



BITS Pilani
Pilani Campus

Automotive Vehicles AEL ZC441

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Lecture 1 - Recap

- Introduction to Automobile
- Development of Automobile (1769 to 2005)
- General Classification (Type I & II)
- Basic Structure &
- Components of Automobile (Basic Structure, Power Plant, Transmission System, Auxiliaries, Controls, Superstructure)

Lecture 2 - Recap



- Chassis & Body
- Classification
- Conventional Construction
- Sub frames
- Frameless Constructions
- Classifications of Body

Lecture 3 - Recap



- Cylinder Block and crank case
- Cylinder Head
- Sump or oil pan
- Intake and Exhaust Manifolds
- Gaskets
- Cylinder Liners
- Piston
- Piston Rings
- Connecting Rods
- Piston Pins
- Crankshaft
- Main bearings
- Valves and Valve actuating mechanisms
- Mufflers

Lecture 4 - Recap



- Need of Cooling system
- Variation of Gas temperature
- Theory of Engine heat transfer and co-relation
- Parameters affecting Heat transfer
- Air cooled Systems

Today's Topic



| Lect No. | Learning Objectives | Topics to be covered | Reference to Text |
|----------|--|--|-------------------|
| 1 | An introduction to automobiles | Overview of the course and evaluation scheme Development of automobiles, General classification, Basic structure and components of automobile | 1TB1,1TB2 |
| 2 | The chassis Construction and Body | Classification, Conventional construction, Sub frames, Frame less constructions, Classification of body, Numerical problems on chassis member bending. | 11TB1, 1 TB2 |
| 3 | Reciprocating Engine Construction and basics | Constructional details, Calculation of displacement velocity and acceleration of piston and connecting rod, Working of 2 and 4 stroke engines. Numerical problems on the above topics | 3TB1 |
| 4 | Cooling systems | Need. Variation of gas temperature. Piston temperature distribution. Theory of engine heat transfer and correlation. Parameters affecting engine heat transfer. Air-cooled systems. | 8TB1, 12RBa |
| 5 | Cooling systems | Types of water-cooling systems. Radiators. Fans. Correlation for the power required for engine cooling. Numerical problems on the above topics | 8TB1, 12RBa |
| 6 | Lubrication systems | Causes of engine friction. Function of lubrication. Mechanism of lubrication. Journal bearing lubrication. | 7TB1, 11RBa |
| | Lubrication systems | Types of lubrication systems. Lubrication of engine components. | 7TB1, 11RBa |
| 7 | Clutch | Definition of clutch, requirements, classification, principle of working of friction clutches, Driving system and Plate clutch (uniform pressure and uniform wear). | 14TB1, 3TB2 |



Automotive Vehicles

Lecture 5

Water Cooling system

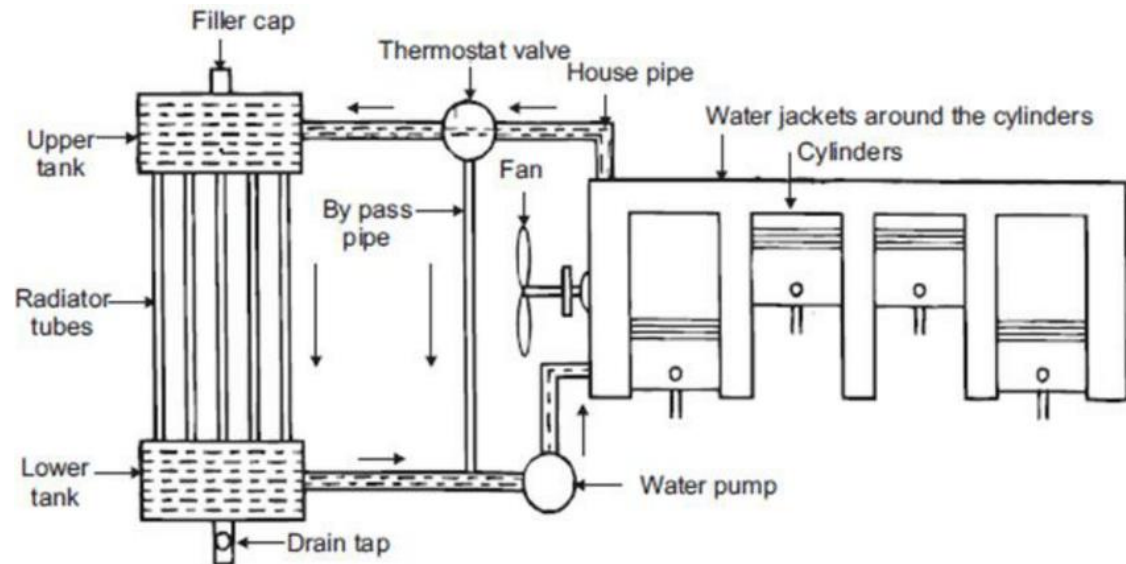


- Water Cooling system
- Types of Water cooling
- Components of Water Cooling system
- Other coolants & Anti-freeze solutions
- Intelligent cooling system

Water cooling system



- Cooling medium is Water
- Engine cylinders are surrounded by Water jackets
- Heat flows from Cylinder walls into Water, goes to radiator and loses heat to air
- Antifreeze is added to water, act as coolant

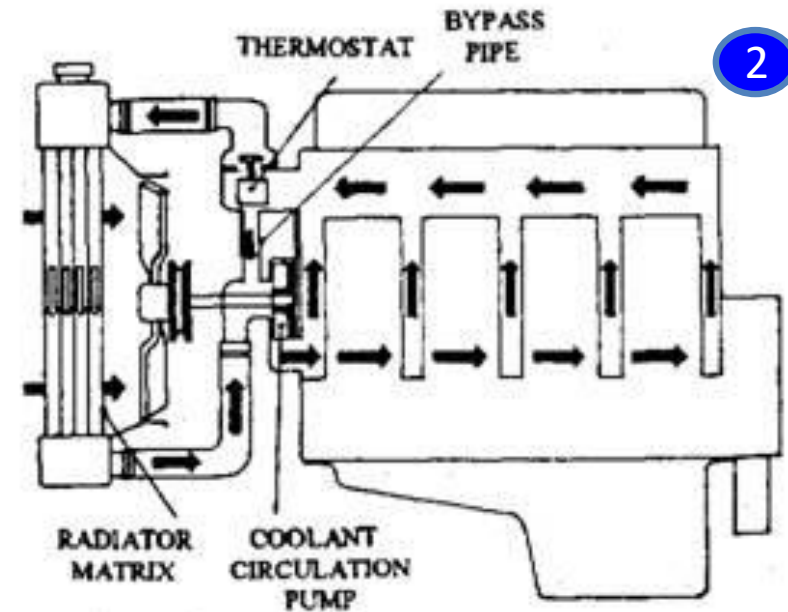
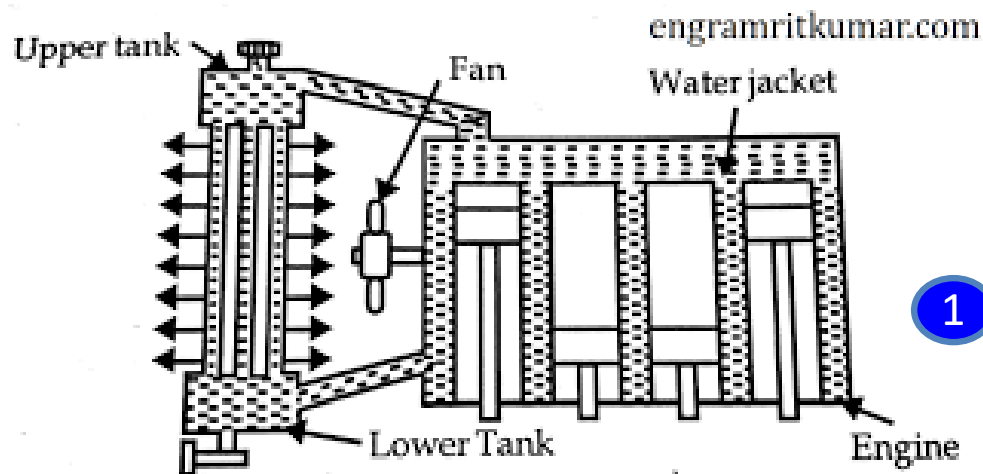


Water cooling system - Types



Two types:

1. Thermosyphon System
2. Pump Circulation System



Water cooling system - Types



Thermosyphon System :

- Simple system
- Consists of Radiator connected to hoses
- Circulation of water is obtained from difference in densities of hot and cold regions
- Circulating water gets heat from Engine cyl and cooling by the same
- Heat is dissipated to atmosphere by conduction & convection
- Water becomes cold when it reaches collecting tank of Radiator and circulated again
- The rate at which water circulates is proportional to heat output or load on the engine
- Fans are mounted and driven by belt / pulleys to assist the flow of cooling air

Water cooling system - Types



Advantages:

- Simplicity & low cost

Disadvantages:

- Cooling is slow due to natural convection
- To have adequate cooling, capacity of the system to be large
- Radiator tank must be located higher than the cylinders which is not possible with modern body styles
- Minimum level of coolant to be maintained in the system, if fails below continuity will break and system will fail

Water cooling system - Types



Pump Circulation system :

- Pump is used for circulation of coolant and Thermostat is employed to control the flow of coolant
- Pump is driven by belt from Engine crankshaft

Advantages:

- Circulation is proportional to load and speed
- Radiator need not to be placed on the side, as it can be placed at rear or side

Disadvantages:

- More complicated and Costlier

Components of Water cooling system



- Radiator
- Pressure cap
- Expansion reservoir
- Thermostat
- Pump
- Fan

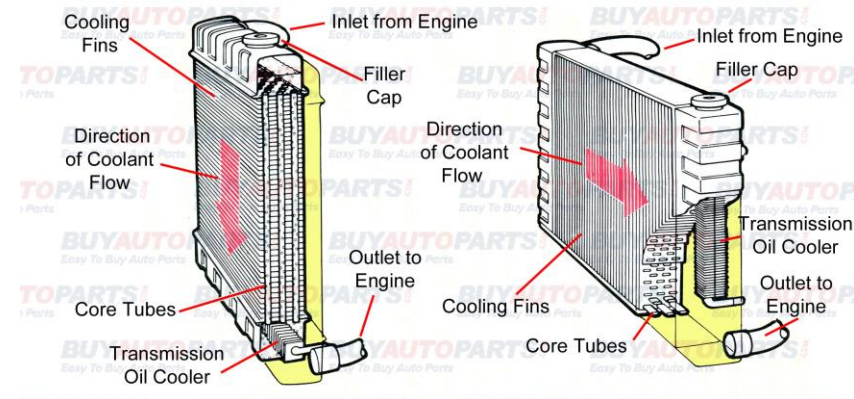
Radiator

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achieve

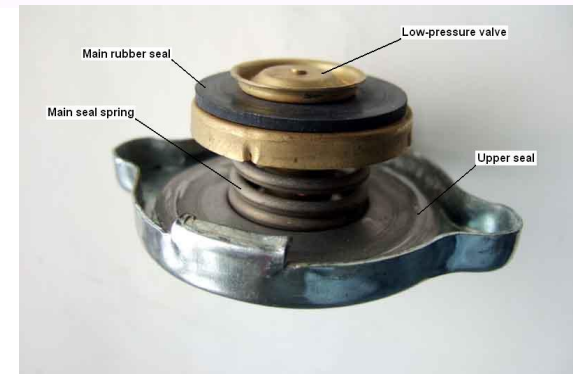
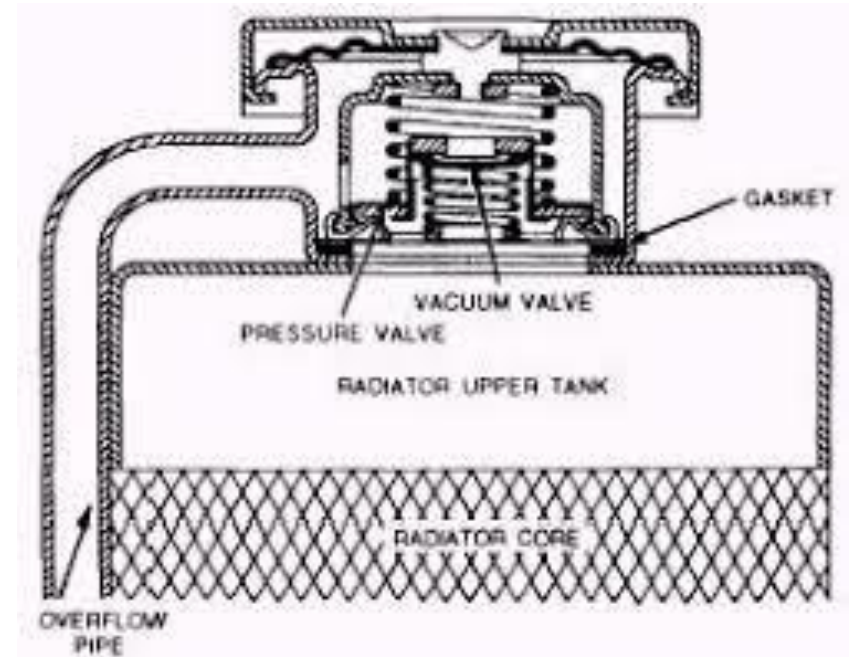
lead

- To ensure close contact of the hot coolant coming out of the engine with outside air, so as to ensure high rates of heat transfer from coolant to air
- Consists of Upper tank, core, lower tank
- Overflow pipe in the header tank and drain pipe in the lower tank are provided
- Hot coolant enters Radiator at top and cooled by cross-flow of air while flowing down the radiator.
- Coolant collects in the collector tank where it is pumped to the engine for cooling
- Two types: **Tubular (Coolant – Tube, Air – around)** and Cellular (Air – Tube, Coolant – around) type.
- Materials: Copper, Yellow Brass, Aluminum



Pressure cap

- Radiator filler neck in modern use is covered with a Pressure cap which forms air-tight joint due to which the coolant is maintained at some pressure higher than the atmosphere.
- Consists of Pressure valve and vacuum valve
- Pressure blow off valve opens releasing excess pressure through overflow pipe.



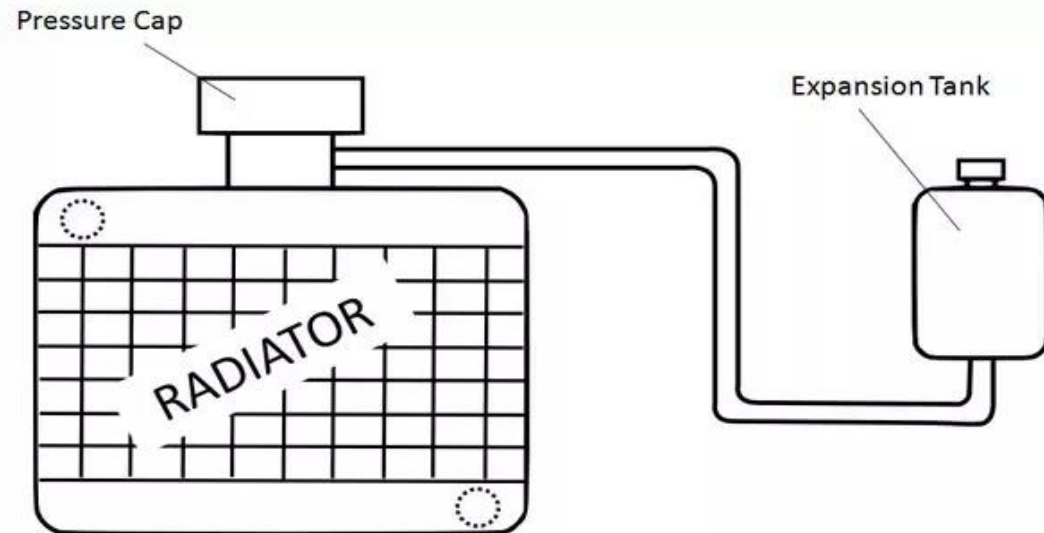
Expansion Reservoir



- Replacing Overflow pipe with expansion reservoir
- Connected with Radiator and receives excess coolant
- And recirculates to the radiator keeping the system full of coolant
- Made of Translucent plastic to indicate level of coolant
- Coolant Recovery system

Advantages:

1. No loss of coolant
2. Corrosion and deterioration of antifreeze is reduced
3. Smaller upper tank is used with Radiator



Thermostat



- To keep a rigid control over the cooling, Thermostat keeps the cooling water temperature to a pre-determined value.
- Helps the engine to reach the operating temperature to operate engine efficiently over 80-100 deg Celsius
- Two types
 1. Bellows or Aneroid type
 2. Wax or Hydrostatic type

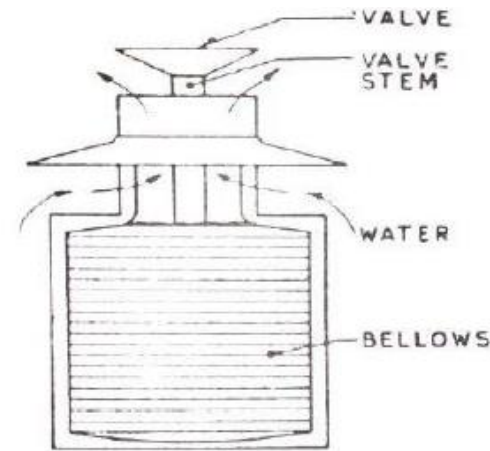
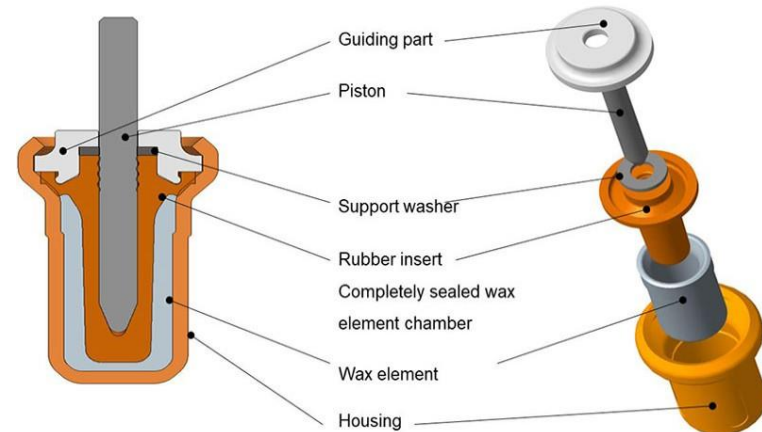


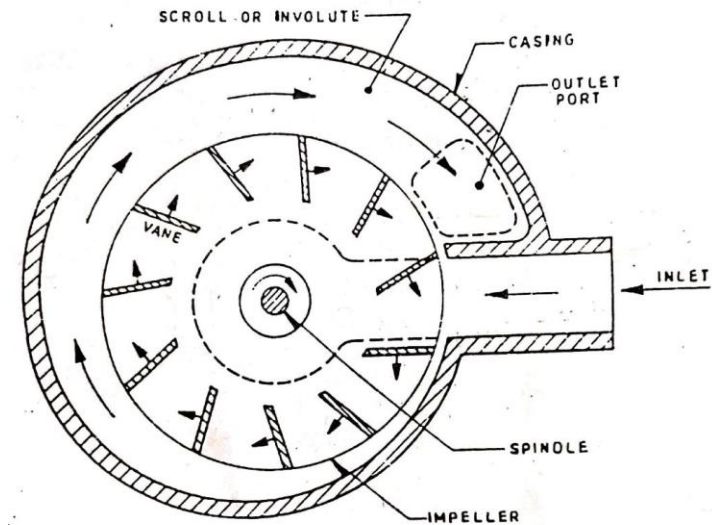
Figure: Bellows type Thermostat



Coolant Pump



- Necessity for the forced circulation type of engine cooling system
- Pump is mounted at the front end of engine driven by crankshaft by V-belt.
- Centrifuge type pump is used



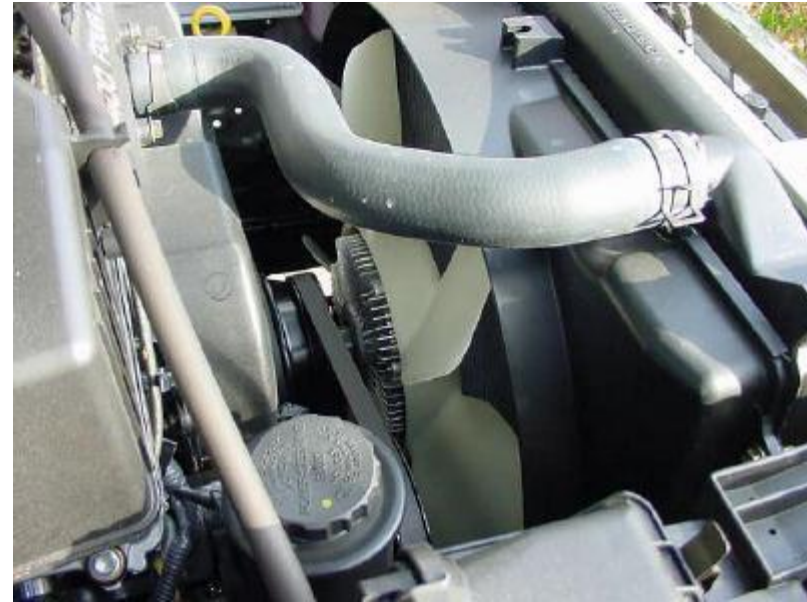
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Fig. 5.15. Coolant pump

Fan



- To provide desired cooling for vehicle moving at heavy load and at a slow speed (E.g. While driving uphill)
- Mounted behind radiator on same shaft of coolant pump
- Driven by V-belt from crankshaft pulley
- Have 4 to 7 blades, spaced unevenly to reduce noise.
- Made of sheet metal and molded plastic materials (E.g. Nylon, Poly propylene) are used.



Other coolants and Anti-Freeze solutions



Coolants:

- Other than water, liquids having high boiling points are used for engine cooling
- E.g. Glycerin (BP 290 deg. Celsius), Ethylene Glycol (BP 195 deg. Celsius).
- High BP increases capacity of coolant to carry heat

Anti Freeze solutions:

- In cold climates, water conversion to Ice causes bursting of radiator core and cylinder jackets
- Hence additives used and called as Antifreezes
- E.g. Wood alcohol (Methyl alcohol), denaturated alcohol (ethyl alcohol), Glycerin, ethylene glycol etc.,

Other coolants and Anti-Freeze solutions



Requirements of Anti- Freeze :

- Thoroughly miscible with water and prevent freezing of coolant to the lowest Amb. Temperature
- Should not have any corrosive action on components
- Its boiling point should be high and hence coolant can operate at higher temperatures
- Should not deposit any foreign matter in jackets, hose pipes or radiator core
- Should have high specific heat capacity than coolant
- Its viscosity should not be excessive so that circulation will not be affected

Intelligent Cooling system



- Engine cooling system to operate at more accurate temperature with uniformity and greater control
- It consists of
 - High performance electric pump instead of an engine – speed – related water pump in a conventional system
 - Multi port, proportional flow control valve instead of thermostat
 - Speed controllable cooling fan
 - Cylinder head gasket with embedded sensors

Advantages:

- Improvement of Thermal efficiency
- Improvement in Fuel economy
- Reduced warm-up time

Pump circulation system

<https://www.youtube.com/watch?v=V7inC4lOpGs>

Petrol and Diesel Engine

<https://www.youtube.com/watch?v=rIK7JIAz9WY>