Winter 2017

OELCHECKER

INSIDER INFO • PARTNER FORUM • TECHNOLOGY FOCUS

CONTENTS

Milispec – Successful niche player sets standards

A „Christmas tree“ on an oilfield in Oman, which caps the well. Milispec supplies the special lubricants for the valves to make sure this is all completely secure.

MILISPEC The Dutch company is a niche player, and extremely successful at that. Milispec‘s products and services focus on four areas. These include the military, aviation, oil and gas extraction, and the navy, including large container terminals. With its three divisions – Lubricants, Service and Analytics – Milispec is an important partner for every customer with their individual value chain. Lubricant analyses which OELCHECK performs for Milispec are an indispensable component of the company‘s Analytics division.

Lubricants and condition monitoring have very specific requirements, particularly for aviation and the military. Milispec has specialised in this field for many years, and rather than „just“ providing its customers with lubricants and additives, the Dutch company offers them customised packages which include outstanding consultation services. Milispec hits the bullseye with this business concept.

Unique product portfolio

Milispec is the leading supplier of speciality products, such as lubricants and additives, with approvals from NATO and many others for military applications. The company is a distribution partner for AeroShell and supplies large airlines as well as operators of sports aircraft and helicopters with speciality lubricants and cleaners.

What‘s more, Milispec is the first distribution partner in Europe to receive AeroShell‘s „Sales and Operational Excellence Award“ for its dedication and high level of expertise. On shore or off, the extraction of crude oil and gas requires the use of extremely hard-wearing and acid-resistant oils and greases. Milispec also supplies the best products for this. A diverse range of test kits, such as for the rapid detection of water or bacteria, complete their product portfolio.

Check-up

Anyone leading a company successfully must take action. Indecision and weak leadership never lead to success. More than ever before, businesses are confronted with unpredictability, complex economic relationships, new technological developments and increasingly high customer expectations. Risks must be identified in advance, and opportunities must be taken advantage of immediately.

However, all this fast pacing requires strategic action, and it has to be consistent. Particularly in turbulent times, our strategy is a valuable orientation and decision-making aid for us. Our focus is always on our customers, innovations and employees. OELCHECK lubricant analyses and services have been an integral part of the daily work of our customers for many years. Our innovation strategy has always enabled us to deliver services that exceed our customers' expectations. Current examples are our analyses for coolants and the OELCHECK-App launch. But every innovation has an impact on our organisational structures. For example, as we have recognised that our Chinese customers trust the quality of the „Made in Germany" lubricant analyses more than those of their own country, we have ceased operations in our laboratory in China. Since then, more oil samples have arrived from China than ever before.

However, it is important to uphold the motivation and cooperation of the employees, even when changing structures. This, in turn, requires management, even if management itself is much called upon in turbulent times. Being an entrepreneur is more than just a job; it's a life's mission, and we love it!

Yours, Barbara Weismann

Milispec – Deployment in the Rotterdam container terminal, the largest in the world

Supply chain management for the world's largest container terminal

Rotterdam – no other port in Europe handles so many goods. And no other container terminal in the world is as large and frequented as the terminal in the port of Rotterdam, APM Maasvlakte II. As the world's most modern container terminal, it is fully automated in everything from automated guided vehicles (AGVs) to quay cranes. All of the energy it utilises is generated by wind turbines.

Milispec experts make a crucial contribution to ensuring that everything runs smoothly in the container terminal. Their work started six months before the first ship moored in Maasvlakte II in 2015. And they had their work cut out for them. Countless engines, gearboxes, bearings, hydraulic systems, ropes and grease lubrication systems were installed at the terminal. The manufacturers of the systems and components had issued a long list of requirements for the lubricants. Based on this list, the port would have needed more than 1,000 different grades of oil and grease for all the moving parts.

This meant that Milispec's first task was to reduce the number of grades. Their second task was lubricant optimisation. Milispec initially selected the lubricant manufacturer with the largest range of products and the most approvals. Then, they reduced the number of gear oils and other lubricants while optimising the selection of lubricants. Some mineral-oil-based lubricants were replaced by synthetic products. Though their price is slightly higher, they achieve longer service lives, are more energy-efficient, and stand up better to low winter temperatures.

Many OEMs had to be consulted in order to avoid risking a warranty loss. Existing contacts with companies such as Künz GmbH, the large Austrian specialist for container cranes, and the multilingualism of Milispec employees proved to be major advantages.

Of course, the extraction of lubricant samples, evaluation of analyses and oil changes are also part of Milispec's customer package. For example, prior to its initial start-up, a zero sample of the gear oil is taken from each gear unit and sent to OELCHECK for analysis. After that, further oil analyses take place at least once a year. In the event of abnormalities, additional samples are analysed.

OELCHECK lubricant analyses since 2002

Milispec conducts business internationally and has therefore already worked with several laboratories for lubricant analytics. But no other laboratory offers a more comprehensive service than OELCHECK. According to John van der Hoeven, Managing Director and founder of Milispec,

„OELCHECK is definitely our preferred laboratory for lubricant analytics. Their laboratory reports are clear and concise. With the analytical results and accurate diagnoses of the OELCHECK engineers, we can make a very good assessment of the condition of used oils. In addition, the data and evaluation provide important leading indicators of possible wear. Illustrations and diagrams clarify a lot. This is very helpful when exchanging information with our customers.

The lab.report customer portal is in a class of its own. We have had several thousand samples analysed from hundreds of machines. With the help of the portal, the machines and samples can be easily managed, and trends are even easier to recognise. The reports are available in several languages. Data can be easily exported and entered into a condition monitoring program.

If we have a question, OELCHECK always has a competent contact person available. And if a lubricant analysis is particularly urgent, we use the express service. If our sample is received in the laboratory by 12 pm, we will receive the lab report by email or via the Internet on the same day. That's service!"

Milispec – Lubricants, service and analytics!

Milispec International b.v. was founded in 2002 by John van der Hoeven. The company conducts business internationally from its headquarters in the north of Rotterdam. The Milispec team, with its seven employees, is supported by long-standing contractors who perform service work on-site within 24 hours. They are always accompanied by a Milispec supervisor during all of their assignments.

Milispec was one of the first companies to take a holistic approach to serving its customers. Customers of the Dutch company have a single competent contact person for everything from lubricants, to monitoring, to changes, to disposal. Milispec has set the bar high with this service package, which contributes significantly to its customers' value chain.

For further information: www.milispec.com

New test instrument in use – four-ball apparatus for oil and grease analyses

Oils and greases that must withstand very high pressures and loads are already tested for their suitability during the development phase. They contain active ingredients (EP additives) which should enable high contact pressures in the mixed friction area. Lubricants in use should also be checked regularly to see whether they still meet the high standards.

The **four-ball test** determines the good load (last non-seizure load) and welding load as four-ball values, as well as various friction and wear characteristics of lubricants in accordance with DIN 51350. The higher the welding load or the lower the wear characteristics of an oil or grease, the better its wear resistance under compressive loading.

OELCHECK now has a new four-ball apparatus (VKA-110) from Hansa Press for performing this test.

The four-ball apparatus in detail

The four-ball apparatus consists of one rotating ball and three stationary balls identical to it, a drive unit and a load arm which carries test weights. The chrome-plated steel balls that it uses are standardised.

The three stationary balls are held in a cup. The lubricant to be tested is added to the cup until the stationary balls are completely covered (approx. 10 ml). The cup is prevented from rotating by an arm supported on the housing.

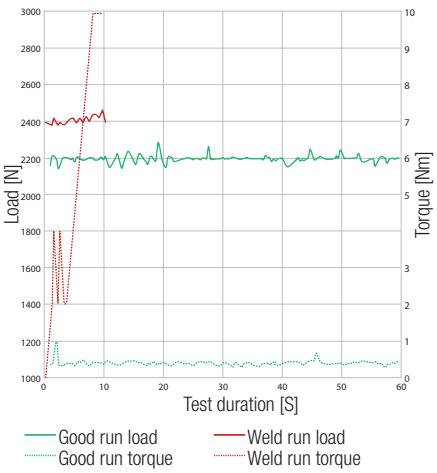
The rotating ball is held on a vertically mounted test spindle which is located above the ball cup. A lever mechanism is used to apply the test load, which can be varied according to the weights applied and the length of the lever. The test load is applied directly to the cup via a vertical ram, and the stationary balls are pressed against the rotating ball. The test spindle, which is driven by an electric motor, rotates at 1,450 min^{-1}. If the test balls seize up, thereby preventing rotation, the power supply is automatically cut off. The torque can be recorded continuously.

Good load and welding load

The welding load is determined by gradually increasing the test load until the balls seize up. Each level of this test lasts for 60 s. The good load is the highest level at which no seizure has taken place. The welding load, on the other hand, is the level at which the seizure occurs. The diagram illustrates an example in which the balls seized up after approx. 10 s (red lines). This is also demonstrated by the sudden increase in torque. The green lines show the last non-seizure load (good load).

The VKA value for the good load and welding load are given in N (Newtons).

VKA measurement of good load and welding load



Wear characteristics

The „hour test“ serves to determine the long-term behaviour of extreme pressure (EP) and anti-wear (AW) additives. The rotating ball rotates with a moderate load of, say, 150 N for one hour on the stationary balls. The size of the wear scars formed on the three stationary balls is given as the average wear scar diameter in mm.

Although the degree to which the situation in the testing equipment can be applied to everyday practice is limited, the VKA test is an important basis for assessing the lubricating effect of a lubricant under high pressure loading. This simple and inexpensive test allows us to draw direct conclusions regarding the performance of the EP and AW additives.

KRL (tapered roller bearing) test for determining changes in viscosity

VI (viscosity index) improvers, which are primarily used in multi-grade engine and hydraulic oils, can become heavily sheared during operation. As a result, the oil thins over time. The tapered roller bearing (KRL) test uses the four-ball apparatus to measure the change in viscosity associated with the decrease in VI improvers.

Instead of the four balls, this test is carried out with a tapered roller bearing which is filled with approx. 40 ml of oil. With the immersion lubrication method, the oil is sheared with the rotating tapered roller bearing at a temperature of 60 °C and a constant load of 5,000 N over a period of 4, 8 or 20 hours. The resulting relative drop in viscosity at 100 °C is indicated as a percentage.

The tests performed with the four-ball apparatus are not included as standard in the OELCHECK all-inclusive analysis kits. The VKA and KRL tests can be added as separate tests upon request.

OELCHECK WIKI

The central point of contact for your questions about lubricant analysis

Our website has already been presenting our visitors with our accumulated knowledge regarding lubricant analyses for many years now. When switching to the new website, we decided to bundle this information into a **Wiki**.

Our new OELCHECK Wiki is divided into the following categories:

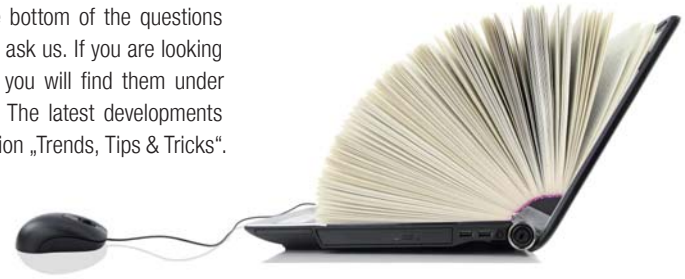
- Test methods and equipment in our OELCHECK laboratory
- Complex terms – simply explained
- Q&A: Questions & answers
- Summaries and tables
- Trends, Tips & Tricks

You can read detailed information on some of our test methods under the heading „Test methods and equipment in our OELCHECK laboratory“. A complete list of current testing procedures can be found at oelcheck.de.

In the section entitled „Complex terms – simply explained“, we take a close look at terms such as „phenolic inhibitors“. And in „Q&A: Questions & answers“, we get to the bottom of the questions that our customers often ask us. If you are looking for detailed summaries, you will find them under „Summaries and tables“. The latest developments are presented in the section „Trends, Tips & Tricks“.

Throughout our entire Wiki, you will find interesting articles on topics related to the analysis of oils, greases, coolants and fuels. It is worth visiting regularly, because the content is regularly expanded and revised as is customary with a Wiki.

Use the link on our website or visit **en.oelcheck.com/wiki/** directly.



Made in Germany – not just diagnosis, but analytics as well

In mid-October 2017, our **exclusive agent „Lubecheck“** took over the processing of lubricant samples in China for us.

The company was founded by Julie Qiu, a former employee in our Guangzhou laboratory. We have since ceased operations in that laboratory.

Our customers in China now also benefit from the following advantages:

- More than 90 different testing methods
- Diagnosis and analysis in Germany
- Consistently high quality control standards
- Clever logistics

We are pleased that our Chinese customers now also benefit from the high level of quality at our Brannenburg laboratory due to improved logistics.

The sale of the all-inclusive analysis kits in China and the shipment of samples to Brannenburg is handled by Lubecheck. Thanks to the daily combined shipments, laboratory reports are generated for all samples within five working days of their arrival at Lubecheck. The reports are then sent by email from Germany or can be accessed via our German or China-hosted web portal.

The close cooperation between OELCHECK and Lubecheck will ensure that our Chinese customers continue to enjoy excellent technical advice in the future.

In the first two months since the changeover, the analysis conducted in Germany has already received a very positive response in China. It seems that, above all, our Chinese customers trust the quality of analytics in Germany more than ever.

The logistics have proven to be a success. Packages arrive from Nanjing daily, some containing more than 100 samples. Thanks to the express service provided by our logistics partner UPS, parcels are often delivered in just one and a half days. Together with express handling in our laboratory, we can often significantly undercut the five-day turnaround time.

Are you interested in oil analytics for the Asian region?
Please contact us at +49 8034-9047250, by email at akv@oelcheck.de or contact our Chinese colleagues directly.

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OELCHECK-App supporting Vestas – Sample data entry in a class of its own

As Europe's largest manufacturer of wind turbines, Vestas has installed nearly 7,800 wind turbines in Germany alone. The company uses OELCHECK's all-inclusive analysis kits for regular monitoring of the lubricants it uses. As the leading laboratory for lubricant and fuel analyses in Europe, OELCHECK is always setting its sights on innovative new products. OELCHECK has now developed an App specifically for Vestas – the OELCHECK-App supporting Vestas – in order to meet the company's special requirements.

Always the right wind turbine – thanks to GPS

Depending on the place of use, completing the Sample Information Form may be cumbersome. In particular, the master data for the turbine must be respecified each time, in legible handwriting, and without getting the form dirty. We wanted to offer our customer Vestas a simple solution by which the assignment of the sample data to the wind turbines would happen almost magically. But how were we going to do that? Retrofitting several thousand systems with QR-Codes was logistically out of the question.

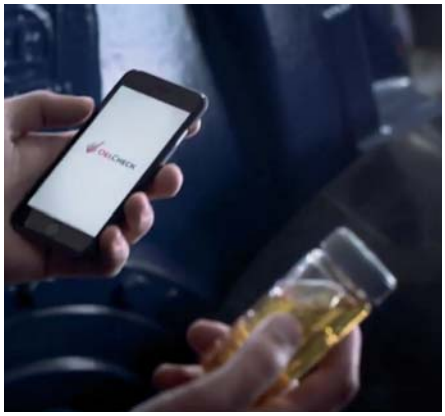
The solution was the GPS positioning data, which are stored on each wind turbine for reasons of safety, as any smartphone can determine the current GPS position. In this way, the user can display the surrounding wind turbines and select the wind turbine in question. The App also works in offline mode, as the GPS data of the individual turbines are stored locally in a database on the smartphone. This data can be updated at any time at the press of a button, so it can always be kept up to date. After the wind turbine has been automatically detected, the Vestas service employee selects the component and adds only the missing sample-related data. This enables regular analysis of the lubricant samples without additional paperwork. If the sample data is entered in offline mode, it can be transmitted later.

The Vestas-App has already been downloaded more than 600 times and used to enter more than 1,000 samples. It is available for iOS and Android.

Now watch the promotional video for the new OELCHECK-App supporting Vestas:

Are you a major customer who would like a lubricant sample data entry App custom designed for your own needs? We would be happy to discuss the possibilities with you. Please call us at +49 8034-9047-250.

The OELCHECK-App for everyone



Of course, all of our customers can benefit from our App launch, because our classic OELCHECK-App, with which the machine is automatically recognised by means of a QR-Code, can be used by anyone.

With this App as well, all you need to do is enter the sample data. Transmission errors and queries regarding illegible handwritten information are a thing of the past. The data is transmitted directly to OELCHECK, and data input is automatically confirmed. It is no longer necessary to fill out a Sample Information Form.

The OELCHECK-App supports the German, English and Chinese languages.

Would you like to switch to our App? No problem!

- Just download the free OELCHECK-App for sample entry from your App Store (available for iOS, Android and Windows) to your smartphone or tablet.
- Log in to lab.report and create your own QR-Code for each of your machines. Attach it close to the sampling point.
- Always tick „Sample information provided online" on your Sample Information Form.

If you wish to provide several machines with QR-Codes, we offer you an **exclusive printing service free of charge**.

If you have any additional questions, please call us at +49 8034-9047-250 or email us at akv@oelcheck.de.

Limit values and their importance

Limit values provide an initial indication as to whether analysis results point to a problem. However, this requires detailed knowledge of the application, the lubricant used and sometimes even the lubricant analysis itself. Important aspects of oil analysis, such as wear or oil condition, also depend significantly on the duration of use. Due to different operating conditions and times, limit values are therefore often difficult to define. The trend line is helpful here, in that it makes a more detailed assessment possible. But one point is crucial; the analytical results must always be evaluated in relation to each other. The mere consideration of individual values can lead to considerable errors in judgement.

Before a diagnostic engineer can evaluate the results of an analysis, he needs a basis for his assessment. In addition to his own experience, he makes use of absolute limit values, fresh oil reference values and the trend line for this. The adjoining sample spreadsheet shows the extent to which the limit values, e.g. of elements in engine oils, can vary.

Where do limit values come from?

Limit values are determined by the following groups, often with very different intentions:

- Component manufacturers
- OEMs
- Oil companies
- Standards, technical groups/organisations
- Laboratories

Manufacturers of components often define limit values for individual parameters which affect the performance or the service life of the component. For example, manufacturers of hydraulic components, such as pumps and valves, give recommendations for oil cleanliness.

In particular, specifications from OEMs relating to warranty cases should be strictly adhered to. This is because OEMs also define limit values to identify necessary repairs and maintenance, establish general conditions for safe operation, and assist in evaluating oil analysis values.

The limit values of oil companies usually relate to the condition of the oil. These are used to judge the point at which additive degradation or ageing has progressed too far, and the oil can no longer reliably fulfil its tasks. This will guarantee that the oil still meets the necessary conditions of use at the time of the oil change.

Limit values and evaluation bases can also be standardised, as is the case, for example, with ASTM. These values issued by specific organisations relate primarily to areas of application and must be examined on a case-by-case basis for their applicability.

The limit values used by the OELCHECK laboratory are statistically determined and validated by engineers using historical analytical data which has been collected in the company's own database for more than 25 years. Special features such as oil and machine type, manufacturer and sampling

Element	Occurrence in engine oils	Gas engines	Diesel engines	Petrol engines
Iron	Cylinder block, cylinder head, valves, valve tappets and guides, crankshaft, camshaft and rocker shaft, piston pins, oil pump	10–40	80–180	90–200
Chrome	Piston rings, roller bearings, crankshaft bearings, piston pins, exhaust valves, gaskets, guide bushes, and, rarely, plain bearings	2–8	4–28	3–16
Aluminium	Pistons, rarely cylinder block, oil pump housings, oil coolers, boosters (turbochargers), guide bushes, plain bearings with aluminium	8–28	12–55	10–120
Copper	Principle component made of brass and bronze. Oil pump, oil coolers, connecting rod bearings, piston pin bearings, rocker shaft bearings, seals	6 – 20	25 – 60	15 – 45
Lead	Usually simultaneously with tin and copper. Leaded (aviation) fuel, running surfaces of connecting rod bearings, subsequently added oil additives	3 – 9	10 – 30	15 – 500
Tin	Usually simultaneously with lead. Running surface of connecting rod bearings, rocker shaft and piston pin bearings, solder in cooling joints	2 – 10	12 – 24	8 – 15
Nickel	Exhaust valves, valve guides, turbochargers, alloy component of high-strength gears as in valve or injection pump controls	– 2	1 – 3	1 – 4
Molybdenum	Mostly piston rings, these days often oil-soluble EP additives in synthetic multi-grade oils, MoS_2 oil additives which contain solids	3 – 8	+4 –16	+ 5 –25
Zinc	Oil additive, corrosion of galvanised components by ester oil e.g. on supporting cores in filters, threaded connections, paint coatings	+ 5 –20	+ 20 –80	+25 –90
Silver	Rarely, silver-coated running surfaces of heavily loaded bearings	– 1	– 1	– 1
Tungsten	Rarely in engine construction, sometimes aircraft engine components	– 1	– 1	– 1
Titanium	Rarely in engine construction, sometimes aircraft engine components	– 1	– 1	– 1

Element	Occurrence in hydraulic oils	Mobile hydraulics	Industrial hydraulics	Servo hydraulics
Iron	Hydraulic pump, hydraulic motor, valves, pistons and piston rods, cylinder tubes, roller bearings, pump housings, pipelines, sealing rings	5–28	3–15	1–7
Chrome	Roller bearings, blades of vane pumps, chrome-plated components	2–20	2–8	1–5
Aluminium	Aluminium-bronze components, pump casings, guide mechanisms, plain bearings, bauxite dust	3–80	2–12	1–4
Copper	Friction lining of multiple disc clutch or brakes, principal brass and bronze components. Pump parts, such as control discs and mirrors, pistons, pipelines, oil coolers, bearings, roller bearing cages, guide rings	8–300	10–40	2–10
Lead	Plain bearing running surface on pump bearings, solder joints, roller bearing cages	2–15	6–18	1–4
Tin	Components of tin bronze, tin solder of cooler joints, bio-oil components	2–25	2–6	1–3
Nickel	Special valves, gear parts in the same oil circuit	– 2	– 2	– 2
Molybdenum	Sealing rings, sometimes molybdenum-containing additives for reducing wear, sealing or scraper rings on hydraulic cylinders	2–5	– 2	– 2
Zinc	Oil additive, corrosion of galvanised components by ester oil e.g. on supporting cores in filters, threaded connections, paint coatings, tubing components	+20–350	+5–15	+1–6

Element	Occurrence in gear oils	Mobile gear units	Industrial gears	Worm gears
Iron	Gearwheels, roller bearings, oil pumps, guides, cast-iron housings, welding beads, pipes	15–850	50–1500	10–220
Chrome	Roller bearings, alloy constituents of high-strength gearwheels, multiple disc clutches	2–40	4–60	2–35
Aluminium	Worm wheels (aluminium-bronze), couplings, oil pumps, friction lining of multi-disc clutch or brakes	5–250	8–300	5–600
Copper	Bronze worm wheels, plain bearings, roller bearing cages, clutch linings, pipes, oil coolers, synchroniser rings, sealing rings	10–180	5–360	5–600
Lead	Plain bearing running surface, bronze abrasion, synchroniser rings, rarely from EP additives	3–80	6–145	15–90
Tin	Plain bearings, coatings, soldering joints, oil component of ester oils	2–40	2–60	2–35
Nickel	Gear wheels, alloy constituent of special steels, high-strength gear wheels	2–25	2–35	2–15
Molybdenum	Synchronous rings, molybdenum-organic additives, MoS_2 oil additives, special gear steel	3–500	10–500	5–25
Zinc	Supporting cores in filters, galvanised piping, coatings of paint containing zinc	15–400	18–450	40–600

Sample table – Limit values

point can also be included in the assessment in order to obtain particularly reliable and specific limit values. This is because OELCHECK asks for detailed information about every lubricant sample in its Sample Information Forms.

Absolute limit values vs trends

Absolute limit values provide quick and easy orientation (see Fig. 1). They are, for the most part, based on statistical analyses of machines operated under comparable conditions.

As long as these operating conditions are in agreement, the limit values used are also applicable. Under differing conditions, such as start-and-stop versus continuous operation, the absolute limit values lose their significance.

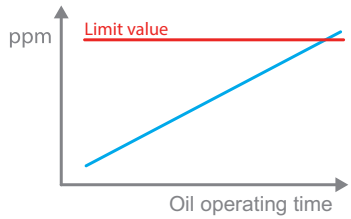


Fig. 1: Example of a linear trend

For all statistics, limit values must always be validated by experienced experts. If they are set too high, it may be that the lubricant has changed significantly or that the machine has been damaged without this being noticed. If they are too low (see Fig. 2), then the accumulating alarms are eventually ignored, because they occur regularly and often without good reason. Then, when an actual problem does arise, no one will respond quickly enough.

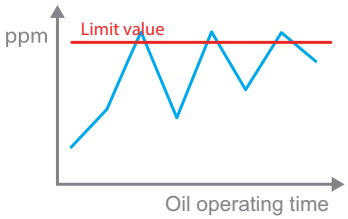


Fig. 2: Example of limit values that are too low

Analytical results often show no ideal trend such as that shown in Fig. 1. Rather, the values (see Fig. 3) vary within a certain range, so that several samples (at least 3-4) are needed to form a trend.

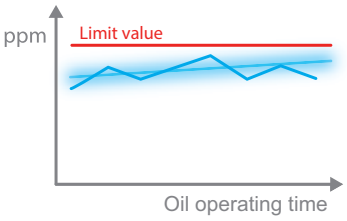


Fig. 3: Example of a typical trend

Only then is it possible to predict the range of values for the next result. It may also be the case that the same values for similar machines but differing trends lead to different recommendations.

If the jump in a wear value is too large compared to the previous sample or in relation to the duration of use, an indication will appear in the OELCHECK diagnosis, even if the result of the analysis is below the absolute limit. Particularly when lubricants have been in use for a very long time, limit values can also be exceeded without the necessity of a warning (see Fig. 4). If the increase is in line with the trend and with the expected range for the duration of use, operation may continue without difficulty.

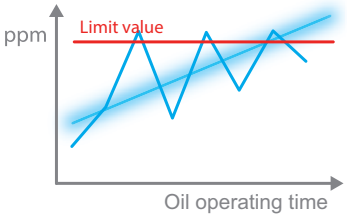


Fig. 4: Example of temporarily exceeding limit values

The trend supplements the absolute limits by making more in-depth interpretations possible. This improves the predictive quality, and emerging problems are detected even earlier. This is because the trend only takes previous analysis values from the same machine into account, and so specific application conditions can best be considered.

It works the same way with the doctor. He compares the results of a blood analysis with their general limit values in relation to the patient's personal attributes and life circumstances. The patient's medical history, i.e. the trend, is then used for the final assessment.

Trends – the tool of choice?

Trends are not always necessary for assessing analytical values. This is partly because enough previous sample data must be available, and you have to start somewhere. On the other hand, there are also parameters that can be comprehensively assessed with absolute limit values.
Included among these are:

- Increased water content – can cause corrosion and/or cavitation, different saturation limits for the different oil types.
- Oil impurities – can lead to increased wear and affect the operation of hydraulic systems, for example.
- Elevated silicon levels – can cause abrasive wear. When assessing silicon content, consideration must also be given to the use of silicon as an anti-foam additive.
- Breakdown voltage – is examined, for example, for transformer and insulating oils.

The decision as to whether absolute limit values are sufficient as a basis for decision-making also depends on the situation. If an oil sample is taken at each oil change in order to detect necessary repair measures or emerging problems, often an assessment based on the absolute limit values is sufficient. If oil change intervals are to be optimised, the trends must always be considered when analysing results that are dependent on the duration of use.

However, even trends are not always reliable. This is due to the fact that the location of the sampling point and the way in which the sampling is performed can have a significant effect on the results of the analysis. Therefore, samples for trend analysis should always be taken in the same place, using the same method. Changes to the conditions of use or maintenance can also affect the trends.

The solution from OELCHECK

OELCHECK combines absolute limit values and trends in the evaluation of all analytical results. Our diagnostic engineers rely on our in-house software SampleRating for sample diagnostics. The software displays limit values, trend curves, diagrams, photos and all the information from the information form pertaining to the current sample and machine at a glance.

Each individual value is colour coded on the basis of often very specific limit values which have been validated multiple times. Our diagnostics engineers can access data from the more than three million samples we have analysed, 200,000 machine-specific limit value tables and more than 10,000 fresh oil references. In this way, OELCHECK combines all the information and advantages of the various assessment methods in order to make a precise diagnosis.

OELCHECK laboratory reports do not include limit values; this is for the purpose of preventing misinterpretations, because values should never be considered individually, but always in conjunction with the other analytical values, the application and the lubricant used. Even a doctor does not simply hand the results of a blood test over to his patient. With their extensive expertise in the fields of mechanical engineering and chemistry, OELCHECK engineers always assess the status of both the machine and the oil, taking all analysed values into account.

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Q & A

In the OELCHECK laboratory reports, the oxidation value is usually indicated under the heading of "Oil condition". But why is it not mentioned in some reports? And what is the significance of this value anyway?

OELCHECK:

The oxidation value has been the most important indicator for the ageing of an oil for many years. However, for some lubricants with base oils containing ester and/or additives dissolved in esters, it is barely relevant any more.

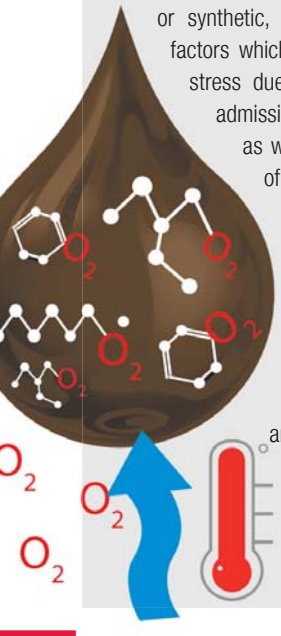
The following products are particularly affected by this:

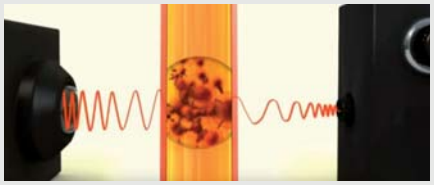
- Biodegradable ester-based hydraulic oils
- Synthetic gear oils with a polyalphaolefin (PAO ester) basis which are often used in the transmissions of wind turbines, for example
- Engine oils with a relatively high FAME (biodiesel) content
- Engine oils with vegetable oil content
- Engine oils with an elevated soot content
- Gas engine oils with a high ester content, such as those used in the operation of engines with biogas, sewage gas or landfill gas.

  For the gas engine oils designed in this way, we stopped providing the oxidation value for individual engine manufacturers some time ago.

Lubricants and oxidation

Every lubricant, whether mineral oil-based or synthetic, ages with time. Important factors which accelerate ageing include stress due to high temperatures, air admission, and catalytic processes, as well as the type and amount of any impurities. As oil ages, oxygen attaches to the hydrocarbon chains of the molecule. This produces double carbon-oxygen bonds (carbonyl groups). These carbon-oxygen bonds can be used in the analysis of the oxidised oil to infer its ageing and thus its remaining usability.





Determination by means of FT-IR spectroscopy

Fourier-transform infrared (FT-IR) spectroscopy is used when considering the oxygen bonds or the oxidation of an oil. It provides information about changes to the oil, such as oxidation, as well as any impurities. FT-IR spectroscopy makes use of the fact that, due to their typical binding form, the molecules present in the lubricant absorb infrared light to different degrees at specific wavelengths. For mineral oils, the different degree of absorption resulting from the ageing of the oil is displayed as a "peak" in the IR spectrum at a certain wave number.

According to DIN 51453, a numerical value for the absorption of the IR radiation based on a one-centimetre thick oil layer can be given in A/cm for mineral oils by subtracting the fresh spectrum from the used oil spectrum.

Limitations of FT-IR spectroscopy

For a mineral oil-based lubricant, even a relatively small „peak" which increases continuously in the used oil spectrum can be interpreted as a clear sign of increasing oil oxidation. However, when determining the oil oxidation of lubricants with ester-containing base oils and/or additives dissolved in esters, FT-IR spectroscopy reaches its limits. Carbonyl bonds are inherent to ester oils, which absorb infrared light at a wave number of approximately 1,740 $cm^{-1,}$ and thus in the same range as the carbonyl bonds which are created as a result of the oxidation of the oil.

In the infrared spectrum of a fresh ester-containing lubricant, an oversized „peak" in the wave number range of approximately 1,740 cm^{-1} is formed by its carbonyl compounds alone.

In contrast, if the used oil is examined, a change in this dominant „peak" due to possible oil oxidation can no longer be calculated.

Although it is no longer meaningful to determine the oxidation value for lubricants with ester-containing base oils and/or additives dissolved in esters by means of FT-IR spectroscopy, its determination according to DIN 51453 is still specified in the fuel specifications of several OEMs. Up to now, only the engine manufacturer MWM has taken these facts into account. The MWM specification for gas-engine lubricating oils does, indeed, indicate a limit value of 20 A/cm for oxidation according to DIN 51453. But there is a note: „The determination of the oxidation does not apply to lubricants containing synthetic esters."

Accurate assessment of the ageing of ester-containing lubricants

Although the oxidation value of ester-containing lubricants cannot be reliably determined with FT-IR spectroscopy, OELCHECK engineers can still provide more accurate information on the ageing of these products. For the most part, they use the following criteria:

- Changes in viscosity
- Any reduction of the additive content
- The degradation of antioxidants
- The AN (Acid Number)
- The BN (Base Number) of the lubricant, which provides information regarding its alkaline reserve for the neutralisation of acids. The BN cannot, however, detect the neutralisation capacity of an oil for every type of acid that may enter the oil during the operation of gas engines with landfill or sewage gas. For these oils, the i-pH value provides crucial additional information regarding the degree to which a used oil is loaded with strong, corrosive acids.

OELCHECK engineers consider the interaction of these values and, based on their own experience and on data from the large OELCHECK database, can issue accurate statements regarding the condition and the remaining usability of any ester-containing lubricant.

OELCHECK is ready to answer any questions you may have about tribology or lubricant analysis. Contact us by e-mail (info@oelcheck.de) or by fax (+49 8034/9047-47).