



Improved Lubricant Testing & Maintenance with Lubricant Chemistry Management

Peter Dufresne
pdufresne@cleanoil.com

Matthew G. Hobbs, PhD
mhobbs@cleanoil.com

OUR MISSION

- Teaching the World a Better Way:
 - To transform the way lubricants are used and maintained.
 - Most maintenance programs are upside down removing as little as 10% of the contamination or targets contamination too late in the process to extend the operating life of the lubricant or prevent mechanical failure.
 - Chemistry which is the underlying cause of lubricant failure is not delt with leaving lubricant systems in an unmanaged state.
 - **Yes, it is worth your time and energy to fix this!**



WHAT IS LUBRICANT CHEMISTRY MANAGEMENT?

- Proactive maintenance that addresses the root causes of lubricant breakdown and oil-related failures:
 - Water, oxygen, catalysts, and oil breakdown products including acids, varnish and its precursors.
- A tool to dramatically extend oil lifetimes and reduce overall impact:
 - Fluid breakdown often viewed as unavoidable, but this need not be the case. Oils only degrade because their chemistry has not been managed.
- A protective shield for critical lubricated equipment:
 - By actively managing oil breakdown, the risk of oil-related failures can be mitigated or eliminated



cleanoil.com



LUBRICANT CHEMISTRY MANAGEMENT, PILLAR 1



YOU CAN'T MANAGE WHAT
YOU'RE BLIND TO



CHRONIC ISSUES OBSERVED WITH ANALYSIS

- Assumption that everything is where it should be!
- Incorrect tests or missing tests
 - Not normally user driven
 - Is this a diesel engine or a jet engine?
 - Tests that do not confirm to ASTM standard
- No base lines or incorrect base lines
- No targets, limits or incorrect limits
 - #'s in outer space
- No interpretation!



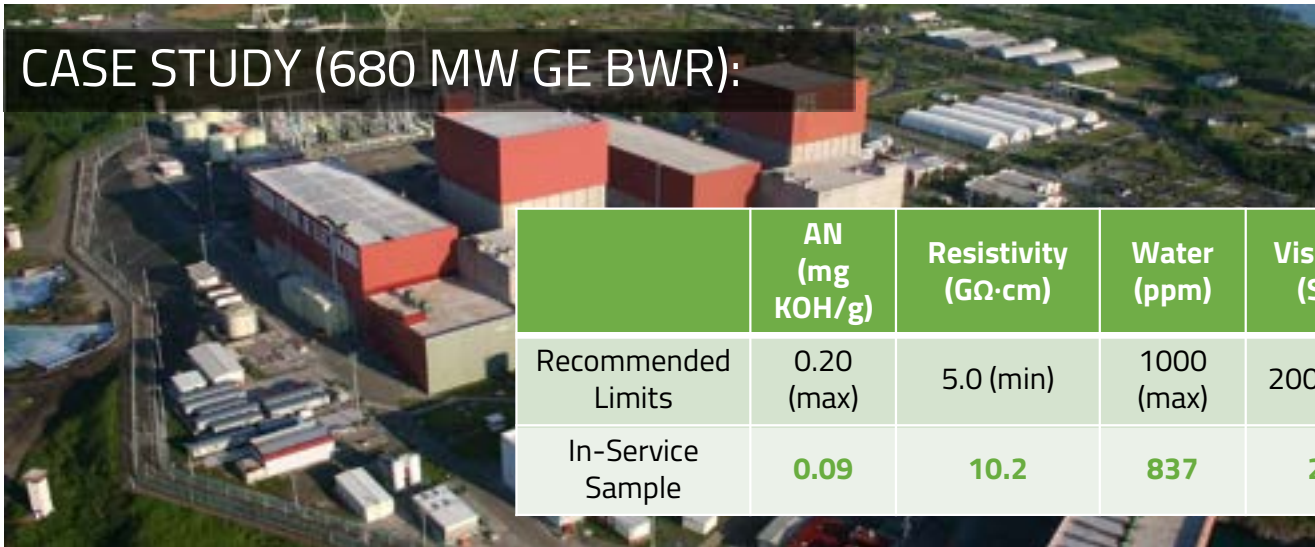
EXPERT GUIDANCE AT YOUR FINGERTIPS

- GEK46357K:
 - “Steam Turbine Generator EHC Fluid and Maintenance.”
 - Available from GE.
- ASTM D8323:
 - “Standard Guide for the Management of In-Service Phosphate Ester-based Fluids for Steam Turbine Electro-Hydraulic Control (EHC) Systems.”
- ASTM D4378:
 - Gas and Steam Turbine Standard.



"ROUTINE" ISN'T GOOD ENOUGH

CASE STUDY (680 MW GE BWR):



	AN (mg KOH/g)	Resistivity (GΩ·cm)	Water (ppm)	Viscosity (SUS)	ISO Particle Count
Recommended Limits	0.20 (max)	5.0 (min)	1000 (max)	200 - 240	< 16/14/10
In-Service Sample	0.09	10.2	837	200	14/12/6



"ROUTINE" ISN'T GOOD ENOUGH

CASE STUDY (680 MW GE BWR):



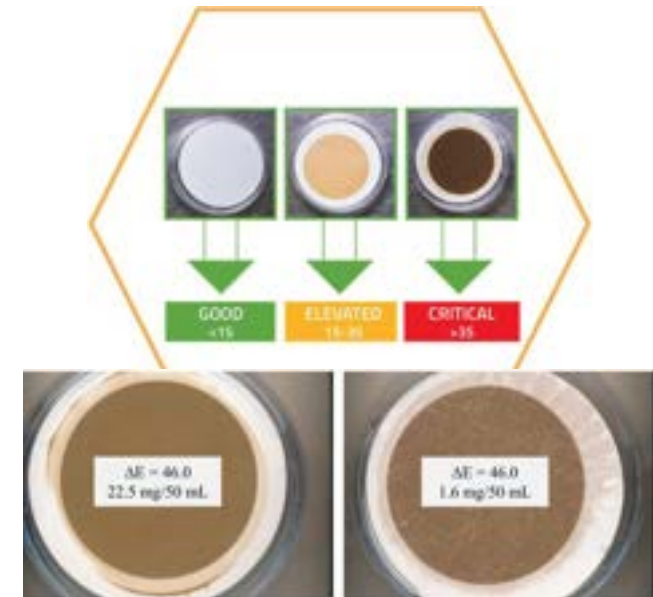
	AN (mg KOH/g)	Resistivity (GΩ·cm)	Water (ppm)	Viscosity (SUS)	ISO Particle Count
Recommended Limits	0.20 (max)	5.0 (min)	1000 (max)	200 - 240	< 16/14/10
In-Service Sample	0.09	10.2	837	200	14/12/6

- MPC Patch Test (0.45 μm): showed fine insolubles that ISO didn't.



MPC TESTING (ASTM D7843-21)

- Expressed as $MPC \Delta E = \sqrt{L^2 + a^2 + b^2}$
- For EHC: also report patch weight and a & b.
 - Patch weight quantifies fine insolubles.
 - MPC a & b can help distinguish varnish & carbon.
 - Two most common fine insolubles in FRFs.
- INSIDER INFO:
 - MPC result increases the longer the oil is in the sample bottle
 - Must be reset, with hold period reported in Hours.
 - UV exposure increases MPC value.



MPC TESTING

- Importance of $\Delta(a+b)$: Distinguishes varnish from carbon/soot.

$$\Delta E \leq 20, \Delta(a+b) \leq 10$$



WHITE = GOOD

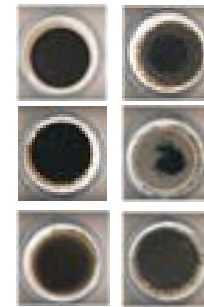
$$\Delta E > 20, \Delta(a+b) > 10$$



AMBER/BROWN =
VARNISH

Chemical Breakdown

$$\Delta E > 20, \Delta(a+b) \leq 10$$



BLACK = CARBON

High Temp Breakdown



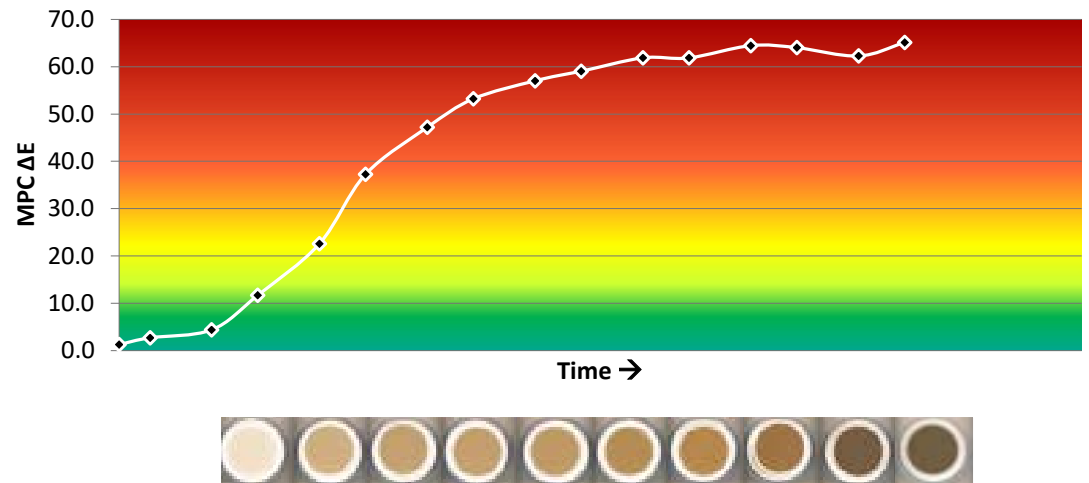


LUBRICANT CHEMISTRY MANAGEMENT PILLAR 2: LUBRICANT MAINTENANCE



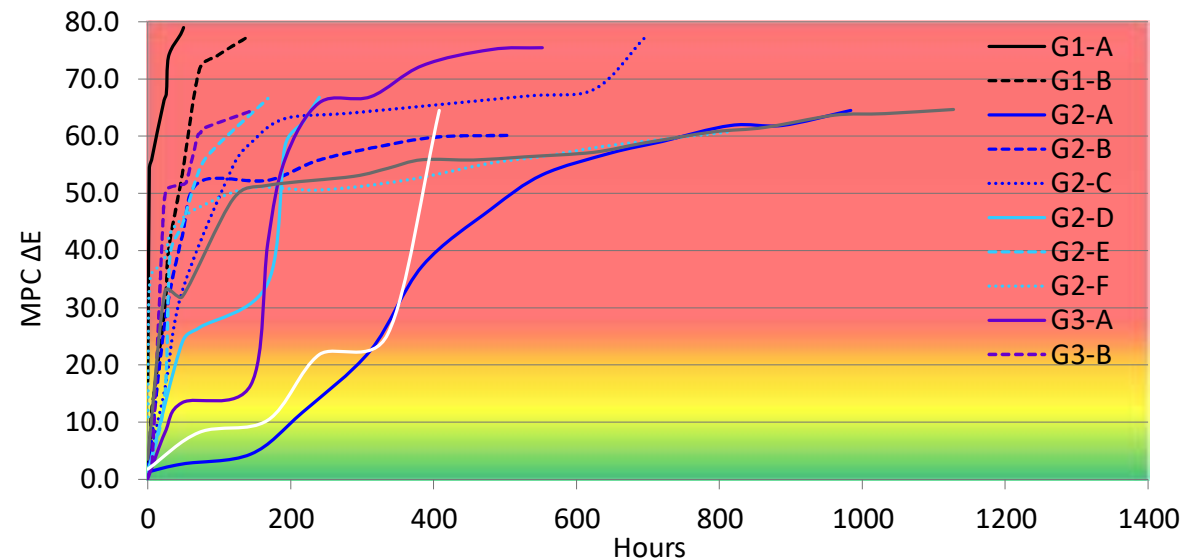
NEW OIL BREAKDOWN TESTING

- Lab-scale oil breakdown can be used to simulate industrial service over multiple years
 - Similar to TOST
 - Also monitor MPC, acid, additives and other key properties.



NEW OIL BREAKDOWN TESTING

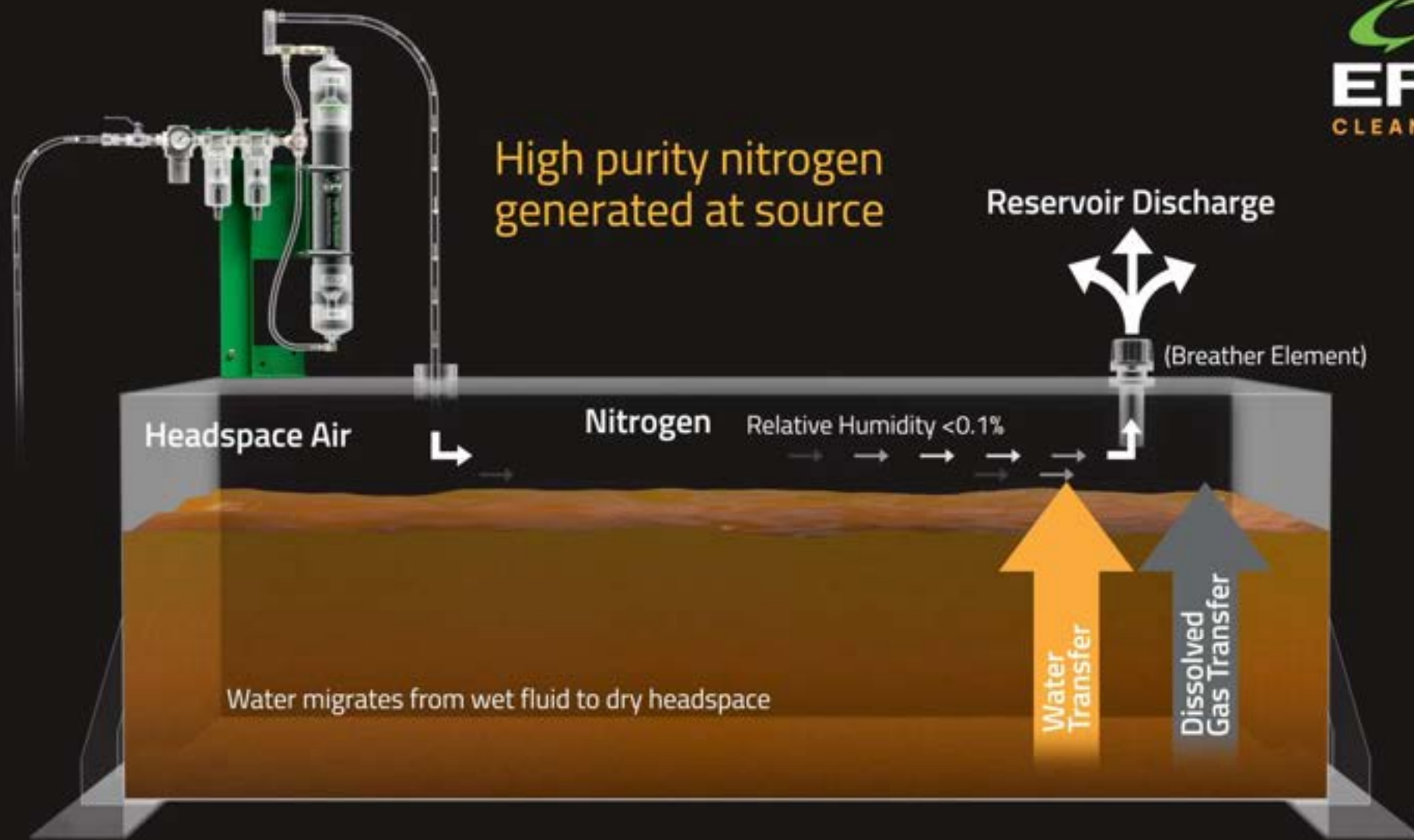
- All major turbine oil brands have been tested.
- All brands will generate high MPC over time.
- There are no varnish free oils.
- Why wait and what are the costs to wait and do nothing?



TMR® ELIMINATE WATER INGRESSION

- TMR®N2 system provides unlimited capacity to remove water and eliminate atmospheric water ingress.
- Generates high purity nitrogen introduced into the reservoir headspace above the lubricant surface forms a nitrogen blanket





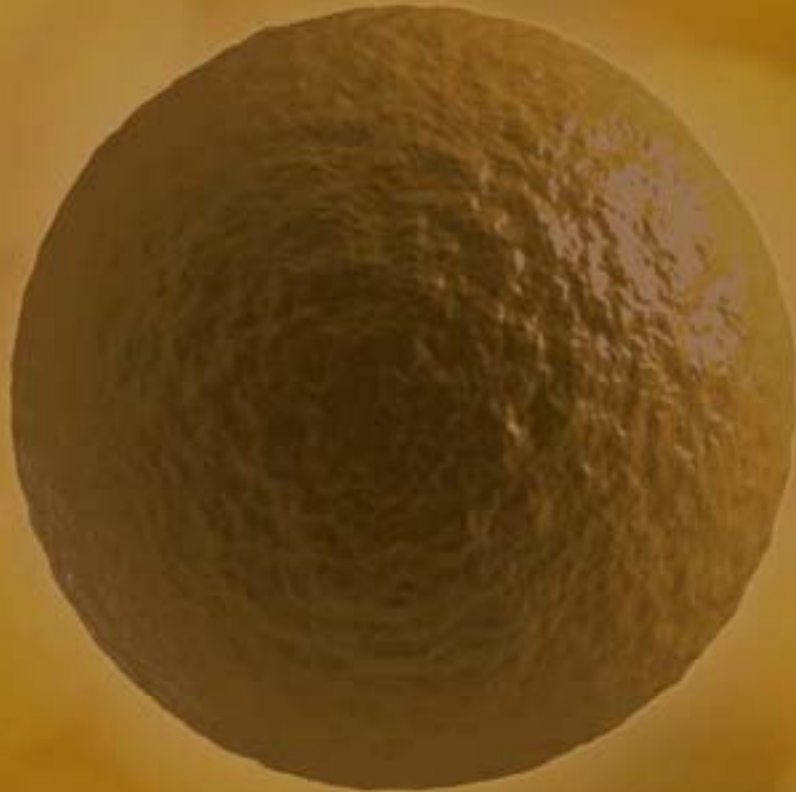
MANAGE MORE THAN ACIDS

- Patented ICB[®] Ion-exchange resin
- ASTM D8323 recommends:
 - Use resins “that feature a demonstrated affinity for PE varnish.”
 - ICB[®] is the only resin engineered to remove PE varnish:
 - U.S. Patent No. 10,926,243 (2021).





EPT
CLEAN OIL



ICB® TYPES BY APPLICATION

Often imitated. Never duplicated. Patented ICB ion-exchange filter.



Meet ICB RO

for Rust & Oxidation Turbine Oil

ICB RO removes varnish precursors and dissolved breakdown products continuously, breaking the accumulation cycle and eliminating the root cause of varnish formation.

ICB RO



Meet ICB FRF

for Phosphate Ester Fluid

ICB FRF is designed to address phosphate ester chemistry, removing acids, phenols and varnish while simultaneously improving resistivity, preventing EHC failures.

ICB FRF



Meet ICB JET

for Aeroderivative Turbine Oil

ICB JET removes acids, oil coking precursors, and dissolved by-products continuously, breaking the accumulation cycle and eliminating the root cause of deposit formation.

ICB JET



Meet ICB AW

for Anti-Wear Hydraulic Oil

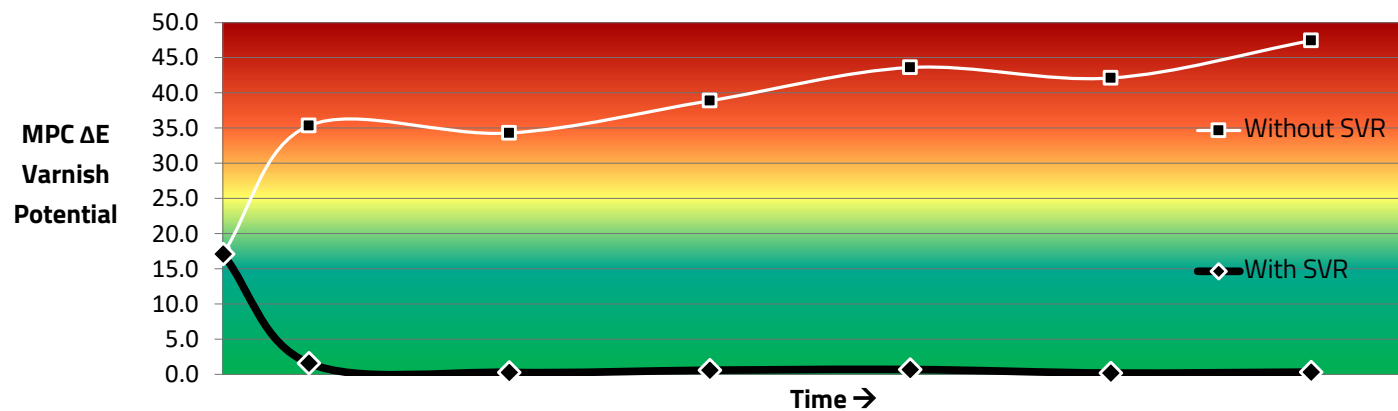
ICB AW selectively removes varnish and varnish feedstocks continuously, breaking the accumulation cycle and preventing varnish problems altogether.

ICB AW



NEW OIL BREAKDOWN TESTING- REPEATED WITH ICB®

- Oil break down testing with & without ICB®™ resins to remove polar breakdown products



WITHOUT ICB®



WITH ICB®



MEET SVR®

- Engineered **lubricant conditioning system** that delivers ICB® treatment at the ideal flow and pressure.
- Utilizes a kidney loop (dialysis) system to manage chemistry in lube oils and hydraulic fluids.
- Works 100% of the time, including during operating conditions when the oil is hot and when contamination is in the dissolved form.
- Eliminates the varnish formation cycle that typically occurs when the oil cools during turbine shut down



cleanoil.com

SVR® HYDRO –LUBE OIL CONDITIONING SYSTEM FOR STEAM TURBINES

- One lube oil conditioning system to manage solid contamination, varnish, and water
- Restores water separation/ demulsibility
- Removes and protects equipment from emulsions that could otherwise damage bearings
- Extends oil life by decreasing additive consumption rates



ECR® EHC FLUID CONDITIONING SYSTEMS

- Combines ICB, TMR, ECR with high efficiency particulate filtration
- ECR needed to remove fine carbon generated from cavitation/ dieseling and other Insolubles.
- Automated approach to restoring and maintaining fluid quality
- Shut down and self-isolating in the event of alarm
- Includes oil quality sensors for particle count and water in ppm



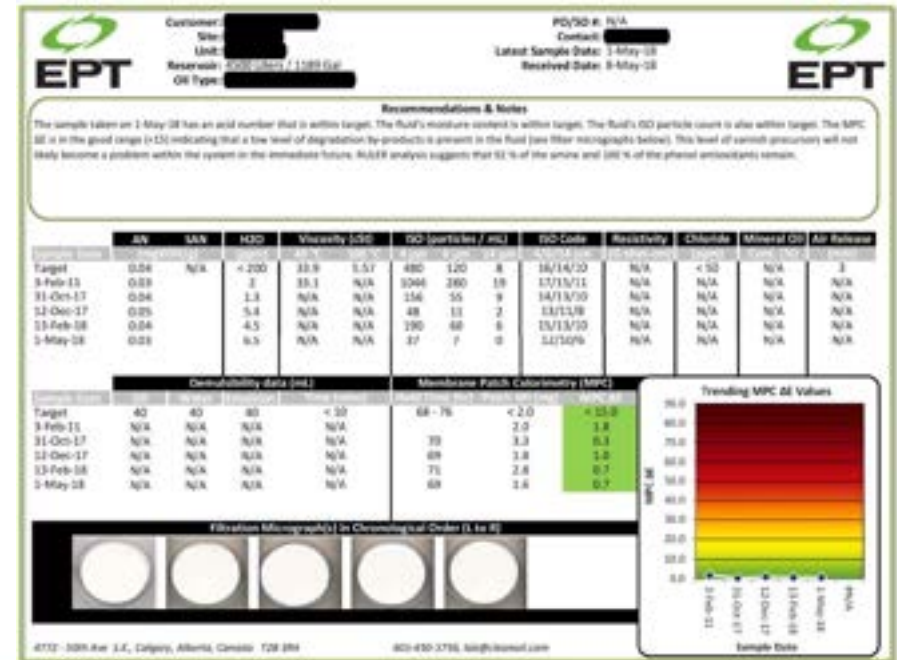


CASE STUDIES



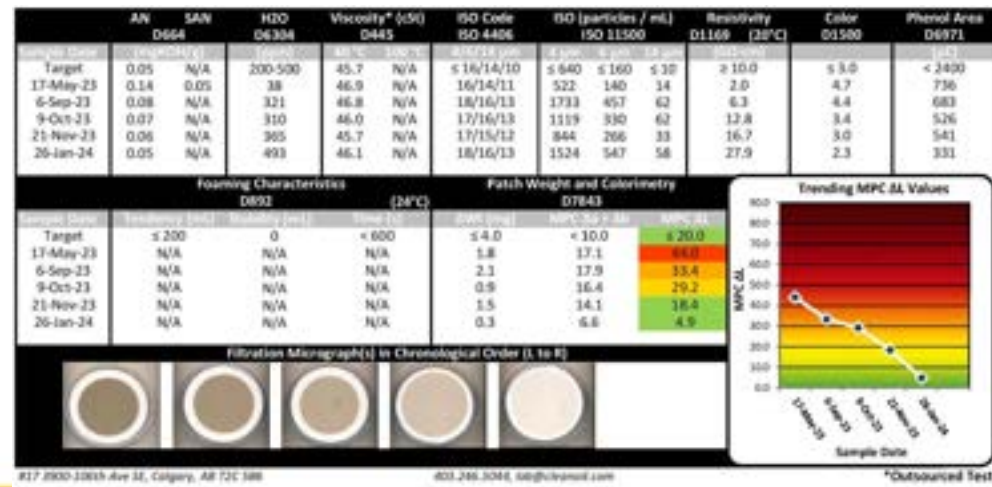
10 YEARS WITH LUBRICANT CHEMISTRY MANAGEMENT

- SVR® installed on new GT Lube oil and operated for 10 years
 - Base load GT
 - Oil would normally have to be replaced by now, but remains in new condition
 - With full time chemistry management
 - MPC has never exceeded 1.8
 - Acid number never exceeded 0.05
 - Remaining Antioxidants (Amine 91%)
 - Lowest risk and cost of operating profile achieved



CASE STUDY

- Case Study 1: 130MW Coal Fired Power Plant, ECR 12000
 - MPC (Varnish) -89%, Varnish Precursors (phenol) -55%, Patch Weight-86%.



CASE STUDY: ELECTRONIC TRIP DEVICE (ETD) TEST FAILURE



- Current ETD Testing results were a major issue prior to using ECR 12000
- Sticking is considered failure
- Slow response is considered issue.
- When failure occurs, rubber mallet is used to strike valve.

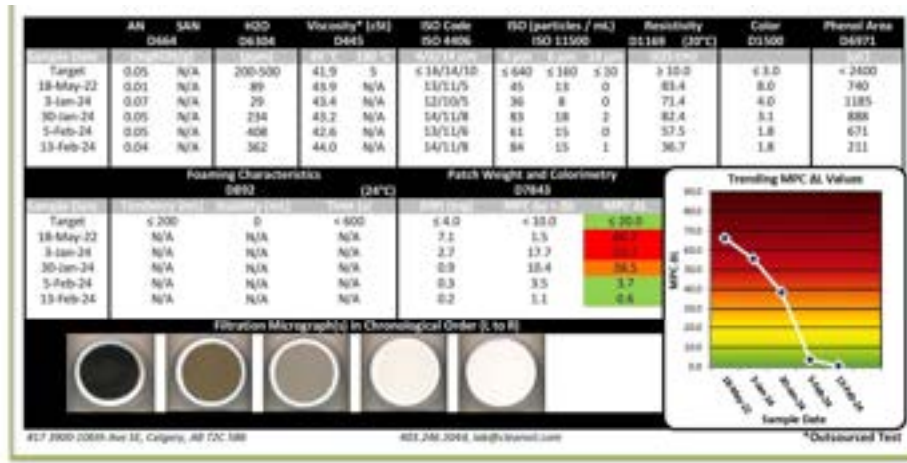
ELECTRONIC TRIP DEVICE (ETD) TESTING RESULTS

- Before ECR 12000
 - In 96 ETD Tests
 - 11 sticks (11.5% Failure)
 - 13 issues (13.5% Failure)
- After ECR 12000 installed
 - In 32 ETD tests since install
 - 0 sticks (0% failure)
 - 2 issues (6.3% failure)
 - 75% reduction in failures compared with out ECR12000
 - No more hammers



LUBRICANT CHEMISTRY MANAGEMENT

- Case Study 2: 759 MW (PWR) Nuclear generating station.
 - ECR12000.
 - MPC (Varnish) -99%, Varnish Precursors (phenol) -82%, Patch Weight-93%.



SUMMARY

- Lubricant maintenance need not be complicated!
 - GEK 46357K & ASTM D8323/ D4378: most up-to-date guidance.
- PILLAR 1: Condition Monitoring.
 - Fix testing programs to include right test, right method, right limit.
 - Correct limits & targets.
 - Measure rates of annual change in additives.
- PILLAR 2: Fluid Conditioning.
 - Chemistry is the primary mode of lubricant failure so manage it.
 - Use the right tools for the right jobs.
 - SVR, ECR, or TRITEK



THANK YOU!

pdufresne@cleanoil.com

Kananaskis, AB



C E L E B R A T I N G



Y E A R S