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OEL CHECK®

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ÖlChecker

INSIDER INFO – PARTNER FORUM – TECHNOLOGY FOCUS

CONTENTS

Vossloh Locomotives - Europe's most successful diesel locomotives

State-of-the-art diesel locomotives from Vossloh leading the way throughout Europe. The European market leader has been setting standards again and again, and not only for efficiency, flexibility and environmental friendliness.

Since 1923, railway vehicles have been built with internal combustion engines, with diesel engines supplied by various manufacturers such as Cummins, CAT or MTU, in accordance with the customer's requirements. Vossloh Locomotives GmbH, which developed from the traditional Krupp-MaK, has achieved its leading position in diesel locomotives through experience, competence and consistent further development. Whether for state, private or industry railways, whether for standard execution or for tailor-made locomotives, the traditional company has consistently offered solutions which meet its customers' needs. The product portfolio includes diesel-hydraulic and diesel-electric models. As an alternative to the purchase of new vehicles, it also refits existing locomotives. In addition, the company develops, builds and produces motorised bogies, compressed air systems and components for cooling and ventilation systems. At the Moers location, Vossloh Locomotives provides a full maintenance, repair and modernisation service for locomotives. More than 80 employees work at the service centre there, of whom more than half in the workshops. The customer delivers the locomotives. Whether the locomotives are towed to Moers or travel under their own steam depends on the transport costs and their condition. For maintenance and repair works, specially trained fitters travel all over Europe. Whether in Athens or in Narvik and Kiruna in the far North, mobile repairs and maintenance work can be executed everywhere.

Regular and thorough inspections are a must for every locomotive. Diesel-electric DE 2700s undergo an inspection every 500 hours of operation or every 4-6 weeks. If the oil has not shown conspicuous features during the oil analyses carried out at the time, then the oil and injectors are replaced after 3,000 hours of operation in each case. The diesel-hydraulic models are subjected to an inspection approximately after every 1,000 hours of operation, according to a fixed maintenance plan. A major part of the engine maintenance is carried out by the respective engine manufacturer or by their certified partner workshops.

Check-up

A flood of information - no thank you? In principle, we all share this opinion, with a major exception! We can hardly get enough information about the oil specimens which you have sent in! Ultimately, for lubricant analysis, the following principle is valid: „The more precise the information, the more accurate and sound the diagnosis!“ and the more accurate the information on the place of action of an oil or grease, the more detailed the description of the lubricant and the more accurate the information as to why the oil should be analysed, the easier it is for OELCHECK engineers to concentrate on the diagnosis. In this way, no precious time is lost on unnecessary investigations, consultations or complex considerations.

Take a couple of minutes, especially on the first occasion. Please complete our sample data sheet as accurately and comprehensively as you can! Missing information wastes our and your time and can be a cause of inaccurate interpretation of the values. No or false information can even influence laboratory results, since laboratory devices are calibrated on the basis of an expected range of values. This can lead to recommendations by our diagnostic engineers which you consider worthless or which even mislead you.

OELCHECK sample data sheets are carefully thought through and proven a thousand times over. All significant questions, for which we need information for the analysis of your samples are stipulated here. In addition to the standard sheet which you normally receive with the prepaid set, you will find further datasheets on our newly designed homepage for specific machines and components, as well as for greases, which you may complete as a PDF document and enclose with the sample. Your investigation results will be stored in our database. Please enter further samples, arranged by you as trend analyses with the same sample description as rapidly as possible via the Web portal. In order to permit the correct visualisation of the course of the trend, once a sample description has been submitted by you, it should not be changed. Your questions and information are important to us. The more questions and information you supply to us with your specimen, the better we can „make the oil speak to you“.

Yours, Barbara Weissmann

In selecting lubricants, the rules and approvals of the respective engine manufacturers should be observed, above all for the engine oil. The diesel engines may range from four-cylinder in-line engines in smaller models to heavy goods and express train locomotives with 16-cylinder V engines. The power produced by the engine is transmitted hydraulically or electrically to the wheel sets. Gears in turn sit on the wheel sets, which must be supplied with gear oils. Nor should we forget radiator antifreeze or greases for the bearings or the wheel flange lubrication. Depending on the operator of the locomotive, it is not always the approval of the component manufacturer or recommendations by Vossloh which is decisive for the choice of lubricant, but also that of the railway company. For example, at its competence centre, Deutsche Bahn AG classifies lubricants into three grades, Q1 to Q3. Q1 stands for the highest quality grade. An approval or listing in the maintenance documents of Deutsche Bahn AG Systemtechnik is regarded as a practice-oriented guideline. It is also used as a guideline by many other railway companies.

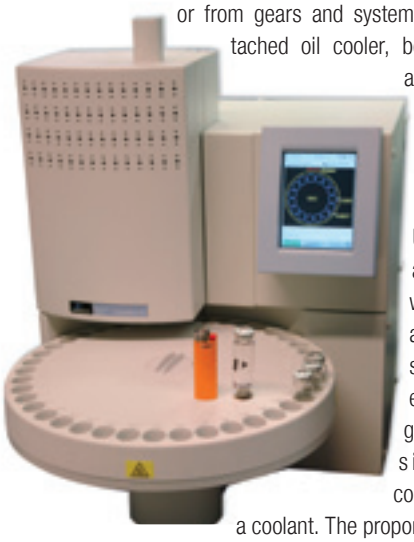
Hence, not only the choice of lubricant plays an important role but also its monitoring in practice. In order, e.g. to check the perfect condition of the oil and of the engine, the technicians of Vossloh Locomotives use OELCHECK lubricant analyses. In each case, after 500 hours of operation, a used oil sample from the engine is investigated. The oil analysis is thus a fixed component of engine maintenance. In addition, gear oils and other lubricants are analysed to clarify causes of damage.

Vossloh locomotives are well-known for their efficiency and reliability. Lastly, they must perform their service in wind and bad weather and sometimes under the most extreme operating conditions. Even at temperatures as low as -40°C during the icy Norwegian winter, there can be no malfunctions. If there are no third party supplies of thermal heat available at such low temperatures during stoppages or even for the whole night, the locomotive engines continue running while stationary. In this way, at least the cooling water of the locomotive warms the carriages. This can nevertheless cause problems in many types of engine, since this measure prevents the cooling of the train. But with incomplete combustion of the diesel fuel under no-load running operation of the cooled engine, unburnt diesel and condensate can get into the engine oil. For regular driving with engine oil temperatures of over 60°C, water and fuel begin to evaporate and vaporise. There is nevertheless a residual risk to the engine, which may only be excluded through regular oil analyses with the precise determination of the water and fuel content of the oil.

In addition to the problems arising from water and diesel condensates, at low temperatures, oil and fuel vapour from the crankcase breather may collect in the loading air shaft. If power is then connected, these vapours can cause the engine to self-accelerate in uncontrolled fashion and thus „run away“. Not least, by virtue of the oil analyses, Vossloh Locomotives has also developed solutions for such low-temperature problems: for example, for the DE 2700, an electric preheating system is built into the engine as a standard feature. In addition, as a prudent measure, more and more locomotives are equipped with an auxiliary diesel engine. Beside the preheating of the cooling water and the fuel, it at the same time guarantees the trickle charging of the on-board batteries. Correspondingly equipped and monitored by OELCHECK with regular lubricant analyses, the locomotives from Kiel always reach their destinations safely, wherever they may be and even at the lowest temperatures.

Coolants in the oil

Headspace gas chromatography detects glycol



During the analysis of oil samples from engines or from gears and systems with an attached oil cooler, besides water, any ethylene glycol content is also an important parameter. Ultimately, in addition to water and anti-corrosion additives, ethylene glycol is a significant component of a coolant. The proportion of glycol and oil thus becomes an important indicator as to whether coolant is penetrating the oil circuit. Water which, in addition to the additives and glycol, gets into the oil can volatilise during normal operation or be baked out of the oil on account of its lower boiling point. In addition, water not only points to leakages in the cooling circuit, it can also get into the oil e.g. through condensation.

On the basis of the glycol content, it is nevertheless easy to understand whether in combustion engines, e.g. a cylinder head gasket is defective or whether the copper tubing in a gear cooler is corroded through.

In addition to the determination of the elements boron, sodium and potassium, to date, the glycol content has been exclusively determined from the FT-IR spectrum. The IR method nevertheless has some disadvantages for investigating glycol. The corresponding absorption band is not very pronounced. In the interaction with other ageing processes, it is frequently displaced. Glycol may thus only be defined with FT infrared spectroscopy above concentrations of 0.08%, with a highly inaccurate quantitative specification and where appropriate, must be estimated via additives.

With the newly introduced headspace gas chromatography (HS-GC), there is now an additional selective process in the OELCHECK laboratory for the definition of free ethylene glycol. In this way, glycol is already demonstrable at significantly lower concentrations with a high degree of precision.

In the first step of the investigation in the head space gas chromatograph, the oil is heated in a tightly sealed glass vessel to 120°C. The volatile components, including ethylene glycol, vaporise; the oil remains in the liquid phase. In the second step, a specimen is extracted from the vapour space via a hollow needle and transferred to the gas chromatograph. All of the components contained in the steam are separated by their boiling points. The ethylene glycol is detected during the data output as an individual „peak“.

The diagram shows as an example, the results of the investigation of an engine oil with 0.02% (corresponding to 200 mg/kg) ethylene glycol (black curve) and by comparison, a fresh oil without ethylene glycol (blue curve). In the case of engine oil contaminated with glycol, the corresponding „peak“ is clearly recognisable.

The investigation with the head space gas chromatograph is a component of the OELCHECK analysis set 5 for engines which are operated with petrol, diesel or plant fuels. It is also available as a supplementary individual test. In the laboratory report, the „GC glycol content in %“ is indicated in the „contamination“ column.

Supplementary devices, maximum safety of operation

Reliable and rapid: this is what OELCHECK customers think of our analysis service. In order that we may continue to cope with the constantly increasing number of samples in the future, we have made provisions. The laboratory is equipped correspondingly if a device genuinely fails for several hours.

We have invested heavily in EDP, installed supplementary devices and in part, significantly optimised existing ones. Above all, this relates to:

- **FT-IR-Spectroscopy** - this forms part of the standard for all analysis sets. With it, impurities are detected and mixing recognised, with the condition of the oil determined with regard to oxidation, nitration and sulphation. In addition to the three available devices, a new FT-IR device was installed. With the NIR, oil samples may also be investigated in the near infrared range.
- The two innovative **KF Titrators** with which the specimens are tested for their water content, are now equipped with automatic sample changers. In order to determine the ON position, a third titrator is integrated into the network. With its optimised software, it offers the possibility of titrating two samples in parallel with two autosamplers at the same time.
- The two **ICP devices** for atomic emission spectroscopy now work significantly faster due to a Cetac ASXPress Plus autosampler, which cleans the sample introduction system as early as the measurement stage.

The following explanations show how systematically OELCHECK proceeds during the introduction of optimised techniques. We usually enter new territory here with the device supplier, since such optimisations cannot be bought off the peg. They have nevertheless guaranteed that to date, no increase in prices have been required since the introduction of the euro in 2002.

In used oil analysis, atomic emission spectroscopy (AES) is the most widely used procedure. For this, OELCHECK deploys two Perkin Elmer ICP devices. These simultaneously determine 29 elements (additives, wear, impurities) with a high degree of precision within a broad concentration range for oil. In addition, through them, the monitoring of additive reduction can be carried out more precisely. The actual measuring time is brief. However, before every measurement, the entire system must be pre-rinsed with the oil of the following specimen and afterwards flushed with solvent. Only in this way have mixtures of samples and hence measuring errors been excluded. The time required for cleaning and rinsing was greater than for the measurement.

The fitting of the ICP devices with the new ASX-Press Plus provided a remedy. By virtue of a supplementary specimen loop and a 6-way valve in the sample feed, the execution of the three steps, pre-rinsing, measurement, rinsing is now overlapping. In this way, the processing time for a sample at an ICP is almost halved with the same precision. In addition, there are some positive aspects for the environment: by omitting the pre-rinsing, a smaller sample volume is required. And by virtue of the shortened analysis times, the energy and argon consumption of the ICP are considerably reduced.

Lödige lifts – makes mobility in buildings safe

In the market for more than 60 years, Lödige Aufzugstechnik GmbH has concluded thousands of projects and gained countless satisfied customers. Whether it's lifts, escalators and travelators, lifting platforms, rolling doors or façade access equipment, the experts of Lödige Aufzüge service, repair and modernise the products of every manufacturer throughout Germany. For existing objects, the company offers full modernisation or the refurbishment of individual assemblies. And evidently, Lödige also builds new lifts, matching lift solutions perfectly to the use of the building in question. The hydraulically operated installations can carry up to 30 tons and service up to 40 stops.

Lödige: lifts and escalators with state-of-the-art technology

Whether it's for the housing industry, health care, commerce or for public use, the list of references is an impressive one, with well-known names such as: BMW, Bosch, IKEA, Möbel XXXL-Lutz, Siemens, Metro, FAAG Frankfurt, Marseille clinics, Rewe, Miele, Deutsche Post or the Bundesrat [Federal Assembly].

But wherever and whatever facilities are built by Lödige, its technicians know that no two lifts or escalators are alike! That's why it is particularly important for its service technicians to know „their" facilities and customers. The Paderborn-based company thus has 8 branches nationwide so that it can act swiftly and on an individual basis.

Every operator of a facility subject to monitoring is obliged, within the framework of the Ordinance on Industrial Safety and Health (BetrSichV), to operate lifts and escalators with the latest technology, to maintain and preserve them in regular fashion, to monitor them and to ensure that qualified staff carry out necessary repair work. The maintenance intervals are not clearly specified by the law. They should nevertheless follow the frequency of use of the lift. Operators who want to play safe use Lödige's maintenance package. The full maintenance TC is an all-round carefree package and includes: reliable cost planning, delivery and installation of all parts subject to wear, remedying of operational faults, support for legal inspections, long-term availability of spare parts, regular inspection of all functions and evidently, a round-the-clock emergency service.

Maintenance operations are carried out at regular intervals 4 to 6 times per year, depending on the size of the installation. In addition, installations are examined every year by the employees of a testing body, such as DEKRA or TÜV. A Lödige service technician attends the main two-yearly inspection.

The company ensures safety through qualified maintenance at the highest level. A set component of this is the complete oil service, in which lubricant analyses by OELCHECK provide important information. A lift requires around 300 litres of hydraulic oil, larger installations significantly more. As a rule, Lödige deploys HVLPD 46-type multi-grade hydraulic oils. These oils, with a viscosity that changes little with temperature, are highly suitable for lift hydraulics which work intermittently or under moist operating conditions. Like engine oils, they have detergent and dispersing characteristics and can thus neutralise small quantities of condensate. More and more frequently, more rapidly biodegradable hydraulic oils based on synthetic esters are used, consisting of inherently shear-resistant multigrade oils. Through the polar characteristics typical of esters, the oil molecules adhere better to the hydraulic cylinders and thus ensure more uniform operation of the lift.

The usage time of a hydraulic oil in a lift until an oil change is usually 7 years. In any case, a sample is withdrawn from the tank after 5 years at the latest. This oil should be warm from operation and the lift should be operated several times beforehand, so that a genuine reference sample is also submitted. The mineral oil-based hydraulic oils of HVLPD 46 type are analysed by Lödige according to the scope of analysis of Set 2, and synthetic fluids of type HEES 46 according to Set 3 (Bio). The result of the oil analysis represents the deciding criterion as to whether and when the hydraulic fluid must be changed. A change not only incurs the cost for fresh oil. In addition to the 300 litres for filling, an additional 150 litres are required for the necessary rinsing process. Several hundred litres of oil must thus be drawn into the hydraulic area and removed from it for disposal.

But Lödige not only counts on OELCHECK lubricant analyses to define oil change intervals in routine inspections. Above all, in older systems, solid or sticky particles can threaten the hydraulics system, and eventually impede the pistons in the control block. The pistons remain suspended or stuck and there is no longer any movement. As a rule, the

Maintenance on an escalator

service technicians can avoid such failures through timely warning indications from the oil.

The importance of on the ground speed is shown by a current example from last summer. After violent weather, the cellar of a company building was flooded to a depth of several centimetres. This also affected the lift shaft, with it suspected that water had also penetrated the hydraulic fluid. The Lödige service technician was on the spot right away to take an oil sample. On the very next day, OELCHECK was able to confirm the suspicion. In order to avoid corrosion and more extensive damage to the hydraulic system, an immediate oil change was carried out. In next to no time, the lift was again operating reliably with mobility ensured.

Automated microscopic particle counting with integrated image analysis software

Clean is not pure! And even oil which looks pure at first sight can still be contaminated by the smallest particles. Particularly for hydraulic systems, oil impurities represent one of the most significant risk factors. 50-70% of all faults and failures in hydraulic and lubricant installations can be attributed to operating media contaminated by solid particles or by fluid or gaseous foreign substances. The level of contamination of an oil due to solid particles is reflected by its purity class. The purity class according to ISO 4406/1999 is indicated as a composite number, such as 21/18/13. The first number relates to particles >4 µm, the middle number to particles >6 µm and the number on the right to large particles >14 µm. For determining solid impurities, the deployment of automatic particle counters represents state-of-the-art technology. Most of these function according to the principle of light attenuation or blocking. A disadvantage of this technology lies in the fact that, e.g. air bubbles, droplets of water or roughly dispersed components inherent to the oil can influence counting in unfavourable situations. In order to be on the safe side in cases of doubt and to exclude these influences, we have installed a special OLYMPUS testing device in the OELCHECK laboratory: The automated microscopic particle counter with integrated image analysis software!

Do we go back to the good old microscope for counting particles in the laboratory? At first sight, it seems so. But the new device opens perspectives achieved by no other particle counting equipment, even if at the start of the particle counting there really was a conventional microscope.

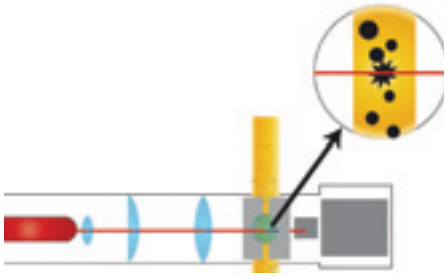
It began with the microscope

Manual microscopic particle counting was and is extremely time consuming and strenuous. In addition, it requires a trained eye and a great deal of experience on the part of the investigator, even if at an earlier stage, when simple counting devices (totalisers) were deployed, microscopic particle counting represented an almost Herculean task for the laboratory assistant. But despite the great effort: all particles appear under the microscope. Fibres and reflecting particles are very easy to recognise. Even very dark and/or heavily contaminated fluids can be investigated in a targeted way with corresponding solvents on membranes arranged in cascade-like fashion with graduated pore sizes. The oil is diluted with different solvents or also undiluted and filtered by means of pressure or vacuum admission flow through a membrane with pore sizes of 1.2 µm, 0.8 µm or 0.45 µm and a diameter of 47/50 mm.

Impurity extracted on the test membrane

The observer can then either manually „count“ the particles extracted on the filter membrane under the microscope or assign them to a purity class by comparison with representative images. Based on investigations with the microscope, additional qualitative statements may be made on the appearance, and in some cases, the origin of the detected particles.

The principle of the light blockade - milestones and the current state of the art



Sketch of the laser particle counter

As an alternative to laborious manual particle counting with the microscope, particle counting was automated. For this purpose, the first laboratory devices were developed during the 1970s. Most of the particle counting devices currently used in lubricant analysis function according to the principle of light attenuation or light blockade and use laser diodes as a light source. Two types of device are deployed here.

Liquid particle counters with optical sensors (APC)

A laser diode serves as a light source for particle counting. A photocell receives the impinging light. The larger the particle, the larger the voltage drop generated by the shaded area on the photocell. The devices are calibrated with a test liquid and pre-defined test pollution according to ISO 11171 and/or 11943. A precondition for a correct determination is that the particles pass through the light beam in sequence, in order to avoid overlap in the measurement cell. In this method air bubbles and water, or silicon droplets can adulterate the result.

Liquid particle counter with imaging techniques (OPA)

For counting particles in oils, OELCHECK uses a significantly improved method, optical particle analysis (OPA). During the investigation, the oil streams uniformly through a cell developed between two glass plates. The particles are scattered in the cell and illuminated by laser light. A high-speed high resolution camera „shoots“ images of the particles. The size of the particles can be computed by means of the pixel count. No calibration of the counter is necessary during this evaluation on the basis of a defined pixel size. The optical particle analysis procedure which we presented

in detail in ÖlChecker Summer 2002 (download at oelcheck.de), categorises individual particles and their formation mechanisms on the basis of particle form. On the basis of the image capture of the particle outlines, the particle is categorised by form of origin. With the aid of assignment to different wear mechanisms, significantly improved evidence can be obtained on the state of wear of the installation. Test devices which function in accordance with the principle of light blockade or attenuation, nevertheless have the disadvantage that, e.g. air bubbles, water droplets or roughly dispersed components inherent to the oil can influence the count (for further details, see QUESTION TIME on page 8). As a rule, this technology cannot be used for liquids deployed as a diphasic mixture, such as HFC liquids or mineral oils, the application of which entails the permanent entry of water, depending on the process.

The differential pressure procedure: a compromise solution

As an alternative method, the differential pressure procedure was introduced at the end of the 1980s and early 1990s. The decisive advantage of this technology lies in the fact that neither air bubbles nor water droplets and/or where relevant, the clouding of fluid caused by them lead to the distortion of the results. The devices designated mostly as „particle monitors" function according to the screening principle. The differential pressure increases or the volume flow decreases as a function of the particles accumulated on a filter. The pore size of the screen is 5, 10 or 15 µm depending on the manufacturer of the device. Pressure or volume flow behaviour is evaluated by comparison with variously contaminated reference oils. In this way, classification by purity class is possible. Particle monitors on the basis of the screen blockade are designed in a highly user friendly way, but do not fulfil most specifications which require information on the particle count for the respective size.

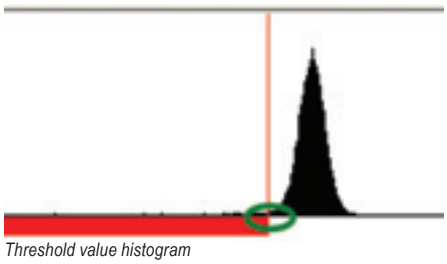
New to OELCHECK - automated microscopic particle counting

The automated microscopic particle count with integrated image analysis software newly installed in the OELCHECK laboratory, is a method in which the described negative influences do not result in any distortions to the results and which capture all of the particles on an individual basis. This is offered as a special investigation and is deployed, e.g. when the optical particle analysis generates results which can only be interpreted in a conditional manner or if residues from a filter or sludge-like sediments are to be analysed.

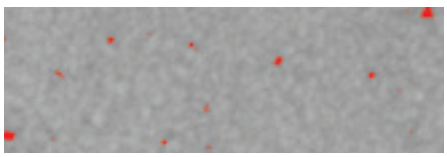
In addition to the categorisation in the conventional ISO 4406/1999 purity classes, the results of the OLYMPUS special microscope also allow qualitative statements. Reflecting, e.g. metallically bright, coloured particles or fibres can be registered and evaluated separately. Through the use of adequate solvents and dilution conditions in preparing the test membrane, interfering liquid components inherent to the oil may be separated. This allows, e.g. additive-related influences on the count result to be excluded. The automated capture of the particles and rapid processing using a high-resolution camera and specially developed image analysis software guarantee a precise analysis which only takes a few minutes. The elaborate manual microscopic count may be omitted. This opens entirely new perspectives for particle analysis.

The use of various solvents and adapted dilution conditions in preparing the sample offers, e.g. the possibility of keeping special active substances, dispersed depending on function, away from the membrane. This new method may even be deployed for non-homogeneous fluids which may contain several fluid phases (e.g. HFC fluids) and which often tend towards colouring or formation of deposits on the filter membrane. Through the targeted choice of threshold levels for particle recognition and the brightness adjustment of the incident light source, included particles may be safely detected.

Calibration with test dust, prescribed for fluid particle counters, may be omitted from the microscope. The particles are measured two-dimensionally, with the longest extension appearing as the particle size in the laboratory report according to ISO 4406/1999. Possible deviations on the basis of the differences between test dust and actual impurities need not be considered.



Threshold value histogram



Recognised particles on test membrane

Examination procedure

According to the lubricant and deployment, the sample is diluted with the necessary solvent. 50 ml of the homogenised sample is filtered through a dried 47 mm filter membrane. Following this, the membrane is flushed with filtered solvent, dried and the weight gain due to the pollution determined. The microscope has a motor-operated cross-sliding table controlled by software, on which the membrane is stretched in a special holder and positioned.

Before the start of measurement, focus points are defined and a selection of a representative membrane section made for analysis. After defining the threshold value for distinguishing between particles and the background membrane, the sample is „raster scanned" microscopically in incident light mode. A high-resolution CCD camera captures all of the particles which appear darker for the grey value. Through image analysis software, these are measured and categorised by their longest extension.

The display of results in the OELCHECK laboratory report

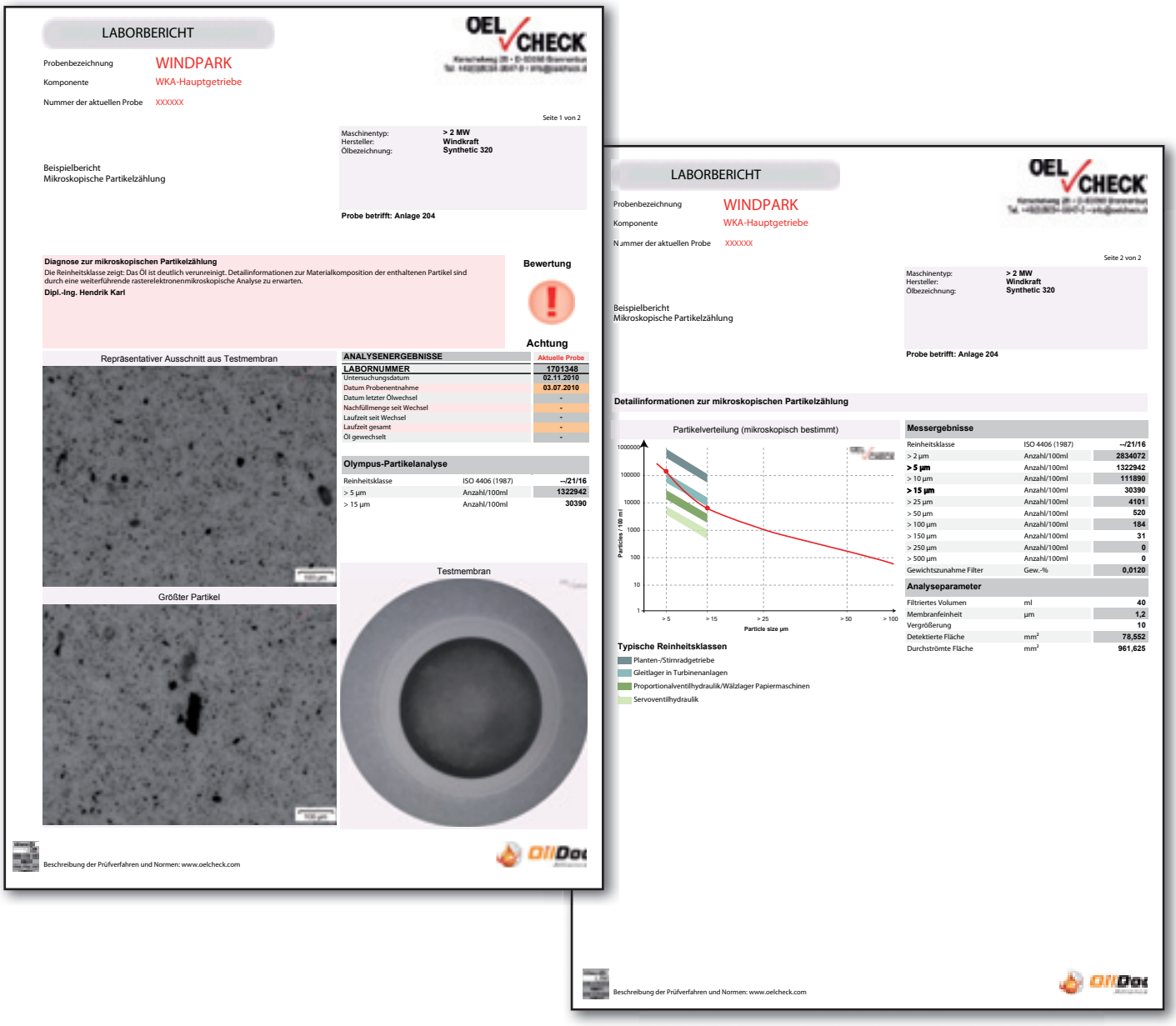
Specification of the purity class is carried out as normal according to ISO 4406/1999. In any case, for the microscopic count, only two classes are specified, which can be calculated from the count of >5 µm and >15 µm sized particles. In order to ensure an easier assessment of the particle distribution, the particle numbers in the >2, >5, >15, >25, >50, >100, >150, >200, >500 µm gradations are represented in tabular and graphical form in the laboratory report.

A colour photograph documents a representative section of the test membrane, being generated with the use of polarised light. The laboratory report also includes an image of the largest detected particles with a 100x enlargement.

Microscopic particle counting with integrated image analysis software sees more

A few months after the commissioning of a wind power plant with an output of over 2MW in southern Europe, an inspection of the planetary gearing revealed unusually strong contamination of the filters. The first investigation of a 100 ml sample in the OELCHECK laboratory gave a conspicuously high proportion of magnetisable metal particles in the oil for a relatively low ferrous value of the PQ index. After this alarm signal and the indication of acute gear wear, the gears were inspected and an oil sample analysed again. The inspection showed no indication of damage to the gear wheels. But where could particles which represented such a threat to the gears and which were present in the filter and the sample have come from?
An investigation of the filtered residues with the OLYMPUS special microscope provided a solution to the riddle. By means of the photographs compared to the laboratory data, the service engineers were able to identify the particles. The cause was not gear wear. A company involved in the assembly of the facility had not done its work properly. In this way, particles of dirt with a contaminating effect and flakes of lacquer pigments from the external painting were present in the gear oil, which most evidently derived from incorrect assembly. A change of oil, which removed the solid particles, provided a rapid remedy before the solid impurities could cause initial damage to the roller bearings and abrasive wear on the surfaces of the tooth profiles.

In the illustrated laboratory report, the exciting research into the causes may be understood.



LABORBERICHT

OEL CHECK

Probenbezeichnung WINDPARK
Komponente WKA-Hauptgetriebe
Nummer der aktuellen Probe XXXXXX

Seite 1 von 2

Maschinentyp: > 2 MW
Hersteller: Windkraft
Ölbezeichnung: Synthetic 320

Beispielbericht
Mikroskopische Partikelzählung

Probe betrifft: Anlage 204

Diagnose zur mikroskopischen Partikelzählung
Die Reinheitsklasse zeigt: Das Öl ist deutlich verunreinigt. Detailinformationen zur Materialkomposition der enthaltenen Partikel sind durch eine weiterführende rasterelektronenmikroskopische Analyse zu erwarten.
Dipl.-Ing. Hendrik Karl

Bewertung
Achtung

Repräsentativer Ausschnitt aus Testmembran

Größter Partikel

ANALYSENERGEBNISSE		Aktuelle Probe
LABORNUMMER		1701348
Untersuchungsdatum		02.11.2010
Datum Probenentnahme		03.07.2010
Datum letzter Ölwechsel		-
Nachfüllmenge seit Wechsel		-
Laufzeit seit Wechsel		-
Laufzeit gesamt		-
Öl gewechselt		-

Olympus-Partikelanalyse		
Reinheitsklasse	ISO 4406 (1987)	--/21/16
> 5 µm	Anzahl/100ml	1322942
> 15 µm	Anzahl/100ml	30390

Testmembran

Beschreibung der Prüfverfahren und Normen: www.oelcheck.com

LABORBERICHT

OEL CHECK

Probenbezeichnung WINDPARK
Komponente WKA-Hauptgetriebe
Nummer der aktuellen Probe XXXXXX

Seite 2 von 2

Maschinentyp: > 2 MW
Hersteller: Windkraft
Ölbezeichnung: Synthetic 320

Beispielbericht
Mikroskopische Partikelzählung

Probe betrifft: Anlage 204

Detailinformationen zur mikroskopischen Partikelzählung

Partikelverteilung (mikroskopisch bestimmt)

Particles / 100 ml
1000000
100000
10000
1000
100
10
1
> 5
> 15
> 25
> 50
> 100
Particle size µm

Typische Reinheitsklassen
Planten-/Stirnradgetriebe
Gleitlager in Turbinenanlagen
Proportionalventilhydraulik/Wälzlager Papiermaschinen
Servoventilhydraulik

Messergebnisse		
Reinheitsklasse	ISO 4406 (1987)	--/21/16
> 2 µm	Anzahl/100ml	2834072
> 5 µm	Anzahl/100ml	1322942
> 10 µm	Anzahl/100ml	111890
> 15 µm	Anzahl/100ml	30390
> 25 µm	Anzahl/100ml	4101
> 50 µm	Anzahl/100ml	520
> 100 µm	Anzahl/100ml	184
> 150 µm	Anzahl/100ml	31
> 250 µm	Anzahl/100ml	0
> 500 µm	Anzahl/100ml	0
Gewichtszunahme Filter	Gew.-%	0,0120

Analyseparameter		
Filtriertes Volumen	ml	40
Membranfeinheit	µm	1,2
Vergrößerung		10
Detektierte Fläche	mm²	78,552
Durchströmte Fläche	mm²	961,625

Beschreibung der Prüfverfahren und Normen: www.oelcheck.com

OEL CHECK®

ÖlChecker

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QUESTION TIME

The industrial gear oils deployed by us are investigated not only by OELCHECK but in some cases, in the laboratory of the old manufacturer or of the filter supplier as well. This has shown that for such comparative analyses, the data for purity classes is often divergent. What might the cause of this be?

OELCHECK:

Even assuming that the samples are optimally distributed as a homogeneous mixture (samples withdrawn in sequence are already inherently distinguishable from each other) and that the calibration of the particle counters is carried out according to the same standards, the purity classes on deployment of automatic fluid particle counters (APC) may actually turn out to be divergent. The high viscosity ISO 220 or 320 gear oils are particularly affected by the differences, as they are deployed, for example, in wind power installations. These oils must normally be diluted before they can be examined with an automatic particle meter. Unfortunately, there is still no standard as to how and in which ratio this dilution should occur and how the particles present in the solvent are to be treated. The selected diluent and the respective mixing ratio can nevertheless significantly influence the determined purity classes.

For the dilution of the highly viscous gear oils, analytical laboratories use the following solvents in different mixing ratios:

- Heptane, xylene or kerosene, diluted with gear oil in a 1:1 ratio
- Pure toluene or a toluene mixture, in a dilution ratio of 1:3
- Specially cleaned aviation hydraulic oil, (basic oil for calibration) in a ratio of 1:1.

Used gear oil may contain the greatest variety of soft and hard particles. Hard particles, which get into the oil through pollution or abrasion, are particularly damaging to the rolling bearings. Particles which are relatively soft and which have a lubricant effect, such as additives and their reaction products, tribopolymers or silicon defoamer droplets normally do not harm the gears. For some types of oil, these soft components are desirable by-products for better reduction of wear. Small air bubbles and droplets can also interfere with the counting. During investigation, all of these particles, small droplets and bubbles pass through the optics of the automatic particle counter. The electronic counter can observe them as shadows. The counting procedure is not, however, able to distinguish soft particles or air bubbles from hard particles which may cause problems.
As a solvent, toluene can provide assistance here. It has the advantage of dispersing the majority of oil-based reaction products, tribopolymers and water and silicone droplets in oil so finely that the counter can no longer detect them. In this way, the particle counter only captures the hard particles. The deployment of toluene is highly practical for gear oils from a technical measurement perspective, but due to possible harmful effects on health, must be handled in the laboratory with particular care.
OELCHECK will be using toluene in future in connection with the optical particle analysis (OPA), diluting the oil in a ratio of 1:3 in such a way that it can pass the optical path at a steady speed. Before dilution, the particles are counted in a fresh solvent and taken into account as a blank value. Under these conditions, we can assume that the purity classes established in the OELCHECK laboratory reports reflect the actual condition of the oil with regard to harmful hard impurities as accurately as possible.
The values indicated for purity classes by on-line or on-site particle counters cannot be compared with the purity classes determined in the laboratory. These particle counters are highly suitable for tentative trend observation (e.g. the oil became cleaner). The displayed numerical value for purity cannot however be compared with calibrated particle counters.

If a sample should be found to have significant differences between the purity classes of OELCHECK and those of an external laboratory, the underlying conditions for the count should be ascertained and compared with our information.

**OELCHECK also answers your questions concerning tribology and lubricant analyses.
Send us your questions by e-mail (info@oelcheck.de) or by fax (+49 8034/9047-47).**