Engine Cooling & Lubrication

Dr. Md. Zahurul Haq, *Ph.D., CEA, FBSME, FIEB*

Professor
Department of Mechanical Engineering
Bangladesh University of Engineering & Technology (BUET)
Dhaka-1000, Bangladesh

zahurul@me.buet.ac.bd
http://zahurul.buet.ac.bd/

ME 417: Internal Combustion Engines
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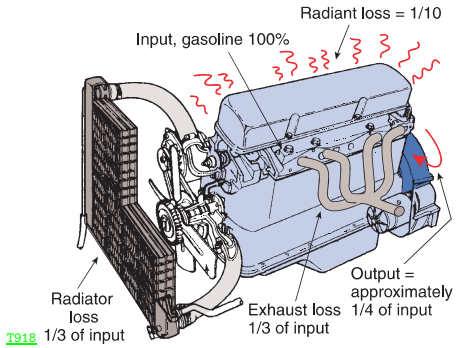
Engine Energy Balance



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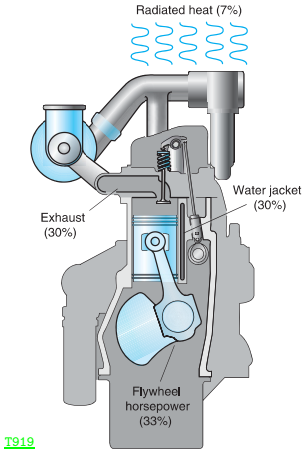
SI Engine



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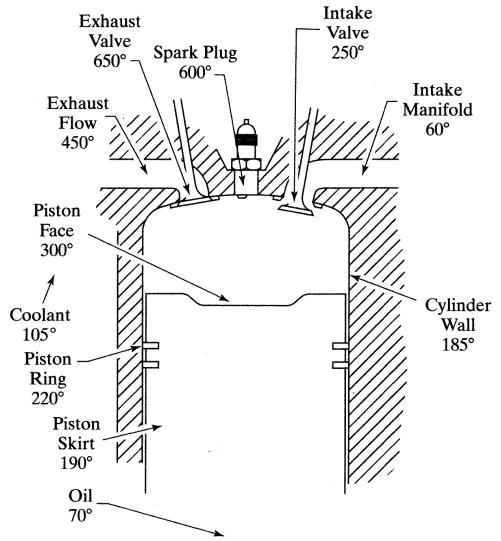
CI Engine

Importance of Engine Cooling

- With overheating, the valves may wrap and the components may expand excessively leading to seized piston.
- At high temperatures, lubricating oil decomposes to give gummy and carbon deposits.
- Large variation of temperature creates thermal stress and may lead to distortion of engine components.
- Overheated spark-plug may cause pre-ignition.



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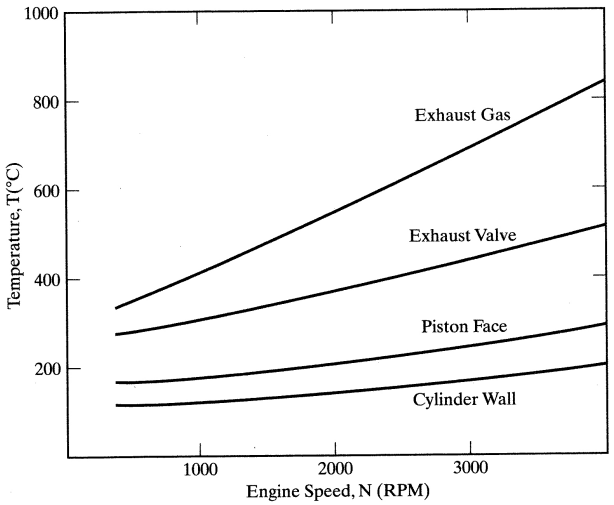
Typical temperature values (°C) in SIE.



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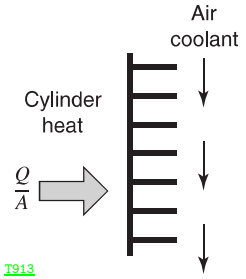
Engine component temperatures as a function of engine speeds for a typical SIE

Engine Cooling: Classifications



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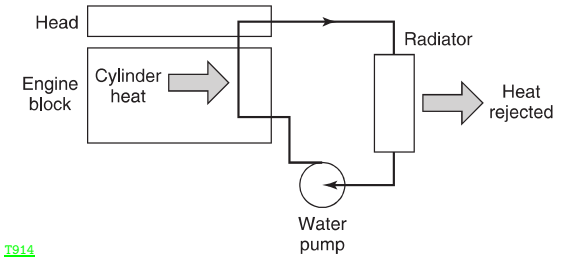

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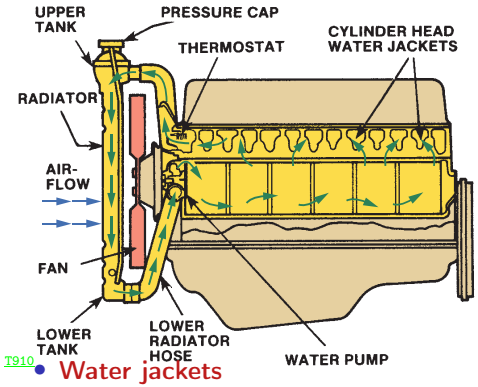
1. Air cooling system *2. Liquid cooling system*

Merits/demerits of Air-cooling systems:

- Simple and light design, less starting trouble, reduced maintenance and operating costs.
- High operating temperatures limits the compression ratio.
- Effective cooling of rear-engines are difficult.

Key Components of Liquid-cooling System



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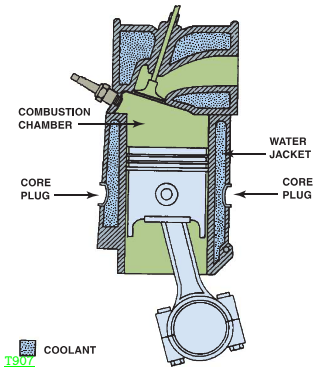

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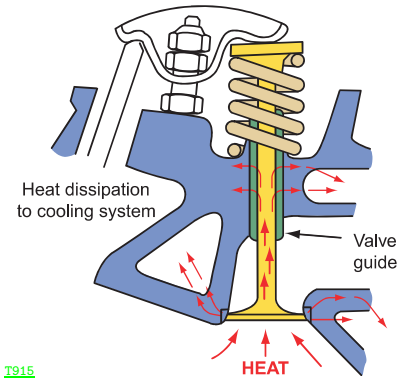
- Water jackets
- Water pump
- Fan and Radiator
- Thermostat closes coolant circulation in radiator in cold engine.



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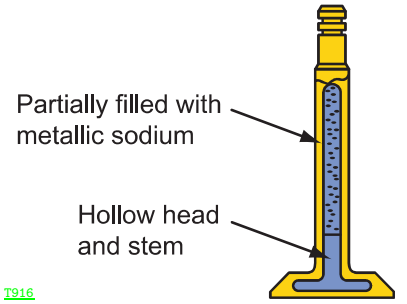

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Engine valve cooling enhancement mechanism.

Friction

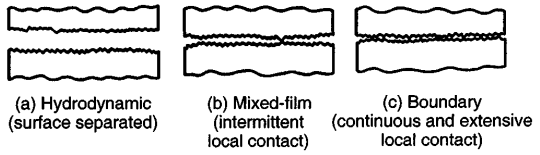
Friction between sliding surfaces may fall into any of **three** categories:

1. **Dry friction**: occurs when there is no lubricant between the surfaces. Continuous sliding at high speed under load generates a lot of heat.
2. **Boundary friction**: Some components, such as cams and their followers, operate under conditions of boundary friction for all or at least most of the time. Hence, some lubricant remains between the surfaces but as molecules bonded or keyed to the surface, rather than as a continuous film, so some metal-to-metal contact occurs.
3. **Viscous friction**: If pressure lubricated, the bearing surfaces are normally separated by a film of oil. Hence, the resistance to motion is solely that due to the shearing of the oil, and is therefore a function of its viscosity.

Lubrication: Applications

Lubrication serves the following purposes:

- **Lubrication**: to minimize friction and hydrodynamically support rotating shafts (the primary task of an engine oil).
- **Sealant**: to help the piston rings in the engine cylinder.
- **Coolant**: to remove heat from hot engine components.
- **Cleaning agent**: to neutralize acids and sludge formed by blowby gases.
- **Coating**: to cover engine moving components with an oil film even when they are subjected to high thrust loads



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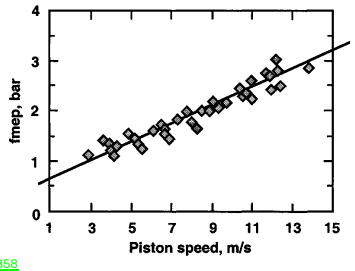
Three basic types of lubrication



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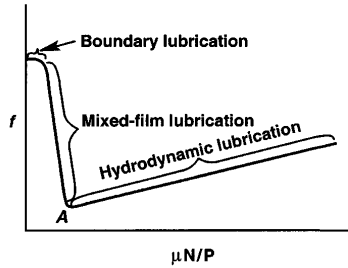

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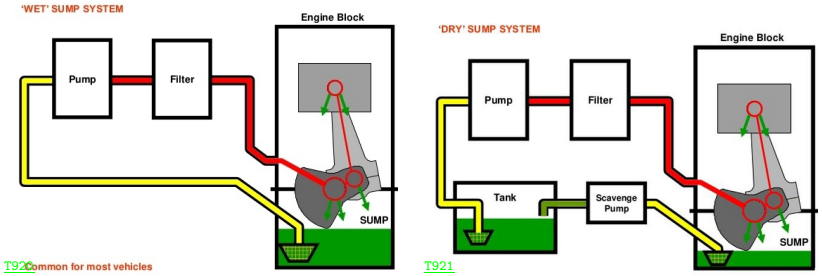
Properties of Lubricants

- Proper viscosity
- Viscosity index and numbers
- Resistance to carbon formation and oil oxidation.
- Corrosion and rust inhibitors
- Foaming resistance
- Detergent-dispersants
- Extreme pressure resistance.

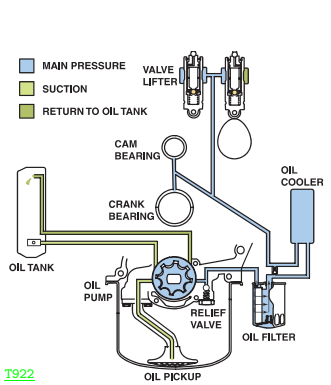
Additives are added to lubricants to enhance the desired properties.

Lubrication: Classifications



T920 Common for most vehicles T921

1. **Wet Sump System**: engine parts are exposed to /dipped in the lubricating oil for getting lubricated.
2. **Dry Sump System**: The dry-sump system uses two or more oil pumps and a separate oil reservoir, as opposed to a conventional wet-sump system. Improved engine reliability due to consistent oil pressure.



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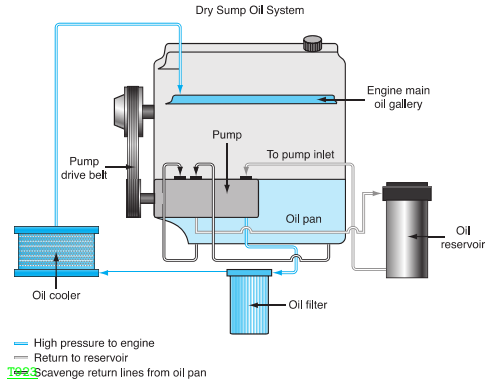

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Wet-sump lubrication *Dry-sump lubrication*