MECHANICAL MAINTENANCE

LUBRICATION

TRAINING MANUAL
COURSE EXP-MN-SM050
Revision 0

MECHANICAL MAINTENANCE

LUBRICATION

CONTENTS

1. OBJECTIVES

To be able to identify, differentiate and use the different types of oils and greases.

To learn the risks associated with using oils.

At end of this course, the attended would be able to:

- Explain the different functions and uses of lubricating oils on an industrial site
- Explain the different functions and uses of lubricating greases on an industrial site
- Differentiate the different types of oils and greases
- Choose the adequate lubricant according to the foreseen use
- Enumerate the different physical and chemical characteristics of oils and greases
- List the methods of lubrication used with oils
- Know the main standards and classification relative to oils and greases
- Identify the quality of an oil or greases, this for the eventuality of its replacement
- Interpret results of oil or grease analysis
- Store, transport, handle safely any container of oil or grease
- Develop a follow-up program of maintenance for site oils and greases, this in collaboration with the concerned department
- To anticipate and avoid any damage or failure by monitoring oil in use.
- To know how to dispose of waste oil.

2. THE FUNCTIONS OF OILS AND GREASES

Lubricants (oils and greases) are used to separate two moving surfaces in order to:

- reduce the friction between them
- enable them to move more easily
- improve the performance or resistance to wear of machines.

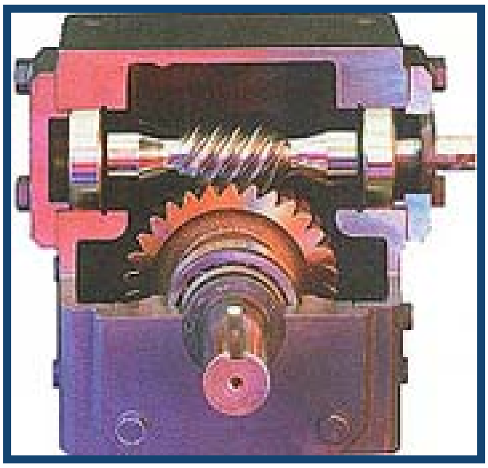


Figure 1: Functions of oils and greases

Generally, any running lubricated mechanism may be monitored by analyzing its lubricant– provided there is no bleed lubrication.

In **industry**:

- Hydraulic presses
- Reducers and gears
- Air and refrigeration compressors
- Turbines
- Industrial heat engines
- Machine tools

Figure 2: Industrial machine (1)

Figure 3: Industrial machine (2)

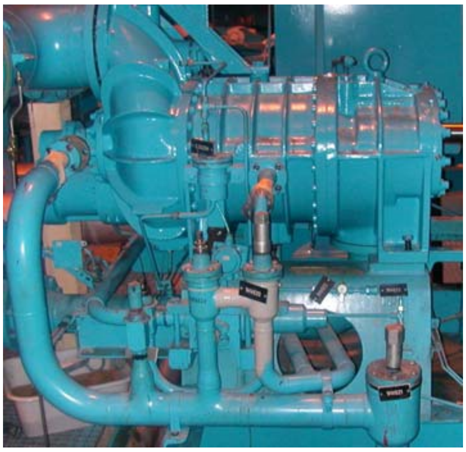


Figure 4: Industrial compressor

In the **so-called "AUTOMOTIVE" field,** this concerns all equipment with an engine:

- Aircraft
- Trucks
- Cars/motorbikes

- Ships
- Agricultural equipment
- Lift trucks

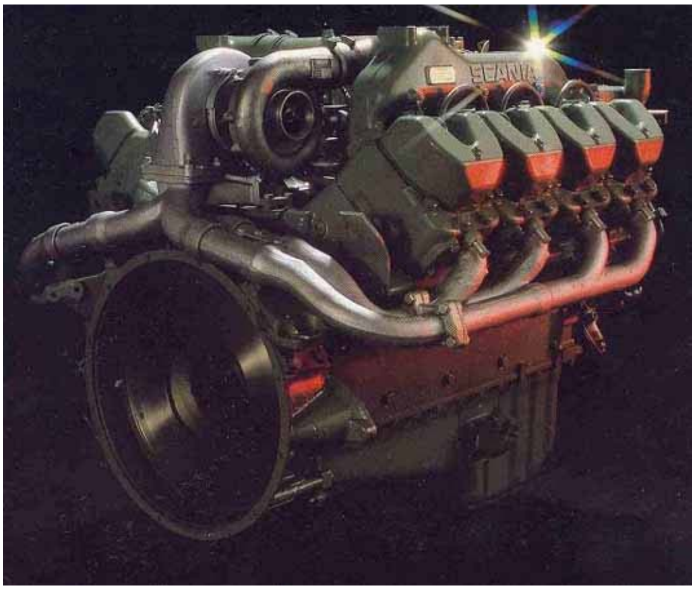


Figure 5: Truck heat engine

2.1. GENERAL FUNCTION OF THE LUBRICANT

The lubricant flows through all the machines and engines.

It has many functions, for example:

- Reduces energy consumption.
- Helps cool the engine.
- Helps keep circuits clean.
- Provides some sealing functions.
- Protects against corrosion.

In addition, the lubricant is a real information vector as while flowing through the various circuits, it picks up any contamination and wear caused or undergone by the machinery.

Therefore, the lubricant becomes degraded in time.

The aim of this analysis is to detect the main anomalies so as to provide the technician with accurate information about the condition of the machinery.

2.2. OIL MONITORING, WHY?

Nowadays, the monitoring of lubricants (and hydraulic fluids) in use has become a real maintenance tool for industrial equipment.

It is possible to diagnose machinery operation by determining the causes of lubricant degradation, thereby solving potential problems, before any actual incident leads to the shutdown of the installation.

By monitoring the lubricants in use, corrective maintenance can therefore be anticipated and therefore avoided.

3. THE ROLE OF LUBRICANTS

The role of lubricants is:

- To reduce wear
- To absorb and remove calories, i.e. heat
- To reduce friction
- To provide a seal
- To remove impurities

To reduce wear:

There are three types of wear:

- **Physical wear,** arising from the nature of the metal and the extent of its fatigue, and for which lubricants have only a limited role to play.
- **Chemical wear**, which is essentially corrosive wear. By their nature lubricants have anti-corrosive properties which can be reinforced to suit the purpose envisaged.
- **Mechanical wear**, which is:
    - wear at a metal-to-metal junction. When two metal parts rub together, local micro-welds are produced.
    - wear by abrasion, resulting from friction between moving parts and the presence of solid particles between these parts.
    - wear by erosion, caused by the impact of solid particles or fluids accelerated to high velocities or under high pressure.

To absorb and remove calories:

The greater part of the resistant work of friction forces is converted into heat. The presence of a lubricant ensures that the mechanical parts are cooled:

- By reducing the quantity of calories produced
- By contributing to the removal of heat

To reduce friction:

the presence of a lubricant between the moving metal surfaces reduces the coefficient of friction to a varying extent. This brings about significant energy savings and substantially reduces wear.

To provide a seal:

- Internally (for example within the various segments of an engine)
- Externally (stuffing box, mechanical packing)

To remove impurities:

These form while mechanisms are operating (for example the soot from combustion in diesel engines). Generally these impurities are then captured by filters.

4. TERMINOLOGY

Oil film

This is a thickness of oil, however thin it may be, that is found between two moving parts and prevents them from touching one another.

Viscosity

The flowing resistance of a lubricant. Viscosity decreases as temperature rises.

Unit of measure: Cst or mm^2/s

Viscosity index (VI)

The VI is important in determining what the viscosity of an oil will be at low or high temperatures.

Large variation of temperature means a low VI

Little variation of temperature means a high VI

Pour point

This is the lowest temperature at which oil can still flow. It can be as low as – 50 °C

Flash point

This is the lowest temperature at which the vapour from heated oil can ignite spontaneously on contact with a flame.

The flash point of oil is between 200 °C and 250 °C

Fire point

This is the lowest temperature at which the ignition of an oil is followed by the combustion of that oil.

Detergency

This is the ability to keep clean surfaces clear of deposits produced by chemical reactions (muds, varnish).

Dispersion

This is the capacity of lubricants to hold insoluble contaminants in suspension so as to avoid plugging the liners or obstructing the lube oil system.

Aniline point

This is the lowest temperature at which a mixture of equal parts of aniline and oil under investigation can be observed in a homogeneous form. The aniline point is a determining characteristic of how a lubricant behaves in respect of certain joints.

5. THE MAIN TYPES OF LUBRICATION

CONDITIONS OF USE	CHARACTERISTICS REQUIRED OF THE LUBRICANT	TYPICAL APPLICATIONS
Hydrodynamic	Viscosity	Pistons Cylindrical gears under a light load
Elastohydrodynamic or mixed	Viscosity / anti-wear	Gears Bearings
Oleaginous or boundary	Lubricity / anti-wear	Sliders Crown gears and worm gears Cam/push rod Sliding-vane pump
Extreme pressure	Extreme pressure	Vehicle transmissions Metalworking

Table 1: Summary table of the main types of lubrication

These lubrication conditions tell us how the oil behaves in relation to its use, but not how it is fed between the moving surfaces.

5.1. HYDRODYNAMIC OR VISCOUS

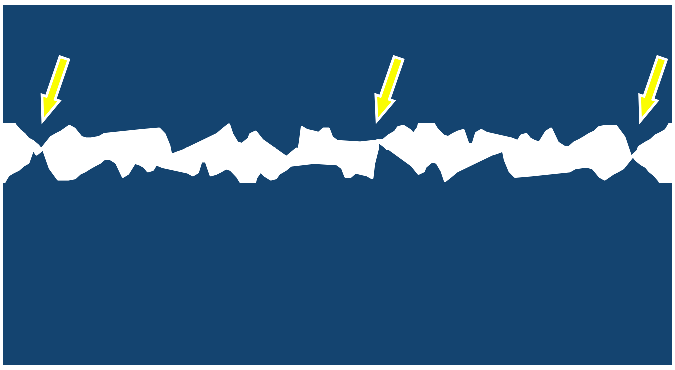
Lubrication is said to be hydrodynamic when the moving surfaces are completely separated from one another by the oil film.

This is the case with the journal bearing in an engine in which the oil film supports and centres the shaft. This oil film is permanent.

Figure 6: Hydrodynamic lubrication

In this case the useful property of the oil is the **VISCOSITY**.

5.2. MIXED LUBRICATION



Lubrication is said to be mixed when the oil film becomes very thin under the effects of pressure and distortion of the moving part. This is the case with gears or bearings.

Figure 7: Mixed lubrication

5.3. BOUNDARY LUBRICATION

Boundary lubrication refers to conditions in which, under the effects of high pressure and low velocity, the moving surfaces are separated by just a few molecules of oil.

Figure 8: Boundary lubrication

In this case the useful property of the oil is the **LUBRICITY**.

6. LUBRICATION METHODS

6.1. SPLASH LUBRICATION

Lubricant is fed to the meshing level by the gear teeth, which dip into an oil bath.

In this case the various bearings are lubricated with grease.

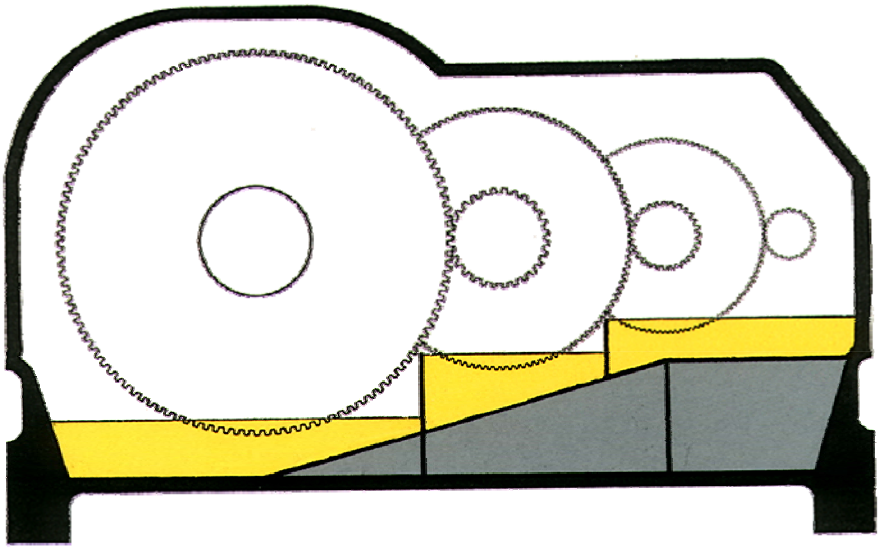
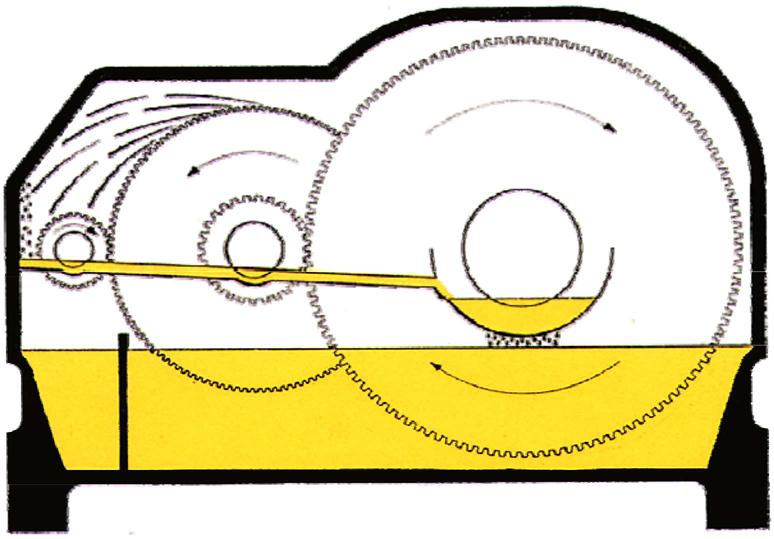


Figure 9: Splash lubrication of gears

The casing is generally fitted with compartments or baffles to avoid excessive stirring of the oil and risking a rise in temperature.



In this type of splash lubrication the bearings are lubricated by oil splashing onto the casing walls and from there onto the bearings.

Figure 10: Splash lubrication of gears and bearings

6.2. LUBRICATION BY CIRCULATION AND SPRAYING

An oil system dedicated to the equipment sprays the parts in contact in order to reduce the friction.

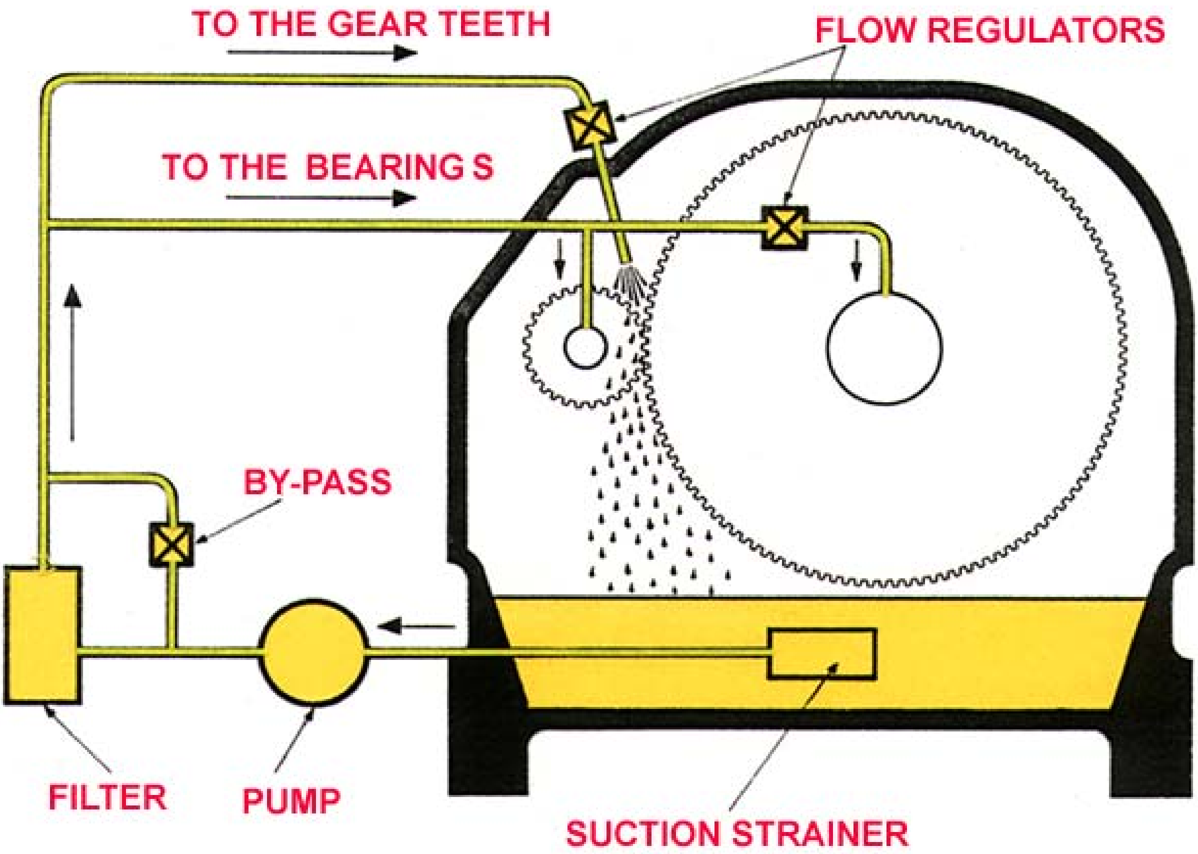


Figure 11: Lubrication by circulation and spraying

This system requires:

- A suction strainer
- An oil pump
- A filter
- A bypass to maintain the filter
- Oil feed manifolds
- Flow regulators.

It is also possible to fit heat exchanger(s) so as to control the oil temperature and take full advantage of the qualities of the oil being used.

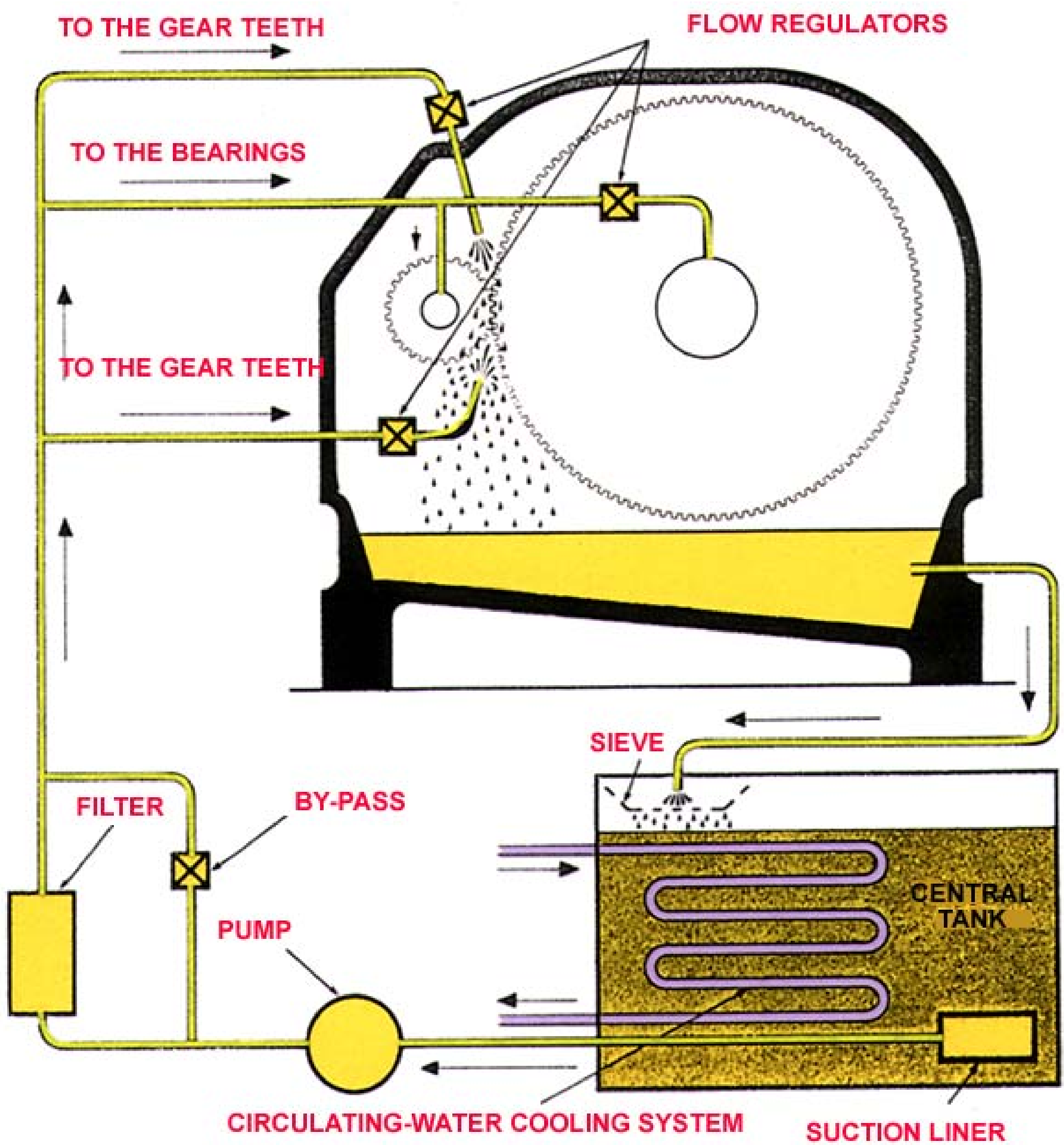
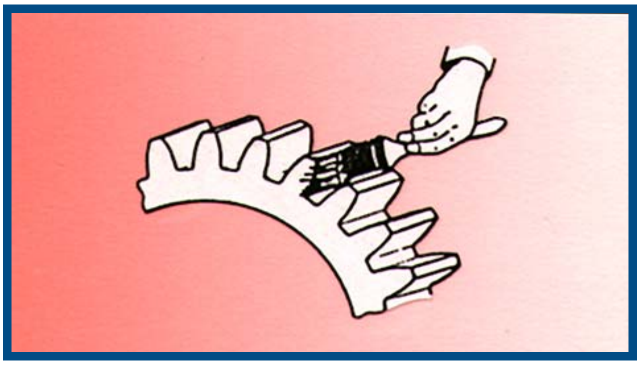
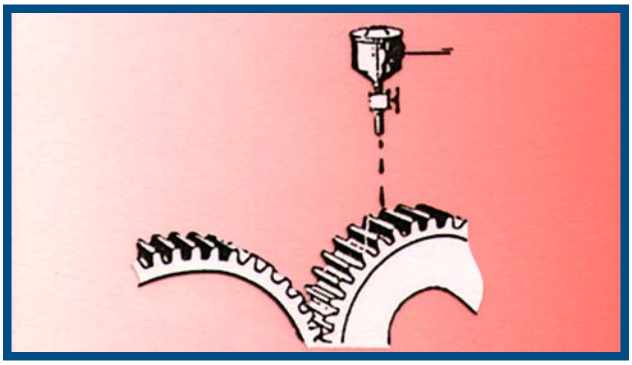


Figure 12: Lubrication by circulation and spraying with the addition of heat exchangers

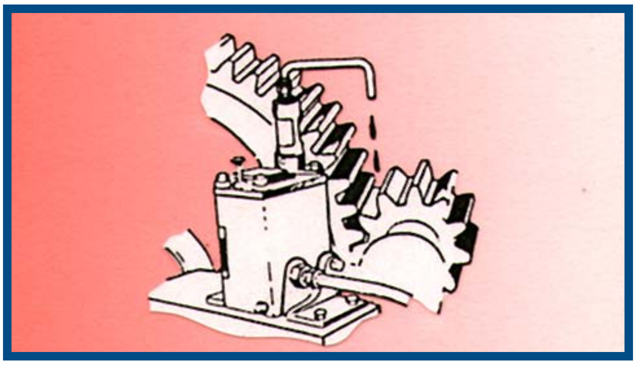
6.3. LUBRICATION WITH GREASE



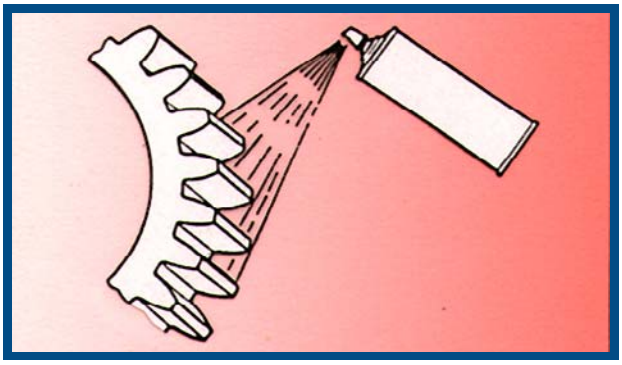
Brushing on



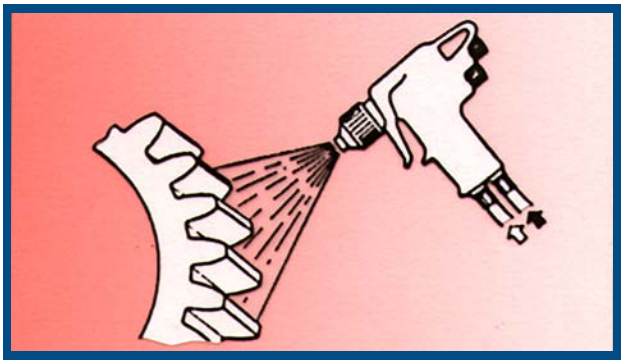
By gravity (drop by drop)



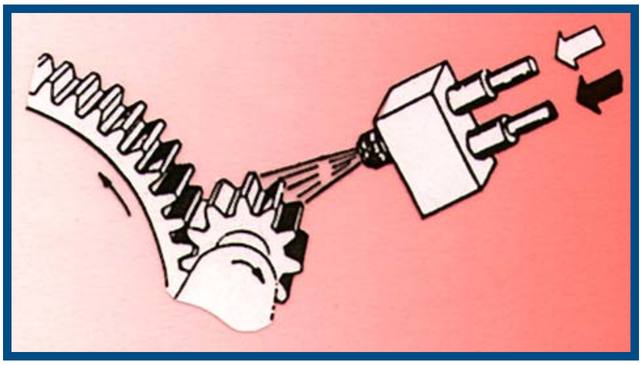
Mechanical greaser (pipette)



Spraying on by aerosol



Manually by spray gun



Automatic spraying

Figure 13: Different greasing methods

6.4. ADVANTAGES AND DISADVANTAGES

	Advantages	Disadvantages
SPLASHING	Simplicity Economical to maintain	Substantial volume of oil Bulky casing
CIRCULATION	Oil is filtered Lower volume of oil Temperature control option Less bulky casing	Oil system Cost of installation

Table 2: Advantages and disadvantages of the different types of oil lubrication

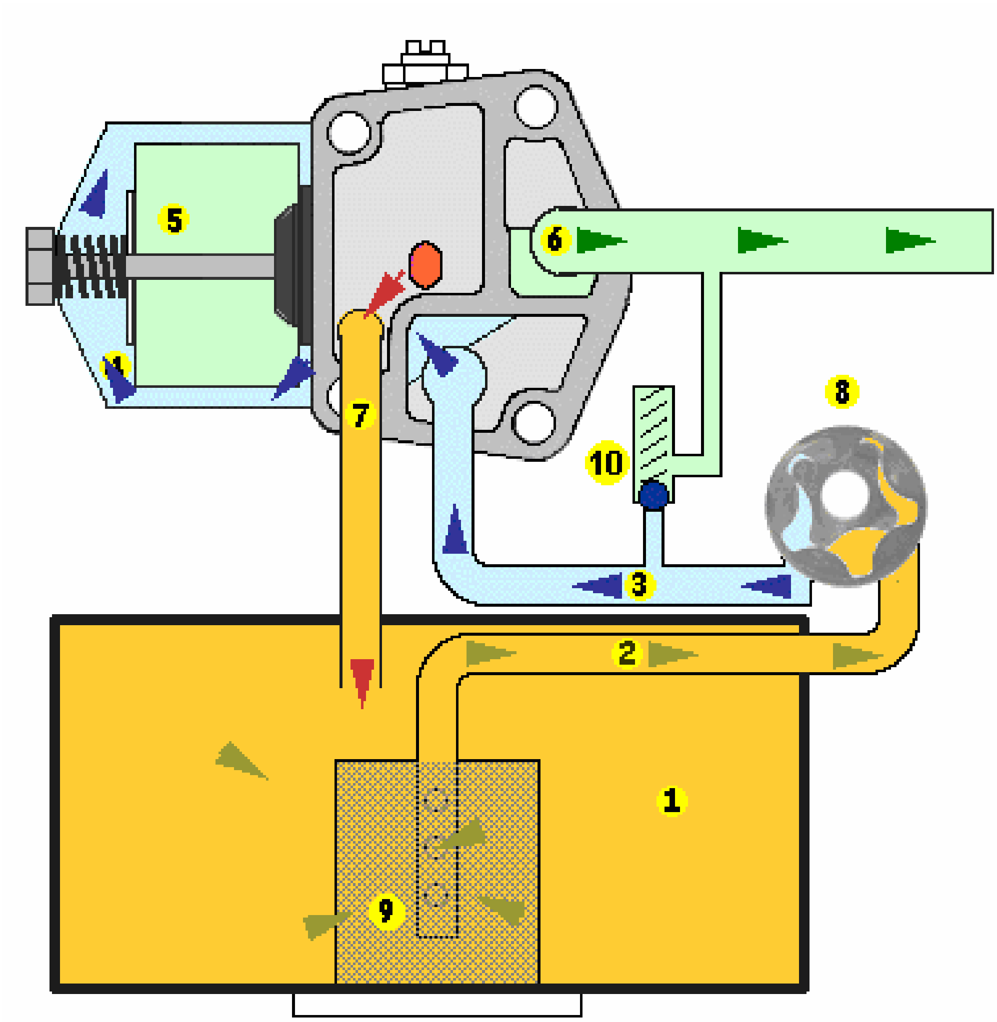
Advantages	Disadvantages
Sealing and greasing system	
Less bulky Simpler and more effective Less costly (especially in vertical arrangements)	Limited “pumpability” (low temperature, extent of the circuits)
Component cooling	
	No removal of calories
Lubrication	
Tolerates heavy loads and impacts Compatible with lengthy shutdowns	Wear often greater due to impurities Lubricant may be forced out under very high load
Equipment maintenance	
Reduced maintenance: - Easy greasing - Infrequent - Sealing function Inaccessible components can be greased for life	Difficult to renew No elimination of wear particles and contaminants Greases sometimes incompatible

Table 3: Advantages and disadvantages of lubrication with grease

7. LUBRICANT DEGRADATION

7.1. FILTERING

7.1.1. Oil circuit



1 – Oil crankcase	*6 – Main oil gallery*
2 – Suction tube	*7 – Relief valve oil return to oil crankcase*
3 – Branch to filter	*8 – Oil pump*
4 – Filter bowl	*9 – Suction screen*
5 – Oil filter	*10 – Clogged filter safety valve (relief valve)*

	Crankcase oil		*Filtered pressure oil*
	Unfiltered pressure oil		*Relief valve oil return*

Figure 14: Oil filter location

The oil is sucked in crankcase 1 by pump 8, through screen 9 and suction tube 2.

The oil leaves the pump under pressure, and reaches the filter through branch 3.

It goes through the cartridge from the outside to the inside.

It reaches the main oil gallery 6, where it is distributed to lubricate the different parts.

When the engine is in good working condition (crankshaft rings and bearings, rod crank pins and covers …), the oil pump can supply a much higher pressure than the normal working pressure (4 to 4.2 Kg/cm^2).

If the pressure is higher than the relief valve calibration, this valve opens to let the excessive oil return to the oil crankcase through pipe 7.

Safety valve 10 is part of the oil filter. If filter 5 is clogged, then oil flows directly from oil pump 8 to the main oil gallery 6 without being filtered.

If the filter is in good condition, then pressure in the light green and light blue areas is identical. The dark blue ball pushed by its spring, closes the by-pass pipe.

7.1.2. Oil filter

The oil filter protects your installation by ensuring a constant lubrication of the moving parts, the oil is thus maintained at the right temperature and minimal level of cleanliness required is ensured by retaining the metal particles resulting from wear and tear, the carburetion residues (heat engines), the products of oil oxidation but also dust and other impurities entering the machine when checking or topping-up the oil level.

There are several types of oil filters:

- Cartridge oil filters
- Centrifugal filters (large installations)
- Disc filters
- Stacked oil strainers

7.1.2.1. Cartridge oil filters

There are two types of cartridge oil filters

- One-piece cartridge (metal)
- Metal or paper cartridge for inserting in filter body body

Figure 15: Metal oil filter

Figure 16: Cartridge filters

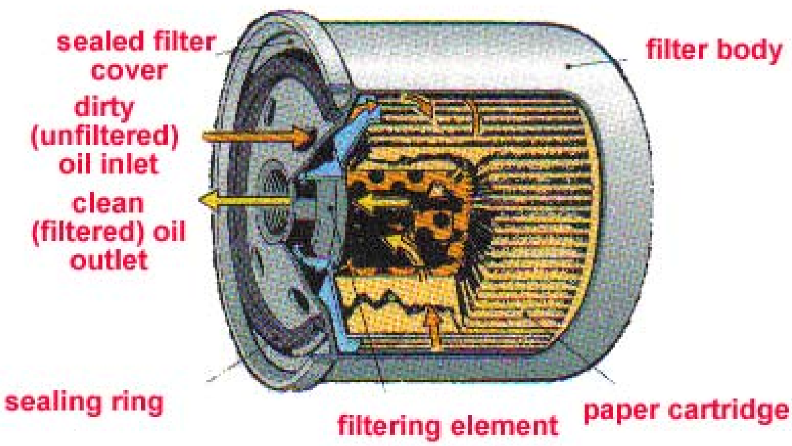


Figure 17: Detail of oil filter

7.1.2.2. Centrifugal oil filter

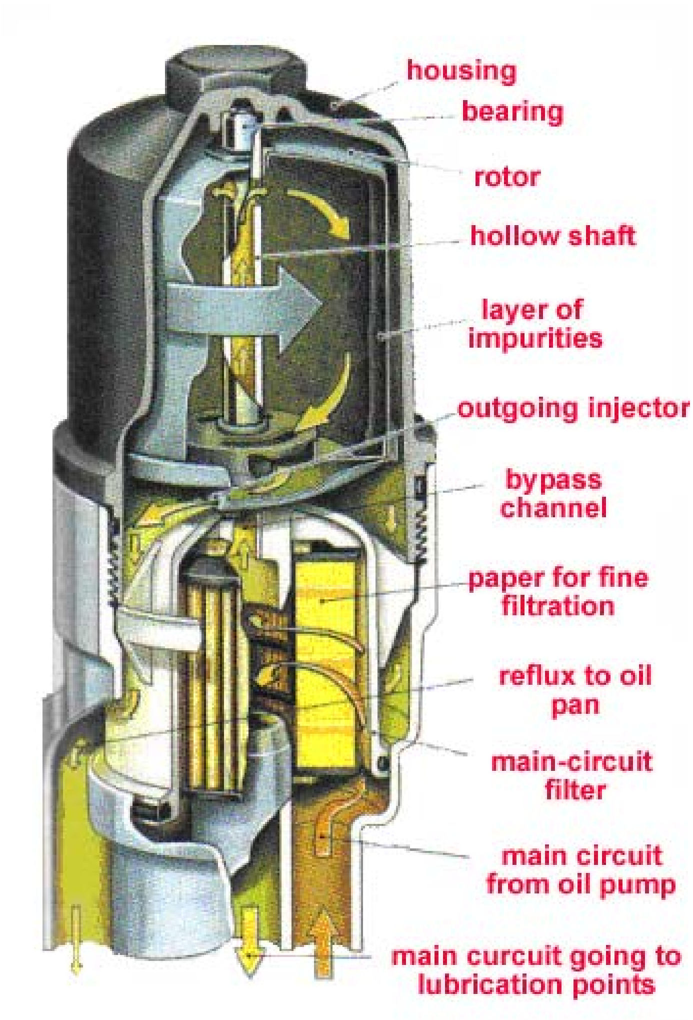


Figure 18: Centrifugal oil filter

7.1.2.3. Important elements

The oil filter has two important elements

- The check valve
- The relief valve

The check valve:

The check valve prevents the filter from being drained when the engine is stopped.

When the engine is running, the check valve is open.

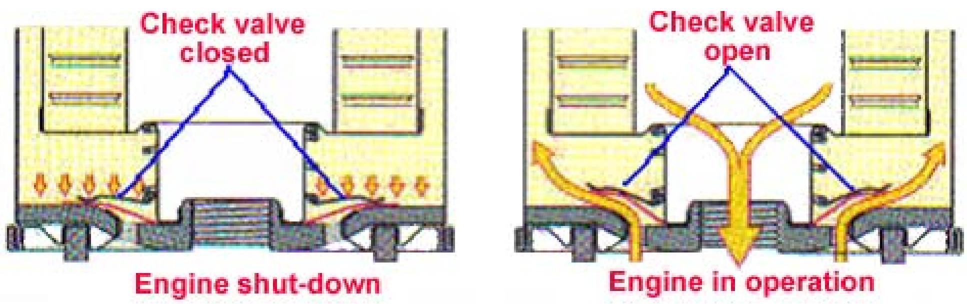


Figure 19: Check valve

The relief valve:

When the filter is clogged – which means the numerous particles in the filtering element stop the oil from going through – the pressure increases and the relief valve located upstream of the filter opens in order to continue lubricating the engine.

This oil is no longer filtered but there is no risk of engine seizing due to lack of oil.

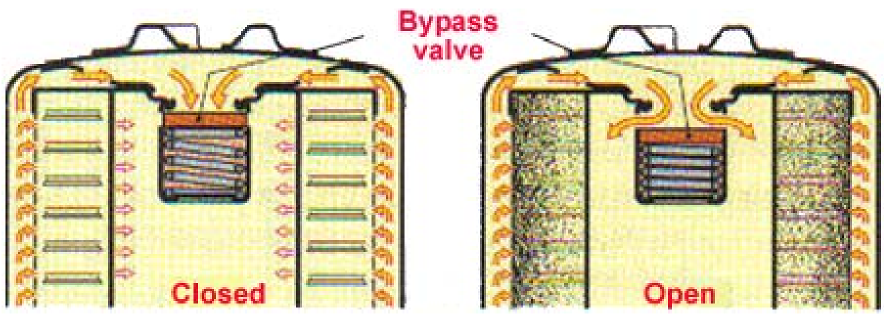


Figure 20: Relief valve

7.1.3. Poor filtering

The oil filter retains the impurities in the oil circuit:

- Metal particles
- Combustion residues
- Dust from the atmosphere
- Water from air condensation
- Oil sludge due to the ageing of oil

All these elements may lead to excessive wear of the installation (or of the combustion engine).

Used oil filters let these impurities go through, which causes malfunctioning and may break the engine or lead to premature wear of the engine in your installation.

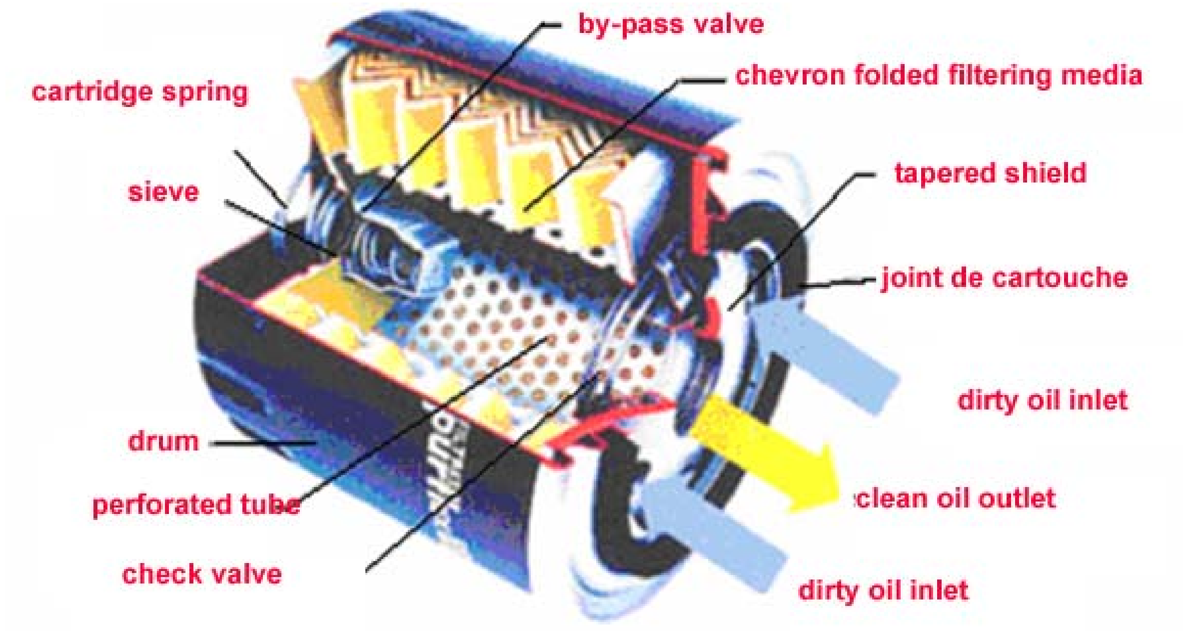


Figure 21: Oil filter section

The oil filter is a vital element for the protection of mechanisms. A dirty filter reduces oil flow, degrades lubrication, and also causes an oil pressure drop.

7.2. CONTAMINATION OF THE LUBRICANT

7.2.1. Contamination by water

Comes from infiltration, condensation, etc.…

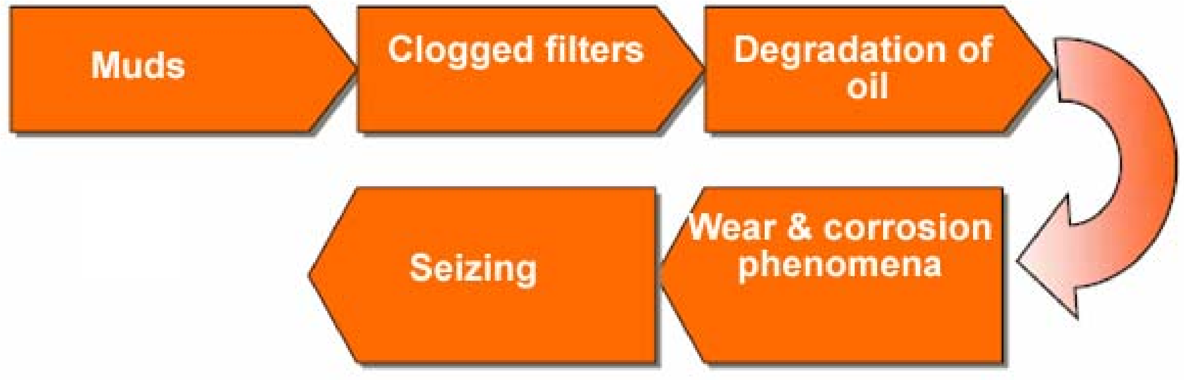


Figure 22: Contamination by water

Water entering the oil circuit may lead to emulsions. These reduce the additive content in the oil and, especially in case of sea water, corrode the lubricated surfaces.

Water in the oil circuit is generally due to:

In the case of heat engines

- Liner sealing defects
- Cracks in the liner or cylinder head
- Nozzle holder sealing defects

With other installations: (located outside)

- Access door sealing defects
- Water entering through air pipe

These water ingresses are often detected by the increase in oil level in the crankcase when preparing the start-up of the installation or engine or by the change in colour of the oil and the presence of a water-in-oil emulsion (called mayonnaise) during operation.

Contamination by water is sometimes difficult to detect. While some synthetic oils facilitate the forming of characteristic emulsions, others, on the contrary, do not and the water in suspension settles in the lower parts of the machines or circuits and may, in this case, lead to mechanical part failure.

7.2.2. Contamination by air

Due to silica in the air

Figure 23: Contamination by air

7.2.3. Contamination by another fluid

Figure 24: Pollution by another fluid

Diesel fuel in the oil circuit may have several origins:

- a sealing fault at injection pump distributor level,
- a sealing fault of the injector needles,
- inadequate vaporisation of the diesel fuel due to the clogging of one or several injection needles,
- frequent idle or fast idle running,
- cold operation on short distances, numerous start-ups.

Such diesel fuel ingresses rapidly cause dilution of the oil, noticeably reducing its viscosity. This generally weakens the oil film and thereby its resistance in areas subjected to heavy loads, such as connecting rod bearings and bearing assemblies, cams and plungers or pads which are subjected to premature wear.

This may also modify the lubricant's lubricating power, thereby decreasing its adhesive power, leading to reduced lubrication and premature wear of the ring segments - some poorly lubricated surfaces may become overheated. The combination of these consequences may ignite the oil vapours in the crankcase and these may explode. This risk is higher during start-ups and especially in cold weather.

The fuel in the oil lowers its ***flash point*** (≈ 30°C for a 5% dilution).

As the diesel fuel in the lubricant does not evaporate at the operating temperature of the engine, every ingress increases the percentage of dilution, thereby increasing the wear.

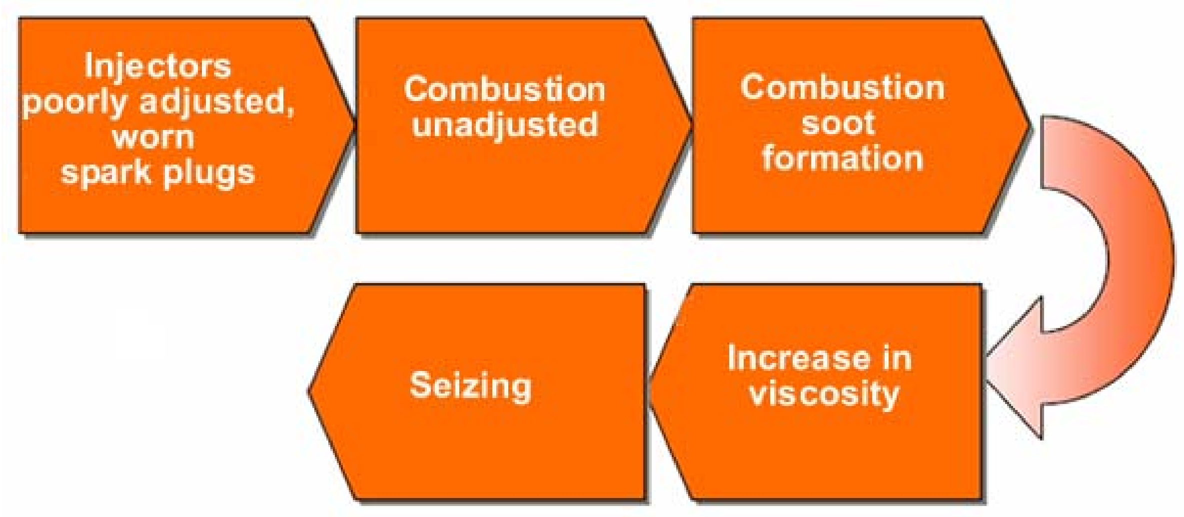


Figure 25: Contamination by fuel

Reminder:

Flash point**:** the lowest temperature at which vapours from a liquid and air mixture will form a gaseous mixture and ignite momentarily upon the application of a heat source such a flame.

8. HYDRAULIC FLUIDS

8.1. MAINTENANCE AND MONITORING OF THE HYDRAULIC CIRCUIT

The initial operating parameters should be recorded:

- Optimal oil temperature
- Power
- Flow pressure
- Permissible clogging pressure for filters
- Etc...

Read and record the operating parameter values regularly in order to detect any deviations from standard figures.

8.2. MAINTENANCE OF OIL QUALITY

Only use oil intended for hydraulic purposes.

Replace the filter cartridges according to the intervals recommended by the manufacturer and after any accidental contamination of the circuit.

8.2.1. Filtering

Contamination control has only recently become an important issue for maintenance departments in companies equipped with hydraulic equipment.

Until now, when designing some installations, the need to add a filter unit depended exclusively on the customer's will.

Since computerized machines have been equipped with increasingly precise adjustment and tolerance hydraulic components, the particles in suspension in the oil have become an important cause of equipment breakdowns.

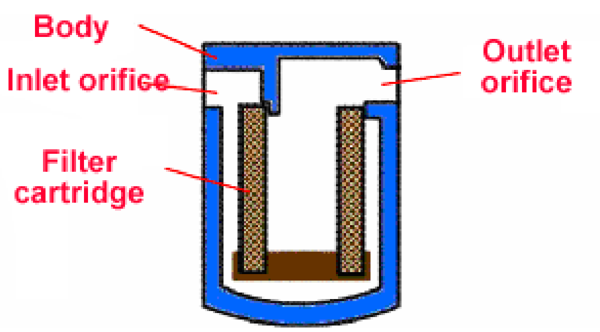


Figure 26: Filter description

When you know from experience that a 5 micron particle may cause breakdowns, it is easier to understand the need to protect equipment from solid contamination.

The filtering technology is one of the first contamination control means.

The pollutants in the hydraulic circuit may cause damage and/or premature wear of the components.

These **pollutants** may be of **two types:**

- Solid: particles from outside, wear particles from components.
- Soluble: water from condensation, from infiltration, solvent, air in emulsion, gum, sludge, etc.…

Generally, the **main components** of an oil filter for hydraulic installations are:

- A housing
- A cartridge filter
- An inlet and an outlet

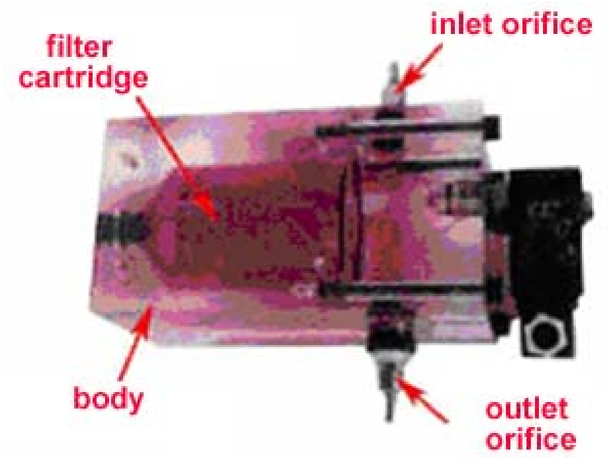


Figure 27: Hydraulic oil filter

The **main characteristics** of a filter for hydraulic installations are:

- Its filtering degree (this is the average Ø of retained particles)
- Its assembly (suction, discharge)
- Its nominal flow
- Its assembly position (careful with suction/discharge direction)

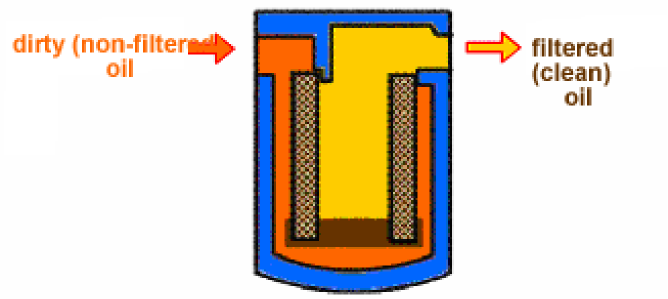


Figure 28: How a filter works

8.2.1.1. Decontamination

Subsequent to contamination of the circuit (accidental water ingress, degradation of a joint, etc.…), it is necessary to “clean” the oil of the installation. The equipment used in order to do so is called a mobile decontamination unit.

Figure 29: Mobile decontamination units

Depending on the quantity of oil in the installation, the oil may be changed completely (with circuit flushing) or it may be passed through the mobile decontamination unit.

All the oil charge passes through the mobile decontamination unit until the parameters are back to normal.

9. LUBRICANTS AND THEIR COMPOSITION

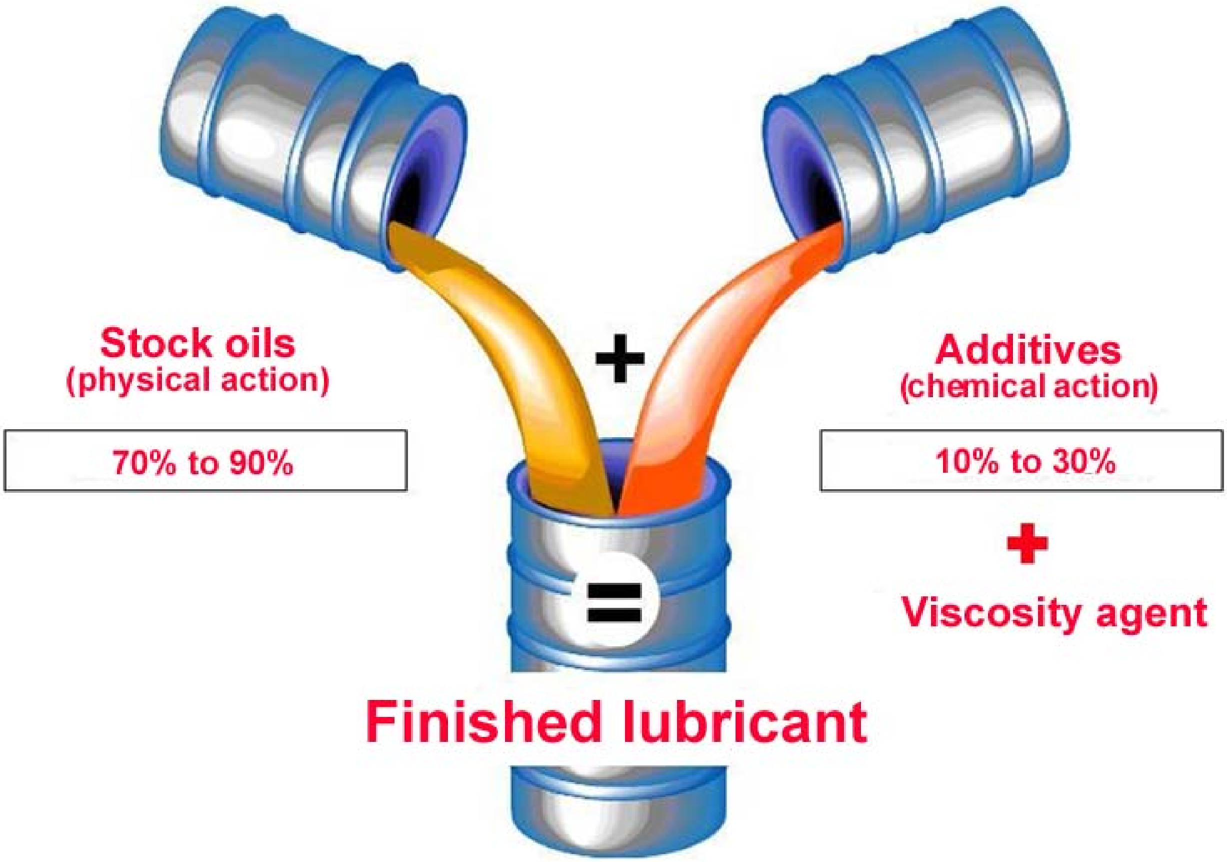


Figure 30: Composition of a lubricant

9.1. COMPOSITION OF BASE OILS

Two categories can be defined

- Mineral oils
- Synthetic fluids

9.1.1. Mineral oils

These are base oils obtained by petroleum distillation and subsequent refining. They correspond to three main trends of a specific nature.

- Paraffinic

- Naphthenic
- Aromatic

PARAFFINIC

- Green cast
- Density lower than 0.9 kg/dm3
- Natural viscosity index close to 100
- Aniline point around 100°C
- Natural pour point -10°C
- Mainly used for lubricating oils and hydraulic transmission oils.

NAPHTHENIC

- Blue cast
- Density higher than 0.9 kg/dm3
- Viscosity index around 40 to 60
- Aniline point around 70°C
- Pour point -30 °C
- Mainly used in refrigeration compressors and as an insulating oil

AROMATIC

- They cannot be used as lubricants due to their instability. Because they are highly efficient solvents they are used as additives in rubber and ink production

9.1.2. Synthetic fluids

These are obtained by chemical synthesis from simple petrochemical products. They have a more clearly defined structure than inorganic bases. This enables some of their properties to be adjusted

The following types can be distinguished

- Polyalpha olefins (PAO)
- Diester
- Ester of polyols
- Polybutene
- Alkylaromatics
- Polyglycols
- Silicones

9.1.3. Selection criteria for base oils

	Lubricating power	Consistency at low temperature	High temperature characteristics	Volatility	Aggressivity on standard gaskets	Oxidation stability	Average price
Naphthenic bases	Good	Good	Good	Good	Average to poor	Average to poor	1,2
Paraffinic bases	Good	Average to poor	Good	Good	Good	Good	1
Alkylates	Average	Excellent to good	Good	Average	Good to average	Good to average	2,5
Polyalpha olefins	Good	Excellent	Good	Excellent	Good	Excellent	5 to 10
Esters and diesters	Excellent	Excellent	Very good	Excellent	Average to poor	Excellent	8 to 15
Polyglycols	Excellent	Excellent	Very good	Average	Poor	Good	5
Silicones	Excellent	Excellent	Excellent	Excellent	Good	Excellent	25 to 50

Table 4: Summary table of the selection criteria for base oils

9.2. GREASES AND THEIR COMPOSITION

Greases are solid or semi-liquid products obtained by the dispersion of a gelling agent in a liquid.

A typical grease is a dispersion of soap in a mineral oil; in other words, a grease is a sponge consisting of oil-soaked soap. This sponge forms a lubricant reserve keeping the lubricant where it is needed.

A diagram defining the constitution of greases looks like this:

GELLING AGENT

+

BASE OIL

+

ADDITIVES
Extreme pressure
Anti-wear
Friction modifier
Dye
Rust preventive
Adhesion promoter

9.2.1. The gelling agent

A gelling agent acts like a sponge, in which the free spaces in the network of fibres are filled with oil just as the pores of a sponge would be:

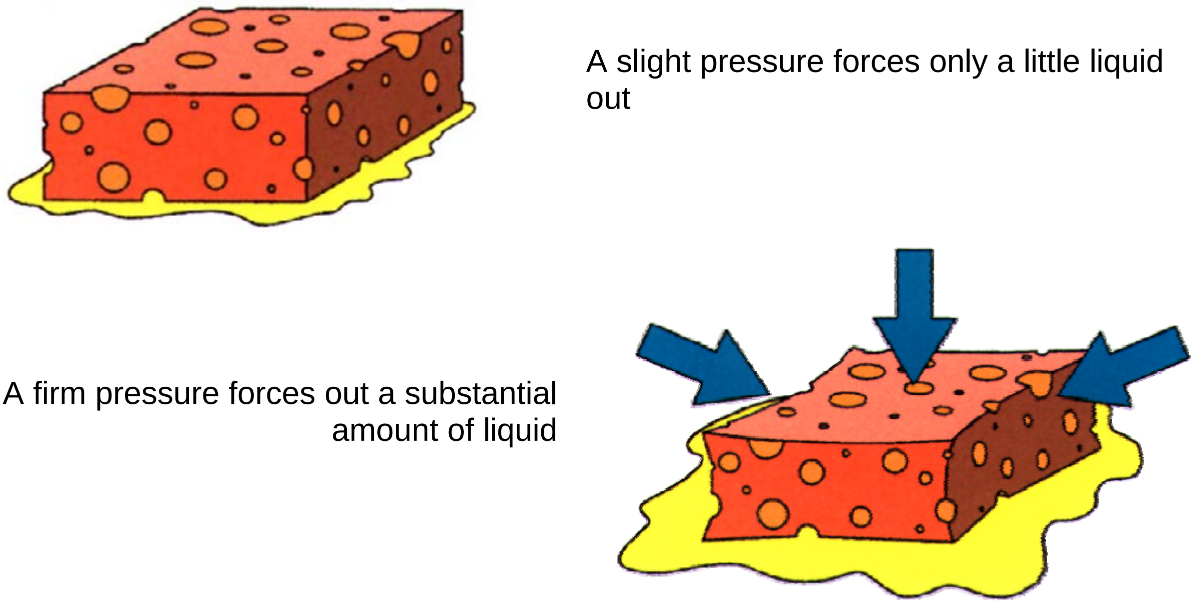


Figure 31: Gelling agent

The origin of a gelling agent:

- Soap which has been preformed or prepared in situ
- Mineral gelling agent
- Synthetic organic gelling agent

9.2.2. The lubricating fluid

The origin of a lubricating fluid

- Mineral oil
- Synthetic oil

Several oils can be mixed to form the base oil.

9.2.3. Grease classification tests

9.2.3.1. Water washout (WWO)

A greased bearing is subjected to the action of a water jet under normalised conditions

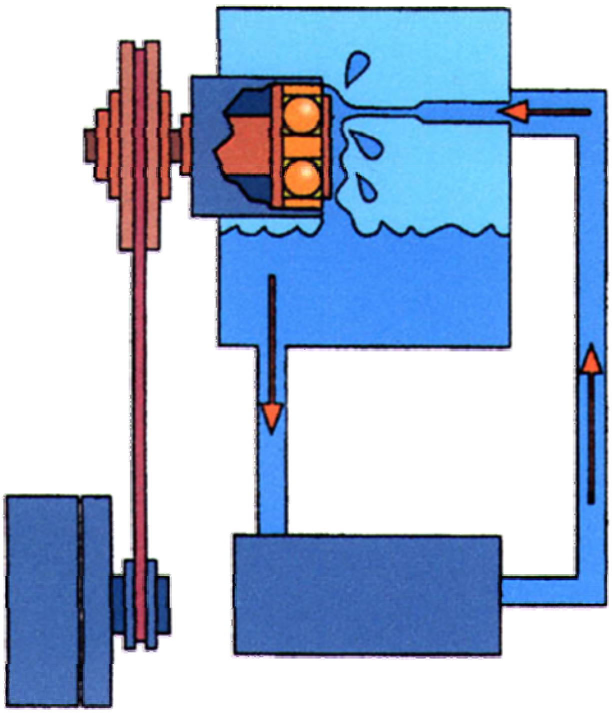
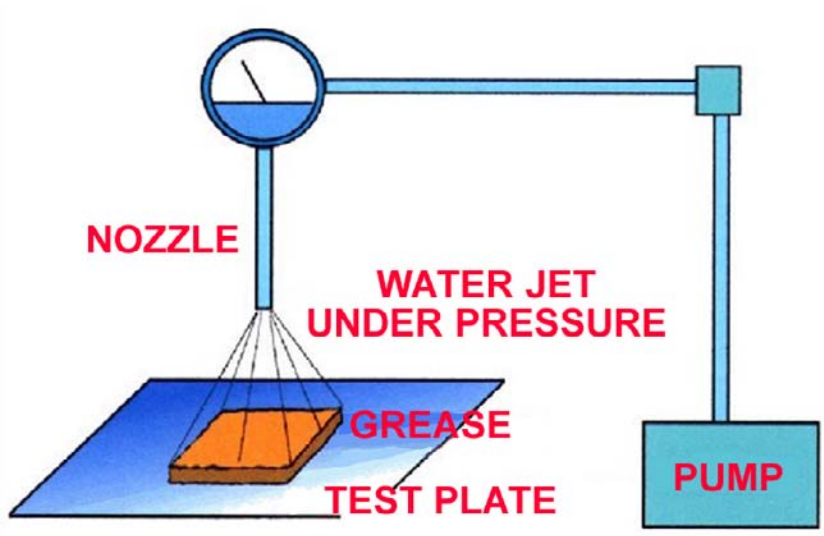


Figure 32: WWO test

- Temperature: 40 °C or 80 °C
- Jet flow rate: 5 ml/sec
- Rotation speed: 600 rpm
- Duration: 1 hour

9.2.3.2. Water Spraying Out (WSO) test



Grease is applied in a thin layer onto a metal plate and subjected to spray from a jet of water at 276 KPa (2.8 bars) at a temperature of 38 ºC for 5 minutes. The remaining grease is weighed. The result is expressed as a % of the grease lost.

Figure 33: Water Spraying Out (WSO) test

9.2.3.3. Anti-wear properties

- Load: Generally 40 kg
- Duration: 1 hour
- Pin speed: 1200 rpm
- Temperature: ambient or controlled
- Results: average diameter of imprints on the fixed balls

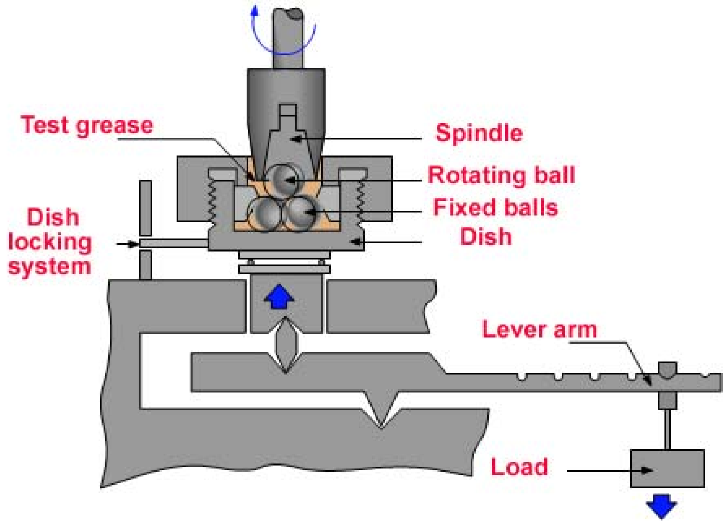


Figure 34: Anti-wear properties test

9.2.3.4. Extreme pressure

- Spindle rotation speed: ASTM » 1700 rpm - DIN » 1400 rpm
- Applied load increased in stages until welding
- Duration of stages: ASTM: 10 s / DIN: 60 s

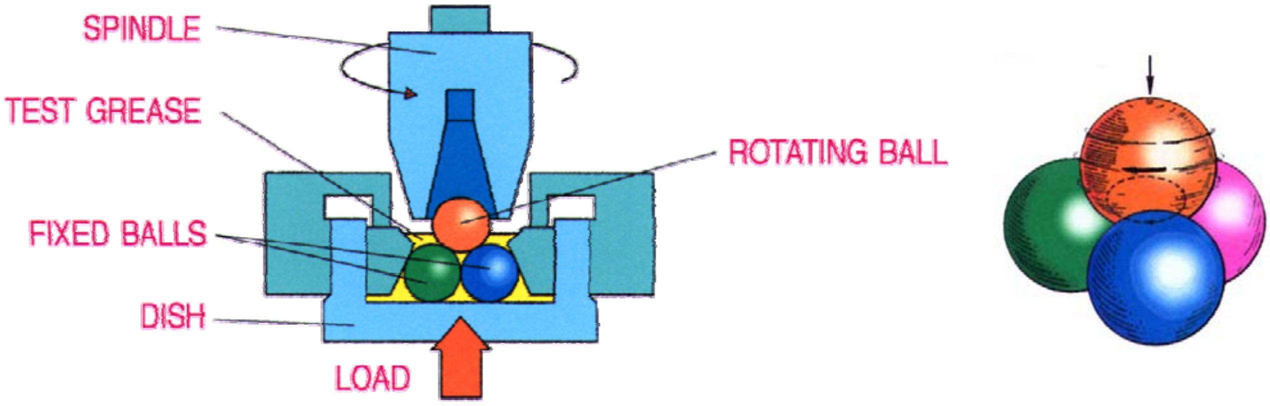


Figure 35: Extreme pressure tests

9.2.4. The characteristics of greases

Drop point:

The drop point of a grease is the temperature at which it starts to flow, in the form of a drop, under the effects of its own weight and the temperature.

This characteristic gives no precise indication of the maximum operating temperature. This temperature is always quite low (from 50 to 60°C).

Adhesion:

In order to lubricate effectively, a grease must adhere to the moving surfaces, even at very high speeds.

However, this adhesion must not be such that it leads to heating up and the destruction of the lubricant.

Physical stability:

When on no load, a grease must not allow too much oil to exude, since it would become impoverished and hardened.

Grease must sometimes lubricate for a very long time; it has to retain its qualities when in use (oxidation test in the presence of pressurised oxygen at 100°C).

Mechanical stability

A grease must retain its structure and consistency under the effects of mechanical work. There must be no separation of oil and soap.

In general, this property is checked by measuring the penetration of the "worked" grease after mechanical mixing (WORKER device: 100,000 blows test)

Load-carrying ability:

Even under great pressure, greases must form an elastic and lubricating cushion which avoids metal-to-metal contact. It is usual to add extreme-pressure and lubricity additives as well as solid lubricants.

The anti-wear or extreme-pressure properties of a grease are measured on machines of the same type as those used for oils.

Water-washout characteristics:

One of the roles of grease is to protect the components it lubricates from corrosion due to the presence of moisture or even water. Anti-rust properties are verified by different methods, in particular the SKF EMCOR test.

Pumpability

This depends on several factors:

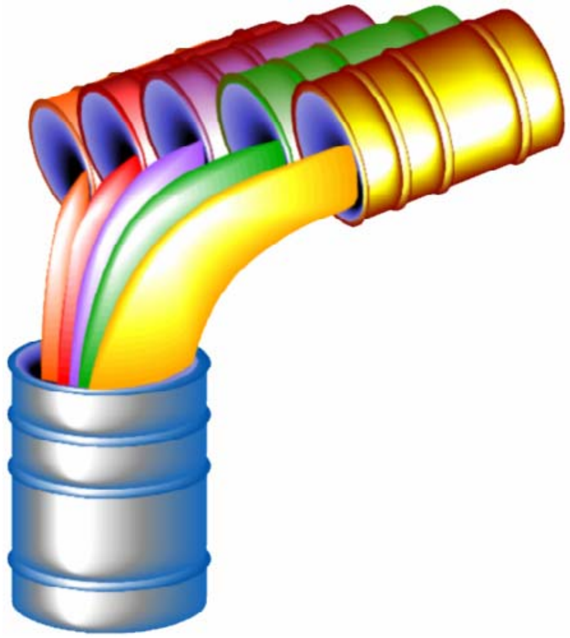
- The characteristics of the grease:
    - Texture,
    - Consistency,
    - Viscosity of the base oil.
- The operating conditions:
    - Temperature,
    - Flow rate.
- The characteristics of the circuit:
    - Circuit feed pressure,
    - Circuit length,
    - Diameter of the feed pipes.

9.3. THE ADDITIVES

Base oils have natural properties that vary in the extent of their development. They undergo refining or treatments with the aim of improving them.

However, all of these natural properties are frequently insufficient or too poorly balanced to be turned into finished lubricants.

It then becomes necessary to complement the base oils with products of a different chemical nature with the aim of enhancing certain of the existing properties or conferring new ones.



Anti-wear

Detergents

Dispersants

Antioxidants

Corrosion inhibitors

Pour point depressant (ppd)

Viscosity improver (multigrade)

…

Figure 36: Additives

The following are used:

- Chemicals known as "dopes" or "additives".
- Fatty matter of vegetal origin. These are products with strong polarity which provide the mineral oils with the lubricity needed in certain cases.
- Solid lubricants, in particular graphite and molybdenum disulphide, which offer the following essential properties:
- A laminar crystalline structure which favours slipping,
- Low friction coefficients,
- Much higher limiting stability temperatures than hydrocarbons.

- Miscellaneous petroleum products:
    - Pitches,
    - Paraffin waxes,
    - Other waxes,
    - Solvents.

The choice and dosage of the additives to incorporate in order to produce the end product depends on:

- The properties to be obtained,
- The susceptibility of the mixture of bases with regard to the additive,
- The combined interaction between the different additives.

.

9.3.1. The function of additives

- To reinforce certain properties of the base oils
    - Pour point
    - Viscosity index
    - Oxidation inhibitor
    - …
- To provide the base oils with properties that they do not possess naturally
    - Detergent
    - Dispersant
    - Rust preventive
    - …

9.3.2. Oxidation inhibitor

Do not confuse OXIDATION STABILITY with THERMAL STABILITY.

Oxidation is a reaction between the compounds (generally base oil) and oxygen (the air in general).

In order for calories to be removed, the oil warms up throughout its entire mass.

Once the temperature is continuously above 50-60°C in the presence of air, the rate of oxidation doubles every 10°C. Oxidation inhibitors then become indispensable.

In service oxidation shows up as:

- Increased viscosity,
- The formation of corrosive compounds,
- The formation of insoluble deposits: Carbon residues/varnish,
- A reddish-brown colour and a sharp odour.

9.3.3. Detergent

For limiting the formation of deposits in hot areas. In engines, detergents also combat acid corrosion created by combustion gases thanks to the addition of an alkaline reserve (TBN).

Detergents and dispersants (dispersing agents) help to keep equipment clean so that the different mechanical components can carry out their functions correctly.

9.3.4. Dispersant

For keeping the solid impurities that make oil dirty during use (soot, dust, particles of worn metal) in fine suspension, so as to stop them collecting at dead points in the system and ensure they are carried to the filter.

Detergents and dispersants (dispersing agents) help to keep equipment clean so that the different mechanical components can carry out their functions correctly.

9.3.5. Antifoam

Most foaming problems are due to poor system design. Foam causes tanks to overflow and adds the risk of poor lubrication (air instead of oil).

Antifoam additives prevent the formation of foam.

They act by breaking down the foam bubbles with the aid of their low surface tension. They are mainly silicones and organic copolymers used in very low quantities (a few tens ppm).

Silicones have a negative effect on oil deaeration.

The quantities have to be adjusted, since an overdosage of additive can lead to the opposite effect, that is, to increase foaming.

9.3.6. Corrosion inhibitor

Corrosion inhibiting additives act by adsorption onto the metal, where they form multiple "impermeable" layers which protect the metal from the action of water, air or the corrosive compounds formed by the oil.

9.3.7. Anti-wear

The use of anti-wear additives is well known (for mixed lubrication conditions: alternation of elastohydrodynamic lubrication/ boundary lubrication)

9.3.8. Viscosity index modifier

To provide maximum effectiveness, a lubricant must be:

- Sufficiently viscous at high temperature to prevent any contact between moving parts
- Sufficiently fluid to ensure easy starting at low temperature

9.3.9. Extreme pressure

Such additives prevent breakdown of the oil film when the lubricated components are subjected to high loads and high pressures.

The additives are adsorbed onto metal surfaces and form a protective layer at high temperature.

9.3.10. Summary of additives

Component	Viscosity index	Pour point	Detergent Dispersant	Oxidation inhibitor	Antifoam	Demulsifier	Corrosion inhibitor Rust preventive	Anti-wear	Extreme pressure	Solid lubricants
Engine	X (1)	X	X	X	X		X	X		X (2)
Hydraulics	X (3)	X	X	X	X	X	X	X		
Turbine				X	X	X	X			
Gears		X		X	X		X		X	X (2)
Compressor (4)				X	X	X	X	X		

(1) : For oils known as multigrade
(2) : In some types of oil
(3) : For oils with a high viscosity index
(4) : Since compressors have very different technologies, the characteristics of their lubricants can also be very different

9.4. HYDRAULIC OILS

9.4.1. Characteristics

Hydraulic oils are composed in the same manner as lubricating oils, but with different characteristics.

Role of a hydraulic system:

- Greater precision of movements,
- Speed changes controlled by the oil flow rate (automation, control, etc.)
- Travel easily reversed
- Power output high in relation to size of equipment,
- Greater flexibility of facilities (number of receptors, distance in relation to energy output).
- Applications: industry, public works, etc.

Hydraulic fluid must meet the following requirements:

- Transmit energy from one point to another, for which it is necessary for:
    - The viscosity to be adapted to the system in order to ensure the equipment is efficient (poor choice leads to cavitation, leaks, etc.)
    - The fluid to be stable under shear.
    - Its compressibility to be low in the presence of air or water (good separation of dissolved compounds)
- Lubricate mechanical components, for which it must:
    - Reduce friction and wear, and prevent seizing: lubricating and anti-wear properties.
- Protect the materials in the system:
    - External contamination: corrosion inhibiting and rust-preventing properties
    - Good lubricant behaviour in respect of joints and metals

Functions and properties of hydraulic oils:

- Cool the components in the system so as to:
    - Absorb the calories given off by mechanical effort in order to cool all operating components.
- Be stable in the operating conditions:
    - Ability to work at high temperature and therefore have good oxidation stability
    - Withstand wide variations in operating temperature: good viscosity index (VI)
    - Maintain its performance in the presence of contaminating liquids: demulsifying properties and good resistance to hydrolysis
    - Maintain its performance in the presence of contaminating gases: antifoam properties and fast deaeration rate
    - Retain its filtration aptitude in the presence of contaminating solids.

Be compatible with the gaskets in the hydraulic components

9.4.2. The hydraulic oil families

There are three hydraulic oil families

- Mineral oils
- Fire resistant fluids
- Biodegradable oils

9.4.2.1. Mineral oils

ISO 6743/4 HM/HV and DIN 51524 HLP/HVLP

AZOLLA ZS 10 to 150: Hydraulic systems not subject to low temperatures (indoors).

EQUIVIS ZS 15 to 100: Hydraulic systems subject to wide variations in temperature. Hydraulic oil ideal for machines working outdoor and subject to cold starting (ISO HV)

9.4.2.2. Mineral oil with very high VI

EQUIVIS XV 32 & 46: Hydraulic oils with a very high viscosity index (VI > 260) and a particularly low pour point allowing operation at low ambient temperatures. Excellent shearing resistance. Ideal for coolers (ISO HV).

9.4.2.3. Ash-free mineral oils

AZOLLA DZF 32 to 68: HM detergent oil without ASH and without SILICONE. Behaves well with high water content.

AZOLLA AF 32 to 68: HM oil without ASH and without SILICONE. Excellent thermal stability. Suitable for certain injection jacks. Compatible with AZOLLA AF only

9.5. COMPATIBILITY OF OILS WITH MATERIALS

Currently, most oils and greases are compatible with the sealing materials used in the installations.

When replacing a sealing device, make sure the device is similar to the one being changed.

When in doubt, carry out a preliminary compatibility test by putting the material to be used in contact with the lubricant in use.

	ISO VG 46					ISO VG 68	ISO VG 100	ISO VG 32-V.I. 100	ISO VG 32-V.I. 150	Monograde	Pressure lubrication
Ambient temperature	-40° C to -20° C -40 to 4° F	-20° C to -00° C 4 to 32° F	00° C to 20° C 32 to 68° F	20° C to 40° C 68 to 104° F	40° C to 60° C 104 to 140° F			-15° C to +30° C	-25° C to +40° C	0° C to 35° C	
AGIP			OTE 46			OTE 68	OTE 100	OTE 32			
ARAL			Motanol HK 46			Motanol HK 68	Motanol HK 100	Motanol GM 32			
BP	Energol SHF LT 15		Energol HP 15/32 HLP22 CS46	Energol HP 32 HP32/46 HLP32/46	Energol HP 68 HLP 46	Energol CS68	Energol CS100	Energol CS32 HL80 HLP32	Energol SHF32		
CASTROL			Perfecto T46			Perfecto T68	Perfecto T100	Perfecto T32 Hyspin AWS32	Hyspin AWH32		
CHEVRON			Mechanism LPS46		Mechanism LPS68	Mechanism LPS68	Mechanism LPS100	Mechanism LPS32			
ELF	Aviation Hydraulic Oil		Elfona DS46 Movixa 46	Elfona DS68 Movixa 46	Polytelis H100 Misola H100 Barelf CH68	Elfona 68	Elfona 100	Misola 32 Elfona 32	Hydrelf DS32	Discal DM30	Elfona DS46
ESSO	Univis J13		Univis N46 Teresso 46 Essolub HDX	Essolub HDX		Teresso 68	Teresso 100 Nuray 100	HP32 Nuto32 Teresso 47 Teresso 32	Univis HP 32		
FIAT										Uriana SAE 30 Uriana Turbo	
FINA			Hydran VT46 Cirkan 46		Cirkan 100	Cirkan 68	Cirkan 100	Hydran 32 Bakola 32 Cirkan 32	Hydran HV 32		
GULF								Harmony AW 32	Hydraulic 32		
HYDROKOMOL								U 32			
MOBIL	DTE 11		DTE Light DTE13 DTE 24 Delvar 1320	DTE Medium DTE 15 DTE 25 Delvar 1320	DTE Heavy Medium DTE 16 DTE 26 SHC 626	DTE Medium	DTE Vactra Heavy DTE 27	DTE 24 DTE Light	DTE 13		
SHELL	Tellus 10	Tellus 22	Tellus 32 Tellus C46 Turbo T46 Rotella X	Tellus 68 Rolexa X		Tellus T68 Tellus C68	Tellus T100 Tellus C100	Tellus S32 Tellus C32 Turbo T32 Ondina	Tellus T37		
TEXACO			Rando 46 Regal R & O 46			Rando 68 Regal R&O68	Rando 100 Regal R&O100	Rando HD32 Regal R & O 32			
TOTAL	Equivis 15		Azola 32 Azola 46	Azola 46 Azola 68	Azola 68 Azola 100 N	Azola ZS68	Azola ZS100	Azola ZS32			
VALVOLINE								Utramax 32			

Table 5: Example of an oil equivalence table

10. CLASSIFICATION

10.1. CLASSIFICATION OF OILS

The following classifications are used:

- **SAE J 300** for engine lubricants
- **SAE J 306** for transmission lubricants
- **ISO** for industrial oils

The grade: This defines the viscosity of the oil when cold or hot

Monograde

Defined by their viscosity:

- Either dynamic at low temperature (from –10 to –35 °C depending on the grade) and kinematic at 100°C for grades SAE 0W, 5W, 10W, 15W, 20W, 25W.
- Or kinematic at 100°C for grades SAE 20, 30, 40, 50, 60 only.

Multigrade

An oil when cold may have a viscosity corresponding to the definition of an SAE grade followed by the W (for example SAE 10W) and when hot, a viscosity featured in the range of an SAE grade without the letter W (for example SAE 40).

Such an oil is said to be MULTIGRADE (the above example uses a multigrade oil SAE 15W-40).

Example:

SAE 15W - 40	
Grade when cold indicated by "W" (W)	**Grade when hot**

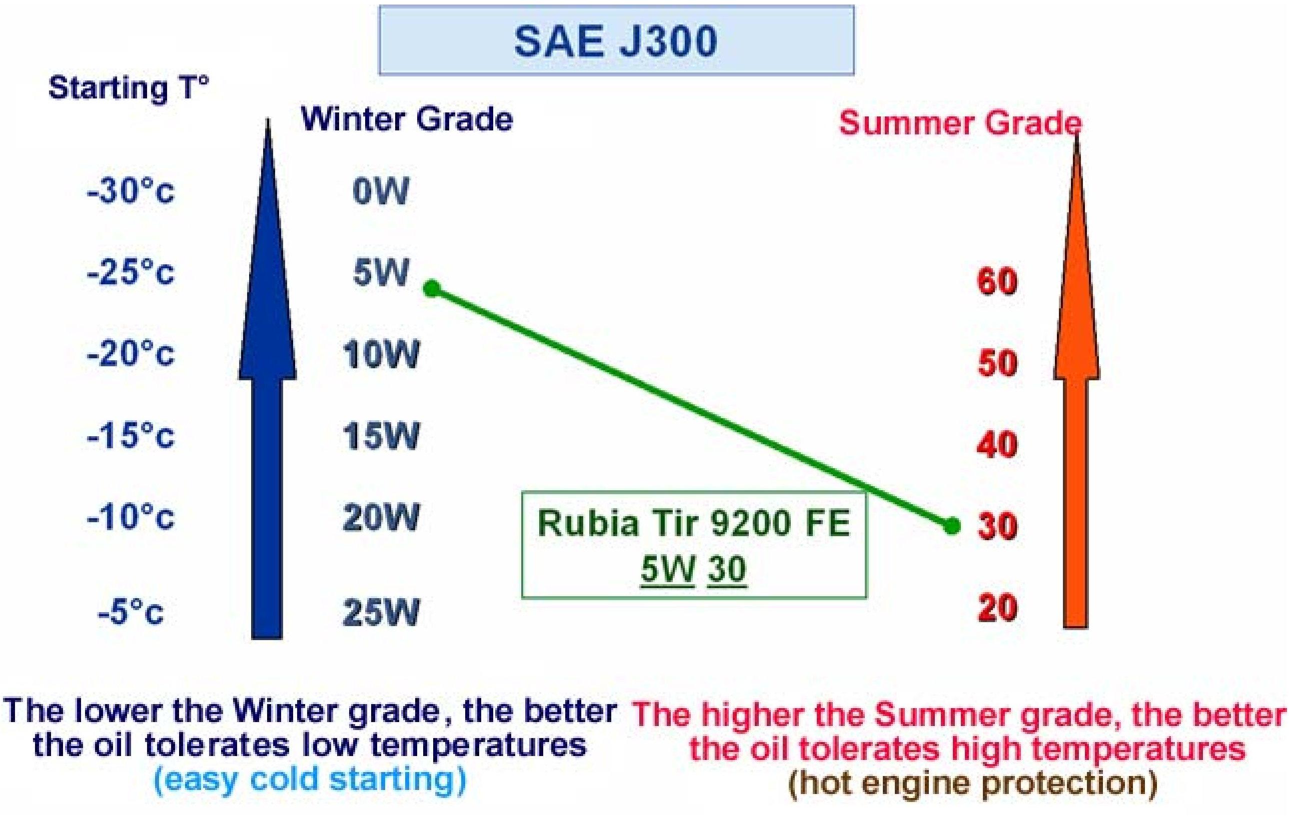


Figure 37: SAE J300 classification for engine lubricants

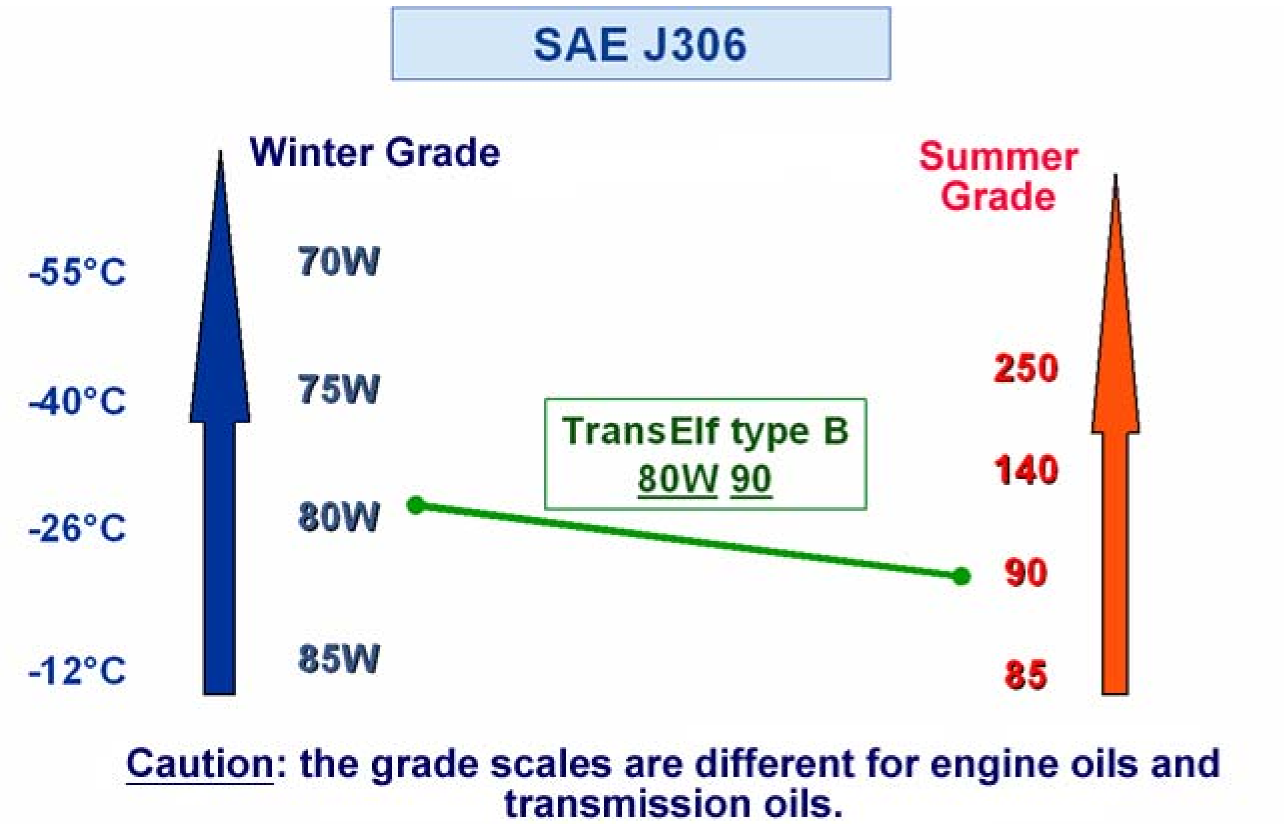


Figure 38: SAE J306 classification for transmission lubricants

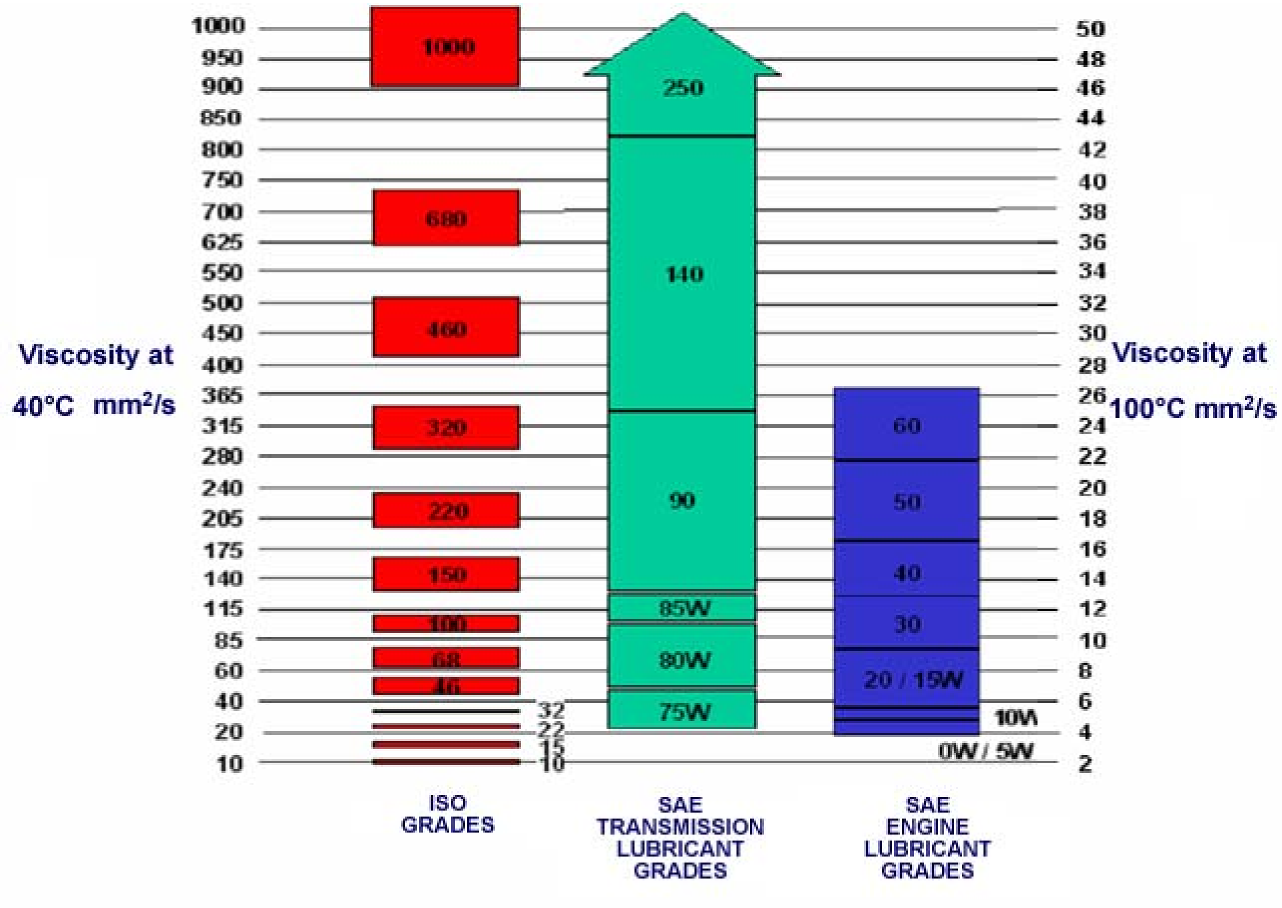


Figure 39: The viscosity scales

10.2. CLASSIFICATION OF GREASES

This is based on the NLGI classification (**N**ational **L**ubricating **G**rease **I**nstitute)

ISO 21 37	WORKED PENETRATION	NLGI
Very soft greases	445- 475 400 – 430	000 00
Soft greases	355 – 385 310 – 340	0 1
Thick greases	265 – 295 220 – 250 175 – 205	2 3 4
Hard greases	130 – 160 85 – 115	5 6

Table 6: Classification of greases

In the same way that oils are classified by their viscosity (ISO Grade), greases are classified by their consistency.

The penetration value of a grease is defined by the following test:

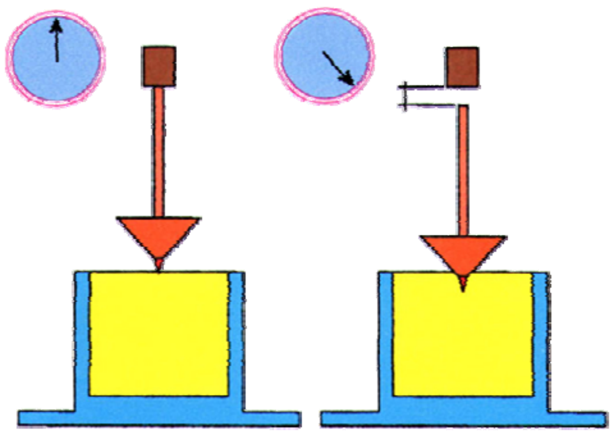


Figure 40: Penetration test

Test conditions

- Temperature 25ºC
- 60 strokes before measurement
- Descent and penetration of cone: 5 sec
- Weight of cone including instruments: 150 g

Results are expressed in tenths of a millimetre and correspond to the cone penetration depth.

10.3. CLASSIFICATION OF HYDRAULIC OILS

Classification of hydraulic oils: ISO 6743 / 4	
HH	Pure mineral oil
HL	Mineral oil with anti-oxidation and anti-corrosion properties
HM	Type HL fluid with anti-wear properties
HR	Type HL fluid with improved viscosity and temperature properties
HV	Type HM fluid with improved viscosity and temperature properties
HS	Synthetic fluid with no fire-resistance characteristics
HG	Type HM fluid with anti-jarring properties (machine tool sliders)
HFAE	Oil-in-water emulsion with over 80% water
HFAS	Aqueous chemical solution with over 80% water
HFB	Water-in-oil emulsion
HFC	Aqueous polymer solution with less than 80% water
HFDR	Water-free synthetic fluid consisting of phosphoric ester
HFDS	Water-free synthetic fluid consisting of chlorinated hydrocarbon
HFDT	Water-free synthetic fluid consisting of a mixture of HFDR and HFDS fluids
HFDU	Water-free synthetic fluid consisting of other components

Table 7: Summary table of the most frequently used hydraulic oils

FLUID OIL	ISO VG (Viscosity Grade)	Average kinematic viscosity value at 40 °C mm^2/s or cSt	Kinematic viscosity limits at 40 °C	
			Min. value mm^2/s	Max. value mm^2/s
	2	2,2	1,98	2,42
	3	3,2	2,88	3,52
	5	4,6	4,14	5,06
	7	6,8	6,12	7,48
	10	10	9	11
	15	15	13,5	16,5
	22	22	19,8	24,2
	32	32	28,8	35,2
	46	46	41,4	50,6
	68	68	61,2	74,8
	100	100	90	110
	150	150	135	165
	220	220	198	242
	320	320	288	352
	460	460	414	506
	680	680	612	748
	1000	1000	900	1100
	1500	1500	1350	1650
THICK OIL	2200	2200	1980	2420
	3200	3200	2880	3520

Table 8: Viscosity and viscosity index of hydraulic oils

11. THE DIFFERENT APPLICATIONS

11.1. OILS

11.1.1. Thermal motor oils

The role of engine lubricating systems is to lubricate moving components, to cool hot components and to remove impurities from the engine.

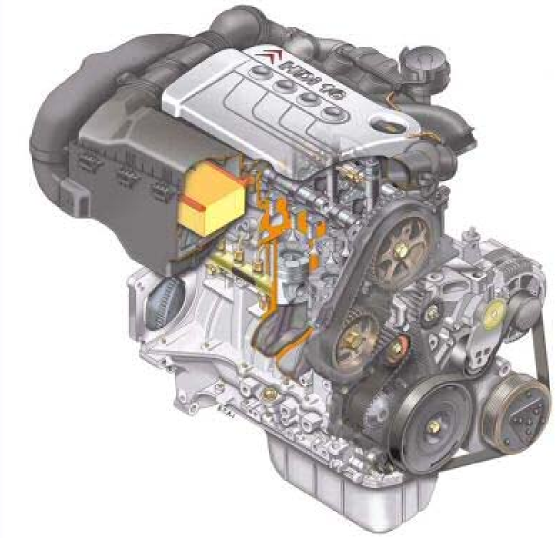
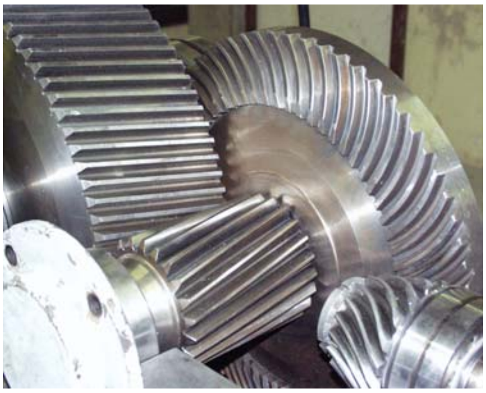


Figure 41: Thermal engine

Examples of motor oils (TOTAL brand):

- ACTIVA ENERGY 9000 0W-30
- ACTIVA FUTUR 9000 5W-30
- ACTIVA 9000 5W-40
- ACTIVA 7000 10W-40
- ACTIVA 7000 DIESEL 10W-40
- ACTIVA 5000 15W-40
- ACTIVA 5000 DIESEL 15W-40

11.1.2. Gear oils



Gears are mechanical components consisting of toothed wheels for transmitting effort to a shaft, doing so at different speeds.

The role of the oil is to form a strong film on the edges of these gears in order to reduce wear.

Figure 42: Gears

Oils are classified in categories of the CKx type where "CK" shows that the oil is a gear oil, and "x" is an indicator of the oil concerned.

Example: an oil designated ISO-L-CKS (or L-CKS) is "a gear lubrication oil operating at a low or very high stable temperature and under a moderate load".

Examples of gear oils (TOTAL brand):

- CARTER EP
- KASSILLA GMP
- CARTER PLUS
- CARTER SH

11.1.3. Two-stroke motor oils

Since two-stroke engines are not fitted with a lube oil sump, lubrication takes place within the actual fuel, which is mixed with this special lubricating oil for the purpose.

Figure 43: Tool powered by a two-stroke engine

Examples of two-stroke motor oils (TOTAL brand):

- TOTAL Racing 2T
- TOTAL Scooter 2T
- TOTAL Sport 2T
- TOTAL Aero DT
- TOTAL Prosylva 2TSyn
- TOTAL Prosylva 2TZ

11.1.4. Transmission oils

In the same way that sumps are filled with motor oil, so gearboxes also have their own type of oil.

The "Transmissions" API classifications are characterised by

GL (**G**ear **L**ubricant) + A FIGURE

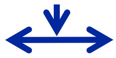
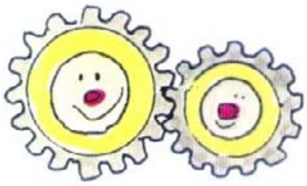
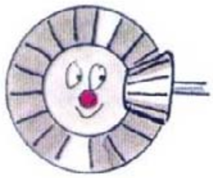
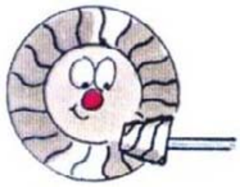
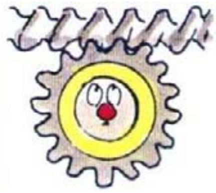
	Axes 			Axes 		
	Cylindrical			Conical	Hypoid	Worm screw
						
				Straight or spiral teeth	Inclined spiral teeth	Tangential wheel
Light load	GL1 GL2 GL3	GL3 GL4	GL3 GL4	GL3 GL4	GL5	GL3
Heavy load	GL4 GL4	GL4	GL4	GL4	GL5	Synthetic GL4

Table 9: Classification of transmission oils

API Grade	Oxidation inhibitor	Antifoam	Lubricity	Anti-wear	Extreme pressure	Rust preventive
GL 1	■	■				
GL 2	■	■	■			■
GL 3	■	■		■		■
GL 4	■	■			■	■
GL 5	■	■			■	■

Table 10: Types of additives in transmission oils

11.1.5. Oils for air compressors and vacuum pumps

OIL	Purpose / Application
DACNIS P 68 to 150	Mineral oils for **piston** and rotary type reciprocating air compressors (grade 46). No compatibility problem with the former DACNIS P and CORTUSA, CORTUSA AC & RO. DIN 51506 VDL.
DACNIS VS 32 to 150	**Mineral** oils for **screw** type rotary air compressors. Intervals between **oil changes up to 4000 hrs**. No compatibility problem with the former DACNIS VS and CORTUSA, CORTUSA AC & RO. DIN 51506 VDL.
DACNIS SH 32 to 100	**Synthetic** oils (PAO) for rotary air compressors. Intervals between **oil changes over 8000 hrs**. No compatibility problem with mineral oils, CORTUSA SP and BARELF SM. ISO 6743-3A DAJ.
DACNIS SE 46 to 100	**Synthetic diester** oils for air compressors (high pressure alternating, rotary (Ingersoll Rand), turbo compressors). Excellent thermal stability. **Caution: compatibility with the joints**. Compatible with CORTUSA SE and BARELF CH. DIN 51506 VDL.

PV 100	**Mineral** oil for vacuum pump (high vacuums up to 10-3 mbar). **Inert gas suction**.
PV 100 PLUS	**Mineral oil** for vacuum pump (high vacuums up to 10-3 mbar). **Moist air suction.**
PV SH 100	**Semi-synthetic oil** for vacuum pump. **Acid or corrosive gas suction.**
NEVASTANE AW / SS / SL	**NSF USDA H-1 foodstuff quality lubricants.** Suitable for lubricating air compressors (screw, piston and vanes). AW range (mineral oils) SS range (semi-synthetic oils) SL range (synthetic oils - PAO)

Table 11: Oils for air compressors and vacuum pumps

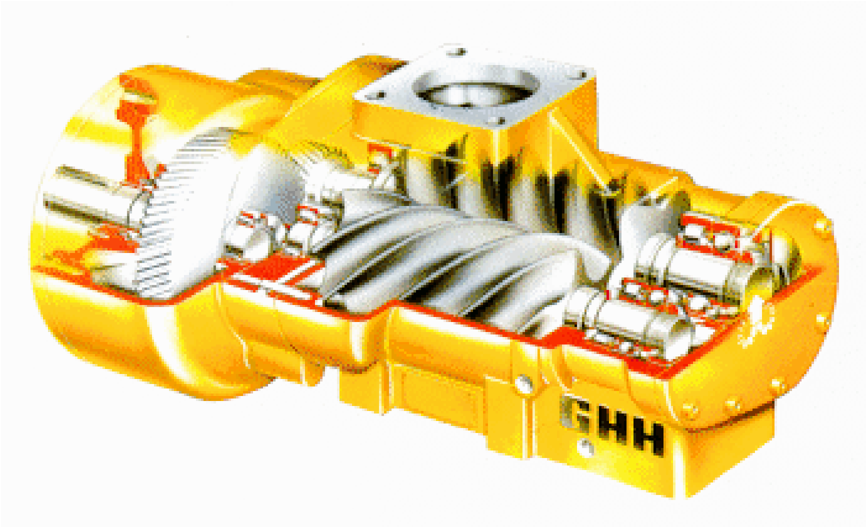


Figure 44: Compressor

11.1.6. Turbine oils

Oil	APPLICATIONS
PRESLIA 32 to 100	ISO: TSA/TGA/TGB/TGE/TSE Mineral oil with additives for lubricating turbines (steam, gas, hydraulic), together with their gears and control systems.
PRESLIA GS 32 and 46	ISO: TSA/TGA/TGB/TGE - General Electric GEK32.568E Mineral oil with **exceptional oxidation inhibiting** properties, for lubricating steam and gas turbines **operating at high temperatures**.
PRESLIA GT 32 and 46	ISO: TSA/TGA/TGB/TGE/TSE - General Electric GEK101941A Mineral oil with exceptional oxidation inhibiting properties, for lubricating gas and combined cycles turbines operating at **very high temperatures for very long service periods.**
PRESLIA SE JET (25 cSt@40°C)	MIL-L-23699E DERD 2499 grade OX27/OTAN O-156 Lubrication of **aeroderivative gas turbines**. Synthetic oil for lubricating turbines based on aircraft engine technology.

Table 12: Turbine oils

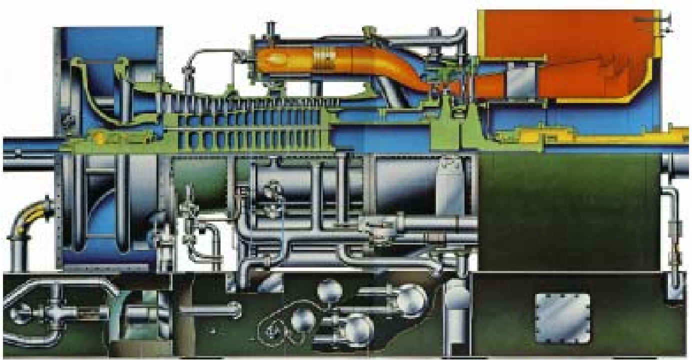


Figure 45: Turbine

11.1.7. Hydraulic oils

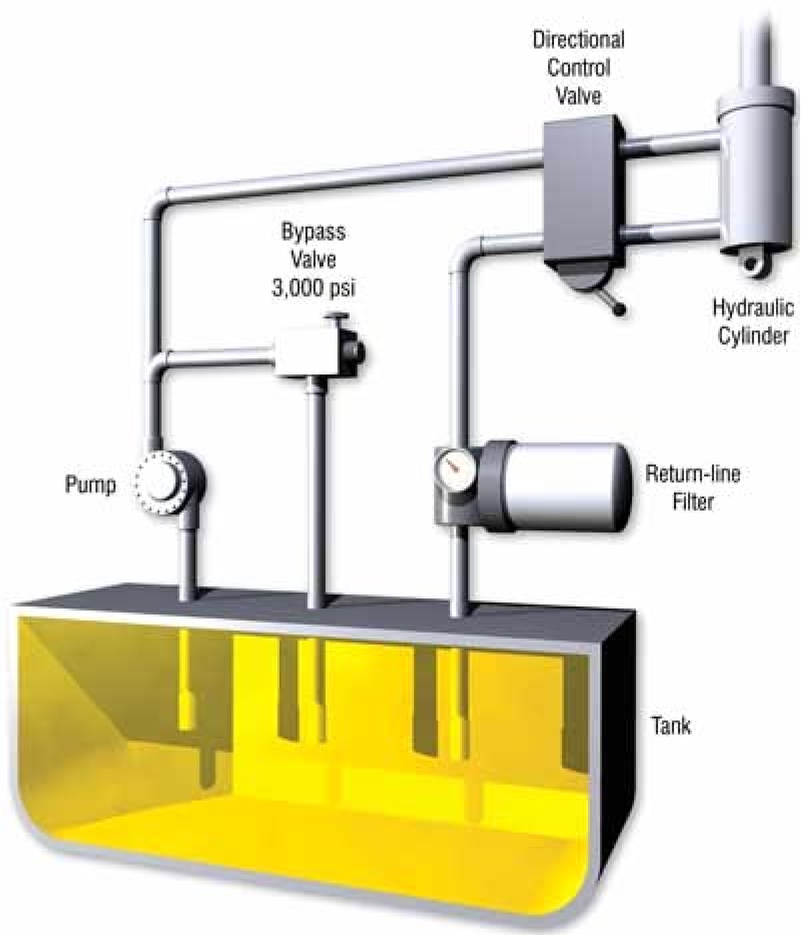


Figure 46: Hydraulic system

A hydraulic system requires some specific items of equipment such as:

- A pump to convert mechanical energy provided by a source (electric motor, thermal engine) into hydrostatic energy.
- Filters for trapping all the particles of contaminants that can find their way into the hydraulic fluid and cause abnormal wear. Filters are classified by the size of the particles retained in the filter. For hydraulic fluids the "filter diameter" is in the order of 3 to 15 µm.
- A distributor (Directional Control Valve) which shares the energy generated by the hydraulic pump among all the receiving components by varying the hydraulic fluid flow rate.
- A tank to store the hydraulic fluid and absorb the variations in volume that occur within the system. Its capacity is 3 to 5 times the pump flow in l/min (e.g. if the pump delivers 50 l/min, the volume of the tank will be 150 to 250 litres).

Hydraulic oils are used in civil works for the power and precision they provide.

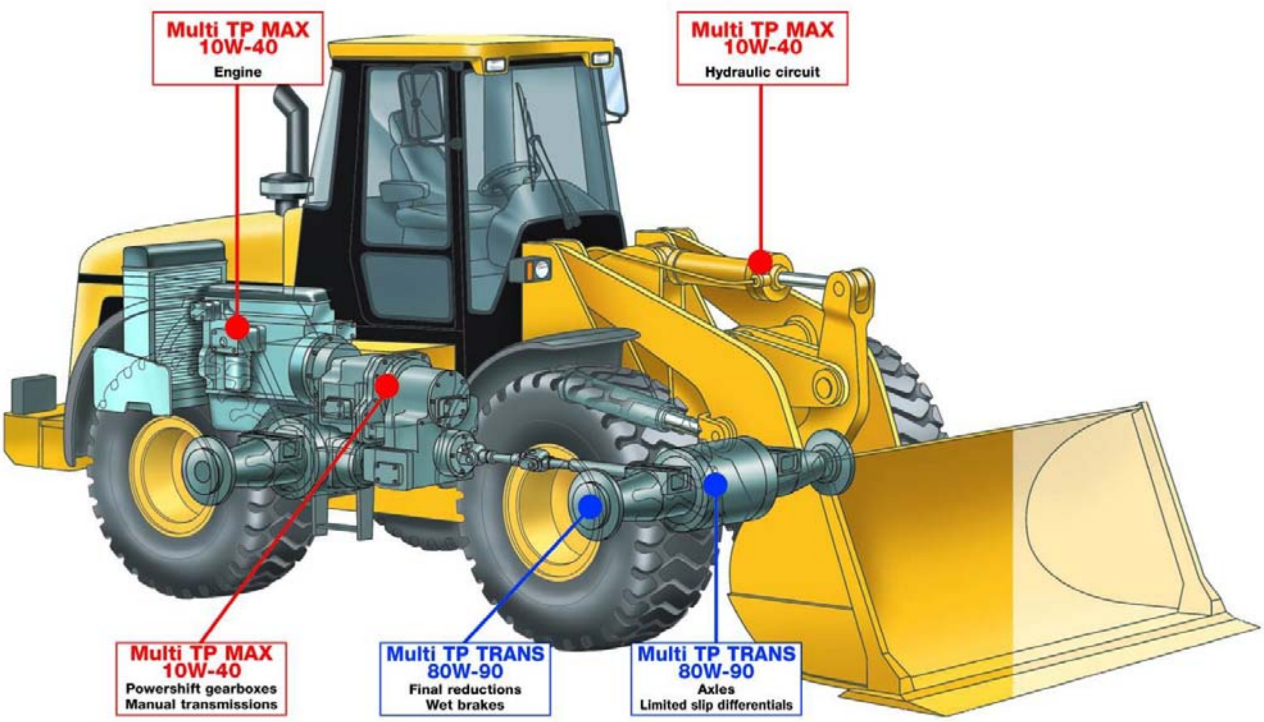


Figure 47: Civil works machine

ELASTOMERS Commercial brands	ASTM symbol	Paraffinic mineral oils (HM, HV)	Water / glycol solutions (HFC)	Phosphate esters (HFDR)	Organic esters (HFDU)	Aromatic hydrocarbons	Operating temperature (°C)
Acrylic Butadiene Nitride: Perbunan N, Butacryl, Krynac, Buna N, Hycar 1203, Paracryl	NBR	👍	👍	STOP	👍	△	-30 / +120
Butadiene Styrene Isoprene: Buna S, GRS	SBR	STOP	👍	STOP	STOP	STOP	-30 / +100
Chloroprene: Neoprene, Perbunan C	CR	△	△	STOP	△	STOP	-40 / +120
Isobutylene Isoprene: Butyl	HR	STOP	👍	👍	STOP	STOP	-40 / +120
Natural rubber: Isoprene	NR / IR	STOP	👍	STOP	STOP	STOP	-30 / +100
Silicone: Silastic	SI	△	△	△	△	STOP	-80 / +250
Fluorosilicone:	FSI	👍	👍	△	👍	STOP	-70 / +220
Fluorinated elastomers: Viton, Fluorel, Kel F	FPM	👍	△	△	👍	👍	-30 / +250

Polyacrylate: Rycar 4021	ACM	△	STOP	STOP	△	△	-15 / +170
Chlorosulphonated Polyethylene: Hypalon	CSM	△	👍	STOP	△	STOP	-50 / +120
Ethylene Propylene: Nordel	EPDM	STOP	👍	👍	STOP	STOP	-50 / +130
Polyurethane: Vulkolan, Adiprene, Vibrathane	EU	△	STOP	△	△	STOP	-40 / +100
Polytetrafluorethylene: Teflon, Fluon, Hostaflon, Agoflon	PTFE	👍	👍	△	👍	△	-200 / +260
Ethylene Polysulphide: Thiokol	T	👍	STOP	△	👍	△	

Table 13: Compatibility between type of gasket and nature of hydraulic fluid

11.2. GREASES

Greases are mainly used in:

- Bearings: the grease stays in the bearing without tending to escape as in the case of oil, and helps to form a seal; protection is assured, even in the event of lengthy shutdowns.
- Journal bearings: greases are preferable to oil when bearings are operating in the presence of vibrations, high temperatures, excessive loads, low speeds.
- Gears: only small gears are suitable for splash lubrication; fluid or semi-fluid greases are used. In small reducers greased for life the tendency is to use synthetic greases.
- Other applications: whenever a loss of seal would prohibit the use of an oil. For example, spray lubricating the drive gears of grinders and cement works furnaces.

TOTAL	Base oil Viscosity at 40°C mm²/s (cSt)	APPLICATIONS
Multi-purpose lithium/calcium soap greases		
MULTIS 2 MULTIS 3	120	**General lubrication of applications having no load constraints and operating in normal conditions.** Operating temperature from -20 to +120°C. *MULTIS 2: ISO L-XBCEA 2 & DIN 51502 K2K-25* *MULTIS 3: ISO L-XBCEA 3 & DIN 51502 K3K-20*
Multi-purpose Extreme Pressure lithium/calcium soap greases		
MULTIS EP 1 MULTIS EP 2 MULTIS EP 3	150	**Industrial applications under load** **Possible applications in transport, agriculture & public works** (journal bearings, wheel bearings, universal joints, chassis, etc.). Operating temperature from -25 to +120°C**.** *MULTIS EP 1: ISO L-XBCEB 1 & DIN 51502 KP1K-25* *MULTIS EP 2: ISO L-XBCEB 2 & DIN 51502 KP2K-25* *MULTIS EP 3: ISO L-XBCEB 3 & DIN 51502 KP3K-20*
MULTIS MS 2	150	**Applications under load, and subject to impacts or vibrations, in transport, agriculture & public works.** Operating temperature -25 to +130°C. Grease with the addition of solid molybdenum disulphide (MoS2). *ISO 6743-9 L-XBCEB 2 & DIN 51502 MPF2K-25*

MULTIS EP 0 MULTIS EP 00	185 150	**Industrial applications under load with centralised lubrication systems.** Operating temperature from -25 to +120°C. *MULTIS EP 00: ISO L-XCBEB 00 & DIN 51502 GP00G-30* *MULTIS EP 0: ISO L-XBCEB 0 & DIN 51502 MP0K-25*
MULTIS ZS 000	42	**Applications with centralised lubrication systems** (truck chassis, all-terrain public works vehicles, etc.). Operating temperature from -45 to +120°C. *ISO L-XECFB 000 & DIN 51502 MP00/000K-45.* *Approvals: Mercedes Benz & MAN.*
Multi-purpose Extreme Pressure high temperature lithium soap complex greases		
MULTIS COMPLEX EP 2	120	**Applications under load with a high operating temperature prohibiting the use of conventional lithium greases.** Operating temperature from -20 to +160°C. *ISO L-XBEHB 2 & DIN 51502 KP2P-20.*
Multi-purpose Extreme Pressure high temperature lithium/calcium soap complex greases		
MULTIS COMPLEX HV 2	340	**Applications under load with a high operating temperature prohibiting the use of conventional lithium greases.** Operating temperature from -20 to +160°C. *ISO L-XBEHB 2 & DIN 51502 KP2P-20.*

Table 14: Summary of the uses of multifunction greases

TOTAL	NLGI grade	Base oil Viscosity at 40°C mm²/s (or cSt)	APPLICATIONS
ALTIS EM 2	2	110	**Bearings for engines, electrical generators, blowers or pumps.** **Light loads.** Greased for life. *ISO L-XBEHB 2 & DIN 51502 KP2R-25.*
ALTIS MV 2	2	160	**Bearings for engines, blowers or pumps.** **Heavy loads.** Greased for life. *ISO L-XBECB 2 & DIN 51502 KP2P-25.*
ALTIS SH 2	2	84	**Bearings for engines, electrical generators, blowers or pumps.** **Light to heavy loads.** Greased for life. Synthetic grease**.** **Leading product in the paper industry.** *ISO L-XDFHB 2 & DIN 51502 KHCP2R-40.*
CERAN WR 1 CERAN WR 2	1 & 2	180	**Multi-purpose greases** (moderate rotation speeds). Lubrication of industrial applications in wet environments (shipping, off-shore, etc.). *CERAN WR1: ISO L-XBFIB1 / DIN51502 KP1R-25.* *CERAN WR2: ISO L-XBFIB 2/ DIN 51502 KP2R-25.*

CERAN AD	0	325	**Cables, chains and open gears in heavy industry and port facilities.** *ISO L-XBDIB 0 & DIN 51502 OGP0N-25.*
CERAN HV	1/2	422	**Bearings under heavy loads in the steel-making industry.** *ISO L-XBFHB 1/2 & DIN 51502 KP1/2R-25*
CERAN HVA	2	422	**Bearings under heavy loads in the steel-making industry** (better resistance to static corrosion and oxidation). *ISO L-XBFHB 2 & DIN 51502 KP2R-25*
CERAN PM	1/2	325	**Bearings under heavy loads in the wet and dry stages of paper-making.** Good resistance to static corrosion and oxidation. *ISO L-XBFIB 1/2 / DIN 51502 KP1/2R-25*
CERAN GEP	0	695	**Reducers and industrial transmissions for grinders and ring gear for cement works furnaces**. Grease with solid additives (graphite & MoS_2). *ISO L-XBFHB 0 & DIN 51502 OGPF0R-25.*

Table 15: Summary of the uses of specific greases

12. LUBRICANT ANALYSIS

12.1. SAMPLING AND ANALYSIS

The lubricant in use reflects the condition of the system.

Figure 48: Lubricating of gears

Therefore, its analysis provides a better knowledge of the machinery. This oil quality monitoring is all the more important as more than half the mechanical failures result from a deficit or a lack of lubricant.

The clear diagnosis of a deficit requires a regular inspection of different parameters such as viscosity, acidity, presence of iron particles, size of particles, etc …

Results are used to detect typical anomalies such as:

- Contamination by internal particles present in the equipment.
- Evolution by comparing the results obtained between each analysis.
- Type of wear.
- Contamination by external agents.
- Degradation of the oil.

The analysis of the lubricant is sometimes combined with vibration analysis and borescope inspections in order to confirm hypotheses.

12.1.1. Information provided by oil analysis

As oil is in contact with all the moving parts in the mechanism, it can provide much information about the condition of the machine.

Due to the conditions the oil is subjected to while the machine is working, it records traces of any anomalies.

12.1.2. Components and detected failures

On a **combustion engine**:

- Sealing problems with the air filtration.
- Cooling fluid ingress
- Fuel permeation (ring sealing)
- Etc.…

On **reducers and gears, turbines**, etc.…

- Failure condition of a bearing or bearing assembly.
- Faulty transmission (damaged gear)
- Etc.…

On a **hydraulic system**:

- Internal contamination
- Sealing fault
- Filtering fault
- Cavitation
- Etc.…

12.1.3. Monitoring methods

On an industrial site, the monitoring method can be carried out in several ways:

- By oil sampling for laboratory analysis
- By visual and tactile inspections (transparency, colour of deposit, texture)
- By continuous monitoring of any change in technical parameters (temperature, flow rate, pressure), history of oil draining and topping-up.
- By a follow-up of corrective maintenance and operating faults for each machine.

12.1.4. Sampling method

Predictive maintenance by monitoring oils in use requires very rigorous sampling methods and reading of events occurring during the life of the whole oil charge >> oil topping-up, draining.

In order to keep the oil well mixed, collect a sample within 10 minutes after shutting down the machine, and after draining a few centilitres to discharge impurities which often concentrate where the samples are collected.

Ideally, the sample should be collected with the mechanism working or running.

Use a clean, dry plastic bottle (350 to 500 ml). Never fill to the top.

Tightly close the bottle (after carefully wiping the neck with a clean rag - without rubbing >> risk of rag fibres in the sample).

Fill-in the sampling sheet and add useful information to help define the analysis to be carried out on the sample.

- Name of the site
- Type of lubricant (turbine, engine, etc.…)
- Working hours of the installation
- Time since last drain
- Number and quantity of oil topping-up

And to provide the laboratory with more precise information about the equipment, also indicate:

- The working conditions of the installation (wet conditions, contamination, dust, severity of use, etc.)
- The characteristics of the lubricant (volume in use, filtration, temperature, pressure, etc.)
- The circuit components (different metals, frequency for changing or cleaning the filters, operation in downgraded mode, replacement of hoses, operations on a component of the installation, abnormal increase in pressure or temperature, etc.)

The reliability of the diagnosis and recommendations resulting from the analysis depend on the quality of the information covering the sample and the sampling.

There are different official systems for monitoring the sampling and analysis of oil:

- ANAC is a diagnostic system based on the interpretation of the analysis of oil in service (used oil). This system is aimed particularly at engines, gearboxes, etc.
- LUBIANA is a diagnostic system developed by TOTAL LUBRICANTS aimed at industrial sectors, having as its objective the preventive analysis of oils in order to improve maintenance.

Sampling and analysing oil makes it possible to monitor and understand how equipment changes with time.

Oils deteriorate during the time they are used, the distances travelled, or due to the premature wear of a mechanical component.

In order to monitor heavy plant in, for example, the petroleum industry (turbines, engines, pumps) oil samples are taken regularly and sent to a laboratory for analysis.

This sampling must be carried out according to a procedure, in order to be certain of obtaining a good analysis and deducing the proactive, preventative or remedial actions to be taken.

12.2. THE ANAC SYSTEM

12.2.1. The sample

12.2.1.1. Taking the sample

A clean jar must be used.

If this sample is taken straight from the outlet of the drain plug, let a few drops run before filling the jar in order to avoid putting a high concentration of impurities into the jar.

Figure 49: Sampling oil

The sample is taken at a representative point in the circuit and preferably while the machine is operating or just after it stops.

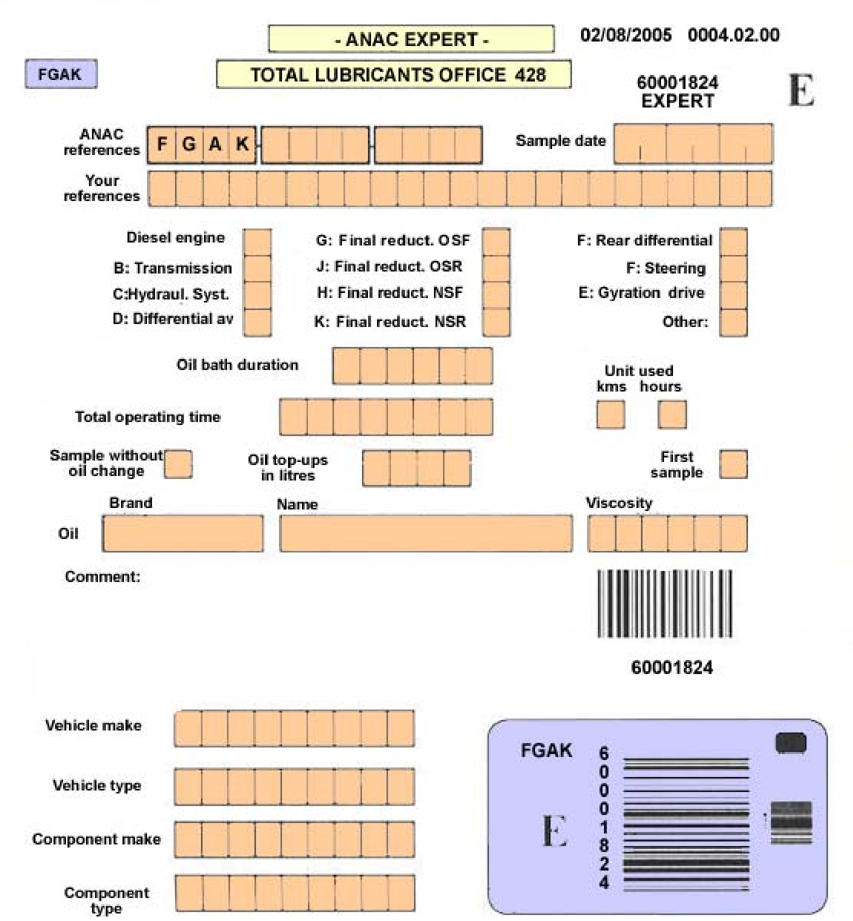
The quantity of oil to be sampled is in the range 150 to 500 ml, depending on the measurements required (150 ml for viscosity, traces of wear and acid number; 500 ml for other measurements such as the particulate count, the HIAC count, the drasticity, the electric strength).

12.2.1.2. The label

A label is supplied with the jar. This must be attached to the jar so that the laboratory can monitor the sample during analysis and avoid using the wrong jar.

Figure 50: Labelling the jar

12.2.1.3. The data sheet



This tells the laboratory about the data relating to equipment regarding date of last analysis, number of km travelled, number of operating hours, type of equipment, etc.

Figure 51: Example of a data sheet

12.2.1.4. Despatch

Place the data sheet and the sample in the envelope supplied. This procedure will ensure that the sample is properly tracked.

12.2.2. The sampling frequency

This naturally depends on the type of machine, the lubricant, the equipment operating conditions, and the relative cost/benefit analysis of the maintenance.

Unless otherwise recommended, the best advice is as follows:

- Analyse on every system oil change
- Analyse between changes:

- Air compressors: every 500 hours, then move to 1000 hours if everything seems correct
- Gas compressors (chemical industries): ditto
- Hydraulic systems: 1000 hours (heat carriers: ditto)
- Refrigeration compressors: from 1000 to 2000 hours
- Turbines: every 2000 hours
- Oils for reducers, gears: ditto
- Machine oils: ditto
- Quenching oil baths: ditto
- Insulating fluids: every 5000 hours
- Motor oils: every 15,000 km or 250 hours

- Cutting fluids:
  - Aqueous, depending on the facility: 1 to 4 weeks
  - Whole, depending on the facility: 2 to 4 months

12.2.3. The analysis

What an analysis looks for

The analysis varies to suit the type of lubricant and the type of equipment being lubricated. The number of investigations carried out on a fluid cannot be reduced below a certain limit, since in order to be complete, the diagnosis must be based on proper information.

12.2.3.1. Analysing the appearance

A visual inspection and odour test can sometimes be a very simple way of revealing anomalies concerning both the contamination and the changes in a lubricant. To guide the rest of the diagnostics, here are some very useful interpretation rules which can be applied on the industrial site itself:

- **If the lubricant has a cloudy look**

  Investigate the hypothesis of a mixture containing immiscible products: a mixture of a mineral lubricant and a synthetic lubricant, or a mixture of a lubricant with a solvent.

  To confirm one of these hypotheses, the next stage of the analysis will be to measure other characteristics: viscosity, flash point (see below).

  The possibility of the abnormal presence of water will also be examined: to be confirmed by a water test (see below).

- **If the lubricant has a milky look**

  If the milky look is lasting, the possible presence of water will need to be confirmed by a water test.

  If the milky look is temporary, the deaeration properties of the oil will be measured in order to confirm if it is in fact a temporary oil aeration condition.

- **If the lubricant has a reddish/brown look and a "burnt" smell**

  The lubricant will be investigated for possible thermal degradation: to be confirmed by measuring the acid number and the viscosity index (see below).

12.2.3.2. Analysing the water content

Water is a poor lubricant, and can therefore cause mechanical malfunctions. It also encourages oil ageing and metal corrosion.

There are many ways by which water can get into a system: a refrigerant leak, steam getting into turbine oil, aqueous cutting fluid getting into machine-tool lube oil, etc.

The presence of water can result quite simply in the breathing of the oil system.

The maximum water content varies from one lubricant to another. Here are some examples:

- Mineral hydraulic fluid, turbine oil: 0,2%
- Machine oils, reducers: 0,5%
- Refrigeration compressor oils: 100 ppm
- Insulating oils: 30 ppm
- Quenching oils: 0,02%

12.2.3.3. Analysing particles

In the context of a predictive maintenance policy, it is very important to detect the particles present in the oil, and to find out their nature, since these particles are a sign of contamination or of degradation in the equipment (dust, sand, scale, metal wear or rust particles, flakes of paint, debris from joints, fibres, etc.).

Figure 52: Example of particles retained in a filter

It is also necessary to try to eliminate such particles, since they can accelerate the wear rate of the equipment.

12.2.3.4. Emission spectrometry

Emission spectrometry can be used to detect metal particles due to wear, as well as oil additives and contaminants. Emission spectrometry with an argon plasma torch can be used to measure the content of numerous elements: traces of metal, alkaline-earth elements, silicon, that is, elements that are representative of

- wear, or
- oil additives, or
- contaminants.

The six main metals that are commonly representative of wear are:

- tin (Sn),
- lead (Pb),
- iron (Fe),
- chrome (Cr),
- aluminium (Al),
- copper (Cu).

12.2.3.5. Closed cup flash point

The flash point of an oil is the lowest temperature to which it must be brought in order for the vapours it emits to ignite spontaneously in the presence of a flame.

The main interest in the flash point is that it gives information on a possible fire risk and on the presence of abnormally high temperatures within the oil system.

To measure the flash point, oil is placed in a pot and gradually heated at a well defined rate.

Standard NF T 60-103 describes a method of determining the closed cup flash point, that is, the pot has a lid fitted with a flue which has a pilot flame above it. The flash point is the temperature of the oil at the moment when a flash is produced by the ignition of the oil vapours.

Overall it is possible to say that a lowering of the flash point can indicate contamination by a gas or liquid that is more volatile than the oil.

It can also indicate the onset of cracking, for example in the case of a heat carrier or quenching fluid.

12.2.3.6. Viscosity and viscosity Index

The viscosity of a lubricant is a very important characteristic since, in addition to the importance it has at recommendation time, it provides valuable information about the lubricants in service.

The viscosity can be influenced one way or another by various factors:

- It can be increased by oxidation, by the addition of a more viscous oil.
- It can be lowered by soluble gases in the oil or by the addition of a less fluid oil.

The occurrence of cracking in a heat carrier fluid, caused by excessive heating, also lowers viscosity.

12.2.3.7. Acid number

The value of the acid number has already been mentioned several times as a very important characteristic of the oils in service.

The acid number is the number of milligrams of potassium needed to neutralise one gram of oil.

Many doped oils in their new state exhibit an apparent acid number resulting from the potassium reaction on the additives.

12.2.3.8. Nitration of oils for gas-powered compressors

All internal combustion engines, whether or not they use spark ignition, create nitrous oxides (NOx) from the nitrogen and oxygen in the air under the effects of high pressures and temperatures.

The NOx content of the combustion gas depends very greatly on the adjustments (ignition advance and carburisation richness in the case of gas-powered compressors).

Since the segmentation seal cannot be perfect, combustion gases (blow-by gases) pass into the sump and the nitrous oxides contained in these gases can react with the oil molecules. These nitration products increase the viscosity of the oil. In addition, laboratory test have shown that the presence of nitrous oxides acts as a catalyst to oxidation.

The need to change a motor oil is dictated:

- By its ageing (oxidation, nitration, consumption of a significant amount of the additives, etc.)
- By its contamination (sooty substances, salts of lead, fuel, water, etc.)

It is very often contamination that makes an oil change necessary.

However, in the case of gas-powered compressors ageing is usually the deciding factor since these engines burn a very clean fuel and contamination is low. This also enables oil change intervals amounting to several thousand hours when using quality oils.

12.2.3.9. Foaming

The foaming of an oil is characterised by the volume and persistence of its foam.

It is measured according to standard AFNOR NF T 60-129: a 190 ml sample in a graduated 1000 ml glass test tube receives 95 ml of air per minute blown through a porous sphere. The blowing continues for 5 minutes, and the oil is then left to rest.

The volume of foam after the 5 minutes of blowing is the foaming tendency.

The volume of foam after 10 minutes of rest is the stability or persistence of the foam.

12.2.3.10. The electric strength

The electric strength, or the breakdown voltage, is the property that an insulating oil possesses to prevent the formation of an arc under the effects of an intense electrical field.

The measurement method is described in standard NF C 27-221. The test consists of applying an AC voltage at a frequency of 50 Hz between two electrodes placed 2.5 mm apart and submerged in the test oil. The voltage is increased until a disruptive discharge occurs. This important characteristic depends essentially on the cleanliness of the oil.

The cleanliness is reduced by the presence of water and suspended solids. It is used to decide whether a drying and filtration treatment is appropriate.

It will sometimes be appropriate to change the oil in cases where oxidation of the product exceeds a certain level (acid number > 0.2).

12.2.3.11. Oil-spot test (motor oils)

This test is very specific to motor oils, since it aims to qualify the following properties:

- Fouling of the oil in service by unburnt particulates (incomplete combustion),
- The residual dispersive power of the oil and its capacity to hold particulates in suspension.

The test can also reveal a certain degree of oxidation of the oil, and the presence of unburnt fuel in the oil.

This test is very simple and consists in depositing a drop of the oil sample onto a filter paper and then examining the spot after it has spread over the paper, usually at ambient temperature and sometimes also at high temperature (200 °C in order to find out in particular the dispersive power of the oil in the hottest parts of the engine).

Examination of the spot reveals

- A central spot which is black to a greater or lesser extent, depending on the fouling of the oil.
- A circular grey spot, the size of which depends on whether or not the dispersion is still effective.

There are of course a multitude of tests depending on the elements being investigated.

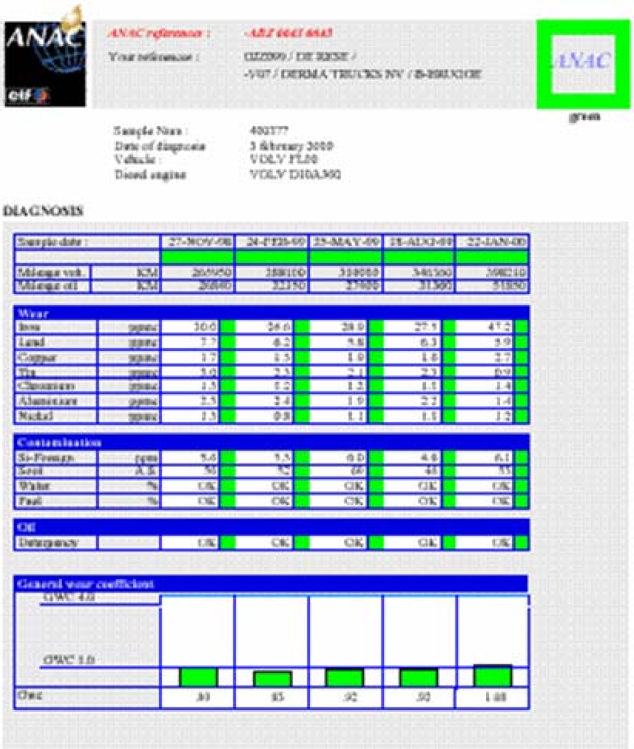
12.2.4. Analysis results

Results are sent to the user in colour-coded form:

GREEN: all is well; the oil and the aspects analysed are within tolerance

ORANGE: one or more of the elements examined is becoming critical or outside the tolerance; think about replacing the oil or taking corrective action

RED: There is a serious risk to the life of the equipment; it is IMPERATIVE to replace the oil and check the state of the machine.



ANAC reference : -ABZ 6645 6643
Your reference : 0Z2090 / DE RIESE /
-V07 / DERMA TRUCKS NV / B-BRUGGE

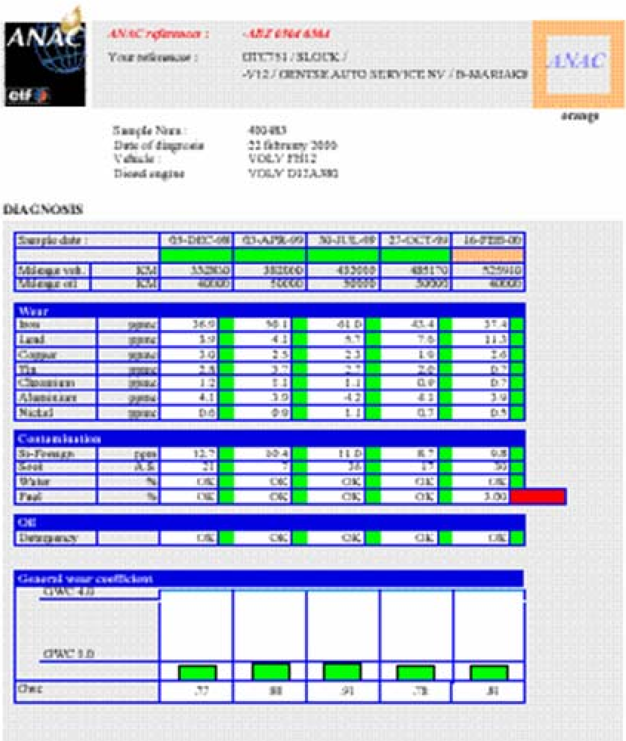
green

Sample Num : 400177
Date of diagnosis 3 february 2000
Vehicle : VOLV FL10
Diesel engine VOLV D10A360

DIAGNOSIS

Sample date :		27-NOV-98	24-FEB-99	25-MAY-99	18-AUG-99	22-JAN-00
Mileage veh.	KM	265950	288100	310050	340500	398210
Mileage oil	KM	20840	22150	27600	31500	51850
Wear						
Iron	ppm	30.0	26.6	28.0	27.5	47.2
Lead	ppm	7.7	6.2	5.8	6.3	5.9
Copper	ppm	1.7	1.5	1.0	1.6	2.7
Tin	ppm	3.0	2.3	2.1	2.3	0.9
Chromium	ppm	1.5	1.2	1.2	1.1	1.4
Aluminium	ppm	2.5	2.4	1.9	2.2	1.4
Nickel	ppm	1.3	0.8	1.1	1.1	1.2
Contamination						
Si-Foreign	ppm	5.6	5.5	6.0	4.8	6.1
Soot	A.S	50	52	60	48	55
Water	%	OK	OK	OK	OK	OK
Fuel	%	OK	OK	OK	OK	OK
Oil						
Detergency		OK	OK	OK	OK	OK
General wear coefficient						
GWC 4.0 / GWC 1.0						
Gwc		.80	.85	.92	.90	1.08

Figure 53: Example of "Green" analysis results



ANAC reference : -ABZ 6564 6564
Your reference : 0TC751 / SLOCK /
-V12 / GENTSE AUTO SERVICE NV / B-MARIAKE

orange

Sample Num : 400483
Date of diagnosis 22 february 2000
Vehicle : VOLV FH12
Diesel engine VOLV D12A380

DIAGNOSIS

Sample date :		03-DEC-98	03-APR-99	30-JUL-99	27-OCT-99	16-FEB-00
Mileage veh.	KM	332830	382000	432000	485170	525910
Mileage oil	KM	40000	50000	50000	50000	40000
Wear						
Iron	ppm	36.9	50.1	61.0	43.4	37.4
Lead	ppm	3.9	4.1	5.7	7.6	11.3
Copper	ppm	3.0	2.5	2.3	1.9	2.6
Tin	ppm	2.8	3.7	2.7	2.0	0.7
Chromium	ppm	1.2	1.1	1.1	0.9	0.7
Aluminium	ppm	4.1	3.9	4.2	4.1	3.9
Nickel	ppm	0.6	0.9	1.1	0.7	0.5
Contamination						
Si-Foreign	ppm	12.7	10.4	11.0	8.7	9.8
Soot	A.S	21	7	38	17	30
Water	%	OK	OK	OK	OK	OK
Fuel	%	OK	OK	OK	OK	3.00
Oil						
Detergency		OK	OK	OK	OK	OK
General wear coefficient						
GWC 4.0 / GWC 1.0						
Gwc		.77	.88	.91	.78	.81

Figure 54: Example of "Orange" analysis results

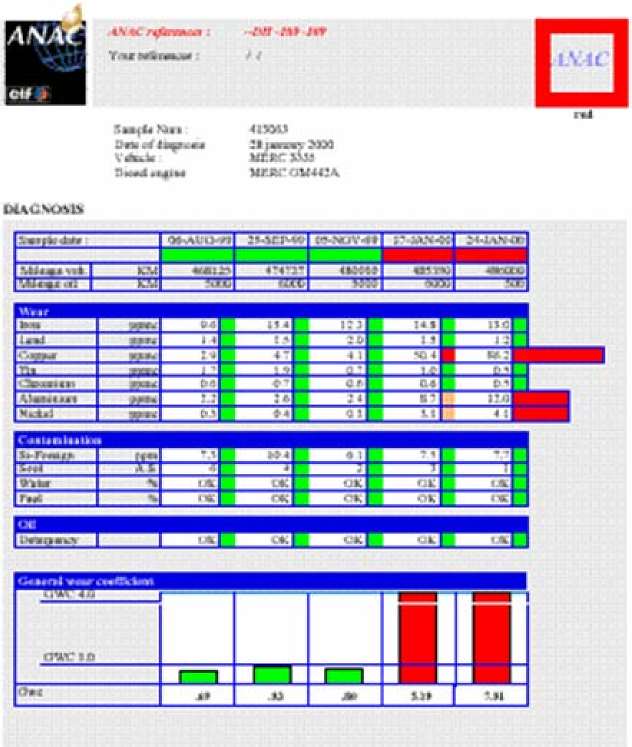


Figure 55: Example of "Red" analysis results

12.3. LUBIANA SYSTEM

12.3.1. System description

This system is designed as a maintenance tool. Its objectives are:

- To detect possible problems => to anticipate faults.
- To optimise maintenance costs (by choosing the lubricant best suited to the operating conditions).
- To optimise oil change intervals (and operational planning).
- To monitor changes in the state of the oil.
- To determine the origin of any contaminants found.

The importance of monitoring the analyses

- To evaluate the operating conditions of the machine

- To determine the origin of any contaminants found
- To understand the progress and type of wear in the machine
- To optimise oil change intervals and work on the consumption by lubricating with the aid of regular analyses.

12.3.2. Putting analytical monitoring in place

Monitoring can only be put in place on equipment with oil capacities greater than 200 litres and on sensitive equipment such as gas compressors, turbines, etc.

For precise monitoring it is necessary

- To carry out regular analysis
- To compare the results obtained with previous sampling (carried out in the same conditions)
- To be informed about the equipment
- To be informed about the lubricant.

12.3.3. The sample

12.3.3.1. Taking the sample

Always take the sample in the same conditions and if possible

Collect the product straight into a clean Lubiana jar, avoiding the first off-take.

Identify the jar as soon as possible using Lubiana stickers

12.3.3.2. Despatch

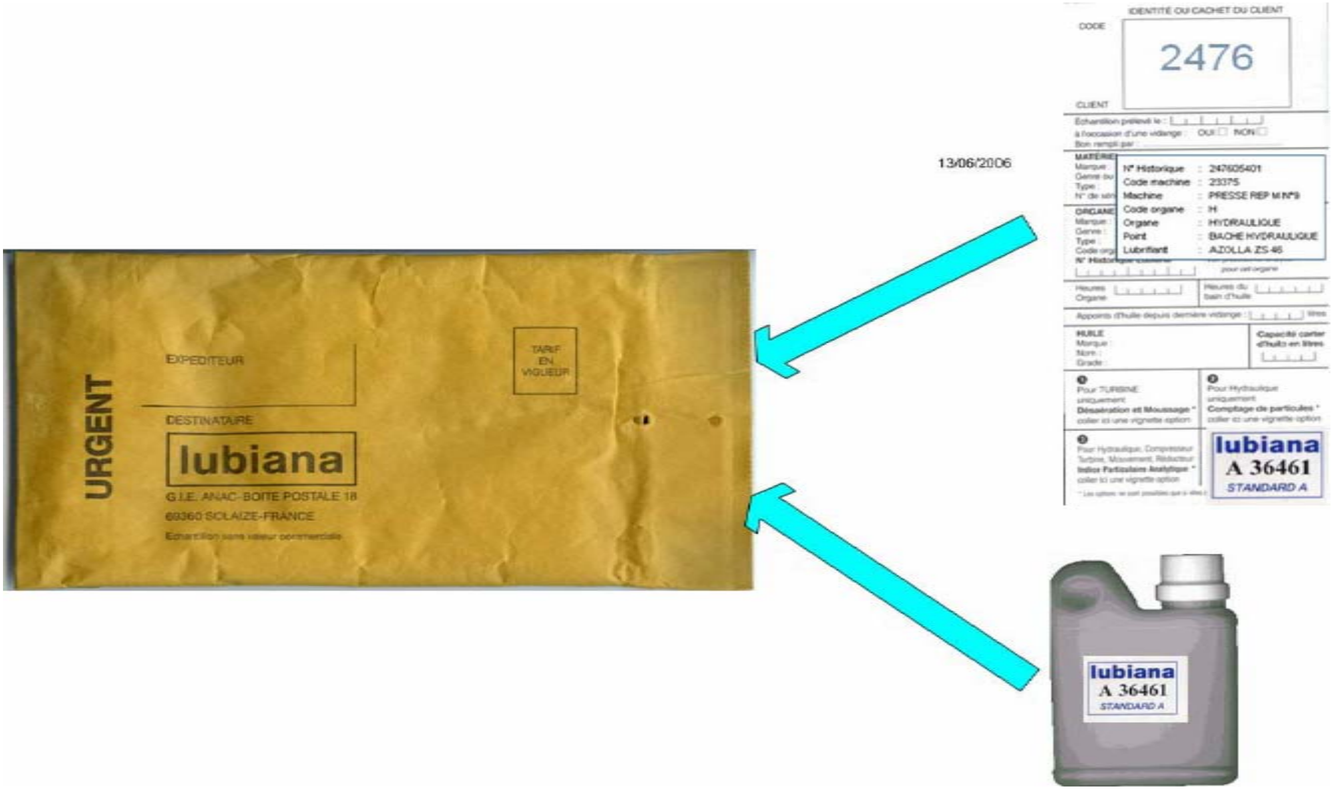


Figure 56: Despatching a "Lubiana" sample

12.3.3.3. Analysis frequency

- Hydraulic system: 1000 hrs
- Turbine: 500hrs /1000hrs
- Air compressor: 1000hrs
- Vacuum pump: 500hrs /1000hrs
- Cold compressor: 500hrs /1000hrs
- Gas compressor : 500hrs /1000hrs
- Reducer: 1000hrs
- Circulating oils: 1000hrs
- Heat carrier: Annually or at six-monthly intervals
- Transformer: Annually or at six-monthly intervals

12.3.4. The analysis

As in the ANAC system, LUBIANA performs a certain number of analyses depending on:

- The machine
- The desired degree of monitoring,
- The oil family (hydraulic, lubricant, grease)
- The previous history of the machine

12.3.5. The results

LUBIANA has software for monitoring machines and can transfer the results of these analyses straight to clients.

13. SAFETY AND STORAGE

13.1. THE RISKS

In general lubricants are not dangerous products.

However, precautions must be taken when they are being handled, stored or distributed.

Inhalation, contact with the skin, contact with the eyes, ingestion and suction must be avoided.

A Safety Data Sheet is available for each product. It provides information on the precautions to be taken with regard to hygiene and safety during handling, storage or distribution of the lubricant.

Full information is available from the:

- Labels on barrels or drums
- Safety Data Sheets
- Product Data Sheets
- The Technical Assistance Service or the supplier's HQSE department

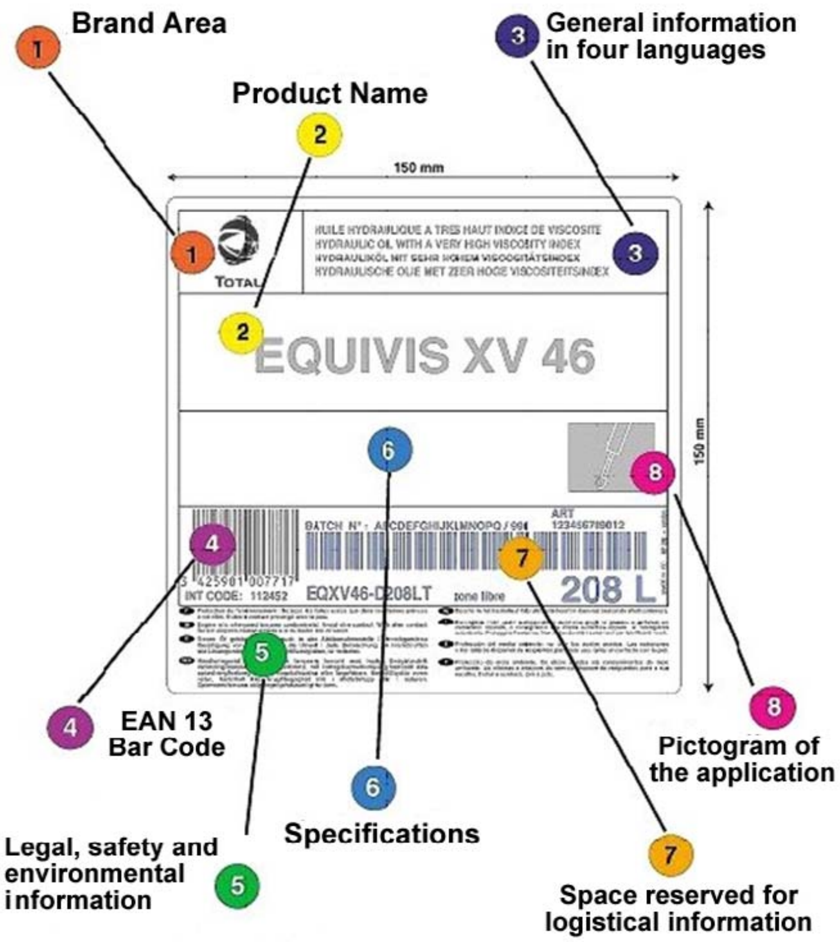


Figure 57: Example of a label (1)

QUARTZ DIESEL 5000 15W-40

FR 01 41 35 40 00 BE)2 288 99 33

Nocif pour les organismes aquatiques. peut entraîner des effets néfastes à long terme pour l'environnement aquatiqueEviter le rejet dans l'environnement. Consulter les instructions spéciales/la fiche de données de sécurité

DK I5 813 701

Undgå udledning til miljøet. Se sælig vejledning/sikkerhedsdatablad

GB01 977 636 200 - 01 923 694 000

Harmful to aquatic organisms, May cause long-term adverse effects in the aquatic environmentAvoid release to the environment. Refer to special instructions/Safety data sheets

SV 40 30 53 60

Undvik utsläpp i miljön. Se särskilda instruktioner eller varuinformationsblad

TOTAL

TOTAL Lubrifiants
16, Rue de la REPUBLIQUE
92970 PUTEAUX
LA DEFENSE FRANCE
Tél :+33.(0)1.41.35.40.00

NL 070 318 04 80BE 02 288 99 33

Schadelijk voor in het water levende organismen ; kan in het aquatisch milieu op lange termijn schadelijke effecten veroorzakenVoorkom lozing in het milieu. Vraag om speciale instructies/veiligheidskaart

FI 46 40 30 53 60

Vältettävä pääsy ympäristöön. Viittaus erityisohjeisiin/Käyttöturvatiedotteisiin

969

R 52/53 / S 61

DE 0211 90 570 - 30 20 2760

Nicht großflächig für Wohn-und Aufenthaltsräume zu verwenden, Exposition vermeiden - vor Gebrauch besondere Anweisungen einholenFreisetzung in die Umwelt vermeiden. Besonder Anweisungen einholen/Sicherheitsdatenblatt zu Rate ziehen

ES 91 722 08 40 - 93 476 67 00

Nocivo para los organismo acuaticos, puede provocar a largo plazo efectos negativos en el medio ambiente acuaticosEvitese su liberación al medio ambiente. Recábense instrucciones especificasde la ficha de datos de seguridad

IT 02 77 59 591

Nocivo per gli organismi acquatici, puo provocare a lungo termine effetti negativi per l'ambiente acquaticoNon disperdere nell'ambiente. Riferirsi alle istruzioni speciali/schede informative in materia di sicurezza

PT 21 723 0800 - 21 723 0832

Nocivo para os organismos aquaticos, podendo causar efeitos nefastos a longo prazo no ambiente aquaticoEvitar a libertaçao para o ambiente. Obter instruçoes especificas/fichas de segurança

NO45 813 701

21 723 0800 - 21 723 0832

Επιβλαβές για τους υδρόβιους οργανισμούς, μπορει να προκαλέσει μακροχρόνιες δυσμενεις επιπτώσεις στο υδάτινο περιβάλλονΑποφύγετε την ελευ¯έρωσή του στο περιβάλλον. Αναφερ¯ειτε σε ειδικές οδηγιες/δελτιο δεδομέωου ασφαλειας

445173 - T

Figure 58: Example of a label (2)

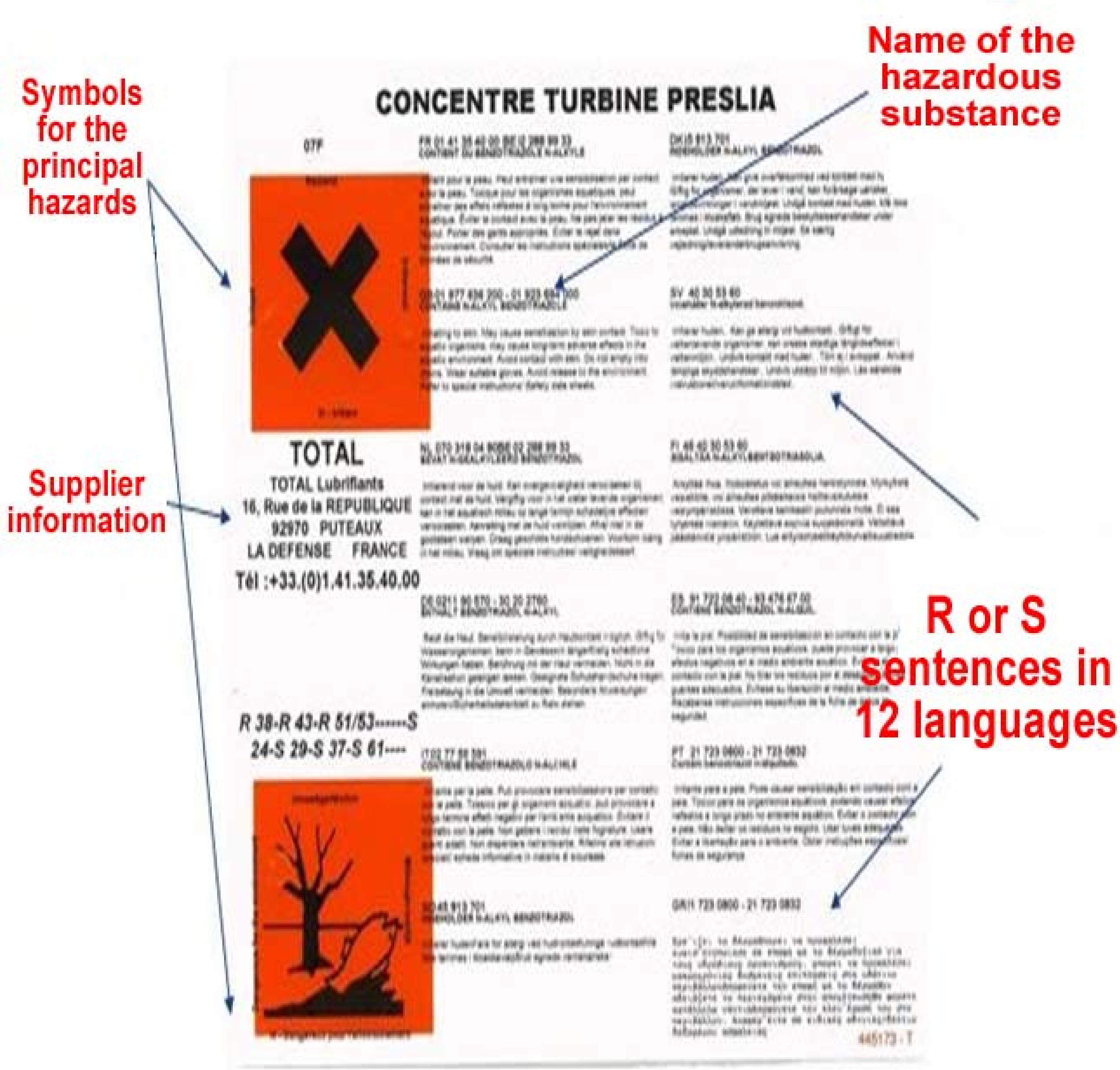


Figure 59: Example of a label (3)

13.1.1. Toxicity

Most lubricants have a low toxicity level, but handlers can be exposed to oils to varying degrees. The main areas of contact with oils and greases are the eyes and the hands.

Some processes can also generate oil mists that are so fine they can penetrate into the respiratory tract.

13.1.2. Precautions regarding use

In order to minimise and prevent accidents, the following precautions must be taken:

Contact with skin:

Follow the strict rules of personal and industrial hygiene.

To avoid physical contact:

- Use oil-proof gloves,
- Wear clothing that provides good protection. Do not wear clothing that has been fouled with oil,
- Solvents such as crude or petrol must not be used to remove oil from the skin,
- Use a barrier cream.

Inhalation

Avoid inhaling oil mists and fumes.

Premises must have good ventilation installed.

The acceptable limit for an oil mist is 5 mg/cm^3, though in fact 1 mg/cm^3 is the advisory limit of the I.N.R.S. (the French National Institute for Safety Research).

Contact with the eyes

Goggles are recommended wherever it is possible for oil to be splashed into the eyes.

In the event of accidental contact, rinse the eyes with water for at least 15 minutes and consult a doctor if irritation persists.

Ingestion

Lubricants have a low level of toxicity by mouth.

In the event of ingestion, do not cause vomiting but see a doctor immediately.

13.1.3. Pressurized oil leaks

If a pipe or hose suddenly breaks, the danger is less important than if there is a micro-leakage.

The rate of oil from a micro-leakage can exceed the speed of sound.

The oil vaporises and becomes as sharp as a needle.

It may penetrate leather gloves and become injected in the hand.

Risk is high and in case of an accident, emergency medical aid is required.

The injury becomes infected immediately.

Mineral oil causes body tissue necrosis.

Hand injuries may require heavy surgery such as skin transplantation but there may still be residual after effects.

Figure 60: Pressurized oil leak

13.1.4. Hot oil

Hot oil may reach temperatures of at least 70°C, and even more sometimes.

Direct contact with oil or contact with a hot pressure-reducing part may cause burns.

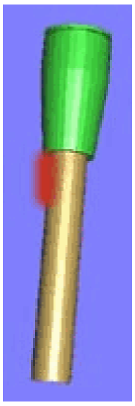


Figure 61: Hot oil

13.1.5. Fumes

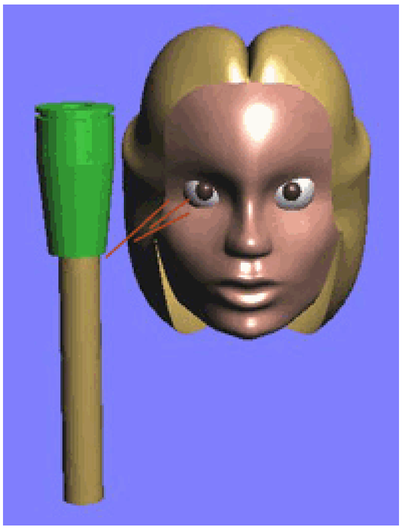
Oil vaporisation may cause lung injury.

Fumes are dangerous if inhaled.

Any fumes must be reported.

Figure 62: Fumes

13.1.6. Splashing



Any splashing on the face and particularly in the eyes should be reported to the medical service very quickly.

Contact with the eyes may cause irritation and even severe injuries.

Figure 63: Splashing in the eyes

Some people are sensitive to some oils which may cause allergies: itching, reddening of the hands or face.

13.1.7. Hose or component bursting

On a hydraulic installation, a hose that bursts may flap about dangerously.

Figure 64: Burst hose

The mechanical damage to a hydraulic component may be caused by the breakage of its casing, by the sectioning of the driveshaft or by the bursting of a part.

A metal part under mechanical stress of traction or torsion may, due to excess pressure, burst and be ejected of its housing like a bullet.

Do not use substitute hoses without knowing the exact use characteristics.

13.2. STORAGE

Storage or handling errors by the user can lead to:

- Leaks or contamination
- The introduction of dirt, dust or water
- The introduction of contaminants into lubricants or machines during distribution
- The mixing of different types of lubricants

Good storage methods are:

- Products must be under cover

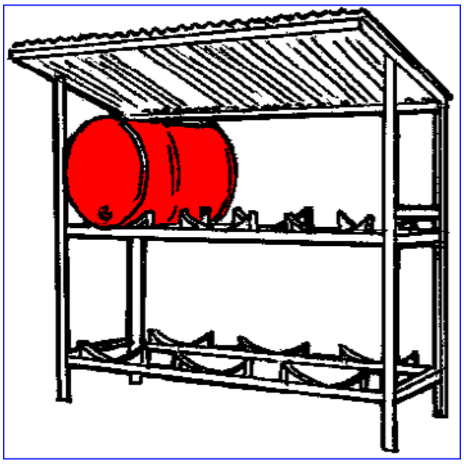
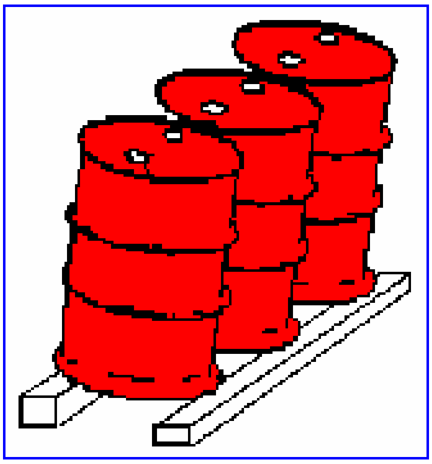


Figure 65: Storage under cover

- Stores must be well lit



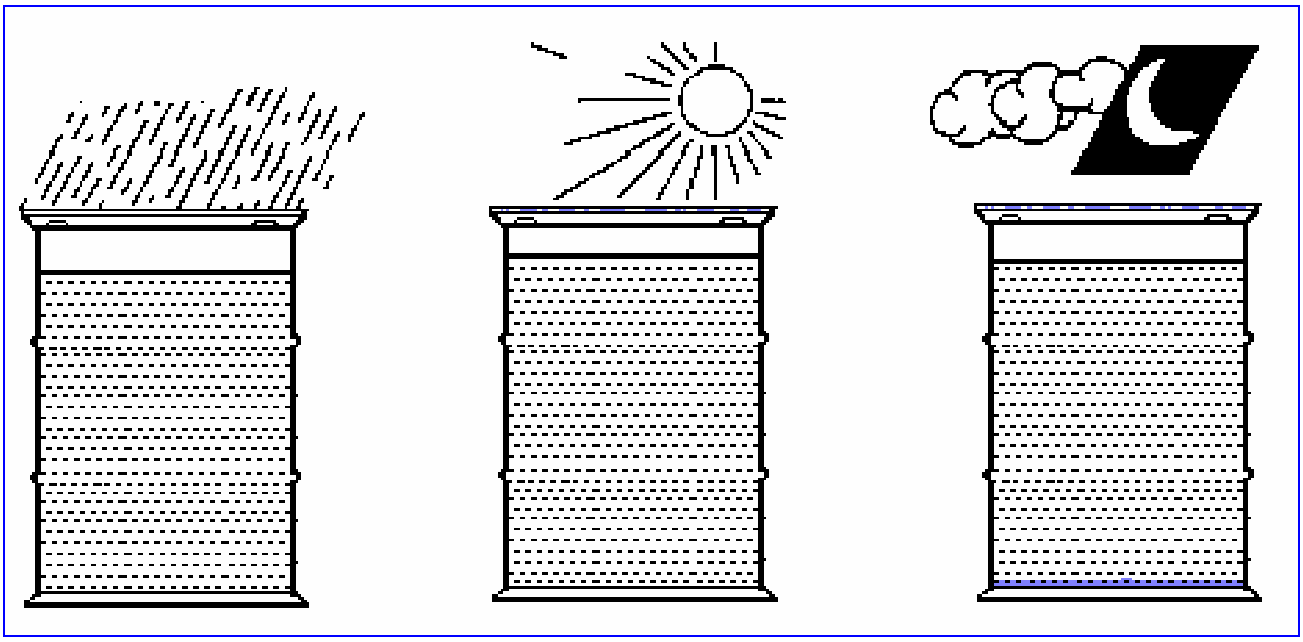
- Stores must be well ventilated
- Stores must be protected from dust, contaminants and water
- For lengthy storage, provide palettes for the containers

Figure 66: Palette

When barrels are stored horizontally, they must be positioned so that the oil covers the taps.

The taps must be on the horizontal so as to prevent air or condensation from entering the barrels.

Figure 67: Storage conditions



Clean oil, as delivered | *The oil and air expand due to the effects of temperature* | *Water is drawn into the barrels when the temperature falls*

Figure 68: Example of incorrect storage

Do not drop barrels from trucks: this can damage the seals

Figure 69: Example of incorrect handling

13.3. WASTE OILS

Waste oils are dangerous waste. They come from hydraulic “engine” lubricants or processing metals.

The so-called “industrial” lubricants, used in various lines of activity, have five main applications:

- hydraulic circuits
- turbines
- insulation
- metal hardening
- coolant fluids

There are two main categories of waste oils:

- **black oils** which include engine oils and some industrial oils (hardening, throttling and wire drawing oils as well as other machining oils); these oils are highly degraded and contaminated.
- **clear oils** that come from transformers, hydraulic circuits and turbines. They are slightly contaminated and generally contain water and particles.

These lubricating oils should not be mixed with soluble waste oils, aqueous machining fluids, water/hydrocarbon mixtures or vegetable cooking oils – these oils must follow different collecting and disposal circuits.

Burning waste oil or disposing of it in the natural environment and sewers is prohibited.

1 litre of oil will spread over 10,000 m² of water

The only solution therefore is to collect replaced lubricating oil or other types for disposal.

Particular attention is paid to this disposal on petroleum sites.

For these reasons, it is important to keep empty barrels or capacities in good condition so that they can be reused for transport on land.

CAUTION: IT IS IMPERATIVE TO IDENTIFY THAT A BARREL IS CONTAINING POLLUTED OILS

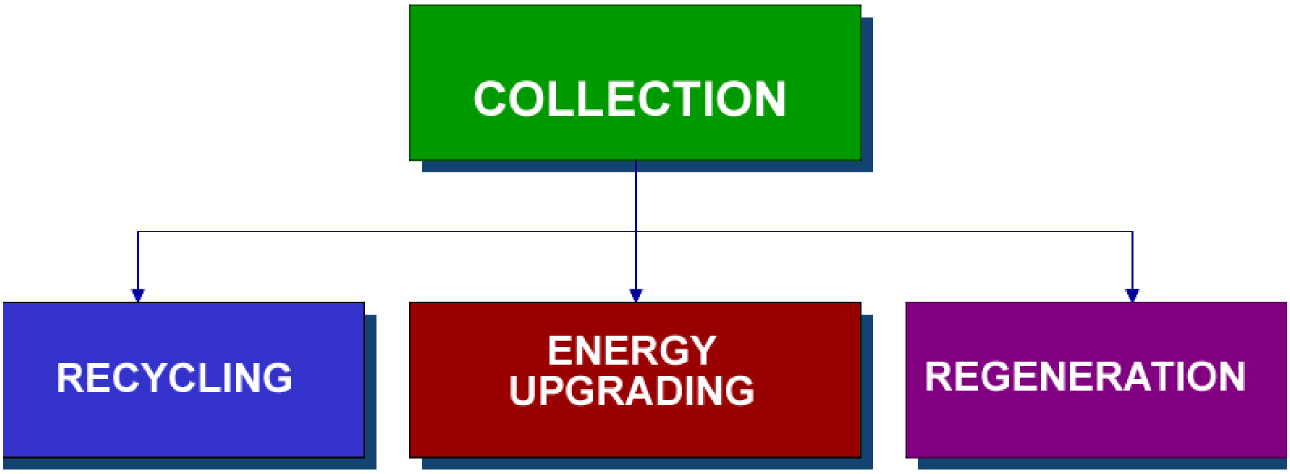


Figure 70: How used oils are dealt with

Clear waste oils are mainly recycled.

Black waste oils are either regenerated or incinerated in cement works or a specialised centre.

13.3.1. Waste oil storage

It is essential not to mix waste oils with other liquid waste (water, soluble oils, cooking oils, askarel and other products containing ***PCBs***…), and also not to mix the different categories of waste oils.

PCB: PCBs or "POLYCHLORINATED BIPHENYLS***"*** are chlorinated chemical derivatives of which there are 209 related substances.

Between 1930 and the beginning of the 80s, PCBs were produced for applications related to electric transformers and hydraulic industrial equipment.

PCBs' excellent electric insulation and heat stability properties, their excellent lubrication and fire resistance were very useful for those applications.

However, their production was prohibited in 1985 due to the danger they represent for man and the environment. Their disposal must be controlled by approved waste disposal companies and their use must be definitively stopped by 2010.

Figure 71: Sea pollution

It is recommended to have leak-proof installations enabling the storage of waste oils until they are collected or disposed of.

It is prohibited to abandon or discharge waste oils in the natural environment.

A single litre of waste oil may contaminate up to one million litres of water.

Figure 72: River polluted by hydrocarbons

13.3.2. Drainage oil recycling

There is a real ecological interest in drainage oil recycling. The waste oils may be recycled in two ways:

- burning: a ton of waste oil yields 0.85 tons of fuel oil
- regeneration: the oil containing impurities is refined. Three litres of waste oil yield two litres of base oil, without additives.

Waste oil is oil which due to its modified properties, no longer complies with its initial requirements (lubricity, etc…) and cannot be improved by maintenance.

These waste oils may come from oils used in engines and mechanisms, water-in-oil emulsions, bilge waters, tank residues, etc… The density, viscosity and contamination of these oils are different from one another.

Thanks to chemical and/or physical processes, waste oils may either be collected or refined, or used as fuel in the concrete or iron and steel industries.

The waste oil's recycling potential is determined by its composition and content in harmful substances.

Figure 73: Industrial centrifugal decanter

If the oil is intended for combustion, it must not contain impurities such as solid matter and water.

- Water content jeopardizes the heating capacity of the fuel oil.
- Solid matter fouls or clogs nozzles and reduces thermal efficiency.

Decanters and centrifuges may be used in order to separate solid matter and water contained in the waste oil.

The decanter treats bulky and fibrous solid matter. The centrifuge installed downstream, separates fine solid particles from water.

The centrifuge is used to separate oil from water and at the same time eliminate solid matter. The centrifugal force eliminates the solid matter and at the same time separates non soluble and different density liquids.

Figure 74: Industrial centrifugal separator

14. EXPERIENCE FEEDBACK

14.1. OIL

For each machine needing to be filled with oil, constructors give

- The type of oil to be used
- The quantity of oil for filling
- The oil change frequency

It is imperative to abide by this information. Overfilling serves no purpose, since it causes oil to be consumed needlessly and could damage the equipment by causing overpressure in the casing and badly affecting the oil seals.

Changing the type of oil risks altering the level of lubrication in the machine for the conditions of use and damaging the mechanical parts of the equipment.

Failing to adhere to the oil change or maintenance frequency of machines (filter replacement) is simply the same as shortening the operating life of the equipment.

14.2. GREASE

Grease is a very important part of lubrication, but do not imagine that a surplus of grease has no effects.

Regular greasing is part of preventive maintenance, but a surplus of grease on a bearing runs the risk of causing the bearing to overheat due to an accumulation of grease.

It is preferable to check the temperatures of plain and roll bearings before adding grease and then find out the date of last greasing.

As a preventative measure, it is necessary to replace the grease in rotating equipment a little before it dries out in its housing.

15. THE MANUFACTURE OF OILS AND GREASES

This is by way of an indication to give an overview of the facilities needed for the manufacture of oils and greases

15.1. ORIGINS OF OILS

VEGETABLE

Pine, colza, peanut, palm, castor

SYNTHETIC

Esters of polyols, Poly Alkylene Glycols (PAG), Poly Alpha Olefins (PAO), Polyisobutenes

PETROLEUM

Mineral oils, hydrotreated oils

ANIMAL

Fish oils, neats foot oil

Figure 75: Origins of oils

15.2. BY ATMOSPHERIC DISTILLATION

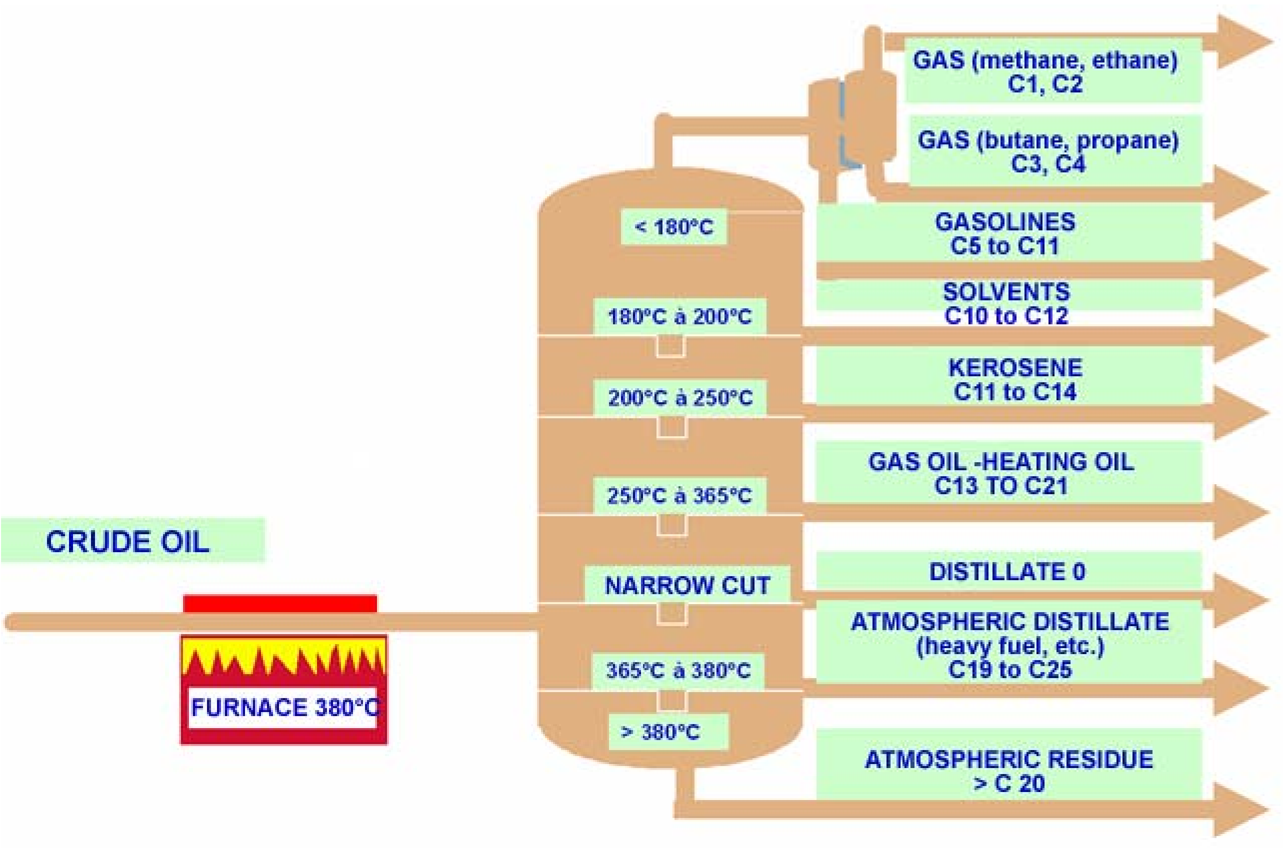


Figure 76: Atmospheric distillation

15.3. BY VACUUM DISTILLATION

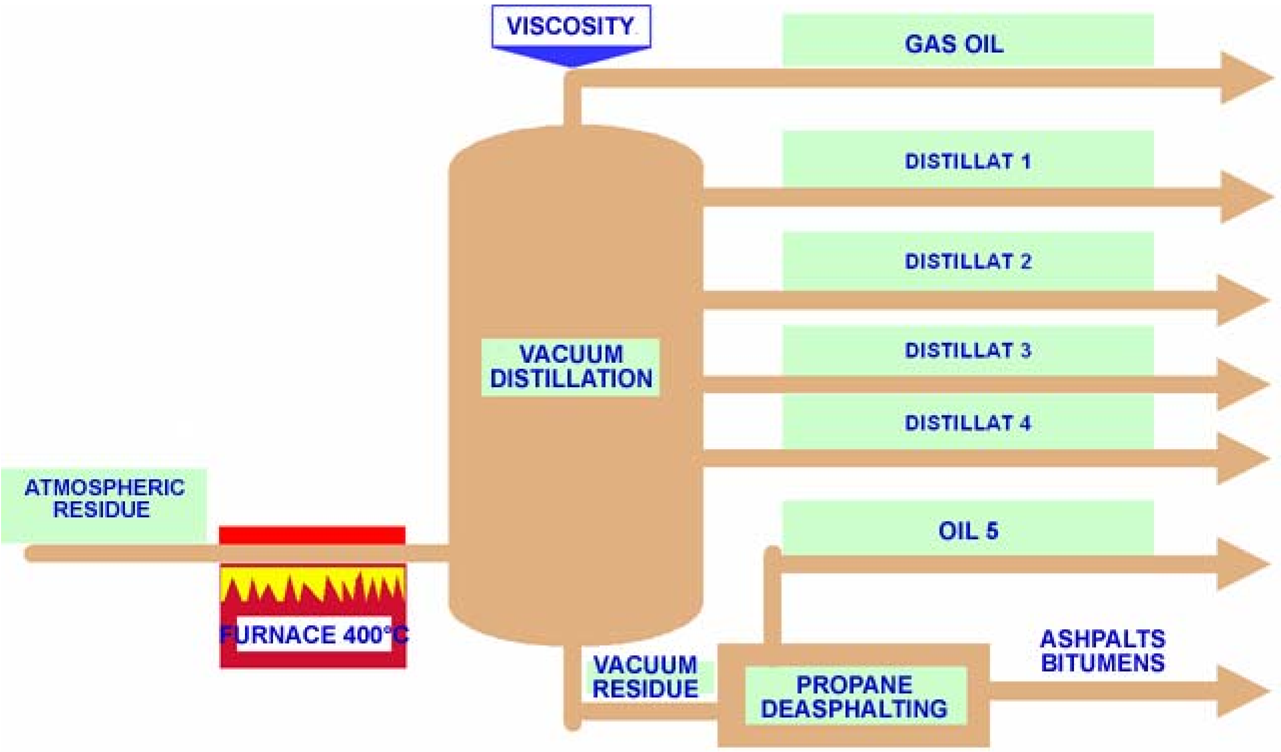


Figure 77: Vacuum distillation

Figure 78: Vacuum distillation tower

15.4. MANUFACTURING DIFFERENCES BETWEEN OILS AND GREASES

15.4.1. Oils

Oils are a mixture of base oil and additives.

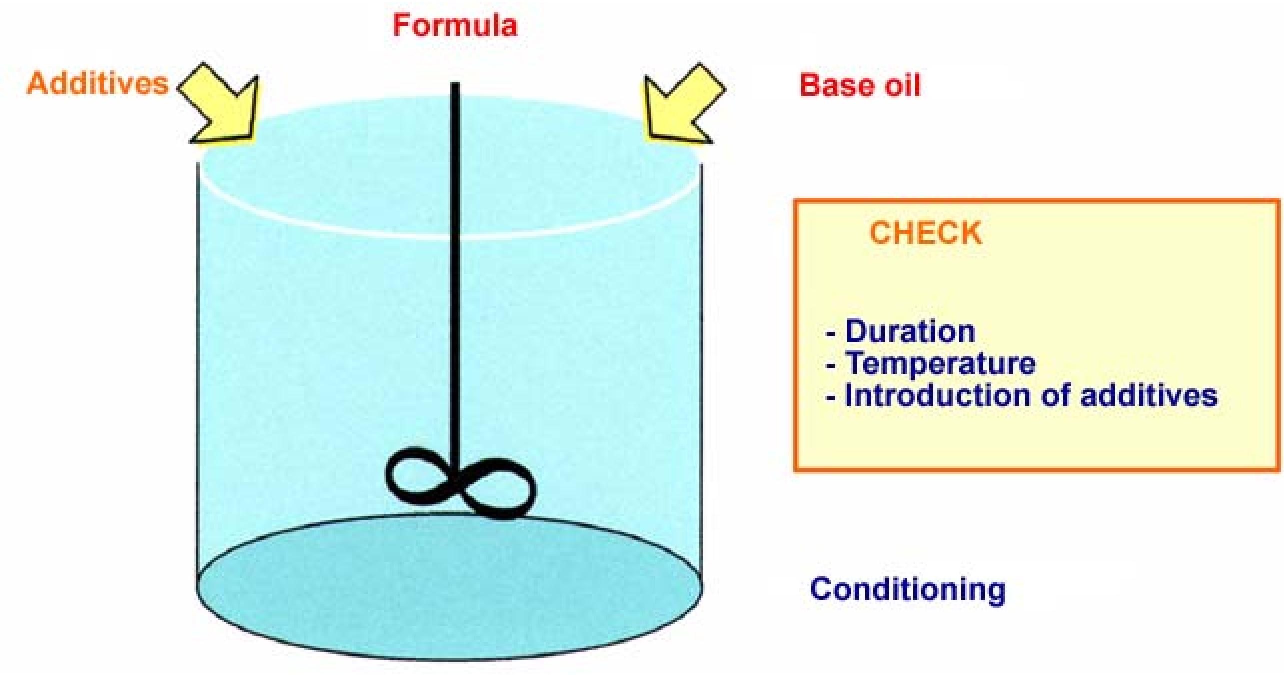


Figure 79: Manufacture of oils

15.4.2. Greases

Greases undergo a four-phase process

- Preparation of the soap
- Dilution and quenching effect
- Milling
- Homogenisation

The diagram presents an example of the manufacturing process for a lithium grease, with a traditional process, known as the tank process.

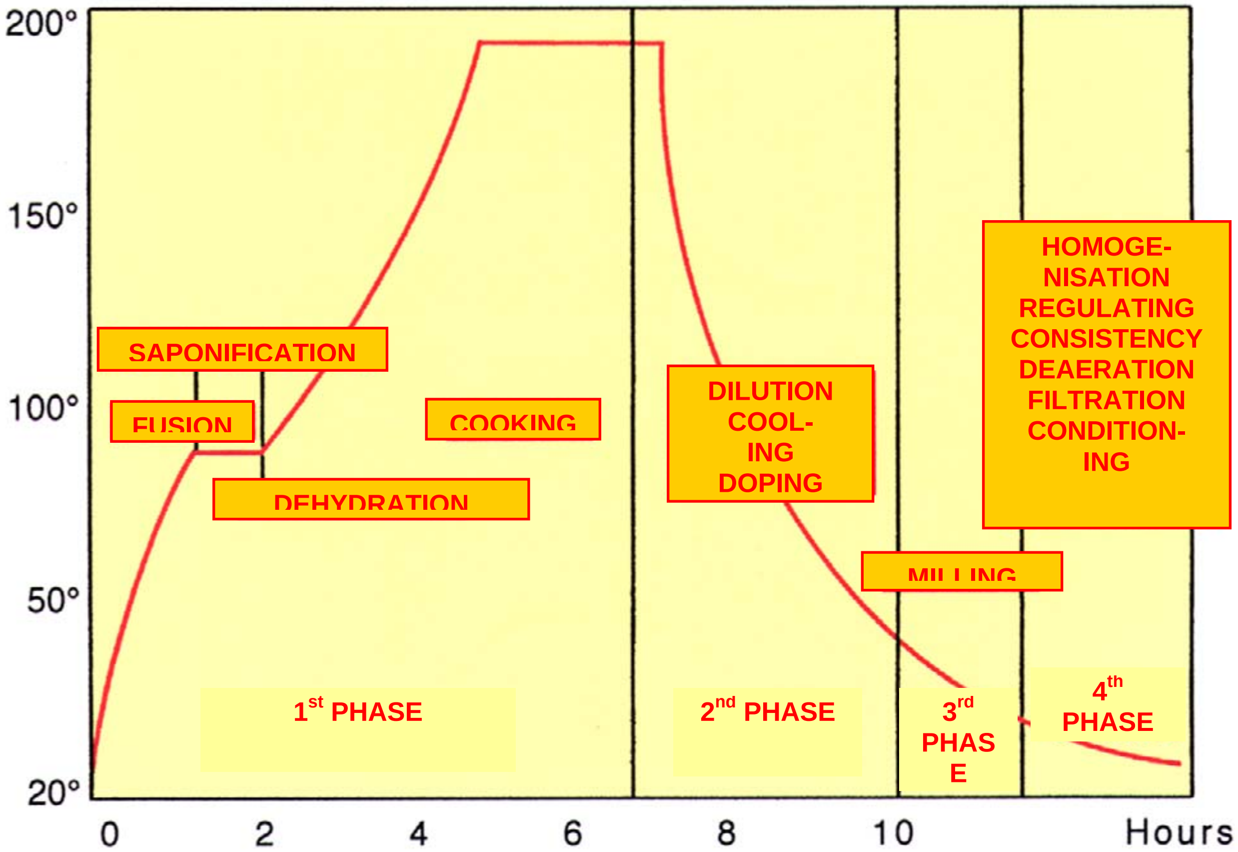


Figure 80: Diagram showing the manufacture of a grease

16. EXERCISES

1. What is the function of lubrication?

2. List at least three roles of lubrication

3. What is viscosity?

4. What is the flash point?

5. What is hydrodynamic lubrication?

6. Mention the elements needed for lubrication by circulation

7. What is a lubricant made of?

8. What is the function of oxidation inhibiting additives?

9. What is the function of anti-corrosion additives?

10. What is the function of dispersing agents?

11. What is a multigrade oil?

12. Define a SAE 20 W 50 oil

13. The grade when hot protects an engine

- ❑ On starting
- ❑ When operating at a high temperature

14. Mention three elements necessary for classifying a grease

15. Mention two systems for checking the analyses of oils

16. In general how are the results of an oil analysis provided?

17. What is provided by a safety data sheet?

18. Is it permitted to pour contaminated oils into the sea or a gutter?

- ❑ Yes
- ❑ No

19. What happens to black oils?

17. GLOSSARY

NLGI
National **L**ubricating **G**rease **I**nstitute

SAE
Society of **A**utomotive **E**ngineers

18. SUMMARY OF THE FIGURES

19. SUMMARY OF THE TABLES

20. CORRECTIONS FOR EXERCISES

1. What is the function of lubrication?

   Lubricants (oils and greases) are used to separate two moving surfaces in order to reduce the friction between them, enable them to move more easily and improve the performance and resistance to wear of machines.

2. List at least three roles of lubrication

   To reduce wear
   To absorb and remove calories, i.e. heat
   To reduce friction
   To provide a seal
   To remove impurities

3. What is viscosity?

   Viscosity is the flowing resistance of a lubricant. Viscosity decreases as temperature rises. The unit of measure is the Cst or mm^2/s

4. What is the flash point?

   The flash point is the lowest temperature at which the vapour from heated oil can ignite spontaneously on contact with a flame. The flash point of oil is between 200 °C and 250 °C

5. What is hydrodynamic lubrication?

   Lubrication is said to be hydrodynamic when the moving surfaces are completely separated from one another by the oil film.

6. Mention the elements needed for lubrication by circulation

   A suction strainer
   An oil pump
   A filter
   A bypass to maintain the filter
   Oil feed manifolds
   Flow regulators.

7. What is a lubricant made of?

   A lubricant consists of a base oil into which between 10 and 30% additives have been mixed.

8. What is the function of oxidation inhibiting additives?

   Oxidation inhibiting additives reinforce certain properties of base oils, such as the flow point, the viscosity index and oxidation inhibition. They also provide the base oils with properties that they do not possess naturally (detergent, dispersing agent, anti-corrosion, etc.)

9. What is the function of anti-corrosion additives?

   Corrosion inhibiting additives act by adsorption onto the metal, where they form multiple "impermeable" layers which protect the metal from the action of water, air or the corrosive compounds formed by the oil.

10. What is the function of dispersing agents?

    Dispersing agents keep the solid impurities that make oil dirty during use (soot, dust, particles of worn metal) in fine suspension, so as to stop them collecting at dead points in the system and ensure they are carried to the filter.

11. What is a multigrade oil?

    A multigrade oil is an oil with a viscosity in a range limited by an SAE grade when cold, determined by the letter W and a grade when hot. Example SAE 5W 30.

12. Define a SAE 20 W 50 oil

    20W: grade when cold
    50: grade when hot
    This oil can be used from -10 °C to +50 °C

13. The grade when hot protects an engine

    ☑ When operating at a high temperature

14. Mention three elements necessary for classifying a grease

    Drop point
    Adhesion
    Physical stability
    Mechanical stability
    Load-carrying ability
    Water-washout characteristics
    Pumpability

15. Mention two systems for checking the analyses of oils

ANAC
LUBIANA

16. In general how are the results of an oil analysis provided?

By colour codes

17. What is provided by a safety data sheet?

The manufacturer

18. Is it permitted to pour contaminated oils into the sea or a gutter?

☑ No

19. What happens to black oils?

Black waste oils are either regenerated or incinerated in cement works or a specialised centre.