ANAC INDUS

Monitoring of industrial oils by analysis.

OBJECTIVES

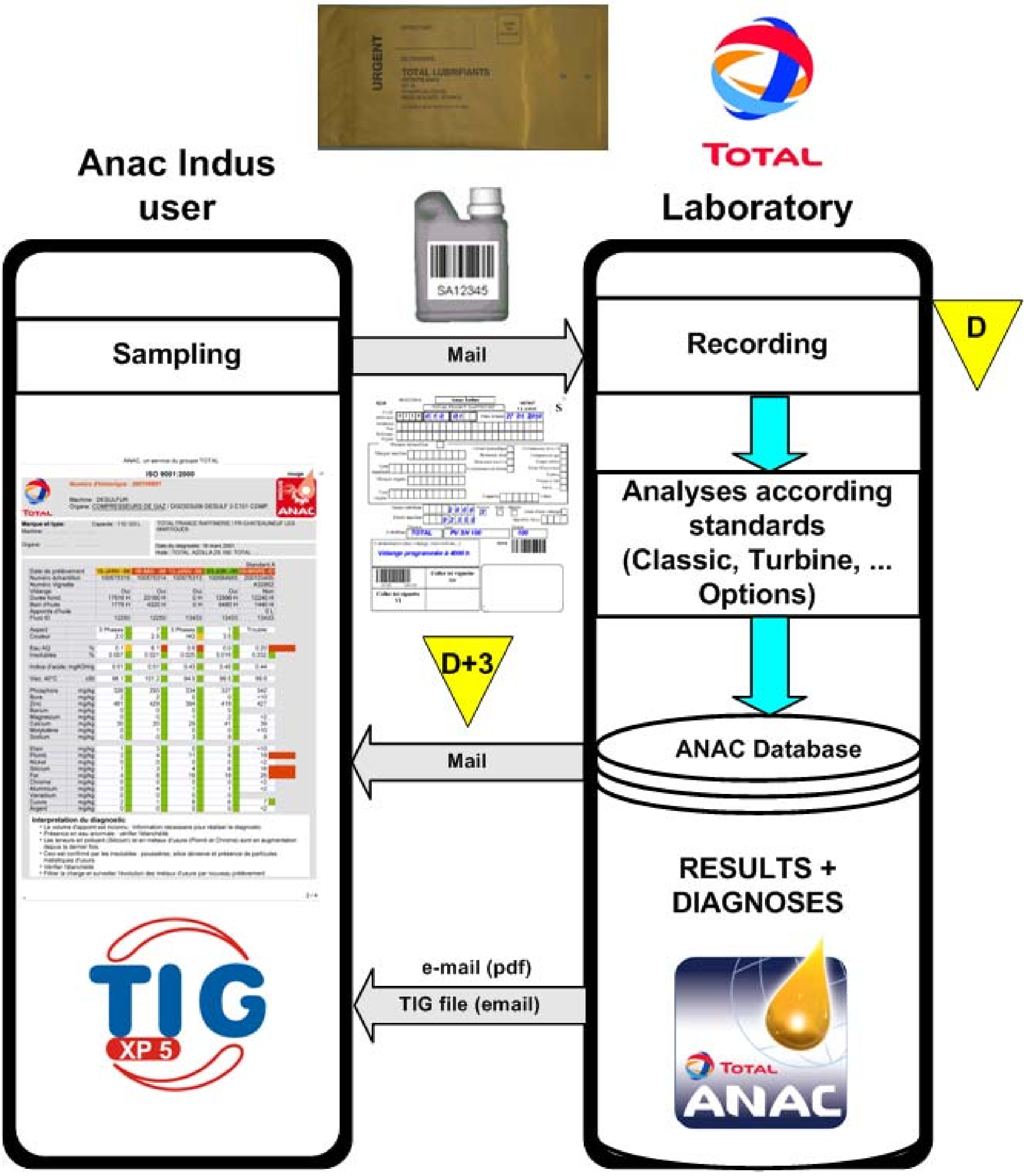
- Monitoring of evolutions in the state of the oil.
- Assessment of the operating conditions of the machine.
- Reduction in maintenance costs.
- Planning of maintenance operations and reduction in production stoppings.
- Optimisation of oil drain frequencies .
- Control that the lubricant used is the best adapted to the operating conditions.
- Determination of the origin of possible pollutions.
- Use along other condition based maintenance methods (vibration analyses, thermography, etc.)

ANALYSIS FRAMEWORKS

CLASSIC (label S)	● Hydraulics (HFC-type non-inflammable hydraulic fluids excluded) ● Bearing. ● Compressor (excepting refrigerating machine compressor) ● Reducer. ● Common analysis for industrial oil.
TURBINE (label T)	● Turbine oil.
FRIGO (label F)	● Refrigerating machine compressor oil.
TRANSFO (label TR)	● Transformer oil.
CALO (label C)	● Thermal oil.
TREMPE (label D)	● Quench oil.
VI (label V)	● Option : Viscosity at 100°c and Viscosity Index (VI).
OPTIC (label R)	● Option : Microscopic analysis: nature and relative size of the solid particles. Provision of the photo of the filter used in the measurement.
AIR (label M)	● Option : Foaming and air release.
PARTIC LNF (Label P)	● Option : Particle counting (LNF)

SYNOPTIC TABLE

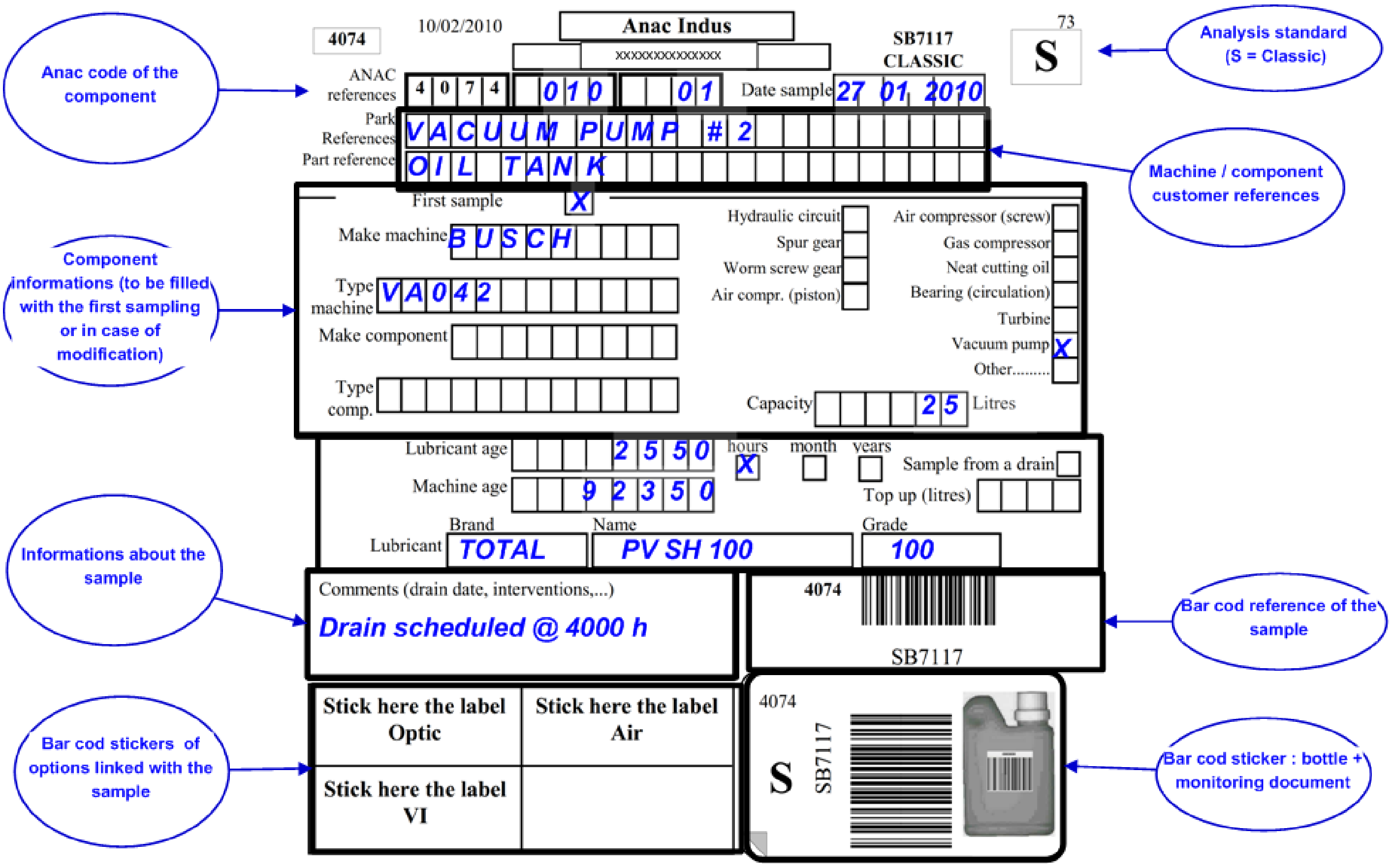
- Always collect the sample under identical conditions, if possible machine running.
- Collect the product directly in a clean ANAC INDUS bottle provided with the kit.
- Identify as quickly as possible the bottle using the ANAC INDUS stickers provided.
- Send the Bottle + form + identification stickers to the laboratory with the envelope provided.



OPERATING INSTRUCTIONS

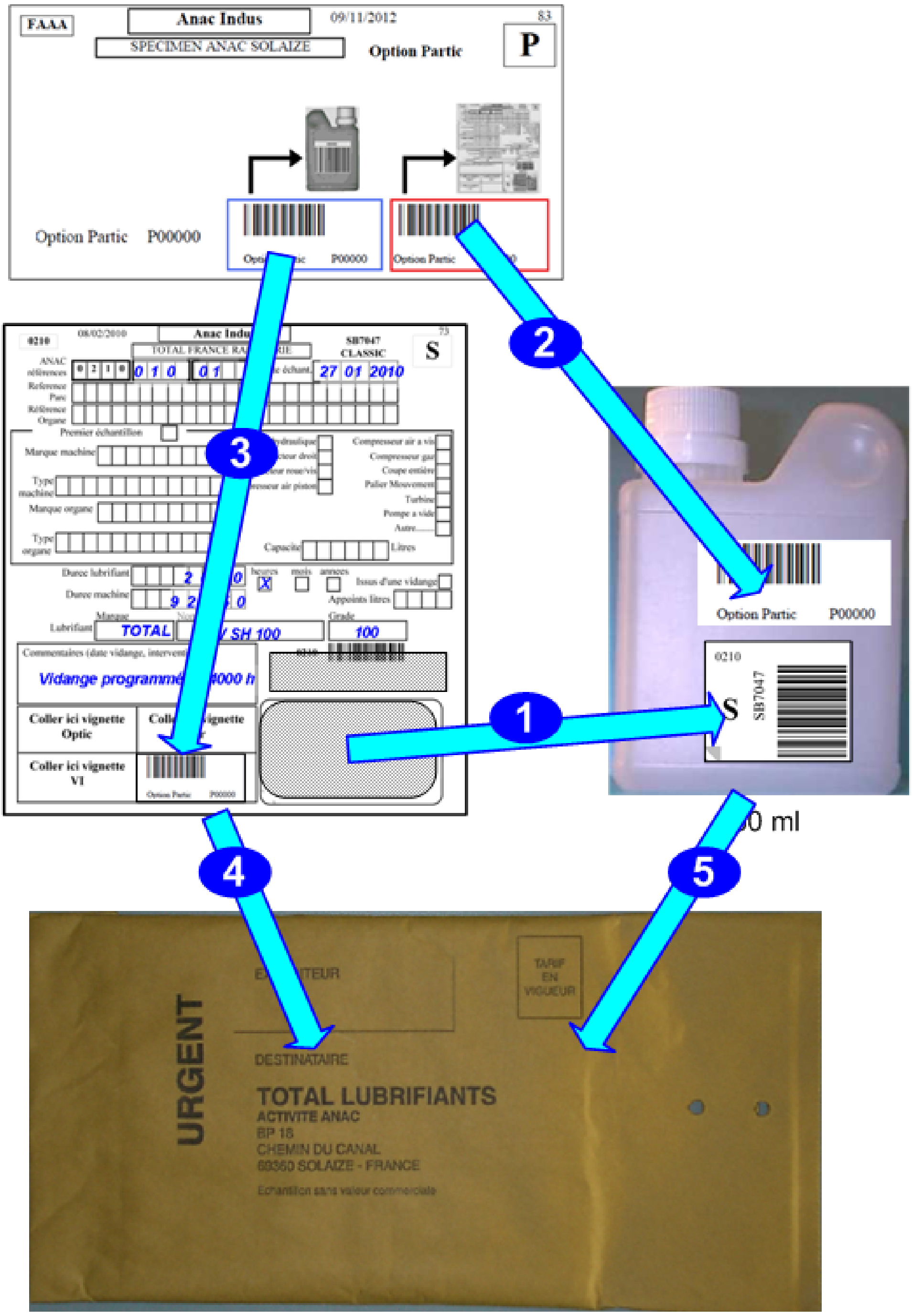
Identification of the equipment and the part where the oil was sampled :

- ✓ Anac reference code which identifies the comment in the Anac Indus database
- ✓ In-plant machine reference (# of machines, series #, installation)
- ✓ Brand, equipment type (hydraulic press, compressor)
- ✓ Identification of machine part (for example: worm reduction and helical gear drive, …)
- ✓ Possible use of identification labels generated by Total TIG XP 5 software.
- ✓ Brand, name of lubricant analysed.
- ✓ Hours (or kilometres) of use : machine and lubricant..
- ✓ Remarks / comments.
- ✓ Stickers of possible options.



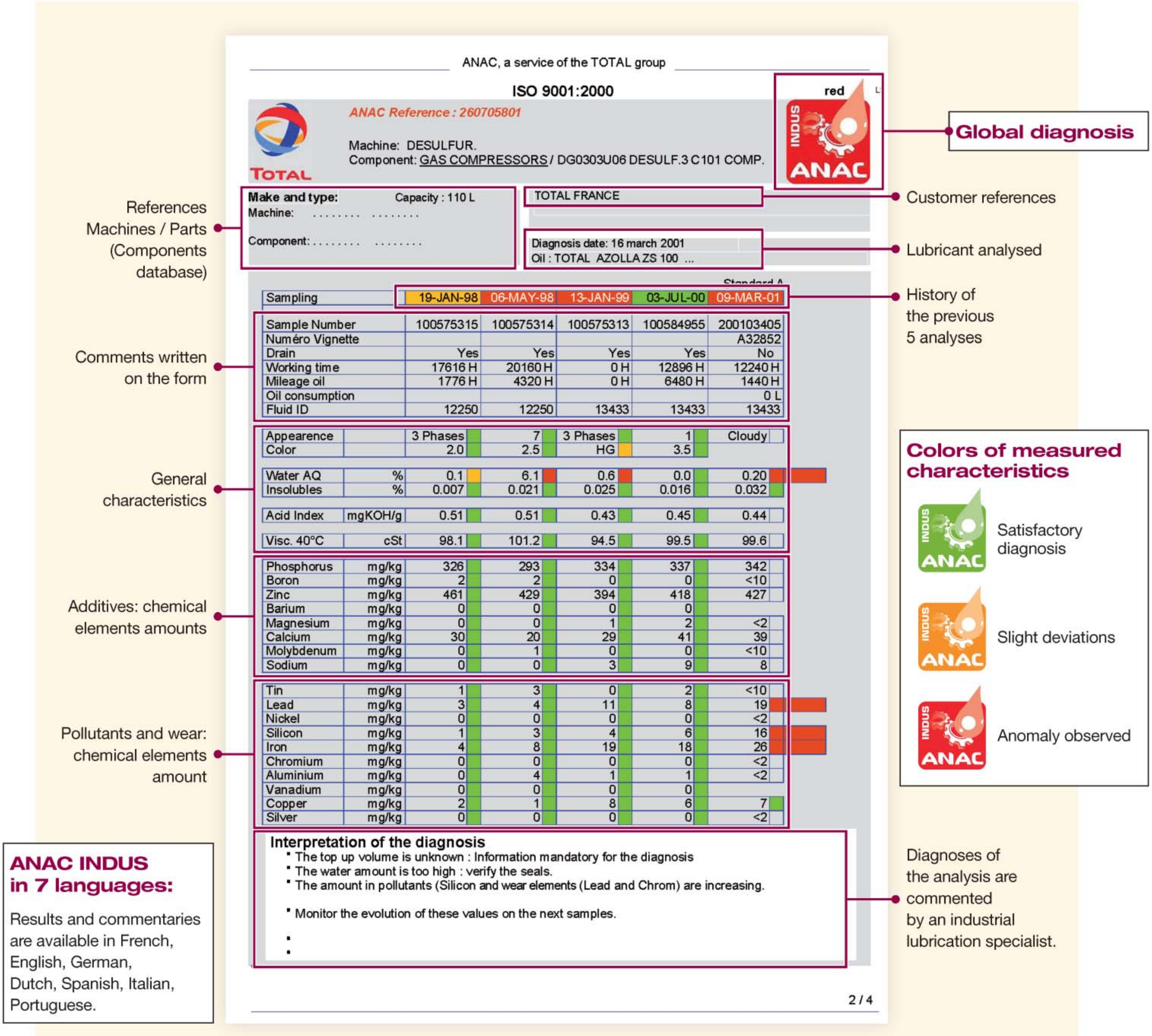
Labels management and sending of the sample

1) Analyse label to be stuck on the bottle (bottle of the option)
2) Label(s) of potential option to be stuck on the bottle of the option.
3) Label(s) of potential option to be stuck on the form of the standard.
4) Informations of the sample written down on the form of the standard.
5) Form of the standard in the envelope.
6) Bottle in the envelope.



PRESENTATION OF THE RESULTS

- 2 diagnosis levels :
  Characteristic-by-characteristic basis and overall.
- Diagnosis expressed by a colour based on traffic lights:
  Green (OK),
  Orange (to be monitored) or
  Red (Serious anomaly)
- Comments on the analysis (made by lubrication specialist) in accordance with the history, type of machine and type of industry.
- Results of the 4 previous analyses on the same form.
- Possible dispatch of results by fax or e-mail (pdf file)
- Full management (results and equipment) through the Anac web site.
- Loading of the analyses, their diagnoses and commentaries into the Total TIG XP 5 maintenance software.
- Results and commentaries in 7 languages : French, English, German, Dutch, Spanish, Italian, Portuguese.



Sampling		19-JAN-98	06-MAY-98	13-JAN-99	03-JUL-00	09-MAR-01
Sample Number		100575315	100575314	100575313	100584955	200103405
Numéro Vignette						A32852
Drain		Yes	Yes	Yes	Yes	No
Working time		17616 H	20160 H	0 H	12896 H	12240 H
Mileage oil		1776 H	4320 H	0 H	6480 H	1440 H
Oil consumption						0 L
Fluid ID		12250	12250	13433	13433	13433
Appearence		3 Phases	7	3 Phases	1	Cloudy
Color		2.0	2.5	HG	3.5	
Water AQ	%	0.1	6.1	0.6	0.0	0.20
Insolubles	%	0.007	0.021	0.025	0.016	0.032
Acid Index	mgKOH/g	0.51	0.51	0.43	0.45	0.44
Visc. 40°C	cSt	98.1	101.2	94.5	99.5	99.6
Phosphorus	mg/kg	326	293	334	337	342
Boron	mg/kg	2	2	0	0	<10
Zinc	mg/kg	461	429	394	418	427
Barium	mg/kg	0	0	0	0	
Magnesium	mg/kg	0	0	1	2	<2
Calcium	mg/kg	30	20	29	41	39
Molybdenum	mg/kg	0	1	0	0	<10
Sodium	mg/kg	0	0	3	9	8
Tin	mg/kg	1	3	0	2	<10
Lead	mg/kg	3	4	11	8	19
Nickel	mg/kg	0	0	0	0	<2
Silicon	mg/kg	1	3	4	6	16
Iron	mg/kg	4	8	19	18	26
Chromium	mg/kg	0	0	0	0	<2
Aluminium	mg/kg	0	4	1	1	<2
Vanadium	mg/kg	0	0	0	0	
Copper	mg/kg	2	1	8	6	7
Silver	mg/kg	0	0	0	0	<2

Interpretation of the diagnosis

- The top up volume is unknown : Information mandatory for the diagnosis
- The water amount is too high : verify the seals.
- The amount in pollutants (Silicon and wear elements (Lead and Chrom) are increasing.
- Monitor the evolution of these values on the next samples.

DESCRIPTION OF THE ANALYSES

Viscosity

This is the kinematic viscosity carried out at a standardised temperature (40°C for industrial oils).
Viscosity is a fundamental value which can be affected by:
* Pollution (increase or decrease)
* Oxidation (increase)
* Thermal cracking (decrease)

Visual appearance

The appearance of an oil (Transparency, deposits) can provide information about a possible deterioration, for example pollution by another fluid or by solids.

Insolubles content

This measurement indicates the quantity of solid impurities (in weight %) retained by filtration using a 5-micron millipore filter. These impurities may come from external pollution by solids or from wear metals, and increase the wear rate of the equipment. These '**insoluble**' particles are in suspension in the oil and that this measurement can be entirely different from the elements content determined by plasma emission spectrometry.

Elements content

The method used to determine the elements content is known as plasma emission spectrometry.
This analysis enables rapid determining, in a single measurement, of the mass concentrations of the various chemical elements present in the oil.
The result is expressed in ppm or **P**arts **P**er **M**illion, or in mg/kg.
1mg/kg = 1 ppm = 0.0001% or 10000mg/kg = 10000 ppm = 1% .
Plasma spectrometry doses only the chemical elements with a particles of a size below 5 microns.
These chemical elements may come either from the additives present in the oil, from pollutions or wear elements.

Water content

Various methods exist for determining water content and these can be differentiated by the expression unit of the result: either in weight %, or in ppm.
The maximum admissible water content in an oil depends on its nature (hydraulic, thermal ...), the criticality of the lubricated circuit and the operating conditions.
The presence of water can have varying consequences both as regards the properties of the oil and the equipment lubricated:
* Chemical reaction (hydrolysis) involving the additives of the formula.
* Oxidation catalyst.
* Formation of an emulsion.
* Corrosion of the machine parts....

In all configurations pollution by water represents an anomaly which must be remedied as swiftly as possible (decantation, filtration, centrifugation, purging, partial or total draining ...)

Acid number

This measurement gives the number of mg of potassium (KOH) required to neutralise the acid compounds present in the oil.
Regular monitoring can provide an indication of the oxidation of an oil : the acid number increases with oxidation.
However one needs to be aware of the fact that some additives have a naturally high acid number even in the absence of degradation. For example, the Zinc Dithiophosphate antiwear additives (hydraulic oils) or the Extreme-Pressure additives of the Phosphorus-Sulphur type (oils for reducers). A new oil with contain these additives will therefore have a high acid number from the beginning of its service life.

Flash point

This measurement indicates the temperature (in °C) to which the oil sample must be raised for its vapours to momentarily catch fire (emission of a 'Flash') on contact with an ignition source.
This value characterises the volatility of the oil and gives an indication of the maximum working temperature of the oil in an open cup .
A drop in the flash point may reveal a degradation caused by cracking or pollution by a solvent.

Conradson Carbon

This measurement also known as Conradson carbon residue represents the carbonaceous residue of an oil after combustion. This result provides indications regarding the tendency towards coking of the oils used at high temperatures (heat transfer fluids).

Particle counting

This analysis is designed to monitor the cleanness of the oils used in high-criticality hydraulic circuits.
The result is expressed in the form of a pollution class representing the distribution of the particles according to size.
For this measurement to be meaningful it is mandatory that :

- the sampling was done under standardised conditions (NF E 48-650 standard).
- only a specific bottle (NFE48-654 and NF E 48-653 standard) was used as supplied by the laboratory along with the « PARTIC » product.

It should be noted that this measurement which is not cheap, is of no interest for oils with visible pollution (cloudy, water ...).

Dielectric rigidity

Dielectric rigidity or breakdown voltage is the property of an insulating oil which use is to prevent the formation of an arc under the effect of an intense electric field.
This important characteristic relies mainly on the cleanness of the oil. It is decreased by the presence of water and pollutants and enables the user plan the drying and filtration treatment.

Drasticity:

The drasticity of a quench oil represents its capacity to cool a metallic mass previously raised to a high temperature. Drasticity is representative of the quenching power of an oil.
Monitoring the drasticity of an oil during service enables one to ensure that its action on the mechanical properties of the parts has remained unchanged. Drasticity can be defined on the basis of two characteristic temperatures:

- ✓ The transition temperature between the heating and boiling phases (theta 1). Its increase may result from oxidation. In this case, an increase in the acid number can be observed. Its decrease may be due to consumption of the quench acceleration additive.
- ✓ The transition temperature between the boiling and convection phases (theta 2). Its decrease may be due to the presence of water.

Air release:

The air release time characterises the capacity of the oil to release the previously dispersed air. When air is introduced into an oil by mechanical agitation or by blowing, etc…, foam may form on the surface.
Air release of an oil can present certain disadvantages:

- ✓ Reduction in the lift of the oil film.
- ✓ Increase in the oxidation rate resulting from an increase in the oil-air contact surface.
- ✓ Increase in the compressibility of the oil, hence a rise in the temperature and an aggravation of oxidation, disturbance in the operation of a hydraulic command.
- ✓ Risk of cavitation.

The air release anomalies in the oil may originate from:

- ✓ pollution (silicon or other pollutants).
- ✓ ageing of the oil.
- ✓ mixing with another oil.

Foaming:

Foaming is defined as the volume of foam and its persistence.
Foaming may result in:

- ✓ Oil losses resulting from overflow of a casing or a tank.
- ✓ It is conducive to oxidation as a result of an increase in the air-oil contact surface.
- ✓ Very strong foaming may bring about a cut-off of the oil pump.

The reasons for excessive foaming may originate from:

- ✓ The return of the tank above the oil level.
- ✓ A very low volume of oil charge given the oil flow and pressure.
- ✓ The need to add antifoaming agents.
- ✓ Pollution.
- ✓ An intake of air into the oil circuit.

POSSIBLE ORIGINS OF CHEMICAL ELEMENTS

SYMBOL	CHEMICAL ELEMENT	WEAR ELEMENT	POLLUTANT	LUBRICATING ADDITIVE	COMMENTS
Al	**Aluminium**	Wear and corrosion of light alloy parts.	Atmospheric dust. Machining	Soaps from certain greases	Element present in certain clays in the form of alumina
Ag	**Silver**	Coating wear in certain hydraulic pumps.			Very seldom met with (!!).
B	**Boron**		Corrosion inhibitors of aqueous fluids.	EP additives (Borates).	Present also in engine oils (dispersant additives).
Ca	**Calcium**		Atmospheric dust. Limestone.	Detergent additives. Grease soaps.	Pollutant encountered very frequenttly in cement works.
Cr	**Chromium**	Wear on chromium-plated parts.			Often alloyed with Nickel or Vanadium.
Cu	**Copper**	Wear and corrosion of cupreous metals (Bronze , Brass,...)	Water conduits (cooling agents ...)	Anti-seizing or conductive grease feeds.	
Sn	**Tin**	Wear and corrosion of tinned parts	Tin weld Galvanised drums		
Fe	**Iron**	Wear and corrosion of cast iron and sreels			
Mg	**Magnesium**	Wear and corrosion of light magnesium alloys magnesium.	Machining	Detergent additives	Present also in engine oils (detergent additives).
Mo	**Molybdenum**	Wear and corrosion of steels alloyed to Cr-Mo		Solid additive: $MoS2$. Antiwear additives	
Ni	**Nickel**	Wear and corrosion of alloyed steels.	Impurities of heavy gas oils.		Associated with Vanadium in the case of heavy gas oils.
P	**Phosphorus**	Wear and corrosion of bronzes and cast iron.		Antiwear (DTPZn) or Extreme- Pressure additives	
Pb	**Lead**	Wear and corrosion of antifriction materials.	Premium grade gasoline. Paints.	Soaps, Antiwear or Extreme Pressure additives, Solid feed	
Si	**Silicon**		Atmospheric dust. Silicone-coated fluids.	Grease thickener Anti-foaming additives	Highly abrasive when present in solid form: Silicates...
Na	**Sodium**		Salt (NaCl). Sea water. Coolants	Grease soaps. Emulsifiers and corrosion inhibitors.	Present in coolants and heavy gas oils.
Zn	**Zinc**	Wear and corrosion of galvanised parts.	Paints.	Antiwear additives (DTPZn) . Metallic feed.	