The Synonym for Oil Care

Proactive Maintenance

Oil Care Systems for Applications in Wind Turbines

Filter aus 100% nachwachsenden Rohstoffen

www.cjc.de

Applications in Wind Turbines

Occuring problems

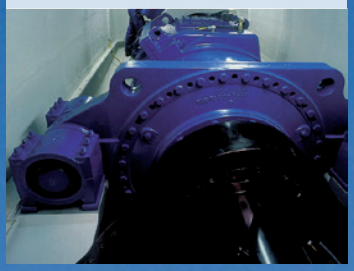
- Wear on bearings and gearboxes
- Frequent oil changes
- Downtimes
- Lost wind yield

These problems are most frequently caused by contaminants in the oil and can be avoided through offline fine filtration.

Gearbox

▶ Gear oil

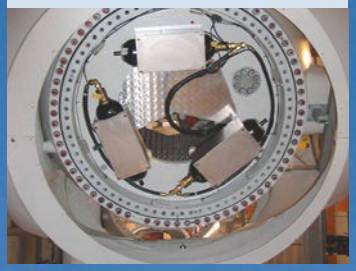
Extreme contamination of the oil systems with particles and water leads to critical downtimes and costs of spare parts of these costly components.



Pitch hydraulics

▶ Hydraulic oil

The smallest of particles and water can cause severe damage to the sensitive pumps, cylinders and valves. Depending on the processes involved, high temperatures can moreover lead the oil to degrade.



Main bearing

▶ Lubrication oil

Dirt and water in the oil systems lead to wear, corrosion, erosion and metal fatigue of the bearings.

Further applications

▶ **Offshore (lubrication and hydraulic oil)**
Oil systems of offshore wind turbines are exposed to even rougher environmental conditions. The failure of the components of offshore wind turbines results in higher maintenance costs and longer downtimes than is the case with onshore wind turbines.

▶ **Tap changers (tap changer oil)**
In the case of transformers connected to the wind farms and used to feed electricity into the grid, the contacts of the on-load tap changers are often contaminated with deposits of oil degradation products. In this context, oil maintenance prevents downtimes.

▶ **Transformers (insulating oil)**
With a specially designed fine filter system, it is possible to dry insulating oil while the transformer is running and, thus, to stabilise the dielectric strength and increase the operational reliability.

Frequent load alternation = considerable abrasion
Poor weather conditions = water in the oil

A filter system for wind turbines should fulfil the following requirements:

- ▶ High dirt holding capacity
- ▶ Absorption of water
- ▶ Adsorption of varnish

Removal of Particles, Water and Varnish

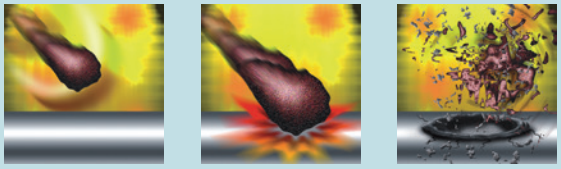
The most common types of wear

Particles

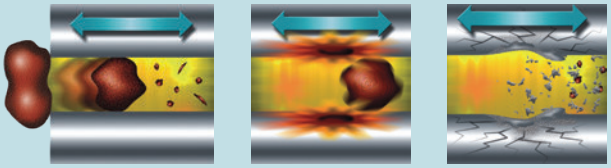
Grooving through abrasion (Bearing ring)

The smallest of particles in the lubrication circuit lead to downtimes, damages to bearings and gearboxes, and corresponding costs. 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) and there cause further wear (sandblasting 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).

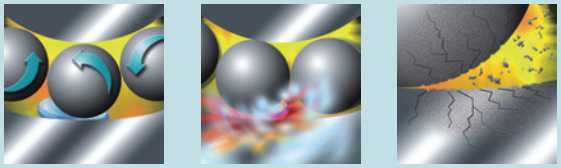


Water

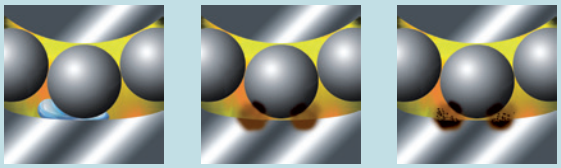
Corrosion (Shaft)

Humid air enters the system via air vents and is absorbed by the oil. Varying temperatures enhance this process. It is particularly oil systems in wind turbines which are exposed to constant water intake resulting from the considerable changes in temperature.

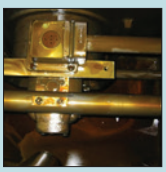
Corrosion
Water or chemical contaminants in the oil cause rust or chemical reactions, which deteriorate the component surfaces.



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



Varnish

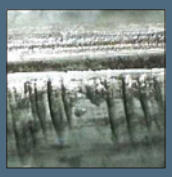


Varnish (Steering gear)

Products resulting from oil degradation occur in both lubricating oil systems and hydraulic oil systems. This is mainly influenced by oxidation (oxygen), hydrolysis (water) and thermal decay at high temperatures. In most cases, all of these three factors combined are at play. The resinlike degradation products are deposited on metal surfaces of the system and form a sticky layer to which particles adhere.

Oil degradation
High temperatures, oxidation and hydrolysis cause the oil to degrade. The resinlike residues of this degradation process are deposited on metal surfaces.

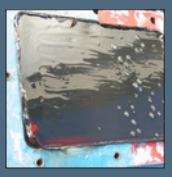
Abrasion



Water in Oil

Corrosion

Varnish

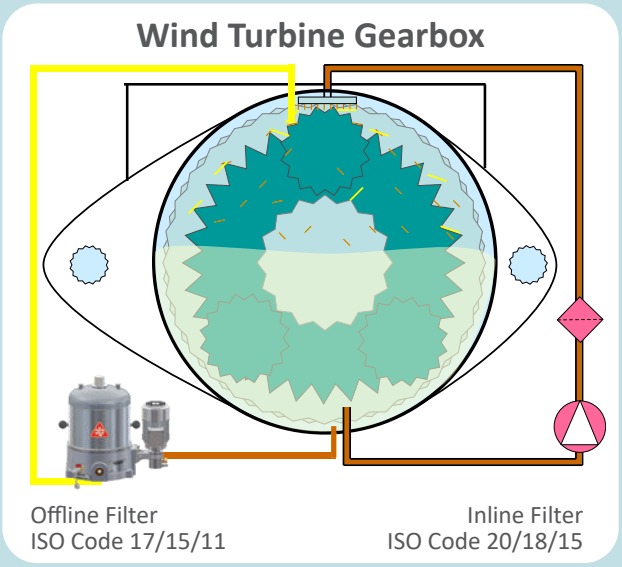


Maintenance of Gear Oil

Offline fine filtration

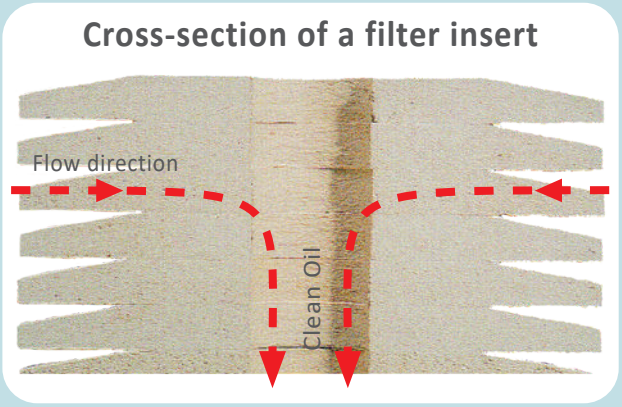
Continuous high oil cleanliness **can only be ensured by continuous offline fine filtration** - in conjunction with the inline filter. Only the offline principle allows a perfect gear oil flow rate / filter size relation. The oil flows through the filter body at an extremely slow pace so that even micro-fine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

The gear pump of the CJC® Fine Filter system draws contaminated oil from the lowest point of the gearbox 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 top side of the gearbox. The filter insert can be changed during usual maintenance cycles of the wind turbine. Optionally, the saturation can be measured with a manometer or sent via a pressure transmitter.



For high-viscosity lubricating oils

Very low temperatures and high viscosity of the gear oils used in the wind turbines pose a special challenge to fine filtration. The robust gear pump also transports high-viscosity lubricating oils (up to ISO VG 460). A special bypass valve prevents CJC® Fine Filter systems from damage even at very low oil temperatures.



Strong abrasion of smallest particles

Fine filtration of gear oil through CJC® Fine Filter Insert ensures that solid particles of down to 3 µm are filtered.

Remove water and varnish

The CJC® Fine Filter insert binds condensation water and dirt simultaneously. The water absorption potential is up to 50 % of the total dirt holding capacity. Varnish and sludgy residues adhere permanently to the fibres of the CJC® Fine Filter Insert.

Low maintenance intensity

Wind turbines are only maintained once or twice a year. CJC® Fine Filter systems operate permanently and virtually maintenance free, without using susceptible electronics. The compact design is ideal for the limited installation possibilities.

CJC® Fine Filter Insert

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 Insert 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 Insert have a filtration degree of at least 3 µm (absolute) and a retention degree of 1 µm (nominal).

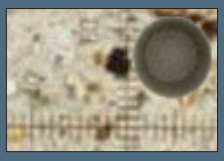
Applications

Gearbox - Maintenance of gear oil

AGMA (American Gear Manufacturers Association) sets the following requirements regarding the cleanliness of oil used in gearboxes of wind turbines: 16/14/11 for new oil before adding to gearbox, 17/15/12 for gearbox after factory testing, 18/16/13 for gearbox during service.

Application Study:

Wind turbine, gearbox, USA
360 litres of gear oil ISO VG 320
Problem: Wear on bearings, water content in gear oil is too high
Solution: CJC® Oil Care System 15/25, insert type BG
Result: ISO Code from 23/19 to 15/12, approx. 100 ppm H_2O



BEFORE filtration
ISO 23/19

AFTER filtration
ISO 15/12

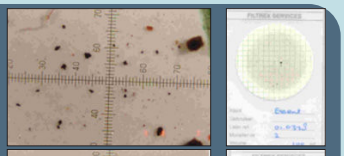
Pitch hydraulics - Maintenance of hydraulic oil

The hydraulic system is strained by external impacts such as the fluctuation of temperature between - 40 and + 60 °C, humidity from 10 % up to 100 % and high wind velocity. The main problem occurring in these oil systems is the contamination with products resulting from oil degradation and oxidation. This leads to deposits at the proportional valves and, thus, to inaccurate pitch adjustment.

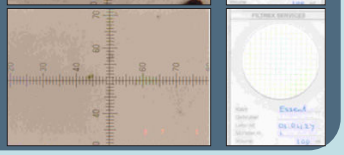
Application Study:

Wind turbine, pitch hydraulics
Problem: High contamination with particles, especially with metal particles
Solution: CJC® Oil Care System 15/25, insert type BG
Result: ISO Code from 20/19/14 to 15/14/10

BEFORE filtration



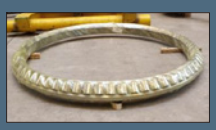
AFTER filtration



Main bearing - Maintenance of lubrication oil

Due to its higher lubricity and the increased heat dissipation, lubricating oil is used ever more frequently instead of grease to lubricate the main bearing. Particles and water content as well as products resulting from oil degradation can be removed from lubricating oil, which is not possible with grease.

Application Study:



Wind turbine, bearing lubrication, Germany
Lubrication Oil ISO VG 320
Problem: Lubricating oil is highly contaminated with abrasive particles from the main bearing
Solution: CJC® Oil Care System 27/108, insert type B
Result: The improvement of the oil cleanliness by two levels already extends the service life of the bearing by a factor of 1.5.

	21/19/16	20/18/15	19/17/14	18/16/13
24/22/19	2 1.6 1.8 1.3	3 2 2.3 1.7	4 2.5 3 2	6 3 3.5 2.5
23/21/18	1.5 1.5 1.5 1.3	2 1.7 1.8 1.4	3 2 2.2 1.6	4 2.5 3 2
22/20/17	1.3 1.2 1.2 1.05	1.6 1.5 1.5 1.3	2 1.7 1.8 1.4	Hydrauliken / Kugellager
21/19/16		1.3 1.2 1.2 1.1	1.6 1.5 1.5 1.3	Wellenlager / Getriebe und andere

Quelle: Noria

„Rolling bearings have a far longer service life if all particles which are larger than the lubrication gap are removed."

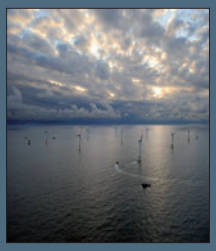
Ref.: SKF

Further Applications

Offshore

Harsh environments strain the oil systems of offshore wind turbines even more. The wind turbines, which are difficult to access, require robust components with a minimum need for maintenance.

Applcation Study:



In the context of offshore application, CJC® Fine Filter systems are used to purify gear, hydraulics and lubricating oil. Preheating (optional) ensures that high-viscosity fluids can also be filtered at low temperatures. The saturation of the CJC® Fine Filter insert can be monitored. Especially when used offshore, the low-maintenance CJC® Fine Filter systems support a trouble-free wind yield.

Reference: BARD Offshore 1, North Sea

High air content in the gear oil - CJC® Upgrade Kit

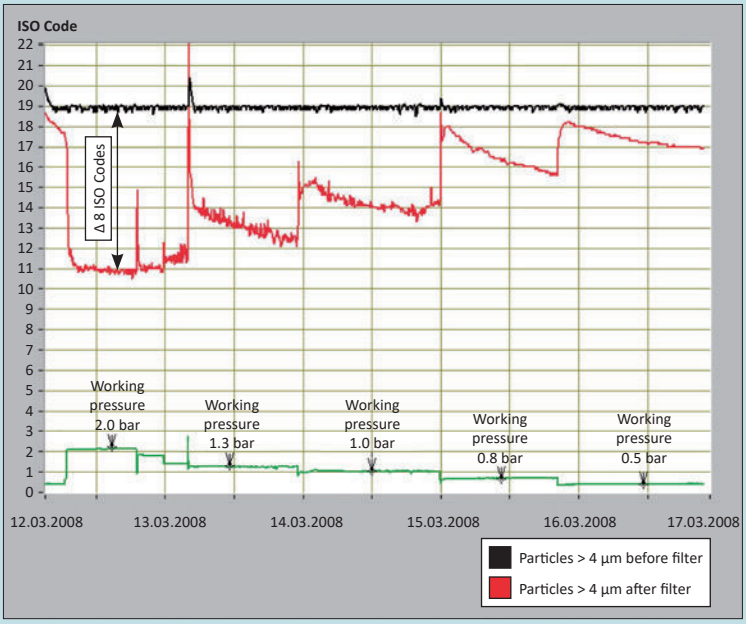
The CJC® Upgrade Kit is a sensible solution for larger contents of air in the oil, for example, in the case of open-style gearboxes or lubrication via spray nozzles. When passing through the filter insert, the air contained in the oil expands due to the difference in pressure between the entry and the exit of the filter. As a consequence, the expanding air bubbles impair the filtration effect.

The CJC® Upgrade Kit increases the working pressure in the CJC® Fine Filter so that the air bubbles shrink or are prevented from becoming as large as to have an impact on the filtration efficiency. The increase in pressure leads to rising retention.

Right-hand figure:
Examination of the impact which different working pressures in the filter have on the filtration efficiency. The tests were conducted within the scope of a worst-case scenario regarding the ingress of air and dirt.

At a working pressure of 0.5, 0.8, 1.3, 1.5 and 2 bars, the quantity of particles > 4 µm (micron) was measured with particle counters before and after passing the CJC® Fine Filter system. The graph clearly shows that the difference between the ISO Codes measured and the strength of the filtration efficiency increase with the increase of the working pressure in the filter.

At a working pressure of 2 bars, the ISO Code could be improved by 8 levels (from 19 to 11).



The CJC® Upgrade Kit consists of:
- CJC® Gear Pump type PV or 6-bar bypass valve
- Non-return valve
- CJC® Fine Filter insert

The CJC® Upgrade Kit was specially developed for the following types of filters:
- CJC® Fine Filter systems 27/27, 27/54 and 27/108

The filters can be easily and quickly refitted during the regular servicing. Upon request, a „quick guide“ will be made available.

Analysing and Evaluating Oil

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.)

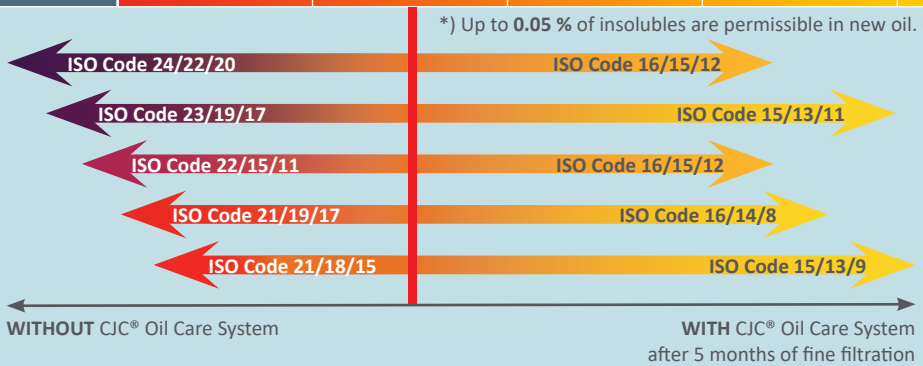
Prolonging the service life of system components

The service life of hydraulic and lubrication system components varies distinctly according to the cleanliness level. Depending on the application, specified oil cleanliness levels for oil systems (ISO 4406) are recommended. The following table shows these minimum requirements in an overview.

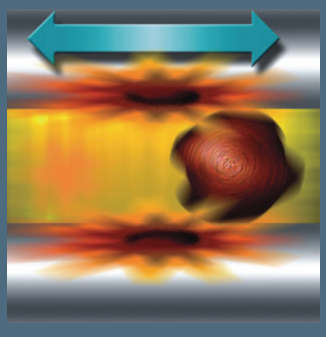
(Source: Noria Corporation)

ISO Code	22/20/17	19/17/14	17/15/12	16/14/11	14/12/10
Oil condition	heavily contaminated	medium contaminated e. g. new oil *)	lightly contaminated	clean	very clean
Useable for	no oil systems	low and medium pressure systems	hydraulic and lubrication systems	servo and high pressure systems	all oil systems
Service life	50 %	75 %	100 %	150 %	200 %

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



Within a period of 5 months, the oil cleanliness levels of five gearboxes of wind turbines were **improved by 5 to 8 ISO Codes**! This corresponds to an extension of the service life by a factor of 2 to 3!



Quantity of particles ≥ 4 µm in 400 litres of gear oil:

Oil cleanliness level ISO 20/17/14
750,000 particles ≥ 4 µm in 100 ml ▶ 3,000,000,000 particles ≥ 4 µm in 400 l at 25 revolutions per hour:
▶ **Contamination of the gearbox per hour: 750 billion particles**

Oil cleanliness level ISO 17/14/11
97,000 particles ≥ 4 µm in 100 ml ▶ 388,000,000 particles ≥ 4 µm in 400 l at 25 revolutions per hour:
▶ **Contamination of the gearbox per hour: 9.7 billion particles**

– worldwide

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History

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.

Qualitäts-Management

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

ÜbCJC® Fine Filter systems are available worldwide through subsidiaries and distributors. Or give us a call!