ASE 1 - Engine Repair

Module 3
Lubrication

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Module 3 – Lubrication

Introduction

After completing this unit, the technician will demonstrate an understanding of automotive Lubrication systems. The technician will also demonstrate the skills required to troubleshoot and replace automotive Lubrication system components.

Objectives

- Define the purpose of the engine lubrication systems
- Define the basic principles of operation of engine lubrication systems.
- Perform inspections and testing procedures on lubrication systems
- Name and describe the components of a typical lubricating system

Lesson 1. Theory and Operation

Purpose of Lubrication

- Maintain a continuous supply of oil
- Reduce friction of moving parts
- Assist cooling the engine
- Help prevent corrosion
- Hold contaminates in oil until drained from engine

Lubrication Description

- Oil Pump
- Pressurizes oil
- Supplies oil volume
- Types of oil pumps
- gear
- gerotor
- Crescent

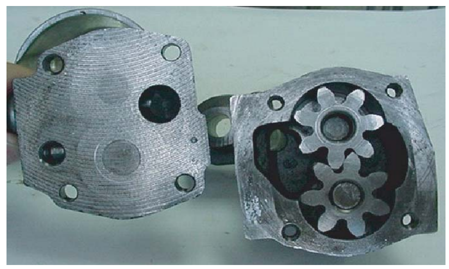

Figure 3-1

Lubrication

- Lubrication Path
- Screen
- Pump pressurizes oil
- Pressure regulator
- Full flow oil Filter
- Main oil galleys
- Crank and Rod Bearings
- Upper block for camshaft and lifters
- Pushrods
- Rocker arms

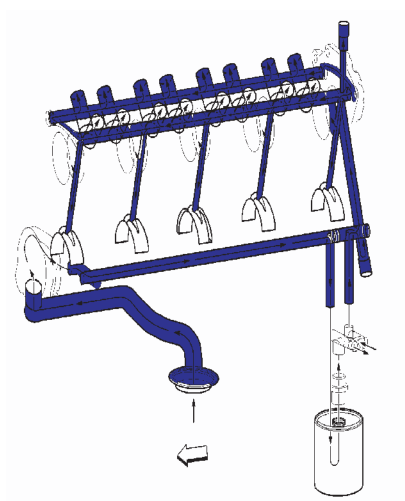

Figure 3-2

Engine lubrication is supplied by a gerotor type oil pump assembly. The pump is mounted on the front of the engine block and driven directly by the crankshaft sprocket. The pump gears rotate and draw oil from the oil pan sump through a pick-up screen and pipe. The oil is pressurized as it passes through the engine block oil galleries. Contained within the oil pump assembly is a pressure relief valve that maintains oil pressure within a specified range.

Pressurized oil is directed through the lower gallery to the full flow oil filter where harmful contaminants are removed. A bypass valve is incorporated into the oil pan, at the oil filter boss, which will permit oil flow in the event the filter becomes restricted. At the rear of the block, oil is then directed to the upper main oil galleries which are drilled just above the camshaft assembly. From there oil is then directed to the crankshaft and camshaft bearings. Oil that has entered the upper main oil galleries also pressurizes the valve lifter assemblies and is then pumped through the pushrods to lubricate the valve rocker arms and valve stems. Oil returning to the pan is directed by the crankshaft oil deflector. Oil pressure and crankcase level are each monitored by individual sensors.

An external oil cooler is available on certain applications, all 6.0L. Oil is directed from the oil pump, through the lower main oil gallery to the full flow oil filter. Oil is then directed through the oil pan outlet oil gallery, located in the left rear of the oil pan, and to the external oil cooler via a hose assembly. Oil flows through the oil cooler and returns to the engine at the oil pan inlet oil gallery, located in the left rear of the oil pan. Oil is then directed to the upper main oil galleries and the remainder of the engine assembly.

Oil

- Viscosity
- Pour point
- Viscosity index
- API Rating
- Additives

Viscosity Index

Resistance to thinning with increasing temperature is called viscosity index. And although a higher second number is good, the oil also has to be robust. That is, it must be able to last for thousands of miles until the next oil change. For example, oil tends to lose viscosity from shear, the sliding motion between close-fitted metal surfaces of moving parts such as bearings. So resistance to viscosity loss (shear stability) is necessary to enable the oil to maintain the lubricating film between those parts.

Flash point is the temperature at which oil gives off vapors that can be ignited with a flame held over the oil. The lower the flash point the greater tendency for the oil to suffer vaporization loss at high temperatures and to burn off on hot cylinder walls and pistons. The flash point can be an indicator of the quality of the base stock used. The higher the flash point the better. 400 ^{o}F is the minimum to prevent possible high consumption. Flash point is in degrees F.

Pour point is 5 ^{o}F above the point at which chilled oil shows no movement at the surface for 5 seconds when inclined. This measurement is especially important for oils used in the winter. A borderline pumping temperature is given by some manufacturers. This is the temperature at which the oil will pump and maintain adequate oil pressure. This was not given by a lot of the manufacturers, but seems to be about 20 ^{o}F above the pour point. The lower the pour point the better. Pour point is in degrees F.

Oil Additives

Use of additives is another approach to improving and maintaining oil performance. High engine temperatures combine with moisture, combustion byproducts (including unburned gasoline), rust, corrosion, engine wear particles and oxygen to produce sludge and varnish. The additives not only assist oil in maintaining good lubrication, they also help minimize sludge and varnish, and any damage from their formation. Here are the categories of key additive ingredients and why they're important:

- Viscosity-index improvers: Reduce the oil's tendency to thin with increasing temperature.
- Detergents: Unlike the household type, they don't scrub engine surfaces. They do remove some deposits, primarily solids. But their main purpose is to keep the surfaces clean by inhibiting the formation of high-temperature deposits, rust and corrosion.
- Dispersants: Disperse solid particles, keeping them in solution, so they don't come together to form sludge, varnish and acids. Some additives work both as detergents and dispersants.
- Antiwear agents: There are times when the lubricating film breaks down, so the antiwear agents have to protect the metal surfaces. A zinc and phosphorus compound called ZDDP is a long-used favorite, along with other phosphorus (and sulphur) compounds. If you musts know, ZDDP stand for zinc diakyl dithiophosphate.
- Friction modifiers: These aren't the same as antiwear agents. They reduce engine friction and, so, can improve fuel economy. Graphite, molybdenum and other compounds are used.
- Pour-point depressants: Just because the 0° F viscosity rating is low doesn't mean the oil will flow readily at low temperatures. Oil contains wax particles that can congeal and reduce flow, so these additives are used to prevent it.
- Antioxidants: With engine temperatures being pushed up for better emissions control, the antioxidants are needed to prevent oxidation (and, therefore, thickening) of oil. Some of the additives that perform other functions also serve this purpose, such as the antiwear agents.
- Foam inhibitors: The crankshaft whipping through the oil in the pan causes foaming. Oil foam is not as effective a lubricant as a full-liquid stream, so the inhibitors are used to cause the foam bubbles to collapse.
- Rust/corrosion inhibitors: Protect metal parts from acids and moisture.

API Symbol

- The API Service Symbol "Donut" is divided into three parts:
- The top half describes the oil's performance level.
- The center identifies the oil's viscosity.
- The bottom half tells whether the oil has demonstrated energy-conserving properties in a standard test in comparison to a reference oil.

The top of the Donut shows the oil's performance level for gasoline and/or diesel engines. The letter "S" followed by another letter (for example, SL) refers to oil suitable for gasoline engines. The letter "C" followed by another letter and/or number (for example, CH-4) refers to oil suitable for diesel engines. These letters officially stand for "Service" and "Commercial." The current API performance categories that can appear in the top part of the Donut are listed in the *API Service Category Chart*.

SAE Viscosity Grade

The center of the Donut shows the oil's SAE viscosity grade. Viscosity is a measure of an oil's flow characteristics, or thickness, at certain temperatures.

The low-temperature viscosity (the first number, 5W in a 5W-30 oil) indicates how quickly an engine will crank in winter and how well the oil will flow to lubricate critical engine parts at low temperatures. The lower the number the more easily the engine will start in cold weather.

The high-temperature viscosity (the second number, 30 in a 5W-30 oil) provides thickness, or body, for good lubrication at operating temperatures.

A multigrade oil (for example, SAE 5W-30) provides good flow capability for cold weather but still retains thickness for high-temperature lubrication.

A single grade oil (a single number in the center of the donut) is recommended for use under a much narrower set of temperature conditions than multigrade oils.

Operators should refer to their owner's manuals to select the proper viscosity oil for the ambient temperature and operating conditions at which the equipment will be used.

Energy Conserving Designation

The bottom of the donut tells whether the oil has energy conserving properties when compared with a reference oil in an engine test. Oils labeled as “Energy Conserving” have passed this test. Widespread use of engine oils with this designation should result in an overall saving of fuel in the vehicle fleet as a whole, but a particular vehicle operator may not experience a fuel savings as a result of using these oils.

The API Certification Mark

The API Certification Mark “Starburst” is designed to identify engine oils recommended for a specific application (such as gasoline service). An oil may be licensed to display the Starburst only if the oil satisfies the most current requirements of the International Lubricant Standardization and Approval Committee (ILSAC) minimum performance standard for this application (currently GF-3 for passenger cars). Many automobile manufacturers recommend oils that carry the API Certification Mark.

Oil Filter

- full-flow paper element
- anti-drain back valve
- oil filter bypass valve

The oil filter is a full-flow paper element unit with an anti-drain back valve. An oil filter bypass valve is used to ensure adequate oil supply, in the event the filter becomes plugged or develops excessive pressure drop.

Pressure Regulator Valve

- Regulates Pressure
- Spring
- Determines pressure
- Valve
- Dumps to suction side of pump

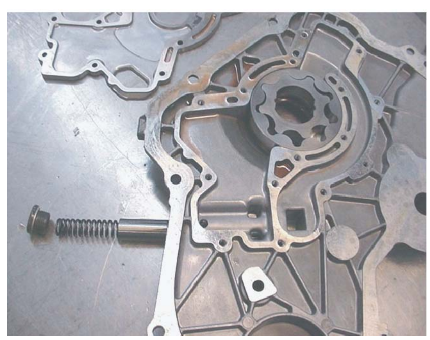

Figure 3-3

Engine Oil Cooler

- The engine oil cooler is a heat exchanger. It is located inside the left side end tank of the radiator

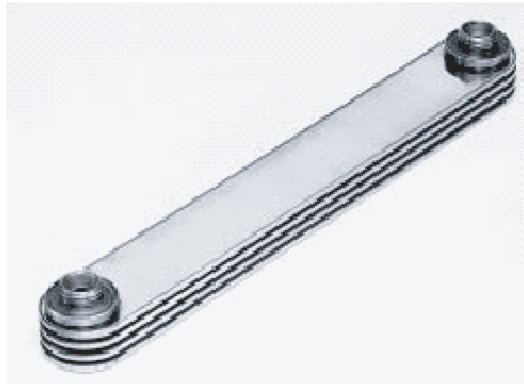

Figure 3-4

The engine oil cooler is a heat exchanger. It is located inside the left side end tank of the radiator. The engine oil temperature is controlled by the temperature of the engine coolant that surrounds the oil cooler in the radiator.

The engine oil pump, pumps the oil through the engine oil cooler line to the oil cooler. The oil then flows through the cooler where the engine coolant absorbs heat from the oil. The oil is then pumped through the oil cooler return line, to the oil filter, to the engine block oil system.

Gerotor Pump

- Positive Displacement
- Inner drive rotor
- Outer rotor
- Oil Pump Housing
- Pressure Relief Valve
- Pressure Relief Valve Spring
- Cover Bolt
- Cover

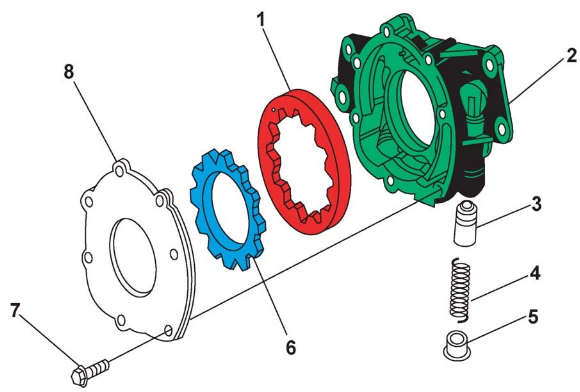

Figure 3-5

A gerotor pump is characterized by an inner drive rotor with external lobes and an outer driven rotor with internal lobes. The center of the inner rotor is offset from the center of the outer rotor and the lobes are in mesh on one side. As the inner rotor drives the outer rotor, the space between the lobes increase in volume creating a low pressure are that then allows atmospheric pressure to push oil from the sump through the pick-up screen into the increasing cavity size. As the inner rotor and outer rotor continue to rotate, the oil is pushed into a decreasing volume against the restrictions in the engine, thus raising the pressure of the oil. The pump is a positive displacement pump.

Gear Pump

- Gear oil pump
- Positive displacement
- Gears
- Body
- Gear shaft

A gear type pump is a positive displacement pump, consisting of two gears side by side. The drive gear in mesh with a driven gear and both are incased in a pump housing with a cover. The cover includes a pick-up screen, an inlet port and a pressure regulator valve. The upper gear in the illustration is driven by the distributor shaft off the camshaft.

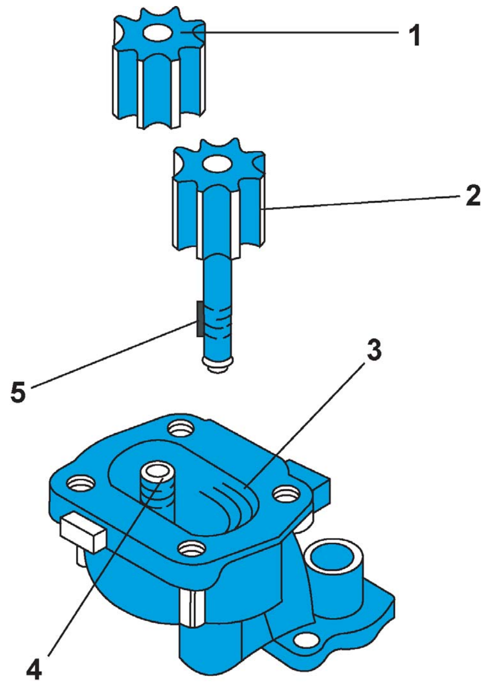

Figure 3-6

Inspection

Clean the oil pump components in cleaning solvent.

Dry the components with compressed air.

Inspect the oil pump for the following conditions:

- Scoring on the top of the gears (1)
- Damaged gears (2) for the following:
- Chipping
- Galling
- Wear
- Scoring, damage or casting imperfections to the body (3)
- Damaged or scored gear shaft (4)
- Damaged or scored gear shaft (5)
- Damaged bolt hole threads
- Worn oil pump driveshaft bore
- Damaged or sticking oil pump pressure relief valve Minor imperfections may be removed with a fine oil stone.
- Collapsed or broken oil pump pressure relief valve spring
- If the oil pump is to be reused, install a NEW oil pump pressure relief valve spring.

During oil pump installation, install a NEW oil pump driveshaft retainer.

Crescent Oil Pump

- Positive Displacement
- Inner gear
- Outer gear
- Crescent

Crescent Gear Pump:

- High Pressure
- Low pressure
- Crescent Shaped Separator

The crescent gear pump is so named because of the crescent shape of the separator between the inner gear and outer gear. It is a positive displacement pump. The inner gear is the drive gear and transfers torque to the outer gear, the driven gear. As the gears rotate in the direction indicated by the arrow, the spaces between the teeth increase, creating a pressure lower than atmospheric pressure. This allows atmospheric pressure to push fluid into the increasing volume between the teeth of the two gears. As the gears continue to rotate, the fluid in between the gear teeth is squished by the decreasing space between the teeth. As this occurs, the fluid is pushed against restrictions in the system that cause the pressure to increase.

PUMP ASM.

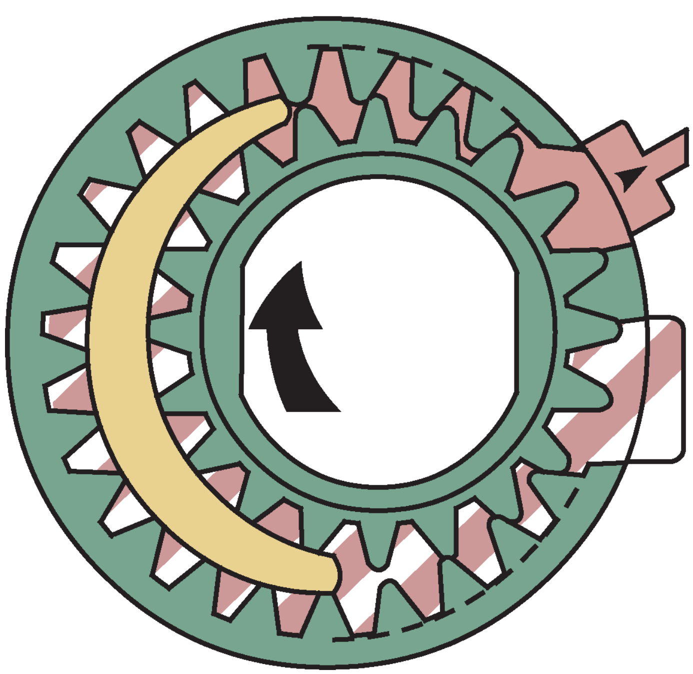

Figure 3-7

Lesson 2. Procedures

Oil Viscosity Recommendation

Note: Using oils of any viscosity other than those recommended could result in engine damage. When choosing an oil, consider the range of temperatures the vehicle will be operated in before the next oil change. Then, select the recommended oil viscosity.

Oil Viscosity Recommendation for 3100 LG8

SAE 5W-30 is the only viscosity grade recommended for your vehicle. For the 3100 LG8 (VIN J) engine, use only oils which have the API Starburst symbol and which are also identified as SAE 5W-30. If the temperature range is-18°F(0°C) or above SAE 10W-30 oil which has the API Starbust symbol is acceptable if SAE 5W 30 oils is not available. Areas where the temperature falls below -29°F (-20°C), either an SAE 5W-30 synthetic oil or and SAE 0W-30 oil is recommended. Both will provide easier cold starting and better protection for the engine at extremely low temperatures. Do not use other viscosity grade oils, such as SAE 10W-40 or SAE 20W-50 under any conditions. For the 3100 LG8 (VIN J) engine, SAE 5W-30 is the recommended engine oil viscosity. Engine oil viscosity thickness has an effect on the fuel economy and the cold-weather operation engine starting and oil flow. Lower viscosity engine oils can provide better fuel economy and cold-weather performance. However, higher temperature weather conditions require higher viscosity engine oils for satisfactory lubrication. When the temperature is consistently above -18°C (0°F), 10W-30 may be used. SAE 20W-50 or oils of other viscosity rating or quality designations are NOT recommended for use in any GMC vehicle at any time.

Oil Viscosity Recommendation for 3800 L36 and 3800 L67

For the 3800 L36 or a 3800 L67 engine, SAE 10W-30 is the recommended engine oil viscosity. Engine oil viscosity thickness has an effect on the fuel economy and the cold-weather operation engine starting and oil flow. Lower viscosity engine oils can provide better fuel economy and cold-weather performance. However, higher temperature weather conditions require higher viscosity engine oils for satisfactory lubrication. When the temperature is consistently lower than 16°C (60°F), 5W-30 may be used. SAE 20W-50 or oils of other viscosity rating or quality designations are NOT recommended for use in any GMC vehicle at any time.

Note: Using oils of any viscosity other than those recommended could result in engine damage. When choosing an oil, consider the range of temperatures the vehicle will be operated in before the next oil change. Then, select the recommended oil viscosity.

Important: When adding to, or changing the engine oil, use ONLY oils of the proper quality. In countries other than the United States and Canada, it may be difficult to find engine oils that display the API STARBURST symbol certifying the oil is for use in gasoline engines. If you are unable to find engine oils displaying the API STARBURST symbol, use engine oils that meet API Service SJ and/or ACEA A1-96, ACEA A2-96, or ACEA A3-96 requirements as shown in the chart above.

Oil Pressure Diagnosis and Testing

Low or No Oil Pressure

The following conditions may cause low or no oil pressure:

- Low oil level Fill to the full mark on the oil level indicator.
- Incorrect or malfunctioning oil pressure switch Replace the oil pressure switch.
- Incorrect or malfunctioning oil pressure gauge Replace the oil pressure gauge.
- Improper oil viscosity or diluted oil
  - Install oil of proper viscosity for expected temperature.
  - Install new oil if the oil is diluted.
- A worn or dirty oil pump Clean or replace the oil pump.
- A plugged oil filter Replace the oil filter.
- A loose or plugged oil pickup screen Replace the oil pickup screen.
- A hole in the oil pickup tube Replace the oil pickup tube.
- Excessive bearing clearance Replace the bearings.
- Cracked, porous, or plugged oil gallery Repair or replace the engine block.
- Missing or improperly installed gallery plugs Install or repair the plugs as needed.
- A stuck pressure regulator valve
  - Inspect the pressure regulator valve for sticking in the bore.
  - Inspect the bore for scoring and burrs.
- A worn or poorly machined camshaft Replace the camshaft.
- Worn valve guides Repair the valve guides as needed.

Oil Pressure Testing

Tools Required:

- J 25087-C Oil Pressure Tester

If the vehicle has low oil pressure complete the following steps:

1. Inspect the oil level.
2. Raise and support the vehicle. Refer to Oil Pressure Diagnosis and Testing in General Information.
3. Remove the oil filter.
4. Assemble the plunger valve in the large hole of the J 25087-C base. Insert the hose in the small hole of the J 25087-C base. Connect the gauge to the end of the hose.
5. Insert the flat side of the rubber plug in the bypass valve without depressing the bypass valve.
6. Install the J 25087-C on the filter mounting pad.
7. Start the engine.
8. Inspect the overall oil pressure, the oil pressure switch, and for noisy lifters. Ensure that the engine is at operating temperature before inspecting the oil pressure. The oil pressure should be approximately 414 kPa (60 psi) at 1,850 RPM using 5W-30 engine oil.
9. If adequate oil pressure is indicated, test the oil pressure switch.
10. If a low reading is indicated, press the valve on the tester base in order to isolate the oil pump and/or its components from the lubricating system. An adequate reading at this time indicates a good pump and the previous low pressure was due to worn bearings, etc. A low reading while pressing the valve indicates a faulty pump.

Oil Consumption Diagnosis

An engine that has excessive oil consumption uses 0.9 L (1 qt) of oil, or more, within 3 200 km (2,000 mi). The following list indicates the conditions and corrections of excessive oil consumption:

- An improperly read oil level indicator dipstick
  - Inspect the oil level while the vehicle is parked on a level surface.
  - Allow adequate drain-down time.
- Improper oil viscosity Use the recommended SAE viscosity for prevailing temperatures.
- Continuous high-speed driving
- Severe hauling, such as a trailer. This causes decreased oil mileage.
- A malfunctioning crankcase ventilation system
- External oil leaks
  - Tighten the bolts, as needed.
  - Replace the gaskets and seals, as needed.
- Worn or omitted valve guides and/or valve stem seals
  - Ream the guides.
  - Install oversized service valves and/or new valve stem seals.
- Broken or worn piston rings
- Improperly installed or unseated piston rings
- Improperly installed or improperly fitted piston
- Plugged cylinder head gasket oil drain holes
- Damaged intake gaskets

Oil Leak Diagnosis

Tools Required:

- J 28428-E High Intensity Black Light Kit

You may repair most fluid leaks by first visually locating the leak, repairing or replacing the component, or by resealing the gasket surface. Once the leak is identified, determine the cause of the leak. Repair the leak and the cause of leak.

Locating and Identifying the Leak

Use the visual inspection method in order to determine if the leaking fluid is one of the following items:

- Engine oil
- Transmission fluid
- Power steering fluid
- Brake fluid
- Some other fluid

Visual Inspection Method

Complete the following steps in order to perform the visual inspection method:

1. Bring the vehicle to normal operating temperature.
2. Park the vehicle over a large sheet of paper, or other clean surface.
3. Wait several minutes, then inspect for dripping fluids.
4. Identify the type of fluid, and the approximate location of the leak.
5. Visually inspect the suspected area. Use a small mirror if necessary.
6. Inspect for leaks at sealing surfaces, fittings, or from cracked or damaged components.
7. If you cannot locate the leak, perform the following steps:
    a. Completely clean the entire engine and surrounding components.
    b. Operate the vehicle for several miles at normal operation temperature and at varying speeds.
    c. Park the vehicle over a large sheet of paper, or other clean surface.
    d. Wait several minutes, then inspect for dripping fluids.
    e. Identify the type of fluid, and the approximate location of the leak.
    f. Visually inspect the suspected area. Use a small mirror if necessary.
8. If you still cannot locate the leak, use the powder method or the black light and dye method.

Powder Method

1. Completely clean the entire engine and surrounding components.
2. Apply an aerosol-type powder, baby powder, foot powder, etc., to the suspected area.
3. Operate the vehicle for several miles at normal operation temperature and at varying speeds.
4. Identify the type of fluid, and the approximate location of the leak, from the discolorations in the powder surface.
5. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. Refer to Possible Causes for Leaks if necessary.

Black Light and Dye Method

A dye and light kit is available for finding leaks.

1. Use the J 28428-E or the equivalent. Refer to the manufacturer's instructions when using the tool.
2. Visually inspect the suspected area. Use a small mirror if necessary Refer to Possible Causes for Leaks if necessary.

Possible Causes for Leaks

Inspect the vehicle for the following conditions:

- Higher than recommended fluid levels
- Higher than recommended fluid pressures
- Plugged or malfunctioning fluid filters or pressure bypass valves
- Plugged or malfunctioning engine ventilation system
- Improperly tightened or damaged fasteners
- Cracked or porous components
- Improper sealants or gaskets where required
- Improper sealant or gasket installation
- Damaged or worn gaskets or seals
- Damaged or worn sealing surfaces

Exercise 3-1

1. What is considered to be excessive oil consumption?
    a. 1 quart or more 10,000 miles
    b. 1 quart or more 5,000 miles
    c. 1 quart or more 2,000 miles
    d. 1 quart or more 3,000 mile