CJC™ Fine Filter Technology

Offline Oil Maintenance in the Energy Sector

Synonym for Oil Maintenance

Applications in Power Plants

Gas turbines

Soft contaminants and oxidation by-products are created due to high temperatures, especially on hot spots, e. g. bearings, valves, pumps and inline filters. These oil degradation products (resin / varnish) are deposited and lead to sticky and clogged components, and therefore to malfunctions in the control system.

Steam turbines

Water can enter steam turbine oil systems in various ways, e. g. through steam that enters via bearing and labyrinth seals, or condensation. Water in oil not only leads to cavitation and corrosion, but also accelerates the oil degradation process. The limit in this case is between 200 and 500 ppm H_2O.

Hydro turbines

Due to the comparatively low operating temperature, primarily solid and liquid contaminants in the oil have a damaging effect on these systems, especially in combined control and lubrication systems. A high particle content in the oil leads to wear on system components, resulting in reduced reliability and life. Furthermore, the oil must be changed more frequently.

Control system fluids

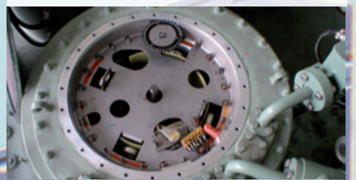
Especially in cases where HFD fluids are used, temperature peaks and contamination with water result in degradation and acidification of control system fluids.

Transformers

Water in the liquid and solid insulation reduces dielectric strength. Especially in older transformers, water accelerates the degradation process of the paper insulation, reduces the life of the transformer and decreases operating safety.

Tap changers

Electric arcs and condensate lead to deposits (carbon, sludge), wear and decreased operating safety. Continuous fine filtration can reduce not only tap changer revisions and therefore downtimes, but also the amount of flushing oil.



Oil maintenance is a requirement

Up to 80 % of all machinery repair and maintenance costs are the result of contaminated system fluids. This is substantiated by several independent analyses at hydraulic and lubrication systems. It is not only the reduced, specific properties of the oils that cause these, preventable, costs. The main cause is wear induced by contamination through solid particles, water and varnish. **These contaminants can be removed reliably and permanently only with continuous offline fine filtration.**

Applications in Power Plants

Coal mills

Gear oils are often loaded with very fine metal particles. The high operating temperature accelerates oil ageing.

Feeding pumps

Condensed water, particles and oxidation by-products in the gear oil reduce life and reliability.

Further applications

Combined heat and power units
Liquid fuel, lubrication oil
Wind turbines:
Gear boxes, pitch hydraulics, main bearings
Waste disposal plants,
Conveyor belts,
Cranes,
Compressors,
Cooling blowers,
etc.

Oil maintenance reduces CO_2-emission

Every litre of oil pollutes the atmosphere with approx. 2.6 kg of CO_2.

Filtering oil and using it for longer therefore not only saves purchasing and disposal costs for oil but also protects the environment.

Removal of Particles, Water and Varnish

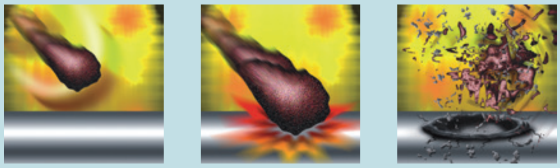
The most common types of wear

Particles

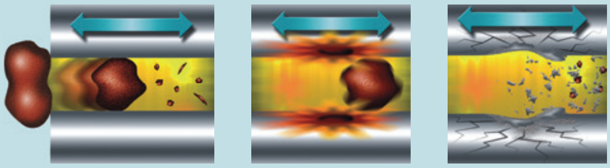
Grooving through abrasion (Bearing ring)

Particle contamination of the oil can only be reduced, not avoided. The contaminants enter the system from the environment (e. g. through venting, oil refilling or repairs), but they are also generated inside the system (abrasion). Every particle in the system can generate more contamination (sand blasting effect).

Erosion
Small particles in a high velocity oil flow come in contact with metal surfaces and edges, breaking off more particles (sand blasting effect).



Abrasion
Hard particles jammed between moving parts destroy the surfaces (abrasive wear).

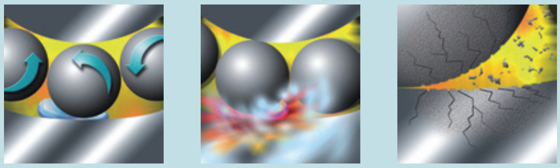


Water

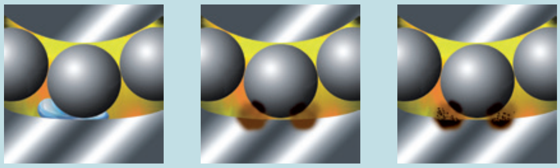
Corrosion (Shaft)

It is very difficult to avoid water contamination of the oil. Humid air enters the system via air vents and is absorbed by the oil. Varying temperatures enhance this process. Cooling water leakages and similar water ingress are also common sources of oil contamination.

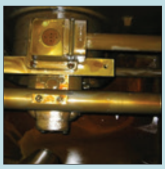
Cavitation
Water droplets in the oil evaporate under high pressure, implode and rip particles off the metal surfaces.



Corrosion
Water or chemical contaminants in the oil cause rust or chemical reactions, which deteriorate the component surfaces.



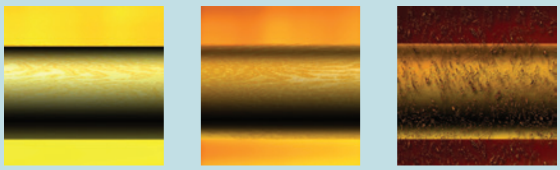
Varnish



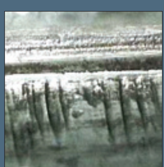
Varnish (Steering gear)

The precursors to varnish, so-called soft contaminants, are primarily created in oil systems' hot spots, e. g. bearings, valves, pumps and high-flow inline filters. Soft contaminants exist both in dissolved and suspended forms.

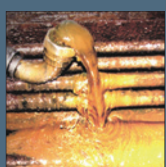
Varnish
Soft contaminants are deposited on metal surfaces and lead to the formation of varnish. Sticky valves, clogged inline filters and varnish-like deposits on bearings are typical of such contamination with varnish.



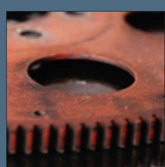
Wear



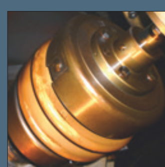
Water in oil



Corrosion

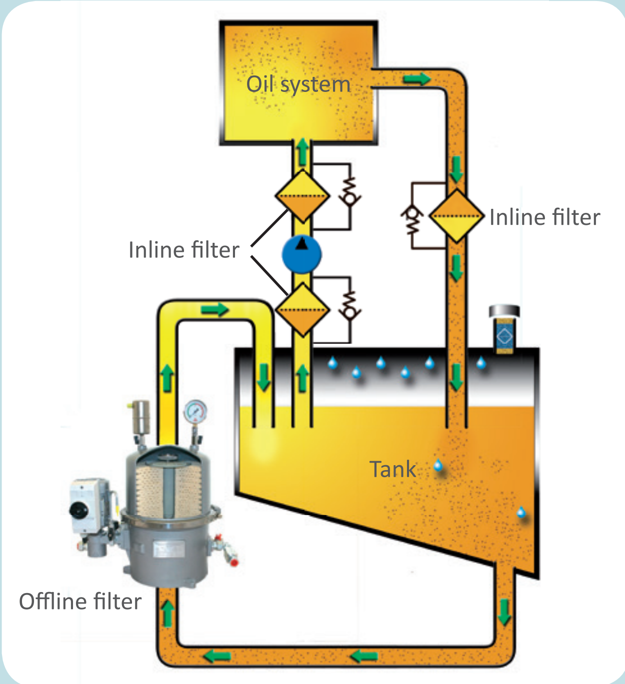


Varnish



Offline Oil Maintenance

CJC™ Fine Filter systems

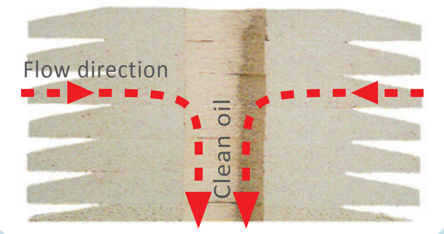


Continuous high oil cleanliness **can only be ensured by continuous offline fine filtration** - in conjunction with the inline filter. Only the offline principle allows a perfect fluid flow rate / filter size relation. The oil flows through the filter body at an extremely slow pace so that even micro-fine particles settle down deep within the filter insert.

„Filter efficiency is basically a function of the fluid's time of contact with the filter material.“

The gear pump of the CJC™ Fine Filter system draws contaminated oil from the fluid system tank of the machine and passes it slowly and at a constant flow rate through the depth filter insert. The oil flows radially from the outside to the inside through the CJC™ Fine Filter insert and returns, cleaned and dried, to the system. The manometer on the filter housing indicates the necessary filter insert change. During insert replacement the CJC™ Fine Filter system is briefly stopped, but the main fluid system remains in operation.

Cross-section of a filter insert



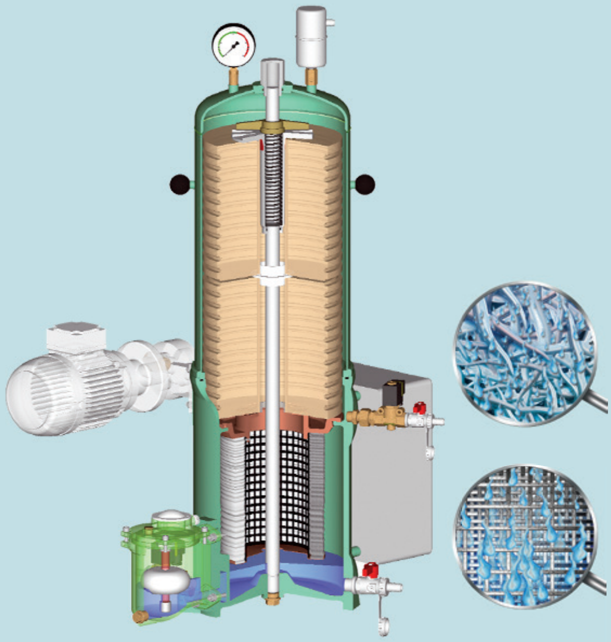
CJC™ Filter Separators

For large amounts of water in the oil or continuous water ingress in the oil system, CJC™ Filter Separators are an appropriate solution for drying and filtering the oil. The specially treated CJC™ Fine Filter insert type BLAT, retains solid particles as well as oil degradation products without absorbing water. The water is separated in a subsequent process in the coalescing element.

The coalescing process starts in the CJC™ Fine Filter insert. During the passage through the mesh of cellulose and cotton linters microscopic water parts combine to droplets.

The water droplets are carried with the laminar oil flow through the coalescing element and attach to the stainless steel mesh because of the larger adhesion forces. The flow pushes them along the metal fibres, lets them combine with other droplets at the intersections and, due to the higher density, fall into the filter base as larger droplets.

Flow switch and solenoid valve regulate the periodical discharge of the accumulated water.



CJC™ Fine Filter inserts

75 % of the insert volume forms a structure of cavities, which explains the very high dirt holding capacity. The extremely absorbent filter material retains water permanently. Oil degradation by-products are deposited at the polar sites of the depth filter insert. Used CJC™ Fine Filter inserts can be disposed of according to the (German) Waste Product Key 150202. Because the filter inserts consist **only of organic materials**, no raw material based separation is required.

All CJC™ Fine Filter inserts have a filtration degree of at least 3 µm (absolute) and a retention degree of 1 µm (nominal).

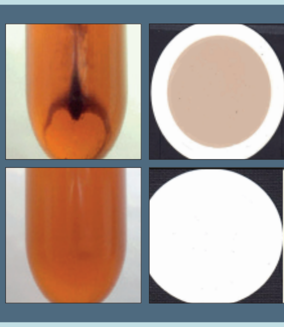
Gas Turbines

Maintenance of lubrication oil

Varnish formation presents the greatest problem in the case of gas turbines. High temperatures and oxidation processes create soft contaminants and oxidation by-products, which lead to varnish-like resin (especially in valves, coolers, pumps, inline filters and bearings) and sludgy deposits, resulting in malfunctions in the lubrication and control systems. In the case of higher operating temperatures, an increase of 10 °C halves the life of the oil. The risk is particularly great for Group II base oils, which are generated by hydrocracking, because they cannot hold the oil degradation products in suspension.

Application Study:

185 MW Siemens gas turbine, power plant, USA, California
21,000 litres lubrication oil (Shell Turbo T 32), lubrication system
Problem: Critical varnish formation, the disolved varnish could not be removed by the existing electrostatic filter
Solution: CJC™ Varnish Removal Unit 27/108, Filter insert type VRi
Result: MPC Index*) was reduced from 41 down to 7 and UC**) from 5 down to 1 within 5 weeks, extended oil life time, prevention against varnish formation, increased availability and reliability of components and machines

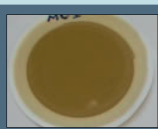


BEFORE filtration:
UC = 5
MPC = 41

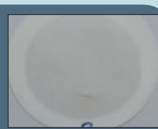
AFTER filtration:
UC = 1
MPC = 7

Application Study:

Two GE 42 MW gas turbines, combined gas and steam turbine power plant, Espania
each 6,500 litres (Mobil DTE 832), control and lubrication system
Problem: Malfunctions due to varnish coated servo valves (control hydraulic), frequent downtimes due to service times
Solution: CJC™ Varnish Removal Unit VRU 27/108, Filter insert type VRi
Result: MPC Index*) was reduced from 55 down to 15 within 2 weeks, upcoming oil changes as well as tank and system flushings weren't necessary any longer, savings because of avoided downtimes

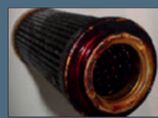


BEFORE filtration



AFTER filtration

Varnish coated valve (control hydraulic)



Varnish coated inline filter (control hydraulic)

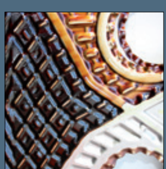
**) MPC (Membrane Patch Colorimetry) Index: the higher the MPC Index, the larger the potential of the oil to generate deposits / varnish (see also page 15).*
***) UC (Ultra Centrifugal) Test: the greater the sedimentation, the more advanced the oil degradation process due to oxidation and thermal load.*

CJC™ Varnish Removal units

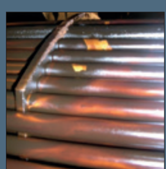
The CJC™ Varnish Removal Unit (VRU) removes both dissolved and suspended soft contaminants from the oil with revolutionary high efficiency. It is ideal for gas and steam turbines.
The optimized filtration process retains soft contaminants in the VRU. These can then be removed from the system completely by replacing the CJC™ Fine Filter insert VRi.

The warm system oil is drawn from the bottom of the tank and then treated and filtered continuously in the VRU before being pumped back to the system tank as varnish-free oil. The varnish-free oil will start to clean all system components it comes into contact with, ultimately resulting in a completely varnish-free system. The varnish level in the oil will typically be halved within a few weeks of operating the VRU.

Heat exchanger with varnish

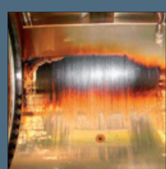


Shell and tube heat exchanger with varnish



Valve piston with varnish

Sleeve bearings with varnish



Steam Turbines

Maintenance of lubrication oil

As in gas turbines, steam turbine oil systems can become loaded with varnish. Steam turbines can also become contaminated with water as a result of processes. Water can enter oil systems as a result of leakages in bearing seals, via labyrinth seals, or condensation and lead to corrosion and cavitation. Furthermore, water accelerates the oil degradation process and stimulates bacterial growth. The turbine manufacturer recommends a maximum system water content of 300 ppm.

Applciation Study:

Steam turbine, lubrication system, Denmark
Problem: Water, particles, rust
Solution: CJC™ Filter Separator 27/108
Result: ISO Code improved from 20/19/14 up to 13/11/6,
water content reduced from 31,400 ppm down to 60 ppm

Bjarne Karlsen, Maintenance Manger, Vattenfall A/S:
„The installation of the CJC™ Fine Filter unit and CJC™ Filter Separator has quickly solved the problem. The unacceptable high water content in the lubrication oil of our steam turbine decreased significantly.“

Application Study:

Brown Boveri steam turbine, power plant, Ireland
4,000 litres lubrication oil (Castrol Perfecto T 46)
Problem: old Centrifuge,
ISO Code 22/19/14, water: 126.300 ppm
Solution: CJC™ Filter Separator 27/54, Filter insert type BLAT
Result: ISO Code 15/14/9, water: 58 ppm

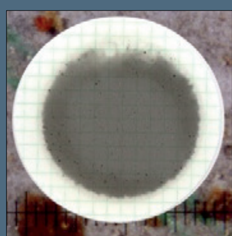
STEAM TURBINE NO. 3				
	WITHOUT CJC™	AFTER Installation of the CJC™ Filter		
	14.01.04	16.01.04	24.01.04	11.10.05
Particles, 2 µm	2,370,916	1,896,134	343,357	16,835
Particles, 5 µm	307,840	436,188	84,781	8,177
Particles, 15 µm	12,936	26,812	4,182	311
ISO Code 4406	22/19/14	21/19/15	19/17/13	15/14/9
Water, ppm	126,300	3,594	892	58

Combined lubrication and control systems

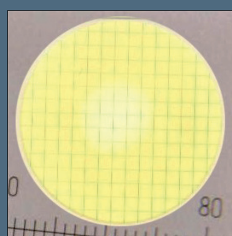
Oxidation and thermal load can lead to the formation of not only varnish, but also acid compounds in the oil. These, like water, facilitate the formation of rust and accelerate the oil degradation process. Whenever abrasive particles come into contact with corrosive surfaces more particles break off. Control systems that are fed from the same oil tank as the lubrication system are particularly vulnerable because their sensitive components wear out even given a low ingress of contaminants from the lubrication system.

Application Study:

Steam turbine, paper plant, Espania
6,500 litres SHELL Turbo CC 46 , control system and bearing lubrication system
Problem: Water ingress through seals, contamination with particles,
formation of sludge due to oxidation of the oil
Solution: CJC™ Filter Separator 27/81, Filter insert type BLAT
Result after 6 months: ISO Code improved from 20/19/16 up to 13/12/7,
water content reduced from 35,940 down to 89 ppm



BEFORE filtration



AFTER filtration

FACTS

The specially developed CJC™ Fine Filter inserts VRi remove oil degradation products (whether dissolved or in suspension) from turbine oil in gas and steam turbines for oil volumes up to 45,000 l

– even from turbines with high operating temperatures!

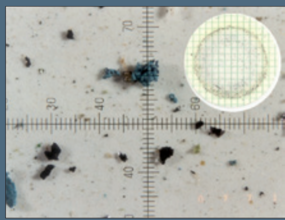
Hydro Turbines

Control systems

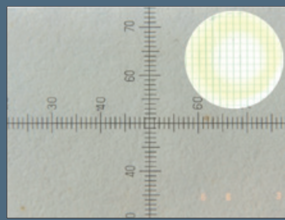
In hydro turbines, as in other turbines, temperature peaks, water ingress and oxidation can lead to oil ageing products, which, as deposits in the system, affect turbines' speed control and control systems. Wear particles, especially metal particles, not only accelerate the further degradation of the oil molecules, but also reduce the life of hydraulic and mechanical components. These can be generated by intensive and continuous loading of the system. If the particles are not removed the contaminants create more wear. Increased water content in the oil leads not only to corrosion but also to cavitation and pitting on the metal surfaces and consequently a higher particle content.

Application Study:

Hydro turbine, Great Britain
3,000 litres Esso FM68, control system
Problem: High particle content and thereby reduced oil life time and wear on system components
Solution: CJC™ Filter Separator 27/108
Result: ISO Code improved from 20/19/17 up to 12/11/8



BEFORE filtration



AFTER filtration

Application Study:

Second largest hydro power plant in the USA
nearly 38,000 litres, storage tank for turbine oil of the control system
Problem: Oil degradation products, solid particles
Solution: CJC™ Fine Filter unit 8x27/108, Filter insert type BLA
Result: ISO Code improved from 22/19/14 up to 13/10/6

Particles on used filter insert

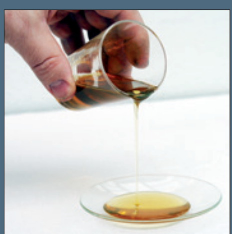
Bevel gears

In hydro turbines too, different types of systems are often fed from the same oil volume. If the bevel gears and control system are supplied from the same oil system, the risks for the control system are identical to those for the lubrication system.

Application Study:

Hydro turbine, Ontario, Canada
800 litres, bevel gear / control system
Problem: Heavy contamination with particles and varnish
Solution: CJC™ Fine Filter unit 27/27, Filter insert type B
Result: ISO Code improved from 19/18/14 up to 15/13/9

TURBINE NO. G3 - Seymour Power Station				
	17-11-04	06-12-04	14-02-05	06-12-05
ISO Code	19/18/14	19/17/14	16/15/11	15/13/9
> 4 µm	390,700	303,500	57,400	17,900
> 6 µm	151,900	118,000	22,300	6,900
> 14 µm	11,500	9,000	1,700	500
> 50 µm	500	300	0	0
> 100 µm	0	0	0	0
Gravimet. Analysis (g)	0.3100	0.0100	0.0096	0.0084
Water (%)	-	-	-	0.028



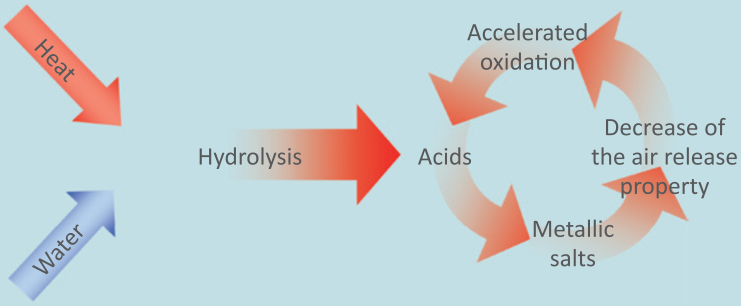
New oil

Oil ageing due to oxidation, thermal load and hydrolysis

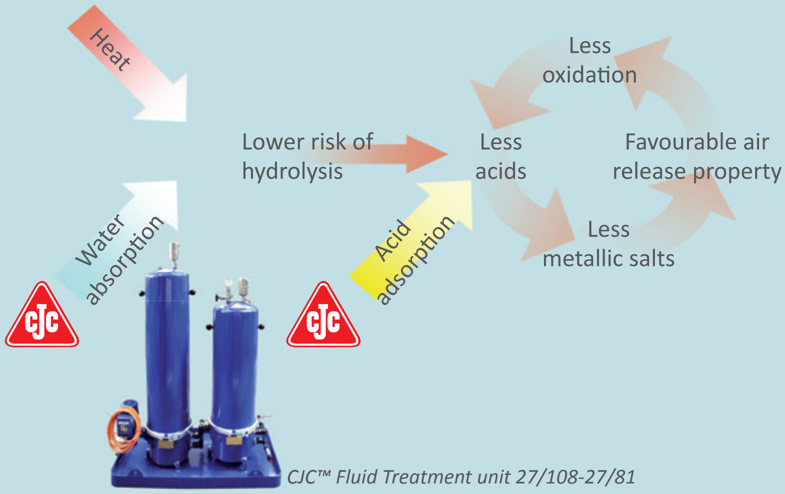
Control System - HFD Fluids

Flame-resistant fluids

Due to the high operating temperatures that exist in, for example, hot steam pipelines, phosphate esters (HFD fluids) are often used in the turbine hydraulic control systems instead of mineral oils. Although they are flame-resistant, such water-free synthetic fluids acidify easily.
High temperatures (> 80 °C) over longer periods, temperature peaks and water lead to hydrolysis in these fluids, during which the phosphate ester molecules are split into their acidic compounds.
The more advanced the hydrolysis, the faster the phosphate ester degenerates.



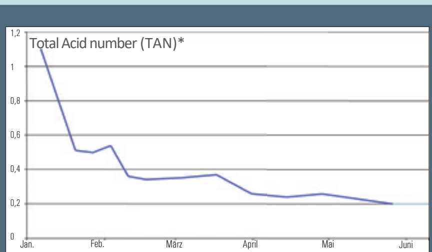
Consequences of hydrolysis:
- Corrosion
- Formation of sludge
- Clogged valves
- Reduced lubricity
- Decreased electrical resistance



CJC™ Fluid Treatment unit 27/108-27/81

Solution: CJC™ Fluid Treatment units
CJC™ Fluid Treatment units absorb water from the HFD fluid and in so doing, reduce the risk of hydrolysis. Furthermore, they absorb existing acids and thus retard the catalytic degradation process of phosphate ester molecules.

Application Study:



Power plant, Denmark
500 litres control fluid (Mobil Pyrogard 53 T)

Result: Total acid number (TAN)*

at the beginning of the test:	1.1
after 2 week of filtration:	0.51 (max. limit achieved)
after 5 weeks of filtration:	0.36
after 4,5 months of filtration:	0.2 (goal achieved)

Water content reduced from 319 ppm down to 31 ppm

** Total acid number (TAN):*
Amount of potassium hydroxide (KOH) necessary to neutralize the acids present in the fluid, recommended max. limit for the neutralization value: 0.5.

CJC™ Fluid Treatment units

CJC™ Fluid Treatment units are specially designed for filtering turbine control fluids. The fluid is pumped through two filter housings (2-stage filtration). In the first stage acid compounds in the oil are neutralized by a CJC™ Filter insert. In the second stage water and dirt are removed from the oil by a cellulose-based CJC™ Fine Filter insert.

Conditioning of Transformer Insulations

Drying and filtration of insulating oil

Water in the insulating media reduces the dielectric strength and thus the transformer's operating safety. It is therefore essential to remove the water. In this regard, it should be noted that the solid cellulose insulation of the transformer contains 100 times more water than the insulating fluid. If the humid oil is simply replaced by dry oil, the concentration is equalised and within a short period of time the water content in the insulating oil is like before the oil change.

In order to achieve a sustainably low water content in the transformer, the aim must therefore be to dry the transformer's paper insulation. Especially in aged transformers, cellulose has a disposition to molecular degradation. It is therefore necessary to dry it gently. Vacuum drying, for example, significantly stresses the ageing cellulose and can accelerate the degradation process. To avoid downtimes the drying process should be conducted while the transformer is in online operation.

The ageing process in the transformer is normally monitored via dissolved gas analysis (DGA). Continuous trend monitoring is only possible if the drying process does not influence the gas composition.

Requirements to the drying method

- Continuous, without downtime
- Gentle, without further load of the paper insulation
- Without influence of the dissolved gas analysis (DGA)

CJC™ Fine Filter technology for conditioning of transformer insulation

Drying: The basic approach for conditioning transformer insulation with CJC™ Fine Filter systems is continuous online operation. The cellulose insulation is dried indirectly via the insulation oil. During continuous operation the oil is dried and the paper insulation gradually releases the water to the returned, dried oil. This indirect drying process best preserves the ageing transformer cellulose.

Fine filtration: CJC™ Fine Filter inserts also remove solid contaminants. The oil is slowly pumped through the depth filter insert and the dirt particles are retained in the numerous cellulose mesh cavities (filtration degree 3 µm absolute, 1 µm nominal). Due to the long contact period between the oil and the filter material, as well as a high retention rate, CJC™ Fine Filter inserts offer a particularly high dirt holding capacity. CJC™ Fine Filter inserts thus ensure a sustainably high dielectric strength and therefore a high operating safety.

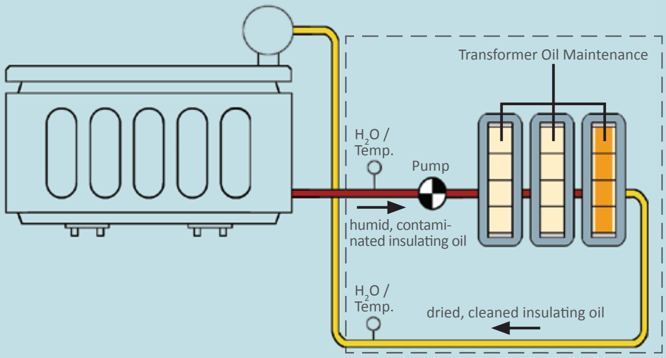
Drying of insulating oil with CJC™ Fine Filter technology.

Prolonging life at high operating safety.

CJC™ Fine Filter Technology for Conditioning of Insulating Oil

CJC™ Transformer Oil unit: Drying by adsorption

In CJC™ Transformer Oil units the warm humid insulation oil is pumped through two filter housings with CJC™ Molecular Sieve inserts and a filter housing with a cellulose-based CJC™ Fine Filter insert. The molecular sieve and cellulose draw the water and the solid contaminants from the oil. Once dried (up to a few ppm residual content of water) and cleaned, the insulation oil flows back to the transformer. In continuous operation, this dries not only the insulation oil, but also the paper insulation.

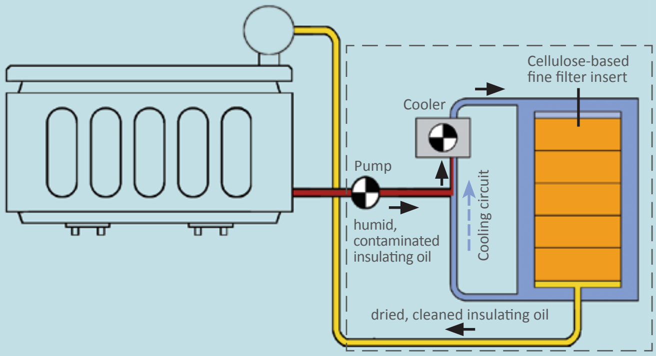


Application Study:

Transformer (building year 1963), Italy
approx. 20,000 litres
Problem: Water content 49 ppm, low dielectric strength (40.3 kV)
Solution: CJC™ Transformer Oil unit 3R27/108, Filter insert type MS and JT
Result: Water content reduced down to 17.4 ppm, dielectric strength increased up to 73.8 kV

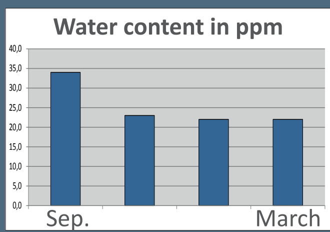
CJC™ PuriDryer: Drying by cooling

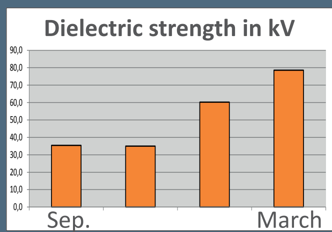
In transformers running at operating temperature the oil absorbs water from the paper insulation. The humid oil is pumped in the CJC™ PuriDryer, where it is cooled to 3 °C. At this low temperature the oil releases the water to the CJC™ Fine Filter insert. The dried oil is pumped back to the transformer, where it absorbs further humidity from the paper insulation. Solid contaminants are also removed by the CJC™ Fine Filter inserts.



Application Study:

Rectifier transformer, Germany
35.8 MVA, oil volume 27 t
Problem: Water content increases from 17 up to 34 ppm
Solution: CJC™ PuriDryer, Filter insert type JT
Result: Dielectric strength increased from 35 up to 78.6 kV, water content was reduced to approx. 20 ppm and kept on the level during operation

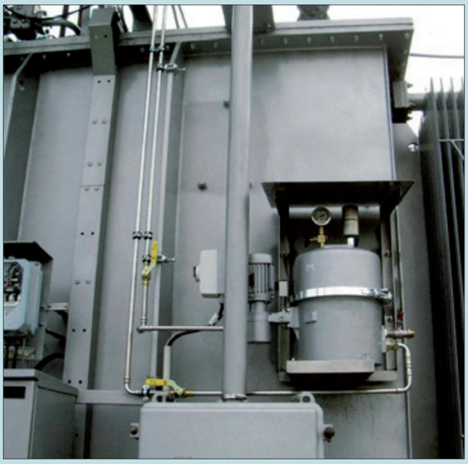




CJC™ Transformer Oil unit 3R27/108
Drying by adsorption

CJC™ PuriDryer 38/100
Drying by cooling

Tap Changer Oil Conditioning



Electric arcs and water - oil ageing in tap changers

Oxidation through electric arcs:
Tap changers regulate the electricity load that is fed into the grid. This means that frequent switching is the norm. With each switching operation an electric arc is generated whose temperature places heavy local stress on the tap changer oil. The oil molecules degrade and the burn-off is deposited on the contact surfaces. The resulting steadily increasing loading of the tap changer oil with particles and oil degradation products reduces the operating safety and reliability of the tap changers. Breakdowns are only a question of time.

Water ingress:
Water enters the tap changer oil as condensate as a result of temperature changes. Condensate and dirt compounds in the oil reduce the oil's interfacial tension, decrease its insulating effect and increase the risk of electric arcs. The contaminants have an additional catalytic effect, i.e. they accelerate the further degradation of the oil.

Negative consequences: The consequences of these influences are a decline in dielectric strength, destruction of the contacts, increased wear and, finally, failures during switching operations. Further consequences include frequent tap changer revisions, which are additionally hampered due to the heavy contamination of the oil (and therefore more expensive) and unnecessary disposal costs for waste oil.

To avoid these negative consequences a continuously high level of tap changer oil cleanliness is necessary. Continuous fine filtration increases the operating safety and reliability of the tap changer, makes tap changer revisions easier and minimises the amount of waste and flushing oil.

Application Study:

Tap Changer 30 MVA transformer, Iceland
approx. 120 litres
Problem: Combustion on contact surfaces, Failures during switching operation
Solution: CJC™ Fine Filter unit 15/25, insert type BGN
Result: ISO Code improved from 23/20/17 up to 18/17/15, color value significantly improved

	20-03-02	27-03-02	14-05-02
> 2 µm	not measurable	288,610	142,395
> 5 µm	not measurable	75,266	70,516
> 15 µm	not measurable	5,517	19,522
ISO Code	-	19/17/13	18/17/15

Application Study:

Swiss Federal Railways, Switzerland
approx. 20,000 litres
Problem: Too many fault switch-offs, consequences: common tap changer revisions, annual disposal of 40 t oil
Solution: CJC™ Fine Filter unit 38/100 in centralized location, conditioning and re-use of the oil

since 1983 - CJC™ Fine Filtration for tap changer oil

Tap Changer Revision

Tap changer
WITHOUT CJC™ Fine Filter

Tap changer
WITH CJC™ Fine Filter

With CJC™ Fine Filter systems these contaminations can be almost completely avoided.

Advantages:
- Prolong maintenance intervals (by 100 %)
- Minimize downtimes
- Decrease amount of waste oil and disposal costs
- Increase reliability

Feeding Pumps - Coal Mills

Boiler feed pumps

The gear oil of boiler feed pumps in power plants is contaminated by particles, water and oxidation by-products. If these contaminants are not removed, the life of not only the oil but also of the pump and other components will be reduced.

Application Study:

Power plant, Ireland
1,600 litres, gear of a boiler feed pump
Problem: Abrasive wear, water, oxidation by-products
Solution: CJC™ Filter Separator PTU3 27/54, Filter insert type B
Result: ISO Code improved from 21/19/16 up to 14/13/9, water content reduced from 1,602 ppm down to 26 ppm), oxidation by-products reduced from 25 % down to 5 %

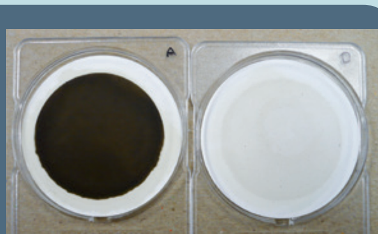
	11-03-05	28-06-05	04-11-05	29-03-06
> 2 µm	1,982,201	1,721,924	461,720	13,949
> 5 µm	469,456	346,961	115,974	7,977
> 15 µm	62,466	37,925	1,827	270
ISO Code	21/19/16	21/19/16	19/17/11	14/13/9
Water	1,602	44	50	26
Oxidation by-products	25 %	35 %	40 %	5 %

Coal Mills

Coal mills gear oils are often heavily contaminated with tiny metal particles. Furthermore, the high operating temperatures have a catalytic effect on the oil ageing process, which leads to a high varnish loading. Particles that enter the bearings damage them and generate further particles, which damage entire lubrication system components. In this application CJC™ Fine Filter systems can reduce the particle content in the oil by 98 % and the amount of resin by 99 % within a few months.

Application Study:

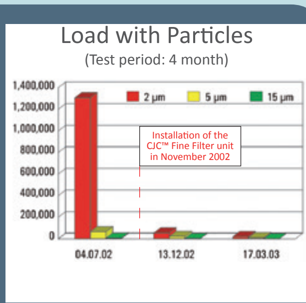
1,000 MW Thermal power plant, New Zealand
approx. 2,000 litres, worm gear of the coal mill
Problem: Coal, abrasive wear and water in the oil
Solution: CJC™ Fine Filter unit 27/54, Filter insert type B
Result: already after 10 days ISO Code -/15/13 was achieved

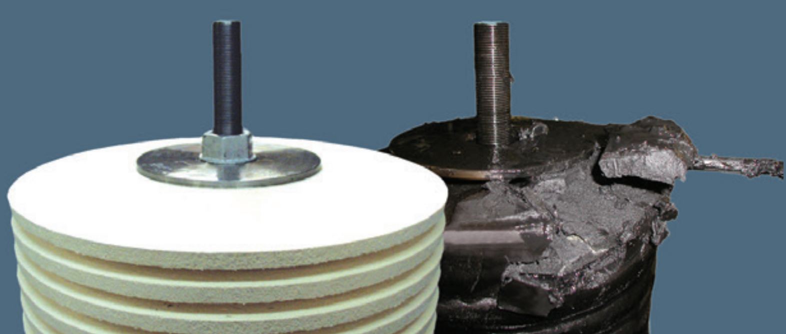


BEFORE filtration   **AFTER 10 DAYS** of filtration

Application Study:

Power plant, Denmark
1,800 litres gear oil, gear of a rolling coal mill
Problem: metal wear
Solution: CJC™ Fine Filter unit 27/81, Filter insert type B
Result: ISO Code improved from 21/17/13 up to 15/13/7 within 4 month





Between 2 and 56 kg of dirt

Depending on their size, CJC™ Fine Filter systems can retain between 2 and 56 kg of dirt before the CJC™ Fine Filter inserts need to be changed.

Further Applications in the Energy Sector

Combined heat and power plants

The high operating temperatures in gas engines result in faster lubrication oil wear than in conventional diesel engines. In addition to contamination with particles due to abrasive wear, oil degradation product loading is particularly critical. If gas engines are driven with bio or landfill gas, acidification often limits the life of the lubrication oil.

With specially designed filter inserts, CJC™ Fine Filter systems can significantly retard this process. Prolonging oil change service intervals not only means savings regarding purchase/disposal of oil, but also less maintenance and increased engine reliability.

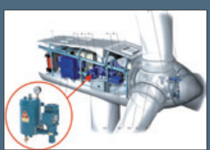
Application Study:

Motor heating power station, Germany
9,000 litres lubrication oil, diesel / gas engine
Problem: Oil loss caused by centrifuges, life time of the backflush filter is too short, operation costs for oil maintenance too high
Solution: CJC™ Fine Filter unit 27/108, Filter insert type B
Result: Oil consumption was reduced from 0.6 g/kWh down to 0.5 g/kWh, prolonged life time of the backflush filter inserts by factor 2, operating costs for oil maintenance reduced by 60 %.

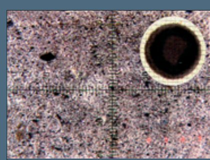
Wind turbine gears

The changing forces on gears of wind turbines lead to heavy wear and varying temperatures cause a large amount of condensate in the gear oils. In order to protect the gears, leading wind turbine manufacturers equip their series-production gearboxes with CJC™ Fine Filter systems. The high dirt holding capacity and the minimal need for maintenance are the primary reasons for the wide acceptance of CJC™ Fine Filter technology in this industry. More and more CJC™ Fine Filters are also being installed in pitch hydraulics and for the lubrication oil care in main bearings.

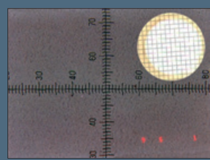
Application Study:



Wind turbine gear
60 litres gear oil
Problem: heavy load of the gear oil with particles and water
Solution: CJC™ Fine Filter unit 15/25, insert type BG
Result: Improved ISO Code from 21/19/15 up to 12/12/9, reduced water content from 1,240 ppm down to 76 ppm



BEFORE test start



AFTER 1 MONTH of filtration

140 kg of dirt is pumped annually through the system, even when typical new oil is used!

Calculation:
At a pump flow of 200 l/min and an operating time of 8 hours/day, 230 days/year:
approx. 0.64 mg dirt in 100 ml oil ▸ approx. 6.4 mg in 1 l oil ▸ pump load with approx. 1,280 mg/min ▸ approx. 76.8 g/hour ▸ approx. 614 g/day ▸ approx. 140 kg/year. (Source: Noria Corporation)

Classification according to ISO 4406 (International Organization of Standardization)

1st Method: Automatic particle count
From a 100 ml sample of the fluid to be examined, the quantity of particles > 4 µm, > 6 µm and > 14 µm is determined. The determined quantities of particles are then categorised in class codes, indicating the oil cleanliness level.

Example - Oil cleanliness level 19/17/14 (typical for new oil):
250,000 up to 500,000 particles ≥ 4 µm,
64,000 up to 130,000 particles ≥ 6 µm and
8,000 up to 16,000 particles ≥ 14 µm are contained in 100 ml of the tested oil.

2nd Method: Microscopic analysis
Only the quantity of particles ≥ 5 µm and ≥ 15 µm is determined.

Example - Oil cleanliness level 17/14 (typical for new oil):
64,000 up to 130,000 particles ≥ 5 µm,
8,000 up to 16,000 particles ≥ 15 µm are contained in 100 ml of the tested oil.

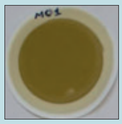
Amount of particles > specified size

more than	up to	ISO Code
8,000,000	16,000,000	24
4,000,000	8,000,000	23
2,000,000	4,000,000	22
1,000,000	2,000,000	21
500,000	1,000,000	20
250,000	500,000	19
130,000	250,000	18
64,000	130,000	17
32,000	64,000	16
16,000	32,000	15
8,000	16,000	14
4,000	8,000	13
2,000	4,000	12
1,000	2,000	11
500	1,000	10
250	500	9
130	250	8
64	130	7

(Extract from the currently valid ISO 4406 standard.)

MPC-Test (Membrane Patch Colorimetry)

50 ml of the oil to be tested and 50 ml filtered heptane are mixed and vacuum-filtered through the test membrane. The colorimetric analysis is conducted after the subsequent drying of the membrane. The residuals on the membrane are analyzed by the spectral sensor. The deposits absorb or reflect the light completely or partially. The differences between sent and reflected light as well as the colour intensity in the respective spectral range allow an MPC value to be calculated. The higher the MPC Index, the heavier the colour change on the membrane and the greater the potential of the oil to generate deposits.

0 - 15	16 - 30	31 - 40	41 - 45	46 - 50	51 - 55	56 - 60
Normal	**Monitor**	**Attention**	**Critical**	**Problematical**	**Oil change**	**System purification**
Normal oil ageing	Critical value for formation of deposits is achieved soon	many soft contaminants, start of deposits on sleeve bearings and cooler spots in the lubrication system	Extremely high amount of soft contaminants, formation of deposits in bearings, valves or tanks	Additive degradation, oxidation, high oil temperatures and long use of the oil can generate further particles, which deposit	Additive degradation and oxidation well advanced, deposits in bearings, valves and tanks	Oil not further useable, deposits in the whole system
						
MPC Index 2	*MPC Index 19*	*MPC Index 35*	*MPC Index 41*	*MPC Index 49*	*MPC Index 53*	*MPC Index 60*

Categorizing of ceanliness levels

Depending on the application, specified oil cleanliness levels for oil systems (ISO 4406) are recommended.
(Source: Noria Corporation)

The service life of hydraulic and lubrication system components varies distinctly according to the cleanliness level (ISO 4406).

22 / 20 / 17	19 / 17 / 14	17 / 15 / 12	16 / 14 / 11	14 / 12 / 10
heavily contaminated	medium contaminated e. g. new oil *)	lightly contaminated	clean	very clean
not useable in oil systems	low and medium pressure systems	hydraulic and lubrication systems	servo / high pressure systems	all oil systems
50 % of nominal service life	75 % of nominal service life	100 % of nominal service life	150 % of nominal service life	200 % of nominal service life

*) Up to **0.05 %** of insolubles are permissible in new oil (DIN 51 524, Part 2).

- worldwide

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Founded in 1928 and located in Hamburg, we develop and manufacture CJC™ Fine Filter technology since 1951. With substantiated know-how and in-house analysis and test facilities we are experts when it comes to the maintenance of oils and fuels.

SYSTEM CERTIFICATION ISO 9001:2008 SGS

Quality

Competent advice and individual solutions, even for the most difficult filtration problems of our customers - that is our daily claim. The certification of our company according to DIN EN ISO 9001:2008 provides us with assurance and motivation.

CJC™ worldwide

CJC™ Fine Filter systems are available worldwide through subsidiaries and distributors.

Find your nearest distributor on our website **www.cjc.de**.

- Or give us a call!