Phase
2

Trade of Motor Mechanic

Module 3

Unit 2

Lubrication System

Produced by

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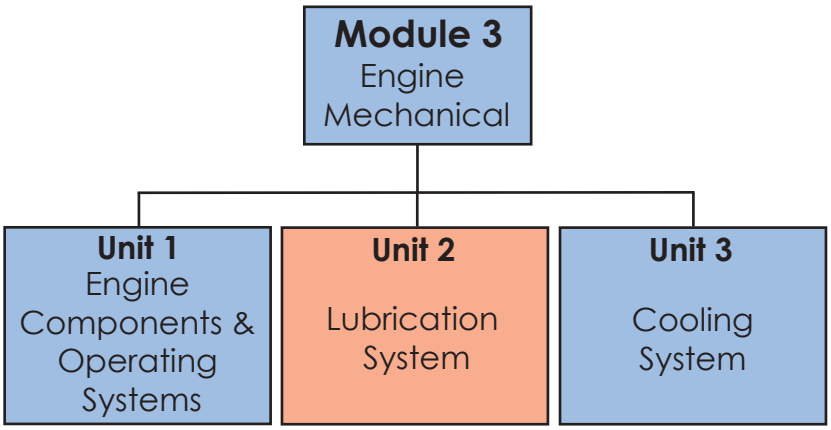
Table of Contents

Introduction

Module 3 of this course covers the Engine Mechanical aspect of automotive technology. This is the second unit in module 3 and covers the Lubrication System.



This unit covers the basic function and operation of the lubrication and system of the automotive internal combustion engine.

Modern vehicle engines use a pressure or force-feed lubrication system where the oil is forced around the engine under pressure. A pump collects it through a pickup tube and a strainer and forces it through an oil filter, then into passageways in the engine block, called galleries. These components along with the relevant health and safety will be covered in detail within this unit.

Unit Objective

- By the end of this unit each apprentice will be able to:
- Describe the function and operation of the lubrication system in an internal combustion engine
- Describe the principle types of engine oil filter, their operation and service procedures
- Define the terms; friction, viscosity, multigrade and describe the benefits of oil on sources of friction
- Draw an oil flow diagram for an engine
- Identify the oil flow path through a dismantled, 4 cylinder engine
- Locate and record engine lubrication system data
- Prepare a vehicle appropriately for service/repair activity and upon completion of work, for return to the customer
- Change the lubricating oil and its filter on an engine
- Describe the environmental protection issues and the 'end of useful life' procedures to be used with engine lubricating oil and filters
- Identify the most popular oil pump types and the method of drive used
- Test the oil pressure on an engine, record and compare the results to the manufacturer's specifications
- State the main causes of excessive oil consumption

1.0 Environmental Protection Issues

Key Learning Points

- Oil, synthetic; used, possible dermatitis - carcinogenic effect
- Waste oil/filters, oily rags, oil dry granules/dust etc., disposal procedures, appropriate storage/collection for industry approved recycling company use e.g. mesh/centifuge filtering and compressing

1.1 Environmental Factors – Used Lubricants

Introduction

- Vehicle service centres generate millions of litters' of used motor oil each year.
- If it is not disposed of properly, used motor oil can interfere with the operation of sewer systems and can easily get into our ground water and streams. In fact, it takes only one litre of used oil to contaminate a million litres of drinking water.
- Re-refining used oil takes only about one-third the energy of refining crude oil to lubricant quality.

Safe environmental disposal of automotive fluids is an essential part of the servicing process. Incorrect disposal is both illegal and dangerous. Different countries use different regulations to administer this process so you should always consult with your local authority as to the specific regulations that apply to you.

As a general rule the following applies:

Illegal Disposal Practices

- Pouring used oil down a drain.
- Pouring used oil into a storm sewer.
- Pouring used oil on your driveway, street, or the ground.
- Disposing of oil in lakes, streams, or wetlands.
- Spreading oil to suppress dust or kill weeds.
- Burning oil outdoors or any other heating devices unless the device is approved for the purpose and the premises appropriately licensed.
- Mixing used oil with other substances.

Remember

- Used oil and oil rags have to be collected by an authorized waste disposal company. Contact them for proper procedures in relation to storage and collection facilities.
- Recycling used oil can conserve the earth's natural resources.
- Used oil can be re-refined and purified into high quality motor oil.
- Recycling used oil can save consumers money.

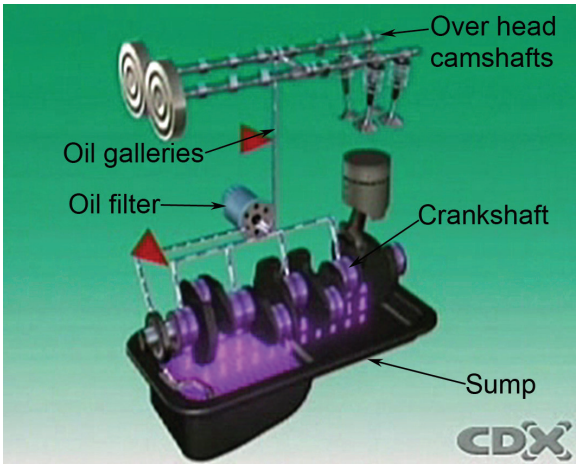
2.0 The Lubrication System

Key Learning Points

- Function of the lubrication system/oil; lubricate and cool engine internals, molecular clearance bridge between moving components, pressure-fed and boundary/type system of lubrication, lubrication system components, their function and operation

2.1 Pressure System

Modern vehicle engines use a pressure or force-feed lubrication system where the oil is forced around the engine under pressure. A pump collects it through a pickup tube and a strainer and forces it through an oil filter, then into passageways in the engine block, called galleries.



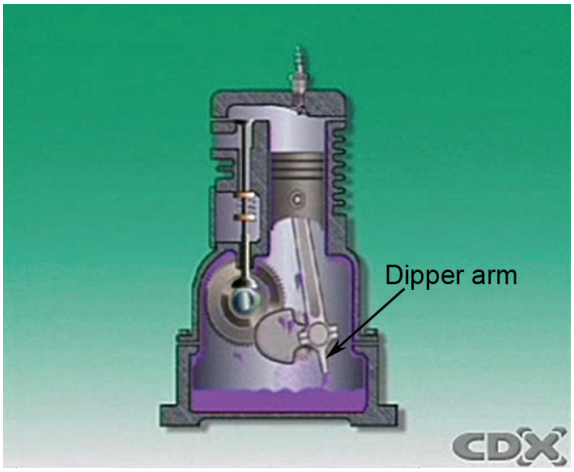
The galleries allow oil to be fed to the camshaft bearings, the valve mechanism and the crankshaft main bearings. Holes drilled in the crankshaft webs allow the main bearings to supply oil to the big-end bearings.

After circulating through the engine, the oil falls back to the sump to cool. This is called a wet-sump lubrication system because the oil is kept in the sump ready for the next time it's used.

Some special engines use a dry sump lubrication system. It uses all of the parts that make up a wet sump system and it lubricates the engine in the same way.

2.2 Splash System

Most small 4-stroke petrol engines use what is called splash lubrication.



On horizontal-crankshaft engines, a dipper on the bottom of the connecting rod scoops up oil from the crankcase for the bearings. In this engine it is also able to splash oil up to the valve mechanism.

Alternatively, an oil slinger can be driven by the camshaft.

A similar system is used in most small vertical-crankshaft engines. Oil is also splashed up to the valve mechanism.

2.3 Oil Cooler

Engines which operate under severe conditions may use an oil cooler to cool the oil in the engine.

In diesel engines, the oil cooler and oil filter are often on the same mounting, on the cylinder block.

The oil cooler is a heat exchanger. It transfers heat from the oil to coolant from the cooling system. Coolant circulates through tubes in the cooler and oil fed from the lubrication system surrounds the tubes. As the coolant circulates, heat is removed from the oil.

In another design, the oil cooler is mounted in the air stream at the front of the vehicle. This type of oil cooler uses the flow of air passing across its fins to cool the air circulating through it. It is called an oil-to air heat exchanger.

2.4 Oil Filters

There are 2 basic oil-filtering systems - full-flow and by-pass. The full-flow type filters all of the oil before delivering it to the engine. The by-pass type only filters some of the oil.

The full-flow type is the more common. Its filter uses pleated filtering paper in a metal housing, to collect harmful particles. (This paper element can be replaceable element and throw-away canister type).

Normally all oil goes through the filter before it gets to the engine, but if the filter clogs up, it can starve an engine of oil. As a safety measure, full-flow filters have a bypass valve. If the filter clogs, this valve opens and directs unfiltered oil to the engine. Dirty oil is better than none at all.

In a by-pass system, the bypass element filters only some of the oil from the pump by tapping an oil line into an oil passage. It collects finer particles than a full-flow filter. After this oil is filtered, it goes back to the sump.

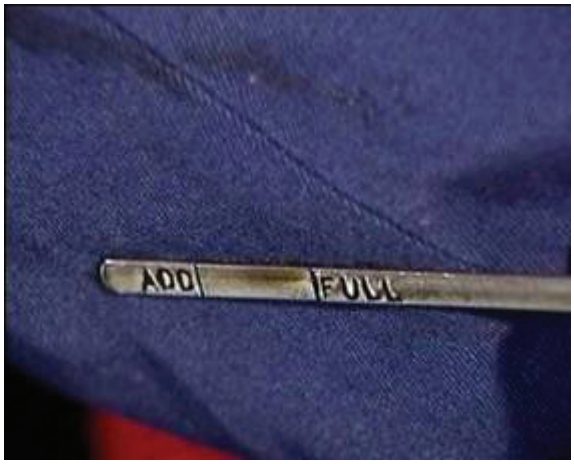
When changing the engine oil and oil filter. The used oil and oil filter has to be disposed in accordance with the current laws and environment regulations.

2.5 Oil Indicators

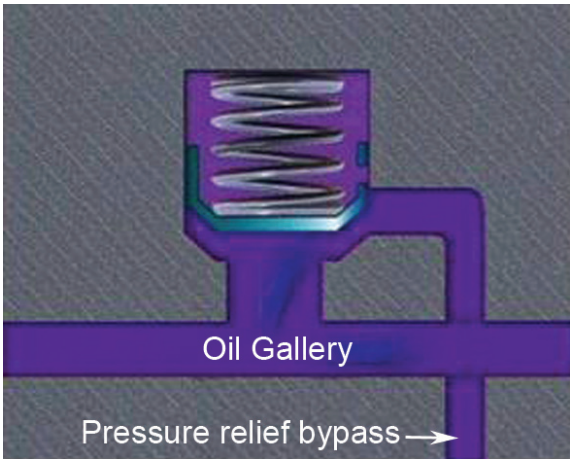
If a lubrication system fails it's serious, so it's crucial to know its working. If oil pressure falls too low, a pressure sensor in a gallery can light up a warning light, or register on a gauge.

Low oil pressure can mean a lack of oil. It may have leaked away, or it may have been burned. This can be caused by worn piston rings which let oil into the combustion chamber. Too little oil in the engine is a problem but so is too much.

The simplest indicator of oil level is the dip stick.



2.6 Oil pressure Relief Valve

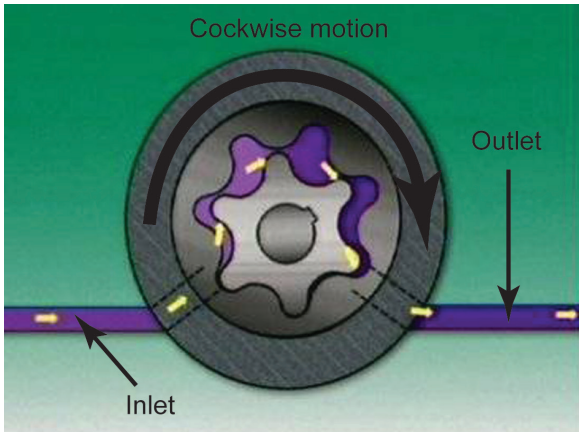


A normal pump is capable of delivering more oil than an engine needs. It's a safety measure to ensure the engine is never starved for oil. As the pump rotates and engine speed increases, the volume of oil delivered also increases. The fixed clearances between the moving parts of the engine prevent oil escaping back to the sump and pressure builds up in the system.

An oil pressure relief valve stops excess pressure developing. It's like a controlled leak, releasing just enough oil back to the sump to regulate the pressure of the whole system.

2.7 Oil Pump

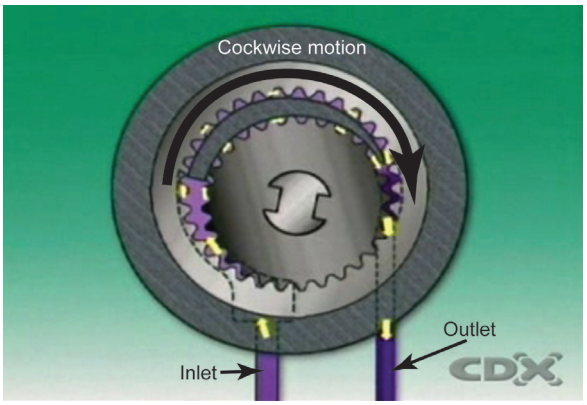
Oil pumps may be driven from the camshaft or the crankshaft.



In *a rotor-type oil pump*, an inner rotor drives an outer one. This is generally driven by the camshaft. As they turn, the volume between them increases. This larger volume lowers the pressure at the pump inlet. Outside atmospheric pressure is then higher. This forces oil

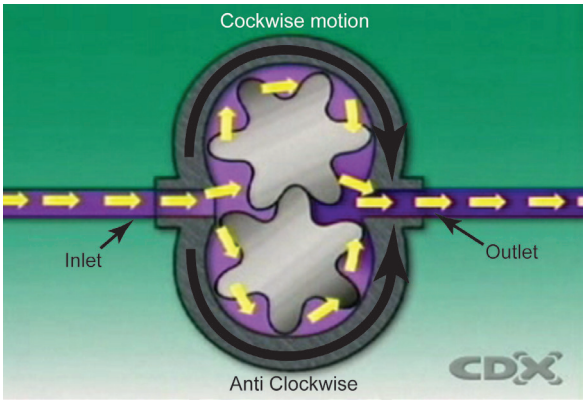
into the pump and it fills the spaces between the rotor lobes. As the lobes of the inner rotor move into the spaces in the outer rotor, oil is squeezed out through the outlet.

The *crescent pump* uses a similar principle. It is mounted on the front of the cylinder block.



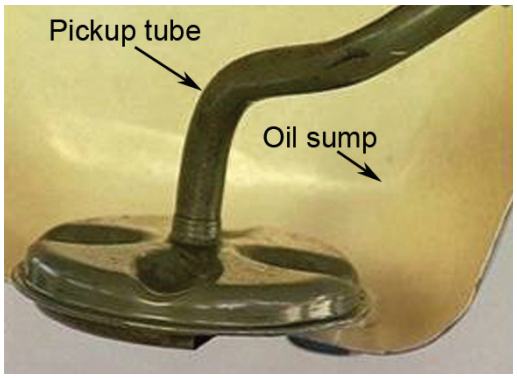
This is generally driven by the crankshaft. The inner gear is on the end of the crankshaft which then drives the pump directly. An external toothed gear meshes with this inner one. Some gear teeth are meshed but others are separated by the crescent-shaped part of the pump housing. The increasing volume between gear teeth causes pressure to fall. Oil is then taken through the intake port and carried around between the gears and crescent, then discharged to the outlet port.

Similarly in a *geared oil* pump, the driving gear meshes with a second gear. This is generally driven by the camshaft. As both gears turn, their teeth separate, creating a low pressure area. Higher atmospheric pressure outside forces oil up into the inlet. The spaces between the teeth fill with oil. The gears rotate and carry oil around the chamber. The teeth mesh again and oil is forced from the outlet toward the oil filter.



2.8 Pickup Tube

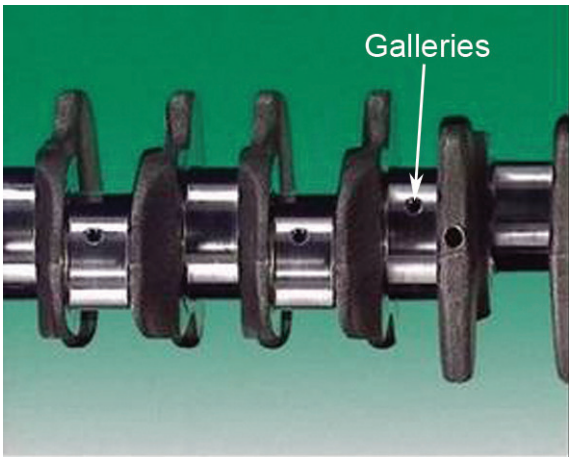
Between the sump and oil pump is a pickup tube with a flat cup and a strainer immersed in the oil. The strainer stops large particles of dirt and carbon entering the pump and damaging it. The pickup tube leads to the inlet of the oil pump on the low pressure side of the pump.



2.9 Spurt Holes and Galleries

Pistons, rings and pins are lubricated by oil thrown onto the cylinder walls from the connecting rod bearings.

Some connecting rods have oil spurt holes. These holes are positioned to receive oil from similar holes in the crankshaft. Oil can then spurt out at the point in the engine cycle when the largest area of cylinder wall is exposed. It lubricates the walls and gudgeon pin and also cools the underside of the piston.



Oil feeds to the cylinder head and through a gallery to the camshaft bearings and valve-train. As well as lubricating these moving parts, it also gathers heat from the engine so its temperature keeps rising. Finally it drains back to the sump to cool and start again.

2.10 Sump

The sump is bolted to the engine under the crankcase.

It is a reservoir or storage container for the engine lubricating oil and a collector for oil returning from the engine lubricating system.

The sump can be formed as a thin sheet metal pressing or aluminium and shaped to ensure that oil will return to its deepest section. The oil pickup tube and strainer are located in this deep section to ensure they stay submerged in oil and to prevent air being drawn into the oil pump. Some high performance vehicles have a baffle tray fitted to prevent churning of the oil by the rotation of the crankshaft. Baffles prevent oil from surging away from the pickup during cornering, braking and accelerating.

The sump's large external surface area helps heat transfer from the oil to the outside air. In some designs, the sump is an aluminium alloy casting with fins and ribs to assist in this heat transfer.

3.0 Engine Oil Filters

Key Learning Points

- Oil filter types and service procedures, replaceable element and throw-away canister

Oil filters covered in section 2.4

3.1 Replacing an Oil Filter

Preparation and Safety

Objective

Replace an oil filter to the manufacturer's specifications.

Personal Safety

Whenever you perform a task in the workshop you must use personal protective clothing and equipment that is appropriate for the task and which conforms to your local safety regulations and policies. Among other items, this may include:

- Work clothing - such as coveralls and steel-capped footwear
- Eye protection - such as safety glasses and face masks
- Ear protection - such as earmuffs and earplugs
- Hand protection – such as rubber gloves and barrier cream
- Respiratory equipment – such as face masks etc.

Safety Check

Make sure that you understand and observe all legislative and personal safety procedures when carrying out the following tasks. If you are unsure of what these are, ask your instructor.

Points to Note

- If the engine has been running, be careful not to burn your hand or arm on the exhaust manifold or any other hot part of the engine when reaching for the dipstick. The dipstick and the oil on it will also be hot.If the oil on the dipstick is not blackish in colour but looks milky grey, this could indicate that there is some water (or coolant) being mixed into the oil. There may be a serious problem somewhere in the engine, such as leaking head gasket and you should report this to your instructor immediately.

Step-by-step Instruction

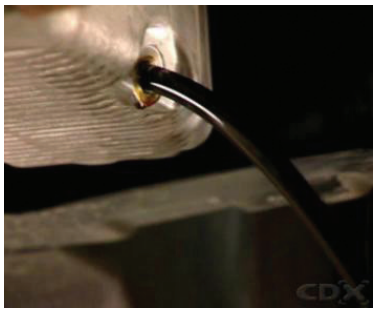
1. *Check new filter availability*: Before removing an oil filter, first refer to the Service Manual for the vehicle and identify the type of filter required. Make sure that a suitable filter will be available as a replacement.

2. *Locate filter and correct tool:* The filter will usually be located on the side of the engine block or at an angle underneath the engine. Some filters have a retaining nut which will require a box wrench to remove it, but most late model vehicles have filters, which are threaded cartridges. These are removed with an adjustable filter wrench.

3. *Remove filter and inspect:* Remove the filter and clean the seating area on the engine so that its surface and the surface of the new filter can seal properly. Make sure that the seal from the removed filter is not still stuck to the engine.

4. *Obtain replacement filter:* Confirm the correct part number and obtain the replacement filter from your spare parts supply. It is good practice to fit a new filter every time you drain the sump.

5. *Correctly fit replacement filter:* Smear a little oil or grease on the surface of the new sealing ring. This will help to make a tight seal, but it will also prevent the gasket from binding and distorting while it is being tightened. Screw in the filter until the two surfaces are touching. To help judge the correct degree of the turn, make a mark on the outside of the filter with a pencil, or even a dab of oil, but remember to wipe the oil off again when you have finished. Do not over tighten the filter. Typically, three-quarters of a full turn is adequate torque for a seal that will not leak.



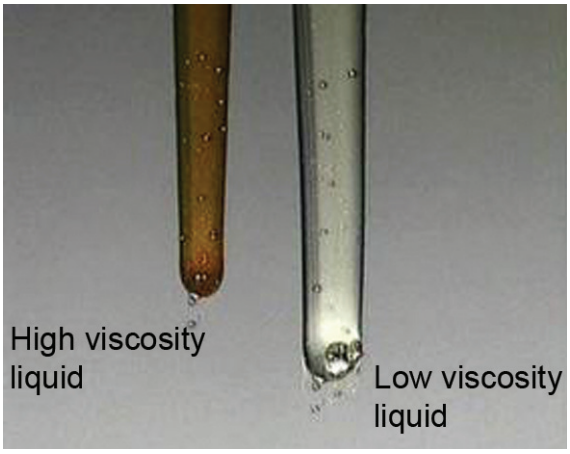
4.0 The Terms; Friction, Viscosity and Multi-Grade

Key Learning Points

- Definition of friction and viscosity, basics of SAE viscosity ratings and API classifications/quality and grades, multi-grade; polymer expansion with increase in temperature, viscosity levels at low/high temperatures

4.1 Functions of Oil

One function of a lubrication system is to reduce friction. Friction occurs between all surfaces in contact. When moving surfaces come together friction tends to slow them down.



But it can also cause serious damage. It can make metal parts so hot they melt and fuse together. When that happens an engine is said to have seized.

How long an engine lasts depends to a large extent on how well it's lubricated, especially at the points of extreme loading.

So lubrication reduces unwanted friction and controls it where it is useful.

It reduces wear on moving parts. Clearances fill with oil so that engine parts move or float on layers of oil instead of directly on each other. Much less power is needed to move them and that's a plus.

It helps cool an engine. It collects heat from the engine and then returns to the sump where it cools.

Some engines have Oil landing on the under-sides of the pistons either by splash or spray that helps lower the temperature of the piston. High powered engines, in particular, those petrol and diesel that are fitted with turbo chargers have special nozzles that spray the oil directly up underneath the piston crown, this helps remove excess heat from the piston. These engines usually have an 'oil cooler' fitted as standard.

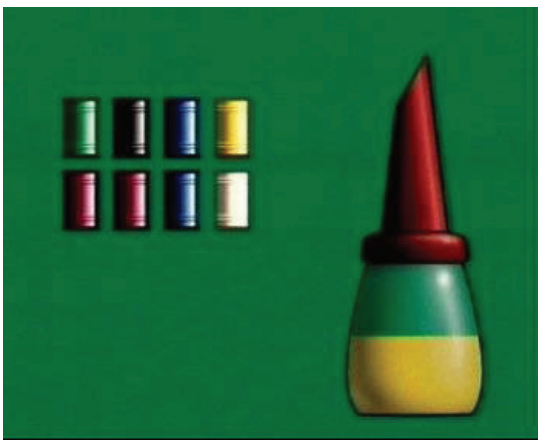
It helps absorb shock loads. A power stroke can suddenly put as much as 2 tonnes force on main bearings. Layers of oil cushion this loading.

Oil is also a cleaning agent. It collects particles of metal and carbon and carries them back to the sump. Larger pieces fall to the bottom.

How Carbon formation takes place (the oil underneath and around the pistons will encounter temperatures above the 120ºC, the recommended maximum temperature of the lubricating oil. At these higher temperatures, the oil oxidizes to form carbon and varnish).

4.2 Oil Additives

Special chemicals called additives are added to the base oil by the oil companies. Different combinations of these additives allow the oil to do different jobs in an engine.



Chemical additives are not pure chemicals having fixed physical and chemical properties. They are complex mixture of chemical intermediates added according to lubricant performance requirements.

Chemical intermediates can be classified as follows:

- Dispersants
- Detergents
- Oxidation inhibitors
- Corrosion inhibitors
- Antiwar agents
- Viscosity modifiers
- Pour Point Depressants

Extreme-pressure additives coat parts with a protective layer so that the oil resists being forced out under heavy load.

Oxidation-inhibitors stop very hot oil combining with oxygen in air to produce a sticky material like tar which clogs galleries.

Corrosion-inhibitors help stop acids forming that cause corrosion especially of bearing surfaces.

Anti-foaming agents reduce the effect of oil churning in the crankcase and minimize foaming.

Detergents reduce carbon deposits on parts like piston rings and valves.

Dispersants collect particles that can block the system, separate them from each other and keep them moving. Then they will be removed when the oil is changed.

4.3 Specification and Terms Associated with Lubricating Oil

Viscosity

Viscosity is the term used to describe the 'resistance to flow' of a liquid. A high viscosity liquid is very slow to flow, (e.g. grease has a very high viscosity) where a low viscosity liquid (diesel fuel) flows very easily. Increasing the temperature of oil causes it's viscosity to drop.

Viscosity Index

This is the number system used by the Society of Automotive Engineers (SAE) to indicate the viscosity of oil. SAE 10 is an example of a 'thin' or 'light' oil while SAE 50 would be a 'thick' or 'heavy' oil. The viscosity number is only an indication of the viscosity, or the 'resistance to flow' of the oil, it is not an indication of the quality of the oil. The quality of the oil is indicated by the API specification.

Viscosity Improvers

These are chemicals that are added or blended in to oil to change its reaction to temperature change. Special polymers that expand when they are heated are used to change the composition of the oil. Remember, multi-grade oils are definitely not a mix of the different standard grade of oils.

Multigrade Oil

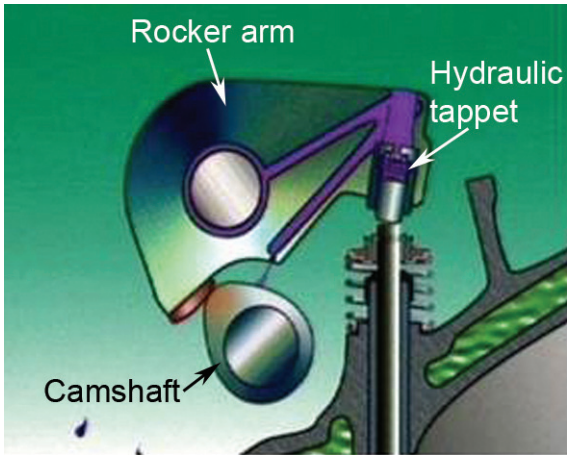
This is the term used to describe oils that have special 'additives' or 'viscosity improvers' added. These are 'multi-viscosity' oils. These oils e.g. 20-50 have a similar level of viscosity or they are as 'light' as standard 20 grade oil at low temperatures and they are as 'viscous' or as 'thick' as standard oil of viscosity figure of 50 would be if it were at the temperature of 100ºC.

API Specification

The American Petroleum Institute has classified engine lubricating oils for with the letter 'S' followed by a second letter. The second letter starts at the letter 'A' which pure mineral oil with no additives, the letter 'B' then follows to the present letter 'J'. Oil that meets or exceeds the API specification of SJ oil is currently the best available until the specification of 'SH' is available.

4.4 Viscosity

For oil to do all of the work that's expected of it, it must have special properties.



Its viscosity is crucial. Viscosity is a measure of how easily a liquid flows. Low-viscosity liquid is thin and flows easily. High-viscosity liquid is thick and flows slowly.

Lubricating oil must be thin enough to circulate easily between moving parts, but not so thin that it will be forced out from between them. If it is forced out, parts will be left in direct contact and they'll be damaged.

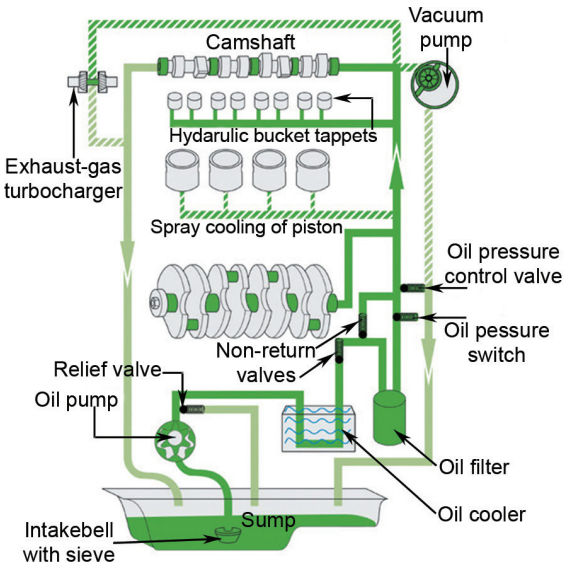
If it's too viscous, it moves too slowly to protect parts, especially in a cold engine.

5.0 Oil Flow Diagram for an Engine

Key Learning Points

- Diagram, full flow system, oil flow pattern through pump, relief valve

Courtesy of Volkswagen



6.0 Oil Flow Path through a 4-Cylinder Engine

Key Learning Points

- Oil flow path; sump, pump, filter galleries, crank-cam journals, return

Practical Task

Please refer to your instructor for additional information, which is available from the automotive technical manuals.

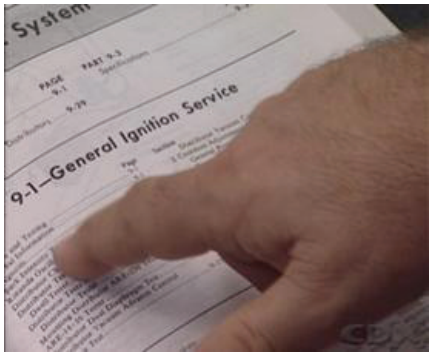
7.0 Engine Lubrication System Data

Key Learning Points

- Use of manufacturer's data; oil specs, engine temp and speed, min - max pressures

Practical Task

Please refer to your instructor for additional information, which is available from the automotive technical manuals.



8.0 Preparation of a Vehicle for Servicing

Key Learning Points

- Use of seat, steering wheel, wing covers, floor mats, cleaning of vehicle exterior and interior bodywork

8.1 Vehicle Servicing

Practical Task

Please refer to your instructor for appropriate vehicle service data, which is available from the automotive technical manuals.

Note: The Use of seat, steering wheel, wing covers and floor mats are necessary when carrying out a repair on a vehicle. It is important that clean clothes are worn and ensure that hands are also clean as they will mark the interior and exterior body panels.

9.0 Changing Oil and Oil Filter

Key Learning Points

- Oil/filter service procedure correct; no leaks/spills, correct level; filter tightening procedure, vehicle mileage and planned next service schedule noted

9.1 Changing Oil and Oil Filter

Also covered in section 3.1

Practical Task

Please refer to your instructor for additional information, which is available from the automotive technical manuals.

10.0 Popular Oil Pump Types and the Method of Drive Used

Key Learning Points

- Pumps, eccentric-bi-rotor, crescent gear type, drive from crank/ camshaft and gear/chain/direct

Oil pump covered in 2.7.

11.0 Testing and Recording Oil Pressure on an Engine

Key Learning Points

- Oil pressure test to manufacturer's procedures, i.e. pressure gauge and tachometer fitted/used correctly, results recorded in suitable format for further analysis/discussion

Practical Task

Please refer to your instructor for additional information, which is available from the automotive technical manuals.

12.0 The Main Causes of Excessive Oil Consumption

Key Learning Points

- Causes of oil consumption; worn piston/rings, valve stem oil seals, leaks etc.

12.1 Causes of Oil Consumption

Engines may lose oil through leakage or burning in the combustion chamber. Complaints about oil consumption should always start with a visual examination for signs of external leaks.

Oil Leaks

These can occur at any joint between two components on the engine that are intended to have a leak proof joint. Leaks can occur at the sump plug, oil filter seals or oil filler cap. Front and rear crankshaft seals and front camshaft seals, vacuum pumps and positive crankcase ventilation systems can also be places of leaks.

Crankcase Pressure

Excessively high pressure in the crankcase can be a reason for oil leaks at shaft seals etc. This is not high oil pressure; it is the pressure of the gases that fill the space underneath the pistons and above the oil level. The positive crankcase ventilation system allows the crankcase ventilate gases through an oil separator and then into the inlet manifold, however, should this oil separator become clogged, crankcase pressure will rise resulting in oil being forced out by the 'blow by' pressure.

Oil Consumption

Worn pistons and rings will result in increased oil consumption. This will be immediately obvious by the presence of blue smoke from the exhaust. Also, the crankcase ventilation will show signs of over activity. Oil may also gain entry into the combustion chamber past the valve stem oil seals. These seals prevent oil being induced into the inlet manifold by the low atmospheric air pressure that exists there; this low pressure is at its lowest when the engine is on over-run (high inlet manifold vacuum). Oil drawn in then will be burned when the throttle is once again opened, then you see the tell tale blue smoke.

Self Assessment

Q1: Which additives keep contaminants in suspension within the oil? (Tick one box only)

- ❑ 1. Dispersants
- ❑ 2. Detergents
- ❑ 3. Antioxidants
- ❑ 4. Anti-foam agents

Q2: Some types of oil cooler have oil tubes that pass through fins which are placed in the air stream as the vehicle moves, what is this type called? (Tick one box only)

- ❑ 1. An oil to oil cooler
- ❑ 2. Oil to air oil cooler
- ❑ 3. Oil to coolant oil cooler
- ❑ 4. An air to coolant oil cooler

Q3: Automotive engines rely on a high or low coefficient of friction for effective performance? (Tick one box only)

- ❑ 1. Low
- ❑ 2. High
- ❑ 3. Both high and low

Q4: Contamination of oil in an engine is usually caused by: (Tick one box only)

- ❑ 1. Natural deterioration of the oil
- ❑ 2. The use of crankshaft labyrinth seals
- ❑ 3. By-products of combustion
- ❑ 4. Dust which enters the dipstick tube

Q5: What does the S.A.E. rating of the oil indicate? (Tick one box only)

- ❑ 1. The interval between oil changes
- ❑ 2. The detergent content of the oil
- ❑ 3. The ability of the oil to resist heat
- ❑ 4. The viscosity of the oil

Q6: Which additives in engine oil reduce build-up of deposits on pistons and valves? (Tick one box only)

- ❑ 1. Dispersants
- ❑ 2. Detergents
- ❑ 3. Inhibitors
- ❑ 4. Depressants

Q7: Which of the following additives gives engine oil its multi-grade property? (Tick one box only)

- ❑ 1. Anti-wear agents
- ❑ 2. Detergents
- ❑ 3. Viscosity index improvers
- ❑ 4. Pour-point depressants

Q8: The purpose of the by-pass valve in an oil filter is to: (Tick one box only)

- ❑ 1. Send some oil to the by-pass filter
- ❑ 2. Allow oil to by-pass the filter when necessary
- ❑ 3. Prevent high oil pressure developing
- ❑ 4. Direct by-passed oil to the sump

Q9: Which component in the lubrication system regulates the oil pressure? (Tick one box only)

- ❑ 1. The oil pump
- ❑ 2. The filter by-pass valve
- ❑ 3. The pressure relief valve
- ❑ 4. The by-pass filter

Q10: Which is the most common oil filtering system employed on automotive vehicles? (Tick one box only)

- ❑ 1. By-Pass
- ❑ 2. Half-pass
- ❑ 3. Treble-pass
- ❑ 4. Full flow

Q11: Oil helps to reduce friction by: (Tick one box only)

- ❑ 1. Removing excess heat
- ❑ 2. Apply a varnish-like substance to moving parts
- ❑ 3. Circulating pressurized oil through the combustion chamber
- ❑ 4. Coating the engine parts with a lubricating film

Q12: Oil helps to seal the space between the piston rings and the cylinder wall by: (Tick one box only)

- ❑ 1. Leaving a varnish-like residue behind
- ❑ 2. Preventing lateral movement of the piston
- ❑ 3. Covering the walls with a lubricant coating and filling any gaps that might be present
- ❑ 4. Pressurizing the lower portion of the engine

Q13: Which of the following items will cause oil pressure problems? (Tick one box only)

- ❑ 1. Excessive main bearing wear
- ❑ 2. Lack of oil in the system
- ❑ 3. A defective oil pump
- ❑ 4. All of these items

Q14: How does the force feed system lubricate main engine bearings? (Tick one box only)

- ❑ 1. By a splash system
- ❑ 2. By a rotating dipper
- ❑ 3. By a return hole at the end of the crankshaft
- ❑ 4. Through holes that are drilled through the crankshaft

Q15: Engine oil with a detergent additive in it, is both an engine lubricant and: (Tick one box only)

- ❑ 1. A cleansing agent
- ❑ 2. An antifreeze solution
- ❑ 3. A mixture of reprocessed engine oil
- ❑ 4. Has a high heat resistance

Q16: What is the function of the relief valve in the engine's lubricating system? (Tick one box only)

- ❑ 1. To thin out the oil in cold weather
- ❑ 2. To boost the oil pressure
- ❑ 3. To protect the lubricating system against excessive oil pressure
- ❑ 4. All of these

Q17: Which of the following items could cause low oil pressure in an engine? (Tick one box only)

- ❑ 1. A clogged pickup screen
- ❑ 2. Excessive oil contamination
- ❑ 3. Both a clogged pickup screen and excessive oil contamination
- ❑ 4. Neither a clogged pickup screen nor excessive oil contamination

Q18: Select the correct option to complete the statement. The viscosity of the oil will _____ as fuel enters the oil. (Tick one box only)

- ❑ 1. Get thicker
- ❑ 2. Increase its viscosity value
- ❑ 3. Reduce its viscosity value
- ❑ 4. Remain the same

Q19: Select the correct option to complete the statement. Viscosity can be defined as the _____ of the oil. (Tick one box only)

- ❑ 1. Pour point
- ❑ 2. Thickness
- ❑ 3. Acidity
- ❑ 4. Oxidation

Q20: Which device controls the pressure of the oil directly coming from the oil pump? (Tick one box only)

- ❑ 1. The pump valve
- ❑ 2. The regulator valve
- ❑ 3. The pressure relief valve
- ❑ 4. The oil pressure switch

Training Resources

- Technical information in book/electronic form on engine lubrication systems, oil; friction-cause and reduction
- Bench unit and operational engines
- Oil, filters, filter tools, used lubrication oil filter, storage-disposal-recycling facilities
- Tachometer and oil pressure gauges
- Manufacturer's data
- Vehicle bodywork, interior and exterior protection materials

Suggested Exercises

1. Use an electronic data facility to procure manufacturer's appropriate data for use with practical exercises
2. Identify the main components in the lubrication system and describe the passage of oil flow through the engine
3. On a training vehicle/unit, carry out a lubrication service
4. Test oil pressure and record findings for comparison to manufacturer's specification in further discussion/analysis with instructor
5. Use vehicle bodywork protection materials/devices on all practical automotive exercises

Task Sheets

Checking Engine Oil

Preparation and Safety

Objective

Check and adjust engine oil level and condition.

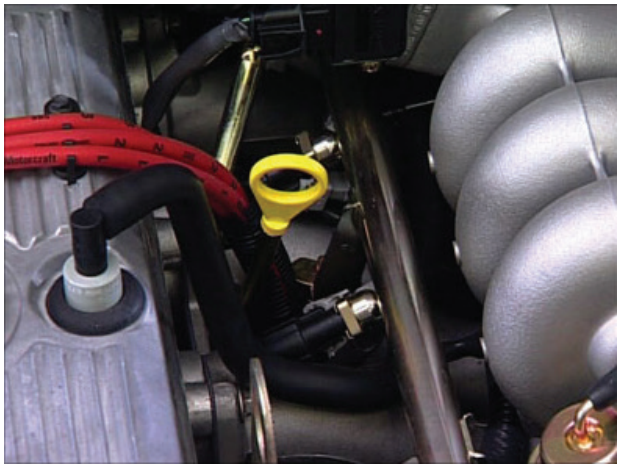
Personal Safety

Whenever you perform a task in the workshop you must use personal protective clothing and equipment that is appropriate for the task and which conforms to your local safety regulations and policies. Among other items, this may include:

- Work clothing - such as coveralls and steel-capped footwear
- Eye protection - such as safety glasses and face masks
- Ear protection - such as earmuffs and earplugs
- Hand protection – such as rubber gloves and barrier cream
- Respiratory equipment – such as face masks etc.

Safety Check

- If the engine has been running, be careful not to burn your hand or arm on the exhaust manifold or any other hot part of the engine when reaching for the dipstick. Remember, the dipstick and the oil on it will also be hot.
- Dripping oil from the dipstick will smoke or burn if it falls on any hot engine areas.



- Make sure that the bonnet is secure with a bonnet stay rod.

- Always make sure that you wear the appropriate personal protection equipment before starting the job. It is very easy to hurt yourself even when the most exhaustive protection measures are taken.
- Always make sure that your work area/environment is as safe as you can make it. Do not use damaged, broken or worn out workshop equipment.
- Always follow any manufacturer's personal safety instructions to prevent damage to the vehicle you are working on.
- Make sure that you understand and observe all legislative and personal safety procedures when carrying out the following tasks. If you are unsure of what these are, ask your instructor.

Points to Note

- Make sure the vehicle is on a level surface and the engine is off before taking a reading. If you don't, you'll get inaccurate readings. The oil will also collect in the sump when the engine is off.
- Typically, the amount of oil needed to raise the oil level from the low mark on the dipstick to the high mark is about a litre. This varies, so always check the shop manual to determine the correct quantity. Never fill the engine with oil to the top of the filler cap!

- If the oil on the dipstick is not blackish in colour but looks milky grey, this could indicate that there is some water (or coolant) being mixed into the oil. There may be a serious problem somewhere in the engine, such as a leaking head gasket and you should report this to your instructor immediately.

- Engine operating conditions can also influence the oils condition. For instance, continuously stopping and starting the engine with very small operating cycles can cause condensation inside the engine. An extreme case of this will cause very rapid oil deterioration and will require frequent oil changes.

Don't forget to replace the filler cap after topping up the oil.

Step-by-Step Instruction

1. *Locate dipstick:* The dipstick is located on the side of the engine block and is usually very easy to find, with a distinctively shaped or brightly coloured handle.

2. *Remove dipstick and wipe clean:* Remove the dipstick, catching any drops of oil on a rag and wipe it clean. There are markings on the lower end of the stick to indicate whether the oil level needs to be topped up.

3. *Take the oil level reading:* Replace the dipstick and push it back down into the sump as far as it will go. Remove it again and the level of oil in the oil pan will be clearly visible on the stick. If the level is below the 'full' or topmost mark, then you should top up the engine to that level with fresh oil.

4. *Check condition of oil:* If the oil appears very black and dirty, it may have lost some of its protective and lubricating qualities and may need to be completely changed. Check the service record or ask the customer when the oil was last changed.

5. *Adjust level if necessary:* If additional oil is needed, estimate the amount by checking the service manual guide to the dipstick markings. Unscrew the filler cap at the top of the engine and using a funnel to avoid spillage, gently pour the oil into the engine.

6. *Recheck the dipstick level:* Replace the oil filler cap and check the dipstick again to make sure the level of oil in the engine is now correct.

Draining Engine Oil

Preparation and Safety

Objective

Safely drain engine oil.

Personal Safety

Whenever you perform a task in the workshop you must use personal protective clothing and equipment that is appropriate for the task and which conforms to your local safety regulations and policies. Among other items, this may include:

- Work clothing - such as coveralls and steel-capped footwear
- Eye protection - such as safety glasses and face masks
- Ear protection - such as earmuffs and earplugs
- Hand protection – such as rubber gloves and barrier cream
- Respiratory equipment – such as face masks etc.

Safety Check

Make sure that you understand and observe all legislative and personal safety procedures when carrying out the following tasks. If you are unsure of what these are, ask your instructor.

Points to Note

- If the engine has been running, be careful not to burn your hand or arm on the exhaust manifold or any other hot part of the engine when reaching for the dipstick. The dipstick and the oil on it will also be hot.

- If the oil on the dipstick is not blackish in colour but looks milky grey this could indicate that there is some water (or coolant) being mixed into the oil. There may be a serious problem somewhere in the engine, such as leaking head gasket and you should report this to your instructor immediately.

Step-by-Step Instruction

1. *Prepare the work area*: Before you begin, you will need to mop up any oil spills, you must have ready a container large enough to hold all the oil from the engine you are about to drain and have enough new oil of the correct type to refill the engine later. In some vehicles, the engine will drain more easily if the filler cap at the top of the engine has been removed, so do this before the car is lifted.

2. *Identify drain plug and removal tool:* Always use the Service Manual to help you locate and identify components if you are not completely sure of their location. The oil drain plug is found underneath the oil pan, which holds all the oil in the engine. Some vehicles have two drain plugs, draining separate sump areas. To minimize the possibility of damage to the head of the bolt, you will need a box wrench or socket wrench to remove and replace the drain bolt. Be very careful that you do not remove the transmission drain plug by mistake.

3. *Remove drain bolt and inspect:* When you have removed the drain bolt separate the sump plug gasket from the bolt and clean the threads. If the threads are damaged then the bolt may need to be replaced. Look for solid metal particles stuck to the bolt and report these to your instructor. They may indicate an undiagnosed problem with the engine.

4. *Drain the oil*: The oil will drain more efficiently from the engine if it is hot, so run the engine for a few minutes before draining. But if the oil is hot it can burn you, so be VERY careful when you remove the plug so that the oil does not spill onto your hand. If the engine is cold you will need to allow much longer for it to completely drain, or the new oil will become contaminated by residual oil still clinging to the inside surfaces of the engine.

5. *Safely dispose of the drained oil*: If the drained oil is hot, take extra care not to spill it, especially not onto yourself. When tipping the oil from the draining container into the recycle container, again look for signs of metal particles left at the bottom of the container.

Replacing an Oil Filter

Preparation and Safety

Objective

Replace an oil filter to the manufacturer's specifications.

Personal Safety

Whenever you perform a task in the workshop you must use personal protective clothing and equipment that is appropriate for the task and which conforms to your local safety regulations and policies. Among other items, this may include:

- Work clothing - such as coveralls and steel-capped footwear
- Eye protection - such as safety glasses and face masks
- Ear protection - such as earmuffs and earplugs
- Hand protection – such as rubber gloves and barrier cream
- Respiratory equipment – such as face masks etc.

Safety Check

Make sure that you understand and observe all legislative and personal safety procedures when carrying out the following tasks. If you are unsure of what these are, ask your instructor.

Points to Note

- If the engine has been running, be careful not to burn your hand or arm on the exhaust manifold or any other hot part of the engine when reaching for the dipstick. The dipstick and the oil on it will also be hot.

- If the oil on the dipstick is not blackish in colour but looks milky grey, this could indicate that there is some water (or coolant) being mixed into the oil. There may be a serious problem somewhere in the engine, such as leaking head gasket and you should report this to your instructor immediately.

Step-by-Step Instruction

1. *Check new filter availability*: Before removing an oil filter, first refer to the Service Manual for the vehicle and identify the type of filter required. Make sure that a suitable filter will be available as a replacement.

2. *Locate filter and correct tool:* The filter will usually be located on the side of the engine block or at an angle underneath the engine. Some filters have a retaining nut which will require a box wrench to remove it, but most late model vehicles have filters, which are threaded cartridges. These are removed with an adjustable filter wrench.

3. *Remove filter and inspect:* Remove the filter and clean the seating area on the engine so that its surface and the surface of the new filter can seal properly. Make sure that the seal from the removed filter is not still stuck to the engine.

4. *Obtain replacement filter:* Confirm the correct part number and obtain the replacement filter from your spare parts supply. It is good practice to fit a new filter every time you drain the sump.

5. *Correctly fit replacement filter:* Smear a little oil or grease on the surface of the new sealing ring. This will help to make a tight seal, but it will also prevent the gasket from binding and distorting while it is being tightened. Screw in the filter until the two surfaces are touching. To help judge the correct degree of the turn, make a mark on the outside of the filter with a pencil, or even a dab of oil, but remember to wipe the oil off again when you have finished. Do not over tighten the filter. Typically, three-quarters of a full turn is adequate torque for a seal that will not leak.

Refilling Engine Oil

Preparation and Safety

Objective

Safely refill engine oil.

Personal Safety

Whenever you perform a task in the workshop you must use personal protective clothing and equipment that is appropriate for the task and which conforms to your local safety regulations and policies. Among other items, this may include:

- Work clothing - such as coveralls and steel-capped footwear
- Eye protection - such as safety glasses and face masks
- Ear protection - such as earmuffs and earplugs
- Hand protection – such as rubber gloves and barrier cream
- Respiratory equipment – such as face masks etc.

Safety Check

Make sure that you understand and observe all legislative and personal safety procedures when carrying out the following tasks. If you are unsure of what these are, ask your instructor.

Points to Note

- If the engine has been running, be careful not to burn your hand or arm on the exhaust manifold or any other hot part of the engine when reaching for the dipstick. The dipstick and the oil on it will also be hot.
- If the oil on the dipstick is not blackish in colour but looks milky grey, this could indicate that there is some water (or coolant) being mixed into the oil. There may be a serious problem somewhere in the engine, such as leaking head gasket and you should report this to your instructor immediately.

Step-by-Step Instruction

1. *Replace drain bolt:* Before replacing the drain bolt, install a new sump plug gasket. Screw in the bolt and then tighten it to the torque level recommended by the manufacturer. You will find this information in the vehicle service manual.

2. *Select correct type of oil*: The service manual or the owner's manual will also tell you the correct grade of oil for the vehicle and the quantity you will need to fill the engine.

3. *Add correct amount of oil:* Pour the oil in carefully so that no oil is spilt onto the outside of the engine and slowly enough to avoid the risk of blowback or overflow. Fill the engine only to the level indicated on the engine dipstick, not until the oil is coming out the top of the filler nozzle. Replace the filler cap.

4. *Run the engine, check pressure*: Start the engine and check the oil pressure indicator on the dash. If the oil pressure is inadequate, stop. Do not continue to run the engine.

5. *Inspect under car for oil leaks*: Check underneath the vehicle to make sure that no oil is leaking from the drain plug.

6. *Stop engine and inspect level*: Turn the engine off and wait thirty seconds, then check the level again with the dipstick. It may be necessary to top off the engine by adding a small additional quantity of oil to compensate for the amount absorbed by the new filter.

7. *Install reminder sticker*: Refer to the owner's manual or the service manual and install a static sticker or door sticker to remind the owner when the next oil change is due.

Suggested Further Reading

- Advanced Automotive Diagnosis. Tom Denton. ISBN 0340741236
- Automobile Electrical and Electronic Systems (3rd Edition). Tom Denton. ISBN 0750662190
- Automotive Mechanics (10th Edition). William H. Crouse and Donald L. Anglin. ISBN 0028009436
- Bosch Automotive Electrics Automotive Electronics: Systems and Components (4th Edition). Robert Bosch. ISBN 0837610508
- Bosch Automotive Handbook (6th Edition). Robert Bosch. ISBN 1860584748
- Bosch Automotive Technology Technical Instruction booklet series (numerous titles)
- Hillier's Fundamentals of Motor Vehicle Technology: Book One (5th Edition). V.A.W. Hillier and Peter Coombes. ISBN 0748780823
- Hillier's Fundamentals of Motor Vehicle Technology: Book Two (5th Edition). V.A.W. Hillier and Peter Coombes. ISBN 0748780998
- Modern Automotive Technology. James E. Duffy. ISBN 1566376106
- Motor Vehicle Craft Studies - Principles. F.K. Sully. ISBN 040800133X
- National Car Test (NCT) Manual (Department of Transport, Vehicle Testers Manual - DoT VTM). Department of Transport
- Transmission, Chassis and Related Systems (Vehicle Maintenance and Repair Series: Level 3) (3rd Edition) John Whipp and Roy Brooks. ISBN 186152806X
- Vehicle and Engine Technology (2nd Edition). Heinz Heisler. ISBN 0340691867
- http://www.cdxglobal.com/
- http://auto.howstuffworks.com/
- http://www.autoshop101.com/
- http://www.cdxetextbook.com/
- Automotive Encyclopedia and Text Book Resource (CD version of e-textbook), Available from your instructor.

Notes

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