CJC® Varnish Removal Unit VRU

GUIDE to Varnish Removal

from oils in Gas & Steam Turbines

Get insight in how to avoid expensive turbine trips due to varnish in turbine oil.

- see our Customer Cases, Article, Product Sheet & Brochure

C.C.JENSEN A/S, Dec. 2022 - www.cjc.dk

Lube & Hydraulic Oil

Gas & Steam Turbine GE 109FA, Combined Cycle Single Shaft

CUSTOMER SAVINGS & BENEFITS

Installing the CJC® VRU Varnish Removal Unit, the following benefits were obtained:

- Varnish reduced - MPC from 44 to 8 in 6 months
- No costly oil change or turbine failure
- Prolonged lifetime of oil

CUSTOMER

Naturgy, CCC Aceca is a Spanish utility company operating power plants in Spain & Latin America.

SYSTEM

Combine Cycle Single Shaft Gas & Steam Turbine.

Type: GE 109FA
Oil type: Lube & Hydraulic Oil
Oil volume: 30,000 ltr

PROBLEMS

Dissolved oil degradation products - leading to varnish formation - were detected via Membrane Patch Colometry Analysis (MPC). Varnish can potentially damage the system and cause turbine malfunction. An existing conventional centrifuge was not able to remove the dissolved oil degradation products, to control the varnish potential and maintain the MPC value below 15.

SOLUTIONS

The customer decided to implement a corrective and preventive solution and opted for the installation and permanent operation of the **CJC® Varnish Removal Unit VRU** with **CJC® Varnish Removal inserts VRi.**

RESULTS

The MPC decreased from 44 to 8 in 6 months. The CJC® VRU cleaned the turbine oil circuit after removing the varnish from the oil and kept the MPC value constantly below 15 without altering the properties of the oil.

FINANCIAL BENEFITS

Thanks to the continuous operation of the CJC® VRU, the plant avoided the costly oil change and potentially great economic losses caused by turbine failures.

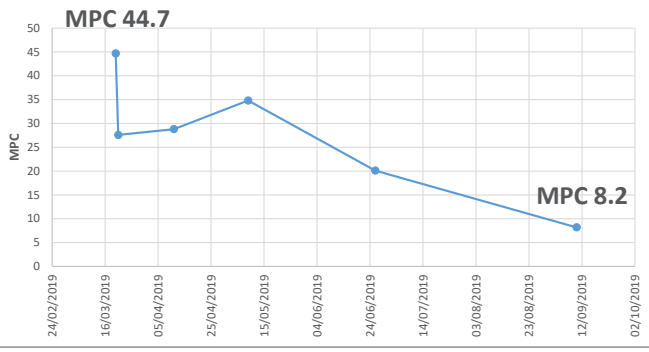
ENVIRONMENTAL BENEFITS

The CJC® VRU prevented premature oil change, prolonged the useful life of the oil, and thus avoided emissions of CO_2.

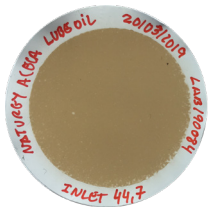
Naturgy, CCC Aceca, Spain with the CJC® VRU Varnish Removal Unit installed

RESULTS

Oil analysis with MPC shows the reduction of varnish:



Inlet MPC 44.7 - BEFORE



Membrane Patch ***BEFORE*** *CJC® VRU installation*

Inlet MPC 8.2 - AFTER

Membrane Patch ***AFTER 6 months*** *operation*

Customer Statement:

Mr. Álvaro García García, Maintenance Manager:

"In addition to the good advice that we have always received, I positively value the effectiveness of the treatment in the short term (6 months), allowing us to prolong the lifetime of the oil, with the corresponding cost savings and reduction of the waste generated."

CCPO6050-UK
Gas Turbines, Combined
Lube & Control
30.09.2022

Customer Case written by:
Mr. Roberto Carrido, C.C.JENSEN Ibérica, Spain
in cooperation with:
Mr. Álvaro García García, Maintenance Manager at Naturgy, CCC Aceca, Spain

C.C.JENSEN A/S
Løvholmen 13 | DK-5700 Svendborg | Denmark
Phone +45 6321 2014 | sales@cjc.dk
www.cjc.dk

Naturgy

October 13, 2020

Roberto Garrido
C.C.JENSEN Ibérica, S.L.
Avda.de les Corts Catalanes, 9-11
Nave 2-3 - Edif.Trade Center III
08173 Sant Cugat del Vallés
(Barcelona) Spain

Dear Roberto:

We confirm that C.C. Jensen supplied a CJC ® VRU – Varnish Removal Unit to our CCGT plant Aceca. The unit was installed on the 30.000 litres lube oil reservoir of our GE 9FA single shaft STAG configuration. Since its installation, the VRU runs flawless and has efficiently removed varnish and insoluble oil degradation products from the turbine oil and lowered the MPC value to safe levels below dE 10. Thanks to the VRU we could restore the oil and reduce the risk of varnish related turbine failures. The VRU also contributed to reduce maintenance work and obtain a great economic and environmental benefit by avoiding oil change.

We are fully satisfied with both performance and efficiency of the VRU and also the excellent service provided at any time for which we would like to thank C. C. Jensen.

I highly recommend C. C. Jensen's VRU for use in turbine oils and encourage turbine operators to use C. C. Jensen's VRU technology.

Your sincerely

Naturgy NATURGY GENERACIÓN, S.L.U.
C.C.C. ACECA

Álvaro García García

Maintenance manager – Naturgy Aceca

Customer Case

Lube Oil

Gas Turbine GE40MW, Cogeneration Plant

CUSTOMER SAVINGS & BENEFITS

Installing the CJC® VRU Varnish Removal Unit, the following benefits were obtained:

- Varnish reduced - MPC from 36 to 7 in 4 months
- No oil change needed - environmental savings
- Extended oil & machinery lifetime

CUSTOMER

Barcelona Carton - manufacturer og coated paperboard made from recycled fibers (WLC) and virgin fibers (FBB). It is the largest producer of WLC in Spain and the only one producing FBB.

SYSTEM

Gas turbine in cogeneration plant.

Type: GE LM 6000 PC
Oil type: Shell Turbo Oil CC32
Oil volume: 7,000 ltr
Temp. operating: 67ºC

PROBLEMS

A hazardous condition was detected in the system due to high level of varnish, MPC above 30. Using conventional filtration technologies did not reduce the MPC sufficiently. This issue led to the implementation of a corrective plan to completely eliminate varnish contamination.

SOLUTIONS

A **CJC® Varnish Removal Unit VRU** with **CJC® Varnish Removal inserts VRi** was installed.

RESULTS

Using the CJC® VRU, the state was changed from HAZARD to CONTROLLOED, since the MPC value was reduced to 7. The CJC® VRU kept the MPC value constant over time at below 15, without altering the properties of the oil.

FINANCIAL BENEFITS

The high efficiency of the CJC® VRU removing varnish from the system avoided the cost of changing the oil as well as large economic losses due to a possible shutdown of the cogeneration plant.

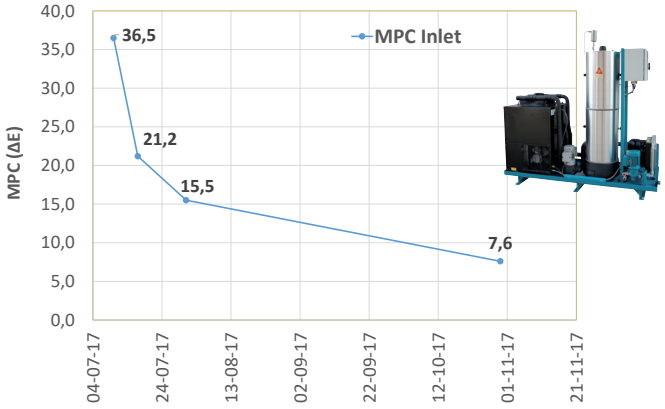
ENVIRONMENTAL BENEFITS

The rapid action of the CJC® VRU provided environmental benefits by avoiding waste oil. Since commissioning, the CJC® VRU has maintained a low level of varnish, extending oil and machine lifetime.

Barcelona Carton, Spain
with the CJC® Varnish Removal Unit VRU installed

RESULTS

Oil analysis with MPC shows the reduction of varnish:



Inlet MPC 36.5 - BEFORE

Membrane Patch
***BEFORE** CJC® VRU installation*

Inlet MPC 7.6 - AFTER

Membrane Patch
***AFTER 4 months** of operation*

Customer Statement:

Mr. Roberto Ledesma, Head of Maintenance:
"The CJC® VRU reduced the MPC value to low, stable, and controlled levels, giving us peace of mind and the security of having clean, varnish free oil. In addition, since the CJC® VRU Filter was put into operation, we have observed fewer pressure filter changes and a reduction in system component failures, which has resulted in financial savings."

CCPO6052-UK
Gas Turbines, Separate Lube & Control
30.09.2022

Customer Case written by:
Mr. Roberto Carrido, C.C.JENSEN Ibérica, Spain

C.C.JENSEN A/S
Løvholmen 13 | DK-5700 Svendborg | Denmark
Phone +45 6321 2014 | sales@cjc.dk
www.cjc.dk

Customer Case

Lube & Control Oil

Combined Cycle, Natural Gas Turbine, GE7FA, Power Plant

CUSTOMER SAVINGS & BENEFITS

Installing the CJC® Varnish Removal Unit VRU, the following benefits were obtained:

- No more costly turbine trips
- Extended oil & component lifetime
- Reduced maintenance costs

CUSTOMER

Major Power Plant in South Carolina, USA.

SYSTEM

Combine Cycle Single Shaft Gas & Steam Turbine.

Type: GE 7FA
Oil type: MOBIL DTE 832
Oil volume: 6,000 US gallons (22,712 ltr)

PROBLEMS

Soft contaminants/varnish caused costly turbine trips even at moderate MPC (Membrane Patch Colorimetric), UC (Ultra Centrifuge) and ISO particle count levels.

SOLUTIONS

A **CJC® Varnish Removal Unit VRU 27/108** with **CJC® Varnish Removal inserts VRi** was installed.

TESTS

The customer installed two different filter systems for a side-by-side test:

A chemical bead filter on turbine CT1 and a CJC® Varnish Removal Unit, VRU 27/108 on turbine CT2.
The customer would purchase two solutions of the filter system that performed the best.

RESULTS

The CJC® VRU outperformed the competition in both oil cleanliness and operational costs/ease of operation since only the CJC® VRU would effectively signal a saturated filter. The customer purchased two CJC® VRUs for both gas turbines CT1 & CT2 and is very satisfied since they have experienced **no more turbine trips!**

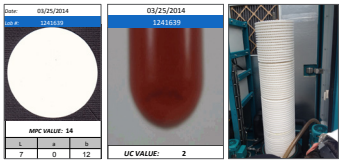
BENEFITS

Installation of the CJC® VRU resulted in no more costly turbine trips. Furthermore, the customer will experience extended lifetime of both oil and components and lower maintenance costs.

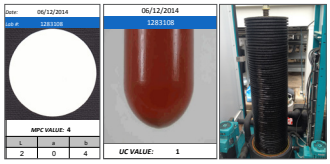
CJC® Varnish Removal Unit, VRU installed at a major power plant Combined Cycle-Natural Gas in South Carolina, USA

RESULT

***BEFORE** installation of CJC® VRU on turbine CT2*
MPC value: *14* *- UC Value: 2*



***AFTER** installation of CJC® VRU, on turbine CT2*
MPC value: *4* *- UC Value: 1*



Oil sampling tests, by TestOil Varnish Analysis, USA

Particles (optical)	BEFORE CJC® Filtration	AFTER 3 days	AFTER 17 days	AFTER 11 weeks
Particles	18/16/12	19/16/13	15/13/10	15/14/11
MPC value	14	14	4	4
UC value	2	2	1	1

Customer Statement:

Manager of Operations & Maintenance:

*"**Before** installation of the CJC® VRU, we were experiencing failed gas valve servo(s) just about every start. We tried other varnish removal units, but we were not getting the results we wanted. **After** we installed the CJC® VRU, within a short time, the varnish problems we were experiencing, diminished. Our varnish levels dropped to very low levels and we have not experienced servo problems since. We are very satisfied with the results and now have again the confidence of a complete start once the start button is pushed."*

CCPO6048-UK
Gas Turbines, Combined
Lube & Control
30.09.2022

Customer Case written by:
Mr. Axel Wegner, Power Segment Manager
C.C.JENSEN Inc. USA

C.C.JENSEN A/S
Løvholmen 13 | DK-5700 Svendborg | Denmark
Phone +45 6321 2014 | sales@cjc.dk
www.cjc.dk

Customer Case

Turbine Oil

ALSTOM Gas Turbine GT8C2, 56 MW, Cogeneration Plant

CUSTOMER SAVINGS & BENEFITS

Installing the CJC® Varnish Removal Unit VRU, the following benefits were obtained:

- Flexible turbine operation
- MPC values below 10
- No oil change needed

CUSTOMER

Salzburg AG, Cogeneration Plant, Austria. The power plant, one of the most modern combined heat and power plants in Europe, supplies town and region with district heating and electricity.

SYSTEM

Lubrication and control system.

Type:	Gas turbine, ALSTOM type GT8C2
Fuel:	Natural gas
Power:	56 MW
Oil type:	Shell Turbo CC 46
Oil volume:	30,000 litres

PROBLEMS

Varnish on valves and bearings led to limited controllability of the gas turbine. Especially during the heating period, a flexible start of the gas turbine could not be guaranteed. The massive amount of generated deposits were caused by peak load operation and oil oxidation products, which accelerate the oil degradation. Despite existing filter systems, the MPC value increased to 54.9. Due to this critical oil condition, an oil change would have been unavoidable.

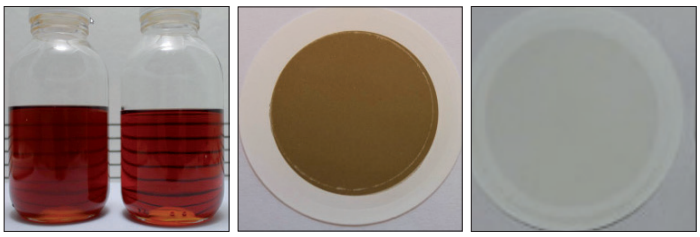
SOLUTIONS

CJC® Varnish Removal Unit VRU 27/108 was installed. The CJC® VRU continuously removes varnish (approx. 8 kg), particles (approx. 8 kg) and water (approx. 8 l) from the turbine oil.

RESULTS

Due to the continuous fine filtration of the oil by the CJC® VRU, the MPC value dropped to an uncritical level. The clean oil continues to remove contaminants and deposits from the system components, so that a MPC value < 10 is achieved and a flexible turbine operation is ensured in long-term. Due to the CJC® VRU, the oil was not changed, but is still in use. Based on these convincing results, two further steam turbines were equipped with CJC® Varnish Removal Units.

Salzburg AG, Cogeneration Plant, Austria.
CJC® Varnish Removal Unit, VRU 27/108 installed at the ALSTOM gas turbine



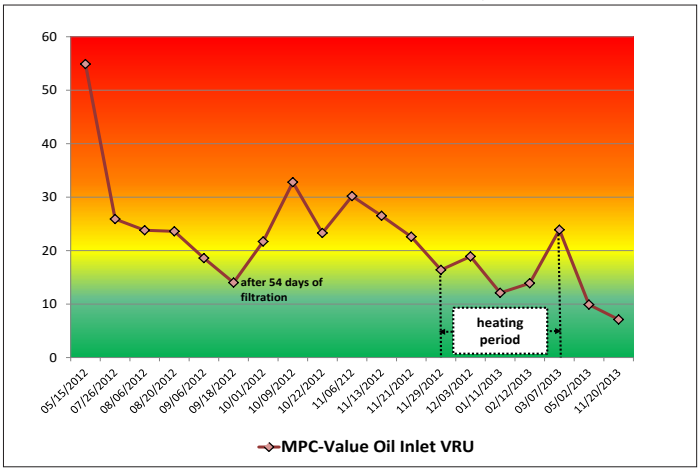
Visual inspection, oil inlet & oil outlet

*MPC Patch **WITHOUT** CJC® VRU*

*MPC Patch **WITH** CJC® VRU*

OIL SAMPLES - MPC TEST

Membrane Patch Colorimetry



**) Further information on MPC values are available on request.*

Steam Turbine ALSTOM:	MPC Before CJC® VRU Filtration	MPC After CJC® VRU Filtration
T8435, 9,000 ltr. Mobil DTE 846	59.2	9.9
T6192, 10,500 ltr. Shell Turbo CC46	32.8	7.8

CCPO6046-UK
Gas Turbines, Combined Lube & Control
30.09.2022

Customer Case written by:
Mr. Michael M. Cornelius
Karberg & Hennemann GmbH & Co. KG, Germany

C.C.JENSEN A/S
Løvholmen 13 | DK-5700 Svendborg | Denmark
Phone +45 6321 2014 | sales@cjc.dk
www.cjc.dk

Customer Case

Lube Oil

Steam Turbine, Siemens SST-400, 65 MW

CUSTOMER SAVINGS & BENEFITS

Installing the CJC® Varnish Removal Unit VRU, the following benefits were obtained:

- No varnish - no risk of failure on heat exchangers, valves or bearings
- Reduced MPC values from 41.6 to 16.3 in 47 days
- No need for oil change - savings 28,000 EUR
- Reduced environmental impact

CUSTOMER

TIRME Environmental Technology Park Mallorca.
Urban waste management plant.

SYSTEM

65 MW Siemens SST-400 Steam Turbine.

Type:	V71A
Oil type:	Cepsa HD Turbines 46
Oil volume:	15,000 ltr.
Temp. operation:	58-62ºC

PROBLEMS

The high level of varnish detected during the periodic overhaul checks led to a corrective plan. The recorded average MPC values of above 30, indicated high failure risk of heat exchangers, valves and bearings, due to contamination with varnish and oil degradation products in the turbine.

SOLUTIONS

A **CJC® Varnish Removal Unit, VRU 27/108** with **CJC® Varnish Removal inserts VRi** was installed.

RESULTS

The MPC decreased from 41.6 to 16.3 over a period of 47 days. Due to thick layers of varnish deposited on the coldest surface areas in the system, filtration with the CJC® VRU was required for 2 years to stabilise the MPC value to below 15.

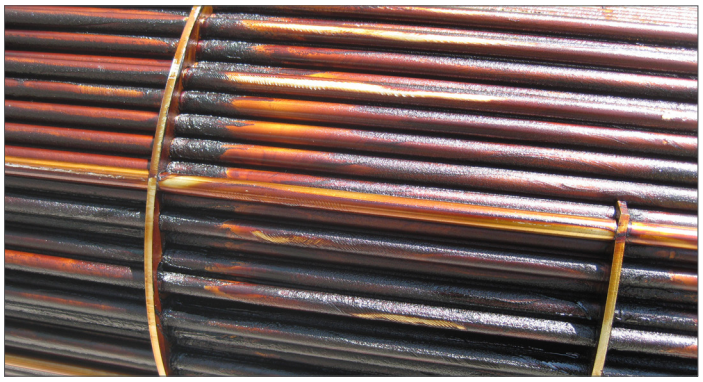
ECONOMICAL BENEFITS

In addition to possible system failures, the CJC® VRU avoided a cost of approximately €28,000 which the changing of 15,000 litres of oil would have incurred. If we also added the cost for oil supply/bleeding and disposal, the resulting cost would have been at least €3,000 higher.

ENVIRONMENTAL BENEFITS

Installation of the CJC® VRU prevented an oil change and waste oil, thus allowed Tirme to continue their environmental policy. The CJC® VRU has been keeping pollution at low levels for more than 3 years without altering the oil's properties.

TIRME Environmental Technology Park Mallorca with the CJC® Varnish Removal Unit VRU installed



Heat exchanger failure due to varnish build-up on the surface

Appearance of the oil after sampling at the CJC® VRU Filter - Inlet & Outlet.

	BEFORE CJC® VRU oil filtration	AFTER 47 days CJC® VRU oil filtration	AFTER 2 years CJC® VRU oil filtration
MPC Value	41.6	**16.3**	13.6

CCPO6051-UK
Steam Turbine
30.09.2022

Customer Case written by:
Mr. Roberto Garrido
C.C.JENSEN Ibérica, Spain

C.C.JENSEN A/S
Løvholmen 13 | DK-5700 Svendborg | Denmark
Phone +45 6321 2014 | sales@cjc.dk
www.cjc.dk

RESOLVING VARNISH CHALLENGES

Varnish Removal Technology in Turbine Oil

BY HASANUR JAMAL MOLLA, SAAD H. AL-DOSSARY, TARIQ NADEEM, AND MOHAMMAD F. AL-SHIHRI.

Varnish is an organic residue produced by irreversible chemical degradation of mineral oil lubricants. It can lead to filter plugging, restricted oil flow, poor heat transfer, valve sticking, fail-to-start conditions, and unit trips.

During rotating equipment operation, heat generated due to friction degrades the oil and produces very small byproduct particles that settle throughout the system as varnish. Spark discharges from static charge buildup in the lubricating oil filters play a key role in its formation. Over time, these particles attach themselves to surfaces throughout the turbine, producing a sticky film. As varnish builds up, performance of rotating equipment suffers.

A variety of varnish removal systems are available in the market. As the conversion between soluble and insoluble varnish is a physical equilibrium process dependent upon temperature, Varnish Removal Units (VRU) are equipped with a cooler to reduce the oil temperature and convert soluble into insoluble varnish. Special filter media inside the VRU capture dissolved and suspended soft contaminants from the oil.

VARNISH FORMATION

Varnish is a sub-micron-sized soft contaminant that is polar in nature. Oxidation and thermal breakdown are among the causes of varnish formation. But the two major reasons are micro-dieseling and static electric discharge.

In micro-dieseling, the implosion of entrained air bubbles as they migrate from low-pressure zones to high-pressure zones creates a local oil temperature in excess of 1,800°F. This is enough to cause severe oxidation of oil molecules and generates carbonaceous byproducts. As system pressures increase, the potential for micro-dieseling rises.

The industry's shift to synthetic and glass filter media has created unexpected side effects due to the combination of tighter filter pore sizes to remove fine sediment with very high filter flux rates to reduce capital cost. The result is significant static charge buildup within the oil system. These spontaneous discharges can generate sparks of static electricity with temperatures greater than 18,000°F. This "cooks" the oil, creating molecule fragments that deplete antioxidant additives. The oil circuit where there is metal-on-metal contact can also generate a static charge.

The conversion between soluble and insoluble varnish is a physical equilibrium process dependent upon temperature.

Oil-degraded soft contaminants are dissolved in the oil at operation temperature which are polar in nature and get absorbed onto dipolar (colder) metallic surfaces. The varnish is formed by soft contaminants agglomerating and hardening into a lacquer-like coating on valve spools and sleeves, bearing surfaces, gears and other internal surfaces of the lubrication system.

The sticky nature of varnish captures hard contaminants as they flow within the system, forming an abrasive finish that accelerates component wear. Furthermore, varnish is an efficient insulator that provokes bearing surfaces to run hotter, and heat exchangers to have lower efficiency.

VARNISH DETECTION METHOD

In Saudi Aramco, all critical rotating machines are monitored by a lubricant condition monitoring (LCM) system. The scheduled samples are tested inhouse. Test slates are decided based on oil type and equipment. However, color and acid

number are checked for all industrial lube oils. When color and acid number are high, the RULER (Remaining Useful Life Evaluation Routine)/ RPVOT (Rotating Pressure Vessel Oxidation Test), and UC (Ultracentrifuge)/ MPC (Membrane Patch Colorimetric Test) are checked to understand the condition of the oil and design the corrective action to prevent unscheduled equipment downtime.

The MPC test has been used for many years in oil analysis as a qualitative test to assess the condition of oil. Recently, several commercial laboratories have developed quantifiable scales to trend the varnish potential of oil. For example, on Analyst Inc.'s scale from 0 to 100, a varnish potential rating of 0 to 15 is considered normal. The range 15 to 30 means monitoring is required. Readings greater than 30 are considered actionable and should trigger rapid remediation.

GAS COMPRESSOR EXAMPLE

Delaval make a 5-stage centrifugal low-pressure (LP) gas compressor driven by a 3,500 hp electric motor. It is a critical asset, operating throughout the year with no standby equipment. The compressor takes gas from the LP suction drum and discharges it to the high-pressure (HP) gas compressor. The compressor runs at 10,295 RPM and delivers 19.27 - 21.55 MMSCFD of gas, with the amount varying from summer to winter. The set alarm and trip temperature of the compressor bearings are 235°F and 250°F respectively.

The compressor train is lubricated through a forced feed system to provide lubrication to the motor, gearbox and compressor bearings. The lube oil reservoir capacity is more than 3,000 gallons of ISO VG 46 turbine oil.

The bearing temperature trend of the LP compressor showed a gradual increase at the inboard (I/B) bearing. It reached above the limit of 250°F and resulted in a trip. The bearing was dismantled, and varnish was found on the bearing. This lowered the oil flow rate because of reduced clearance and a reduced heat dissipation rate (Figure 1 and 2).

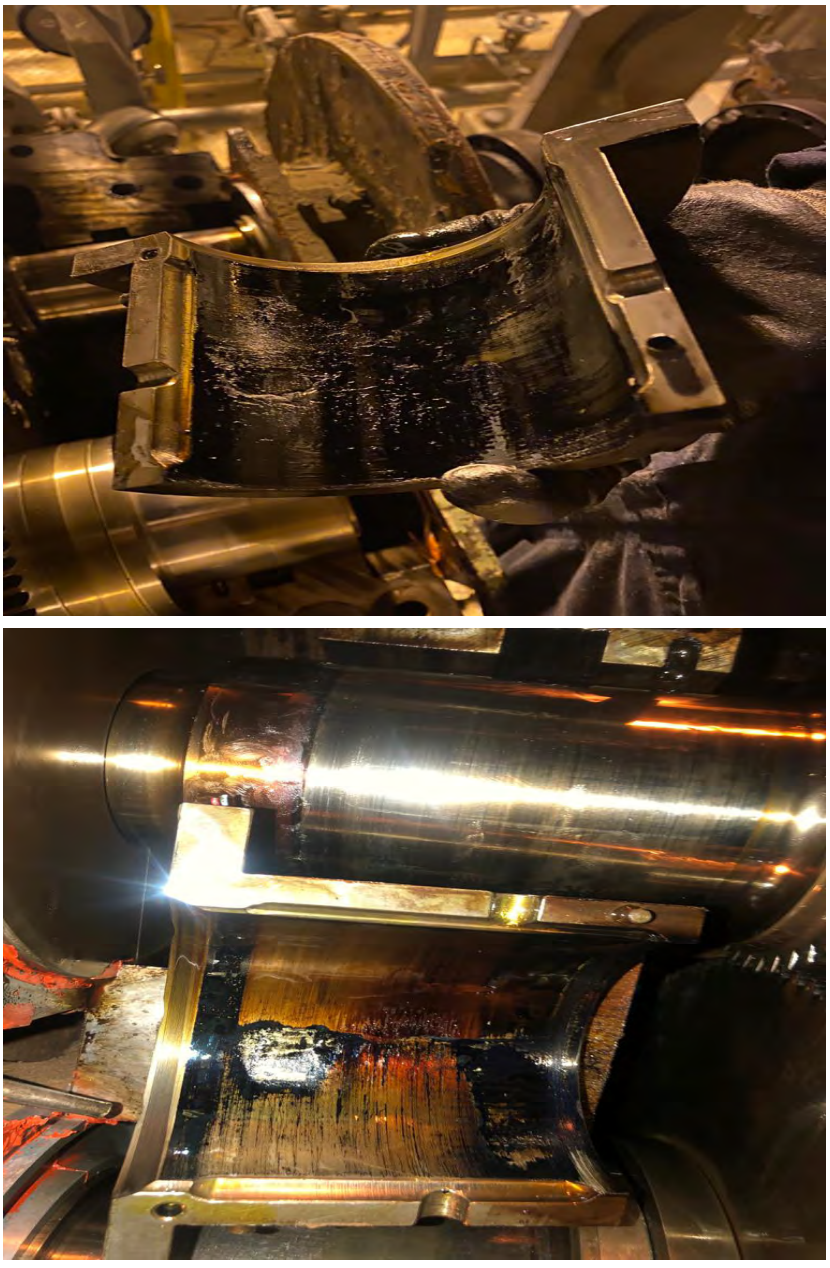


Figure 1: Varnish was found in the compressor gearbox, bearing, and shaft.

VARNISH REMOVAL TECHNOLOGY

An offline Varnish Removal Unit (VRU) was connected to the LP gas compressor lube oil system while the machine was running. The VRU suction is taken from the lube oil reservoir drain valve. The VRU discharge is returned back to reservoir through a one-inch socket welded on the reservoir inspection manway.

The VRU utilizes filter media optimized for varnish removal. The warm oil is drawn from the system tank to the VRU by means of the transfer pump. The oil first passes through a blast cooler, then a heat exchanger, and finally a chiller system before reaching the filter housing. The oil temperature comes down to approximately 50°F before reaching the filter media that captures dissolved and suspended soft contaminants.

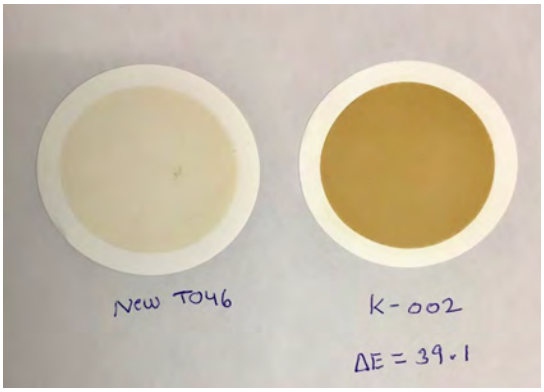


Figure 2: The lube oil sample testing revealed a very high level of varnish presence; the test result for new (left) and in-service lube oil (right).

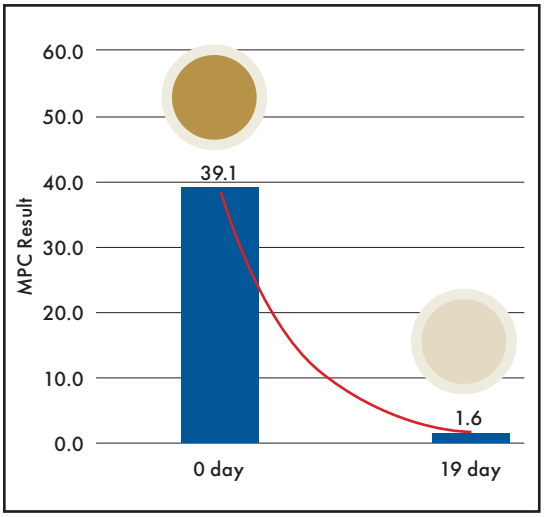


Figure 3: MPC Results Trend.

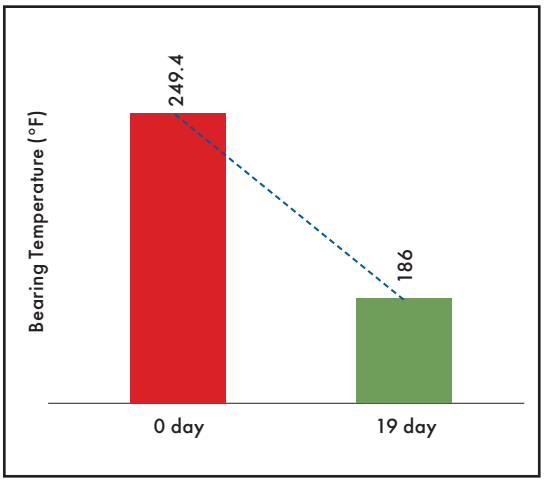


Figure 4: Bearing Tempt Trend.

Varnish has traditionally been defined as an insoluble deposit. However, it also exists in soluble state. The conversion between soluble and insoluble varnish is a physical equilibrium process dependent upon temperature. The soluble varnish becomes insoluble by reducing the lube oil temperature and can then be removed easily from the lube oil system.

After extracting the varnish from the lube oil, it is returned to the main lube oil system. Varnish-free oil now starts to clean system components in contact with oil, resulting in a varnish-free system for up to a few months depending on system condition.

After utilizing the VRU for a few weeks on the LP gas compressor, bearing temperatures and the condition of the lube/seal oil were improved. Oil samples subjected to MPC tests showed a drop from 39.1 to 1.4 within 19 days of operation. Bearing temperatures dropped from 249.4°F to 186°F within 19 days due to the removal of varnish and better heat dissipation as well as increased oil flow.

The usage of the VRU in combination with MPC testing of the lube oil system reduced the bearing temperature by detecting and cleaning varnish deposits. This improved heat dissipation and prevented any equipment trips due to high bearing temperatures. It also eliminated the immediate need for oil replacement, system flushing, and chemical cleaning. ■

Hasanur Jamal Molla, Lubrication Engineer, Consulting Services Department, Saudi Aramco

Saad H. Al-Dossary, Dynamic Analysis Group Leader, Consulting Services Department, Saudi Aramco.

Tariq Nadeem, Reliability Engineer, North Ghawar Producing Department, Saudi Aramco

Mohammad F. Al-Shihri, Reliability Unit Supervisor, North Ghawar Producing Department, Saudi Aramco

The varnish removal unit utilized by Saudi Aramco. Courtesy: CJC

Product Sheet

CJC® Varnish Removal Unit, VRU

CJC® Fine Filter for Gas & Steam Turbines

The CJC® VRU in cover

The CJC® Varnish Removal Unit VRU 27/108

APPLICATION

The CJC® Varnish Removal Unit, VRU has an unheard high efficiency in removing soft contaminants from oil - dissolved and suspended – even from hot operating gas and steam turbines.
Oxidation and varnish are known to cause problems in many industries, resulting in very costly production stops, turbine trips, loss in revenue etc.

BENEFITS

- Less varnish related turbine trips
- Lower maintenance costs
- Extends the lifetime of both oil and components
- No need for system flushing and tank cleaning
- Avoid temperature increase
  – no varnish in the cooling system

APPLICATIONS

Designed for efficient removal of soluble varnish from any size turbine:

- Gas and steam turbines with combined or separate lube and control oil system
- Base or peak loaded gas or steam turbines operating at low, medium or high oil temperatures
- Also for highly stressed and high temperature oil systems in general.

FUNCTION

The VRU is designed to remove dissolved and suspended soft contaminants by polar attraction in the optimized cellulose based Varnish Removal inserts, VRi. It does this without any additional power, chemicals or beads which may be harmful to the oil's additive package.
The warm system oil is drawn from the bottom of the tank to the VRU by its own transfer pump. The oil is being treated and filtered in the VRU before sent back to the system tank as varnish free oil.
The varnish free oil will start cleaning all system components in contact with oil, ultimately resulting in a complete varnish free system. The varnish level in the oil will typically be cut in half within a few weeks of operating the VRU.
The VRU is prepared for online data logging via CJC® Trender Tool.

TECHNICAL DATA

Varnish Removal Unit		VRU 27/108 380 - 420V @ 50 Hz & 440 - 480V @ 60 Hz
Pump inlet pressure, max.	bar/psi	0.5/7
Power consumption, aver.	kW	2
Full load current, max.	A	4
Filter Insert VRi 27/27	pcs.	4
Oil reservoir volume, max. *)	ltr/gal	45,000/11,900
Oil viscosity **)		<ISO VG68
Oil temperature, max *)	°C/°F	105/221
Varnish holding capacity, up to	kg/lb	8/18
Total weight	kg/lb	290/640
Design pressure, filter	bar/psi	4/58
Dimensions LxWxH incl. + free height	mm inches	1600x650x1598+575 63x25.6x62.9+22.6

**) For more than 45,000 L or higher temperatures, please contact us*
***) For viscosities higher than ISO VG68, please contact us*

APPLICABLE FILTER INSERTS

Type	Application for
Varnish Removal insert, VRi	Gas and steam turbines, large compressors and hydraulic oil systems

The CJC® Varnish Removal Unit, VRU 27/108 is only functional, if used in conjunction with the CJC® VRi 27/27 Filter Insert.

(Please ask for Product Sheet ID nr. PSFI3214)

PSST1109-UK
01.072022

C.C.JENSEN A/S
Løvholmen 13 | DK-5700 Svendborg | Denmark
Phone +45 6321 2014 | sales@cjc.dk
www.cjc.dk

Product Sheet

CJC® Filter Insert, type VRi

Specially designed for removal of dissolved varnish in hydraulic and turbine oils

CJC® VRi FILTER INSERTS

The CJC® Varnish Removal insert, VRi 27/27, is used in the CJC® Varnish Removal Unit, VRU. The VRU contains 4 x VRi 27/27 Filter Inserts, which are specially designed for efficient removal of dissolved and suspended soft contaminants from turbine lube and hydraulic oils that operate at continuously high temperatures.

Used for the maintenance of the below applications:

- Gas turbines
- Steam turbines
- Compressors
- Hydraulic systems
- Generators
- Gearboxes

CJC® Filter Insert VRi 27/27

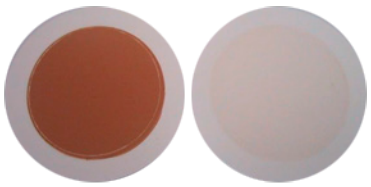
The CJC® Filter Insert VRi 27/27 is only functional when used in conjunction with the CJC® Varnish Removal Unit, VRU 27/108. Only the distinctive oil treatment and flow characteristic of the CJC® VRU ensures precipitation and polymerisation of dissolved varnish in the oil.

CONTAMINATION CAPACITY

Based on field experience we have observed that the total Dirt Holding Capacity (DHC) is dependent on the shape and density of particles and other variables within an oil system.

Contamination Capacities	Size
	27/27
Solids, kg (lb)	4 (8.8)
Water, ltr (gal)	2 (0.53)
Varnish, kg (lb)	4 (8.8)

Documented cases have shown the removal of 4 kg (4,000 g)/8 lb of solid contaminants and oil degradation products per filter insert with one VRU Filter Insert change (4 x VRi 27/27 16 kg/32 lb). Single-pass efficiency for varnish removal and MPC reduction of up to 99 percent. An Ultra-Centrifuge test can also be used to detect varnish.



88% MPC reduction

*Typical single pass efficiency for varnish removal and MPC reduction from **MPC ΔE 66 to MPC ΔE 7.7.***

COMPONENTS

CJC® Filter Inserts consist of cellulose bonded discs **made of 100% natural cellulose fibres from sustainable resources; no plastic, no metal, no chemicals.**

DISPOSAL OF USED CJC® FILTER INSERTS

CJC® Oil Filters are green solutions, and at C.C.JENSEN one of our objectives is caring for the environment. Therefore, please arrange for proper disposal of used filter inserts in accordance with your own local legislation.

IDENTIFICATION

To order the VRi Filter Inserts, please use:

Article No.:

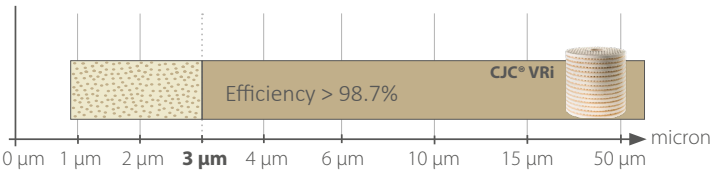
- 1 x VRi 27/27: PA5601370

FILTRATION TECHNOLOGIES

- **Oxidation and oil degradation products**
  The CJC® Filter Insert VRi removes all phases of oil degradation; oxidation/resin/sludge/varnish, which are retained by the special cellulose material using adsorption and absorption forces.
- **Oil filtration degree**
  *Particles can be removed as shown in the illustration below *)*
  For offline oil filtration, the dirt holding capacity is paramount because the offline process will have time to remove contaminants, unlike in-line filtration. Our focus is on removing the smallest and most harmful particles.
- **Water removal**
  VRi Filter Inserts will typically be able to keep the water in oil below saturation point (mineral/synthetic oils). All three phases of water (dissolved, emulsions and free) will be absorbed by the cellulose fibres.
- **Acidity stabilisation**
  Acidity is a natural part of the oil degradation process and will be retained by the CJC® Filter Insert using absorption technology. The VRi 27/27 Filter Insert is documented not to affect the functional phenolic and aminic anti-oxidant additive package of the oil. *(Please request the CJC® VRU Product Sheet, ID no. PSST1109).*

*) Oil Filtration Efficiencies - Particles

CJC® Filter Inserts



CJC® **VRi** Filter Insert:

- very high efficiency for varnish removal
- efficiency not influenced by oil temperature, volume or type
- patented and best varnish removal technology in the market
- high varnish retention capacity

C.C.JENSEN A/S
Løvholmen 13 | DK-5700 Svendborg | Denmark
Phone +45 6321 2014 | sales@cjc.dk
www.cjc.dk

BENEFITS in general

C.C.JENSEN DEPTH FILTER EFFICIENCY TEST

CJC® Filter Inserts are designed to last for one year, therefore testing of a high density depth filter for a few hours does not make sense. The C.C.JENSEN test is inspired by a modified ISO 16889, using finer test dust (UFTD), which resembles real dust and wear particles better than the coarse MTD test dust used in the standard Multi-pass test - designed for thin pleated filter media. The test modification also includes a much longer test time to get close to a real-life application scenario. The main advantage of CJC® Filter Inserts is the huge surface area, which distributes the oil flow and particles evenly and ensures stable low velocity for optimum retention of contamination. The large filter mass makes this unmatched high dirt holding capacity possible.

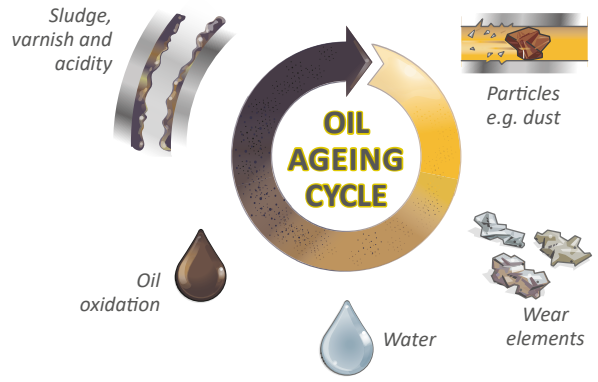
DIRT HOLDING CAPACITY CREATES VALUE

Competitive Filter Insert costs divided by dirt holding in kg:

3-micron filtration	Example 1	Example 2
Filter Insert type	Competitive pleated filter	CJC® cellulose depth media
Cost of element vs. Filter Insert	1 x €	4 x €
Dirt holding capacity	0.100 kg	4 kg
Cost per kg removed contamination	10 x € per kg	1 x € per kg

SLOW DOWN OIL AGEING

By removing all four contamination types (particles, water, acidity, and varnish), the CJC® Filter Inserts can slow down the oil ageing process and prolong the oil lifetime (see ill. 1). CJC® often results in 2-5 times longer oil lifetime, leading to considerable savings and reduction of CO_2 emissions. Field experiences show that removing particles of 3 µm and below with CJC® Filter Inserts has a significant effect on oil and component lifetime.



ill. 1)

CJC® Filter Inserts remove all catalyst in the "oil ageing cycle" and will slow down the oil degradation process. If contaminants are not removed, a vicious circle starts and the oil degradation process speeds up.

YOUR BENEFITS WITH CJC®

CJC® Filter Inserts have the highest dirt holding capacity on the market due to special cellulose-based material. Furthermore, the unique construction of the bonded discs, creates a large filtration area (see ill. 2) resulting in reduced costs of ownership. The CJC® Filter Inserts are a modular design, which allows them to fit any applications and requirements.

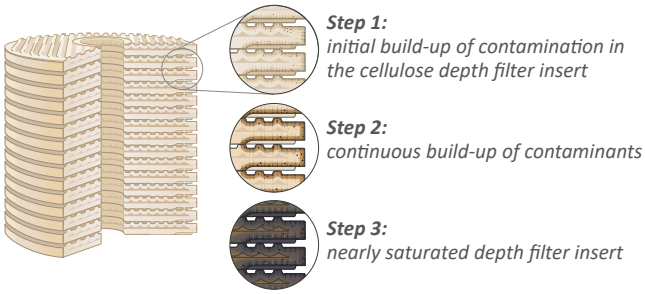
1. **The CJC® Filter Insert features:**
   a. Depth media of moulded cellulose.
   b. Highest Dirt Holding Capacities (DHC).
   c. **100% natural cellulose fibres from sustainable resources; no plastic, no metal, no chemicals.**

2. **Removal of contaminants, 4-in-1:**
   a. **Particles:**
   Lifetime of both oil and component are increased considerably.
   b. **Oil degradation products:**
   Avoid sticking valves, lacquering, and varnish on metal surfaces.
   c. **Water:**
   Reduce the risk of micro-pitting, bacterial growth, sludge etc.
   d. **Acidity/TAN:**
   Reduce oil ageing and wear on equipment.

3. **OEM requirements**
   Experience and application knowledge of C.C.JENSEN ensure that CJC® solutions can meet specifications from OEMs on oil cleanliness.

All helping to minimise further degradation of the oil.

CJC® DEPTH FILTRATION EFFICIENCY



ill. 2)

This graphic describes the technology and the efficiency of depth Filter Inserts removing contaminants by adsorption & absorption.

MAINTENANCE RECOMMENDATIONS

To achieve the highest possible oil cleanliness level, the CJC® Filter Inserts need to be changed at least once a year. Because of accumulated oil degradation products (oxidation, acids, and varnish) no matter what the pressure gauge indicates the used Filter Inserts should be replaced annually. Leaving filter media in service for longer than one year will result in decreased oil filtration efficiency and increased risk of breakdowns and component wear.

PSFI3214-UK
16.09.2021

C.C.JENSEN A/S
Løvholmen 13 | DK-5700 Svendborg | Denmark
Phone +45 6321 2014 | sales@cjc.dk
www.cjc.dk

CJC® Oil Filtration presents

CJC® Varnish Removal Unit

Solution for removal of dissolved and suspended soft contaminants from oil in

Gas & Steam Turbines

Avoid varnish related turbine trips, downtime & expensive repairs.

Prevent oil change & reduce CO_2 footprint.

Your challenges

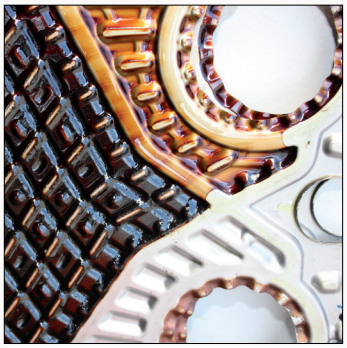
turbine trips | oil aging | valve sticking | in-line filter blocking

- send us your oil sample - contact your nearest CCJ Distributor

When varnish strikes, the costs associated with a production outage are often very high. The precursors to varnish, the so-called soft contaminants, are created in the hot spots in the oil system, e.g. bearings, pumps and high flow in-line filters. Recent studies have found that the soft contaminants exist in both dissolved and suspended phases and should be removed in order to avoid varnish formation. Once formed, varnish can seize and clog valves, filters and other small passages and reduce the oil life considerably.

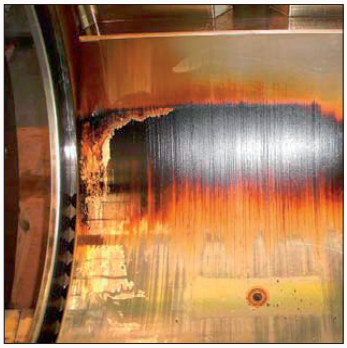
When soft contaminants are dissolved in oil, typically at temperatures above 40ºC (100 ºF), they cannot be removed through standard mechanical filters or electrostatic filters. The soft contaminants are polar in nature and adsorb onto dipolar, colder metallic surfaces in "cold spots", e.g. valves and coolers. They will also settle out when the oil temperature decreases during outages. The soft contaminants also have lower thermal stability than the oil so they are more likely to bake onto cold and hot surfaces, e.g. journal bearings.

Varnish coated in-line filter of IGV servo valve hydraulics



Varnish on plate heat exchanger

Varnish on valve spool



Varnish on journal bearing, gas turbine

FACTS

Consequences of Varnish

- Valve sticking ▸ loss of control, which results in turbine trips or fail-to-start
- Filter blockage ▸ restriction of oil flow, which increases oil temperature and wear
- Sandpaper surface ▸ increases component wear
- Ineffective heat exchangers ▸ increases oil temperature
- Lacquer baked onto bearings ▸ flow restriction, increased wear and temperature
- Frequent oil changes and system flushing

Your solution

high efficiency | low maintenance | reliable | easy to install

3 in 1 Solution

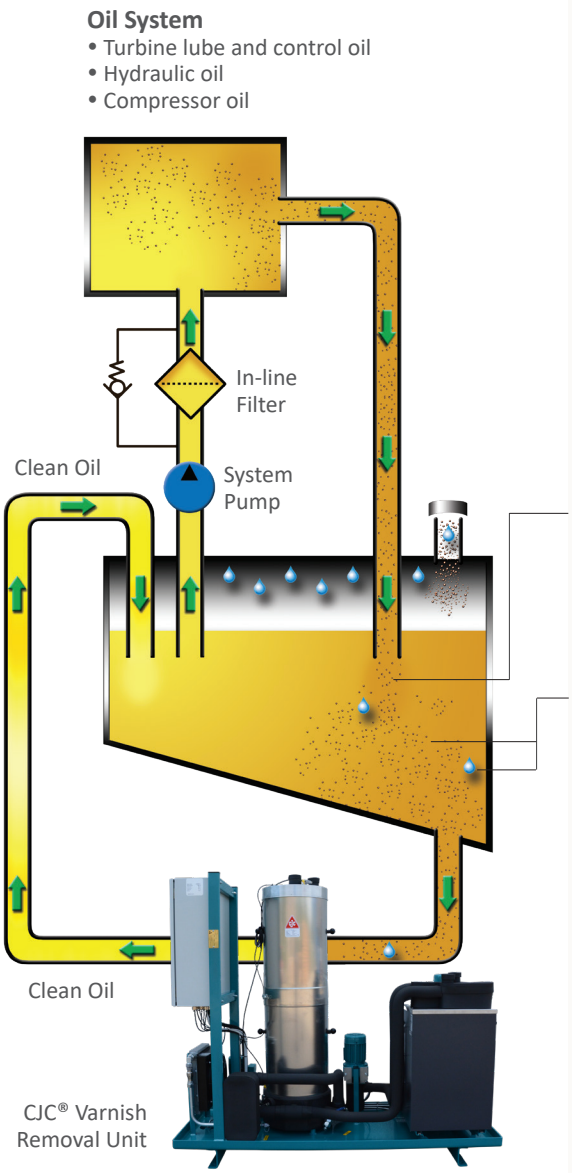
use the CJC® VRU and remove
varnish, particles & water - in one single pass

C.C.JENSEN A/S introduces the CJC® Varnish Removal Unit with a revolutionary high efficiency for removing soft contaminants from oil – dissolved and suspended – even from hot operating gas and steam turbines.

The CJC® VRU is designed to remove dissolved and suspended soft contaminants by polar attraction in the optimized, cellulose based CJC® Varnish Removal inserts, VRi. It does this without any additional power, chemicals or beads which may be harmful to the oil's additive package.

The hot oil is drawn from the lowest point of the system tank to the CJC® Varnish Removal Unit by means of the transfer pump on the unit. The process inside the unit includes passing the oil through the efficient CJC® Varnish Removal insert, VRi 27/27 specially designed for varnish removal in combination with the CJC® Varnish Removal Unit. After cleaning, the oil is returned to your system.

The varnish free oil will start cleaning all system components it comes in contact with, ultimately resulting in a completely varnish free system. The varnish level in the oil will typically be cut in half within a few weeks of operating the CJC® VRU.



Contamination
now under Control!

3 in 1 Solution
The optimized filtration and treatment in the CJC® VRU captures the soft contaminants, which can then be removed from the system completely by replacing the CJC® Varnish Removal insert, VRi

Varnish
Oil degradation products – dissolved and suspended – are removed from the oil and system components.

Particles & Water
Not only varnish is removed, also particles and water is retained in the inserts and removed from the oil.

FACTS

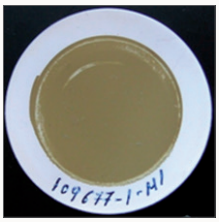
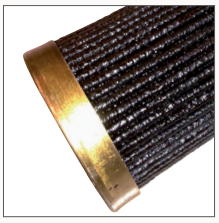
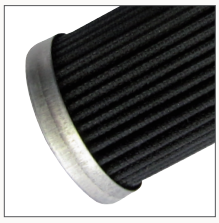
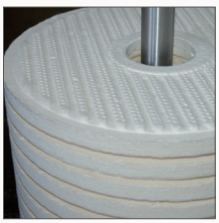
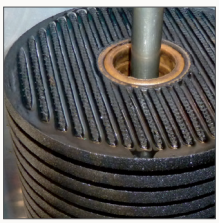
The specially designed CJC® Varnish Removal inserts VRi, used in the CJC® Varnish Removal Unit make it possible to remove oil degradation products from oil in gas and steam turbines, up to 45,000 L (11,900 gal) – dissolved and in suspension

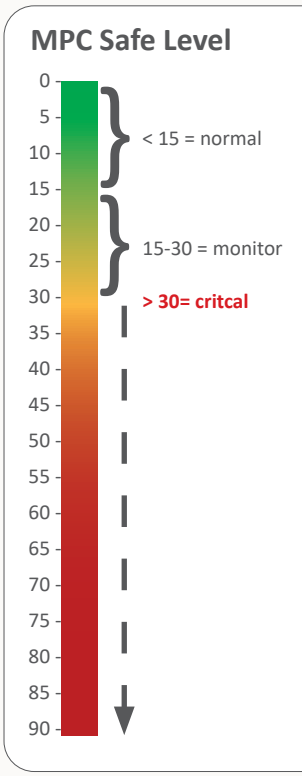
– even from high temperature operating turbines!

Our result

no turbine trips | no oil aging | no valve sticking | no in-line filter blocking

Before and **After** installation of CJC® VRU

Turbine oil BEFORE filtration with the VRU			Turbine oil AFTER just a few weeks of filtration with the VRU®
Millipore membrane MPC>50			Millipore membrane AFTER filtration with the VRU, MPC <10
Ultra Centrifuge test, initial sample before the VRU (inlet)			Ultra Centrifuge test, sample after a single pass through the VRU (outlet)
Clearly visible varnish at the metal surface BEFORE startup the VRU			No more varnish at the metal surface AFTER startup the VRU
6 months WITHOUT VRU: Varnish on the in-line filter			**6 months WITH VRU:** No varnish on the in-line filter
Varnish Removal insert, VRi before startup			Varnish Removal insert, VRi, after filtration



CASE

Customer

A 95 MW Combined Cycle Power Plant in Spain. Two base loaded gas turbines each containing 6,500 L (1,700 gal) of Mobil DTE 832 oil. Varnish level measured with Membrane Patch Colorimetric was reduced from MPC 55 to MPC 15 within two weeks of operating the CJC® VRU. By using the CJC® VRU, a pending oil change and flushing were not necessary anymore, and turbine trips due to varnish were avoided!

The savings obtained from reduced oil purchases, flushing and oil handling, add up to approximately

$ 35,000

per gas turbine.

Your benefits

no expensive turbine trips | no uncontrolled shut downs

Benefits

- **80% drop in oil-related turbine trips**
- **MPC of <15 guaranteed**
- Increased system reliability and availability
- No turbine trips or sticking valves due to varnish
- Prevent uncontrolled shutdowns and reduces maintenance costs
- Extends the lifetime of both oil, additives, and components, e.g. bearings, valves, seals etc.
- No need for system flushing and tank cleaning
- Improved lifting oil pressure
- More stable bearing temperature
- Less vibrations due to varnish in bearings

Savings (average)

Avoiding a turbine trip and prolonging oil life can result in huge savings.
A real example:

- $ 40,000 saved by avoiding a turbine trip (not including lost revenue)
- $ 35,000 saved on oil, flushing and disposal costs
- $ 4,600 per hour penalty for not supplying energy

Total cost for a turbine trip can easily exceed $ 100,000 including downtime penalties.

Environment

- **75% reduction in oil consumption**
- With the CJC® VRU the oil lifetime can be extended to **10-20 years** in operation without compromising its properties
- Extend the lifetime of components
- No use of ion exchange resin
- Prolonged oil and additive lifetime
- CJC® VRi Varnish Removal insert is made of 100% natural cellulose

Less Maintenance

- **50% shorter oil service time during outage**
- No need for system flushing and tank cleaning
- Avoid malfunction of hydraulic valves e.g. inlet guide vane valves
- Reduced consumption of in-line filters
- Avoid sludge and varnish build-up in heat exchangers
- Minimal maintenance and supervision of the CJC® VRU
- Maintenance of the CJC® VRU does not require shutting down the main oil system

C.C.JENSEN
- contact us today!

Manufacturing & headquarters

C.C.JENSEN A/S
Løvholmen 13 | DK - 5700 Svendborg | Denmark
Tel. +45 6321 2014 | Fax: +45 6222 4615
sales@cjc.dk | www.cjc.dk

C.C.JENSEN worldwide

Benelux
C.C.JENSEN Benelux B.V.
Tel.: +31 182 37 90 29
info.nl@cjc.dk
www.ccjensen.nl

Chile
C.C.JENSEN S.L. Limitada
Tel.: +56 2 739 2910
ccjensen.cl@cjc.dk
www.ccjensen.cl

China
C.C.JENSEN Filtration
Equipment (Tianjin) Co. Ltd.
Tel: +86 10 6436 4838
ccjensen.cn@cjc.dk
www.ccjensen.cn

Denmark
C.C.JENSEN Danmark
Tel: +45 7228 2222
ccjensen.dk@cjc.dk
www.cjc.dk

France
C.C.JENSEN France
Tel: +33 366 753 170
contact.fr@cjc.dk
www.ccjensen.fr

Germany
KARBERG & HENNEMANN
GmbH & Co. KG
Tel: +49 (0)40 855 04 79 0
kontakt@cjc.de
www.cjc.de

Greece
C.C.JENSEN Greece Ltd.
Tel.: +30 210 42 81 260
ccjensen.gr@cjc.dk
www.ccjensen.gr

India
C.C.JENSEN India
Tel.: +91 4426241364
ccjensen.in@cjc.dk
www.ccjensen.in

Italy
KARBERG & HENNEMANN srl
Tel: +39 059 29 29 498
info@cjc.it
www.cjc.it

Poland
C.C.JENSEN Polska Sp. z o.o.
Tel.: +48 22 648 83 43
ccjensen@ccjensen.com.pl
www.ccjensen.pl

Spain
C.C.JENSEN Ibérica, S. L.
Tel.: +34 93 590 63 31
ccjensen.es@cjc.dk
www.cjc.dk

Sweden
C.C.JENSEN AB
Tel.: +46 8 755 4411
sales@ccjensen.se
www.ccjensen.se

United Arab Emirates
C.C.JENSEN Middle East
Tel.: +971 4 447 2886
ccjensen.uae@cjc.dk
www.cjc.ae

United Kingdom
C.C.JENSEN Ltd.
Tel.: +44 1 388 420 721
filtration@cjcuk.co.uk
www.ccjensen.co.uk

USA
C.C.JENSEN Inc.
Tel.: +1 770 692 6001
ccjensen@ccjensen.com
www.ccjensen.com

Scan the QR code and find your nearest distributors at www.cjc.dk/contact

- or give us a call!

Your local C.C.JENSEN Distributor

C.C.JENSEN A/S
www.cjc.dk