered by the oil.
  - The higher the letter designation, the higher the level of protection.

- API classifications (most commonly used)
  - CF, provides protection from bearing corrosion and high temperature deposits in supercharged engines when using a wide quality range of fuels (severe duty diesel).
  - CF-2/CG-2, used in two-stroke diesel engines requiring highly effective controls over wear and deposits (heavy-duty trucks and buses, off-highway equipment, construction and stationary equipment).
  - CF-4/CG-4, used in turbocharged or supercharged heavy-duty diesel engines.

Factors to Consider When Choosing an Engine Oil

- The manufacturer’s minimum requirements for the engine series being used
- Typical operating environment for the engine
- Fuel quality and grade
- Availability of brands meeting specifications
- Cost