EHC Fluid Maintenance – Testing and Monitoring Best Practices

Canoil Canada Ltd.
October 15, 2020

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TODAYS TOPICS

- Introduction to Canoil Canada and our speaker
- Why PHOSPHATE ESTERS
- What Are PHOSPHATE ESTERS
- Condition MONITORING TESTS AND MEANING
- New TESTS
- New FILTRATION AND PURIFICATION
- Lessons Learnt
- Questions
- Future webinars

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CANOIL CANADA LTD

- Canoil is owned by 3 partners that have been in the chemical and lubrication business for more than 35+ years each.
- Ted Austin has been in the phosphate ester business for more than 40 years with a leading manufacturer and distributors.
- Henry Sapiano and Gamil Alhakimi are both PHD chemists with a wide range of experiences. This makes these 3 partners an excellent team. Plus, Henry has 20+ years with a major oil company.
- Canoil Canada Ltd was established in 2002 with the acquisition of Canoil/Cortek Ltd (1985-2002). Canoil has grown to be a global supplier of grease and lubricant products.

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CANOIL CANADA LTD

- Canoil is ISO 9001:2015 & Z299.3 certified.
- Canoil has the rights to MOV LONG LIFE® grease used in nuclear safety related equipment. Also MOV EXTRA® is used in industrial and commercial related equipment.
- Canoil has the rights to VSG® 'The Green Grease' used at hydro dams throughout the world. Canola oil based and specifically designed to lubricate wicket gates.

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- Canoil Canada Ltd has a dedicated packaging plant that packages grease & lubricants in various containers for many of the major oil manufactures.
- The packaging plant is certified under Halal, Kosher, and NSF H1

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NORTH AMERICAN DISTRIBUTOR OF REOLUBE TURBOFLUIDS

- Reolube Turbofluids® are manufactured by Lanxess who are a $8 Billion US dollar international company. Canoil Canada is the north American distributor of the Reolube Turbofluid brand, servicing Canada, The United States, and Mexico.
- Reolube Turbofluids are high performance phosphate ester, self-extinguishing fire-resistant fluids intended for use in applications where fire resistance is critical. Originally developed for use in electrohydraulic control systems for stream turbines. They also have applications in gas turbines, turbo-compressors, reactor coolant pumps and generators.

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- What does Canoil Canada have to offer to users who have a need for phosphate ester fluids?
  - North American distributor of the Reolube Brand – product is in stock and warehoused in Toronto – product can normally ship out within 24 hours and be delivered anywhere in North America in 2-5 business days. Plus. some stocking in the US.
  - We provide fluid analysis and in-depth reporting with comments when helpful.
  - We provide technical assistant with the fluid monitoring.
  - Our goal is to help increase the longevity and condition of your fluid.

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BIOGRAPHY
KEN BROWN

Ken is a P.Eng. with a BASc and MASc in Mechanical Engineering from the University of Waterloo. His Master's thesis was on the wear of CANDU reactor tube materials.

In 1976 he joined Ontario Hydro working on bearings, lubes, seals and EHC fluids for new and existing fossil and nuclear power stations on standards, design specifications, tender reviews and trouble shooting.

Ken left OH in 1993 and now provides support to Canoil and EPRI as well as to individual power stations on EHC, STO and other issues.

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BIOGRAPHY CONT'D

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For EPRI, Ken has contributed to several Lube Notes and was the main contractor for their EHC fluid maintenance and the EHC fluid compatibility guides. He continues to provide day to day technical support as well as being an invited speaker at EPRI TGUG and CBM workshops.

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WHY THIS WEBINAR?

First, many of the issues we see with phosphate ester fluids are preventable.

- In many cases something was not done, or the decision makers were not aware of current requirements.
- A lot has been learned on the 70 plus years these fluids have been used and new options are available on a regular basis.
- This seminar is an introduction to phosphate ester control fluids with more to follow.

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WHAT ARE PHOSPHATE ESTERS?

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Phosphate esters are esters of orthophosphoric acid with phosphorous and oxygen surrounded by three (tri) benzene ring compounds that can vary.

- They have a number of uses as fire resistant hydraulic fluids, but are also used as plasticizers, antiwear additives, and as a solvent in inks, synthetic resins, gums, adhesives (namely for veneer plywood).
- First use in lubrication field in the late 1930's as antiwear additives in crankcase, gear and aircraft engine oils.
- Greater use in WW II as less flammable hydraulic fluids in aircraft.
- Then used industrially in the 1950's in power stations, steel mills and other applications requiring a more fire-resistant hydraulic fluid.

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WHY PHOSPHATE ESTERS

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Phosphate ester **fire resistant** fluids have;

- Higher flash and fire points
- Higher autoignition temperatures
- Lower heats of combustion
- Higher hot manifold temperatures
- Consistent good spray flammability results
- Most importantly, phosphate ester fluids are **self-extinguishing**. Consequently, they are not as likely to spread flaming streams or form flaming pools of fluid.

Caution: Other non-aqueous fluid types do not have all these advantages

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DIFFERENCES FROM MINERAL OILS

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- Higher specific gravity – *1.13 vs 0.86*
- Lower viscosity index – *20 vs 90 or more*
- Good wear protection without additives
- Good oxidation resistance but can have poor hydrolytic stability
- Good plasticizers so different elastomer compatibilities
- Much more fire resistant!

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ELASTOMER COMPATIBILITY CHART

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MATERIAL	SEALS, HOSES, AND BLADDERS	WIRE AND CABLE INSULATION	PAINTS
ACRYLONITRILE BUTADIENE STYRENE (ABS)	U		
ACRYLIC			U
ALKYD PAINT (STOVED/BAKED)			S
BUTYL RUBBER	R		
ETHYLENE PROPYLENE RUBBER (EPR & EPDM)	S		
EPOXY PAINT (CURED)			R
NATURAL RUBBER (NR)	U		
CHLOROPRENE RUBBER (CR) NEOPRENE	U		
NITROCELLULOSE			U
NITRILE BUTADIENE RUBBER (NBR) BUNA N	U		
NYLON (PA66)	R	R	
PHENOLIC RESINS			U[2]
POLYETHYLENE (PE)		A	
CHLORINATED POLYETHYLENE	S[1]		
POLYPROPYLENE (PP)		A	
POLYURETHANE			S
POLYVINYL CHLORIDE (PVC)	U		
SILICONE RUBBER (VMQ)	S[1]	A	
POLYTETRAFLUORETHYLENE (PTFE) TEFLON	R	R	
FLUOROCARBON RUBBER (FPM) VITON	R		

Do not use Buna N

Many are okay.

Specify what you want.

There are many versions of Viton

Note 1; Compatible but can affect fluid

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PHOSPHATE ESTER EHC FLUIDS

ICL	LANXESS		
Fyrquel EHC-N	**Turbofluid 46XC** and OMTI	Trixylenyl Phosphate Ester (TXP)	Lowest air release times and good hydrolytic stability
Fyrquel EHC-S EHC Plus	**Turbofluid 46B** (Durad EHB)	Butylated Phenol Phosphate Ester (TBPP)	Good oxidation resistance
Fyrquel EHC	-	Blend of butylated phenol and trixylenyl phosphate ester	Compromise of the natural and synthetic

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EHC FLUID LIFE

Many factors affect the life of the fluid. Many of these are relatively easy to control with the original OEM equipment BUT you must work to the current information from the turbine and fluid suppliers. Lessons have been learnt in 70 plus years. Also, do not assume that the current equipment is performing correctly or being operated or maintained as required. Canoil can help.

Doing the required tests, using the right limits and taking the appropriate actions are also essential to correct the root causes of fluid degradation.

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ROOT CAUSES OF FLUID ISSUES

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One or more of the following;

1. Purification media not changed soon enough.
2. Purification flowrate is wrong.
3. Purification media is wet or dry and/or fouled.
4. Purification housings are air bound.
5. Defective valves.
6. Wrong purification media.
7. Wrong fluid is being used.
8. Overstressed fluid (hot spots, low levels, etc.)
9. Material incompatibility
10. Unsuitable part or maintenance substitutions.

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FOCUS ON MAINTENANCE TO AVOID…

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EHC FLUID TESTING

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First do not assume that the current fluid test program is right or that the tests are being done properly.

The tests being done should be compared against those recommended in the EPRI reports, against the current turbine and fluid supplier recommendations and against those tests required to address any specific local problems.

Fortunately for EHC fluids in North America, routine fluid testing can be included in the cost of the fluid.

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WHY BOTHER TESTING?

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The purpose of fluid testing is to able to assess the condition of the fluid.

The reason is to catch fluid issues before they can cause operational problems. Also so that they do not cause unnecessary remedial work including fluid changes, system flushes, excessive filter changes, excessive media changes, excessive fluid bleeding & feeding and the like.

You have to do the right tests, at the right time, the right samples, do the right interpretation and take the right actions.

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NEW TESTING GEK 46357G

2012

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Color	monthly
Water Content	"
Neutralization Number	"
Particulates	"
Resistivity	3 months
Mineral Oil Content	"
Metal Content	"
Viscosity	6 months
Air Release	"
Chlorine Content	"
Foaming	12 months
Specific Gravity	?
Pour Point	?
Flash Point	?
Fire Point	?
Autoignition Temperature	?
Fire Resistance	

New test requirements in blue.

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Frequency Test	Monthly or Bimonthly	Quarterly	Semi-annually	Annually or Upcoming Outage
Acid Number	✔	✔	✔	✔
Appearance	✔	✔	✔	✔
Color	✔	✔	✔	✔
Particle Count	✔	✔	✔	✔
Resistivity	✔	✔	✔	✔
Water	✔	✔	✔	✔
Chlorine	Do if Resistivity low	✔	✔	✔
Mineral Oil	Do if Appearance, Color or Viscosity odd	✔	✔	✔
Viscosity	If fluid contamination suspected	If fluid contamination suspected	✔	✔
Metals (by ICP)	If Acid or Particles high or if deposits	Do if Acid or Particles high or if deposits	✔	✔
Air Release	Do if Metals high or if deposits	Do if Metals high or if deposits	Do if Metals high or if deposits	✔
Foaming	Do if Metals high or if deposits	Do if Metals high or if deposits	Do if Metals high or if deposits	✔
Other	✔	✔	✔	✔

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Canoil has technical notes on all the tests and what they mean. Contact us.

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Canoil test program - GE

COLOR

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New fluid 0.5-1.0

3.0 – 4.0 typical for used GE & W

7.0 – 8.0 typical for Alstom and NEIP

Know what is normal and watch for it.

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SOMETIMES NOT SO SIMPLE - COGEN

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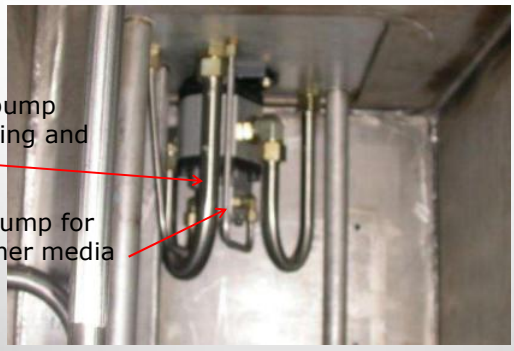

Larger pump for filtering and cooling

1 gpm pump for conditioner media

Pumps are above the fluid and there is a long suction line. Pump seal can wear, sucking in air leading to dark fluid and degradation.

Trust OPEX from truly sister units – Canoil can help as well to share info.

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ACIDITY (NOT REALLY)

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As fluid is used, acid like compounds can be formed.

Normal target is <0.1 mgKOH/g with proper changes of the purification media.

Caution: too high at any time can lead to later problems and shortened fluid life. As acid number gets higher, the degradation rate can increase. Also if too high, the fluid charge cannot be saved with traditional means.

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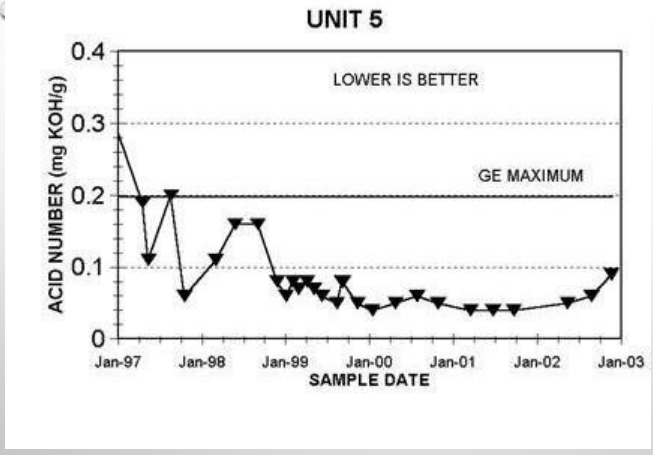

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Much better with more FE changes and dry media

Caution: fluid issue can have more than one cause. In this case there were 14 other improvements mainly re procedures.

ACID NUMBER – GE FOSSIL

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GE FLUID PURIFICATION HOUSINGS

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CAP NUT

DRAIN

VENT

ONE CARTRIDGE HIGH
'1' GPM

TWO CARTRIDGES HIGH
'2' GPM

NOTE: VENT HOUSINGS AFTER INSTALLATION AND AS REQUIRED.

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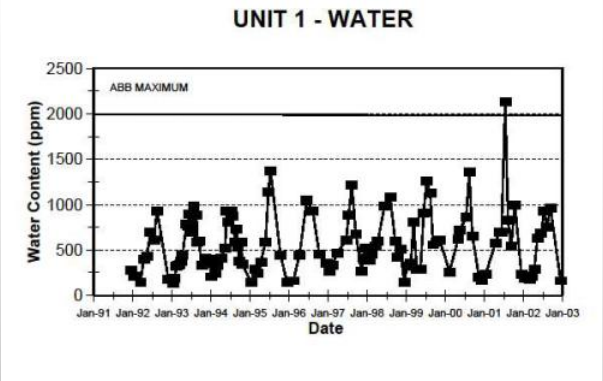

Trend plot and do it vs date so that seasonal variations are more obvious.

High water content can cause fluid degradation and affect the operation of electrostatic filters.

ALSTOM WATER CONTENT

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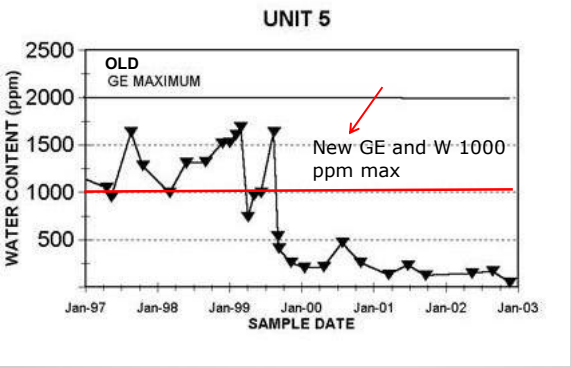
WATER CONTENT



Dryer fluid can extend fluid life and also that of some purification media, and reduce maintenance on desiccant breathers.

MUCH BETTER WITH RESERVOIR DRY AIR PURGE

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PARTICLE COUNT

Too high can lead to shorter fluid lives, to servo and or solenoid valve problems with sticking and to screen/filter blockage. Resample and determine **source** if still high. Check system.

Caution: a high particle count should always be investigated and corrected. This is in case a pump is in distress, contaminated fluid was added and/or a filter is bypassing. The goal is to prevent compromising the system.

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ISO 4406 is only the method of reporting the counts not the procedure.

Particles counts >X microns

>4, >6, >14 microns

Counts can also be reported for other sizes.

With servo valves target 17/15/12 or lower.

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ISO 4406:1999 Scale Number Table		
Number of particles per millilitre		Scale number
More than	Up to and including	
2 500 000		> 28
1 300 000	2 500 000	28
640 000	1 300 000	27
320 000	640 000	26
160 000	320 000	25
80 000	160 000	24
40 000	80 000	23
20 000	40 000	22
10 000	20 000	21
5 000	10 000	20
2 500	5 000	19
1 300	2 500	18
640	1 300	17
320	640	16
160	320	15
80	160	14
40	80	13
20	40	12
10	20	11
5	10	10
2.5	5	9
1.3	2.5	8
0.64	1.3	7
0.32	0.64	6
0.16	0.32	5
0.08	0.16	4
0.04	0.08	3
0.02	0.04	2
0.01	0.02	1
0	0.01	0

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PARTICLE COUNT

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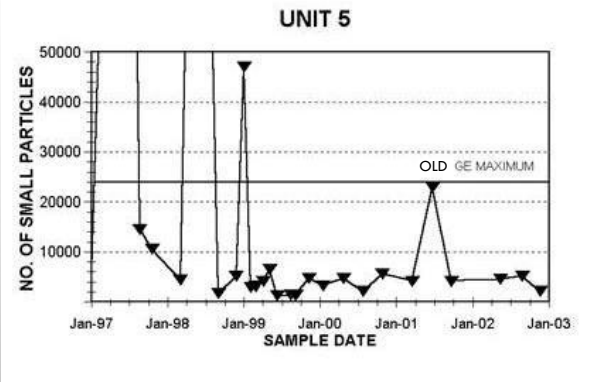

Can depend on the sampling point but there should not be great spikes. Check sampling procedure and compliance.

KNOW WHO AND HOW THEY TOOK THE SAMPLE

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RESISTIVITY

Keep high to prevent electrokinetic wear of servo-valve internals such as the spools and flappers.

Normally controlled by fuller's earth, Selexsorb and some IX purification media.

Caution: can also affect other close clearance components with pressure drops including pressure control and relief valves.

Caution: some servo-valve designs can be more tolerant than others.

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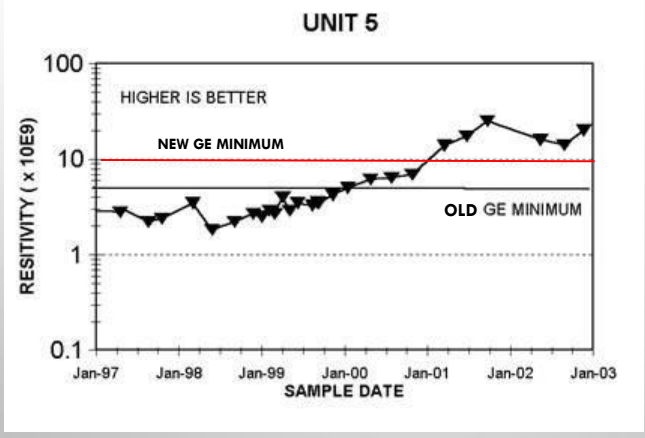
RESISTIVITY



Important to trend and to determine if too low is a real issue.

SLOWLY GETTING BETTER WITH RIGHT CHANGES AND DRY MEDIA. SHOULD GO UP WITH NEW MEDIA.

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ELECTROKINETIC WEAR

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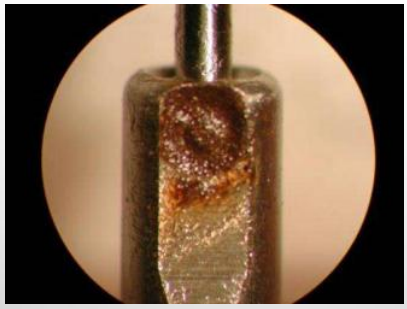

Moog flapper showing electrokinetic wear.

Also had 'wrong' torque motor showing need to properly inspect pulled servo valves.

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NEWER TESTS - PATCH

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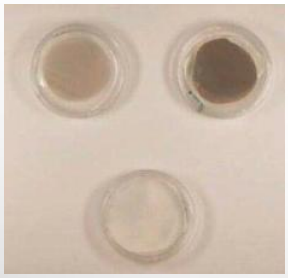

Note: The standard ASTM MPC test needs to be modified for phosphate ester fluids as does the reporting in some cases.

MPC uses a 0.45 micron patch. A dark patch and/or a high patch weight can indicate existing or pending varnish and/ or soot problems.

Done by Canoil as required.

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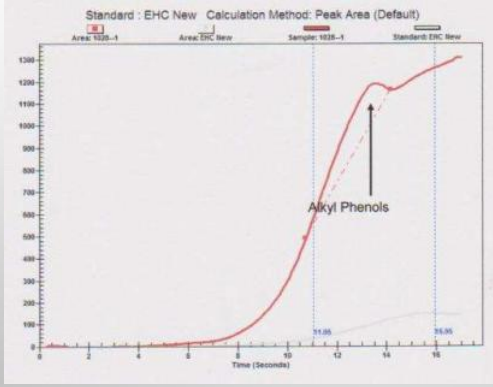
NEWER TESTS – RULER AREA



To large an area under the bump can indicate fluid degradation. Deposits and/or varnish can be more likely.

Done by Canoil but not by other suppliers.

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NEWER PURIFICATION MEDIA

Originally the turbine OEMs did not intend to purify the fluid, and this did not work well. Then the importance of controlling the chlorine content and hence the resistivity was found to be necessary. With time the OEMs, to varying degrees, have also gone to lower acid numbers, lower water contents and different media. Media types include;

- Activated alumina (not for servovalve systems)
- Low sodium activated alumina (not for servovalve systems)
- Fuller's earth (attapulgus clay)
- Selexsorb GT (AA and zeolites)
- **Ion exchange (WBA)**
- **IX (mixed resins/wet or dry)**
- Other

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NEWER TREATMENT -ELECTROSTATIC COLLECTORS

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Not good but a Canoil goal is to prevent fluid getting this bad. It was not our fluid.

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LESSONS LEARNED

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EHC fluids should provide years of trouble-free service.

This only possible when;

- The fluid is being stored, added and maintained correctly.
- The EHC system is operated properly including fluid levels, cooling, filtering, purifying and testing.
- The EHC system components are purchased, maintained and examined properly.

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LESSONS LEARNED

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In many cases the reason that the fluid is trending or has gone out of specification is that something changed or did not happen. It is seldom a fluid issue.

Verify that what is supposed to happening or used, is in fact. Walk the lines, check stores and maintenance practices.

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CANOIL WEBSITE WHITE PAPERS

Canoil Canada Ltd.

- Canoil Turbofluid EHC Fluid Annual Testing Program
- Suggested Phosphate Ester Control Fluid Test Schedule
- Managing the Health of Fire Resistant Steam Turbine Electrohydraulic (EHC) Control Oils
- 100,000 hours of service Reolube 46XC
- Q&A EHC Fluid
- TF Suggested Test Schedule Alstom
- TF Suggested Test Schedule May 2017 GE W NEIP
- TN Canoil Turbofluid Testing Advantages
- Turbofluid Tests Explained Canoil TF46XC Test Report – example
- Condition-Monitoring of Phosphate Ester Hydraulic Fluids – Machinery Lubrication
- EPRI Lube Notes References
- Explaining Fire Resistance tests

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FUTURE WEBINARS

- One will cover fluid testing in more detail and others will be specific to the turbine OEM.
- OEMs considered so far are GE, Westinghouse and Alstom. Others as required.

www.canoilcanadaltd.com

SEE ALSO CANOIL EHC FLUID HEALTH CALCULATOR

www.ehcturbofluid.com/#calculator

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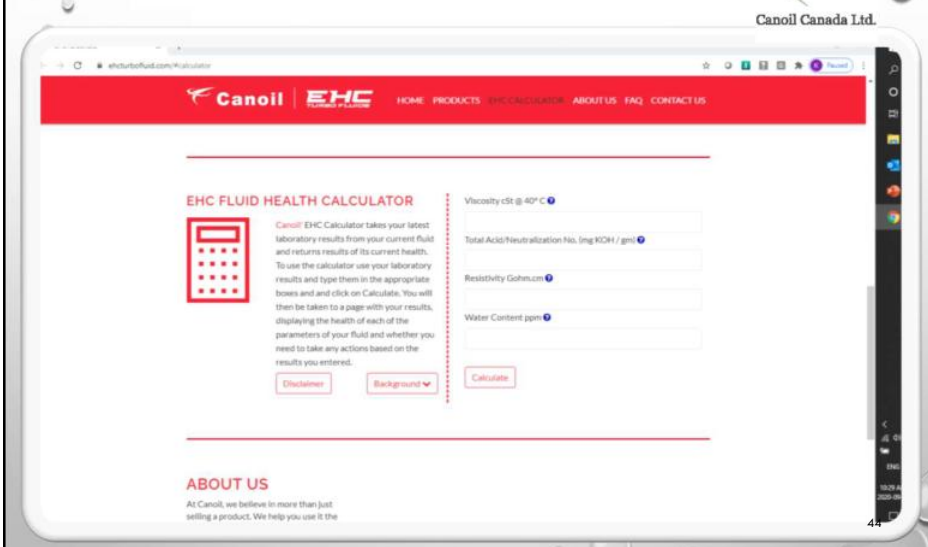

TRY IT

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The information provided in this webinar is believed to be correct and was reviewed and approved by Canoil who are solely responsible for the content. Suggestions as to root causes are based on findings at specific facilities. Because there are many variables, any actions or nonactions should be done in consultation with your subject matter experts and/or suppliers. Canoil can provide specific suggestions for fluid customers.

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Thank you, and now for Q&A items.

Your questions will be anonymous and can only be viewed by the moderator and the speaker.

You also have the option to send an e-mail or call. Include test reports if possible.

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