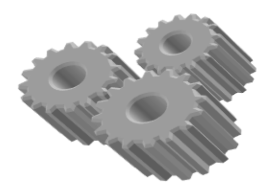
TTE

# MECHANICAL TECHNOLOGY

# LUBRICATION

# FACT

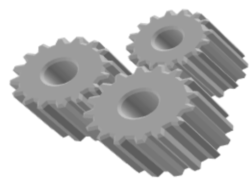
- COLLECTIVELY, BRITISH INDUSTRY COULD SAVE £1.5 BN/YR AS A DIRECT RESULT OF IMPROVING ITS USE OF LUBRICANTS.
- BRITAIN SPENDS £8 BILLION A YEAR ON MAINTAINING PRODUCTION MACHINERY
- AT ANY ONE TIME 50% OF MACHINES ARE IN NEED OF ATTENTION.
- A MACHINE NOT WORKING IS NOT EARNING.
- BY USING THE PRACTICAL PRINCIPLES OF TRIBOLOGY FOR EVERY £1,000 INVESTED £40,000 CAN BE SAVED



# LUBRICATION

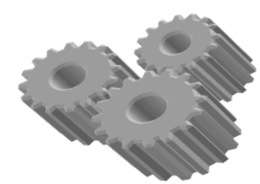
## LUBRICATION AND LUBRICATION SYSTEMS

- PURPOSES AND ACTIONS OF LUBRICANTS
- LUBRICATION TYPES AND APPLICATIONS
- LUBRICATION SYSTEMS



# PURPOSES AND ACTION OF LUBRICATION

- TO REDUCE FRICTIONAL RESISTANCE
- TO REDUCE WEAR
- TO DISSIPATE HEAT
- TO PREVENT CORROSION
- TO PREVENT CONTAMINATION



# THE ROLE OF A LUBRICANT

## THE MAIN FUNCTION IS TO PREVENT OR MINIMISE WEAR

a) BY PROVIDING A FILM TO SEPARATE INTERACTIVE SURFACES

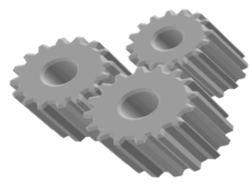
b) BY COATING THE RUBBING SURFACES WITH A PROTECTIVE FILM

## OTHER FUNCTIONS INCLUDE:

c) COOLING – BY REDUCING FRICTION AND TRANSFERING HEAT

d) PROTECTION – BY INHIBITING CORROSION

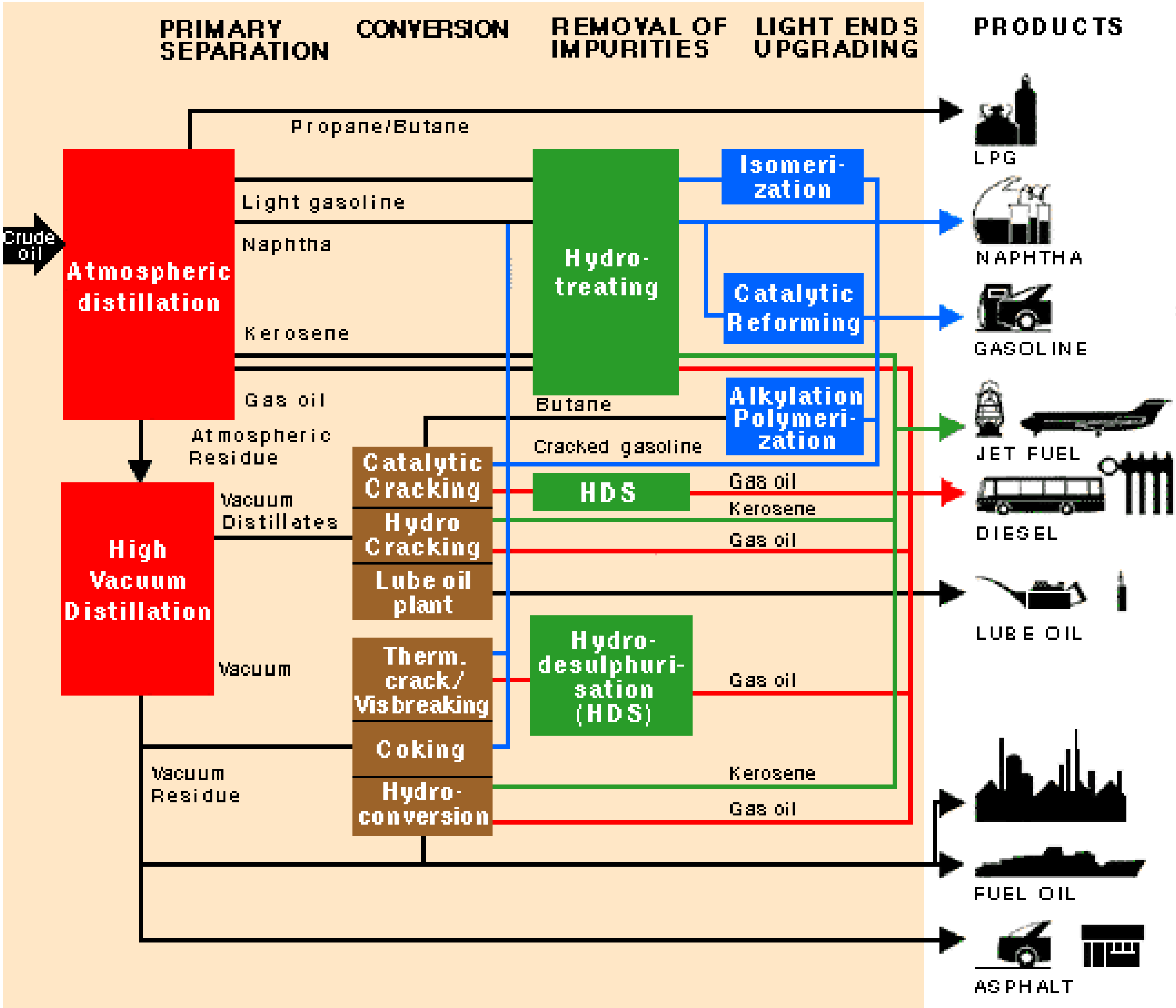
e) CLEANING – BY FLUSHING PARTICLES AWAY

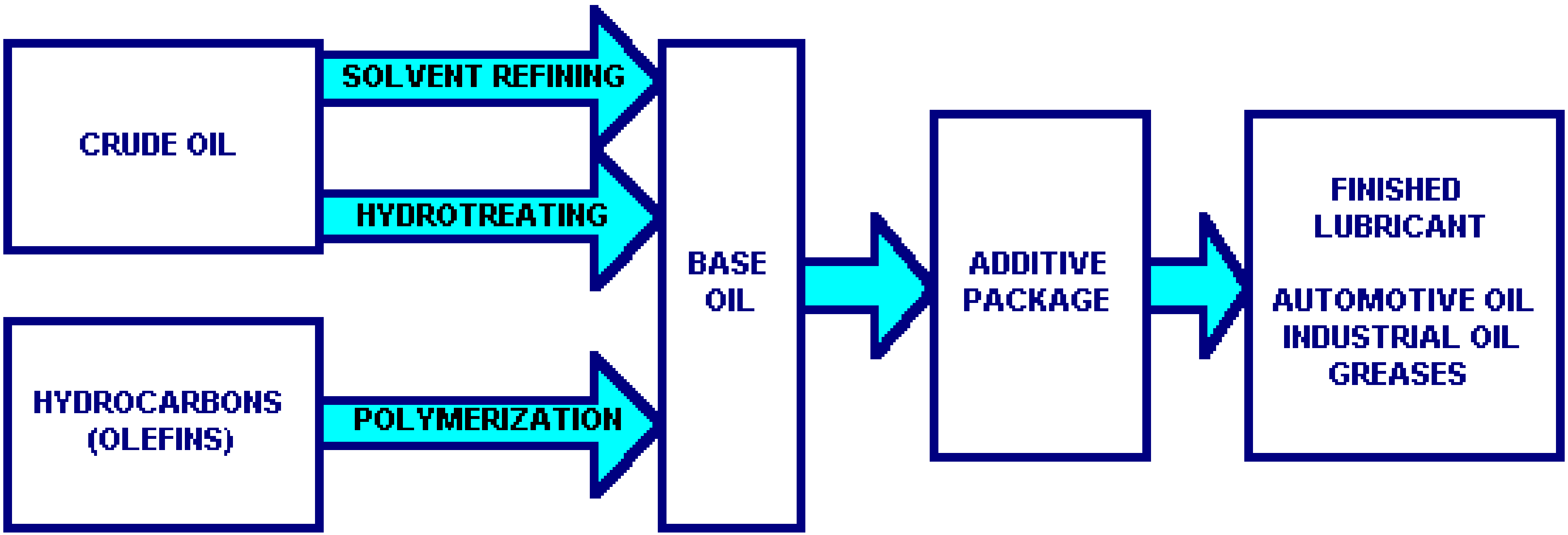


# WHAT LUBRICANTS

- OILS AND GREASES

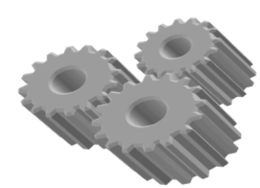
- MINERAL
- VEGETABLE
- SYNTHETIC


PRIMARY SEPARATION
CONVERSION
REMOVAL OF IMPURITIES
LIGHT ENDS UPGRADING
PRODUCTS
Propane/Butane
Crude oil
Atmospheric distillation
Light gasoline
Naphtha
Kerosene
Gas oil
Atmospheric Residue
Hydro-treating
Isomeri-zation
Catalytic Reforming
Alkylation Polymeri-zation
Butane
Cracked gasoline
High Vacuum Distillation
Vacuum Distillates
Vacuum
Vacuum Residue
Catalytic Cracking
Hydro Cracking
Lube oil plant
Therm. crack/ Visbreaking
Coking
Hydro-conversion
HDS
Hydro-desulphuri-sation (HDS)
Gas oil
Kerosene
Gas oil
Gas oil
Kerosene
Gas oil
LPG
NAPHTHA
GASOLINE
JET FUEL
DIESEL
LUBE OIL
FUEL OIL
ASPHALT


CRUDE OIL
SOLVENT REFINING
HYDROTREATING
HYDROCARBONS
(OLEFINS)
POLYMERIZATION
BASE
OIL
ADDITIVE
PACKAGE
FINISHED
LUBRICANT
AUTOMOTIVE OIL
INDUSTRIAL OIL
GREASES

A base oil must be refined to the highest level, and then compounded with specially selected chemical additives.

The additives used depend on the specific application of the lubricant.



# Detergents

These chemicals are usually metallic based, and are designed to control deposits and keep engine components clean.

They are able to clean existing deposits in the engine, as well as disperse insoluble matter into the oil.

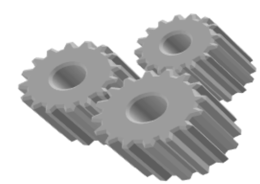
Detergents control contamination resulting from high temperature operation.

# Dispersants

These are usually ashless organic chemicals, which control contamination from low temperature operation.

Both detergents and dispersants attach themselves to contaminant particles, and hold them in suspension.

The suspended particles are so finely divided that they pass harmlessly between mating surfaces and through oil filters. The contamination is removed from the engine when the oil is changed.



## Oxidation Inhibitors

These agents reduce oxygen attack on the lubricating base oil.

## Rust Inhibitors

Rust inhibitors protect iron/steel from oxygen attack, by forming a protection screen over the surface of the metals

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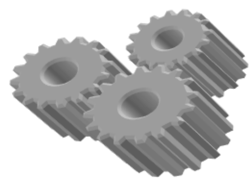
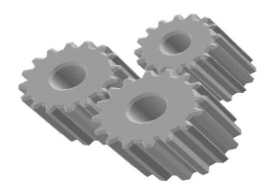


# Corrosion Inhibitors

Acids are produced by the combustion process, and when engine oil degrades with use. Unless rendered harmless by the engine oil, the acids can cause rapid deterioration of engine components. Corrosion inhibitors protect non-ferrous metals by coating them and forming a barrier between parts and their environment.

# Anti-Wear Agents

These agents prevent wear due to seizure or rubbing surfaces. Compounds such a zinc dialkyt-dithiophosphate break-down microscopic hot spots and form a chemical filter which eliminates metal-to-metal contact.



# Foam Depressants

Detergent and dispersant additives can facilitate aeration of an oil which results in foaming. This can reduce the lubricating ability of the oil, and interfere with the pumping of the oil. A foam depressant controls this tendency.

# Viscosity Index (VI) Improvers

VI improvers control the viscosity of multi-grade oils. They are polymers which act like "popcorn". At low temperatures, they are "tight-balls" which do not significantly increase the oils resistance to flow. However, at high temperatures, these "tight balls" explode into long chain polymers, which interweave and increases the oil's resistance to flow(viscosity). The tendency of an oil to "thin" at high temperatures is controlled and reduced.

# Pour Point Depressants

Base oils contain hydrocarbons that tend to crystallize into waxy material at low temperatures. Incorporation of a chemical which reduces the size of wax crystal formation can give an oil better low temperature fluidity.

Viscosity is an important attribute of all lubricating products. It is a measure of the ability of oil to flow. The challenge of a lubricating oil is to flow easily at engine start-up and thus provide immediate protection for the moving parts. Conversely, the tendency of an oil to "thin-out" at higher temperatures must be controlled to provide protection to the moving parts as the engine reaches operating temperature.

# Measurement of Viscosity

The viscosity of an oil is measured at a specified temperature to determine the ability of the oil to flow through a standard opening. There are four major classifications of viscosity:

**ISO VG -** measurement in centistokes (cSt) at 40 C
**AGMA -** American Gear Manufactures Association
**SAE** - Society of Automotive Engineers e.g. SAE30
**Saybolt -** These units are in S.U.S an were used by various refiners to specify viscosity at 100 F or 210 F

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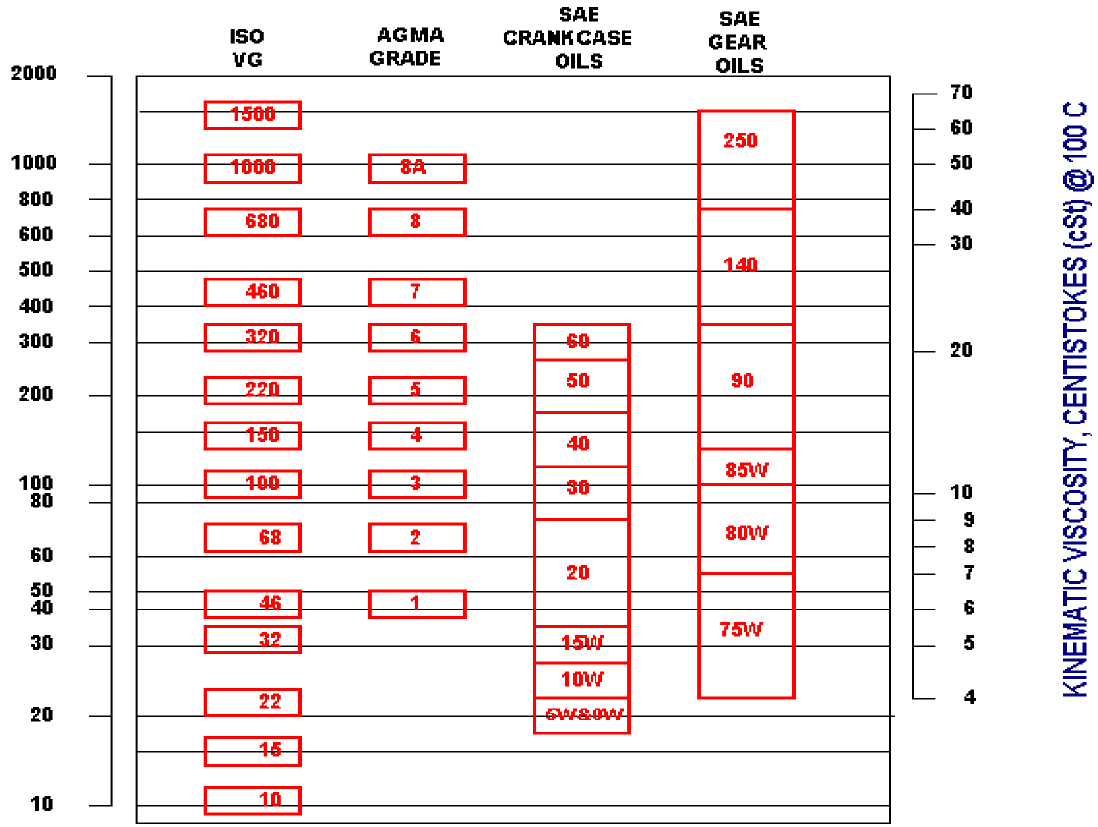
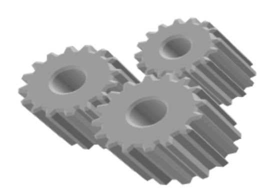
# VISCOSITY EQUIVALENTS




**NOTES:**

*Assumes 100 VI single grade oils. Read across horizontally.
*SAE grades based upon viscosity at 100 C. ISO and AGMA grades based upon viscosity at 40 C
*Equivalence is in terms only of viscosity. Quality requirements are a separate consideration.
*Viscosity limits are approximate: For precise data, consult ISO, AGMA and SAE specifications.
*W grades define only in terms of 100 C viscosity. For low temperature limits, consult SAE specifications.

*ISO = International Standardization Organization
*AGMA = American Gear Manufacturers Association
*SAE = Society of Automotive Engineers

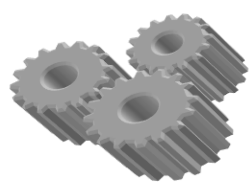


If you need a lubricant which stays at the friction point for a long, long time, there is only one solution: a lubricating grease.

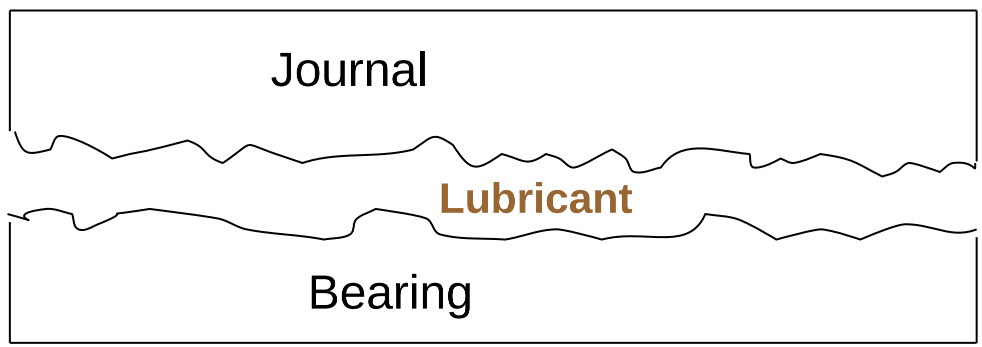
It is based on lubricating oil, thickener and additives.

Its main characteristics include the following: Optimum drop point, good oxidation resistance, resistance towards fluids and steam, good temperature stability.

But greases offer a lot more: depending on the application, they are rapidly biodegradable, electro-conductive, resistant to ambient media, they protect against corrosion, have a high load-carrying capacity, are neutral towards materials, reduce noise, food-safe, ...

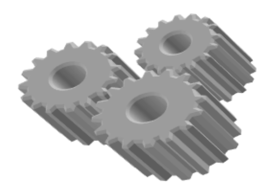


# If lubrication fails – even briefly – friction will be generated



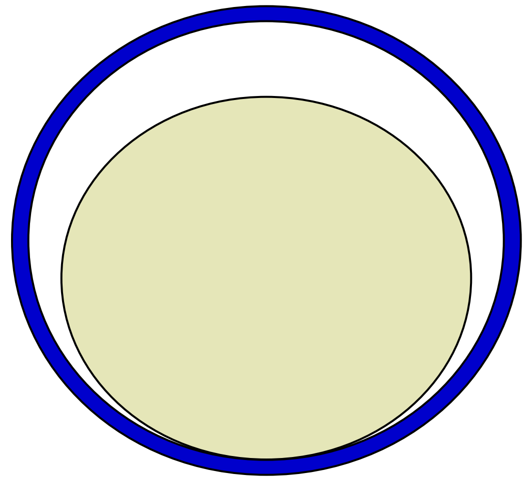

## Causing :-

1. Wear
2. Overheating
3. Subsequent equipment failure

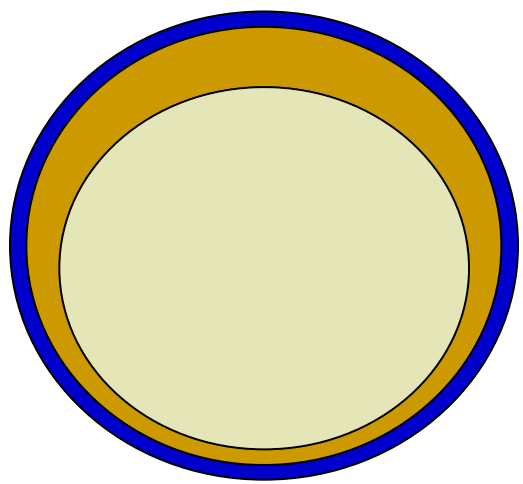


**No lubrication** –

**Parts touch, causing friction**

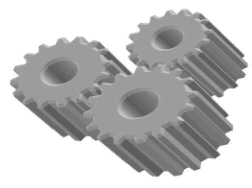


**Lubrication** – **Oil wedge separates**



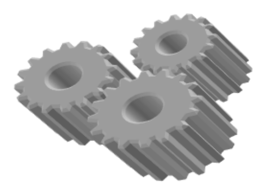
# THE RIGHT CHOICE

- **Fundamental to reliability**
- **Chosen through research, design and test**
- **Optimised to suit varied conditions under which equipment operates**



# CONSIDERATIONS

- Weight of machine parts
- Speed of rotation
- Materials
- Operating temperatures
- Operational loading
- Period of operation

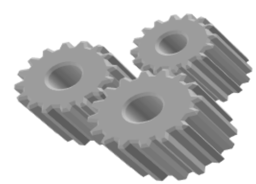


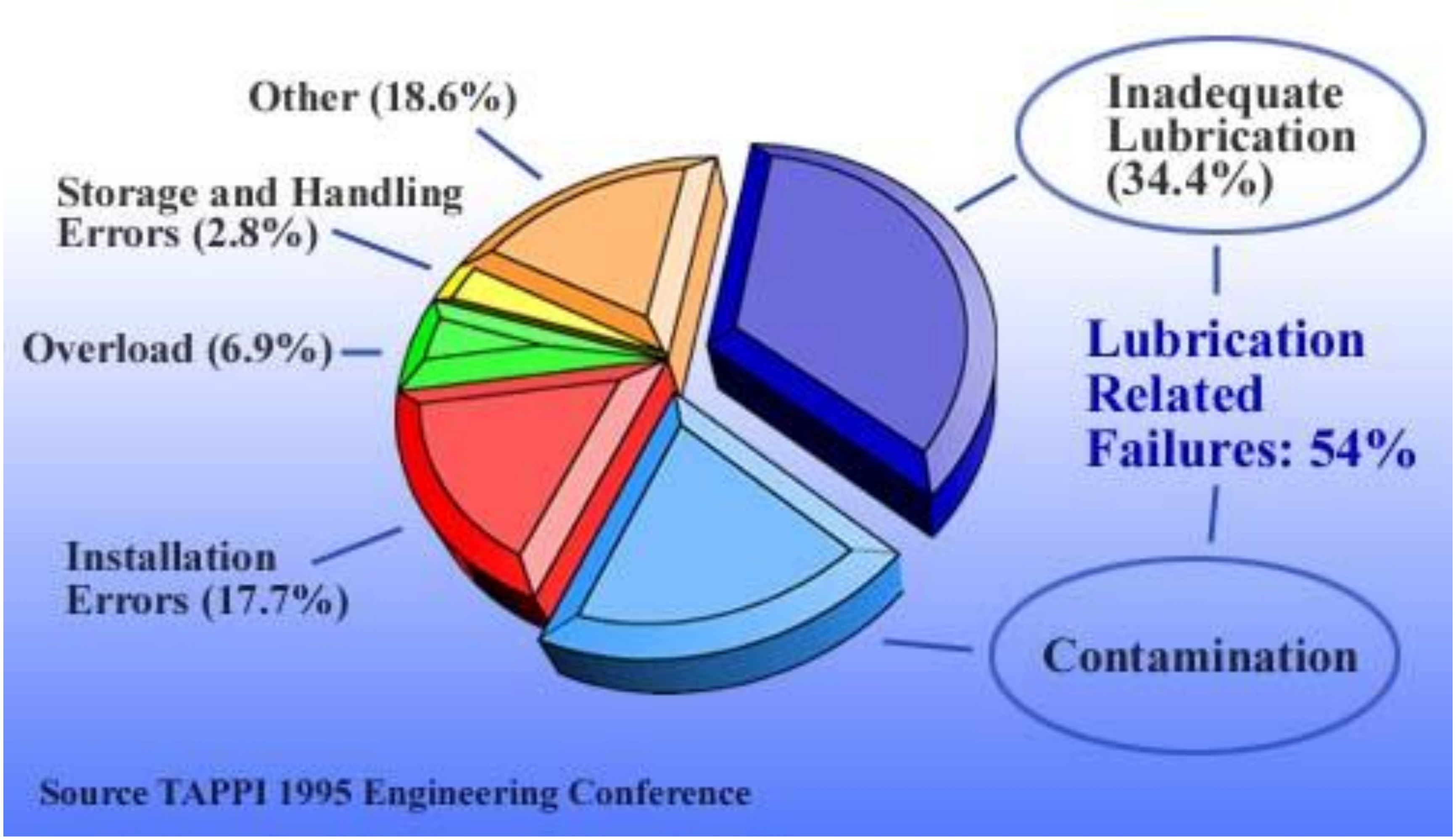
# USE OF OIL DEPENDING ON ITS VISCOSITY

- **Thin oils** - **Flow easily, ideal for light drives/loads**

- **Medium oils** - **Slightly thicker, flows slower, ideal for sumps**

- **Thick oils** - **Very tacky, sticks easily to surfaces**
  **Ideal for gearboxes**

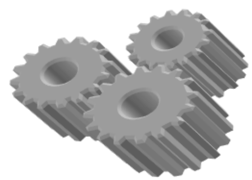



Other (18.6%)
Storage and Handling Errors (2.8%)
Overload (6.9%)
Installation Errors (17.7%)
Inadequate Lubrication (34.4%)
Lubrication Related Failures: 54%
Contamination
Source TAPPI 1995 Engineering Conference

# Lack of Lubrication

If lubrication fails even briefly, metal will run on metal and friction will be generated.

This causes wear, overheating and reduced equipment life



# Contamination

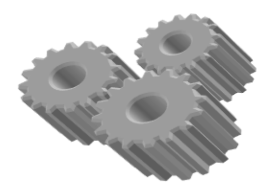
**Due to the small clearances between moving parts,**
**a single particle will penetrate the**
**lubricant film, causing gauling, friction and wear**

*Examples :*

Dust, grit, the wrong lubricant, etc.

**Water is enemy No. 1**

0.01% Water = 50% reduced bearing life



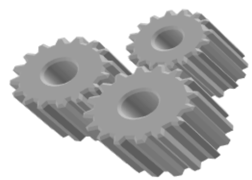
# Lubrication

- Must always be present
- Keeps moving parts separate
- Even brief failure can cause damage

**For good lubrication :**

- Make the right choice **QUALITY**
- Ensure the right amount **QUANTITY**
- Ensure the right **FREQUENCY**

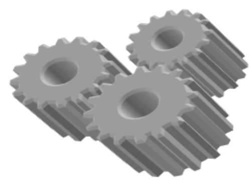
*AND MAINTAIN*



# Lubrication

**Lubrication plays different roles :**

- It minimises friction & wear
- It takes away heat
- It fights corrosion



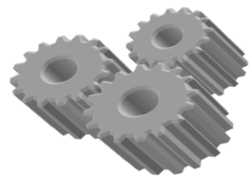
# Lubrication

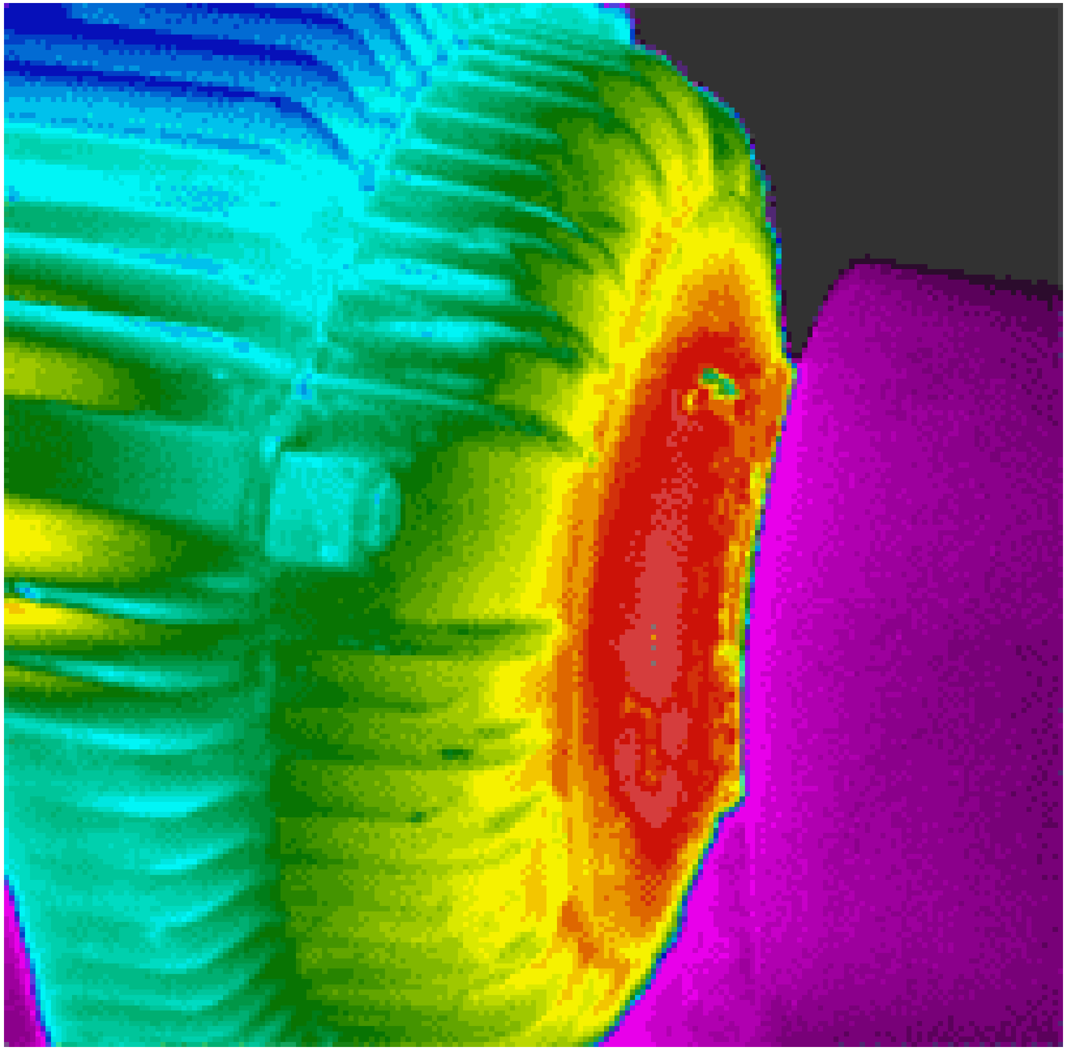
## Too Much

- The oil will churn
- The equipment will overheat
- The equipment will fail

## Too Little

- Friction will occur
- The equipment will overheat
- The equipment will fail





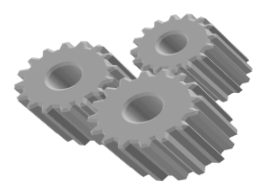
# Lubrication

## The Right Choice

- Fundamental to reliability
- Decision made by equipment design engineers and company engineers
- Optimum choice to suit varied conditions under which equipment operates

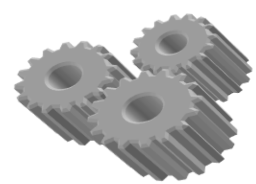
## Considerations

- Weight of machine parts
- Speed of rotation
- Materials
- Operating temperatures and many more



# Oil Film Breakdown Occurs :

- Too high a temperature
- Contamination
- The wrong lubricant

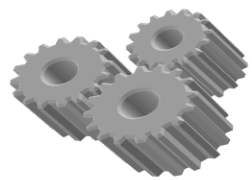


# Viscosity

**A fluid's ability to resist flow**

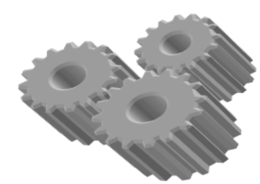
Low viscosity - Flows easily

High Viscosity - Flows slowly

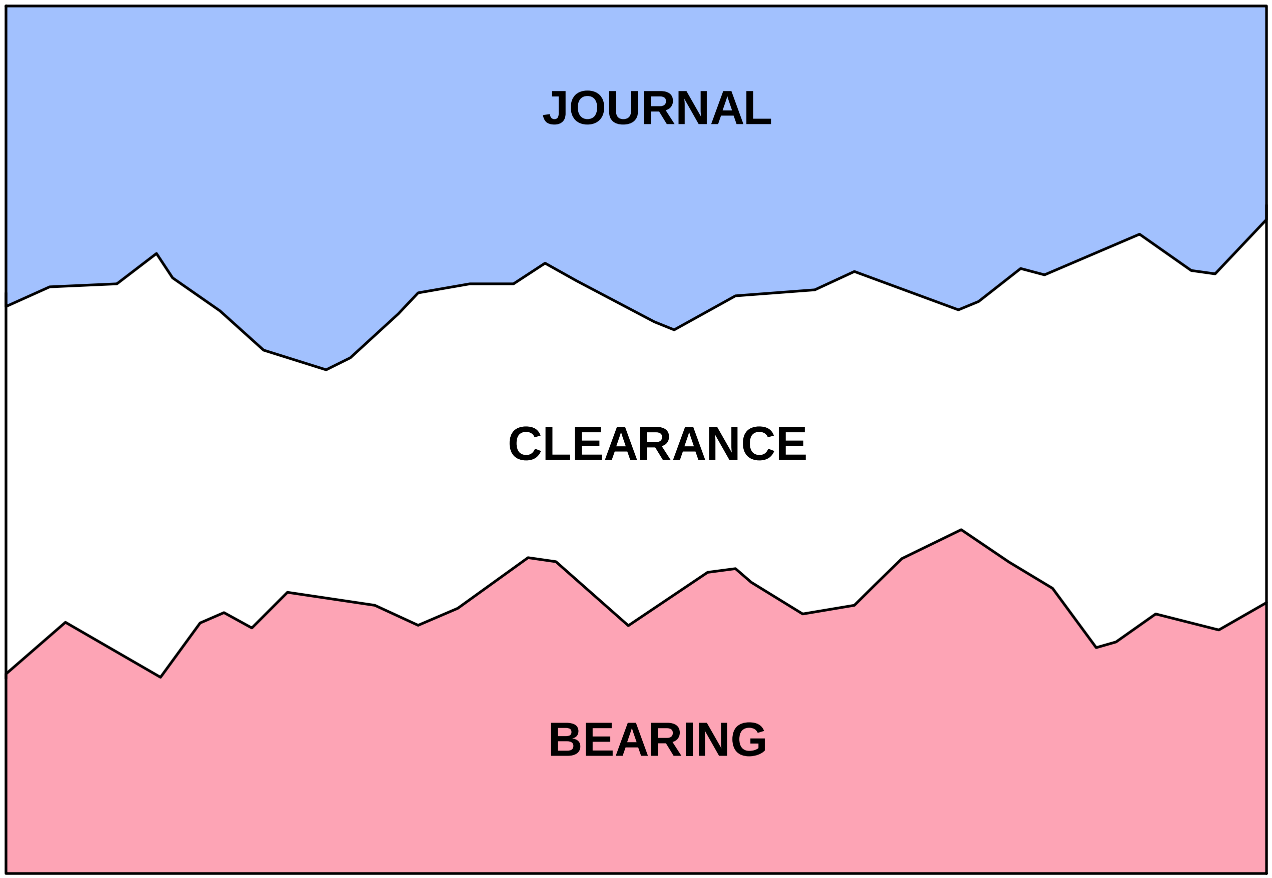


# Examples of Lubrication

| | |
|---|---|
| **Easing oil** | ***(seized nuts and bolts)*** |
| **Cutting oil** | ***(lathes etc.)*** |
| **Grease** | ***(natural and synthetic)*** |
| **Oils** | ***(natural and synthetic)*** |
| **Anti-seize greases** | |



# Lubrication



# Lubrication - Grease

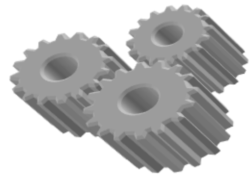
***What is Grease ?*** **Soap in oil emulsion**

***What is an emulsion ?*** **A creamy liquid in which particles of oil or fat are evenly distributed**

***How is grease made ?*** **Fatty acid + Base = Soap**

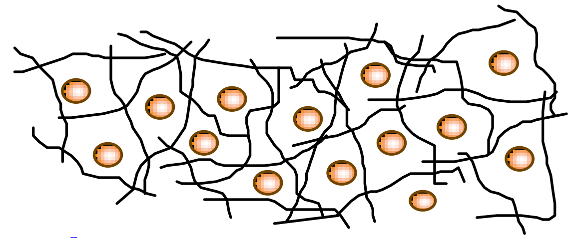
**Fatty acids are chemicals split into fatty acids and glycerides by hydrolytic decomposition**

**Soap is based on : Lithium, Sodium, Calcium, Aluminium, Barium**



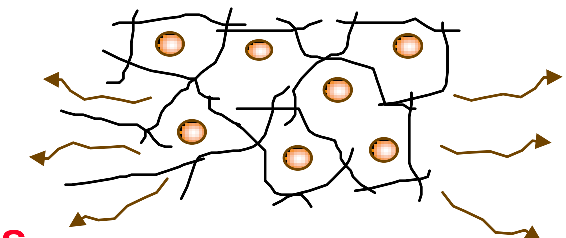
# Lubrication - Grease

**Normal correctly used grease**



Oil held between strands

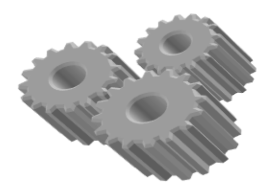
**Result of over greasing**



Oil lubricant escapes

**Strands break - Oil lubricant escapes**

**- Churning and overheating occurs**



## Grease Degradation

Grease degradation is a gradual process.

Most grease degrading influences are more present only while the motor is running; however degradation can occur while a motor is idle.

Grease degradation can be caused by any of the following conditions:

**Grease hardening** –
This usually results from absorption of dirt, moisture or oxidation over a long period of time.

**Chemical breakdown** –
Typically caused by excessive heat. Overgreasing can cause overheating.

**High bearing loads** –
Side-loaded motors can load a bearing system more than a direct coupled motor.

**Oil separation from grease base material** –
This occurs on motors that remain idle for long periods of time, when the grease is churned excessively, and over time due to the designed normal bleed rate.

**Rotational speed of the bearing** –
The higher the speed, the more grease will degrade.

**Bearing size** –
The larger the bearing, the more grease degradation can occur. The size of the bearing can usually be equated to the horsepower of the motor.

**Environment** –
Bearings operating in ambient temperature above 140°F can cause more rapid degradation of the grease.

# Lubricant application

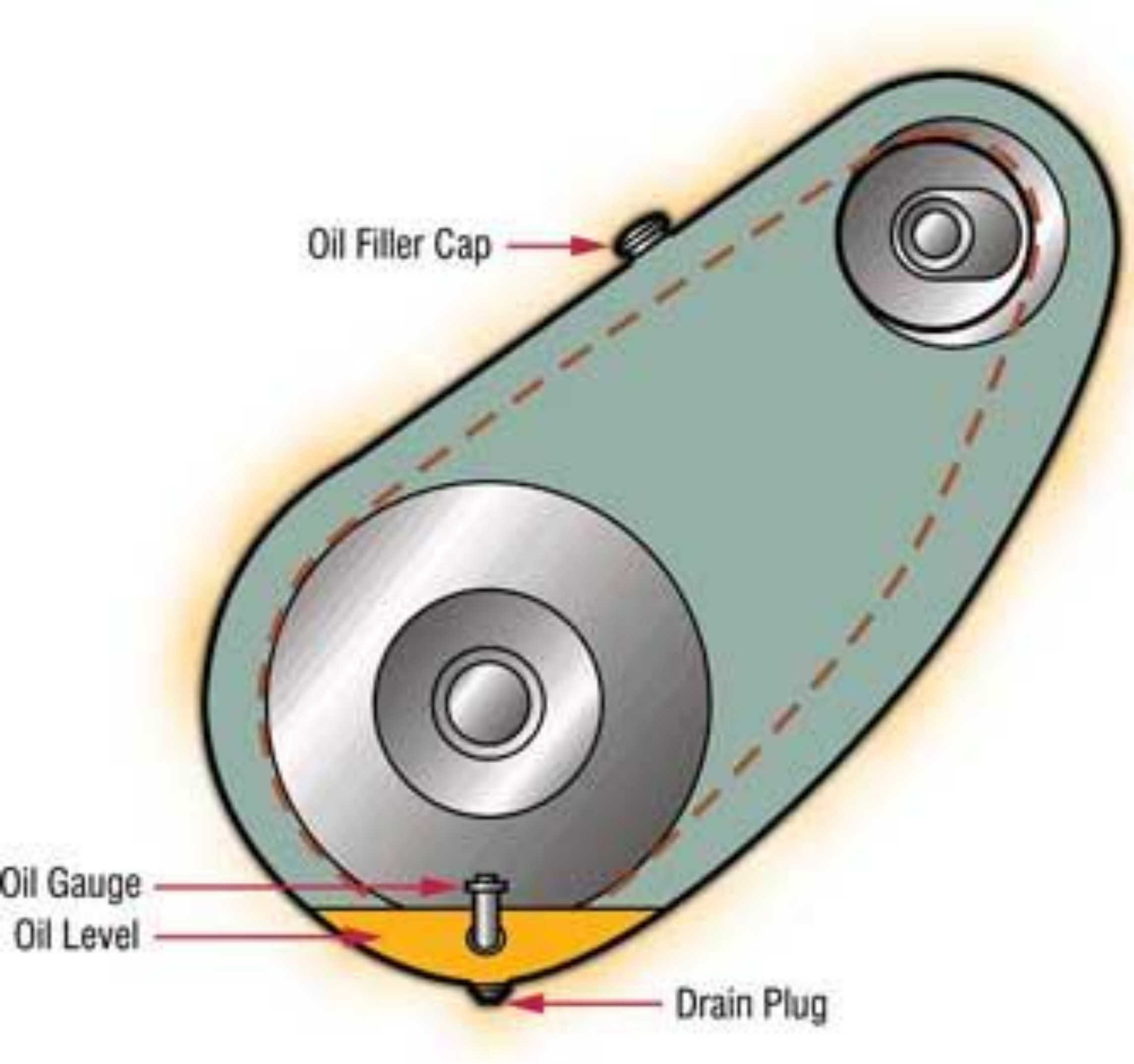
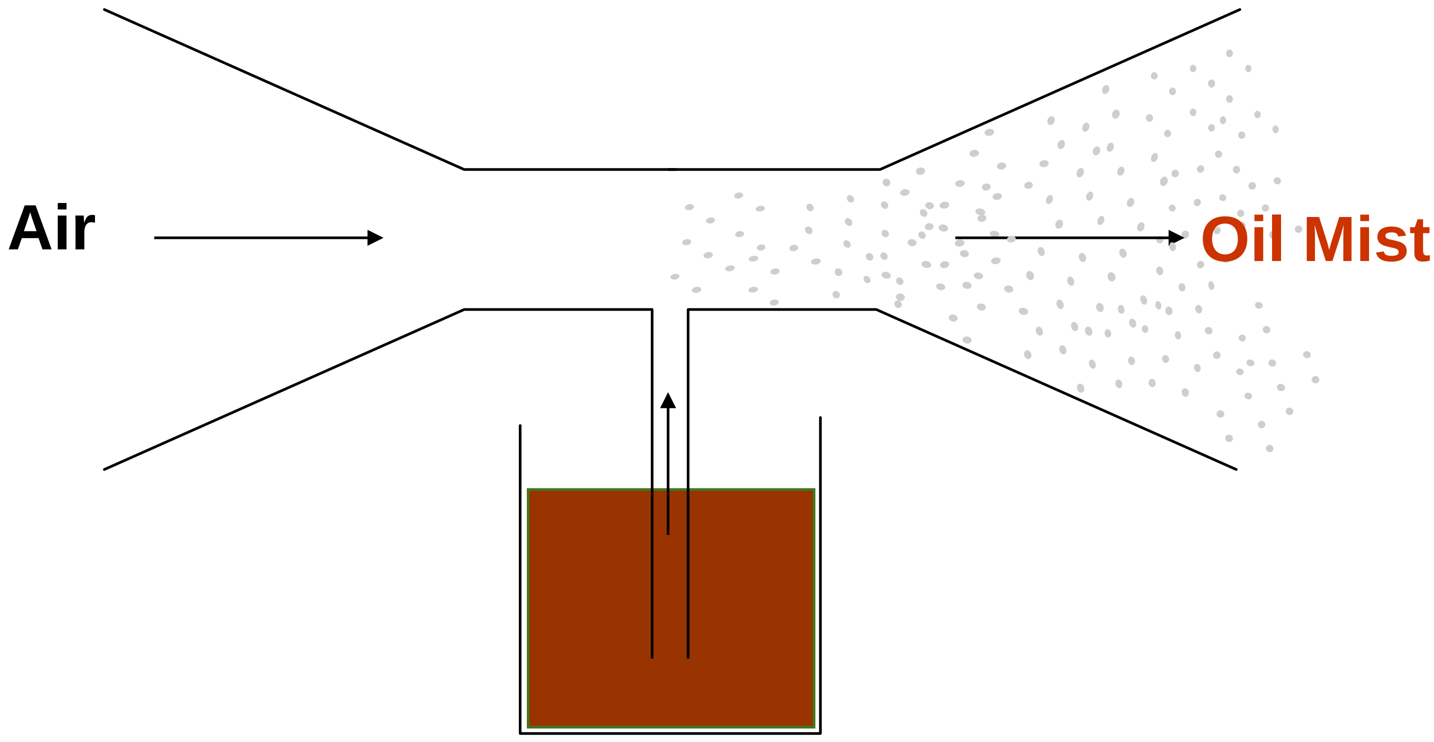



Figure 5. Oil Bath Lubrication

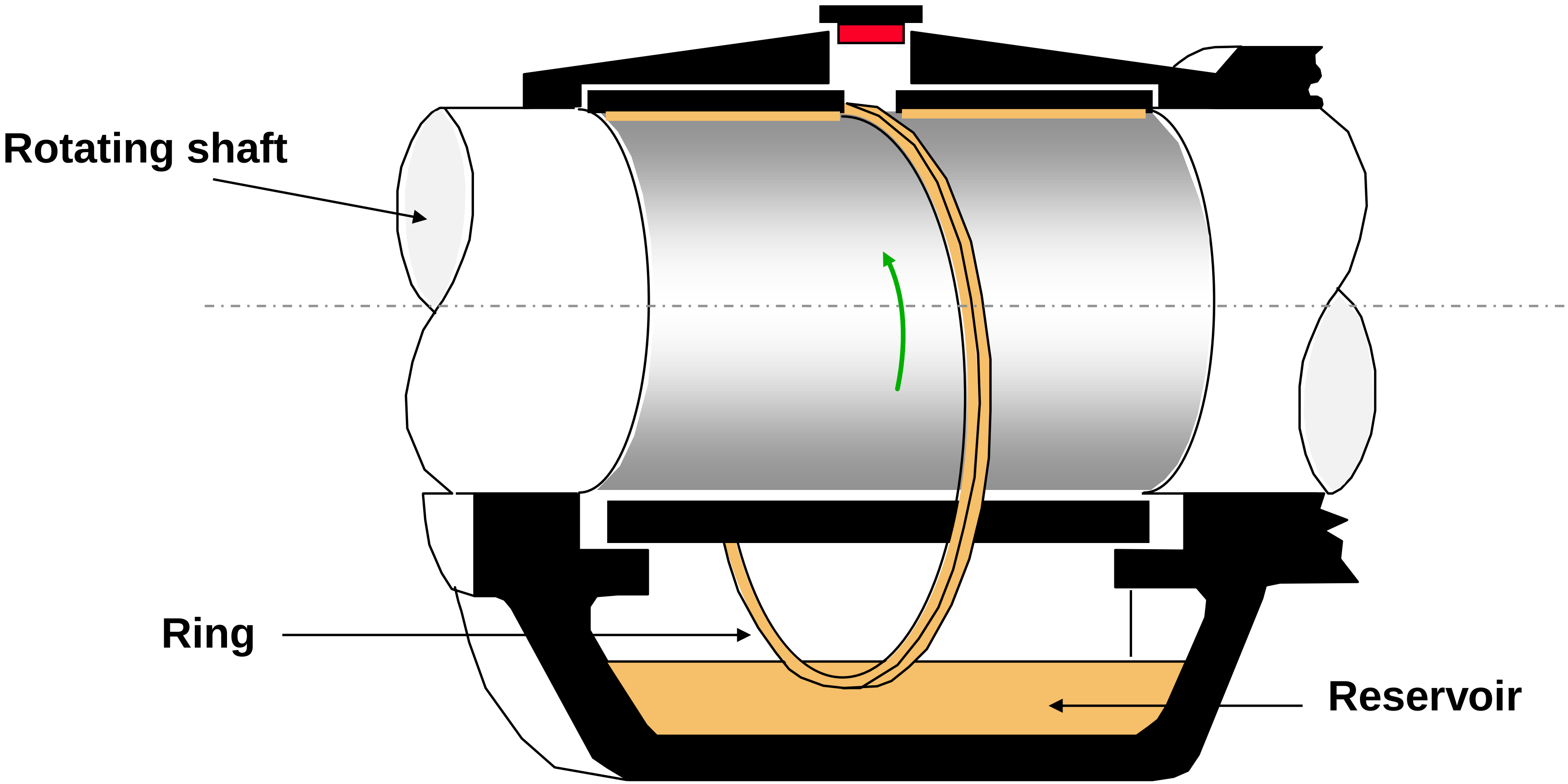
**Oil Bath Lubrication**

In oil bath lubrication, a short section of the chain runs through the oil in the bottom of the chain casing. The oil level should extend only to the pitch-line of the chain at its lowest operating point. Having long sections of chain run through the oil bath can cause oil foaming and overheating.

# Oil Mist System



# Oil Ring Lubrication

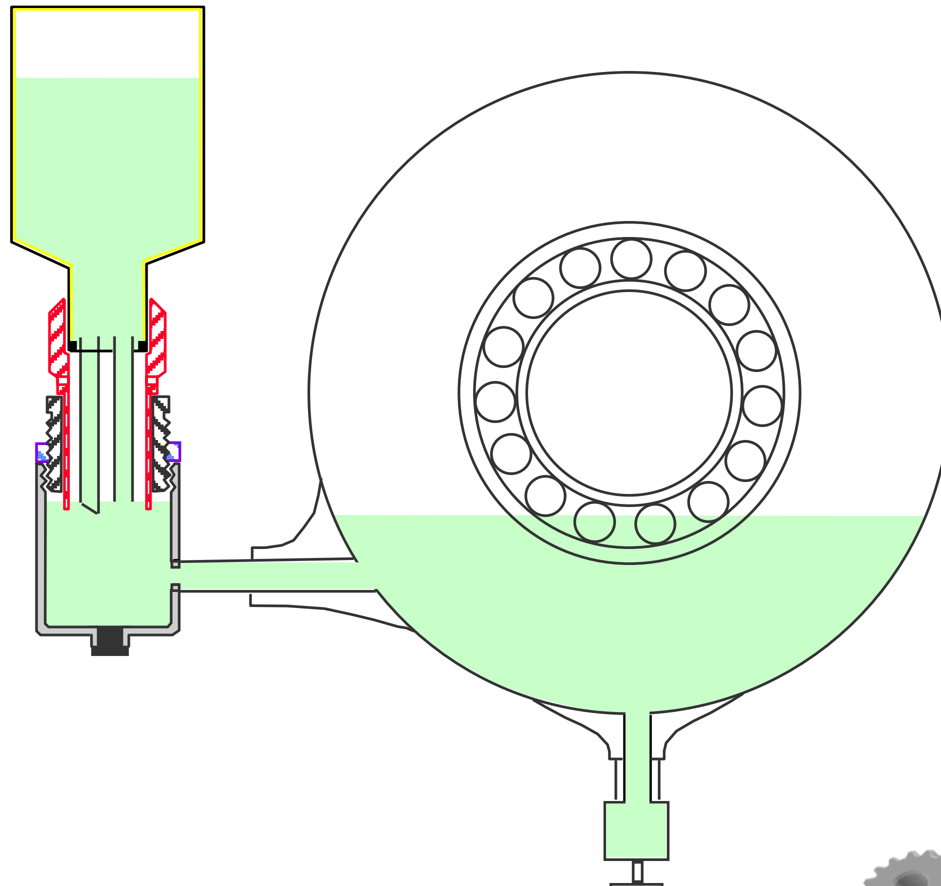


# Rotating Equipment Lubrication

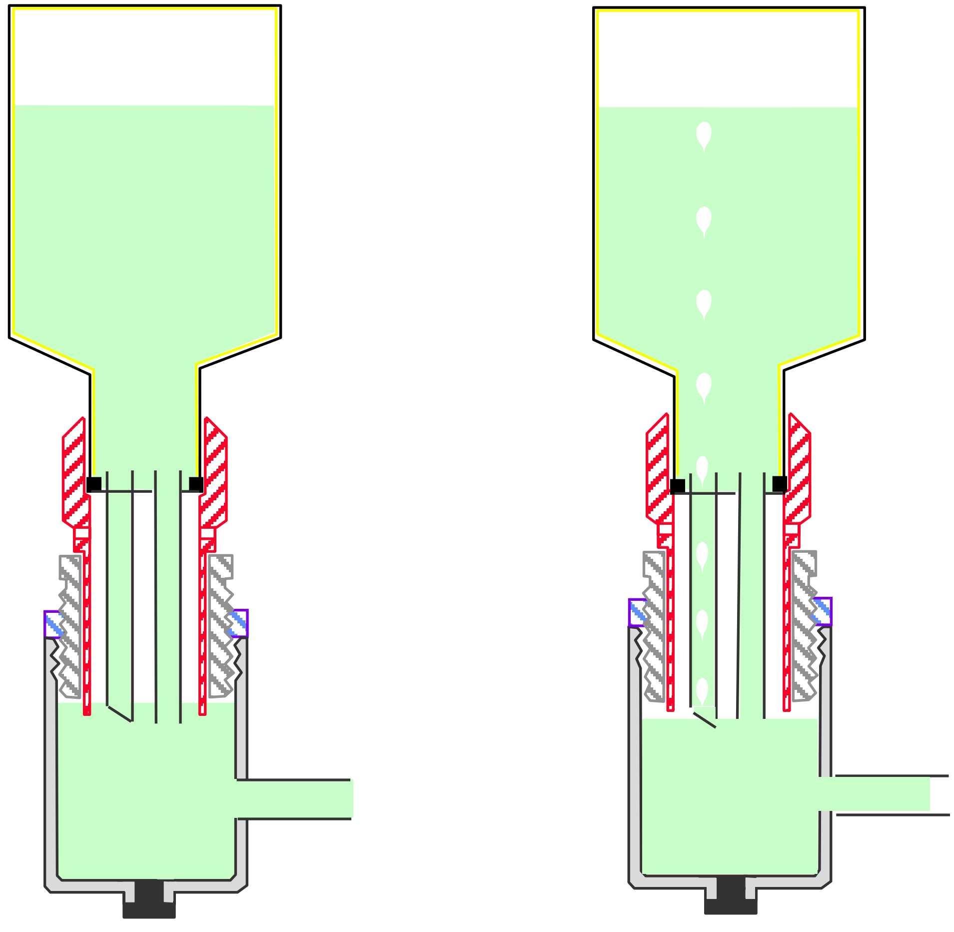
## THE CORRECT AMOUNT

- **Oil lubricated bearings:**
- **The correct oil level in the bearing housing is halfway up the lowest ball or roller bearing.**
- **This level is pre-determined by engineers. It can be adjusted to this set position using an oil level gauge which aligns the Denco position against a permanent level mark on the outside of the bearing housing.**

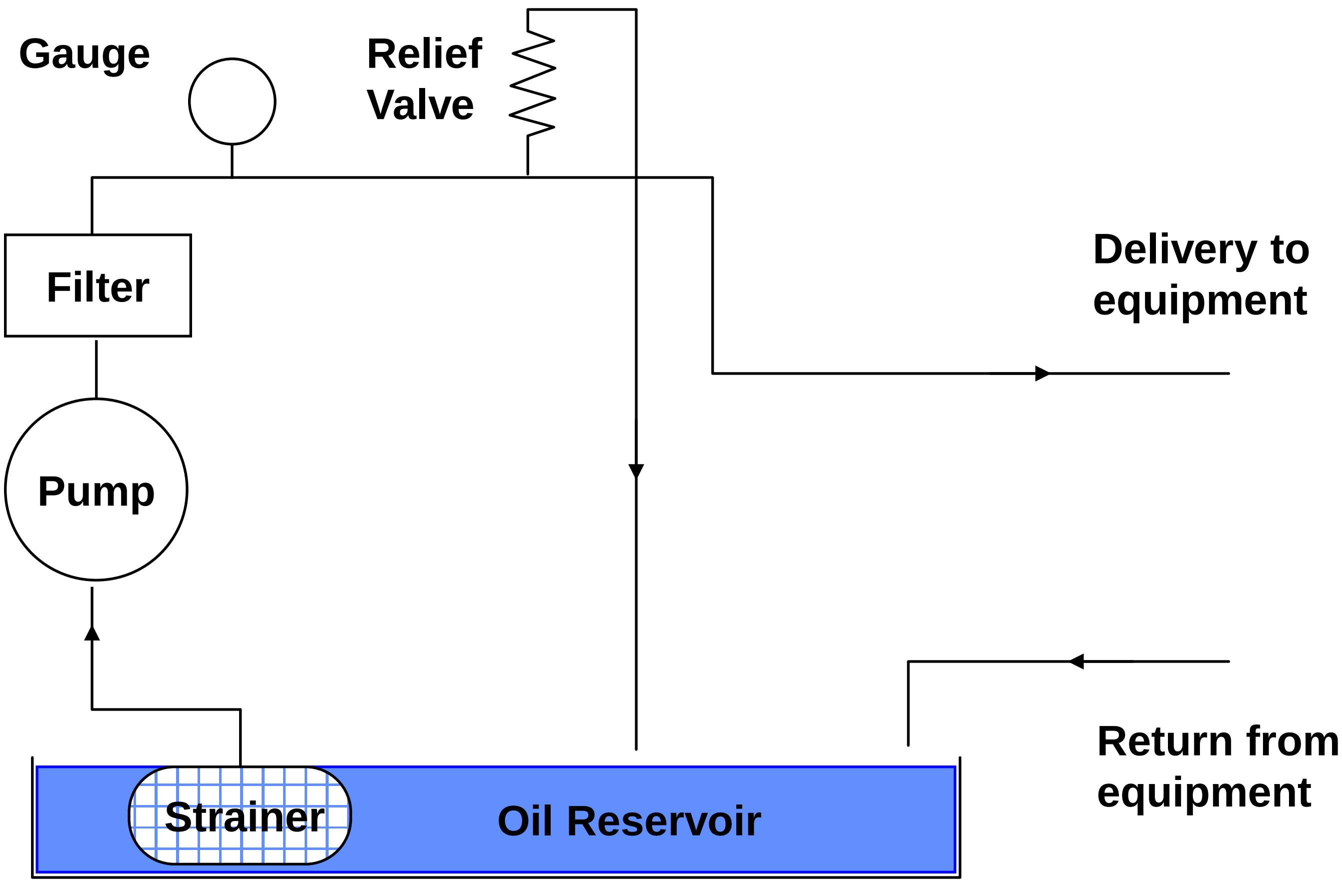
***All Bearing Housings Must Have This Mark Permanently Established***

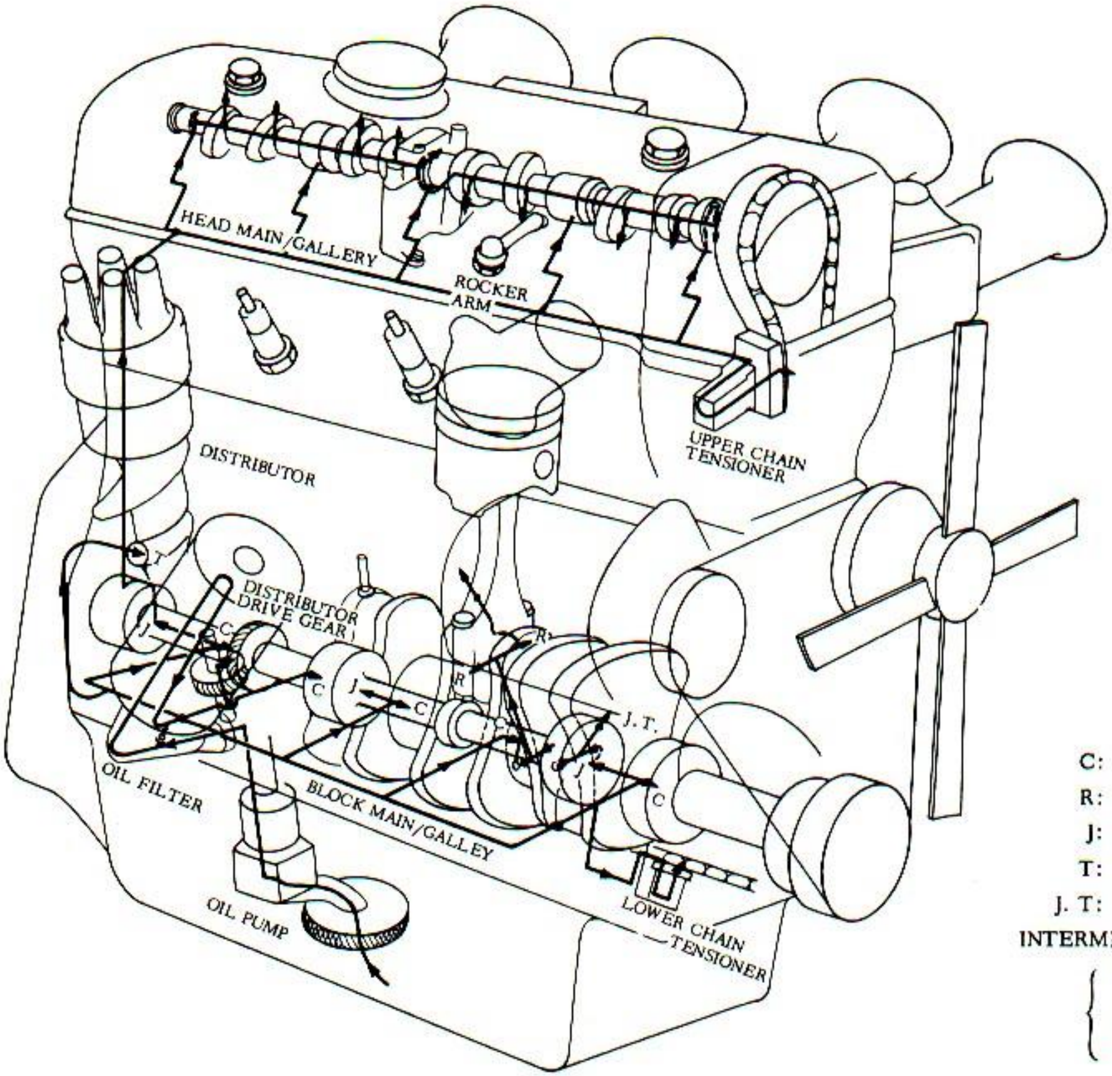


# Denco Lubrication



# Pressurised Lubrication System






C: CRANK MAIN BEARING
R: CONNECTING ROD BEARING
J: JACKSHAFT BEARING
T: TACHOMETER DRIVE GEAR
J. T: JACKSHAFT THRUST PLATE

INTERMITTENT LUBRICATION PORTION
- ROCKER ARM
- JACKSHAFT THRUST PLATE
- DISTRIBUTOR DRIVE GEAR

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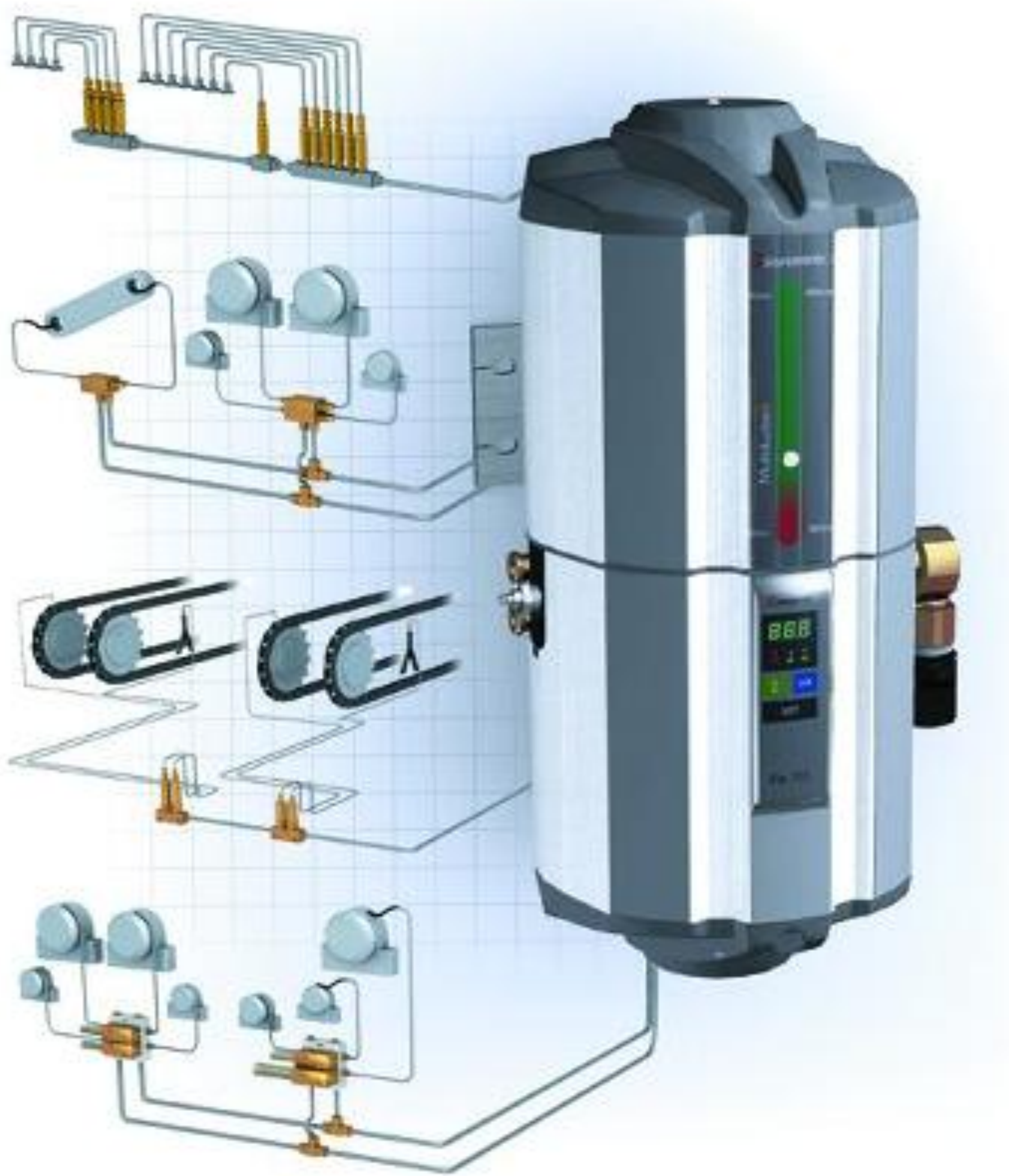
# EXAMPLE OF AN AUTOMATIC PRESSURISED LUBRICATION SYSTEM



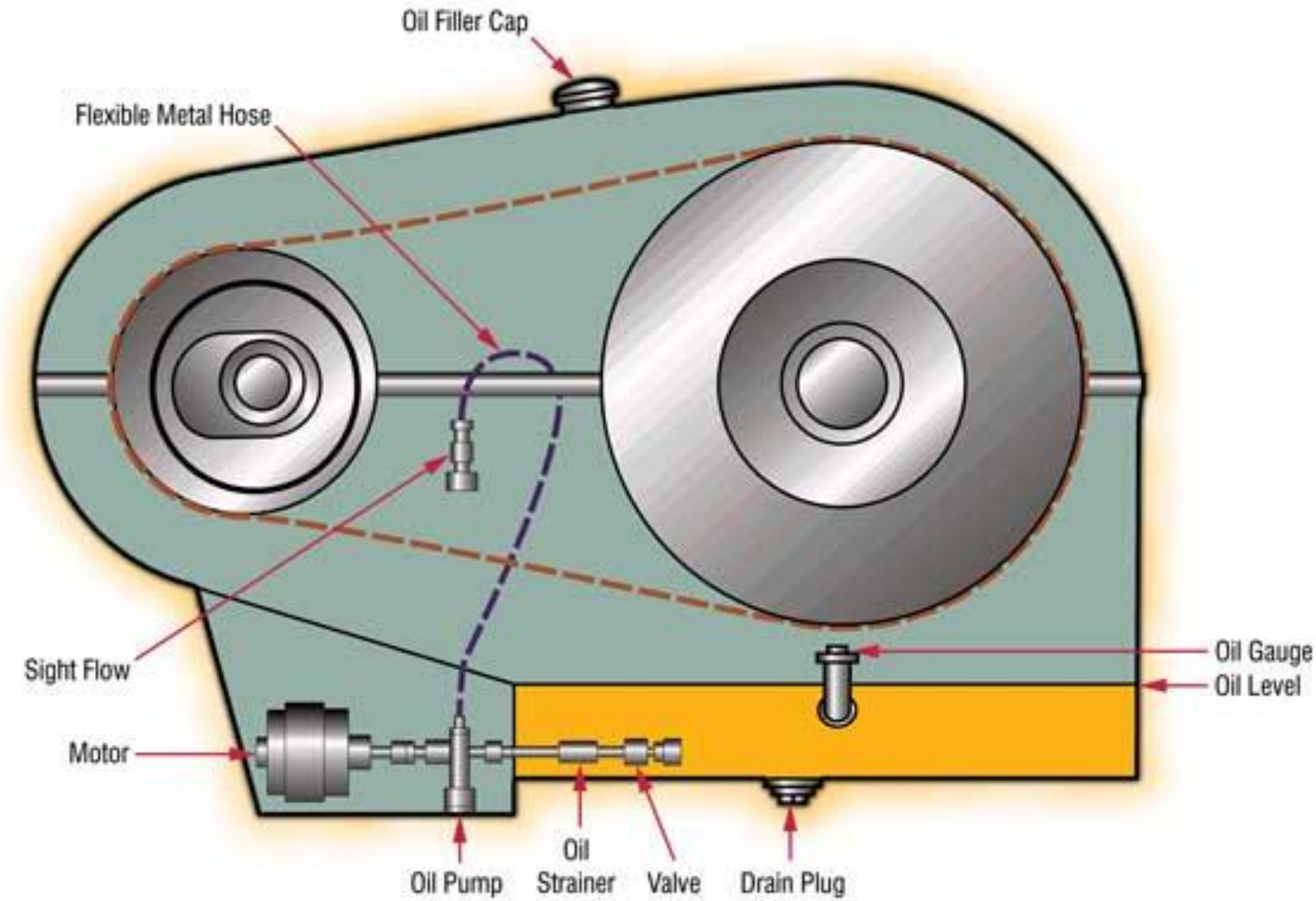
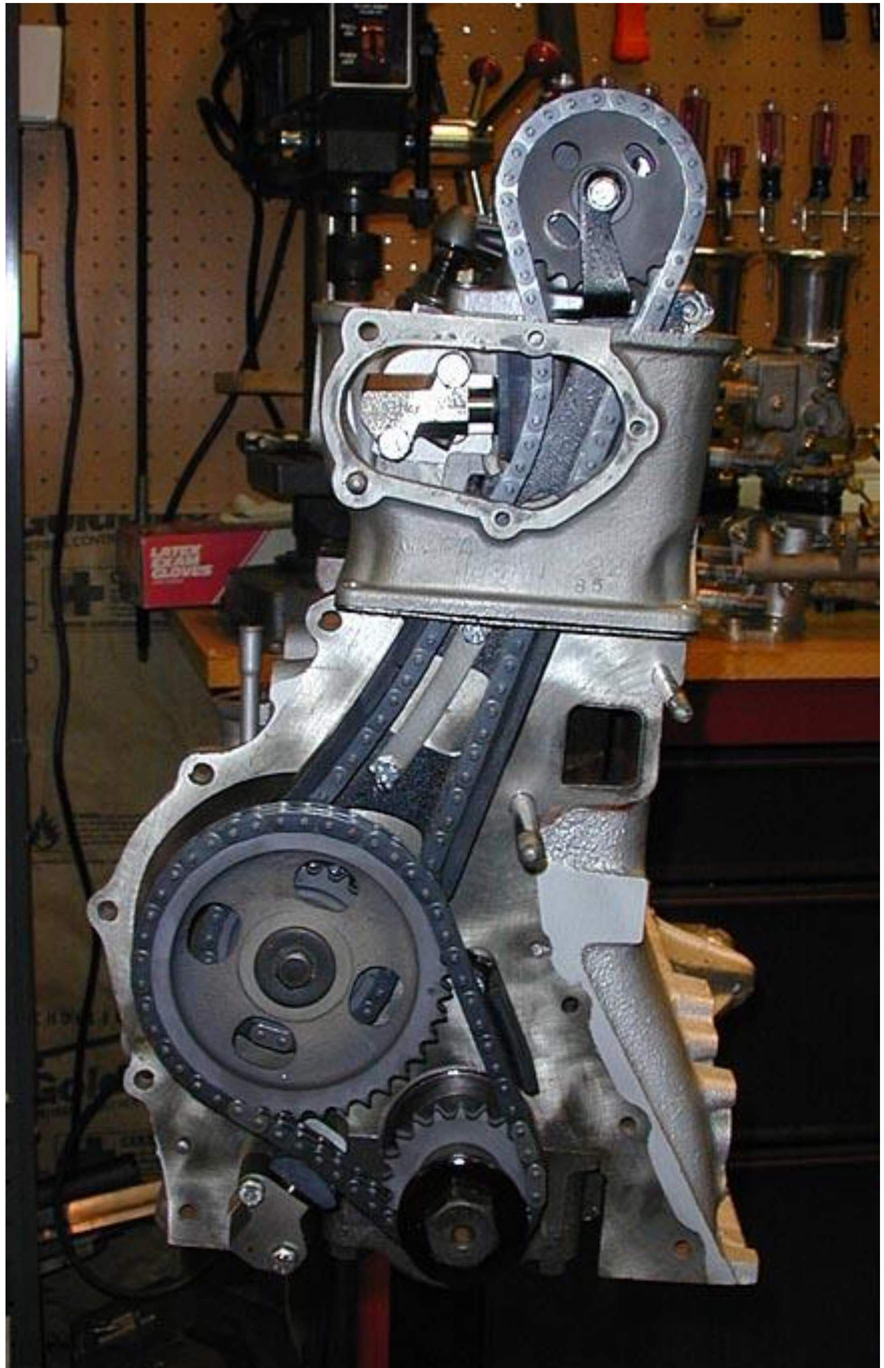
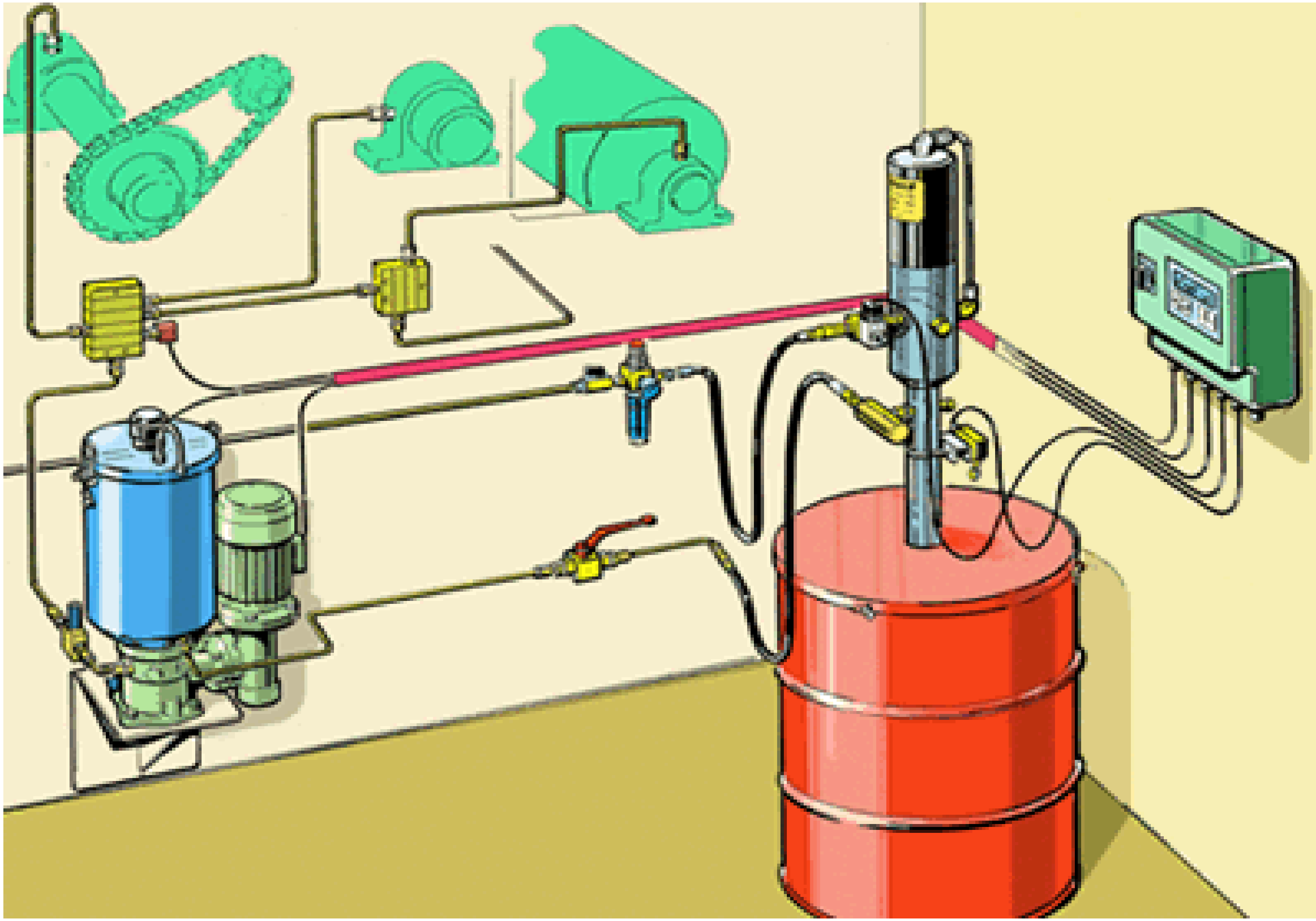
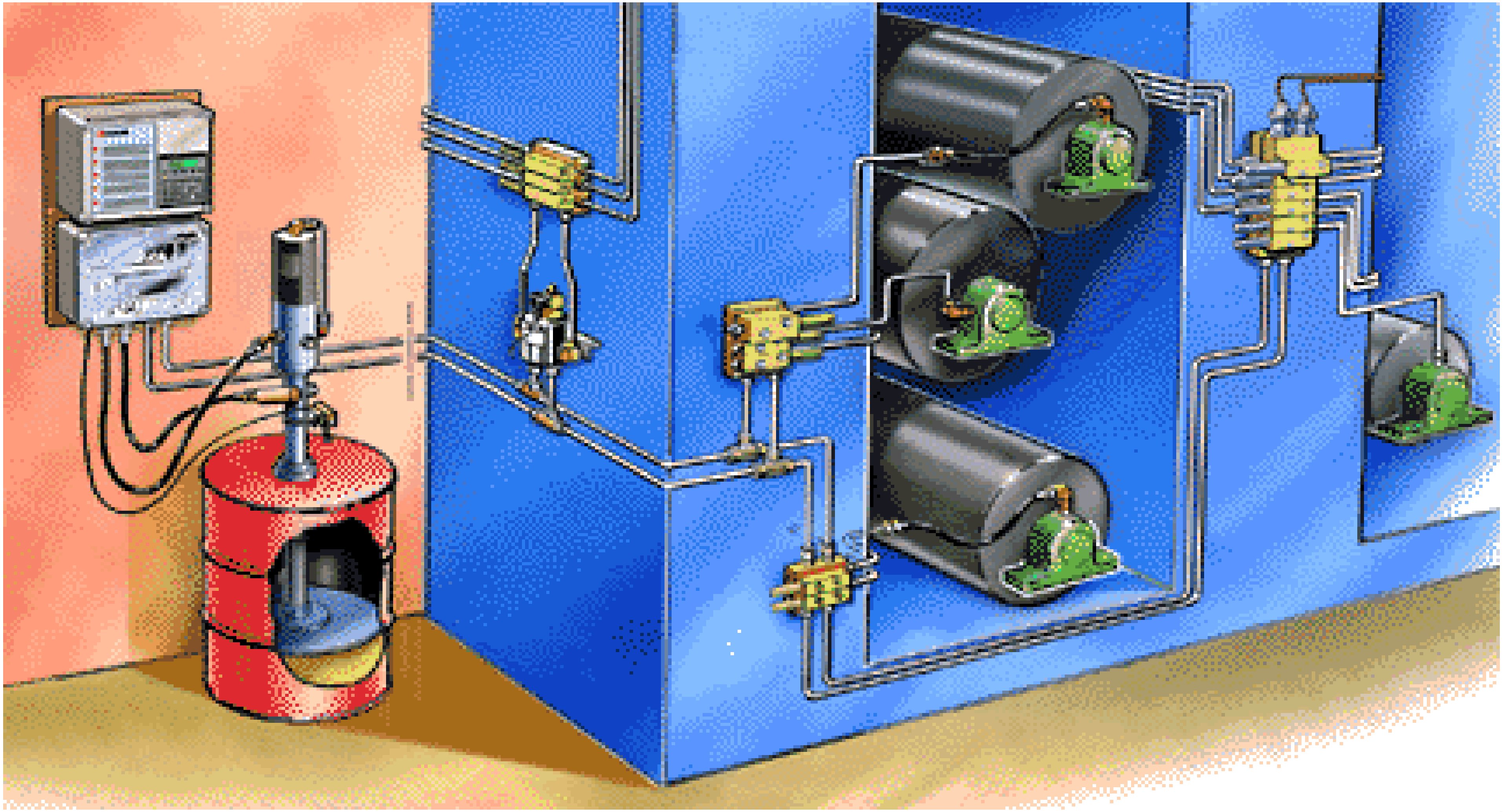



**Figure 7. Oil Stream Lubrication**



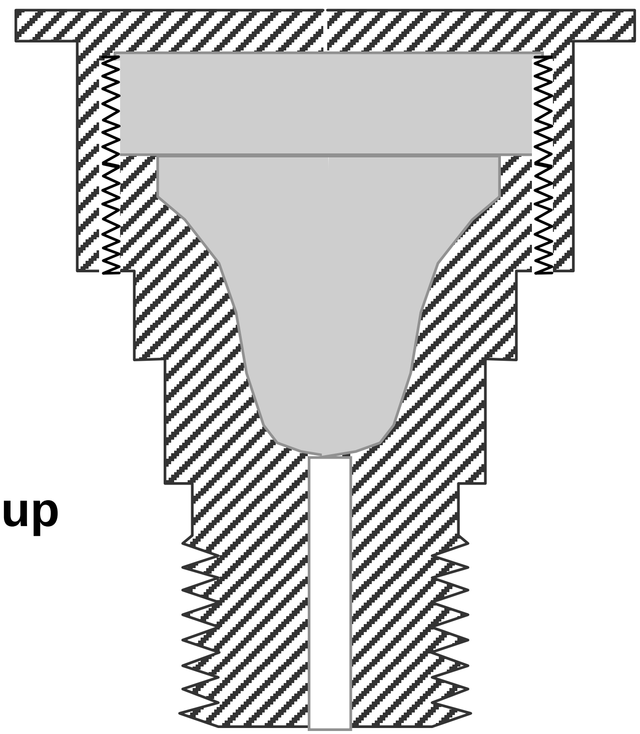
# Lubricators, multi-line Systems

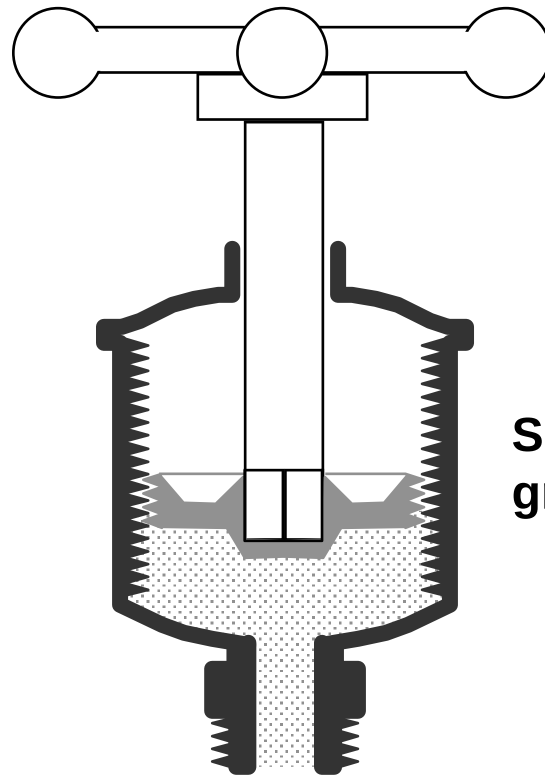




# Grease Lubrication

Grease Cup





Screw type grease cup

# AIRCRAFT LUBRICATION

Chek-Chart AVIATION

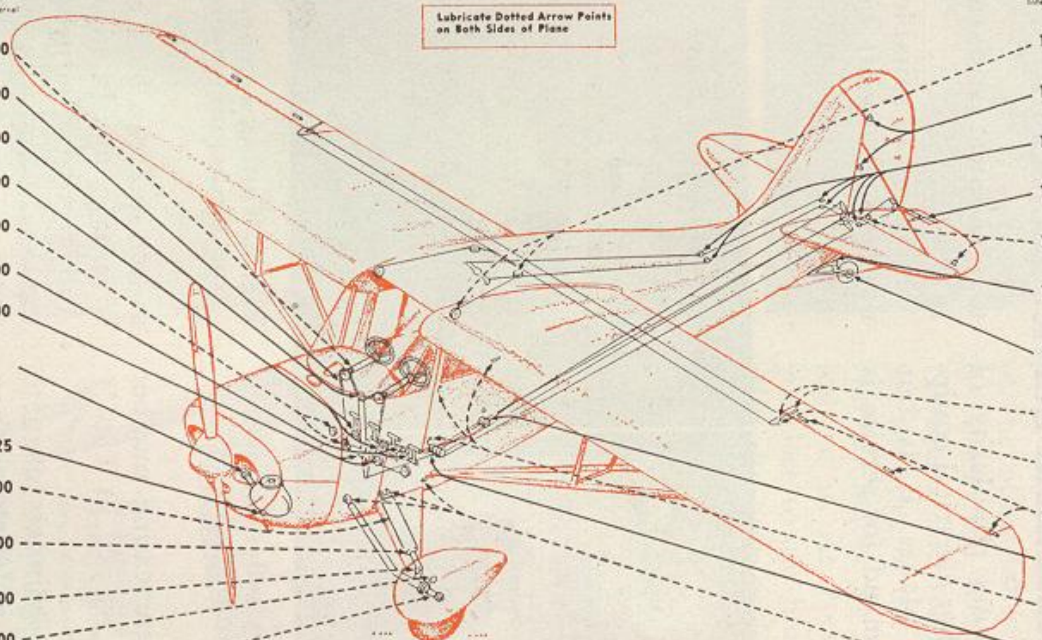
## DETAILED INSTRUCTIONS

1. CAUTION — Under dusty conditions, points should be washed with gasoline and brush, and relubricated every 25 hours.
2. ELEVATOR SHAFT BEARINGS — Lubricate every 100 hours with a mixture of GM and OG (Grade 1080).
3. SHOCK STRUT — To fill shock strut, jack plane up and disconnect Landing Gear Pivot at bottom. Raise strut past horizontal position and fill to level of plug with OH.

REFER TO LUBRICATION SERVICE SECTION FOR ENGINE ACCESSORIES AND GENERAL SERVICE INSTRUCTIONS

**Lubricate Dotted Arrow Points on Both Sides of Plane**

| Lubricant • Interval | | |
|---|---|---|
| Control Column Universal Joints | OD | 100 |
| Control Column Chain | OD | 100 |
| Control Column Sprocket Bearing | OD | 100 |
| Rudder Pedal Shaft Bearings | OD | 100 |
| Aileron Lower Control Pulleys | OD | 100 |
| Brake Pedal Bearings | OD | 100 |
| Elevator Shaft Bearings (See Instruction 2) | | 100 |
| Engine Oil Tank Fill (Check before each flight) (See KEY for OIL GRADE) (Drain and refill every 25 hours) | OG | |
| *Engine Oil Tank Drain* | | 25 |
| Shock Strut Piston Bearing (Fitting) | GA | 100 |
| Shock Strut (See Instruction 3) | OH | 100 |
| Landing Gear Pivot | OD | 100 |
| Brake Cable Pulley (Some models) | OD | 100 |
| Landing Gear Wheel Bearings (Remove, clean and repack) | GC | 100 |



| Interval | Lubricant | |
|---|---|---|
| 100 | GM | Aileron Upper Control Pulleys |
| 100 | GM | Rudder Hinges |
| 100 | GM | Trim Tab Cable Pulleys |
| 100 | GM | Trim Tab Hinge |
| 100 | GM | Elevator Hinges |
| 100 | GA | Tail Wheel Swivel |
| 100 | GA | Tail Wheel Bearings |
| 100 | OD | Aileron Actuating Rod Ends |
| 100 | OD | Aileron Bellcrank |
| 100 | OD | Aileron Hinges |
| 100 | OD | Elevator Control Pulleys |
| 100 | OD | Cabin Door Hinges and Latch |
| 100 | OD | Rudder and Elevator Pulleys |
| 100 | OD | Landing Gear Pivots |



## —KEY—

### FUEL AND OIL RECOMMENDATIONS

| ENGINE | | PLANE MODEL | FUEL GRADE | AVIATION OIL GRADE — Ground Temperature | | | | |
|---|---|---|---|---|---|---|---|---|
| MAKE | MODEL | | | Above 70°F. | | 70°F. to 20°F. | | Below 20°F. |
| Continental | A 65-8 | 11 AC | 73 | 80 | AN 1080 | 65 | AN 1065 | (SAE 20) |

### CAPACITIES

ENGINE OIL TANK
4 qt.

FUEL TANKS
Main Tank — 15 gal.
Auxiliary Tank — 8 gal.

### TIRES

| MAIN LANDING GEAR | |
|---|---|
| Size | Inflation Pressure |
| 6.00-6 | 13-15 lbs. |
| TAIL WHEEL | |
| 6-2.00 | Solid |

### INTERVALS

25 = 25 Hours
100 = 100 Hours

### LUBRICANTS

- GA = AN-G-3a—GREASE, low temperature, lubricating (If GA not available, use GN)
- GC = AN-G-5—GREASE, high temperature, water resistant
- GM = 2-64A—GRAPHITE, powdered
- GN = AN-G-15—GREASE, general purpose, lubricating
- OD = AN-O-4—OIL, gyro instrument, lubricating
- OG = AN-O-8—OIL, lubricating, aircraft engine
- OH = 3580-D—OIL, hydraulic, petroleum base

# AERONCA

*(Courtesy Chek Chart Corp.)*

# "46" CHIEF

CHEK-CHART No. 4-AAA

# Lubrication – Health Safety and Environment

Risk assessment

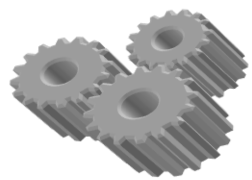
Storage

Handling

Application

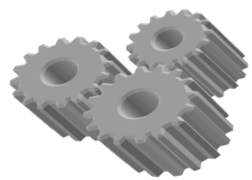
Contamination

Disposal



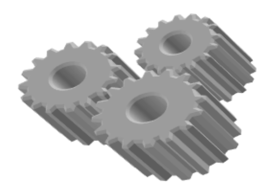
# Lubrication

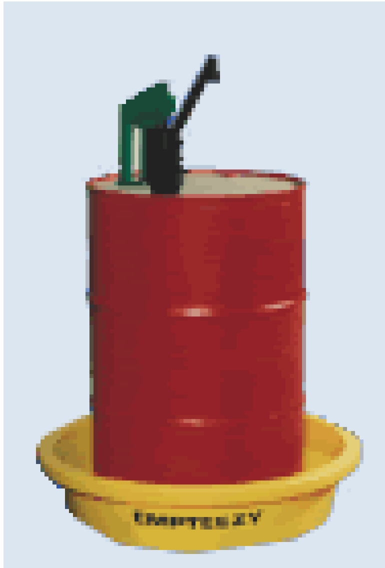
- **Protect against the elements, especially rain**
- **Maintain optimum stock (not too little - not too much)**
- **Use correct dispensing equipment (hand pumps, lub. oil, dispensing trolleys etc.)**
- **Use dedicated, capped and labelled containers**



# Lubrication - Safety

- **No naked flames**
- **Clean up spillages**
- **Keep area clean and clear**
- **Remove slipping and tripping hazards**
- **Wear correct PPE**
- **Avoid skin contact**
- **Never lift heavy drums.  Use lifting equipment**
- **Always clean receptacles before use (contamination)**
- **Never over stock**
- **Dispose of used oil / grease only as recommended by HSE & company guidelines (environmental)**




EMPTEEZY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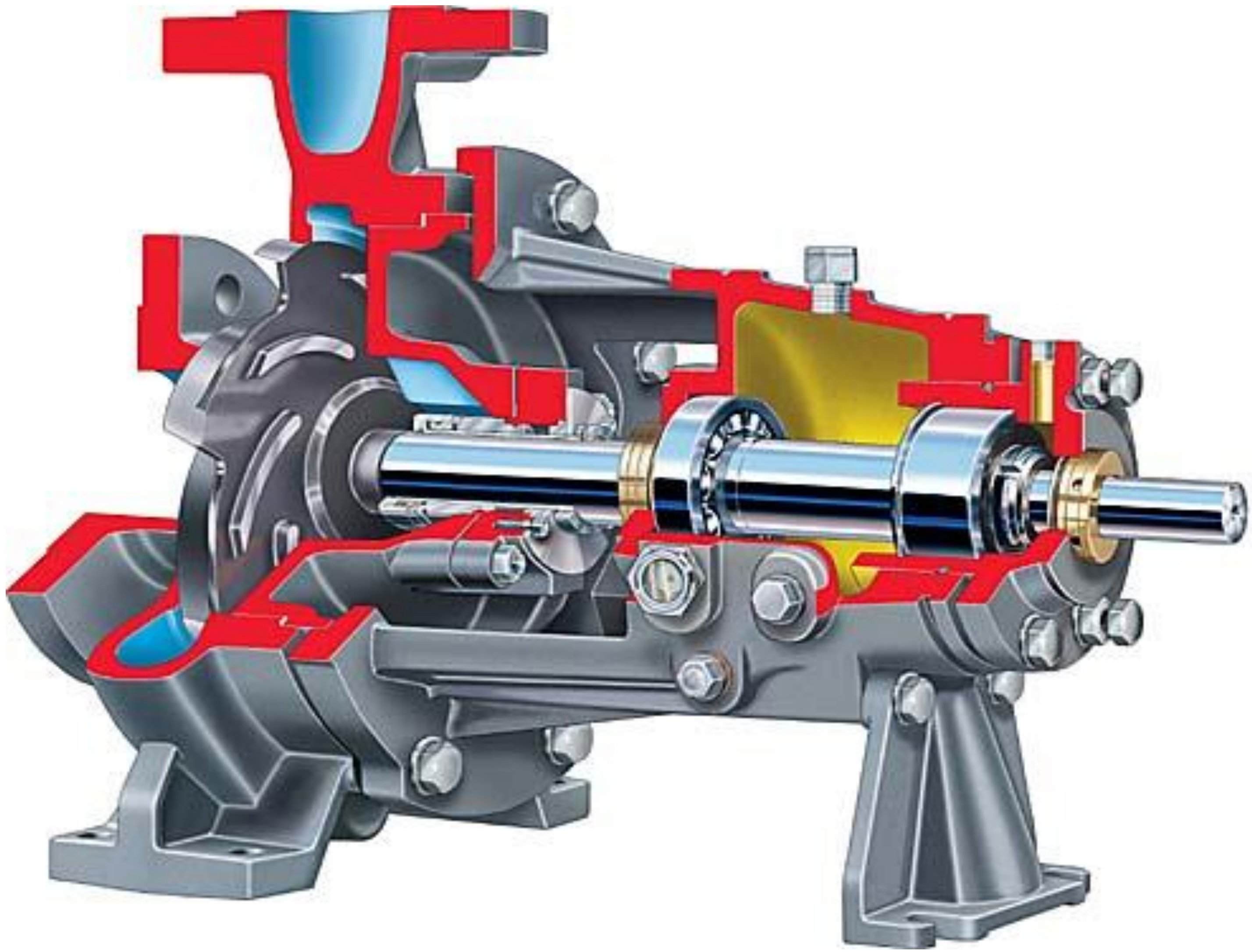
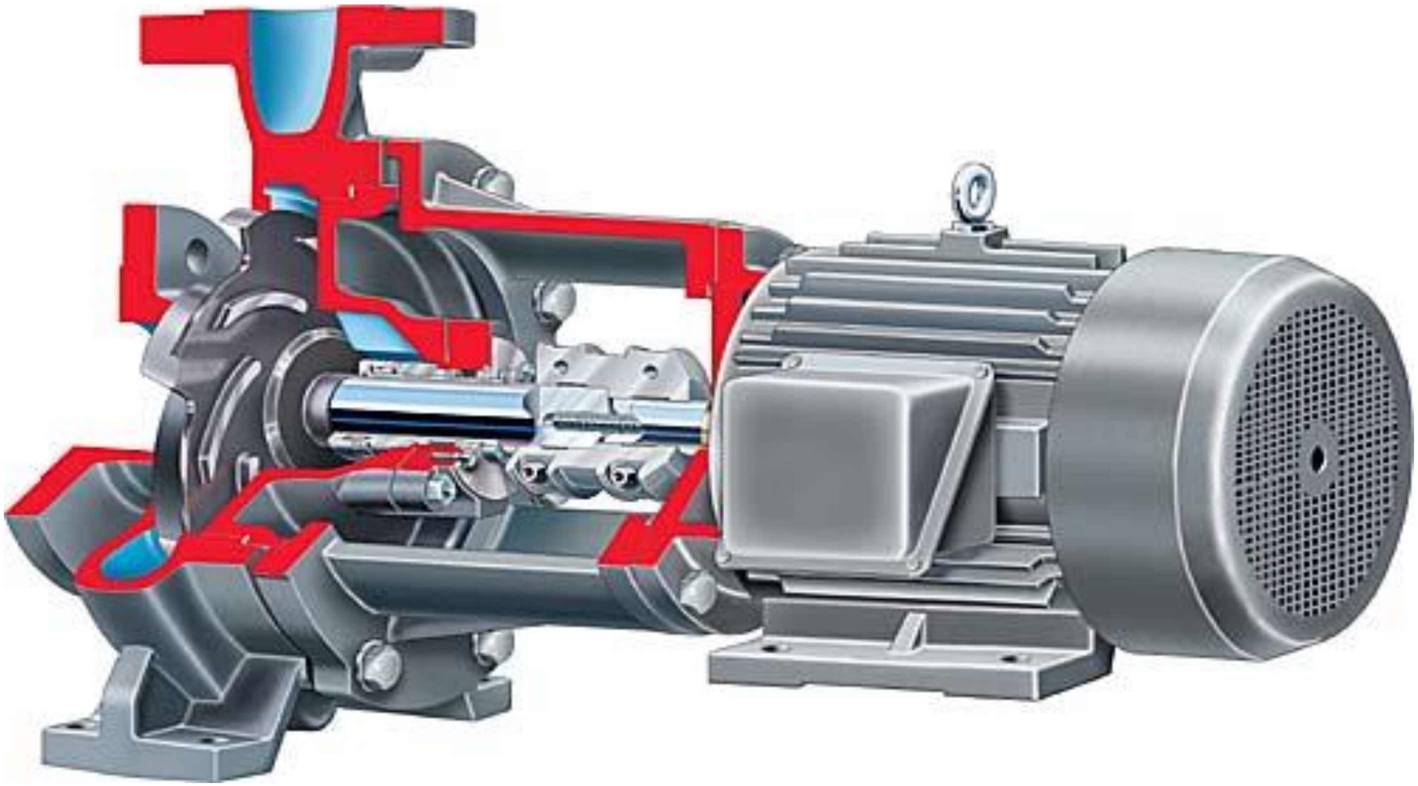
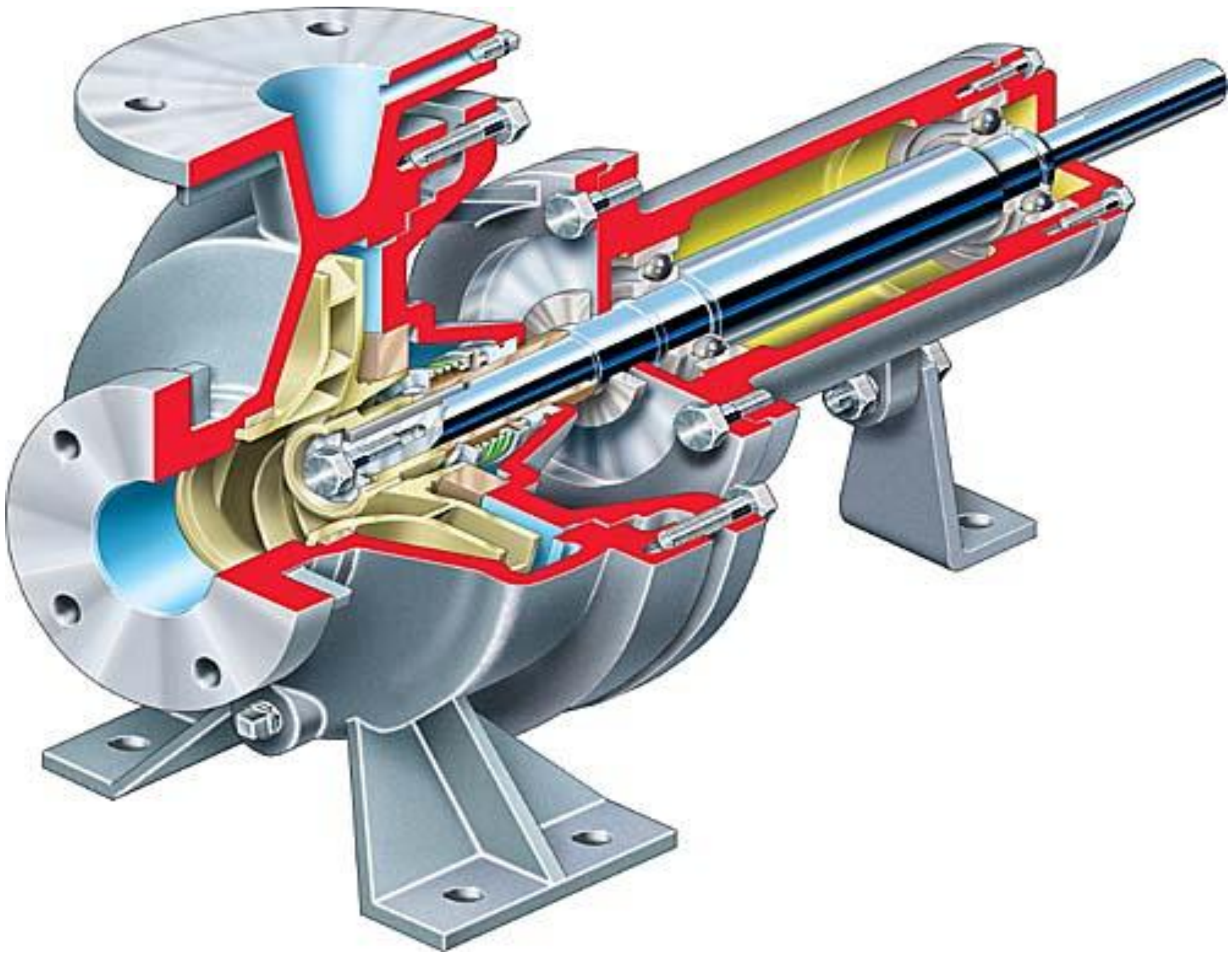
# Overhung, Single Stage Process Pump



## Overhung, Close Coupled, Process Pump



# Cast Iron Pumps



# Standard Overhung Impeller