CONTENTS

LUBRICATION AND LUBE OIL / FUEL OIL SAMPLING

The following Technical Procedure applies to all vessels owned or managed by the company.

1. LUBRICATING OIL AND FUEL OIL SAMPLES

The Chief Engineer Officer is to maintain a record of all details pertinent to the submission of samples e.g. date delivered to Oil Company Representative, port, origin of sample, type and grade of oil, hours in use, to facilitate later referencing.

Samples have in the past been mislaid and even mixed-up as a result of inadequate or incorrect labelling and identification. In the event of analysis reports not being received timeously by this Department, the Chief Engineer Officer will be required to produce evidence of correct despatch of the sample and, if necessary, be asked to resolve the matter himself.

2. ANALYSIS OF OIL SAMPLES

The Chief Engineer Officer shall ensure that the following procedure regarding analyses of oils is followed:

2.1. Sampling is to be done following the Supplier sampling procedure. Sampling points are to be sufficiently flushed to remove any debris (paint, rust etc. from threads) which will contaminate the sample giving false results. Sampling points to be permanently marked with either a tag or stencil.

2.2. **Supplier samples shall be taken at least twice a year**. 48 Free samples are provided by the Supplier per vessel per year. Sample bottles shall be requisitioned as required.

2.3. Before doing annual oil changes for certain equipment (winch gear boxes and hydraulic tanks of sufficient volume), previous analysis results should be checked or a sample is to be submitted for testing by an outside party. If the oil is fit for continued service as per LO Analysis report it is unnecessary to change the oil.

2.4. In the months where a sample is landed for analysis there is no requirement to do on-board testing.

2.5. All test results on board and from supplier to be placed in File 6.6.11 A[1]

[1] W 32 / 2020

2.6. Oil samples are to be drawn as follows

DESCRIPTION of MACHINERY	ON-BOARD TEST FREQUENCY	ON-BOARD EQUIPMENT TEST REQMNT					SHORE ANALYSIS (RECOMMENDED FREQUENCY)
		WATER TEST	Cl_2 TEST	BN TEST	VISCO TEST	SPOT TEST	
MAIN ENGINE	EVERY 500 HRS OR MONTHLY	Yes	No	Yes	Yes	Yes	Every 4th Month (3 x per Annum)- **Gulf Oil**
AUXILLIARY ENGINES	EVERY 500 HRS OR MONTHLY	Yes	No	Yes	Yes	Yes	Every 4th Month (3 x per Annum)- **Gulf Oil**
STERN TUBE	MONTHLY	Yes	Yes	No	Yes	Yes	Every 4th Month (3 x per Annum)- **Gulf Oil**
STEERING GEAR PORT & STBD TANK	Every 4th Month, preferably 2 Months either side of the Supplier sample (3 x per Annum)	No	No	No	Yes	Yes	Every 4th Month (3 x per Annum)- **Gulf Oil**
FORWARD WINCH HYDRAULIC SYSTEM (SW Cooled Hydraulic)	Every 4th Month, preferably 2 Months either side of the Supplier sample (3 x per Annum)	Yes	Yes	No	Yes	Yes	Every 4th Month (3 x per Annum)- **Gulf Oil**[2]
AFT WINCH HYDRAULIC SYSTEM (SW Cooled Hydraulic)	Every 4th Month, preferably 2 Months either side of the Supplier sample (3 x per Annum)	Yes	Yes	No	Yes	Yes	Every 4th Month (3 x per Annum)- **Gulf Oil**[3]
EMERGENCY GENERATOR	Every 4th Month (3 x per Annum)	Yes	No	No	Yes	Yes	Annually - Gulf Oil[4]
WINCH/WINDLASS GEAR BOX OIL	N/A						Annually - Gulf Oil[5]
CARGO CRANE HYDRAULIC OIL	N/A						Annually - Gulf Oil[6]
HATCH COVER HYDRAULIC OIL[7]	N/A						Annually - Gulf Oil[8]

2.7. Information to clearly state in the appropriate place on the bottle label: ship's name, identification of machine from which the sample was drawn, total running hours of machinery, total running hours of the oil being sampled, details of the oil type and date. It is necessary to monitor the oil only before the purifier.

[2] W 31 / 2024
[3] W 31 / 2024
[4] W 31 / 2024
[5] W 31 / 2024
[6] W 31 / 2024
[7] W 49 / 2022
[8] W 31 / 2024

2.8. The Chief Engineer Officer shall ensure that the sample bottles are posted or couriered direct to the relevant test laboratories and subsequently follow this up with the agents.

2.9. Reports of any serious irregularities evidenced by the analysis of the oil will be relayed by email to the vessel.

3. CYLINDER SCRAPE DOWN ANALYSIS[9]

Cylinder Scrape down Analysis, here after abbreviated to CSA is to be carried out every 1000 - 1500 hours, and must be done 100-150 hours after cleaning Under Piston space[10]. This is an integral part of the preventative measures to pre-empt damage to liners and piston rings[11]. Under piston cleaning schedule is monthly for all 2 stroke engines, but CSA is to be done only after every 1000-1500hrs service and 100hrs after cleaning UP space. All ships have copies of the CSA sampling procedures from Lukoil[12].

3.1. Features / Advantages and Benefits

The residue oil taken from the piston-underside and the system oil give an indication of:

- Wear performance, e.g. by measuring the content of Iron (Fe), Copper (Cu) and Chromium (Cr)
- Remaining base number (BN), which is an indicator of protection against corrosive wear.
- The performance of the stuffing box
- The degree of system oil dilution in the cylinder scrape down oil in order to make the
- corresponding corrections in the test results for viscosity, BN, PQ index and Fe.
- Contaminants such as water or system oil which effects combustion quality

3.2. Description

The samples shall be taken while operating the engine at representative and stable load i.e. in a calm sea condition. To get a good comparative result, the conditions when taking the samples need to be almost similar to the previous sampling[13], and this is normally done at 80-85%, same as doing the ME performance test. Follow the guidelines on the CSA sampling procedures from Lukoil. On some engines each unit has a sampling point, other engines have combined sampling points, so when a high iron content is found, we then have to investigate each unit to see which is the problem one.[14]

---

[9] W 32 / 2020 (Entire Section)
[10] W 02 / 2021
[11] W 02 / 2021
[12] W 02 / 2021
[13] W 02 / 2021
[14] W 02 / 2021

3.3. Procedure for MAN Engine

- To take a sample the valves shall be closed for a set period of time e.g. 1 hour.
- After the drain oil has filled the pipe and the bottom of the piston underside a sample shall be taken via sample cock per Unit.
- The first 200ml shall be drained into a bucket, thereafter a sample of about 100ml shall be taken directly into the sample bottle. After the sample has been taken the valves shall be restored to its original position.
- Samples to be drawn from all cylinders at the same time.
- A representative sample of the system oil must be taken in order to enable checking of the performance of the stuffing box.

It is essential that you fill in All the information required for this service; otherwise the laboratory will not be able to offer the full service and benefits of this procedure. It is also good practice to take additional samples after any overhaul (which can be noted under “Remarks”).

Samples to be landed at the next convenient port.

3.4. Procedure for Kobe Engines

Only one sample can be drawn due to engine design, this is to be taken while operating the engine at representative and stable sea. Usually, the piston underside residue is continuously drained to a pressurized collecting tank. The pipes from the engine to the tank have a common sample cock located above a two-way ball valve, which is normally open during engine operation.

To ensure the consistency of the analysis results, CSA samples should be taken no more than 100-150 hrs[15]. after cleaning the under-piston spaces, while operating the engine at representative load in calm sea. In addition, one sample of system oil (ME sump) is analyzed to check the performance of the stuffing box and to identify the degree of system oil dilution in the cylinder scrape down oil and make the corresponding corrections in the test results for viscosity, BN, PQ index and Fe.

3.5. Inspect the Cylinders Through the Scavenge Ports

To support the laboratory analyses and compare data it is important inspect the cylinders through the scavenge ports and provide photos evidence of the findings:

a. Take photo of liner, injector nozzles and exhaust valve through scavenge port to illustrate surface condition of liner.

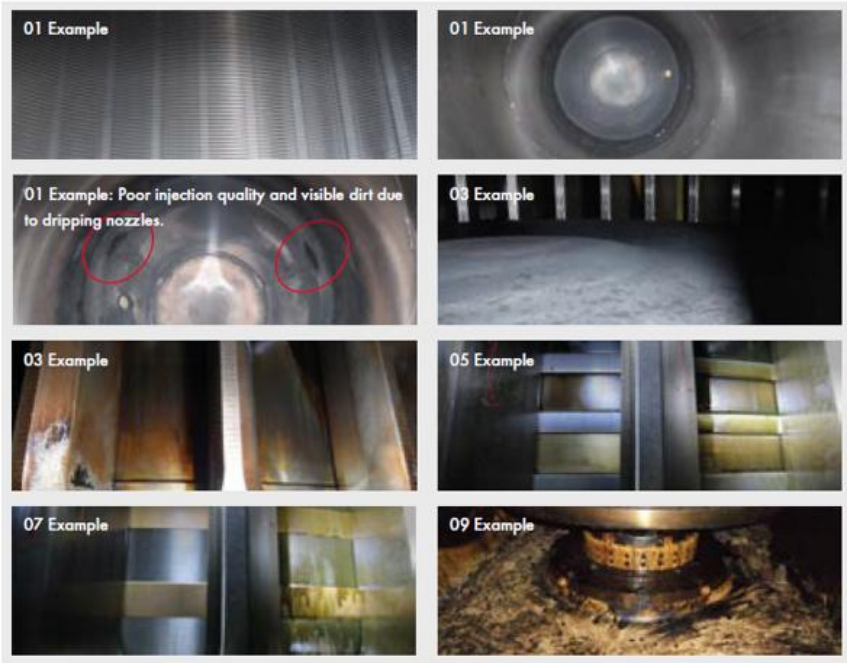
b. Comment on appearance of surface and injector nozzles.

c. Take two photos of upper crown land to illustrate the amount of carbon deposits: one photo of the piston crown and top land and the second one of the top lands and first ring. Comment on cleanliness and condition of deposits.

d. Take photo of piston rings. Please dry surface and take close up to illustrate running surface of rings and cleanliness of intermediate lands. It is good practice to dry the surface of one scavenge port for comparison to the adjacent ‘wet’ one.

e. Comment on running surface and cleanliness of intermediate lands. Take photo of piston skirt.

f. Comment on cleanliness and condition of piston skirt. Take photo of stuffing box to illustrate cleanliness of piston underside. Comment and inform whether it will be cleaned after inspection.



[15] W 02 / 2021

Laboratory tests		Purpose
Base Number (BN)	ASTM D 2896	The base number describes the alkalinity of the oil, which is necessary to neutralize the acidic components formed during combustion to prevent the risk of corrosive wear.
Kinematic Viscosity (KV)	ASTM D 445	Changes in Kinematic Viscosity can indicate contamination.
Flash Point	ASTM D 3828	A change in the Flash point of the oil shows fuel ingress or contamination.
Water	ASTM D 6304	Water contamination can indicate leakage or condensation and can indicate higher risk of corrosive wear.
Soot/Insoluble	ASTM E 2412/IP316	The soot or oil-insoluble level in the oil gives an indication on combustion quality.
System Oil Dilution	In-house method	The System oil dilution shows the performance of the stuffing box and helps to make the necessary corrections in the test results for viscosity, BN, Fe and PQ Index.
PQ Index	Manufacturer	The PQ Index identifies ferromagnetic particles in the oil. This allows to assess the iron wear level and to categorize it as abrasive or corrosive wear.
Wear elements: Aluminium (Al), Chromium (Cr), Copper (Cu), Iron (Fe), Lead (Pb), Tin (Sn)	ASTM D 5185	Wear and contaminant metals are either wear particles in the oil caused by abrasive or corrosive wear on machinery parts or ingress of external contaminants. Elemental spectroscopy analysis by ICP can precisely determine all metals, including wear, contaminant and additive metals from trace level to higher concentrations. For some elements, there are several possible sources. For example, silicon in the oil can be caused by wear (piston crown material), antifoam additives or contamination (dirt or sand). Only by evaluating the complete set of results is it possible to determine the exact sources of the particles.
Contaminant elements: Sodium (Na), Silicon (Si), Molybdenum (Mo), Nickel (Ni), Silver (Ag), Vanadium (V)	ASTM D 5185	

CSA represents an additional tool for monitoring engine operating condition and cylinder lubrication. It allows for assessment of the performance of each cylinder unit. The residue oil taken from the piston underside and the system oil is analyzed and can give indication/insights on:

- Wear performance by i.e. content of Fe, Cu, Cr and others
- Remaining BN indicating a safety margin against corrosive wear.
- Contaminants such as water or system oil.
- Indications on combustion quality.

3.6. These results can then be used as a tool to:

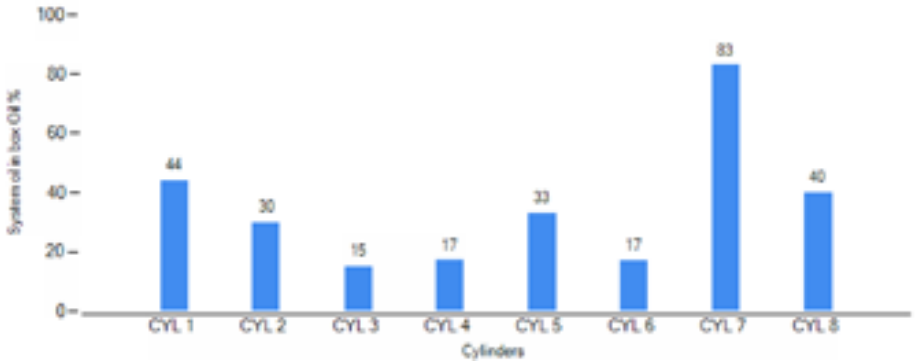
- Check and optimize Cylinder Oil feed-rate
- Remaining BN indicating a safety margin against corrosive wear.
- To extend time between overhaul by life time of cylinder liners and piston rings.
- Monitor stuffing box performance and reduce system oil consumption.

3.7. That will translate into Benefits, such as:

- Optimized Engine Operation via Oil Condition Monitoring.
- Higher safety margin from break-down/Reduced risk of off-hire.
- Savings on System Oil and Cylinder Oil Cost.
- Extend time between overhaul by savings on Engine parts and Maintenance cost.

- Environmental befits due to reduced waste.

3.8. Example on Stuffing Box Performance by System Oil Leak Rate per Unit.



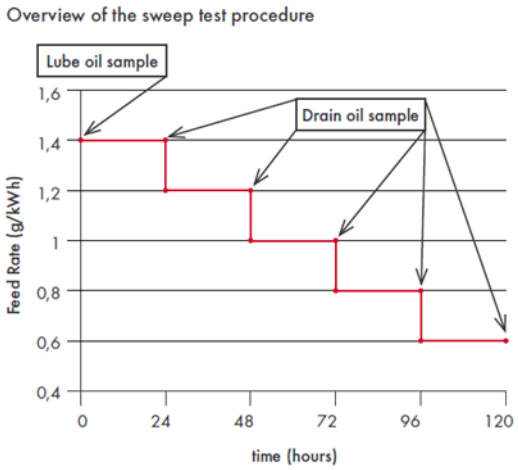
3.9. The following procedure is for new vessels and vessels that have had all their liners replaced.

3.9.1. Sweep Test (NB Only New Vessels and for New Liners)

The sweep test is a tool to optimize the feed rate of MAN engines. Each engine is different and should be individually evaluated. Vessels should refer to and follow closely the MAN sweep test procedure (MDT guideline (S/L: SL 2014- 587/JAP; LDF1/ JUSV/ case no: 8002-2014) to ensure that test results are accurate, meaningful and unambiguous. In addition, LUKOIL Marine Lubricants' Technical Service will provide recommendations and instructions in order to get representative samples and improve the accuracy of the analysis results. The sweep test should be done at steady load above the lubrication breakpoint and preferably on high Sulphur fuel. The feed rate is adjusted to different values. Each feed rate must be operated for 24 hours before taking a sample and switching to the next feed rate.

The sweep test procedure is very similar to the standard CSA sampling procedure:

- Clean piston underside of all cylinder units.
- Take one FRESH cylinder oil sample from cylinder oil day tank.
- Take one USED system oil sample at the engine inlet during engine operation.
- Take drain oil samples at each feed rate after operating the engine for 24 hours.
- Fill in the submission forms at the time of each sampling



3.10. Laboratory Address

The sample submission form is delivered with the sample bottles. Please ensure you complete the sample forms using correct machinery and lube oil descriptions. The mandatory fields are marked by a red frame. These fields need to be filled every time with the actual data.

Fill in the accurate Feed rate i.e.

- MAN engine: “Basic feed rate.

Provide additional relevant engine data to help the interpretation of CSA results:

- Indicate details such as Turbo Charger cut out
- Note specific designs such as the type of cooling system, Liner type and design.
- Identify piston type and coating.

Send the full set of samples for analysis to:
Tribocare FZC.
A2-74, SAIF Zone, PO Box: 122405, SHARJAH,
UAE
Ph: +971 06 5528799
Mail: info@tribocare.com

4. TRIBOIRON ONBOARD FERROUS IRON TESTING[16]

The TriboIron Test Kit has been provided to allows for onboard an analysis of the abrasive and corrosive iron content of an oil sample drawn from the under piston. This will complement the SCA (SCRAPE DOWN ANALYSIS) as it will allow for instant results. We have added Form No 6.6.11b TriboIron Onboard Test Record to the SMS for capturing and tracking the data.

[16] W 32 / 2020

After 1st January 2020, the new fuel sulphur cap became mandatory by IMO. The new fuel called "FUEL 2020" is often a blend of fuels with issues such as compatibility, stability, CCAI number, flash point, high catfines. There is a potential for the cylinder liners to become polished or scuffed. Therefore, as guide but not limited to, Ferrous iron testing needs to be done: -

i. After unit overhauls (liners, pistons, Rings) - every 48 running hours until the iron content drops once the piston rings have bedded in properly.

ii. 24 hours after changing to a different batch of fuel.

iii. 24 hours after making any changes to the cylinder oil feed rate or change of cylinder oil grade.

iv. To test any cylinder unit if you notice overheating of the under-piston spaces when compare to any other unit.

NOTE: Read the test kit instruction manual carefully, a guidance note has also been added to the Form 6.6.11b - TriboIron On Board Test Record for ease of reference. If in doubt test again.

NOTE: This is the first defence against excessive liner /ring/ piston groove wear. If excessive amounts of Iron are found, immediately inform your Ship Manager.

5. MICROBIOLOGICAL INFESTATION IN LUBE AND FUEL OILS

It is accepted that the shipboard environment offers all the conditions ideal for sustaining most varieties of micro-organisms. These bacteria and fungi are latent in fuels and lubes and able to multiply at a very fast rate -doubling in number every 30 minutes under favourable circumstances.

6. LUBE OIL STATIC FILTERS

Refer to Circ. dated Jan 2021[17]

6.1. Forward

On trunk piston engines, the increased rating, the continuous deterioration of quality of all grades of fuels, the trend to burn cheaper and lower grade fuels and hence the passage into the lube oil of higher volume of contaminants, concur to aggravate the condition of lubrication of the engine.

The filtering of the lube oil is one of the essential factors of a proper lubrication.

A faulty operation of the lube oil filter generally has very costly consequences for the engine both as wear and a probability of failure.

[17] W 02 / 2021

In fact, feeding an engine with unfiltered lube oil, for whatsoever reason, may cause scoring of bearings and pins, wear of pins, less or more severe and extended seizures of bearing and pins up to pin cracks.

On the contrary the dismounting, mounting and control of the lube oil filters are considered as common cleaning and assigned to the less skilled personnel.

6.2. Dismounting and Mounting of Filters

Before beginning the dismounting of the filter, it is essential to completely drain the oil, by opening the drain cocks or by removing the drain plugs, from both the filter chambers before the cartridge (dirty side) and after the cartridge (clean side).

If the filter body is not emptied, unfiltered oil will pass from the dirty to the clean side of the filter when the cartridge is removed.

We recommend to fix on the filter body in a conspicuous position a label reading as follows:

'BEFORE REMOVING THE CARTRIDGES, DRAIN COMPLETELY THE OIL FROM CHAMBERS BEFORE AND AFTER THE CARTRIDGES BY OPENING THE DRAIN COCKS OR BY REMOVING THE DRAIN PLUGS LOCATED IN THE LOWER PART OF THE FILTER BODY.'

If the cartridges locating pipe is open on the top, during all the time the filter is open, pay attention that no foreign materials (rags, bolts, gasket fragments,) enter into this pipe.

Because the inside of the locating pipe is on the clean side of the filter, such foreign materials could enter into the engine lube oil system and reduce or block the lube oil flow to the bearings.

On filters which are not yet provided with, we recommend to purchase and fit the proper baskets on the top of the cartridges locating pipe.

6.3. Control of Cartridges and Gaskets

Cartridges and gaskets removed from the filter should be carefully examined.

Damages of these parts are a sign that the engine is running with unfiltered lube oil.

The extent of damage to the filter will determine to what extent the bearings should be opened up in order to establish if damage has occurred to the bearings.

Considered the negligible cost of the gaskets, but the expensive damages their failure can cause, every time the cartridges are removed it is useful to renew all the gaskets paying attention that all the old ones were removed.

Ensure a spare set of cartridges are kept on board for every filter[18]

6.4. Characteristics of the Cartridges

Filtering cartridges are commercial articles, made by more or less qualified builders, easily found on the market also through more or less reliable dealers.

A filtering cartridge is characterized by the following two main parameters

- The filtering area (the net area of passage of the fluids);
- The grade of filtration (porosity), not always well known by the user.

A defective filtering area causes an initial high pressure drop and a quick increase of the pressure drop.

When it is not intended or possible to re-install the filter in its original condition, by fitting suitable cartridges, this situation can be overcome by shortening the intervals between replacement or cleaning of the cartridges.

The grade of filtration means the size of the particles passed through the filter; it can be defined in two ways:

- Nominal grade of filtration which is the average size of a certain percentage of the particles passed through the filter. Given a certain nominal grade of filtration it cannot be excluded that, although in a small percentage, particles larger than the nominal grade (for example twice or three times it) can pass through the filter and cause damages.

The nominal grade of filtration can be determined only by laboratory tests.

- Absolute grade of filtration which is the diameter of the sphere that can be inscribed in a section of passage (mesh) and therefore practically the maximum size of the particle that can pass through the filter.

For this reason, we refer always to the absolute grade of filtration.

Indicatively for full flow filters (through which is passing the full quantity of the lube oil entering into the engine), the recommended absolute grade of filtration is in the field from 25 to 45 microns, depending on the type of the engine and on the type of service.

A cartridge having an unsuitable grade of filtration shows a low initial pressure drop and a negligible increase of the pressure drop in the time.

It is evident that the use of such a cartridge may cause severe damages.

[18] W 02 / 2021

6.5. Paper Cartridges

Filters are often fitted with paper cartridges at least for the first 100 - 200 engine running hours.

For certain type of operation of the engines, it can be useful to use paper cartridges for the whole life of the engine.

PAPER CARTRIDGES CANNOT BE CLEANED OR WASHED, and once used they must be replaced by new cartridges.

Even a small quantity of water in the lube oil may cause the swelling of the paper fibres, their failure and also the blocking of the cartridge.

6.6. Metal Wire Gauze Cartridges

Filters can be fitted with metal wire gauze cartridges, or they can be fitted with this type of cartridges after the first period of operation during which paper cartridges were used.

Wire gauze cartridges may be cleaned usually by washing them in a suitable solvent and then brushing and blowing them always from the clean toward the dirty side.

Generally, the cleaning of a cartridge does not recover the full original filtering area; hence a cleaned cartridge will reach the limit of pressure drop in a shorter time than a new cartridge.

The traditional cleaning above mentioned may damage the gauze wires when these are very thin (30 microns) or may recover only a little part of the filtering area when the gauze has special weave.

In these cases, it may be necessary to use ultrasonic equipment to clean the cartridges.

6.7. Automatic By-Pass Valves

Depending on their use filters may be fitted with automatic by-pass valves.

These are required when the filter is fitted with paper cartridges which, if blocked, could not withstand the difference of pressure due on one side to the maximum delivery pressure of the lube oil pump, with cold oil, and on the other side to the very low pressure built by the small quantity of oil passed through the blocked cartridge and hence collapse and broke.

The by-pass valves are set at a pressure (2.5 – 3kg/cm^2) higher than the maximum fixed as the limit of operation of the cartridges (1.5 kg/cm^2).

It must be kept in mind that when a by-pass valve opens there is always a risk for the engine because in such an event unfiltered lube oil reaches the engine bearings.

When filters are fitted with metal wire gauze cartridges, which should withstand the maximum pressure built in the system, we advise to block or to blank off and remove the by-pass valves.

6.8. Time Between Maintenance

It is normally accepted that a filter cartridge should be renewed or cleaned when the pressure drop of the fluid passing through reaches 1.5 kg/cm^2 [19] and this may occur in very variable times. Ensure the guidelines in the filter operating manual is followed. Make reference to the Mespas[20] regime for any PMS on this filter and ensure proper PMS records are kept in Mespas[21].

Therefore, it is essential that filters be provided by suitable instruments (differential pressure gauge before and after filter) enabling to know continuously the pressure drop and that these instruments are always kept efficient.

It must be kept in mind that 'A FILTER THAT HAS NO PRESSURE DROP OR DOES NOT GET DIRTY IN THE TIME' not necessarily is operating properly.

Often the contrary is true because the filter has no pressure drop for:

- not suitable grade of filtration;
- cartridges and gaskets failure.

6.9. Change Over Valves on Duplex Filters

Duplex filters are supplied with change over valves to switch the oil flow from the cartridge in service to the stand by one.

Often the changes over valves are provided with manually operated pressure balance valves to balance the pressure before and after the change over valve when this has to be operated.

If the pressure is not balanced the change over valve may be unnecessarily forced and damaged, when operated, which may make the filter useless as duplex and may compel to stop the engine to maintain the filters.

[19] W 02 / 2021
[20] W 03 / 2024
[21] W 03 / 2024