

## LUBRICATION

Process or technique used to reduce friction and wear between moving mating parts

Tribology is the science of friction, lubrication and wear. There are two main sources of friction

- adhesion - sticking of parts due to atomic level attractions, this increases the smoother the surface
- abrasion - mechanical interference of surfaces, this increases with surface roughness

These two convert kinetic energy into thermal energy.

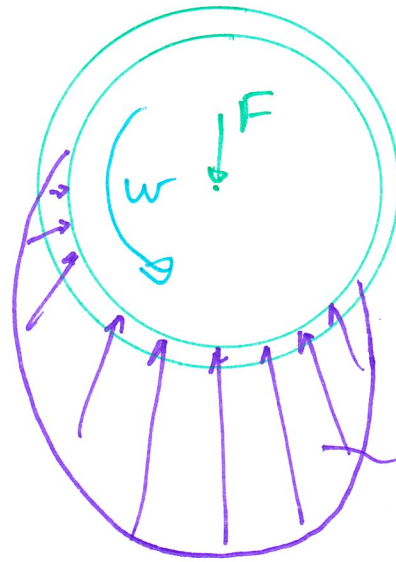
### Types of Friction

- 1 Dry Friction - between 2 solids  
No dif. between static & kinetic friction
- 2 Fluid Friction - in a viscous fluid
- 3 Lubricated Friction - 2 solids separated by a liquid
- 4 Skin Friction - Boundary layer effect between a liquid and a solid
- 5 Internal Friction - internal to a solid undergoing deformation

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## Lubrication types

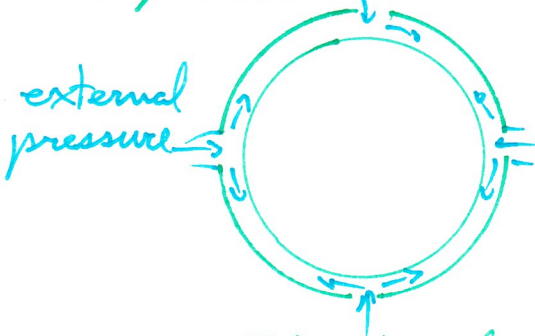
Hydrodynamic - film pressure created and maintained by relative motion



Hydrodynamic Lift generated by fluid being dragged into the gaps

Circumferential Pressure Profile

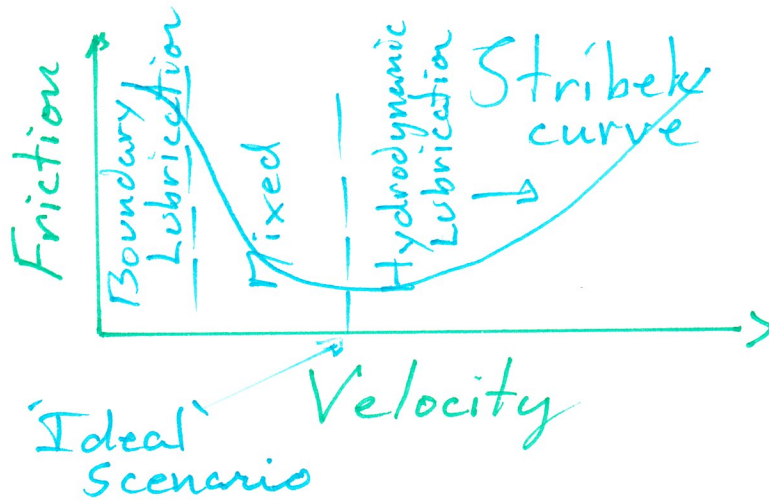
Hydrostatic - external pressure source is used to develop and maintain separation



Elasto-hydrodynamic - phenomenon that occurs between rolling surfaces in the presence of a lubricant (in gears, roller bearings, etc.)

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Boundary Lubrication - super thin separation of parts - it is a failure of the thick film developed in hydrodynamic lubrication



VISCOCITY the shear stress is proportional to the ratio of change of the velocity with respect to the distance from the surface

$$\tau = \frac{F}{A} = \mu \frac{du}{dy}$$

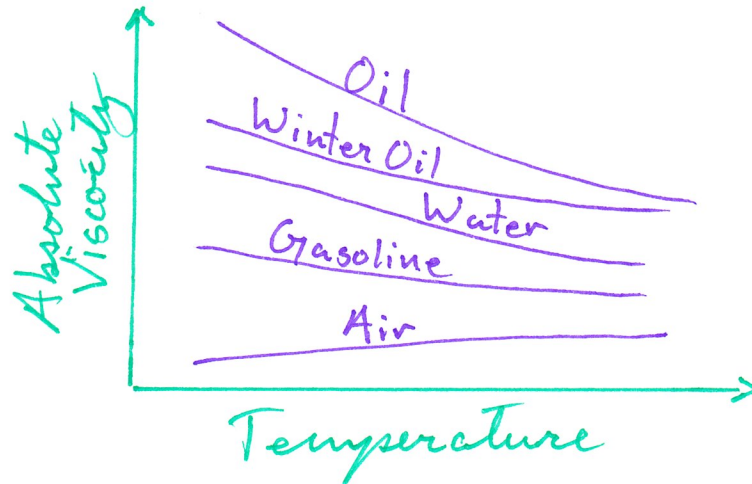
called Absolute or Dynamic Viscosity

Kinematic viscosity is the ratio of the absolute viscosity to the density

$$\nu = \frac{\mu}{\rho} \quad \frac{\frac{N \cdot s}{m^2}}{\frac{kg}{m^3}} = \frac{m^2}{s}$$

Units of centistokes ( $1 \text{ cSt} = 1 \text{ mm}^2/\text{s}$ )

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Motor oil weight designations

ex 5W-20

the W stands for WINTER indicating its cold temperature properties and the second number is for its properties at 100°C

| SAE Grade | Centistokes @ |       |
|-----------|---------------|-------|
|           | 40°C          | 100°C |
| 10W       | 32            | 5.4   |
| 20        | 68            | 6.8   |
| 20W       | 46            | 8.7   |
| 30        | 100           | 11.4  |
| 10W30     | 66            | 10    |

GREASE - refers to a semi solid type of lubricant. Like oil its purpose is to

- 1) provide a film of lubricant
- 2) distribute and dissipate heat
- 3) prevent corrosion on surfaces
- 4) protect parts from foreign materials
- 5) remove unwanted contaminants.

| Grease                                   | vs. | Oil   |
|--|-----|---|
| Low temps < 200F                         |     | High Temps  |
| Low speeds                               |     | High speeds                                       |
| Extra protection from contaminants req'd |     | Oil tight seals are req'd                         |
| Simpler enclosures are desired           |     | Central supply available and used for other parts |
| Longer operation w/o service is desired  |     | Bearing type necessity                            |

Other factors may include:

- Oil - easier to replace/renew
- less churning losses.
- grease can be used to suspend solid lubricants like graphite.

### Additives in Grease and Oil

- Antioxidants - reduce oil degradation
- Anti foam agents - reduce foaming
- Antiwear - chemically bonds to surfaces
- Rust Inhibitors - corrosion due to oxidation.
- Extreme Pressure - also used in cutting fluids
- Tackifying Agents - sticks to parts
- Corrosion Inhibitors - other sources of corrosion
- VI Improvers - Viscosity Index improvers
- Demulsifiers - separates water from oil