Advances in Water Removal from Turbine, Gear and Hydraulic Oil

Simple Solutions for Removing Moisture, even with Strong Emulsions, from Oils up to ISO VG 1000

By Justin Stover

Executive Summary

Ugly. Torturous. Scourge. Devastating. Catastrophic. Insidious. These are just a few of the words to describe the effects of water in oil. You get the picture. For good reason, water has been called the second most destructive contaminant next to hard particles. OEM's and end users are seeking solutions to battle water and looking for new ways to efficiently remove it without breaking the bank. This paper outlines advances for efficient water removal, even with strong emulsions and high viscosity fluids.

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Clean Oil – Bright Ideas

Introduction

Water Contamination – A Dangerous Opponent

Water in oil is dangerous because it causes many problems with the machine and the oil itself. Following are some of the effects of water contamination:

- Rust and corrosion
- Film strength loss
- Filter plugging
- Steam damage
- Aeration
- Lower viscosity
- Accelerated oxidation

Many experiments have also shown that water promotes micropitting. Water is always present in oil. All lubricants are susceptible to attack. It is introduced through ingression, condensation, or by oxidation. Sometimes it enters through leaks and faulty seals. It can also be added through improper or careless oil storage and handling.

"The presence of water in lubricating oils can **shorten bearing life down to 1 percent or less**, depending upon the quantity present."
- SKF

Once it gets in, the battle with water is on. Water is a formidable foe as it exists in three phases; dissolved, emulsified, and free. In the dissolved state, water molecules are finely dispersed in the oil similar to humidity in the air that surrounds us. Emulsified water is a mixture of oil and water that results in a milky or cloudy appearance. It is similar to fog. Lastly, free water is clearly visible as it settles out much like rain. Water is most dangerous in the free and emulsified states. Most component manufacturers' today state that water content in oil should never exceed 500 ppm is the full life potential is to be realized.

For instance, research has shown that bearing life is adversely affected by water. Reliability and lifetime are a function of reducing water content (see Figure 1).

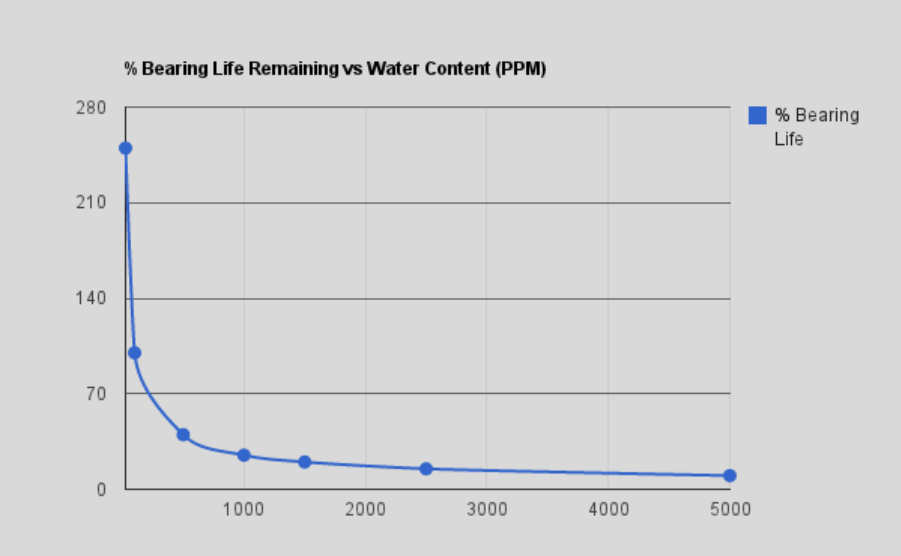


Figure 1
Effect of Water in Oil on Bearing Life (Timken)

ADVANCED WATER REMOVAL

Water Removal Methods

There are several methods to remove water from oil. Some are more rigorous than others. Some are simple and inexpensive while others are more complex and require a significant investment. Every method has advantages and disadvantages so each must be carefully evaluated for the right fit. Here is a look at advanced solutions for efficiently and economically removing water form oil, even with strong emulsions.

Desorbers

These units operate by the "air stripping" principle. Desorbers heat the oil slightly before it enters the integrated chamber. Heated oil meets a counter flow of cool air inside the chamber. Air, now heated by the oil, will expand and draw water from the oil. The subsequent air-cooling condenses the water and it is drained out of the system. The cycle continues as the now dry air is recirculated to remove water from incoming oil (see Figure 2). This cycle repeats and the oil is dehydrated.

Desorbers will remove free, emulsified and dissolved water from all types of oils effectively and reliably. Viscosities up to ISO VG 1000 can be treated with this technique. They are ideal for use in applications where water ingress is a continuous and significant problem. Desorbers will not remove additives and are suitable for oil volumes up to 15,000 gallons.

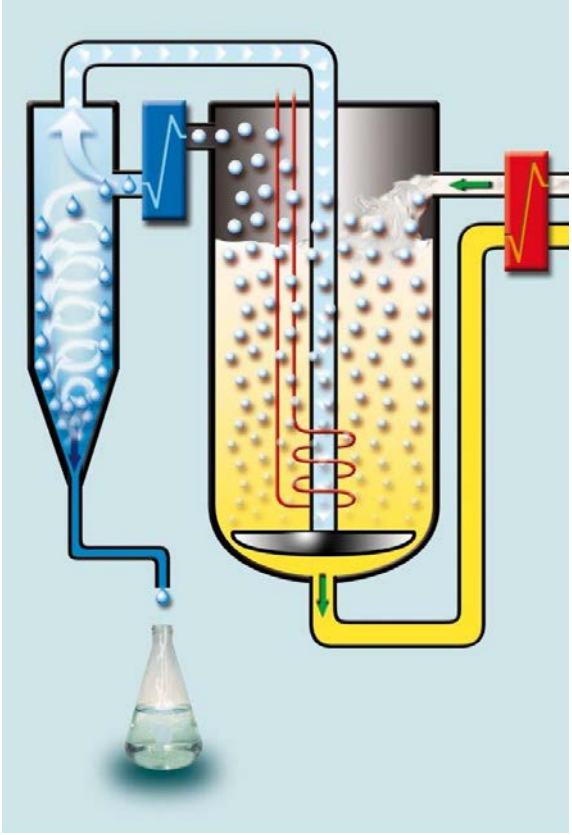


Figure 2
Desorber Principle

For more technical information about Desorbers please click on the following link:
http://www.cjc.dk/products/desorbers-water-removal/

DESORBER CONFIGURATIONS

D10
COMPACT DESORBER

D10
COMPACT DESORBER
WITH FINE FILTER

D40
HIGH VOLUME DESORBER

D30
MOBILE DESORBER

DESORBERS vs. VACUUM DEHYDRATON

How do Desorbers Perform Against Older Technology?

Older technologies for water removal such as Vacuum Dehydration are commonly used. Advanced technologies such as Desorbers offer distinct advantages. Good practice is to set water level targets according to reliability needs (see Appendix - Table 2). Best practice is to remove water below the saturation point so the oil is clear & bright. Following is a table that provides a head-to-head comparison of Desorbers vs. Vacuum Dehydrators:

Table 1 Performance Comparison

SOLUTION	WATER TYPE REMOVED	ECONOMY 1. Purchase Cost 2. Operational Cost	ADVANTAGES	TRADEOFFS
VACUUM DEHYDRATION	Free Emulsion Dissolved	1. VERY HIGH 2. HIGH	Removes particles and gas, can be portable, easy installation	Nuisance tripping with sudden water ingress, efficiency decreases with water content >500 ppm, high maintenance
DESORBERS	Free Strong Emulsion Dissolved	1. HIGH 2. LOW	Not affected by viscosity, can handle high water levels, low maintenance, user friendly, effective with Gear Oils and EALs	Particle and varnish removal only with additional filters in parallel, increased energy consumption

”Best practice is to remove water below the saturation point so the oil is **clear & bright**”

DESORBERS and EALs?

How do Desorbers Perform with EALs?

The US Environmental Protection Agency understandably does not want any oil in the waters they oversee. That is why in recent years the latest Vessel General Permit came into force, stating that ships sailing in US waters are to use EALs in all oil-to-sea interfaces (unless it’s technically infeasible).

So as a responsible and law abiding company you change your lubricating oil to a biodegradable one that meets requirements. All is well until you find out that the EALs may have some serious disadvantages. But don’t worry, there is a proven solution!

The Problem

First, EALs may affect the tightness of your standard seals as many conventional rubber made seals are not compatible with the EALs. So there is a serious risk of water ingress to your stern tube, your thrusters, your rudders and your controllable pitch propeller systems.

Second, it turns out that EALs will absorb a considerably larger amount of water than conventional mineral oil. Your EAL supplier may assure you that their product will maintain its lubricating abilities even with as much as 30 % water. However, that level of water contamination poses a serious risk of corrosion, wear and tear, and other water related damage.

Furthermore, the water in many EALs will cause strong emulsions to form. These emulsions can be hard to break and so severe that conventional methods of water removal are rendered ineffective (i.e. centrifuges, filters, coalescers).

The Advanced Solution

C.C. Jensen has more than 60 years of experience with development and production of oil filtration systems for a great variety of applications. In response to the challenge posed by EALs, Desorbers have been deployed and have successfully removed water quickly and efficiently.

One Unit Solves Two Problems

Retrofitting equipment in the marine industry requires compact solutions. Anyone that has been through the water tight doors near the stern tube or thrusters will know what that means. Therefore in order to provide fine filtration and to break stable emulsions, C.C. Jensen combined the Desorber and HDU Fine Filter technologies. The result is a compact unit with one inlet and one outlet. It is a true plug-and-play solution that is easy to install even in narrow spaces and ready to work in less than 30 minutes.

The unit will effectively remove fine particles from the oil and remove water from emulsified EALs, returning clean and dry oil to the system. The unit is built on well documented and patented techniques and the first of its kind in the market.

CASE STUDY

Pulp Mill in Peril

Problem: Water in 250 Gal of Vacuum Blower Lubricating Oil
Solution: D30 Desorber

"**$350,000** in Savings"

An alert operator noticed that the sight glass turned milky and hazy due to water contamination. Further investigation revealed that the water-over-oil cooler had failed. A Desorber was immediately installed to combat this threat. In 1 week nearly 7 gallons of water was removed. Pulp Mill staff calculated a cost savings of $350,000 (see Figure 3-4).

Figure 3 [Left] Sight Glass *before* installing Desorber

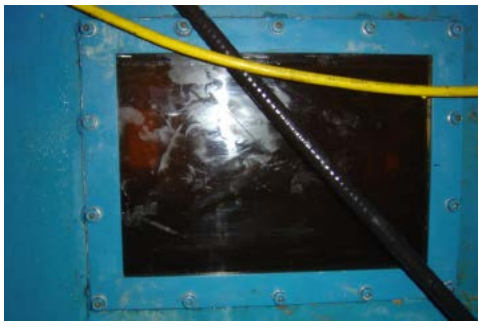


Figure 4 [Right] Sight Glass *after* installing Desorber

CASE STUDY

Water Trouble on the High Seas

Problem: Water in 200 Gal of EAL – Stern Tube
Solution: D10 Desorber with Fine Filter

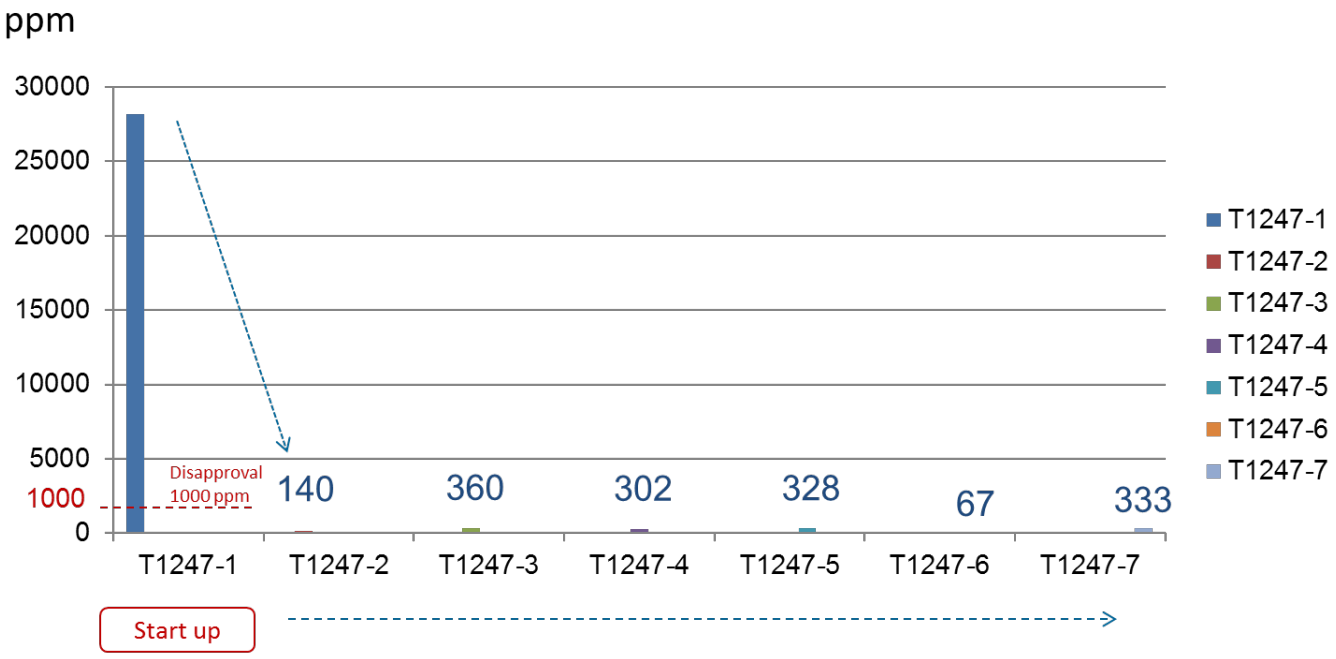
Water Reduction of 28,000 ppm / 12 Gallons in just 3 days!

A Bulk Carrier operation was forced to repeatedly change oil and components due to wear and tear caused by water ingress. Conventional methods of water could not keep the water under control. A Desorber was installed and the water was removed quickly, saving thousands of dollars in downtime and maintenance.

In 3 days after start up, the Desorber unit separated totally 12 gallons of water. Despite a continuous ingress of water, the Desorber unit will maintain a very low water level (see Figure 5-6).

Figure 5
Oil Samples

Figure 6
Water Reduction in ppm



DESORBER OVERVIEW

Defeat Water For Good

Removing water contamination is a challenge. But the battle can be won using advanced technologies such as Desorbers. A well-planned water removal program can dramatically extend component life and yield savings in the hundreds of thousands of dollars (see Appendix - Table 1).

With a Desorber it is possible to remove large amounts of water and particles from a wide range of lubricants including EAL's (Environmentally Acceptable Lubricants) / biodegradable lubricants - even from emulsified oils and high viscosity fluids.

BENEFITS

- *Removal of large amounts of water - even from emulsified lubricants - preventing formation of acid and microbial growth*
- *Reduced corrosion and wear/tear of rubber made sealings*
- *Extended lifetime of both the oil and system components*
- *Prevents uncontrolled shut downs*
- *Reduce maintenance costs*
- *Compact size*

About the Author

Justin Stover serves as Sales Manager at C.C. Jensen. He is a Certified Lubrication Specialist (STLE) and a Machine Lubricant Analyst II (ICML). He has over 16 years of experience working closely with OEM's and end users to achieve clean and dry oil in their machines. Justin focuses on developing contamination control strategies, reliability, condition monitoring, oil analysis interpretation and cost savings. He can be reached at justin@ccjensen.com

WOULD YOU LIKE TO LEARN MORE?

No Cost Evaluation

If you would like to evaluate a Desorber system at no cost, please email ccjensen@ccjensen.com and reference this White Paper to take advantage of this offer.

Sales and Rental Units Available

If you would like to get pricing and availability of a Desorber system to remove water from your application, please email ccjensen@ccjensen.com and request "Desorber Sales"

Clean Oil Guide

For your free copy of the *Clean Oil Guide* please email ccjensen@ccjensen.com and request yours today!

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APPENDIX

Table 1 – Life Extension Factor for Water Removal

LEM - MOISTURE Level

Current Moisture Level, ppm	Life Extension Factor (Source: Noria Corp.)								
	2	3	4	5	6	7	8	9	10
50,000	12,500	6,500	4,500	3,125	2,500	2,000	1,500	1,000	782
25,000	6,250	3,250	2,250	1,563	1,250	1,000	750	500	391
10,000	2,500	1,300	900	625	500	400	300	200	156
5,000	1,250	650	450	313	250	200	150	100	78
2,500	625	325	225	156	125	100	75	50	39
1,000	250	130	90	63	50	40	30	20	16
500	125	65	45	31	25	20	15	10	8
260	63	33	23	16	13	10	8	5	4
100	25	13	9	6	5	4	3	2	2

1% water = 10,000 ppm • Estimated life extension for mechanical systems utilizing mineral-based fluids.

Example: By reducing average fluid moisture levels from **25 000 ppm** to **391 ppm**, machine life (MTBF) is extended by a factor of **10.** (MTBF = Mean time between failure)

Table 2 –How Low Should Water Levels Be?

Target Dryness Table

Machine or Fluid Type	Reliability Penalty Factor									
	1	2	3	4	5	6	7	8	9	10
Steam Turbine – Bearing Oil	2000	1500	1000	750	500	400	300	200	100	50
Steam Turbine – EHC Fluid	2000	1500	1250	1000	750	600	500	400	325	250
Mobile Hydraulics – Mineral Oil	10000	5000	3000	2000	1000	750	500	400	300	200
Diesel Engine Oil	20000	10000	5000	3000	2000	1000	500	400	300	200
Air Compressor Lube – Mineral Oil	4000	3500	3000	2000	1000	500	400	300	200	100
Industrial Gearbox	3000	2000	1500	1250	1000	750	600	500	400	300
Transmission / Differential	10000	5000	3000	2000	1000	750	500	400	300	200
Paper Machine Oil	4000	3500	3000	2000	1000	500	400	300	200	100
Motor or Pump Bearing Oil	2000	1500	1000	750	500	400	300	200	100	50
Industrial Hydraulics – Mineral Oil	4000	3500	3000	2000	1000	500	400	300	200	100
Phosphate Ester Hydraulic Fluid	2000	1000	1250	1000	750	600	500	400	325	250
Diesters or Polyol Esters	3000	2000	1500	1250	1000	750	600	500	400	300

10000 ppm = 1%

REF: NORIA