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Doppelmayr – Number 1 in the global cableway market

Up, up and away with the CabriO open-top cableway! The first cableway in the world which can accommodate 30 passengers on its upper deck floats up towards the Stanserhorn in Switzerland!

On a par with elevators, cableways are at the top of the list worldwide in matter of safe transportation! A worldwide quality and technology leader in the cableway sector, the Doppelmayr/Garaventa Group is decisively involved in this.

Doppelmayr began its story of success as an innovative mechanical engineering company in 1892. The company's first cableway was at the same time a highlight for one of the most famous ski areas of the world: The first Doppelmayr chairlift was built in 1937, in Zürs am Arlberg. Since then, Doppelmayr has supplied more than 14,400 cableway systems to clients in more than 88 nations. The most recent milestones include the longest detachable gondola lift in the world - 5,801 m. It was put into operation at the beginning of April 2013, in DaNang, Vietnam. The spectacular open-top CabriO cableway leads to the Stanserhorn in Switzerland. It is the first open-top cableway in the world. Of the up to 60 persons that can be accommodated in the cabin, 30 can enjoy the ride on the upper deck, with an unobstructed view of the alpine world. A system with integrated solar collector represents an important step in the direction of a sustainable future. The new photovoltaic chairlift, which generates a third of its own power consumption from solar energy, is operating in the Austrian ski resort of Golm.

Headquartered in Wolfurt, in the Austrian federal state of Vorarlberg, the group of companies has production facilities, as well as sales and service locations, in more than 33 countries worldwide. These transport systems are setting new standards. Whether in summer and winter tourismareas, or in urban transport, people are moved with extremely comfortable and, most importantly, safe systems. Systems for the transport of materials and cableways for the preventive triggering of avalanches are convincing in their efficiency and performance. Multi-seasonal utilisation concepts complete the comprehensive range. However, wherever a new cableway system is installed, each one is carefully adapted according to its tasks and the environment. Cableways originated in high mountain areas. They withstand extreme temperature fluctuations, extreme winds and heavy snowfall, in other words: They have to perform under the most difficult conditions. Outside of the alpine environment, operating conditions are usually significantly milder, resulting in a high degree of operational safety and maximum availability.

Check-up

Just like in the Wild West! Our summer festival at the beginning of August was literally hot, and the setting was truly perfect: A large Western saloon, the roadway of an old Gold Rush town, and all not very far from our Brannenburg lab. All the OELCHECK Indians, cowboys (and girls) and their families celebrated with enthusiasm! While panning for gold, a glittering nugget would turn up here or there, and shooting using the laser rifle required hawk's eyes and a steady hand. An exciting ride on the bull took some real commitment. „Chief" Paul Weismann provided us with a demonstration of his strength and skill on the bull. But several cowgirls stayed on even longer than he did.

We were completely charmed by the magician and his tricks. Peter Weismann assisted him in several astounding feats. The OELCHECK family kids of course also could not miss out on the Wild West festival. Everyone liked the pony rides, and the large paddling pool provided the right amount of cooling at 38°C. The evening arrived with a large barbecue, featuring Western-style delicacies. A country band started to play, and when the line dancers, after their great performance, asked everyone to join in, the dance floor filled up! Of course there were no real bullets at the OELCHECK summer festival – just a lot of fun and enjoyment while spending time together on an enchanting summer evening!

Yours, Barbara Weismann

The „Emirates Air Line" in London

The „Mariche Tramo Expreso" is located in Caracas/ Venezuela

Safety first – This is Doppelmayr's motto in regard to lubricating systems. In order to exclude right from the start all risks incurred through the possible use of inadequate lubricants, all new systems are filled at the factory, using only selected and internally approved products. Doppelmayr uses only special oils and greases that have been extensively tested and found to deliver optimum results during long-term operation under all possible environmental conditions. Lubricants are also delivered in the original Doppelmayr containers. Clients will recognise the original product by its blue colouring. The operating instructions for each cableway include a list of lubricants that have been approved by Doppelmayr for filling or refilling. In case of using other products, Doppelmayr does not assume any liability in regard to functional safety, and warranty claims will be excluded. Oils used for the brake hydraulics and the cable hydraulic clamping systems are especially thoroughly inspected. The reliability of the hydraulic oils is of paramount importance in this. Brake hydraulics and the emergency drive hydrostat contain up to 200 l of hydraulic fluid. In the past, the system's cables were kept under tension using huge weights, nowadays, hydraulic cable tensioning systems that contain up to 450 l of hydraulic oil are used for this purpose. Depending on the system, the tension force can be between 300 and 1,200kN. To prevent too much slip on the cables, a constant base tension is required. However, the cable cannot be overly tight either, since this could potentially cause damage to other system components.

The approved long-term synthetic hydraulic oils are especially suited to utilisation across a wide range of temperatures. Selected ingredients improve the ageing properties and increase the corrosion-protection capacity. At the same time, the glide properties and wear protection of the hydraulic components are optimised. In extremely low and/ or high temperatures, Doppelmayr uses a partially synthetic fluid with multigrade characteristics.

Shear stable VI (viscosity index) improvers guarantee highly consistent viscosity even during extreme use, such as operation at below freezing temperatures. Condensation and possibly percolated water are precipitated very rapidly and completely, and can thus be drained in the course of a brief standstill without having to replace the entire fill.

Doppelmayr provides a well connected customer service network around the world. Prior to each season, i.e. once or twice a year, a major inspection is performed on each cableway. If this is not possible during the day, the inspections are carried out at night, step by step. The operator can also choose to have their own customer service perform maintenance on the system. For monitoring the greases, gear- and hydraulic oils, as well as to check wear on the components which they lubricate, service technicians recommend the proven lubricant analyses of OELCHECK. The analyses kits are a fixed component in the range of spare parts. In the course of examining the gear- and hydraulic oils, among other things, contamination, e.g. by water or tramp oil, and purity classes are thoroughly checked. Water and an inadequate purity of fluids present the greatest threats to gears and hydraulics. Operators that receive a green symbol on their OELCHECK lab report are given the go-ahead by Doppelmayr to change the oils as needed, no longer on a fixed schedule, but depending on their condition. This reduces the cableway operators' cost for lubricants and maintenance.

And Doppelmayr knows: With the OELCHECK lubricant analyses, everyone is on the safe side.

It fulfils its promise – The OELCHECK sample delivery pouch

Our employee's method of filling the OELCHECK delivery pouch is of course not recommended! However, after receiving several complaints about oil-stained mail, we put it to the test once again.

❶ *We put it to the test and filled 200 ml of oil directly into the delivery pouch instead of a sample container.*

The result: The pre-addressed delivery pouch included with our analysis set is truly leak proof! It is made of oil-proof plastic material, and performs as promised.
Provided, however, that the sender has properly sealed it using the self-adhesive closure.

❷ *The plastic pouch was then properly closed.*

It completely seals and leak-proofs the delivery pouch, in case a sample container has not been correctly closed and fluid leaks out. To prevent oil stains, the sample information sheet travels piggyback, in a transparent plastic bag located on the outside.

❸ *Then came the big test: Closed side down, oil loose on the inside. The result: The OELCHECK delivery pouch is leak proof!*

OELCHECK China – Even better service, made in Germany!

At the OELCHECK lab in Guangzhou, in the South of China, things are really moving! Since the official opening in March of 2013, many of our customers in China are now also benefiting from the advantages of our OELCHECK lubricant analyses. Our lab is almost identical to the one in Brannenburg, since the data acquired in China is transferred to the German system over a secure data link and interpreted there right away by the German engineers. This way, our customers in the Far East are not forced to do without the experience of the engineers in Germany. – However, apart from lubricant analyses, we offer a complete package of additional services in China.
Our German experts are deployed in China on a regular basis, and are at your disposal for:

- training your employees and customers
- the selection and simplification of the types of lubricants used
- the fixing of longer oil-change intervals
- the assessment of cases of damage.

Dipl.Ing. (FH) Steffen Bots (in the photo, on the left) is the OELCHECK diagnostic team manager, and will provide you with an individual consultation.

Wherever you operate, we at OELCHECK are there for you!

Good investment for young and old – The 2012 OELCHECK Christmas donation

It's good to give! In fact, for several years now, we no longer give gifts to our customers at Christmas. Instead, we invest the corresponding sum into the most diverse projects in our home community of Brannenburg. In 2012, the amount of the donation was €15,000, and all local organisations involved in intensive social work for children or youths, or that are dedicated especially to the elderly, were given the chance to participate. Hugo Weismann and Nora Bots, our youngest at OELCHECK, acted as the lucky stars in our lottery of donation cheques, valued between €500 and €5,000. There was great joy at the unexpected windfall, and all the organisations found good use for the money. The societies for traditional costumes invested in clothing for their youngest members. In three kindergartens, the new, modern photo printers are very popular with the young artists. In the skate park, €5,000 replaced the dilapidated equipment and installed new ramps. In the sports club, all three child and youth departments were happy to receive a grant. And in the multigenerational house Flintsbach/ Brannenburg, €5,000 went towards the purchase of a new vehicle to transport mobility challenged senior citizens.

Lucky winners! A total of eight clubs were happy to win cheques in the 2012 OELCHECK Christmas donation lottery - all cheques have now been cashed!

Have fun playing with the new equipment! The Brannenburg Sports Club was also very happy about the OELCHECK Christmas donation for children and youths.

BAYERNOIL – Gas turbine generates power for a refinery

The Transalpine oil pipeline (TAL) starts at the Triest oil terminal in north-eastern Italy, crosses the Alps to Schwechat, continues through Ingolstadt and ends at Karlsruhe, with a total length of 465 kilometres. It has transported over 1.2 billion tons of crude oil since it was put into service in 1967. That is an enormous volume, of which a large part is processed by Bayernoil refineries. Bayernoil is a refinery consortium of OMV Deutschland GmbH, Ruhr Oel GmbH, Eni Deutschland GmbH and BP Europa SE. The company operates the largest refinery in the Bavarian region and thus ensures the security of middle distillate supply in the region.

From approximately 10.3 million tons of crude oil per year, Bayernoil produces quality products including liquefied gases, fuels, petrol, jet fuel, diesel, heating oil and bitumen. The capacity of the storage tanks is more than 1.8 million cubic metres. Around 725 employees work in the two company sites in Vohburg and Neustadt-on-Danube, some of them working in shifts to ensure that products will be available to company partners according to their requirements. The two operating sites work like a refinery at a single location. To make sure that this functions smoothly, they are connected by 11 pipelines.

„Refining means purifying or enhancing. Obtaining the full range of mineral oil products from crude oil requires a multi-stage process. It is split into its various components in different plants and further processed into fractions. The complex production processes run around the clock and are automatically controlled and monitored by trained employees in two control rooms. All finished products are subject to stringent internal and external quality control as specified by DIN and ISO standards, EC directives and the standards of the shareholders. The safety of the refinery takes first priority. In March 2013, several plants in Vohburg were subjected to obligatory TÜV audits for the first time. A total of some 4,500 different fittings and devices were checked or repaired. Overhauling and cleaning work took place in parallel. During the shutdown period, about 1,500 additional employees from partner companies were working on the refinery sites.

CHD heat exchangers – the product fed into the system is heated to initiate the chemical reaction with the catalyst.

Onsite turbines supply power

Operating the plants, in which every litre of crude oil has to be heated to over 200°C, requires an enormous amount of power. This is partly produced directly by Bayernoil. At the Neustadt location, part of the power supply is ensured by a large gas turbine. It has been operating for more than 20 years.

Gas turbine being inspected for damage by a boroscope (endoscope).

OELCHECK monitors turbine oils

The gas turbine is lubricated by 6,500 litres of a semi-synthetic ISO VG 32 gas turbine oil. Every six years, it undergoes a major inspection. An oil change is needed about every three years. To allow this to be scheduled well in advance, the oil is tested every six months at OELCHECK in a trend analysis, since the gas turbine is the main source of power for the refinery. If it were damaged or failed unexpectedly, the resulting cost and effort would be considerable.

Turbine oils, especially in gas turbines, must be monitored carefully. OELCHECK offers nine different analysis kits for testing turbine oil. Data for the turbine-specific parameters is provided on customised sample information sheets. Turbine oil sets also include larger sample containers (up to 1 litre), because certain test procedures, such as water and air separation characteristics, or foam release characteristics, require a fairly large amount of oil. For many years, the oil in the gas turbine at Neustadt has been tested twice a year using the OELCHECK T6 analysis kit. The remaining service life of the oil can be estimated from the trend data if the operating conditions do not change significantly. In addition to degradation of antioxidants in the oil, additional contaminants are detected at an early stage. This is important because all changes can adversely affect oil ageing, air release characteristics, wear protection and foaming characteristics.

You can find an overview of all analysis sets, in particular for turbine oils, on:
www.oelcheck.de/untersuchungsumfaenge.html

Monitoring hydraulic fluids

Whether in stationary systems such as injection moulding machines, presses and elevators, or in mobile systems such as construction and agricultural machines, loading plants or transport vehicles – hydraulic fluids are being used in the most diverse systems, and in almost all industries and companies. More than 125,000 t per annum are being sold in Germany alone. More than 10% of total mineral oil sales are accounted for by hydraulic oils. The fairly low-priced oil is still regarded by many as a simple supplies. But for a long time now, hydraulic oils have evolved into special fluids without modern hydraulic systems will often no longer function. However, the higher the levels of performance and specialisation, the more carefully these fluids must be maintained and monitored.

Hydraulic fluids handle a wide range of tasks. They transfer forces, drive machines, assume control functions, lubricate moving parts, protect against wear and corrosion, cool, dampen vibrations, and remove possible contaminants. But the performance of modern hydraulic systems is increasing, and so are the demands made on the fluids.

- **More compact systems**
  As a rule, the new systems are designed for smaller amounts of oil. However, a reduced volume of oil leads to shorter retention times in the oil container. Meaning that less time is available for cooling. The operating temperature of the fluid increases. In order to counteract the accelerated ageing process caused by the higher temperatures, hydraulic oils must be designed to be more oxidation proof.
- **Increasing pump pressures**
  The heart of a hydraulic system is its pump, which produces an almost continuous volume flow. With high pressure, it transports the oil to its work sites, the hydraulic motors and hydraulic cylinders. In the past, depending on design, 400 bar were reached on average. Nowadays, fluids must withstand pump pressures of 600 bar and more. Innovative hydraulic fluids are therefore designed with improved lubricity, thanks to which they can handle the higher mechanical stresses.
- **Decreased gap tolerances, perfected valve technology**
  The increase in operating pressures is made possible not only by optimised pump technology, but also through decreased gap tolerances, better surface finishes and a more fine-tuned valve technology, letting components function even more efficiently and precisely. However, filterability and purity of the fluids must be regarded much more critically than in the past.
- **Higher Energy Efficiency**
  Hydraulic systems should also operate on as little power as possible. The fuel for the diesel engines of the mobile hydraulic power units, or the power for the many stationary hydraulics are huge cost factors. Fluids that flow more easily at the same temperature, because they are either less thick or contain friction-reducing additives, allow for more cost-effective utilisation.
- **Permanent availability**
  Hydraulic systems are expected to be permanently available, and in a state of maximum production safety. Modern systems fulfil these requirements, provided they use hydraulic oils that have been designed for long-term use. But even using these requires filtration and maintenance of the oil fill, as well as continuous monitoring of the oil by analysis.

Hydraulic fluids and DIN 51524 or ISO 11158

There are numerous hydraulic oils, of different performance capacity, and for the most diverse applications. The classic and most used hydraulic oils of types HL (HL), HLP (HM), HLPD (HG), HVLP (HV) and HVLPD are mostly produced based on mineral oils. Rapidly biodegradable hydraulic oils according to DIN ISO 15380 are mostly synthetic oils based on saturated esters. Hydraulic systems with an elevated risk of fire, e.g. in foundries, hard coal mining industry, and aeronautics, require special fluids that are not easily ignited, and that do not continue to burn independently (more on this in the spring 2011 edition of ÖlChecker). The most frequently sold hydraulic oils are specified in performance classes pursuant to DIN 51524 or ISO 11158.

Important minimum requirements of these oils are defined in DIN 51524 (parts 1 - 3) and ISO 11158. Besides purely physical data such as viscosity, density, flashpoint, pour point, ash or neutralisation number, typical tests relating to the area of operation are required.

- **Demulsification capacity:** shows whether and how fast water separates from oil.
- **Air separation characteristics:** makes it possible to draw conclusions in regard to cavitation tendency.
- **Foam behaviour:** states whether the oil tends to form foam on its surface.
- **Seal compatibility:** evaluates behaviour against elastomers.
- **Oxidation stability:** provides information about long-term use.
- **Wear protection:** is correlated using mechanical tests.
- **Purity classes:** define a baseline cleanliness of the fresh oil.
- **Filterability:** shows whether the oil composition may become a cause of filtration problems.

However, the DIN specifications only represent the lowest common denominator for the fluid characteristics. One important aspect is not considered by the DIN at all: the miscibility of different hydraulic oils.

Performance class for hydraulic oils

Abbreviated designation DIN 51524-x	Abbreviated designation ISO 11158 ISO 6743-4	Brief description of the composition		Remark
H	HH	unalloyed mineral oils without additives	mostly group I	rarely used anymore
HL	HL	as for H + corrosion protection + oxidation inhibitors	Mineral oil group II and III	very rarely as hydraulic oil
HLP	HM	as for HL + wear protection + improved filterability; additives containing zinc and without zinc possible	mostly mineral oil, also groups II to V	current standard, Problem: compatibility when using different additives
HVLP	HV	as for HLP + high viscosity index for optimal V-T behaviour	Groups III to V	energy-efficient fluids, large temperature operating range
HLPD	-	as for HL + detergency and dispersing effect against water and dust	Groups II and III	Use under wet and dusty conditions in mobile devices
HVLPD	-	as for HVLP + with high VI for large temperature range + dispersing capacity	Groups III to V	energy-efficient oils for large temperature range and in case of sludge formation
-	HG	similar to HLPD + special friction coefficient characteristics	Groups II and III	when better antifriction properties are required

There is no distinction between zinc-free or zinc-containing oils. HLP hydraulic oils can fulfil all requirements of DIN 51524-3, independent of whether additive combinations contain zinc to help achieve the performance level. The oils are miscible, but rarely compatible with each other in any ratio. This becomes especially apparent in a degradation of the air output characteristics, which provide information on the cavitation tendency of a fluid. Filterability and often also seal compatibility degrade when zinc-free and zinc-containing HLP oils are mixed.

Synthetic fluids are the current trend

High-grade hydraulic fluids with better base oils or synthetic base components are being utilised more and more frequently. In the past, the base consisted of simply refined mineral oils of API Group I, but nowadays, it is mostly the hydrated or hydrocracked oils (synthesised hydrocarbons) of groups II and III. Base oil group IV with its polyalphaolefines (PAO) offers an especially interesting outlook, as does group V with synthetic fluids such as esters, polyesters or glycols.

The trend towards partially and fully synthetic fluids has a technical background:

- **Increased ageing stability**
  In the manufacturing process of the synthetic oils, in oils of groups II and III molecular structures are saturated with hydrogen, while the sulphur content is reduced to less than 0.03%. In the oils of groups IV and V, molecules are newly formed. In either case, the viscosity temperature behaviour (higher VI) and ageing stability improve. All oils age depending on temperature and time in operation. In addition, ageing is accelerated by contaminants such as water, dust or wear particles. In contrast to mineral oils, hydrated (hydrogen saturated) oils, or pure synthetic oils, show fewer „weak points“, which can react with oxygen and initiate ageing, in their molecular structure. In addition, using modern anti-oxidants that are based on phenols, amines or salicylates (which neutralise „free radicals“), the oxidation tendency is suppressed until the additives are used up. For this reason, synthetic oils can remain in operation significantly longer than mineral oils.

- **Reduced formation of deposits**
  Thanks to the advantages of synthetic fluids and sophisticated formulae, for the most part high-grade hydraulic fluids need fewer supplements and additives, which, as reaction products, can form deposits. Due to the naturally high VI, the viscosity-temperature behaviour does not have to be optimised with long-chain polymer compounds, which can cause sticky residue. Better lubrication properties help reduce the content of high pressure additives, the reaction products of which can form hard deposits. Filterability is improved and the function of precisely operating proportional valves is ensured. While they are in use, this also reduces the danger of deposits being formed in the system.

- **Expanded operating temperature, improved energy efficiency**
  The efficiency of a hydraulic system can be significantly influenced by the viscosity of the fluid. The thinner a hydraulic oil, the lower the flow losses and the better the heat transfer. But a hydraulic oil that is too thin can cause internal losses, which has a negative effect on performance and leads to an increased oil temperature. Besides the pump speed and working pressure, hydraulic efficiency is highly dependent on the oil viscosity at the pump inlet. A high VI of the fluid not only achieves improved cold start behaviour, but also ensures that the viscosity remains as consistent as possible at different temperatures, thereby reducing flow- and churning losses. Besides ensuring optimum viscosity, a responsiveness of the friction-reducing additives that is adjusted to the working temperature improves energy efficiency.

OELCHECK analysis kits for specialists and all-rounders

Modern hydraulic oils save energy and can remain in operation longer. On the downside, they are considerably more expensive and usually react more sensitively. Regular monitoring of these oils will help to avoid unpleasant surprises. OELCHECK offers the standard analysis sets 2 - 5 for the analysis of hydraulic fluids. In addition, special sets are available for biodegradable or highly flammable fluids. All calculated values and visual findings will be commented on by experienced engineers, and recommendations will be made for further action in consideration of the system and the time in operation.

Analysis kit 2: for mineral oil based hydraulic oils - up to app. 1,000 litres

Our starter kit contains a range of tests that are usually sufficient for the routine monitoring of small to medium systems. The following parameters are monitored:

- Wear metals: iron, chromium, tin, aluminium, nickel, copper, lead, manganese and molybdenum.
- PQ index, which includes all magnetic wear particles, independent of their size.
- Additive: calcium, magnesium, zinc, phosphorus, barium, boron, sulfur.
- Contaminants: silicon (dust), potassium, sodium, lithium (grease), water.
- Oil condition: Viscosity at 40°C and 100°C, viscosity index (reference to non shear-stable additives), oxidation by FT-IR, (also shows additive changes), visual impression (picture shows colouring or particles).
- Particle count according to ISO 4406 provides information on the degree of contamination.

Analysis kit 4: for synthetic hydraulic fluids - up to app. 1,000 litres

Analysis set 4 includes all parameters of set 2 and also provides information on:

- Water (using the Karl Fischer method): Each ppm of water counts, especially in the case of synthetic fluids in which water can lead to increased acid formation. Too much water can also cause corrosion, cavitation or oil oxidation. Depending on oil and system type, the water content of a hydraulic fluid should not exceed certain values (between 150 and 800 ppm). In particular, low water contents cannot be determined precisely enough with the FT-IR method (set 2).
- NZ or AN, the acid number: If this shows an increase in comparison to the clean oil values, it can be concluded that there is increased oil oxidation or the degrading of oil additives. It provides essential supplemental information for the extension of oil change intervals.

Analysis kit 5: for all types of hydraulic oils - more than app. 1,000 litres

Set 5 includes an additional analysis:

- The RULER test: It is very important for large oil volumes or systems in which oil is not changed for years. This test determines ageing characteristics with particular precision, since the result given is the proportion of anti-oxidants still contained in the oil in relation to clean oil. Since oxidation inhibitors are continuously consumed while the oil is in operation, their residual amount and the operating time of the oil can indicate the remaining duration of use that is to be expected.

Additional special tests

The OELCHECK standard analysis sets cover all parameters relevant to statements regarding the further retention of a hydraulic fluid in the system. But sometimes a customer wants to delve deeper into the subject matter. In case of special questions and problems, our diagnostic engineers will be pleased to advise you. They will recommend individually selected, additional special tests. An entire palette of tests is available for your use.


Brugger test

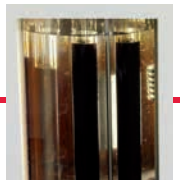

KRL


Filterability


LAV


Foam behaviour


Demulsification capacity


TOST test

Brugger test (DIN 51347)

While DIN 51524 defines the minimum requirements for wear protection of the hydraulic fluids, their load capacity values can be subject to extreme fluctuations in practice. If, for example hydraulic cylinders stick-slip or rattle, and hydraulic pumps, especially vane pumps, show a decreased output, this indicates a fluid of inadequate performance.

The Brugger test was developed to better evaluate the adhesion and wear protection of an oil on moving components. In the loaded pairing of a turning ring against a cylinder, over which oil is poured, an abrasion indentation is formed. The smaller this is, the better a hydraulic fluid is able to wet the paired surfaces, thereby suppressing squeaking noises and stick-slips.

KRL, tapered roller bearing test (DIN 51350-6)

Many hydraulic fluids, such as type HVLP, contain other VI improvers in addition to a good quality natural VI. These „thicken“ the oil, improve the viscosity temperature behaviour, and lend the fluid an above average multigrade characteristic. VI improvers consist of very long chain molecules, which can be severely sheared under load. At the same temperature, the used oil then becomes much thinner than the fresh oil. The loss of viscosity is irreversible. The effects on the hydraulic system of an oil that has become too thin at operating temperature are accordingly severe.

One method to determine the change in viscosity as a result of the destruction of the VI improvers is the KRL test (tapered roller bearing). This variation of the four ball test (German: VKA) examines lubricants whose viscosity under high load should not change for a long time. The result provided by the KRL test is the viscosity before and after the test, as well as the relative decrease in viscosity at 100°C.

Filterability (DIN ISO 13357-2)

The filterability of an oil describes its behaviour while flowing through a filter. This test, which was originally developed for clean oils, provides the opportunity to check hydraulic oils that are still in development, to ensure that no prematurely blocked filters occur in practice. For used oils the test is used, for example, after an oil or filter change, filter service life has been shorten. Problems are often found as sticky deposits on the filter medium, or in the form of unsatisfactory oil purity. The cause of this can be another additivation, a different oil type, or the detachment of tribopolymers and the oil's own ageing products. In the case of reduced filter service life, testing the filterability of the used oil in comparison to that of the clean oil will quickly show whether the composition of base oil and additives is the cause of the problem, provided that all other technical values are equal.

The filterability of an oil is given as a simple numerical value. If, for example, an HLP 46 clean oil achieves a value of F=98 in the filterability test, its filterability is excellent. If F values are lower than 50, problems and decreased filter service life can be expected.

LAV, Air separation characteristics (DIN ISO 9120)

Just like water or other liquids, every oil contains air. Since it is „dissolved“ air, it cannot be seen in the form of bubbles. How much air a clean oil can absorb depends on its saturation behaviour. This is influenced mainly by the oil temperature, the oil type, the viscosity, the additivation, and the pressure in the system. The air absorption capacity also changes in the course of operation, by mixing oils that contain different additives, as well as through contaminants or oxidation products. Under the effects of temperature, the air dispersed throughout the oil may be released in the form of visible air bubbles. These are the cause for the „diesel effect“, or cavitation. A deterioration of the LAV in comparison with clean oil is often the reason for system malfunctions. The air output characteristic can be improved neither with additives nor by mechanical means.

Because the exact air content in oil is difficult to determine, there is no standard for this. The LAV value determined in the OELCHECK lab indicates by means of density how long it takes until the air dispersed in oil is separated up to a residual content of 0.2 volume percent.

Foam behaviour (ASTM D892)

Surface foam is formed when air bubbles with a diameter of more than 15 µm up to a few millimetres float up from the oil and do not immediately disintegrate. The walls of the gas-filled foam cells are formed by thin lamellae of liquid. Especially oils with a high content of additives tend to an increased foam formation. In contrast to the LAV test, the foam behaviour can be improved by foam inhibitors – mostly by those containing silicone. However, silicone oil may markedly deteriorate the air separation characteristic of oils. Therefore, caution should be exercised during a subsequent addition!

The foam behaviour may deteriorate: When inhibitors are filtered out, oils age strongly, or oils with different surface tensions are mixed. An excessive foam formation may lead to an oil foam leak, and thus to environmental problems.

In the lab, air-perfused high temperature insulating bricks (HTI bricks) in the oil are used to determine how long it takes until the surface foam disintegrates after stopping the air flow.

WAV, demulsification capacity (DIN ISO 6614)

Other than dust, hydraulic fluids are often contaminated by water, which may enter the system in the form of condensate but also during the high-pressure cleaning process. Water accelerates the formation of corrosion. If it is heated in the points of contact due to friction, steam bubbles may form, which are the cause of cavitation in hydraulic pumps. A quick separation of the oil from the water is desirable. Hydraulic oils according to DIN 51524 should have a demulsifying effect.

However, the opposite effect can also be useful. For hydraulic oils of the non-standardised category HLP-D, the water is not to be separated, but to be neutralised by emulsification.

The WAV test, in which oil and water are mixed in a ratio of 1:1 and then stirred, indicates after an idle period if, and how quickly, water separates from the oil. Frequently, the formation of an emulsion can also be observed through an intermediate layer, and this emulsion is responsible in practice for muddy deposits.

TOST test (DIN EN ISO 4263)

In large industrial facilities, hydraulic fluids must remain in use over several years. The oxidation stability plays an important role for the oils used in such facilities. For the assessment of used oils, the oil oxidation, or ageing, is determined with FT infrared spectroscopy and the change of NZ or of AN. A prediction, regarding which oil is better suited for long-term use, can be obtained with the TOST test. In the TOST test, pure oxygen flows through the warmed oil, to which water is added, for a period of about 3 months and in the presence of a copper coil. The increase of the acid reaction product formed during this process is regularly measured. The longer the process lasts, until the oil becomes “acid”, the more suitable it is for long-term use.

Conclusion:

Modern hydraulic fluids, which are partly or completely synthetic, in general offer a markedly higher performance than conventional hydraulic oils. They can remain in use longer, protect better against wear and cavitation, and help save energy. This also means, however, that their price is correspondingly higher. In order for an investment into these contemporary fluids to pay off and allow you to use their complete performance capability, you should monitor their use with our OELCHECK trend analyses.

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Q & A

Due to the short oil service life, resulting from relatively high temperatures of over 75°C in the hydraulic tank, we changed the oil, around 6 weeks ago, in a few stationary hydraulic systems from a mineral oil-based hydraulic oil to a synthetic fluid. After the change, your lab reports show a residual content of mineral oil of less than 2%. With a value of 17/14/11, the oil purity was very good. There were no negative results. However, larger leakages have appeared on different seals more recently. What can be the reason for this?

OELCHECK:

In many applications, a seal is considered as a relatively unimportant and inexpensive machine element. Should it fail, however, this may have adverse effects not just for a hydraulic system. Engines or gears may loose so much oil due to failure of the seal that the result is inadequate lubrication, which may lead to damage, including the total failure of the system. In addition, for mobile applications, the environment may be greatly affected. If there is a substantial oil loss in connection with an oil change, the reason for this loss must be determined at all costs.

In sealing techniques, the following principle applies: There are no leakage-free systems! This means, that there are always leakages. It is only a question of maintaining the system. For machines and plants, leakages may appear on static sealing locations, e.g. on screwed-on oil troughs, mounted valve blocks, or between half casings. However, oil drips are more frequent at sealing locations with dynamic stresses. Most problems occur on classic radial shaft seal rings (Simmerrings®) on rotating shafts or linear guideway seals, e.g. those installed in pistons with hydraulic movement.

Lubricants interact strongly with sealants. On the other hand, they also contribute to the functioning of the sealing. Compatibility tests of standard sealing materials are thus required in the standards for gear oil, hydraulic oil and turbine oil. Some manufacturers even insist on their own approvals for seal materials. In general, any oil that meets the requirements is fine. Nevertheless, it happens again and again that, especially after an oil change, higher leakage amounts are detected even though the newly used oil showed good results during the tests with the sealants. There could be several reasons for that.

- The viscosity, one of the most important oil characteristics, affects the mechanical sealing behaviour. If the new lubricant has a lower viscosity than the old one, it can leak more easily, e.g. in case of pre-damaged seals. If its viscosity is markedly higher, a thicker oil film is formed in case of linear movement. More oil can then be wiped off.
- The compatibility between the oil itself and the sealant is normal, but problems appear when changing the oil. The compatibility between the oil and a relatively brand-new standard sealant is tested in the lab by a static storage in the upper temperature range. The compatibility between the oil and a relatively brand-new standard sealant is tested in the lab by a static storage in the upper temperature range. This means that the sealant should neither swell nor shrink, become neither harder nor softer, if it comes in contact with the lubricant. Both effects can be observed in practice. It depends on the base oil, the additives and the sealant to decide what direction to take.
- When changing from mineral oil to synthetic oil, problems may definitely appear. Synthetic lubricants on the basis of polyalphaolefin or polyglycol often lead to a slight shrinking of standard seals. The contact pressure of sealing lips is slightly reduced, and the leakage amount increases. However, opposite effects are also possible. Thus, ester-based synthetic oils or modified or boosted additive systems may cause a softening, and thus a swelling of the seal. This is no less a problem because the seal, due to its "growing", presses more strongly against a shaft for example, especially for dynamic sealing systems. The temperature at the sealing lip increases. Abrasion, ageing and brittleness result, which finally lead to the destruction of the seal.
- When changing the oil, a markedly different acid number (neutralisation number/acid number) can result, for example from a different additive (with zinc or zinc-free, other type of oxidation inhibitor), which influences the interaction between oil and seal. The elasticity of a seal may change only slowly if the original oil was relatively "acid" (neutralisation number over 1.5 mgKOH/g) and the new oil reacts in a nearly neutral way (neutralisation number under 0.45 mgKOH/g).

In principle, the following is true: as long as one meets the specifications and approvals of the system or the oil manufacturer, there are rarely any problems with seals. Leakages may appear if a different type of oil is used when changing the oil. Especially when using a different oil type, where the composition of the base oils and the formulation of additives differs, the effects with regard to the seals should be clarified.

If you have questions about tribology or lubricant analysis, OELCHECK can answer them. Send us your questions by e-mail (info@oelcheck.de) or by fax (+49 8034-9047-47).