



**stle***Nashville*

May 19-23, 2019 | Omni Hotel Nashville

## **UNDERSTANDING EHC FLUID CONDITION MONITORING**

**Ken J. Brown, P.Eng, CLS**

**Canoil Canada Ltd., Toronto**

**toll free 888 442-5008 or 416 466-3144**

**[ken@canoilcanadaltltd.com](mailto:ken@canoilcanadaltltd.com)**


**Matthew Hobbs, Ph.D.**

**EPT, Calgary**

**403 450-1764**


**[mhobbs@cleanoil.com](mailto:mhobbs@cleanoil.com)**






Phosphate ester fire resistant fluids have been in use in the control systems of steam turbines for over 50 years.

Many things about these fluids and their condition monitoring had been understood for the most part, but this is not always the case now.





The reasons include some or all of the following;

- The types of triaryl phosphate being used are changing.
  - The designs are changing and more variable.
  - Less make-up fluid is being used.
  - The purification media is changing.
  - More labs are doing some testing.
  - Different tests are being done.
  - Plus site and supplier personnel are changing.
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# Why Phosphate Esters


Phosphate ester **fire resistant** fluids have;

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

**Caution:** Other fluids seldom have all these advantages



## Other Differences from Mineral Oils

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

# Elastomer Compatibility Chart

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 <sup>2</sup>
POLYETHYLENE (PE)		A	
CHLORINATED POLYETHYLENE	S <sup>1</sup>		
POLYPROPYLENE (PP)		A	
POLYURETHANE			S
POLYVINYL CHLORIDE (PVC)	U		
SILICONE RUBBER (VMQ)	S <sup>1</sup>	A	
POLYTETRAFLUORETHYLENE (PTFE) TEFLON	R	R	
FLUOROCARBON RUBBER (FPM) VITON	R		

Many are  
okay.

Specify  
what you  
want.

There are  
many  
versions of  
Viton

*Note 1;  
Compatible  
but can  
affect fluid*

# Common Phosphate Ester Control Fluids

Now ICL      Now Lanxess

FYRQUELS		REOLUBE TURBOFLUIDS		TYPE	FEATURES
EHC	HYD	EHC	HYD		
EHC-N (Stauffer EHC)	220N	Turbofluid 46XC and OMTI	220X	Trixylenyl Phosphate Ester (TXP)	Lowest air release times, best hydrolytic stability and good overall.
EHC-S EHC Plus	220	Turbofluid 46B (Durad EHB)	HYD 46B	Butylated Phenol Phosphate Ester (TBPP)	Best bulk oxidation resistance.
-	-	<del>Turbofluid 46</del>	<del>HYD 46</del>	<del>Isopropyl Phenol Phosphate Ester (IPPP)</del>	<del>Better hydrolytic stability than butylated synthetics.</del>
EHC	-	-	-	Blend of Butylated Phenol and Trixylenyl Phosphate Ester	A compromise of the natural and synthetic.

*Fyrquel is a TM of ICL & Reolube a TM of Lanxess.  
Canoil is an authorized distributor for Lanxess Turbofluids.*

# Root Causes of Fluid Issues

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.



## Root Causes of Fluid Issues cont'd

11. Plus, it is **not possible** for many older and some newer plants to adequately maintain the fluids and prevent operational problems following the original turbine OEM's original procedures and/or with the original equipment.

# Why Test?

The reason is to catch fluid issues **before** they can cause operational problems. Also, so that any issues 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, with the right samples, do the right interpretation and then take the right actions.

# Testing GEK 46357

## In-service Fluid **1977 – not current**

Test	Frequency	Limit
Chlorine Content	monthly*	150 ppm (max)
Water Content	" *	0.2% (max)
Neutralization Number	" *	0.3 mgKOH/g (max)
Mineral Oil Content	"	4.0% (max)
Specific Gravity	"	1.13 (min)
Particulate Contamination	"*	SAE A-6D Class 3

*\* Every 48 hours if a marked increase occurs until problem is alleviated.*

# Testing GEK 46357A

## Operating Fluid 1979 – better but do not use

Test	Frequency	Limit
Particulate Contamination	monthly	SAE A-6D Class 3
Chlorine Content	monthly*	<b>100</b> ppm (max)
Water Content	<b>weekly</b> *	0.2% (max)
Neutralization Number	<b>3 months</b> *	<b>0.2</b> mgKOH/g (max)
Mineral Oil Content	<b>3 months</b>	4.0% (max)
Specific Gravity	<b>3 months</b>	1.13 (min)
Resistivity or Conductivity	<b>3 months</b>	<b>5 Gohm.cm (min)</b>

\* Every 48 hours if a marked increase occurs until problem is alleviated.

*Note: Other characteristics were listed but no test frequency is specified. These are Color, Viscosity at 40 and 100C, Pour Point, Flash Point, Fire Point, and Autoignition Temperature.*

*Testing for Neutralisation not changed to monthly until GEK 46357F in 2010!*

# New Testing GEK 46357G – 2012 - use


Color	monthly	
Water Content	"	1000ppm
Neutralization Number	"	
Particulate Contamination	"	
Resistivity	3 months	10 Gohm.cm
Mineral Oil Content	"	0.5%
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  
requirement  
in blue.***



# Past Typical EHC Fluid Issues



- Electrokinetic wear of servo valves
  - High acid numbers
  - Foaming
  - Deposits such as bathtub rings in reservoirs
  - Rapid filter plugging
  - Elastomer incompatibility
- 

# Current EHC Fluid Issues

- Varnish
- High MPC
- Fluid darkening
- High phenol content (weak acids)
- Electrokinetic wear of servo valves
- More use of hoses

<https://www.ehcturbofluid.com/#calculator>



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## EHC FLUID HEALTH CALCULATOR



Canoil' EHC Calculator takes your latest laboratory results from your current fluid and returns results of its current health. To use the calculator use your laboratory results and type them in the appropriate boxes and and click on Calculate. You will then be taken to a page with your results, displaying the health of each of the parameters of your fluid and whether you need to take any actions based on the results you entered.

[Disclaimer](#)

[Background](#) ▼

Viscosity cSt @ 40° C ?

Total Acid/Neutralization No. (mg KOH / gm) ?

Resistivity Gohm.cm ?

Water Content ppm ?

[Calculate](#)

Input your data and get an evaluation



# Color



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.

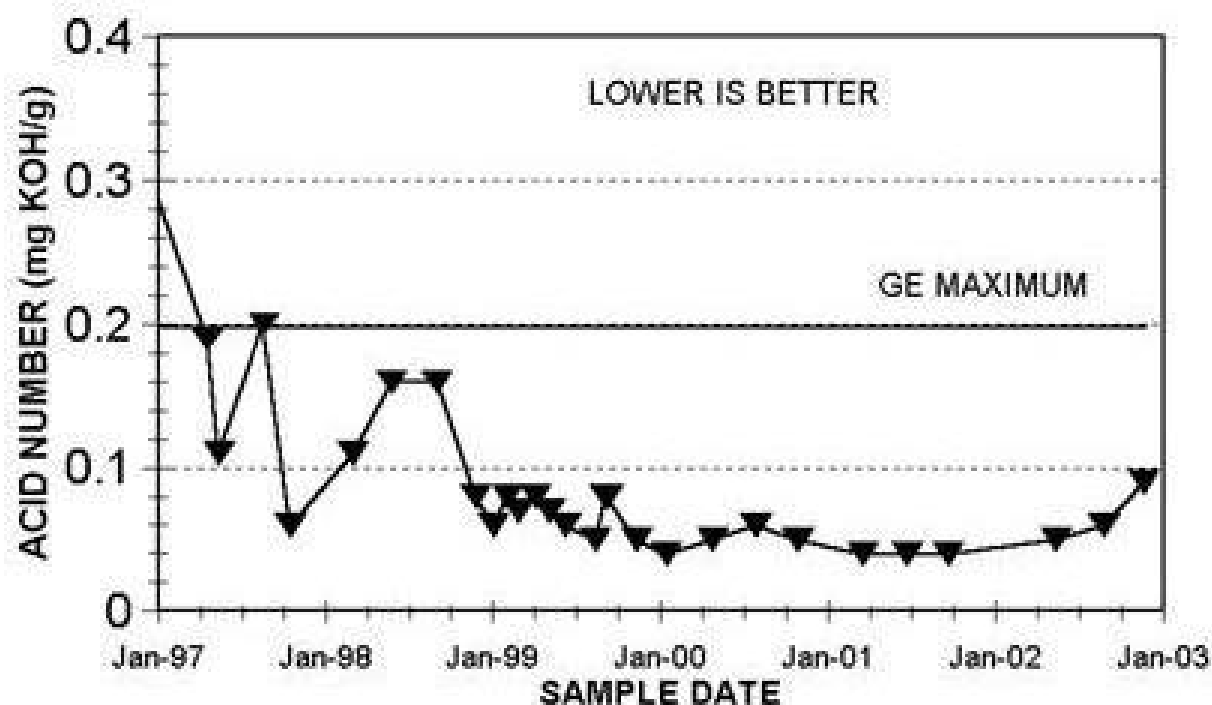
# Acidity (not really)

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

*Normal target is  $<0.1$  mgKOH/g with proper changes of and the right flow for 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.

## UNIT 5



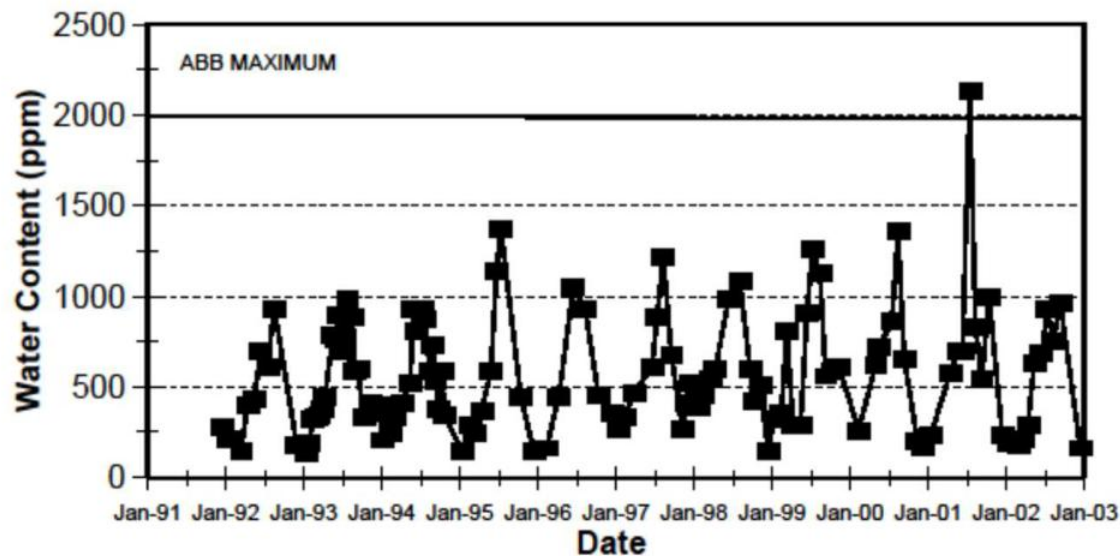
*Much better  
with more FE  
changes  
and dry media*

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

## Acid Number GE Fossil

***Caution: ASTM D664 vs D974 vs FTIR***

## UNIT 1 - WATER



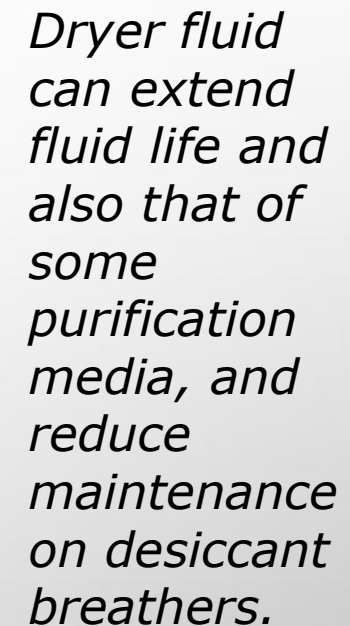
*Trend plot  
and do it vs  
date so that  
seasonal  
variations  
are more  
obvious.*

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

Typical Alstom Water Content

*Caution: Trend results*

## UNIT 5



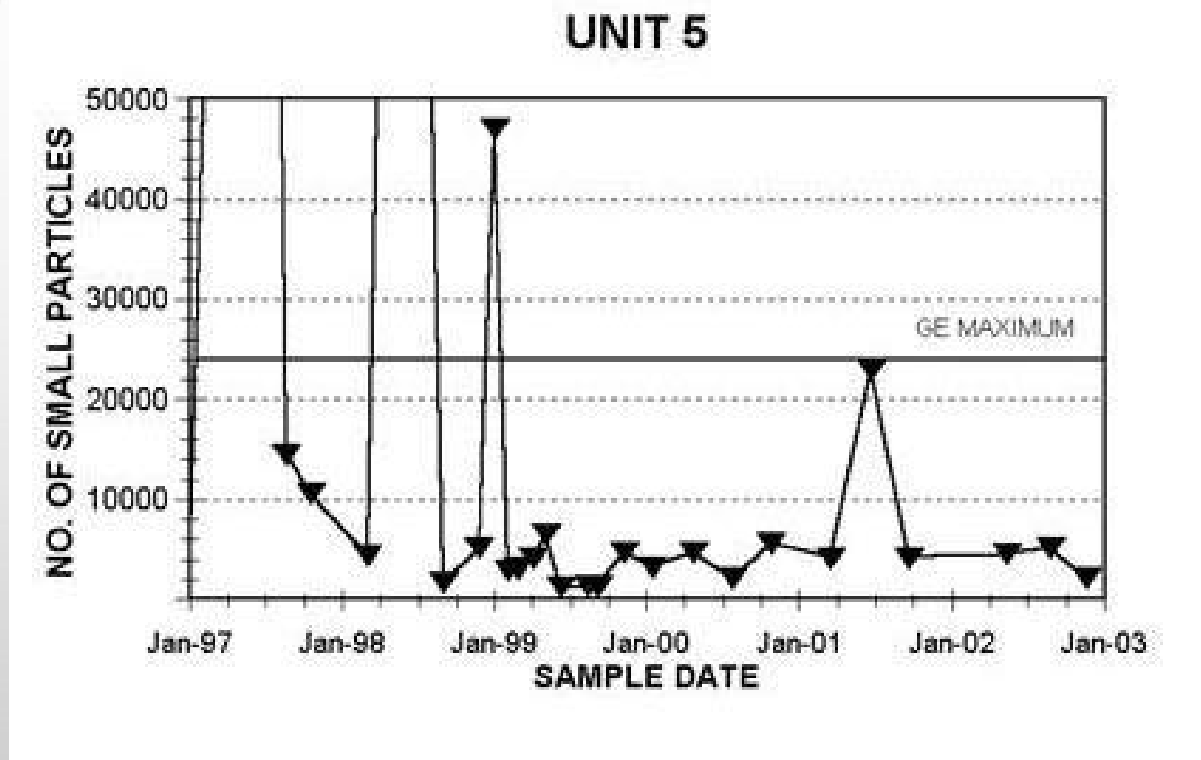
Caution: It might be possible to go too dry.

## Particle Count

Too high can lead to shorter fluid lives, servo and or solenoid valve problems with sticking and 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 or a filter is bypassing. The goal is to prevent compromising the system.

# Particle Count



*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**

***Caution: ISO 4406 is only the reporting***

# Resistivity

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

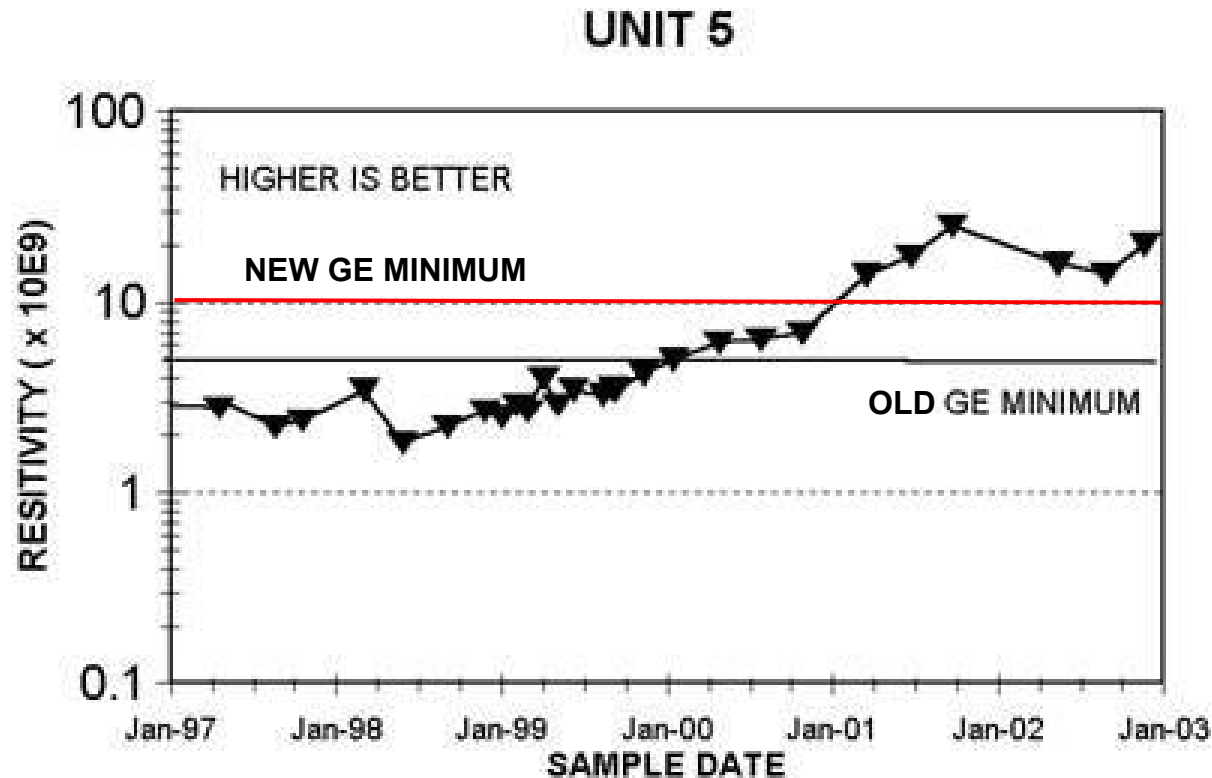
Normally controlled by fuller's earth, Selexsorb and some IX purification media.

**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.



# Resistivity

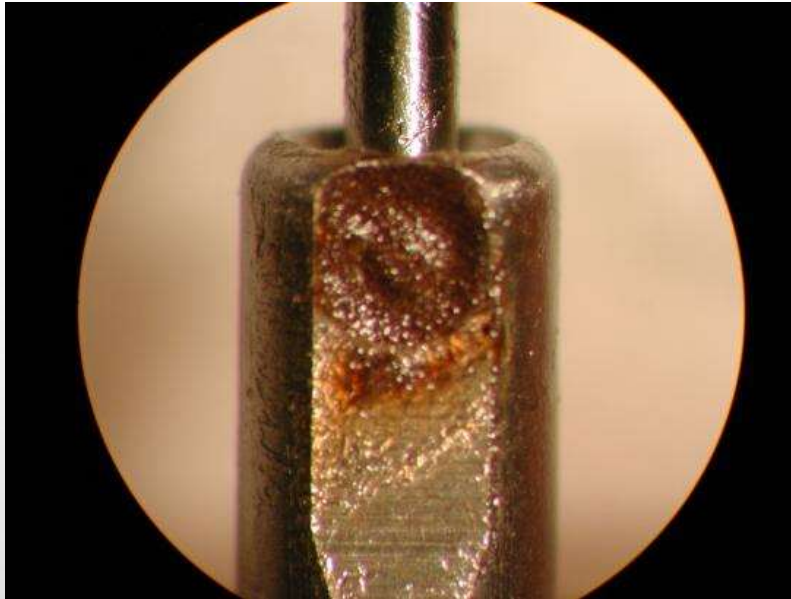


Important to trend and to determine if too low is a real issue.

Slowly getting better with right changes and dry media. Should go up with new media.

*Caution: Was the test at 20C?*

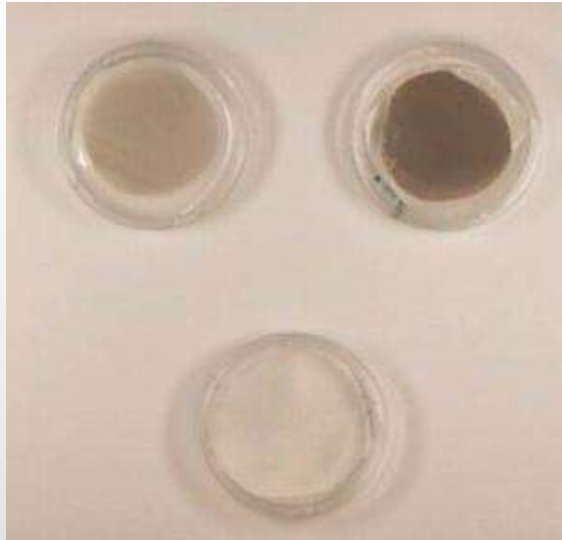
# Electrokinetic Wear of Servovalves



Moog flapper  
showing  
electrokinetic  
wear.

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

# New Tests - Patch

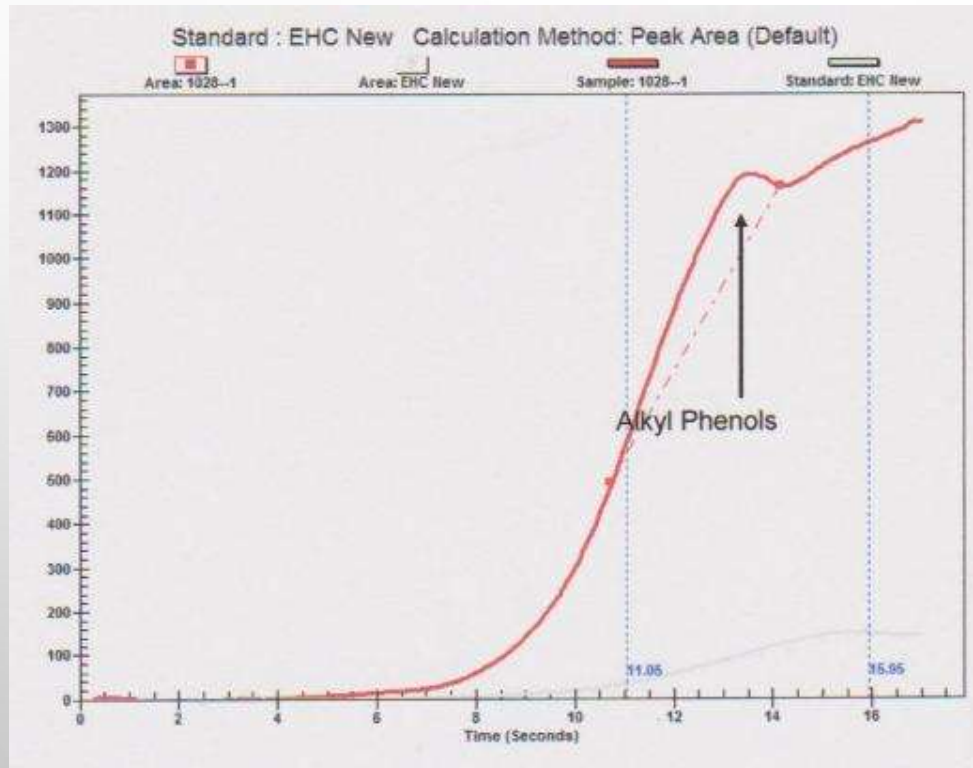


*Note: The standard ASTM MPC test needs to be modified for phosphate ester fluids as does the reporting in some cases.*

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.

**Caution: What patch, what diluent, what drying, etc.**

# New Tests – Ruler Area



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

**Caution: What software, what was it with new fluid and was it with the Green Solution?**

# New 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 (attapulugus clay)

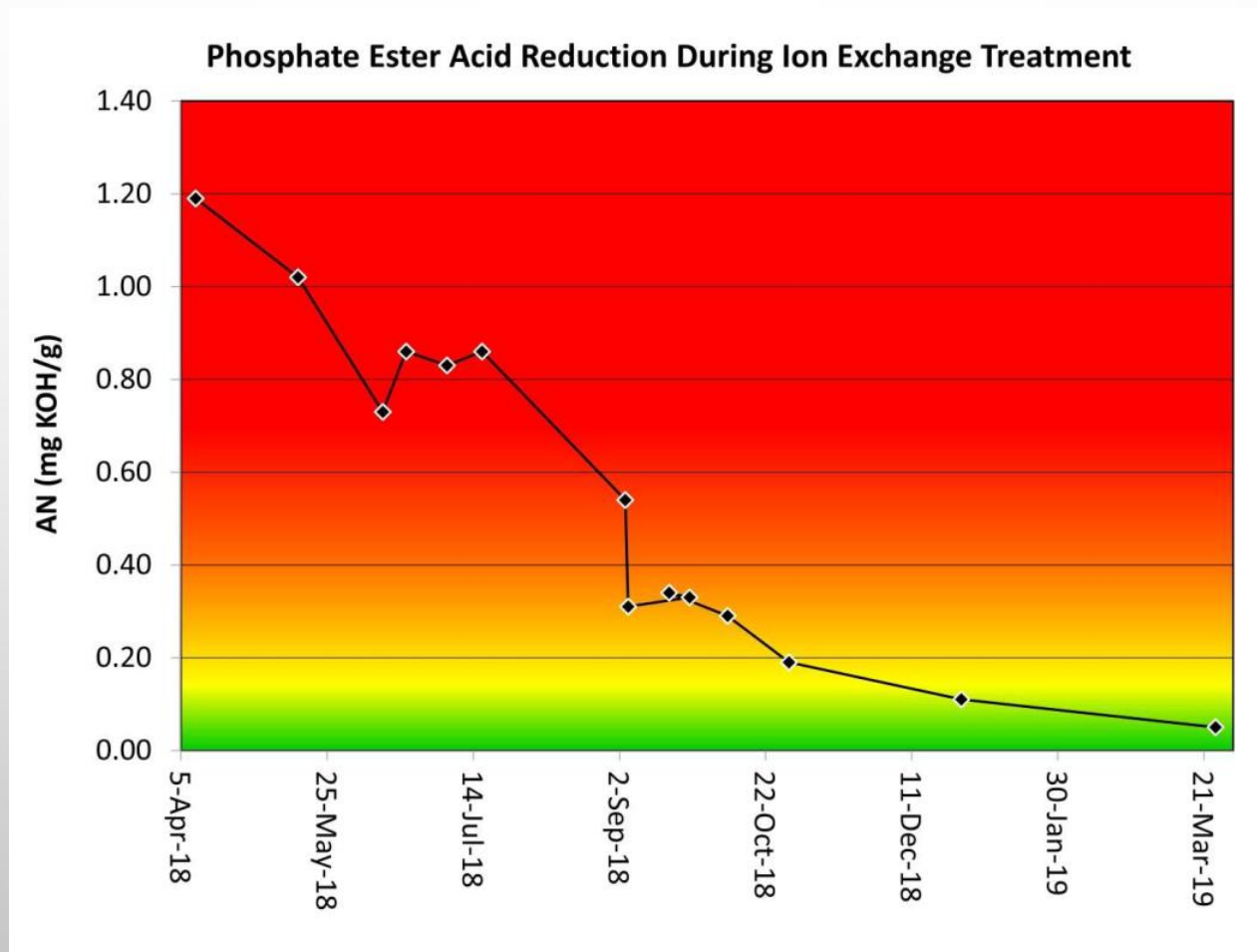
Selexsorb GT (AA and zeolites)

Ion exchange (WBA)

IX (mixed resins/wet or dry)

Other

# Acid No. Reduction with IX



GE D11 Steam Turbine - Purification system has two 6x18 cartridges.

# New Fluid Treatment Tritek 1280



Two ICB IX cartridges, two ECR™ electrostatic collectors, a 6" x 18" 3 micron filter, TMR™ N2 (dry nitrogen) unit and heater.



# Used Electrostatic Collectors



Not good but a Canoil goal is to prevent fluid getting this bad.



# Summary

- Know the **current** turbine OEM and industry requirements for fluid testing.
- Adapt as required for **your** units.
- **Trend** the fluid and other relevant data.
- Set conservative **targets**.
- Make sure that the tests being done are **suitable**.
- **Bench mark** as required.
- Be **careful** comparing results from different labs.
- For **condition monitoring** include filter elements, servo valves, pumps, etc.
- There are subject matter **experts** at Canoil, EPT and Lanxess who can help.

The image features a light gray background with a subtle gradient. In the top-left and bottom-right corners, there are clusters of realistic water droplets of various sizes, rendered with soft shadows and highlights to give them a three-dimensional appearance. The text "Thank you" is centered in the middle of the frame.

*Thank you*