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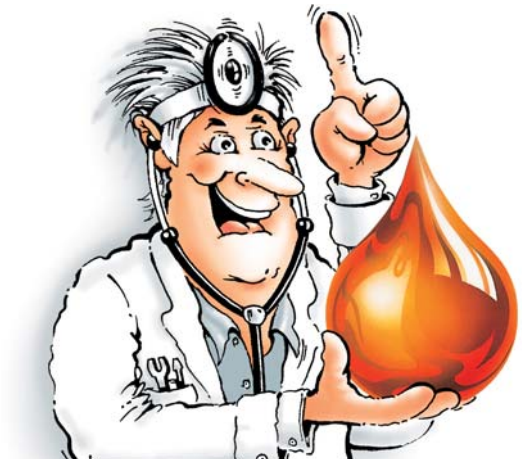
ÖlChecker

INSIDER INFO – PARTNER FORUM – TECHNOLOGY FOCUS



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Eickhoff – Shearer loaders for use below ground

Assembly of an Eickhoff shearer loader prior to use in underground mining in Huainan/China.

Eickhoff Maschinenfabrik und Eisengießerei GmbH has been based in Bochum, at the heart of the Ruhr District, since 1864. The medium-sized company, which is divided into four principal areas, now operates in international markets. Eickhoff has traditionally been a step ahead with high performance machines for the mining industry.

Eickhoff is also a leader in the production of coking plant machines and locomotives through its subsidiary, Schalker Eisenhütte. It also manufactures a wide range of vendor parts at its own foundry. A further major pillar is gear manufacturing, where a strong position has been established in the manufacture of wind turbine transmission systems. Eickhoff Bergbautechnik GmbH specialises in the development, construction and manufacture of shearer loaders, continuous miners and roadheaders for mining and tunnelling.
In coal mining, the shearer loaders from Bochum work at the forefront of the coalface. A coal seam is divided into faces and the coal is then extracted from the individual sections. Where faceworkers previously operated, today it is the shearer loaders which cut and convey the coal. This type of machine is up to 20 metres long, 3.75 metres high and weighs up to 165 tonnes. It moves up and down the coalface on the conveyor. At the front end, the shearer loader has rotating cutting cylinders with chisels, which cut a coal strip out of the seam in a forward movement. The Eickhoff SL 1000 shearer loader with an installed total power of 2590 kW, can cut at a height of up to 7.10m. The recovered coal falls behind the cutting cylinder into the chain conveyor, on which the coal is continuously transported away.

Eickhoff does not only build high-performance shearer loaders. In 2010, the company received the BAUMA innovation prize for what is currently the most intelligent mining machine in the world. Efficient computers and communications systems as well as state-of-the-art sensor technology and infrared cameras, radar and vibration probes enable the Eickhoff SL 750 EiControlPlus shearer loader to identify underground obstacles and barriers between coal and surrounding rock autonomously. This has made it possible for the first time to realise the idea of an automatic longwall mining operation where workers can concentrate on monitoring functions in a safe environment.

Eickhoff mining machines are serviced worldwide by over 100 field service technicians. They are also on site when an Eickhoff loader is installed

Check-up

A business venture involves taking risks and sometimes venturing into unknown territory. This takes courage. Enterprising courage coupled with the right intuition for the right markets, the right themes and innovative ideas moves us forward. „Courage at the beginning, good fortune at the end“. The wisdom of the Greek philosopher Democritus equally applies today as it did nearly 2,500 years ago.

Putting a good idea into practice requires courage, perseverance and steadfastness - for it is often necessary to swim against the tide. As we began preparing for the first OilDoc Conference and Exhibition in Autumn 2009, we were still in the midst of the bank crisis. The time seemed to be unfavourable, the economic news was not the best and pessimists hardly contributed to improving the mood. But we were convinced of our idea and despite all the prophecies of doom, we set to work. In the following months, we were confronted with a great deal of work and many challenges, as well as stress. Could we put together a genuinely interesting programme by virtue of excellent speakers? Would we receive enough applications to ensure that the event paid for itself? Would we be risking the good reputation of our entire company should we fail to live up to the high expectations of the participants? Our courage was ultimately rewarded with success, above all due to the positive response of the participants.

We had the same result as at the OilDoc Conference when we established our company still called WEARCHECK at the time. In 1991, Germany was still a developing country in terms of lubricant analysis. Nonetheless, we were convinced that an independent laboratory which provided meaningful oil analyses and sound advice would inevitably be successful in the market! Our success showed that we were right - our company will be celebrating its 20th anniversary in May 2011!

Barbara Weissmann

for the first time. A new shearer loader is initially assembled above ground at the customer and subsequently disassembled again. This allows employees to familiarise themselves with every detail of the machine. This can take up to two weeks and is followed by assembly below ground. Assembly at the coal face can take up to two weeks. Assembly ultimately depends on the local conditions as it is not always possible to transport the entire machine to the coalface. Sometimes, it has to be installed in individual units, which extends the assembly time. Before the shearer loader is finally put into operation, test runs are carried out and the machine is modified to suit the prevailing conditions if necessary.

In the start-up phase, the shearer loaders are monitored by Eickhoff service technicians and initial maintenance is carried out with the operator. The service technicians also provide technical support for subsequent maintenance if required or offer a maintenance service.

An Eickhoff SL 1000 shearer loader undergoing final assembly at the factory in Bochum.

Experts with the necessary specialised knowledge provide mechanical and electrical maintenance on site. In countries such as China or Russia, the teams are further supported by interpreters. The operating instructions of the machines specify maintenance intervals on a shift, daily, weekly or monthly basis. Monthly maintenance requires about six hours and additional preparation time. The compulsory programme for this includes lubricant analysis for the gear and hydraulic oils.

The shearer loaders have gears for power transmission to the cutting elements and traction drives. Hydraulic oils assist operation of the supporting arms and canopy. High-temperature greases are used for the lubrication of electric motors and high-performance greases for bearings exposed to vibrations and water. Like other hydraulic equipment in underground mining, Eickhoff uses the prescribed fire-resistant, HFC hydrous hydraulic fluids (for detailed information, see pages 5-7). As the working conditions in mines are extreme, not least due to the high level of dust that needs to be contained with water, Eickhoff protects the hydraulic system against solids contamination with special filters. The systems are provided with return flow filters and pressure filters as well as a clogging indicator to show when replacement is necessary.

HFC hydraulic oil change intervals depend on the duration of use and condition of the oil. Contaminants and wear particles play a crucial role, as does the necessary water content of the HFC hydraulic oil, which should be between 35% and 50%.

These and other significant parameters are reliably monitored at the OELCHECK laboratory with lubricant analyses typical for HFC oils. For timely analyses, samples mainly from European customers of Eickhoff are monitored by OELCHECK. Reference samples from other countries are also sent to OELCHECK time and again. These are carefully examined at the laboratory in Brannenburg, For the purpose of quality assurance, own laboratory results are often compared with the values of foreign laboratories or the values are re-examined by the diagnostic specialists at OELCHECK. This enables Eickhoff service technicians to assess the condition of lubricants and machinery worldwide in accordance with harmonised standards.

Fast and precise water analysis

OELCHECK investigates every oil and grease sample for its water content with analysis kits. Ultimately, water generally poses a high risk to all lubricated components. In high concentrations in waste oil, it can affect lubricant film formation and cause the corrosion of machine parts.

However, there are liquids, which as fresh oil, already have a high water content or only function with a high water content. A typical example are fire-resistant hydraulic oils. Of these fluids, about 50% of the water content must also be checked. In such a high range however, the usual method of coulometric water analysis based on the Karl Fischer principle (ÖlChecker Winter 2000) can no longer be used. This method can only be used to reliably determine water contents within a trace range of less than 10 ppm up to about 10,000 mg/kg, i.e. up to 1%. A further titrator has now been installed to allow the OELCHECK laboratory to perform fast and accurate water analyses for water concentrations of more than 1%. It is used to determine the water content using the volumetric method for lubricants with higher water contents.

Coulometric determination of the water content

Water analysis based on coulometric methods is ideal for lubricants with a water content in a trace range of 10 ppm up to several thousand ppm (mg/kg). In this way, water contained in the sample is quasi „boiled out". For determination using water vapour, additives and other sample components which could disturb titration, as when using a direct method, are retained in the sample.

Titration is a procedure used in quantitative analysis in chemistry. A known substance with an unknown concentration is converted in a chemical reaction using a standard solution with a precise concentration. The volume of the spent standard solution is measured and the unknown concentration of the sample solution calculated. Quantitative water analysis by titration was named after the German chemist Karl Fischer, who developed the method.

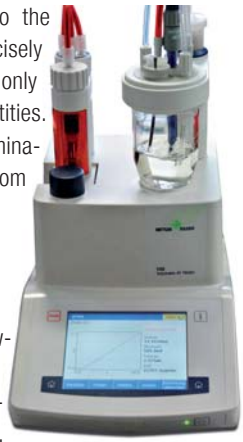
A method is described as coulometric if it is used to determine the quantitative amount of an oxidable or reducible compound. It is based on measurement of the electrical charge or amount of electricity converted at a working electrode.

In the indirect coulometric determination of the water content, about 2 g of the lubricant sample is weighed into a glass vessel and hermetically sealed with a septum. The sample is subsequently heated to 140°C in an oven integrated in an autosampler. At the same time, the septum is pierced with a hollow needle and the sample vessel flushed with nitrogen. The vaporised water is transferred in this nitrogen stream into the actual measuring cell where it is initially titrated. This method is therefore classified as an indirect titration procedure.

A measuring cell contains a special Karl Fischer reagent from which iodine is produced by means of a generator electrode. As long as the nitrogen stream flushes water vapour from the sample glass into the measuring cell, it immediately reacts there with the iodine. The generator electrode must permanently compensate this loss of iodine and uses electrical current in the process. Once the water from the sample has reacted, the produced iodine remains unused in the measuring cell.

This condition is detected by a second electrode, the indicator electrode, and titration is ended. The water content of the sample can be calculated based on the amount of electricity used.

The coulometric method is extremely sensitive. The supply of electricity to the generator electrode is precisely regulated so that iodine is only produced in very small quantities. This enables precise determination of the water content from 10 mg/kg.



Volumetric analysis of water content

In some applications however, special lubricants with water contents of several per cent are required. A typical example of this are fire-resistant HFC fluids (see page 5-7). These fluids normally have water contents between 20 and 50%. However, glycol-based synthetic oils, such as those used in worm gears, usually contain over 2,000 ppm water as fresh oil. For such samples, the limits of coulometric water analysis are reached. On account of the finely dosed production of iodine in the titration cell, each individual determination would take a long time in order to produce iodine corresponding to the high water volume.

Since March of this year, OELCHECK has been using the new, direct volumetric Karl Fischer titrator for determining the water content of such lubricants.

In this process, water is not removed by heating, instead the sample is injected directly into the measuring cell. The required iodine is present in a solution which is continuously added in small amounts with a burette. The rest of the process is identical with the coulometric method: when the water has reacted, unused iodine remains in the solution and is detected by the indicator electrode. Titration is complete. The water content is calculated from the used volume of titration solution rather than from the amount of electricity used.

With three Karl Fischer titrators, the OELCHECK laboratory is now optimally equipped for rapid and precise water analyses in all concentration ranges, with the coulometric procedure for trace levels of up to several thousand mg/kg and with the volumetric procedure for lubricants with higher water contents of up to 100%.

How can E10 be detected in engine oil?

Since its market launch, the new E10 Otto fuel, a four-star petrol with a 10% ethanol content, has stimulated wide public discussion. The central focus is on its risk-free suitability for engines of certain types of vehicle. Especially at low engine temperatures on short journeys, this can lead to an increased introduction of E10 into the engine oil. Oil and ethanol are incompatible or do not mix. Excessive ethanol in engine oil could cause similar engine wear as excessive cooling water. At the same time, the engine oil becomes „thinner". Due to the limited availability of this new fuel to date, not very much practical data is available to confirm these fears.

At the OELCHECK laboratory, a specially adapted investigation method is immediately available with which the proportion of E10 containing ethanol in engine oil can be specified. Since ethanol contains a significant amount of oxygen compared to conventional fuels, the GC method (see ÖlChecker Winter 2005) for chromatographic separation of oil and fuel, currently used to determine the petrol and diesel components in engine oil, is not suitable for E10. For the determination of the E10 content in engine oil, the ethanol component is ascertained with a head space gas chromatograph. The glycol content (antifreeze) described in detail in ÖlChecker, Winter 2010, was also measured using the same device and a similar method. With our investigation method specially adapted for the detection of ethanol, the oil sample is heated in a hermetically sealed container, whereby ethanol and petrol evaporate from the oil sample. Only this vapour is injected into the gas chromatograph. After separating all components contained in the vapour by means of a GC column, the ethanol content is indicated as a percentage. The petrol component is still indicated using the conventional GC method contained in the analysis kit 2.

Agnion Heatpipe Reformer technology – a new method for decentralised energy supply

Wood gasifier installation

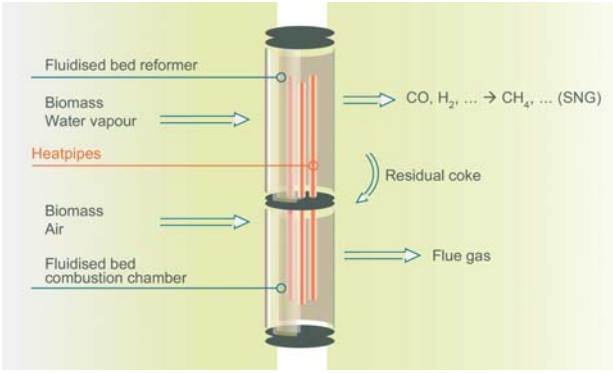
The future belongs to renewable energy. In 2011 in Germany, more than 6,000 biogas plants will produce a total of 17.1 million MWh of electricity. The installations of ever increasing size have one disadvantage however. The demand for material to be fermented is so high that it often has to be transported over long distances, which is uneconomical and has a negative impact on the carbon footprint.

As an alternative, combined heat and power plants have been installed; these operate using gas obtained from burning wood or pellets. However, the gases contain nitrogen and large amounts of tar. No gas engine oil is able to absorb these extreme contaminants. Consequently, the engines are highly susceptible to damage. Agnion Technologies GmbH, Pfaffenhofen has now developed a new energy generating plant technology for the production of environmentally-friendly energy. With Agnion's Heatpipe Reformer technology, syngas can be produced from wood. Downstream processes allow syngas to be used for high temperature heat, biomethane and electricity. The first Heatpipe Reformer has been undergoing practical tests since 2009. The groundbreaking ceremony for the first commercial installation is scheduled for April 2011. The employed gas engine oils and in turn the engines are monitored by regular lubricant analyses by OELCHECK.

The new technology consists of an allothermic gasification of solid biomass. The Heatpipe Reformer consists of three core components: a fluidised bed reformer, heat pipes and a fluidised bed combustion chamber.

The solid fuel enters the actual fluidised bed gasifier, the reformer, via a lock system. In a fluidised bed of this type, a sand bed is held in suspension by a gas flow. In the Heatpipe Reformer, steam serves this purpose. In this fluidised, highly turbulent sand bed, fuel particles are optimally mixed and at temperatures of around 800°C, begin to convert into a gas mixture consisting predominantly of hydrogen and carbon monoxide (syngas).

The major innovation of the Heatpipe Reformer concept is that the central problem of heat input is resolved very simply with so-called heat pipes.



Schematic arrangement of a Heatpipe Reformer

This concept enables the required flows of heat to be transferred between combustion chamber and reformer at a low temperature gradient and high specific output. This allows the allothermic gasifier to be designed especially simple, cost-effective and compact. In the allothermic reforming process, biomass forms with water vapour a syngas consisting of about 40% hydrogen (H_2) and 20% carbon monoxide (CO). Parallel reactions additionally produce about 20% carbon dioxide, 10% methane (CH_4), water vapour and small amounts of higher hydrocarbons, so-called tars.

The clean and methane-rich gas is ideal for the operation of gas engines. Not only can it be converted into electricity in the engine, but synthetic natural gas can also be produced through CO separation.

However, special gases such as biogas, mine gas or landfill gas have previously posed a challenge for engines. In addition to contaminants and hydrogen sulphide in the gas, the sulphurous acids produced in the combustion process are a significant problem. The engine oil must absorb and neutralise these acidic components and the hydrogen sulphide to prevent damage to the gas engine.

The gas produced with the Heatpipe Reformer also contains small amounts of sulphur. To what extent these affect the engine oil and how the alkaline reserve in the engine oil behaves is closely examined in accompanying lubricant analyses by OELCHECK. The AN (Acid Number or neutralisation number) is a measure for the degree of oil acidification. The BN (Base Number) indicates the content of alkaline additives in the oil. This is a significant criterion for determining how many acidic components can still be neutralised and rendered harmless by the oil.

Accordingly, the BN should always be higher than the AN. In gas engines which operate with variable gas qualities, the initial pH provides additional information on the degree of acidification. In lubricant analysis, the general condition of the oil as well as contained wear elements and contaminants are determined. These have a profound effect on the useful life of the oil and provide important information on the condition of the engine.

Agnion was established in 2007. Today, the group has 30 employees. As a result of its own development activities, over 30 inventions have been filed for patent since 2008. The first commercial installation in Achental will have a thermal input of 1.3 MW and supply 360 kW electricity and 600 kW heat. It will therefore have a total efficiency of 75%. Whereas pellets will be used in the pilot installation, woodchip will be used in Achental. Apart from ash, which can be disposed of normally, the fuel leaves no residues.

There are plans to install 100 installations in Bavaria over the next few years; industrial and waste wood, straw and hay will serve as fuel. If further development goes to plan, Agnion Heatpipe Reformer technology will represent a sustainable and at the same time a lucrative method for decentralised energy supply. Finally, unlike wind and solar energy, this technology does not require any investment in storage capacity and electricity grid.

The analysis of fire-resistant HFC hydraulic fluids

In the steelworks (© fotolia)

The fluids used in hydraulic systems must fulfil a variety of tasks. They transmit power, lubricate moving parts, cool, protect against corrosion, dampen vibrations and remove contaminants. Classic hydraulic oils such as HLP, HVLP, HLPD, etc., are manufactured predominantly on the basis of mineral oils. Rapidly biodegradable hydraulic oils consist mainly of ester-based synthetic oils. Hydraulic installations exposed to an increased risk of fire nevertheless require fluids that are fire-resistant or do not continue to burn autonomously. Due to their particular composition, other test methods are employed for the analysis of HFC and HFD waste oils, as is the case for mineral oil-based products. OELCHECK can also provide suitable analysis kits.

Fire-resistant hydraulic fluids are indispensible for applications in numerous industries and are partly prescribed by law - these include the coal mining, steel and foundry industry, forging presses and metal die casting machines, control equipment of power plant turbines or aircraft flight controls. Fires can break out in the event of leakages or line breaks by mineral oil-based hydraulic oils having a spontaneous ignition temperature below 400°C making contact with highly heated system components. As a result, a hydraulic installation can constitute a high risk. In foundries, for example, systems are installed with several thousand litres of hydraulic fluid.

In the event of leakage, it is highly probable that a mineral oil will ignite on contact with the red-hot steel. This would create a fiery inferno within seconds, with fatal consequences for both the people working there and the production facilities.

Fire-resistant and flame-retardant

The criteria for the fire resistance of hydraulic oils are specified in current specifications, directives and standards („7. Luxemburg Report", ISO 6743/4, VDMA, CETOP, etc.). Fire-resistant HFC hydraulic fluid should not catch fire, e.g. even at temperatures above 600°C. However, „fire resistant" does not mean that such hydraulic fluids cannot burn at all. In simple terms „fire resistance" means greater fire safety as well as offering more time to bring people to safety in the event of an accident and initiate fire-fighting measures.

Classification of fire-resistant hydraulic fluids

In general, fire-resistant hydraulic fluids can be divided into two categories: hydrous and anhydrous fluids. Classification is shown in the table below.

Hydrous fire-resistant fluids

HFA - these fluids contain an extremely high water content of over 80%. HFA-E are mineral or synthetic oil based oil-in-water emulsions. HFA-S belong to synthetic solutions that are generally polyglycol based. These usually contain more water than the emulsions.

Classification of fire-resistant hydraulic fluids

Group		Water content	Description	Typical applications
HFA	**HFA-E**	c. 80-90%	Oil-in-water emulsion	Mining, pressure water installations
	HFA-S	about 90 - 95%	Synthetic solution	Mining, pressure water installations
HFB		about 40%	Water-in-oil emulsion	Not approved for use in Germany due to high mineral oil content
HFC	**HFC**	about 50%	Polymer solution (water/glycol)	Mining, steel industry, foundry
	HFC-E	about 20%	Polymer solution (water/glycol)	Mining, steel industry
HFD	**HFD-R**	0%	Phosphoric acid ester	Control liquid in steam turbines, aircraft engines
	HFD-S	0%	Anhydrous chlorinated hydrocarbons	
	HFD-T	0%	Mixture of HFD R and HFD S	
	HFD-U	0%	Carboxylic acid ester	at very high pressures or as environmentally-friendly fire-resistant fluids, e.g. in tunnel drilling machines

HFA fluids are often used at temperatures between +5°C and +55°C and at relatively moderate pressures for underground mining. As they are very thin-bodied like water, leakage losses are a frequent occurrence. Their useful life may be impaired by bacteria and fungal infestation.

HFB – this category also includes water-in-oil emulsions. These contain about 40% water; the remainder is usually mineral oil. These are also fire-resistant, but not approved for use in Germany due to their poor fire properties.

HFC – these are the most common hydrous, fire-resistant hydraulic fluids as they have the best fire resistance and hydraulic properties. Fluids of this type are water-glycol based, aqueous polymer solutions and have a water content of about 50% or about 20% as HFC-E.
HFC fluids are prescribed for underground mining. They are also used wherever hydraulic fluid escaping under high pressure can ignite on contact with hot materials. At temperatures above 600°C, these fluids should not ignite or continue to burn. These fluids can be used at ambient temperatures of -20°C to +65°C and up to working pressures of 250 bar. When using these fluids, a stable ratio between water and glycol must be ensured as changes in viscosity may result due to the evaporation of water at high temperatures.

Anhydrous fire-resistant fluids

HFD – these fluids have the best hydraulic properties of all fire-resistant hydraulic fluids. They are preferably used when working with a naked flame or red-hot materials. These fluids are also used as a control fluid in steam turbines or aircraft engines. HFD-R is phosphoric acid ester based, HFD-S is anhydrous chlorinated hydrocarbon based. Carboxylic acid ester is used for the production of HFD-U, which is particularly suitable for very high pressures or as an environmentally-friendly fire-resistant fluid, e.g. in tunnel drilling machines. The operating temperature range of HFD fluids is between -20°C and +150°C.
An installation to be changed from an HFC fluid to an HFD fluid must be thoroughly flushed beforehand. Vice versa, HFD residues in the system must be thoroughly removed and bound with special chemicals if necessary.

Working under extreme conditions in a steelworks (© fotolia)

Special analyses for fire-resistant hydraulic fluids

Oil analyses have been firmly established in the field of hydraulics for monitoring oil condition and for pro-active maintenance. The aim is to increase operational reliability and availability and reduce costs at the same time by:

- safely adjusting the oil changing intervals to suit the prevailing conditions by monitoring the condition of the oil;
- monitoring the oil purity as the most frequent cause of failure;
- ensuring that operators effectively optimise oil maintenance measures;
- recognising irregularities in good time to avoid unplanned failures.

Due to their special composition and the underlying conditions resulting from their use, fire-resistant fluids require the use of additional special investigation methods. Similar to rapidly biodegradable hydraulic fluids, anhydrous HFD fluids can be checked with „Biosets“ using the OELCHECK analysis kit 3. Owing to their high water content, certain aspects must be taken into account for hydrous HFC fluids. OELCHECK offers an investigation programme that has been specially adapted for hydrous HFC fluids.

For the routine testing of HFC fluids in medium-sized installations, OELCHECK offers the analysis kit 3. The following parameters are monitored:

- **Element analysis**
  Metallic particles, dust, corrosion, additives, tramp oils, salts, e.g. from the water.
- **PQ index**
  Magnetic metal particles or contaminants.
- **Kinematic viscosity at 40°C**
  Lubricity and fluidity, oil aging, water loss.
- **Water content in %**
  Monitoring of the application concentration, evaporation compensation.
- **pH/reserve alkalinity**
  Monitoring of chemical additives: residually active additive reserve for neutralisation and corrosion protection.
- **Visual checks**
  Coarse contaminants, turbidity, discolouration, tramp oil.

For hydraulic installations with capacities of several hundred litres or installations with increased availability or additionally required longevity of components or oil filling, OELCHECK recommends the analysis kit 5, which also tests the following parameters:

- **Solid contaminants**
  Contamination control, filtration and indication of the solid contaminant content in per cent by weight.
- **Density**
  Control parameters for application concentration and tramp oil content
- **Purity class**
  Particle counting (fine and very fine particles), quality of filtration

Example of an HFC laboratory report

LAB REPORT

OEL CHECK
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Unit ID HFC Hydraulic
Component Hydraulic
Current sample number 1701608

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OELCHECK GmbH · Postfach 1116 · 83094 Brannenburg

Example report
Analysis scope: Analysis-Kit 3 + Olympus particle analysis

Machine type:	**Shearer loader**
Manufacturer:	**XYZ**
Sample from:	**Hydraulic, HL LH**
Oil brand name:	**Stuart Isocor E 68 PLUS**
Oil quantity in system:	**255**

Diagnosis for the current laboratory values
The wear values are in the normal range. Water content and viscosity of this water based hydraulic fluid are in an acceptable range. The pH value is lower than expected. The cleanliness code of the oil is far above the limits recommended by the component manufacturers. I recommend that you change the oil as soon as possible if you have not already done so. The system should be thoroughly cleaned or flushed during the oil change to avoid negative impact on the new oil.
Dipl.-Ing. Rüdiger Krethe

Sample Rating

action

Bottle and Cap

ANALYSIS RESULTS			Current sample	Previous samples		
LAB NUMBER			**1701608**			
SAMPLE RATING						
Date tested			25.03.2011			
Date sample taken			07.03.2011			
Date of last oil change			-			
Top-up since change			0			
Operating hrs since change		M	9			
Total operating hrs		M	12			
Oil changed			no			
WEAR						
Iron	Fe	mg/kg	9			
Chrome	Cr	mg/kg	0			
Tin	Sn	mg/kg	10			
Aluminum	Al	mg/kg	1			
Nickel	Ni	mg/kg	2			
Copper	Cu	mg/kg	0			
Lead	Pb	mg/kg	0			
Molybdenum	Mo	mg/kg	0			
PQ index	-		OK			
CONTAMINATION						
Silicon	Si	mg/kg	3			
Potassium	K	mg/kg	0			
Sodium	Na	mg/kg	116			
Water K. F.	% (m/m)		17.3			
OIL CONDITION						
Viscosity at 40°C	mm²/s		69.04			
ADDITIVES						
Calcium	Ca	mg/kg	1			
Magnesium	Mg	mg/kg	1			
Boron	B	mg/kg	2			
Zinc	Zn	mg/kg	8			
Phosphorus	P	mg/kg	0			
Barium	Ba	mg/kg	0			
ADDITIONAL TESTS						
Reserve alkalinity	ml 1n HCl		0.6			
PH value	-		7.4			

Description of standards and test methods: www.oelcheck.com

OilDoc Alliance

LAB REPORT

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Tel. +49(0)8034-9047-0 • info@oelcheck.de

HFC Hydraulic
Hydraulic
ple number 1701608

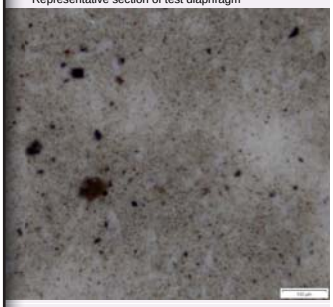
page 2 of 3

Machine type:	**Shearer loader**
Manufacturer:	**XYZ**
Sample from:	**Hydraulic, HL LH**
Oil brand name:	**Stuart Isocor E 68 PLUS**
Oil quantity in system:	**255**

port
ope: Analysis-Kit 3 + Olympus particle analysis

microscopic particle analysis
ample were filtered through a dried 1,2µm mebrane. The membrane is significantly surfaced and shows a high level. The cleanliness of the fluid is insufficient compared to the requierements of a standard hydraulic system.
diger Krethe

Representative section of test diaphragm

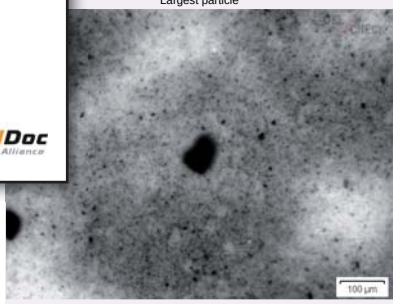


ANALYSIS RESULTS		Current sample
LAB NUMBER		**1701608**
Date tested		25.03.2011
Date sample taken		07.03.2011
Date of last oil change		-
Top-up since change		0
Operating hrs since change	M	9
Total operating hrs	M	12
Oil changed		no

Olympus particle analysis

Cleanliness class	ISO 4406 (1999)	**--/20/17**
> 5 µm	Particles/100ml	**741360**
> 15 µm	Particles/100ml	**87462**

Largest particle



Testing membrane

Description of standards and test methods: www.oelcheck.com

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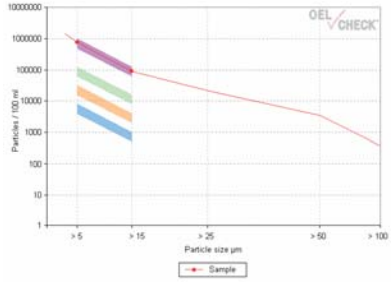
Example report
Analysis scope: Analysis-Kit 3 + Olympus particle analysis

Detailed informations for microscopic particle analysis

Particle distribution (microscopic determined)



Measurement results		
Cleanliness class	ISO 4406 (1999)	**--/20/17**
> 2 µm	Particles/100ml	**1373897**
> 5 µm	Particles/100ml	**741360**
> 10 µm	Particles/100ml	**224490**
> 15 µm	Particles/100ml	**87462**
> 25 µm	Particles/100ml	**20818**
> 50 µm	Particles/100ml	**3294**
> 100 µm	Particles/100ml	**352**
> 150 µm	Particles/100ml	**0**
> 250 µm	Particles/100ml	**0**
> 500 µm	Particles/100ml	**0**
Weight increase filter	% Wt.	**0,0373**

Analysis parameter		
Filtrated volume	ml	**50**
Membrane grain size	µm	**1,2**
Magnification		**10**
Scanned area	mm²	**78,552**
Streamed area	mm²	**1256,000**

Typical cleanliness classes
- Planetary and spur gears
- Plain Bearings in turbine systems
- Prop valve hydraulic / Rolling bearing paper machine
- Servo valve hydraulic

OEL CHECK®

ÖlChecker

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QUESTION TIME

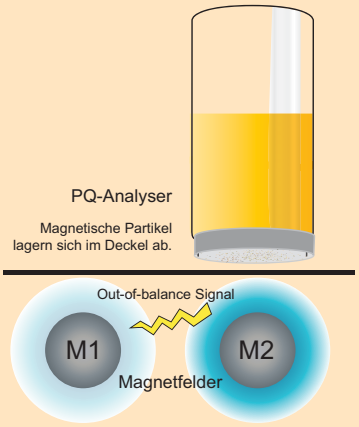
In your laboratory reports, you specify under „Wear“ the contents of metals and elements found in the sample in mg/kg. The PQ index is also shown under „Wear“. For the majority of samples, only „OK“ is shown. For the gear oil from two of our wind turbines, you specify a figure for PQ. What exactly is the PQ index, up to what value do you state „OK“ and what does the value express?

OELCHECK:

We determine for each oil and grease sample, among other things, also the iron content in mg/kg and the dimensionless PQ, the Particle Quantifier Index. The iron content is determined with ICP spectrometry, but this is only suitable for particles smaller than 3 µm. By contrast, the PQ refers to the total amount of magnetisable iron in the sample. Especially for oil samples from transmissions, diesel engines and hydraulic systems as well as grease samples, it provides useful information on abnormal and mostly acute wear processes.

The two values are interpreted together because the PQ index provides information on size distribution of the iron particles in addition to the pure iron value. Important conclusions concerning the condition of the installation can be drawn from the combination of both results.

The PQ test principle



Determination of the PQ index is based on the fact that iron, which is used as a core in a coil, is magnetised and the magnetic field of the coil is simultaneously strengthened. The PQ measuring instrument contains two magnetic coils, one measuring and one reference coil, in magnetic balance. If a sample contains magnetic iron particles, these act as an iron core in the measuring coil, strengthening its magnetic field. This strengthened magnetic field influences the reference coil and disturbs the magnetic balance between the two coils. This results in induction. The disturbance of the balance between the measuring and reference coils is specified as an index. The PQ instrument is calibrated with a sample with PQ=0 and a sample with PQ=750. The index for the sample is calculated based on this two-point calibration. PQ values below 25 do not provide a clear indication of existing wear. That is why we state „OK“ for values below 25.

The samples are initially stored upside down for 20 minutes. This allows all iron particles contained in the oil to settle on the white seal of the flat lid. The robot of the Analex PQ analyser (Kittiwake Developments) then places the sample on a turntable, which moves the sample evenly over the measuring coil. Depending on the amount of contained iron particles, the magnetic field is strengthened and the balance with the reference coil is disturbed. The measured out of balance signal is directly proportionate to the content of iron particles in the sample, irrespective of their size.

Conclusion

The PQ index is dimensionless. No indication of the iron content is made in a unit of measurement, e.g. mg/kg. It is not possible to convert the value proportionate to the amount of iron particles in a gearbox, for example. The PQ index generally increases with an increasing content of magnetisable iron.

PQ values below 25 are an indication of normal wear. The iron particles are extremely small for the most part and do not readily settle in the oil so that other methods can be used for quantitative determination. In the laboratory report, PQ values below 25 are correctly indicated with „OK“. Values above this are shown as figures in the laboratory report. These indicate an increased iron content. With incorrect sampling where oil with a high iron particle content was taken from a filter bowl, for example, index values far above 5,000 were measured.

The PQ index initially shows its full potential when viewed together with the iron content determined in ICP spectrometry:

- **Increased PQ index - increased iron content**
  „Normal“ wear. Both values are approximately the same. This suggests continually progressing wear processes, which are mostly dependent on the operating time.
- **High PQ index - slightly increased iron content**
  „Acute“ wear. Iron particles can have different causes, e.g. pitting, erosion or chipping in the form of larger particles. Damage can be prevented by taking corrective measures in good time in particular when abnormal wear processes are indicated.
- **Slightly increased PQ index - high iron content**
  „Corrosive“ wear. Iron particles, e.g. rust and corrosion particles introduced into the oil through water, are not magnetisable. These are often so small that they do not readily settle in highly viscous gear oil. At a high iron value, not accompanied by a high PQ index, strong corrosive wear can be concluded in almost all cases.

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