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OEL CHECK®

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ÖlChecker

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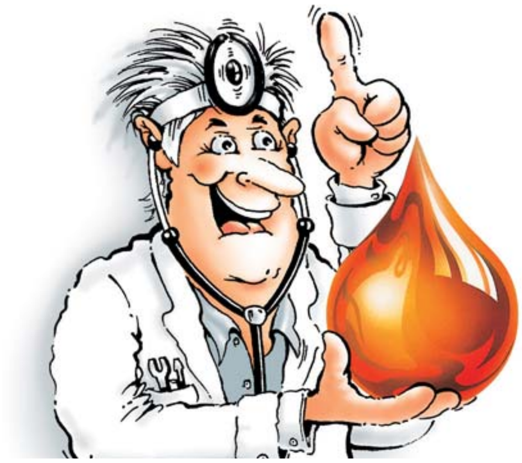

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Liebherr particle filters protect people and the environment

Soot filters: indispensable for construction machinery used in closed spaces

Liebherr's robust, high-power diesel engines are used primarily in the company's earthmoving equipment, mobile cranes and special machines. They are characterised by advanced technology and precise machining.

The four- and six-cylinder inline engines produced in Bulle (Switzerland) and the six- and eight-cylinder V-engines cover the power range of 200 to 500 kW. A combination of intelligent electronic design and advanced injection and exhaust recirculation technologies not only ensures compliance with European emission regulations, but also forms the basis for fulfilling even more stringent requirements in the future.

Very high fuel efficiency is achieved with modern common-rail diesel injection systems. However, these systems also lead to the production of extremely fine combustion and soot particles, which are only marginally captured by the motor oil. Soot and fine particles carried in the exhaust stream that end up in the environment can be harmful to health. For this reason, machines powered by diesel engines cannot be used in environmentally sensitive application areas such as tunnel construction or in closed buildings such as recycling plants unless they are equipped with a soot filter in the exhaust path. For approximately three years, Liebherr has offered suitable filters for OEM installation or retrofitting.

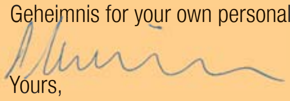
One of the challenges in developing these particle filter systems for construction machinery is that they are essentially different from exhaust handling systems for diesel lorries due to different standards and requirements. In the latter systems, selective catalytic reduction (SCR) is used to reduce nitrogen oxide (NOx) emissions by approximately 90% (in stationary operation). Among other things, this is achieved by injecting AdBlue, a clear 32.5% solution of high-purity synthetic urea in demineralised water, into the exhaust stream. This urea solution, which is used at a rate up to 1.5 litres per 100 km, is held in a separate tank. It is sprayed into the exhaust stream ahead of the catalytic converter by a dosing pump or an injector. With the aid of the urea, the nitrogen oxides (NOx) are converted into nitrogen and water vapour in a chemical reaction. This "active" aftertreatment of exhaust gases to reduce nitrogen oxides for diesel engines in construction

Check-up

Imagine that you're reading the new book Traumfirma ("Dream Company") and you find OELCHECK among the twelve companies presented there. Is this just a pipe dream? No, it's not: we are indeed one of the dream companies described by Christine Sönnig and Georg Paulus in their new book. The qualifying conditions are that the principles they described in their first book Traumfirma are present in the company and put into practice to at least a certain extent. We didn't even apply to be included in the project. An instructor who conducted a telephone training course for OELCHECK employees proposed us as a candidate. That's what started the ball rolling, and the authors paid us a visit.

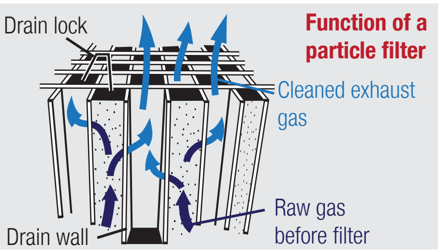
They examined our company in detail and conducted a "dream company potential" analysis by means of an anonymous employee survey. The result was clear: OELCHECK is a genuine dream company, even though the demands on OELCHECK employees are higher than average. Since the founding of our company in 1991, the number of tested specimens has doubled every four years, and we now have more than 50 employees. This sort of growth creates major challenges, especially with regard to corporate culture. In a small family business, everybody knows each other and personal contact between employees and the boss is a matter of course. Maintaining this personal contact, even with our further expansion, is one of the main concerns of our management team. Even with all the technology, people come first at OELCHECK. This is how it is and how it will remain, because after all OELCHECK is a dream company!

One more tip: at www.traumfirma.de/geheimnis.htm you can order a copy of Traumfirmen – und ihr Geheimnis for your own personal inspiration. I hope you enjoy it!



Yours,
Barbara Weismann

machinery is still a long way off. However, AdBlue will become a current topic for mobile machinery as well by the time Level 4 of the Exhaust Gas Standard takes force in 2014.



The primary task of particle filters for construction machinery is to reduce soot emissions. Liebherr's designers have developed particle filter systems tailored precisely to the company's construction machines. They are designed to withstand the severe conditions of construction site use, and they remove at least 97% of the soot and fine particles while reducing carbon monoxide (CO) and hydrocarbon (HC) emissions by 75 to 90%. Five filter sizes are available, corresponding to different engine power ratings. They can easily be adapted to the equipment, even in case of retrofitting. The systems are installed in place of the existing silencer, whose role they also assume. The system is integrated in the engine compartment. The Liebherr solution reliably avoids field of view restrictions, as is sometimes the case with equipment retrofitted outside the engine compartment.

Of course, even the best particle filters require maintenance. Although the retained soot particles are automatically oxidised by continuous passive regeneration when the exhaust temperature is greater than 250°C for at least 50% of the operating time, combusted or evaporated motor oil constituents containing metallic elements, such as calcium, phosphorous, zinc, sulphur or boron, remain in the filter module as deposits. These oil residues must be removed with all types of diesel particle filters (DPFs). If the low-ash Liebherr 10W-40 motor oil developed especially for use with DPF systems is used, the cleaning interval can be increased from an average of 1,000 operating hours to 2,000 operating hours. At the end of this interval, the filter module is dismounted and sent to a service centre, where it undergoes heat treatment in a special oven and is then cleaned.

In addition to the right motor oil with fewer ash-forming additives than conventional motor oils, fuel quality is a critical factor for proper operation and effectiveness. Only diesel fuel that has a sulphur content less than 50 ppm (0.005%) or complies with the EN 590 standard may be used. Heating oil, which usually contains considerably more than 1,000 ppm sulphur, would negate the effectiveness of the DPF and therefore cannot be used a fuel. It is essential to use a low-ash, low-SAPS motor oil, which means an oil with low sulphate ash, phosphorus and sulphur (see the "Question time" section of this issue for more information on low-SAPS motor oils). Liebherr low-ash 10W-40 motor oil is specifically formulated for heavy-duty diesel engines with particle filters and/or exhaust gas aftertreatment systems. It complies with the ACEA E4, E6 and E7 specifications and the US API CF-4, CG-4, CH-4 and CI-4 specifications. It is also specifically approved by leading engine manufacturers. However, it must be borne in mind that low-ash motor oils have a reduced alkali reserve (measured as the Base Number or BN) and therefore have less capacity for neutralising acids, which arise in greater quantity when sulphur-containing fuels are used.

Depending on the model, the engine of a construction machine holds 20 to 50 litres of motor oil. Based on field tests using engines with DPFs, Liebherr recommends changing the oil at fixed intervals of 500 operating hours. If the oil lifetime is exceeded without supplementary oil checks, there is a risk of engine damage due to increased viscosity and the formation of spongy deposits as a result of an increased concentration of soot particles in the motor oil, which contains fewer dispersants than conventional motor oils on account of the low-ash characteristic.

The experts in the Liebherr customer service department strongly advise against the use of a supplementary bypass filter for uncontrolled extension of the oil service interval. Experiments accompanied by oil analyses have repeatedly shown that the primary reason for the extended oil change interval is solely the increased oil volume resulting from the bypass filter.

The decisive factors for reliable engine operation and full effectiveness of the particle filter are regular checks and maintenance, the low-sulphur quality of the diesel fuel, and a low-ash, high-performance motor oil. Periodic oil analyses indicate whether the soot content of the motor oil has passed the critical 4% level and whether adequate amounts of dispersants are still present in the oil. For example, if an engine is filled with a motor oil that is not low-ash or a fuel with too much sulphur content is used with a low-ash motor oil, this can have negative effects on the engine and the particle filter. If anything goes wrong, OELCHECK can test the fresh and used oils, as well as the fuel, in its laboratory. This determines precisely whether an unsuitable lubricant or an unsuitable fuel was used.

OilDoc Conference & Exhibition

Feb. 1-3, 2011
Rosenheim · Germany

Lubricants
Maintenance
Tribology

Current information at:
www.oildoc.com

Welcome to Rosenheim
just 50 km from Munich, Bavaria




International cooperation and a top-class committee

The OilDoc Conference and Exhibition is the leading European event in the fields of lubrication, maintenance and tribology.

This is where the leading lights of the R&D world, renowned scientists, experienced technical specialists and experts on the effective use of lubricants get together. In addition to OELCHECK, the American STLE is now an official supporter of this event. The Program Committee is top-class. In addition, leading international media cooperate with the OilDoc organisers and have already started with preparatory reporting.

Official supporter: STLE

The Society of Tribologists and Lubrication Engineers (STLE) is an official supporter of the OilDoc Conference and Exhibition. It is probably the world's most important association of tribologists and lubricant engineers. STLE represent the interests of more than 4,000 technology experts in the industrial, scientific and administrative sectors in the USA, Canada, and many other countries. STLE offers its members:

- an extensive range of seminars;
- valuable opportunities for international networking;
- a wide variety of technical information, along with the Journal and the Newsletter.
- STLE courses are at the leading edge. There is no European organisation that offers training courses at the same high level. Nevertheless, STLE certification as a lubrication technology specialist, metalworking fluids specialist or oil monitoring analyst commands international respect.

Extensive information on STLE is available at www.stle.org or personally at the OilDoc Conference and Exhibition in February 2011. The Program Committee includes an STLE representative. In addition, STLE participates in the event with technical presentations and its own information booth at the exhibition.

The Program Committee features prominent individuals

Prominent members of the scientific community and leading figures in the application sector are actively involved in the Program Committee.

The German members include (photos from top left to bottom right):
Prof. Dr.-Ing. Wilfried J. Bartz from the Technical Academy of Esslingen, Dr.-Ing. Mathias Woydt from the German Federal Institute for Materials Research and Testing (BAM), Dr.-Ing. Klaus Michaelis from the FZG Technical University of Munich, and Dr Arthur Wetzel from ZF Friedrichshafen AG. The committee is chaired by Dipl.-Ing. Peter Weismann from OilDoc GmbH and Dipl.-Ing. Rüdiger Krethe from OELCHECK GmbH.

OilDoc in the media

The first preliminary announcements have already appeared in publications such as VDI Nachrichten, Instandhaltung, and Betriebstechnik & Instandhaltung.
A major advertising campaign in Tribology & Lubrication Technology (TLT), the house journal of STLE with a circulation of 13,000, began in April.
A cooperation agreement with the publisher Moderne Industrie was signed recently for the following magazines:

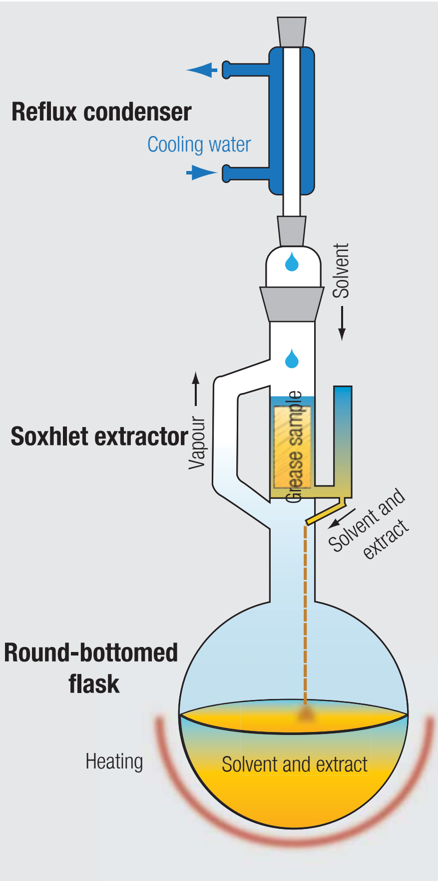
- Fluid
- ke
- Maintenance
- Production

In addition, a cooperation agreement has been inaugurated with the American publishing company Lubes'n'Greases (LNG). LNG publishes several print and online publications. Lubes'n'Greases is published for American readers and in a special edition for Europe. LNG's weekly newsletter Lubreport reaches 13,200 subscribers in more than 115 countries. Lubes'n'Greases will report on the OilDoc Conference and Exhibition in the print and online versions of its newsletter. An advertisement for the OilDoc Conference and Exhibition will appear in the May 2010 issue of LNG.

Online now – download the English version of ÖlChecker!

It was certainly high time. During the past months, we received more and more requests from our customers for an English version of ÖlChecker. Now the first English version of ÖlChecker has appeared with the Winter 2009 issue. From now on, every successive issue will be translated. Around two to three weeks after the German version appears, the English version will be ready at www.oelcheck.com under Downloads. The German print version of our customer newsletter has been published three times each year since 1998, and it has now reached the proud circulation figure of 8,500 copies per issue. With the English version, ÖlChecker opens up an entirely new dimension in the twelfth year of its existence.

New: oil content analysis of lubricating greases using a Soxhlet extractor



Soxhlet extractor

The Soxhlet extractor takes its name from Professor Franz von Soxhlet (1848–1926), who originally used it to determine the fat content of dried foods. However, with only minor modifications the apparatus he developed also does an excellent job of separating the base oil and thickener of a lubricating grease.

Lubricating greases usually consist of 70 to 90% oil The rest is a thickener based on a metallic soap such as a lithium, calcium, barium, aluminium or other soap, which acts like a sponge that holds the oil. After the oil has been separated from the soap, it is possible to draw conclusions about more than just the oil and thickener components of the grease. Separation into solids and oil also enables a thorough analysis of the type of base oil used, including its composition (mineral or synthetic), viscosity (high or low), and additive content (EP additives, antioxidants and corrosion inhibitors).

A solvent such as n-pentane is used to extract the base oil from the fresh or used grease. It is poured into a round-bottomed flask. The Soxhlet extractor with the extraction thimble is placed on top of the flask. The thimble is made from latex to prevent entrainment of the entire specimen. This latex thimble acts as a membrane through which the base oil and the solvent can diffuse, while the solid components remain behind. A water-cooled reflux condenser is located above the Soxhlet extractor.

The solvent is heated to boiling point in the flask. The vapour rises up to the reflux condenser, where it condenses. The liquid solvent drips back down into the Soxhlet extractor containing the grease specimen. The solvent passes through the latex thimble and thins the soluble components present in the grease to the point that they separate and are able to diffuse through the latex. When the extractor is full, the mixture of solvent and oil flows through an external siphon back into the round-bottomed flask. This process is repeated several times in order to extract as much oil as possible from the grease. Only the solvent is vaporised in this process; the already extracted oil remains in the flask due to its higher boiling point. This means that only pure solvent reaches the grease specimen each time.

Conclusion

After completion of the extraction process, only the thickener or the soap structure of the grease or solid lubricant, such as graphite or MoS_2, is left in the latex Soxhlet thimble. The solid component of lubricating pastes can also be analysed.

The round-bottomed flask contains the solvent and the dissolved base oil. The solvent is distilled off. What remains is the base oil used to produce the lubricating grease, including its oil-soluble additives, adhesion enhancers and other oil-like additives.

These two constituents can be investigated separately. In particular, it is possible to perform tests on the base oil that would not be possible with the formulated grease. An element analysis using ICP provides information on the sulphur content of the base oil. The elements that can be detected in the base oil are fully dissolved, while solid constituents and wear particles remain in the thickener. The oil type is determined using IR spectroscopy. The viscosity of the base oil can be determined easily.

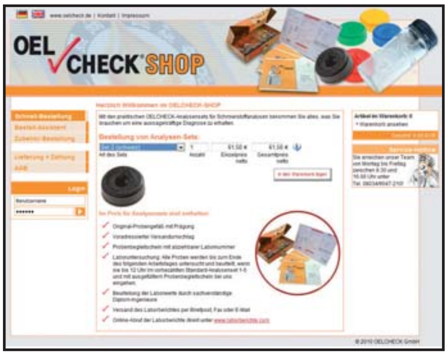
OELCHECK offers Soxhlet extraction as an individual test. The required amount of grease is approximately 5 g. For damage analyses, it is advisable to compare the used grease with the fresh grease because the analysable contaminants and wear particles also remain in the latex thimble when the used grease is processed.

Grand opening! Our significantly improved OELCHECK shop is now online!

Our customers have been able to order analysis kits and accessories online for many years. Unfortunately, the range of choice was limited. Starting now, everything is much easier because we have significantly improved our online shop.

- If you simply wish to reorder our standard analysis set, just click the "Fast Order" button.
- If you don't know which analysis set is the most suitable for a particular specimen, the "Order Wizard" can help you out. Indicate which type of equipment you will be taking specimens from, and you will see OELCHECK's recommendation for the optimal scope of testing. You can also display a sample laboratory report.
- The "Accessories Order" button takes you to our practical assistant for sample taking, with an image of each item.

It takes only a moment to register for the Online Shop, which saves you the trouble of entering your address data in the future. If you have already registered your data for accessing our customer portal at www.laborberichte.com, you can use this data for convenient log-in right from the start. Your data is stored directly.



Fischer: 101 injection presses and 9 million plastic plugs a day

It's hard to find a company that embodies the German spirit of innovation better than Fischerwerke GmbH & Co. KG. Founded 62 years ago, it is now one of the world leaders in fastener technology.

For 30 years, Professor E.h. Senator mult. E.h. Dipl.-Ing. (FH) Klaus Fischer has been at the helm of the company group. Under his leadership, Fischer has developed into an internationally active enterprise offering reliable, cost-effective solutions in the chemical, steel and plastic sectors.

The foundation for this was laid in 1958 by company founder Artur Fischer with the invention of the "S plug", an expanding plug made from plastic. With more than 1,100 registered inventions and 570 granted intellectual property rights in Germany alone, he is one of the country's most influential innovators. His most important inventions include the synchroflash (1949), undercut anchors for concrete and fischertechnik construction kits. Nowadays innovation is on every employee's agenda at Fischer, and it is not limited to products. Each year the staff generate 14 patent applications for every 1,000 employees.

This innovative force can presently be seen in Waldachtal in the Northern Black Forest region, where approximately nine million plastic plugs in all imaginable varieties are produced every day.

In order to manufacture these enormous product volumes, the company currently has 101 injection presses available. The majority of these precision machines were made by Arburg. Injection presses from Ferromatik Milacron and Netstal are also used. The injection presses operate 24 hours a day. Around 11 metric tons of plastic granulate are processed each day for the daily output of 9 million plastic plugs.

Fischer relies on absolute top performance. Everything must work perfectly. The central maintenance department, with a staff of 12 led by Werner Stahl, is responsible for the maintenance of the equipment in the Waldachtal plant. Their duties also include filling, monitoring and servicing the hydraulic systems of the equipment. An injection press holds 200 to 700 litres of hydraulic fluid, depending on the model. HLP 46 hydraulic fluids meeting the DIN 51524 T2 standard are used. Quality is a key consideration in the selection of the hydraulic fluid.

Fischerwerke has a diverse product spectrum!

Fischer's maintenance technicians impose precisely defined requirements on the hydraulic medium, such as:

- maintaining a high purity class, starting with the delivered fresh fluid;
- good filtration characteristics;
- rapid air separation capability, since excessive dissolved air in the fluid can cause cavitation in pumps and valves;
- zinc-free and low-ash for the latest generation of machines;
- high aging stability;
- reliable corrosion protection.

Maintaining optimal purity classes is a particularly crucial criterion for fluid selection and assessing use characteristics. To avoid the impairment of components or oil lifetime by residual contamination, even fluids prefiltered by the manufacturer are always filtered again before they are added to the hydraulic system. Although the injection presses are equipped with microfilters as standard equipment, the hydraulic fluid is also filtered again once each year with a mobile bypass filter unit as part of preventive fluid maintenance.

The aim of the maintenance staff is to achieve the longest possible oil lifetimes together with maximum operational reliability of the equipment. Consequently, the hydraulic system contents are changed solely on the basis of the condition of the fluid, rather than on the basis of the number of operating hours. Here OELCHECK lubricant analyses serve as trustworthy control and monitoring tools. At least once a year, fluid specimens are taken from the hydraulic systems of all injection presses and tested in accordance with Analysis Set 2.

Fischer's maintenance staff have already managed to achieve considerable savings with the consistent implementation of their strategy. After all, the time required to take specimens and the price of an oil analysis are negligible compared with the effort of an oil change or the cost of a new charge of hydraulic fluid. What's more, Fischer has sworn to banish every form of waste in its operational activities.

There's a good reason why Klaus Fischer was once called "Germany's greatest process optimiser" in a major newspaper.

Analysis Set 2: ideal for stationary hydraulic systems

- Precise determination of particle counts and sizes with indication of the three purity classes according to ISO 4406, as well as other particle sizes greater than 21, 38 and 70 µm in accordance with SAE 4059.
- Wear metals. Copper, which is present in pipes and non-ferrous alloys, is especially significant. In addition, trace amounts of iron, chromium, tin, lead, aluminium and nickel are determined.
- Magnetic iron wear particles in the form of the PQ index can be used to draw conclusions regarding corrosive wear (non-magnetic) versus abrasive wear.
- Additives such as calcium, zinc, phosphorous and sulphur are present in HLP oils containing zinc. Zinc-free oils contain only sulphur and phosphorus as elements. In the analysis, attention is given to the fact that zinc-containing and zinc-free HLP hydraulic fluids should not be mixed with each other, due to the risk of poor filtration characteristics resulting from zinc soap formation.
- Any contaminants such as silicon, potassium, sodium or water that may be present indicate whether water, such as hard water from the cooling circuit which evaporates at a temperature of 80°C, has left its "hardening agents" and mineral content in the oil.
- Comparison of the infrared spectrums of the fresh and used oil indicates the extent of oil aging and oxidation.
- The viscosity at 40°C and 100°C and the viscosity index provide an indication of the additives and of oil aging and mixing.
- The visual impression, odour and appearance allow a plausible diagnosis to be recognised in combination with the other values.

Typical limit values for motor oils from diesel engines (stationary or non-stationary)

Wear metals, contaminants and additives

Limit levels and warning levels serve as indicators of the amounts of foreign particles found in used oil that are still tolerable or, when compared with fresh oil, indicate when the altered lubricant must be changed.

Values well above tolerable wear levels can also indicate an acute damage process. However, it is not easy to specify these warning levels. Hardly any engine or equipment manufacturer defines limit levels for used oil. This is because the operating conditions and times are too specific and the origins of the foreign particles found in the oil are too diverse. Consequently, determining these factors is one of the essential tasks of every oil analysis. After all, the type, quantity and (to a certain extent) the size of the particles provide valuable information about wear, contaminants, and the additives in the oil. We already listed the limit levels for wear metals in the Spring 2001 issue of ÖlChecker (oelcheck.de/downloads). However, since then additional test methods have become available. Engine performance levels have been consistently upgraded, other fuels are used now, and low-viscosity motor oils reduce fuel consumption. This means it's high time to publish up-to-date warning levels based on millions of used oil analyses performed by OELCHECK on oil specimens from diesel engines in utility vehicles and construction machines.

When warning and limit levels are used for the diagnosis of a specific oil specimen, the interactions between the values and other criteria should also be taken into account. A variety of factors play a role here, including the engine manufacturer, the engine type, the type of fuel used, the oil volume, the motor oil type, the service life of the motor oil, and any topping-up quantities. The operating conditions can also vary markedly from one situation to the next. After all, the engine of a heavy construction machine operates under different conditions than the engine of a lorry travelling long distances on a motorway at uniform speed.

However, all of these engines have one thing in common: their motor oil contains a lot of valuable information about the oil itself as well as the state of the engine. For example, the microscopic particles suspended in the oil provide an indication of the amount of wear of the corresponding parts or components. Elements such as sodium, potassium or silicon indicate contamination by road salt, hard water, glycol antifreeze or dust. Comparison of the amount of metallo-organic additive elements (such as calcium, magnesium, phosphorus, zinc, sulphur or boron) in the used oil and fresh oil also provides an indication of changes to the oil, such as additive depletion or possibly the mixing of different types of oils.

OELCHECK uses ICP to determine more than thirty different elements in motor oils. In addition to the presence of the elements, atomic emission spectroscopy (AES) is used to determine the concentrations of the elements (for more information on ICP, see ÖlChecker Winter 2005, pages 6 and 7, or oelcheck.de/wissen).

OELCHECK routinely determines the following elements and values as part of motor oil testing and lists them in the lab report: iron, chromium, tin, aluminium, nickel, copper, lead, calcium, magnesium, boron, zinc, phosphorus, barium, molybdenum, sulphur, silicon, sodium, and potassium. In some cases OELCHECK also determines other elements, such as silver, vanadium, tungsten, or ceramic elements such as cerium and beryllium, which are only rarely present in motor oils. They are only listed in the lab report if they are actually proven to be present or if the customer specifically requests this.

The table on the right shows the possible cause for the presence of the elements found in oil, i.e. whether they are related to contaminants, wear or additives.

Various factors must be taken into account when assessing a lab report and the values of the elements found in the oil. Naturally, it is not sufficient to simply assess the elements based on their quantities. In order to assess the measured values, it is important to know whether the individual elements indicate contamination, wear, or changes to the additives. However, these values are also interrelated to a certain extent. The relative proportion of various wear elements provides an indication of the affected machine parts or components, for example. In addition, it is important to know how long it has taken for the oil to become enriched with specific wear elements since the last oil change. The operating time of the overall system or the running time of the engine, the oil volume relative to the engine power, and the topping-up amounts must also be considered when analysing or diagnosing warning levels.

In order to reliably assess the values determined for the used oil and their relationship to each other and to other factors, it is necessary to have a suitably large volume of data and analytical expertise. Based on the results of millions of oil specimens, their expertise and many years of experience, OELCHECK's diagnostic engineers can define warning levels that form a valuable basis for assessing the analytical data. However, additive elements and base oil types can differ considerably, depending on the type of oil used, so it is necessary to set suitably broad warning levels. Specific warning levels can only be defined for a specific oil type.

The basic rule:

Warning levels must be set lower:

- the larger the oil volume;
- the shorter the oil service life;
- the lower the engine speed;
- the lighter the load.

The warning and limit levels listed in the following table for wear elements, contaminants and additives are based on:

- a semi-synthetic diesel motor oil, SAE 10W-40, API CJ-4, ACEA E7;
- used in a modern diesel engine with an oil volume of approximately 25 to 50 litres;
- operation using fuel compliant with EN 590 (contains 5% FAME);
- a motor oil service life of approximately 500 operating hours or a mileage of approximately 75,000 km.

However, the stated values are distinctly dependent on the oil manufacturer, the correct engine type, the service life of the oil charge, the oil volume, and the topping-up quantities (if any).

Table 2: Warning and limit levels for oils used in diesel engines

Element		Upper warning level	Origin of the element in the motor oil specimen
Wear elements			
Iron	Fe	80–180	Cylinder block, cylinder head, timing wheels and timing chains, valves, valve tappets and guides, crankshaft, camshaft, rocker arm shaft, piston pins, roller bearings (with chromium), oil pump. Rare: residues of ferrocene, a fuel additive for soot reduction. Distinguishing between corrosion and wear based on the PQ index.
Chromium	Cr	4–28	Piston rings, crankshaft bearings, piston pins, exhaust valves, gaskets, guide bushes, chrome-plated parts and gearwheels. Fe, Al and Cr are usually found in combination with Si in engines, because dust causes the most piston (Al), piston ring (Cr) and cylinder (Fe) wear.
Tin	Sn	12–24	Often together with lead (Babbitt bearings) or copper. Running surfaces of connecting-rod bearings, rocker arm shaft and piston pin bearings, solder (consisting of lead and tin) in soldered radiator joints; constituent of some synthetic base oils, additives in flame-resistant fluids.
Aluminium	Al	12–55	Primarily from pistons, oil pump housings, oil coolers, torque converter parts, turbocharger, guide bushes, plain bearings, cylinder blocks of all-aluminium engines (together with silicon) and dust containing bauxite (aluminium oxide).
Nickel	Ni	1–3	Alloy constituent of exhaust valves, valve guides, turbochargers, high-strength gearwheels, and turbine blades. Instead of being galvanised or chrome plated, parts such as filter components may be nickel plated. Constituent of heavy oil (together with vanadium).
Copper	Cu	25–60	Main constituent of brass and bronze. As wear metal from oil pumps, connecting-rod bearings, piston pin bearings, rocker arm shaft bearings, bronze worm gears, and sintered brake and clutch discs. Resulting from the corrosion of oil coolers, piping, and seals.
Lead	Pb	10–30	Usually in combination with tin and/or copper. Connecting-rod bearings, nearly all running surfaces of plain bearings, and soldered joints in combination with tin.
Molybdenum	Mo	4–20 Up to 500 in fresh oil	Contained in transmission synchroniser rings, piston rings, and heat-resistant steels. Component of an antioxidant and friction modifier additive package in modern synthetic multigrade oils and PD gear oils; rarely as MoS_2 oil additives.
Contaminants			
Silicon	Si	15–30 Up to 15 in fresh oil	Dust in intake air, antifoam additive in motor oil, worn seals containing silicone, residues of parting agents and silicone greases (also in oil sampling syringes), worn aluminium alloys (all-aluminium engines).
Potassium	K	2–30	Additive in aqueous media such as glycol antifreeze or cooling water. Mineral salt in road salt or tap water.
Sodium	Na	5–30 Up to 800 in fresh oil	Additive in glycol antifreeze or cooling water. Road salt, tap water or wastewater, salty air. Additive components in some motor oils as a substitute for calcium or magnesium compounds. Thickener in lubricating greases.
Lithium	Li	2–10	Constituent of multipurpose greases (thickener). Indication of contamination by grease or assembly pastes.
Antimony	Sb	1–3	Present in some lubricating greases as an EP additive in the form of antimony oxide; in connection with lead or tin in bearing alloys of plain bearings.
Silver	Ag	1–3	Silver-plated running surfaces of highly loaded plain bearings, such as in locomotive engines; silver solder residues. Silver is attacked by additive systems containing zinc.

Element		Upper warning level	Origin of the element in the motor oil specimen
Contaminants			
Tungsten	W	1–2	Rare in engine construction; alloy constituent for increasing hardness and corrosion resistance.
Titanium	Ti	1–3	Oil level indicator (float). Alloy constituent in springs and valves. From ceramic components. As white titanium oxide in plastics and paints. Marker additive in motor oils.
Vanadium	V	1–3	As a constituent of chrome-vanadium steel alloys in valves and valve springs. Like nickel, it is a constituent of petroleum. Blow-by product when ship engines are operated with heavy oil fuels.
Beryllium	Be	1–3	CuBe valves and valve seats. Sintered bearings, constituents of sintered ceramic components or in jet engine oils. Prohibited in F-1 engines.
Cadmium	Cd	1–3	Components of plain bearings exposed to corrosion. Sometimes also deep red pigments in plastics and paints.
Cobalt	Co	1–3	Possibly from components of turbines or from roller bearing alloys in connection with iron.
Manganese	Mn	1–3	Alloying element, usually with iron. Steel used in valves, roller bearings. gearwheels or shafts. Contaminant in manganese mines (with Si). Very rarely: additives containing manganese.
Tantalum			Only found in oil as a constituent of ceramic components.
Cerium			Only found in oil as a constituent of ceramic components.
Zirconium			Only found in oil as a constituent of ceramic components.
Additive			
Calcium	Ca	600–5,000	Oil additive, detergent dispersant oil additive. Improves cleaning and dispersion capacity as well as heat resistance. Occasionally calcium-containing dust from building sites, lubricating grease constituent, or from cooling water or tap water containing calcium.
Magnesium	Mg	100–1,500	Oil additive; improves the corrosion protection, thermal stability and dispersion capacity of motor oils. Increases the alkali reserve (BN). Alloy constituent of engine blocks. Hardening agent in hard tap water or salt water.
Boron	B	10–500	Improves engine cleanness as an oil additive. Borates are constituents of cooler antifreeze and corrosion protection media.
Zinc	Zn	Up to 2,000 in fresh oil	Improves wear protection as an oil additive. Zinc-plated components such as filter support cores, threaded fittings, paints containing zinc, and vulcanised synthetic materials.
Phosphorus	P	600–2,000	Oil additive in almost all types of oil; used to improve EP characteristics and reduce wear; has an anti-corrosion and antibacterial effect, reduces friction, and renders metal surfaces chemically inert.
Barium	Ba	2–20	Usually not an additive in motor oils. For improving EP characteristics. Friction modifier in ATFs. In the form of barium-complex soap, a constituent of greases and assembly pastes.
Sulphur	S	500–6,000	Constituent of base oils based on mineral oil. For this reason it is present in almost all oils, but in widely varying amounts. Along with phosphorus, sulphur is also a constituent of almost all additive packages for wear and corrosion protection and is often found in connection with calcium and zinc.

OEL CHECK

Öl Checker

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QUESTION TIME

Many manufacturers of motor oils advertise their newest oils with the designation "low SAPS" or "low ash". What does this term actually mean?

OELCHECK:

The abbreviation SAPS stands for "sulphated ash, phosphorus and sulphur". A low-SAPS motor oil is therefore an oil with a low proportion of sulphate ash, phosphorus and sulphur. These oils are also designated "low-ash" due to their low tendency to ash formation. The requirement to use low-ash additives in the formulation of modern motor oils may sound simple, but developing this sort of motor oil is a true challenge for every lubricant producer.

Requirements for low-SAPS lubricants are relatively recent. Compliance with stricter emission standards could only be achieved by installing catalytic converters or particle filters. For proper operation, these components required new types of motor oils with a low tendency to form ash deposits and fewer additives containing sulphur and phosphorus. If too many residues remain when the motor oil is incinerated (the laboratory test is performed at 800°C), the fine pores of the diesel particle filter or the vanes of the catalytic converter quickly become plugged and their lifetime decreases drastically. Phosphorus and sulphur are highly poisonous to catalytic converters. They render the surfaces inert and impair the function of removing toxic substances from the exhaust gas in all types of catalytic converters for diesel, petrol and gas engines.

As shown by oil analyses, conventional high-performance motor oils have a high concentration of metallo-organic active substances. For a long time, the standard wisdom was that the more calcium, magnesium, boron, zinc, and (of course) phosphorous and sulphur a motor oil contained, the better was its alkali reserve (BN), and thus the better the oil. After all, the additives are what provide high wear protection and good engine cleanness. The proportion of additives has been significantly reduced due to exhaust after-treatment. This was made possible by using low-sulphur fuel and by modern oil technology and engine technology. In this way, emissions of harmful substances have been markedly reduced. However, it was necessary to develop entirely new additive packages in order to combine this with fulfilling increasingly demanding requirements for longer oil change intervals, less friction, and good wear protection.

The trend is inevitably heading toward increasing use of low-ash, low-SAPS oils. This is also reflected in the specifications of the Association des Constructeurs Européens d'Automobiles (ACEA) and the specific oils approved by vehicle manufacturers. ACEA E6 motor oils for utility vehicles are allowed to have a maximum ash content of 1.0%. Since 2004, ACEA C1 to C4 also take this into account for passenger cars. They all specify significantly reduced proportions of ash-forming substances in motor oils as a prerequisite for achieving a longer useful life of catalytic converters and particle filters.

SUMMARY

Using low-SAPS motor oils is particularly imperative with modern vehicles. However, when selecting a suitable motor oil you should always observe the specifications or oil types approved by the engine manufacturer in the operating manual. Modern oils only work properly with the fuels specified in the EU, which are designed for modern engines with their exhaust aftertreatment systems in cooperation with low-SAPS oils.

Subsequent addition of additives is fundamentally prohibited because such additives always increase the ash content. An oil analysis can show whether a particular oil is an unadulterated low-SAPS oil.

OELCHECK is always ready to answer your questions about tribology and lubricant analyses. Send us your questions by e-mail (info@oelcheck.de) or by fax (+49 8034/9047-47).

OELCHECK in a winter wonderland

The OELCHECK team after the awards presentation

On the last weekend of February, we got ready to really enjoy the winter once again. After a short journey, we arrived at Robinson Club Amadé in the middle of Amadé Ski World, Europe's largest contiguous ski area with 860 kilometres of runs. After checking into our rooms, we left them right away because our programme consisted of skiing, sledging and snowshoe hiking instead of work.

After this we could look forward to a gala dinner. This repast was also just what we needed, since we were all on hand for the Winter Olympiade on Saturday. Under a friendly sun, our five teams joined the other competitors in the best of moods. They all delivered top performances in snow boccia, curling, nailing, and other sporting challenges such as a snow race with Segways, the ingenious two-wheeled scooters. The only thing that proved to be rather complicated for some members of the team was an oil test with cooking oils, which was specially conceived for us. That's hardly surprising when you consider that it involved recognising exotic types such as grapeseed oil. After the awards presentation, we enjoyed a wonderful evening. On Sunday there was once again a generous breakfast, and after a team weekend in a winter wonderland we set off for home.

SEMINARS

Seminar dates – Autumn 2010

13–15 Sept.	Machine Monitoring by Oil Analysis for Hydraulic Systems
16 Sept.	Advanced Seminar: Hydraulic Systems
4–6 Oct.	Machine Monitoring by Oil Analysis for Engines
7 Oct.	Advanced Seminar: Engines
25–27 Oct	Optimal Lubricant Management
8–10 Nov.	Machine Monitoring by Oil Analysis for Industrial Applications
11 Nov.	Advanced Seminar: Industrial Applications

For detailed information and registration forms, please visit www.oelcheck.de. Your contact person is Rüdiger Krethe (tel. +49 (0)8034 9047-210, rk@oelcheck.de).