



Oil Degradation [Varnish]

CJC™ Fine Filters and CJC™ Filter Separators not only remove particles and absorb water from oils - they also remove degradation products

Degradation products known as "soft contaminants", are the precursors of varnish deposits on metal surfaces of machines and components



Oil Maintenance



C.C.JENSEN



Introduction

[Varnish]

“A thin, insoluble, nonwipeable film deposit occurring on interior parts, resulting from the degradation and polymerization of oil”

(source: Noria)



Any lubricant in service or in storage will degrade over time, depending on the type of oil, the operation conditions and the environment. When the oil degrades, it will change its composition and functional properties. During the degradation process, a number of unwanted products are formed, which can lead to varnish deposits, all of which will result in costly consequences for machinery, such as corrosion, sticky valves, varnish, etc.

In this brochure you can read about the causes and consequences of oil degradation, and you can also find solutions both to remove and monitor degradation products.



HDU 15/25 PV



HDU 27/27 P



PTU 15/25 PV



PTU2 27-27 PV

CJC™ Fine Filters and CJC™ Filter Separators not only remove particles and absorb water from oils - they also remove degradation products

Oil Maintenance

Removal of degradation by-products from oil

*Oil degradation is a common problem
in both lubrication and hydraulic systems*



C.C.JENSEN

1

The Problem

Oil degradation is a common problem both in lubrication and hydraulic systems. The main causes of oil degradation are typically oxidation, hydrolysis and thermal degradation. In many cases it is a combination of all three.

Process	Oxidation	Hydrolysis	Thermal degradation
Reagent	Oxygen	Water	Heat
Process catalysed by:	Temperature / Water	Oxygen / Temperature	Water / Oxygen
	Transition metals (wear particles, Cu, Fe, Si) Contaminants (contamination in general, oxidation products) Pressure		

The degradation process is catalysed by:



Oxygen

Oxidation

Oxidation is the breakdown of the oil with oxygen as reagent. The oxidation process involves a series of reactions forming acid compounds and polymerized compounds. Oxidation leads to insoluble products (sludge) that may precipitate as a thin film forming lacquers or varnish deposits on hot or cold metal surfaces.



Water

Hydrolysis

Hydrolysis is the breakdown of the oil with water as reagent. Like oxidation, hydrolysis can result in acid compounds and varnish. Oxidation products such as: hydroperoxides, carboxyl acids, ketones, aldehydes and others usually possess increased solubility in water and therefore often accelerate the hydrolysis process.



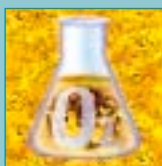
High temperature

Thermal Degradation

Thermal degradation is the breakdown of the oil activated by heat (high temperature). Typically thermal degradation occurs in the hot spots of the system. It can also result in polymers and insolubles compounds, which lead to varnish formation as occurs in the oxidative degradation.



Wear particles

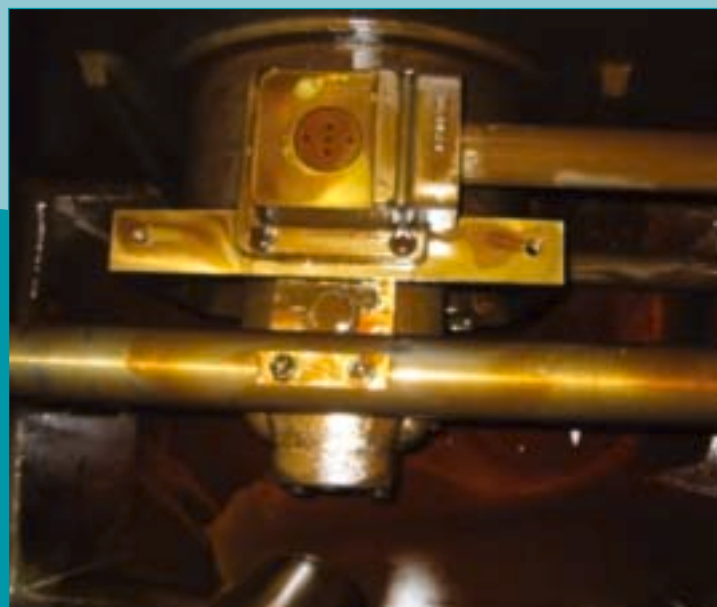


Contaminants

Oxidation

Hydrolysis

Thermal Degradation



Example of varnish formation on a steering gear

Oil degradation and Consequences

Oil degradation will result in:

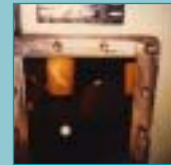
- **Formation of acidic compounds:**
Acid promotes corrosion, for example pitting corrosion, this leads to increased wear in the internal surfaces of the machine.
- **Increase in oil viscosity:**
The oil's resistance to flow will increase, which will result in friction, wear and loss in efficiency of equipment.
- **Decreased additive performance:**
Antioxidant additives react with the degradation products and counteract the acid formation. As the oil oxidizes, the antioxidant additives are depleted and then the oil is exposed to degradation. Detergents, which have the ability to disperse and suspend organic acids, sludge and other contaminants, are also consumed in the oil degradation process, like antioxidants.
- **Varnish formation:**
Varnish deposits are sticky and will trap hard contaminants creating a "sandpaper surface". This "sandpaper" causes accelerated wear in components. In addition to this, varnish can result in filters and valves blocking, and orifices clogging. Furthermore varnish acts as an insulator, reducing the effect of the heat exchangers, resulting in higher temperatures and accelerated reaction speeds.

Once the varnish deposits have formed on the metal surfaces, it is very difficult to dissolve them.

Consequences of the oil degradation:

- **Shorter oil life**
An increase in the level of oil degradation
Degradation products act as a catalyst for further oil degradation
A reduction of additive performance
- **Reduced oil performance**
Loss of lubricity
Valve failure
Restricted oil flow
- **Reduced productivity**
Monday morning problems: slow start-ups
Increased downtime
Reduced machine performance
- **Higher energy consumption**
Friction and wear
- **Increased maintenance costs**
Increased filter change frequency
Increased wear off components
Acidic corrosion in metallic components
Component failures
Cleaning of the oxidation deposits
- **Environmental pollution consequences**
Greater disposal costs of oil and filter changes
Leakages

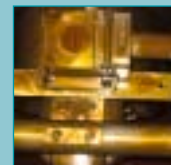
Examples of varnish:



*Oil reservoir
(Plastic
Moulding
Machine)*



*Machine
components*



*Steering
machine*

2

The Solution

Removal of degradation by-products, before they have time to react further and form insoluble sludge and varnish deposits

Oil degradation by-products cannot be removed with the conventional mechanical filters because of the submicron particle, with a high level of solubility in the oil.

Oil degradation by-products can be removed by CJC™ Fine Filters and CJC™ Filter Separators through means of a combination of **adsorption** and **absorption** processes.

Adsorption is the physical or chemical binding of molecules or ions to a surface called the adsorbent. In contrast with **absorption**, in which molecules or ions are taken up by the volume by physical or chemical processes.

CJC™ Filter Inserts, made of cellulose fibers, have a high surface area and can be effective as **adsorbents** and **absorbents**. In addition, due to their chemical nature, they are highly suited to pick-up oxygenated organic molecules, such as oil degradation products.



Absorption
can be illustrated by this drawing: The chemical substances (the cake) are taken up by the volume

Absorption



Adsorption
can be illustrated by this drawing: The chemical substances (the cake) are binding to a surface

Adsorption

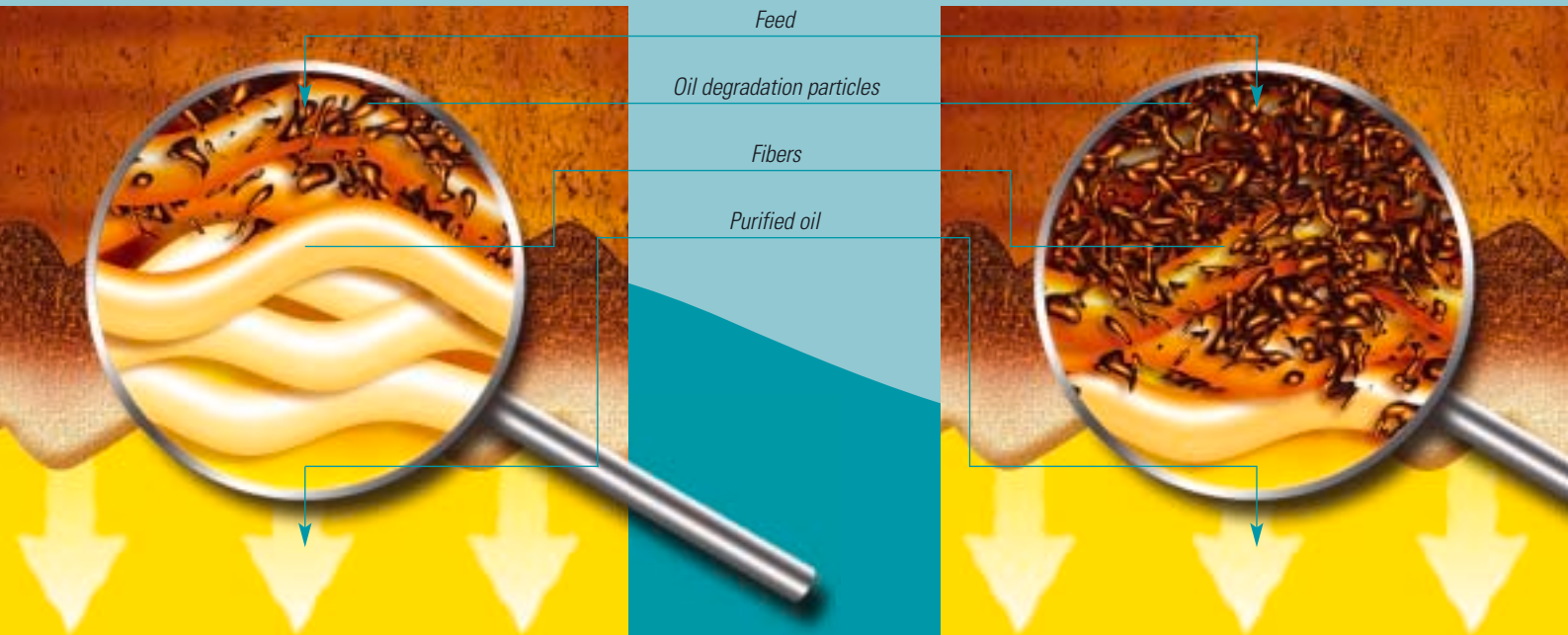
The CJC™ Solution

Fibrous filter treating oil at outset

This figure shows the contaminated oil approaching the fibers early in the life of the filter

Fibrous filter near exhaustion

This figure shows the nearly loaded filter still producing clean oil, at some later time, having nearly exhausted the filter medium



Absorption and Adsorption by CJC™ Filter Inserts

Cross-section of fiber

Each cellulose fiber consists of millions of cellulose molecules. Each strand of cellulose molecules has a diameter of 10^{-6} cm (0.000001cm)

Degradation products are **absorbed** and **adsorbed** into the cellulose material



Film diffusion:

Transport from the oil to the boundary of the adsorbent (fiber). The resistance is pictured as a fictitious film

Macropore diffusion:

Transport within the adsorbent (fiber). It could be viewed as among the subfibers

Micropore diffusion:

Transport from the pore fluid to the adsorption sites at the adsorbent surfaces. This could be viewed as among the molecules



CJC™ Filter Inserts removes contaminants of any kind and size

- **Hard contaminants:** wear particles, debris, dirt
- **Soft contaminants:** oil degradation products
- **Water**



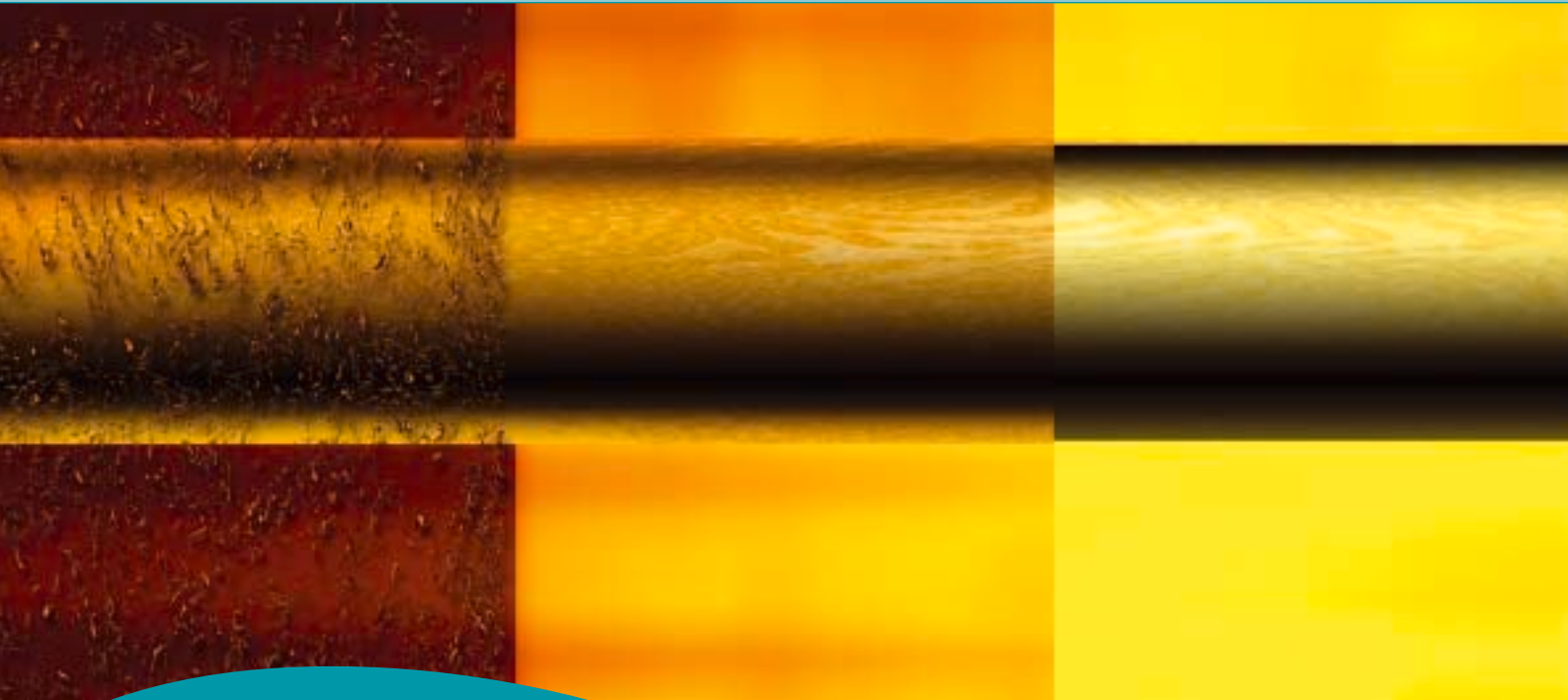
3

The Result

CJC™ oil filtration will maintain both oil and system clean

- Longer oil life
- Increased oil performance and lower energy consumption
- Increased productivity
- Less maintenance
- Environmentally friendly

An oil system free
from varnish deposits



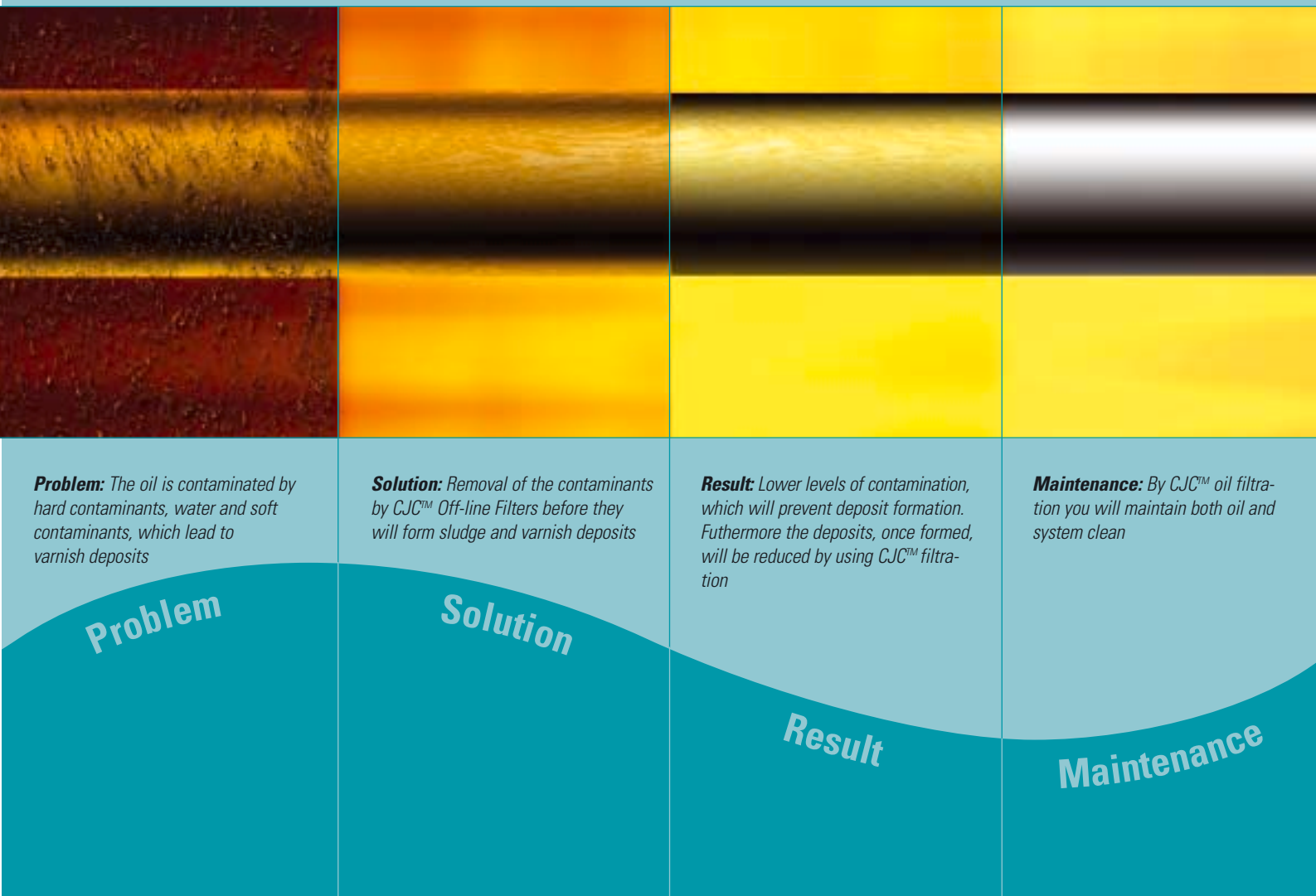
Removal of varnish deposits from metal surfaces

Removal of varnish deposits from metal surfaces

By using CJC™ Off-line Filters, the amount of varnish deposits on metal surfaces will be reduced. It is explained by the adsorption equilibrium behavior.

There is an equilibrium between the two phases, i.e. the fluid (oil) and varnish on the surfaces. When the oil becomes cleaner, the deposits from the system become unstable because the concentration of oil degradation products in the oil has decreased. This will result in a decrease of the amount of adsorbed substance. In other words this means, that the oil degradation products on the metal surfaces are released. The oil functions as a system cleaner.

Summary





How to monitor oil degradation?

Soft contaminants are compounds of molecular sizes, which cannot be measured by conventional particle counting methods

There are several methods that measure different aspects of the degradation process. These methods generally measure the amount of certain degradation products from oil or the amount of additives in the oil.

The following are indications of oil degradation:

- **Dark color**
- **Sour and putrid odor**
- **Increase in oil viscosity**



Sour and putrid odor indicates oil degradation



Increase in oil viscosity indicates oil degradation

Indications of oil degradation

Dark color indicates oil degradation



Methods to monitor oil degradation

Methods to monitor the level of degradation in the oil:

- **Viscosity Test:**
This test measures the oil resistance to flow. It can be used as an indicator of oil degradation.
- **TAN (Total Acid Number):**
This analysis measures the level of acid compounds. It can also be used as indicator of oil degradation.
- **Colorimetric Analysis:**
This analysis can determine the level of oil degradation by using the color of the contaminants.
- **Ultracentrifuge Test:**
This test uses the gravitatory forces to extract and settle the contaminants of the oil. The sediments are compared with a sedimentation rating system to determine the degradation of the oil.
- **Gravimetric Analysis:**
This analysis can determine the level of oil degradation by measuring the weight of residual components.
- **Infrared Spectroscopy:**
(FTIR Analysis -Fourier Transformation Infrared Spectroscopy)
This analysis is based on the principles of molecular spectroscopy. It can verify the level of oil degradation by the identification of the functional groups (e.g. ketones, carboxylic acids) in molecules.



Viscosity test



TAN analysis



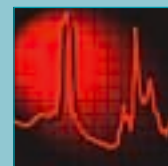
Colorimetric analysis



Ultra-centrifuge test



Gravimetric analysis



Infrared spectroscopy

Methods to monitor the consumption of additives:

- **FTIR Analysis**
(Fourier Transformation Infrared Spectroscopy)
It can monitor the additive depletion.
- **RULER Test** (Remaining Useful Life Evaluation Routine)
It measures the remaining antioxidants by voltammetric analysis.
- **RBOT Test** (Rotating Bomb Oxidation Test)
It measures the oil's resistance to oxidation under prescribed conditions.



C.C.JENSEN



C.C.JENSEN all over the World

The CJC™ Off-line Filters are distributed by our own international sales organisation and designated distributors

CJC™
stands for
reliable supply
all over the
world



Manufacturer

Denmark:

C.C.JENSEN A/S • Løvholmen 13 • DK-5700 Svendborg • Denmark
Tel.: +45 63 21 20 14 • Fax: +45 62 22 46 15 • E-mail: filter@cjcdk • www.cjcdk

Subsidiaries

UK:

C.C.JENSEN LTD. • Tel.: +44 1 388 420 721 • E-mail: filtration@cjcdk.co.uk • www.cjcdk.co.uk

USA:

C.C.JENSEN INC. • Tel.: +1 206 789 1710 • E-mail: ccjensen@ccjensen.com • www.ccjensen.com

Spain:

C.C.JENSEN Ibérica, S. L. • Tel.: +34 93 590 63 31 • E-mail: ccjensen.es@cjcdk • www.ccjensen.es

Poland:

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

Netherlands:

C.C.JENSEN (Netherlands) A/S • Tel.: +31 182 37 90 29 • E-mail: ccjensen.nl@cjcdk

Ireland:

C.C.JENSEN A/S (Ireland) • Tel.: +353 61 374 943 • E-mail: ccjensen.ie@cjcdk

Chile:

C.C.JENSEN S.L. Limitada • Tel.: +56 2 555 80 02 • E-mail: ccjensen.ch@cjcdk • www.ccjensen.cl

Greece:

C.C.JENSEN Greece LTD. • Tel.: +30 210 42 81 260 • E-mail: ccjensen.gr@cjcdk

*We are represented all over the world by distributors.
Find your nearest distributor on our website: www.cjcdk - or give us a call.*

Your local CJC™ distributor

Oil Maintenance

Head office:

C.C.JENSEN A/S • Denmark
Løvholmen 13 • DK 5700 Svendborg
Tel. +45 63 21 20 14 • Fax: +45 62 22 46 15
E-mail: filter@cjcdk • www.cjcdk

