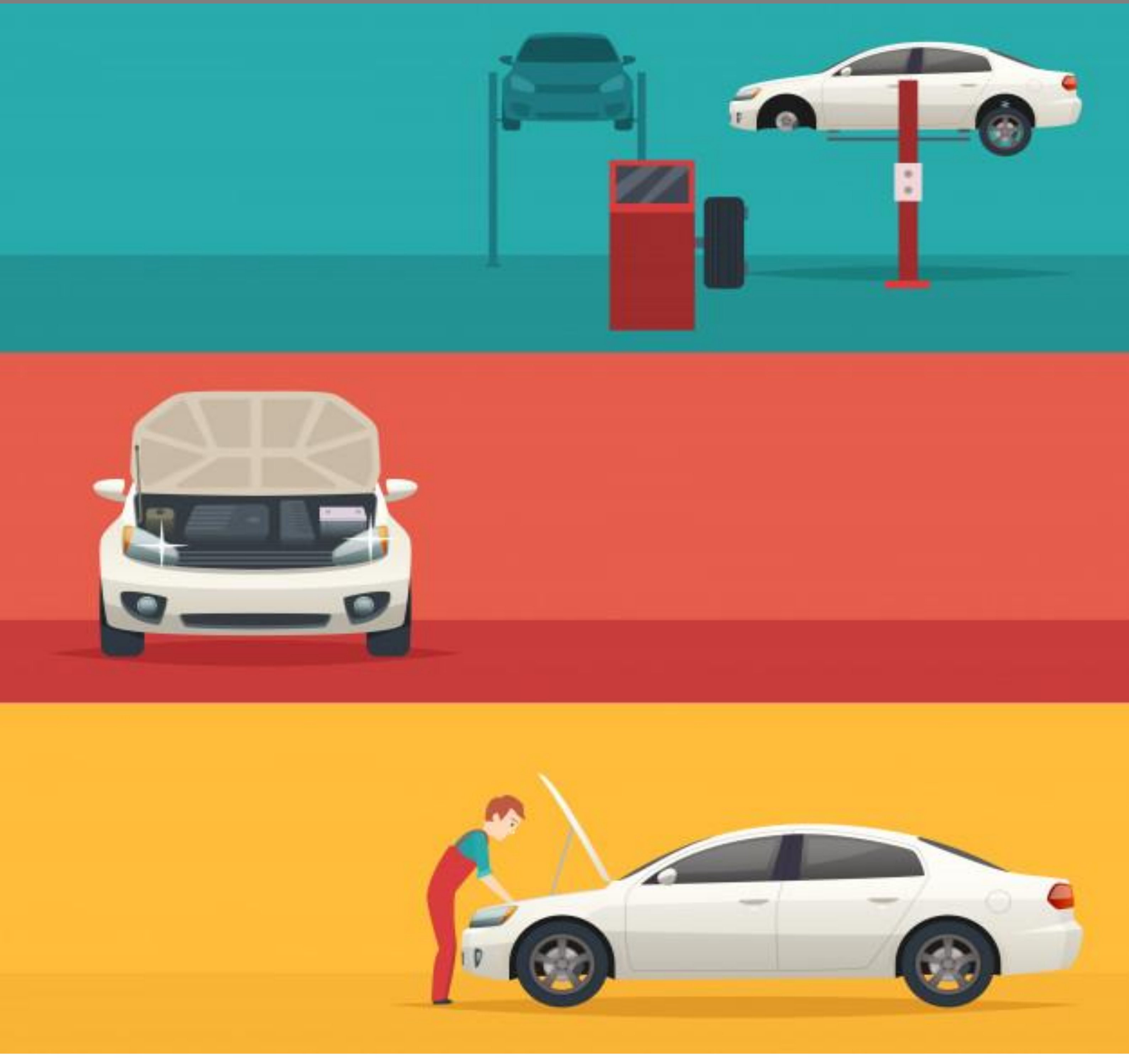
MODULE

MINOR SERVICE



AUTOMOTIVE TECHNOLOGY CENTRE (ATeC)
POLYTECHNIC OF SULTAN MIZAN ZAINAL ABIDIN

MODUL MINOR SERVICE ini merupakan satu modul pembelajaran yang di olah untuk tujuan bahan kursus pembelajaran sepanjang hayat di bawah Automotive Technology Center, Politeknik Sultan Mizan Zainal Abidin. Modul ini merangkumi teori berkenaan sistem sistem pelinciran kenderaan, sistem penyejukan dan juga sistem penyalaan enjin kenderaan. Di dalam modul ini juga terdapat penerangan dan prosuder amali melakukan servis asas sistem pelinciran, sistem penyejukan dan juga sistem penyalaan kenderaan.

EDITOR:
Ts MUHD HASANUL ISYRAF BIN MAT JUNOH

PENULIS:
AHMAD JAMSANI BIN MAHMUD
Ts DR MOHD HAFIZIL BIN MAT YASIN

TERBITAN EDISI 2021

DITERBITKAN OLEH:
Automotive Center of Technology
Jabatan Kejuruteraan Mekanikal,
Politeknik Sultan Mizan Zainal Abidin,
Km 8, Jln. Paka, 23000 Dungun, Terengganu

TELEFON:
09 - 840 0800
09 - 845 8781

EMAIL:
webmaster@psmza.edu.my

CONTENT

Lubricant System	**1**
Ignition System	**9**
Cooling System	**12**
Engine Oil Check	**16**
Engine Oil Draining	**18**
Replace Oil Filter	**19**
Engine Oil Filling	**20**
Coolant Draining	**21**
Coolant Bleeding	**24**
Radiator Fan Functional Test	**26**
Dismantle and Visually Inspect Spark Plug	**26**
Spark Plug Gap Check	**28**
Spark Trigger Test	**29**

THEORY

Engine oil

Engine oils are employed primarily to lubricate contiguous components in relative motion within the internal combustion engine. The oil also removes heat generated by friction, carries abraded particles away from the friction surface, washes out contaminants, holds them in suspension, and protects metals against corrosion. The most common engine oils are mineral oils treated with additives. Higher stress resistance requirements combined with extended oil-change intervals have led to widespread application of fully and semi-synthetic oils.

The quality of an engine oil is determined by its origin, the refining processes used on the mineral oil (except in the case of synthetic oils) and the additive composition.

Additives are classified according to their respective functions:

- Viscosity index improvers
- Pour-point improvers
- Oxidation and corrosion inhibitors
- Detergent and dispersant additives
- Extreme-pressure (EP) additives
- Friction modifiers
- Anti-forming agents.

Figure 1: 15W-40 engine oil

SAE viscosity grades

The SAE grades are the internationally accepted standard for defining viscosity. The standard provides no information on the quality of the oil.

A distinction is made between single grade and multi-grade oils. Multi-grade oils are the type in widespread use today. Two series are employed for the designation where the letter "W" (winter) is used to define specific cold-flow properties. The viscosity grades including the letter "W" are rated according to maximum viscosity , maximum viscosity pumping temperature and the minimum viscosity at 100°C. Viscosity grades without the "W" are rated only according to viscosity at 100°C.

Engine Oil Function

Function	Description
Lubricating action	Friction is generated between sliding parts. The engine oil can reduce the friction between such parts. The engine oil forms an oil film on the sliding parts in the engine, which reduces the friction of the sliding parts and makes them operate smoothly.
Cooling action	The engine has cooling devices such as the radiator, but there are some parts such as the pistons and sliding parts that are difficult to cool with the cooling system. The circulating engine oil absorbs the surrounding heat from these parts and cools them by carrying the heat elsewhere and dissipating it.
Cleaning action	Metal wear particles and burning residue such as sludge and carbon are generated in an engine. If these accumulate on sliding parts or in oil channels, they may increase wear or clog the oil channels and cause lubrication defects. To prevent such materials from accumulating, the engine oil washes them away. They float in the engine oil and the oil carries them to the oil filter.
Rust prevention action	The oil prevents rust by forming an oil film over the surfaces of parts so they do not make contact with air and moisture. It also neutralized acidic substances that are generated during combustion and that can damage the engine.

Importance of Lubrication Systems

Arguably, proper lubrication is the most important factor in industrial maintenance. Without lubricating systems, many industrial and manufacturing processes would wear down from friction, overheating, and generally require maintenance much more quickly. (Without lubrication, industrial bearings rarely last more than 10% of their potential life span.) Machinery that requires constant maintenance increases production downtime and negatively affects commercial productivity overall. Some US-based estimates attribute a little over 50% of total industrial bearing failures to a lack of proper lubrication.

Oil-Rite Corporation

Common Lubricants for Lubrication Systems

Lubricants can be a solid, a solid/liquid dispersion, a liquid, a grease, or a gas. Viscosity refers to a substance's ability to resist flow under force and is the most important feature of any lubricant. The thickness of a particular substance is an important, secondary aspect of any lubricant.

Most often, lubricating systems use oil (which is considered a liquid) or grease. Oil makes an excellent lubricant because it possesses a fairly high level of viscosity and does not adhere to surfaces (as a liquid). The best oils for lubricant applications are mineral oils like petroleum because they resist degeneration much longer than organic oils. Grease is a semisolid that is even more viscous than oil. Grease lubrication in industrial settings does not use the kind of grease that comes from animal fat.

Rather, it uses a combination of soap and mineral or vegetable oil. More and more frequently, industrial lubrication is using grease made with synthetic oils, such as silicones, hydrogenated polyolefins, fluorocarbons, and esters. This switch to synthetic grease is rooted in the affordability of synthetic oils as well as the broader range of viscosities, consistencies, and environmental impact that these synthetic compounds offer. Grease is generally used on parts that require less lubrication, since it lasts longer and requires less upkeep.

How They Work

An automatic lubrication system is able to provide simultaneous lubrication of different machine parts by attaching itself to the machine. (Although they are automated, some

ALS systems may require the engagement of a manual pump or activation button to start.)

Automatic lubrication systems vary widely by compatibility and configuration. However, they all share five primary components known as a controller/timer, a pump, a supply line, metering valves/injectors, and feed lines.

- The controller, or timer, is the mechanism used to activate and shut off the lubricating system, either externally or from inside the pump.
- The pump is responsible for transporting lubricant into the main system from the reservoir (where the lubricant is stored).
- The supply line connects to the pump and enables the lubricant to travel to the metering valves/injectors.
- The metering valves, or injectors, are responsible for measuring the lubricant and subsequently dispensing it into the feed lines.
- Via the feed lines, the lubricant is finally delivered to its predetermined application points.

Types

As alluded to previously, lubrication systems vary widely in their configuration and application. One of the more convenient methods of categorizing automatic lubrication systems depends on a system's method of operation.

Single line progressive lubricating systems derive their name from the way lubricant progressively travels among a sequence of metering valves. In this type of system, the pump delivers a single lubricant shot to trigger the lubrication process. A series of valves or pistons shifts and progressively diverts lubricant to bearings or other application points before diverting lubricant to the next valve. Some type of timer feedback mechanism is responsible for eventually stopping the progression.

Parallel lubrication systems differ from single progressive systems by using multiple, parallel systems of valves or injectors. Unlike in a single progressive system, each injector is restricted to a single point of lubricant application. Parallel lubrication systems can come in single line parallel formats or double line (or dual line) parallel formats. In both types of systems, pressurized lubricant is vented back to the reservoir during the lubrication process.

(Single line parallels accomplish this by shutting off the pump, while double line parallels accomplish this via a second supply line.) The main difference between single and double line parallel lubricating systems lies in the fact that the latter possess reversing valves that allow pumps to pressurize the second supply line during the lubricating process.

Sometimes, automatic lubrication systems are distinguished by the type of specific lubrication applications they are designed for. Examples of such systems include chain oilers, air lubricators, gas pumps, chain spray/brush lubricating systems, and constant level oilers. Chain oilers are designed to work with rail or chain. Air lubricators, on the other hand, provide both lubrication and filtration to compressed air lines.

They may be installed outside of the air system, but more often, they are built directly into the air line, where they are able to provide constant lubrication to all the mechanisms inside it. Gas pump lubricators are designed to keep fuel pumps from becoming dry (which can cause permanent damage), while chain spray/brush lubricating systems can be found for oven applications in the food manufacturing industry. Finally, constant level oilers are used to maintain the fluid level in different kinds of equipment. In particular, they help bearings, gearboxes, pump housings, and pillow blocks from losing too much moisture and generating friction. (Although not the focus of this article, it is important to note that internal combustion engines rely on force-feed or pressure-feed automatic lubrication systems, sometimes with the help of an auxiliary pump.)

Multi-point lubrication systems are often distinguished by the presence of a distribution block. This block connects to and receives input from a single lubrication unit while directing its output to a system of multiple hoses. The hoses running from the distribution block lead to separate bearings and/or machinery.

A variety of other lubrication systems exist. These include multi-port direct lubricating systems, mist lubrication systems, minute volume/low pressure spray systems, recirculating oil lubricating systems, single line resistance lubricating systems, and others.

Advantages of Automatic Lubricating Systems

Automatic lubricating systems are superior to manual lubricating methods for a number of reasons. Only a few are below:

Consistency. Rather than restricting machinery lubrication to widely dispersed application times, ALS offers frequent, consistent, and real-time lubrication that is much more effective at maintaining machine longevity. Manual methods often run the risk of over-lubricating machinery to compensate for irregular lubrication methods. The real-time application made possible by ALS removes this risk. ALS removes physical risks associated with manual lubrication, especially manual lubrication that must be performed while machinery is actually running.

Efficient time usage. Since ALS lubricates machinery while that machinery is running, it slashes industrial downtime and improves the efficient usage of time.
Cost savings. The previous advantages of ALS combine to make enterprises more cost-effective and productive overall. Calculating ROI (often with the aid of a lubrication system manufacturer) is an easy way to see the benefits of using centralized lubricating systems rather than manual methods.

Applications

Industries that take advantage of the benefits offered by lubrication systems include the automotive industry, food and beverage, mining, printing, packaging, steel, paper, and industrial machining. Actual locations that depend on lubricating systems include power plants, oilfields, and steel processing facilities. Some types of lubricating systems are even used at residential homes for computer and car maintenance.

Care and Upkeep

Automatic lubricating systems are sophisticated features of industrial environments that require a great amount of care to maintain properly. Perform regular inspections on your lubrication system. Regular inspection is important to catch damage such as loose or damaged lines. Such damage can lead to over-lubrication, which in many respects is as dangerous as under-lubrication. It is recommended to check your systems at least once daily. Change or service components of your lubrication system at regular intervals. It is usually possible to obtain recommended lubricant changing schedules from your lubrication system manufacturer or supplier. Filters within lubrication systems are another important component that require regular servicing to keep them clear from dust and debris. Do not store or use lubricants in extreme temperature conditions. Extreme temperature conditions or fluctuations tend to ruin the viscosity of lubricants, and thus the overall effectiveness of your lubrication system.

Choosing an Automatic Lubrication System

Those interested in setting up one or more lubricating systems for themselves should take a few things into consideration. First, they must decide between oil-based systems and grease-based systems. For the upkeep of stationary manufacturing equipment, like CNC milling machines, oil-based lubricating systems offer the best service. For mobile units like trucks, construction equipment, or mining equipment, grease systems work best.

Of course, if different applications require different needs, it is always possible to set up both oil and grease lubricating systems. Furthermore, lubricant system users must make sure that whatever lubricant they select is compatible with the temperatures, speeds, and torques at which their machines operate. Some oil bases have better stability than others. For the same reason, lubricant system users should consider the environment in which they work.

Lubricant system customers must also decide what system configuration will best meet their application requirements. An example of such a decision is choosing between progressive and parallel lubrication systems. Series progressive lubrication systems shut down when any line or bearing in the system becomes defective. This carries the advantage of warning operators of a mechanical problem early.

If production uptime is extremely imperative, however, it may be best to use parallel systems which do not depend on every link in the system performing at optimal capacity. Parallel systems may also be preferred for other reasons. For example, a double line parallel lubrication system is ideal in scenarios that require lubrication over long distances or under extreme temperatures.

Deciding which lubrication system will best serve your specific needs should not be made in isolation. It is worthwhile to invest in finding a lubrication system supplier with a reputation not only for delivering high quality products (e.g. through partnering with multiple product lines), but for expert customer advice and custom solutions. Manufacturers often do not provide "standard" versions of important parts or accessories such as filters, pressure gauges, and grease fittings; thus, it is important to discuss the totality of your desired lubrication system with a supplier.

When purchasing lubricating systems from suppliers, be aware that certain packages may come with strings attached that do not necessarily benefit the customer (e.g. requiring customers to purchase lubricant directly from a supplier to guarantee certain warranty privileges). Take time to seek out a supplier who has not only the ability but a true will to provide you with the best lubrication application possible.

IGNITION SYSTEM

Although there are many different types of ignition systems on the market today, most can be placed in one of the three groups:

- Conventional breaker-point ignition (in use since the early 1900s)
- Electronic ignition (popular since the early 1970s)
- Distributorless ignition (introduced in the mid-1980s)
- Here’s an overview on how each of these systems operate.

Conventional Ignition System

Conventional_Break_Point_Ignition_System

An automotive ignition system is divided into two electrical circuits -- the primary and secondary circuits. The primary circuit carries low voltage. This circuit operates only on battery current and is controlled by the breaker points and the ignition switch. When the ignition key is turned on, a low voltage current from the battery flows through the primary windings of the ignition coil, through the breaker points and back to the battery. This current flow causes a magnetic field to form around the coil.

The secondary circuit consists of the secondary windings in the coil, the high tension lead between the distributor and the coil (commonly called the coil wire) on external coil distributors, the distributor cap, the distributor rotor, the spark plug leads and the spark plugs. As the engine rotates, the distributor shaft cam turns until the high point on the cam causes the breaker points to separate suddenly. Instantaneously, when the points open (separate) current flow stops through the primary windings of the ignition coil. This causes the magnetic field to collapse around the coil. The condenser absorbs the energy and prevents arcing between the points each time they open. This condenser also aids in the rapid collapse of the magnetic field.

The line of flux in the magnetic field cut through the secondary windings of the ignition coil, creating a high voltage - high enough to jump the gaps between the rotor and the distributor cap terminals, and the electrodes at the base of the spark plug. Assuming that the engine is properly timed, the spark reaches the air-fuel mixture in the cylinder and combustion begins.

As the distributor continues to rotate, electrical contact between the rotor and distributor cap terminal is broken, stopping the secondary flow. At the same time, breaker points close to the complete the primary circuit, allowing primary current to flow. This primary current will again create a magnetic field and the cycle is repeated for the next cylinder in the firing order.

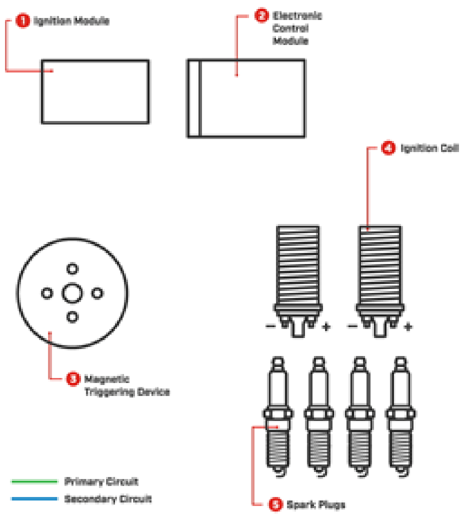
This process takes place within a few milliseconds. In fact, it happens approximately 18,000 times per minute at 90 miles per hour.

Electronic Ignition System

The need for higher mileage, reduced emissions and greater reliability has led to the development of the electronic ignition system. This system still has a distributor, but the breaker points have been replaced with a pickup coil, and there's an electronic ignition control module.

Electronic_Ignition_System

Like conventional ignition systems, electronic systems have two circuits: a primary circuit and a secondary circuit. The entire secondary circuit is the same as in a conventional ignition system. In addition, the section of the primary circuit from the battery to the battery terminal at the coil is the same as in a conventional ignition system.



With the ignition switch turned on, primary (battery) current flows from the battery through the ignition switch to the coil primary windings. Primary current is turned on and off by the action of the armature as it revolves past the pickup coil or sensor.

As each tooth of the armature nears the pickup coil, it creates a voltage that signals the electronic module to turn off the coil primary current. A timing circuit in the module will turn the current on again after the coil field has collapsed. When the current is off, however, the magnetic field built up in the coil is allowed to collapse, which causes a high voltage in the secondary windings of the coil. It is now operating on the secondary ignition circuit, which is the same as in a conventional ignition system.

Distributorless Ignition System

Very different from conventional and electronic – coils sit directly on top of the spark plugs, no spark plug wires, and the system is electronic.

Distributorless_Ignition_System

The third type of ignition system is the distributorless ignition. The spark plugs are fired directly from the coils. Spark plug timing is controlled by an ignition module and the engine computer. The distributorless ignition system may have one coil per cylinder or one coil for each pair of cylinders.

There are several advantages of not having a distributor:

- No timing adjustments.
- No distributor cap and rotor.
- No moving parts to wear out.
- No distributor to accumulate moisture and cause starting problems.
- No distributor to drive thus providing less engine drag.
- Learn more about quality spark plugs, find your car part, or find where to buy your auto part today.

What is a Cooling System? A typical 4 cylinder vehicle cruising along the highway at around 50 miles per hour, will produce 4000 controlled explosions per minute inside the engine as the spark plugs ignite the fuel in each cylinder to propel the vehicle down the road. Obviously, these explosions produce an enormous amount of heat and, if not controlled, will destroy an engine in a matter of minutes. Controlling these high temperatures is the job of the cooling system.

The modern cooling system has not changed much from the cooling systems in the model T back in the '20s. Oh sure, it has become infinitely more reliable and efficient at doing it's job, but the basic cooling system still consists of liquid coolant being circulated through the engine, then out to the radiator to be cooled by the air stream coming through the front grill of the vehicle. Today's cooling system must maintain the engine at a constant temperature whether the outside air temperature is 110 degrees Fahrenheit or 10 below zero. If the engine temperature is too low, fuel economy will suffer and emissions will rise. If the temperature is allowed to get too hot for too long, the engine will self destruct.

How Does a Cooling System Work? Actually, there are two types of cooling systems found on motor vehicles: Liquid cooled and Air cooled. Air cooled engines are found on a few older cars, like the original Volkswagen Beetle, the Chevrolet Corvair and a few others. Many modern motorcycles still use air cooling, but for the most part, automobiles and trucks use liquid cooled systems and that is what this article will concentrate on.

The cooling system is made up of the passages inside the engine block and heads, a water pump to circulate the coolant, a thermostat to control the temperature of the coolant, a radiator to cool the coolant, a radiator cap to control the pressure in the system, and some plumbing consisting of interconnecting hoses to transfer the coolant from the engine to radiator and also to the car's heater system where hot coolant is used to warm up the vehicle's interior on a cold day.

A cooling system works by sending a liquid coolant through passages in the engine block and heads. As the coolant flows through these passages, it picks up heat from the engine. The heated fluid then makes its way through a rubber hose to the radiator in the front of the car. As it flows through the thin tubes in the radiator, the hot liquid is cooled by the air stream entering the engine compartment from the grill in front of the car.

Once the fluid is cooled, it returns to the engine to absorb more heat. The water pump has the job of keeping the fluid moving through this system of plumbing and hidden passages.

A thermostat is placed between the engine and the radiator to make sure that the coolant stays above a certain preset temperature. If the coolant temperature falls below this temperature, the thermostat blocks the coolant flow to the radiator, forcing the fluid instead through a bypass directly back to the engine. The coolant will continue to circulate like this until it reaches the design temperature, at which point, the thermostat will open a valve and allow the coolant back through the radiator.

Circulation The coolant follows a path that takes it from the water pump, through passages inside the engine block where it collects the heat produced by the cylinders. It then flows up to the cylinder head (or heads in a V type engine) where it collects more heat from the combustion chambers. It then flows out past the thermostat (if the thermostat is opened to allow the fluid to pass), through the upper radiator hose and into the radiator.

The coolant flows through the thin flattened tubes that make up the core of the radiator and is cooled by the air flow through the radiator. From there, it flows out of the radiator, through the lower radiator hose and back to the water pump. By this time, the coolant is cooled off and ready to collect more heat from the engine. The capacity of the system is engineered for the type and size of the engine and the work load that it is expected to undergo. Obviously, the cooling system for a larger, more powerful V8 engine in a heavy vehicle will need considerably more capacity then a compact car with a small 4 cylinder engine.

On a large vehicle, the radiator is larger with many more tubes for the coolant to flow through. The radiator is also wider and taller to capture more air flow entering the vehicle from the grill in front Antifreeze The coolant that courses through the engine and associated plumbing must be able to withstand temperatures well below zero without freezing. It must also be able to handle engine temperatures in excess of 250 degrees without boiling.

A tall order for any fluid, but that is not all. The fluid must also contain rust inhibiters and a lubricant. The coolant in today's vehicles is a mixture of ethylene glycol (antifreeze) and water. The recommended ratio is fifty-fifty.
In other words, one part antifreeze and one part water. This is the minimum recommended for use in automobile engines. Less antifreeze and the boiling point would be too low. In certain climates where the temperatures can go well below zero, it is permissible to have as much as 75% antifreeze and 25% water, but no more than that. Pure antifreeze will not work properly and can cause a boil over.

TYPES OF COOLING SYSTEMS

There are mainly two types of cooling systems : (a) Air cooled system, and (b) Water cooled system. Introduction to air cooling: Turbo cooling have been adopted for IC-engines at least since 1975 by I Kalmar and J Antal for Nox reduction in CIengines. Engineers from SWRI contributed in the same subject between 1990-1991 with adress to M Shahed and RH Thring in the "Clean Diesel Project" Volvo Truck also performed a MSc thesis work carried out by Jan Wiman in 1991. III. AIR COOLING SYSTEM Air cooled system is generally used in small engines say up to 15-20 kW and in aero plane engines. In this system fins or extended surfaces are provided on the cylinder walls, cylinder head, etc.

Heat generated due to combustion in the engine cylinder will be conducted to the fins and when the air flows over the fins, heat will be dissipated to air. The amount of heat dissipated to air depends upon :
(a) Amount of air flowing through the fins.
(b) Fin surface area.
(c) Thermal conductivity of metal used for fins.

Advantages of Air Cooled System

Following are the advantages of air cooled system :

(a) Radiator/pump is absent hence the system is light.

(b) In case of water cooling system there are leakages, but in this case there are no leakages.

(c) Coolant and antifreeze solutions are not required.

(d) This system can be used in cold climates, where if water is used it may freeze.

Disadvantages of Air Cooled System

(a) Comparatively it is less efficient

(b) It is used in aero planes and motorcycle engines where the engines are exposed to air directly.

Air cooling Cars and trucks using direct air cooling (without an intermediate liquid) were built over a long period from the very beginning and ending with a small and generally unrecognized technical change.

Components of Water Cooling System

Water cooling system mainly consists of :

(a) Radiator

(b) Thermostat valve

(c) Water pump

(d) Fan

(e) Water Jackets

(f) Antifreeze mixtures.

Radiator It mainly consists of an upper tank and lower tank and between them is a core. The upper tank is connected to the water outlets from the engines jackets by a hose pipe and the lover tank is connect to the jacket inlet through water pump by means of hose pipes.

There are 2-types of cores :

(a) Tubular

(b) Cellular

When the water is flowing down through the radiator core, it is cooled partially by the fan which blows air and partially by the air flow developed by the forward motion of the vehicle. As shown through water passages and air passages, wafer and air will be flowing for cooling purpose. It is to be noted that radiators are generally made out of copper and brass and their joints are made by soldering. Thermostat Valve It is a valve which prevents flow of water from the engine to radiator, so that engine readily reaches to its maximum efficient operating temperature.

After attaining maximum efficient operating temperature, it automatically begins functioning. Generally, it prevents the water below 70°C. Bellow type thermostat valve which is generally used. It contains a bronze bellow containing liquid alcohol. Bellow is connected to the butterfly valve disc through the link. When the temperature of water increases, the liquid alcohol evaporates and the bellow expands and in turn opens the butterfly valve, and allows hot water to the radiator, where it is cooled.

Water Pump It is used to pump the circulating water. Impeller type pump will be mounted at the front end. Pump consists of an impeller mounted on a shaft and enclosed in the pump casing. The pump casing has inlet and outlet openings. The pump is driven by means of engine output shaft only through belts. When it is driven water will be pumped. Fan It is driven by the engine output shaft through same belt that drives the pump. It is provided behind the radiator and it blows air over the radiator for cooling purpose.

Water Jackets Cooling water jackets are provided around the cylinder, cylinder head, valve seats and any hot parts which are to be cooled. Heat generated in the engine cylinder, conducted through the cylinder walls to the jackets. The water flowing through the jackets absorbs this heat and gets hot. This hot water will then be cooled in the radiator. Antifreeze Mixture In western countries if the water used in the radiator freezes because of cold climates, then ice formed has more volume and produces cracks in the cylinder blocks, pipes, and radiator. So, to prevent freezing antifreeze mixtures or solutions are added in the cooling water.

The ideal antifreeze solutions should have the following properties : (a) It should dissolve in water easily. (b) It should not evaporate. (c) It should not deposit any foreign matter in cooling system. (d) It should not have any harmful effect on any part of cooling system. (e) It should be cheap and easily available. (f) It should not corrode the system. No single antifreeze satisfies all the requirements. Normally following are used as antifreeze solutions : (a) Methyl, ethyl and isopropyl alcohols. (b) A solution of alcohol and water. (c) Ethylene Glycol. (d) A solution of water and Ethylene Glycol. (e) Glycerin along with water, etc.

Advantages of Water Cooling System

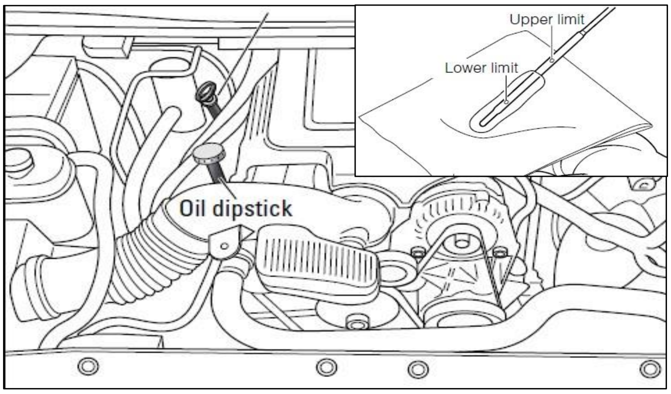
(a) Uniform cooling of cylinder, cylinder head and valves
(b) Specific fuel consumption of engine improves by using water cooling system
(c) If we employ water cooling system, then engine need not be provided at the front end of moving vehicle
(d) Engine is less noisy as compared with air cooled engines, as it has water for damping noise.

Disadvantages of Water Cooling System

(a) It depends upon the supply of water
(b) The water pump which circulates water absorbs considerable power
(c) If the water cooling system fails then it will result in severe damage of engine
(d) The water cooling system is costlier as it has more number of parts. Also it requires more maintenance and care for its parts.

PRACTICAL

Engine oil level check

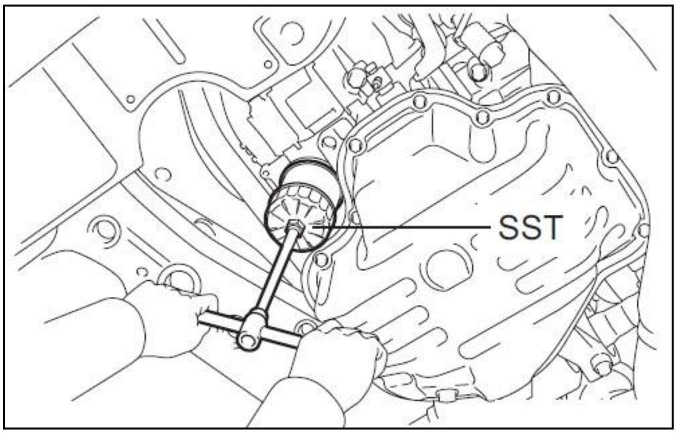
DIAGRAM	PROCEDURE
	1. Stop the engine 2. Locate the dipstick / oil level gauge. 3. Pull out the dipstick / oil level gauge. 4. Wipe out the oil on the end of dipstick with clean cloth and insert it again. 5. Pull out the dipstick and observe that the oil level is between the lower limit (L) and the upper limit (F). 6. Check the condition of oil in the engine oil by observing the oil film in dipstick / oil the level gauge.

Engine oil draining

DIAGRAM	PROCEDURE
	1. Start the engine and allow it to warm up, the stop the engine, and wait for 5 minute 2. Remove the oil filler cap 3. Lift up the car on lifter or, jack up front part of the car and secure with safety stand 4. Put the oil drain pan below the drain plug

	5. Drain the engine oil by removing the drain plug of the oil pan by using wrench. 6. Wait until all the oil from the engine to drain out 1.

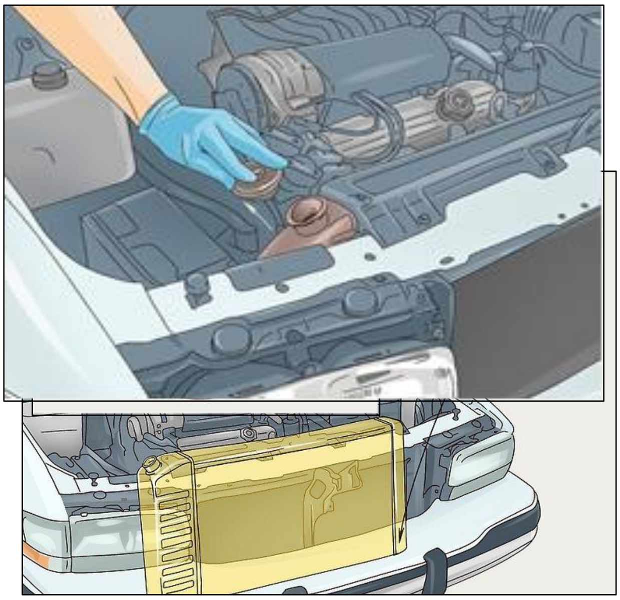
Replacing oil filter

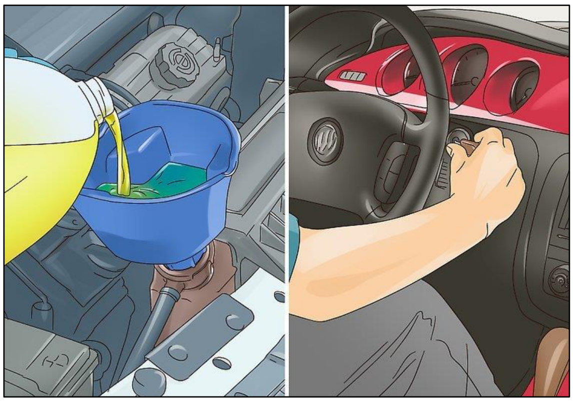
DIAGRAM	PROCEDURE
	1. While draining the oil from the engine, locate the oil filter 2. Loosen the oil filter by using oil filter wrenchr, the remove it using hand 3. Apply clean engine oil to the gasket of a new oil filter. 4. Lightly screw the oil filter into place by hand, then tighten it until the gasket contacts the seat 5. Then by using oil filter wrench, tighten the oil filter a 3/4 turn.

Engine oil filling

DIAGRAM	PROCEDURE
	1. Clean and install the oil drain plug with a new gasket. 2. Use a wrench to tighten the drain plug 3. Use a funnel to pour new oil into the oil filler hole 4. Replace the oil filler cap and run the engine for 30 to 60 seconds 5. Shut off the engine and wait 5 minutes for the oil to settle into the oil pan, and then check the oil level again 6. If the level of the oil is less that required level, add again new engine oil 7. Repeat step 5-6 until the level of the engine oil in correct level 8. Check for engine oil leak from oil filter and drain plug area

Coolant Draining

DIAGRAM	PROCEDURE
 	1. Lift the hood of vehicle and locate the radiator 2. Twist off the pressure cap on top of the radiator. Make sure the drainage pan is underneath the drain plug to catch the coolant. 3. Release the drain plug, on the underside of the radiator 4. Let the liquids drain completely before resealing the plug

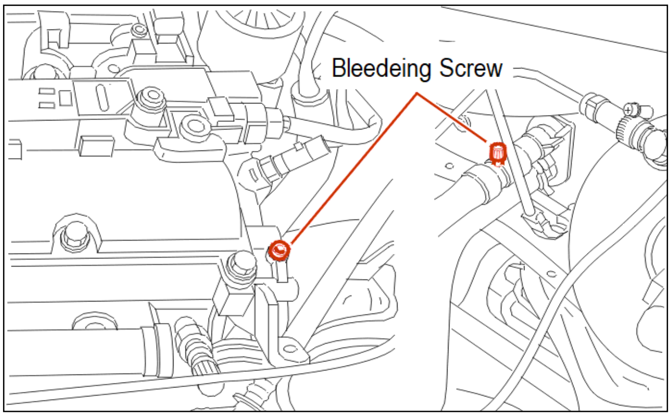


Flushing the cooling system

1. Pour radiator cleaner and distilled water into the radiator.
2. Add the fluids into the radiator reservoir where you removed the pressure cap
3. Turn on key to start the engine, let vehicle on with the heat on full blast for 5 minutes (The cleaner and water will work its way through the entire cooling system of your car to remove any residue of old antifreeze)
4. Turn off the engine and let it cool for 15 minutes. Ensure that the engine is cool
5. Open the pressure cap and drain plug to drain the radiator. Make sure the drainage pan is underneath the drain plug to catch the cleaner and distilled water
6. Flush the radiator with tap water until the drainage runs clear
7. Repeat filling the radiator with tap water, running the car with the heat on, and draining it once it's cooled. Once the water runs clear, flush the system one last time with distilled water.

	Refilling the coolant into cooling system 1. Mix antifreeze coolant with distilled water in empty container. (Follow the ratio of coolant-water suggested by coolant manufacturer) 2. Pour the antifreeze mixture into the radiator where you removed the pressure cap 3. Start your vehicle to pull the mix antifreeze coolant into your cooling system. 4. Turn on your vehicle with the heat on full blast to pull the remaining fluid in. 5. Always check the coolant in radiator, top off the coolant into radiator until it is full while the engine is running for 10 minute to bring the engine to operating temperature. 6. Turn off the engine and let your car cool for 10 minutes before removing the pressure cap again. Check to see if the coolant is level with the fill line inside the radiator. If not, add more coolant into radiator. 7. Install the pressure cap.

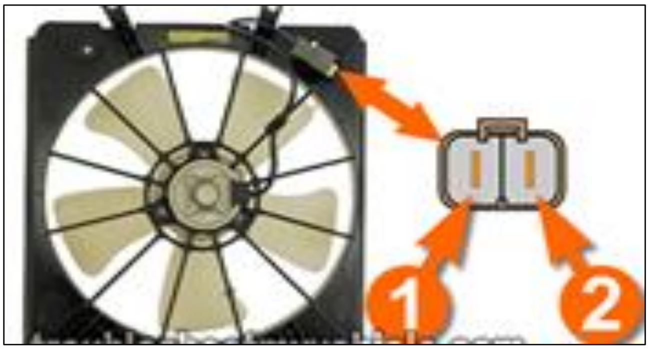
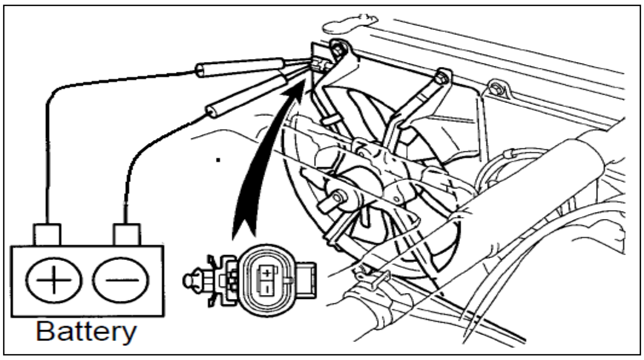
Coolant bleeding procedures

DIAGRAM	PROCEDURE
  	**Cooling System With Bleed Screw** 1. Make sure the coolant in radiator is full 2. Turn on your vehicle with the heat on full blast to pull the remaining fluid in while radiator cap install in its place 3. Always check the coolant in radiator, top off the coolant into radiator until it is full while the engine is running for 10 minute to bring the engine to operating temperature. 4. Locate the bleed screw and place a pan on the floor to catch the coolant that will come out through the screw. 5. Once the engine has reached operating temperature, turn the coolant bleed screw one to two turns counter clockwise using a wrench of the correct size. **Do not remove the screw off or you will have a stream of boiling coolant coming out of the valve**. 6. Let some coolant flow out from the valve or when a stream of coolant free of air bubbles flowing from under the screw, tighten the screw again. 7. Turn off the engine and wait for it to cool.

Cooling System Without Bleed Screw

1. Make sure the coolant in radiator is full
2. Turn on your vehicle with the heat on full blast to pull the remaining fluid in while radiator cap still removed
3. Always check the coolant in radiator, top off the coolant into radiator until it is full while the engine is running for 10 minute to bring the engine to operating temperature.
4. When the engine reaches operating temperature, you will see through the radiator neck the coolant flowing.
5. Wait for a few seconds to allow coolant to flow.
6. At this point, air has been purged from the system. Turn off the engine and let it cool.
7. Then, add more coolant to the radiator if necessary, to bring the level up to the bottom of the radiator neck.
8. Squeeze the upper radiator hose to expel air after adding more coolant
9. Repeat step 3 to 5 until there are no more air has been purge from the system.
10. Turn off the engine, reinstall the radiator cap and wait for it to cool.

Radiator fan functional test

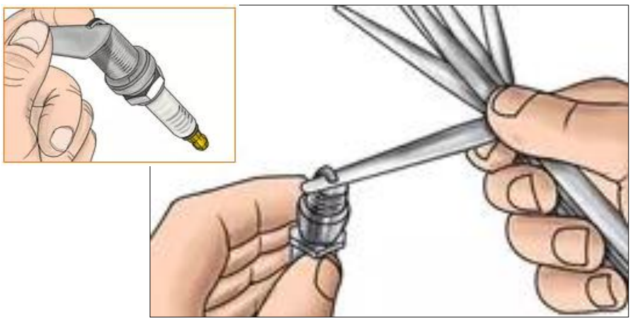
DIAGRAM	PROCEDURE
 	1. Unplug the radiator fan motor from its connector 2. Apply ground to the connector terminal labelled with the number 2 using a jumper wire connected to the battery negative (-) post 3. Apply power (12 Volts) to the connector terminal labelled with the number 1, using a jumper wire 4. Check that the cooling fan rotates smoothly

Dismantle and visually inspect spark plug

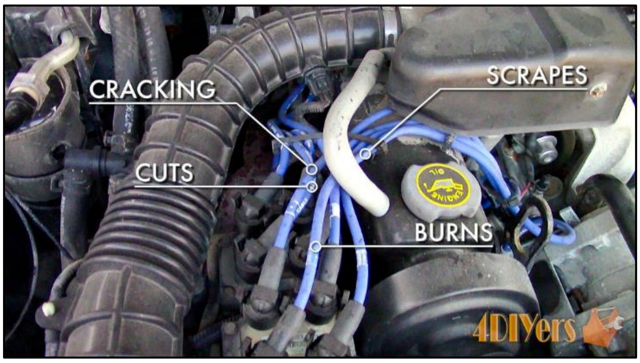
DIAGRAM	PROCEDURE
	1. Use a socket or wrench to remove the nuts holding down the spark plug cover and remove the cover
	2. Disconnect spark plug coil wiring from the coil 3. Remove the coil mounting bolts, and pull out the coil from its place.

	4. Inspect THE condition of the coil for any crack, burn or etc.
	5. Disconnect spark plug coil wiring from the coil 6. Remove the coil mounting bolts, and pull out the coil from its place.

Spark plug gap check

DIAGRAM	PROCEDURE
	1. Use feeler gauge to check the spark plug gap meets the specification for your vehicle. 2. Re-check the gap by placing the feeler gauge between the two electrodes

Visual inspection on high tension cables for crack and burns

DIAGRAM	PROCEDURE
	1. Visual inspect at the wires for any cracking, melting, cut, scraped, or burned exterior casing. 2. Inspect the boots on both ends for any damage and inspect the terminals for any corrosion

Spark trigger test

DIAGRAM	PROCEDURE
	1. Remove the spark plug from the engine. 2. Plug the spark plug on ignition coil. 3. Ground the threaded part of the spark plug to the engine block. 4. Crank the engine and see any spark at the spark plug tip

RUJUKAN

Halderman J. D. (2015), Automotive Engines Theory and Servicing, 8th Edition, Pearson College Division, ISBN-13: 978-0-13-351500-8

Halderman J. D. (2013), Automotive Chasis Systems. 6th Edition, Pearson College Division Additional references supporting the course

Gilles T. (2015), Automotive Service: Inspection, Maintenance, Repair, 5th Edition, Cengage Learning, ISBN : 1305445937, 9781305445932.

Erjavec J., Thompson R. (2014), Automotive Technology: A Systems Approach, Cengage Learning, ISBN : 1305176421, 9781305176423

Glencoe (2006), Automotive Excellence. Part 1, The Mc Graw Hill Companies

Duffy J. E. (2013), Modern Automotive Technology, 8th Edition, The Goodheart-Willcox Publisher

Halderman J. D. (2013), Automotive Steering, Suspension and Alignment. 6th Edition, Pearson Education

Hadfield C. (2011), Automotive Service Job Sheets for NATEF Task Mastery, Cengage Learning, ISBN : 1111137986, 9781111137984

Reimpel J. and Stoll H. (2001), The Automotive Chassis. 2nd Edition, Butterworth Heinemann.

e ISBN 978-967-2099-81-9

AUTOMOTIVE TECHNOLOGY CENTRE (ATeC)
POLYTECHNIC OF SULTAN MIZAN ZAINAL ABIDIN