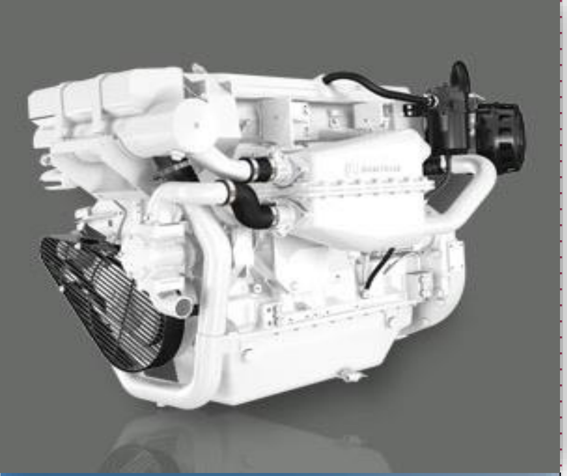

The Hidden World of Fluid Management

Equipment Fleet Management 2016 National Conference

Columbus, OH

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ME, OMA I

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A Machine is Talking to us… But, Are We paying Attention?

The torque converter lock-up is sending fault codes

The coolant PH is too high and it is low in OA

The brakes are chattering

The engine is having issues with soot

There is a leak in boom cylinder

The engine is having oil dilution beyond 5%

Inspection reports high oil level

Telematics show high idle utilization

The hydraulics have high particle counts and dirt

The engine oil appears milky

The differential oil lacks LS additive

The transmission shows high aluminum

Agenda and Expectations

- A changed world in technology
- A changed world in fluids
- Fluid analysis is still an underutilized tool

- Get acquainted with the changes
- Measure the challenges
- Take home some initiatives and implement changes that will impact you operation

Agenda

Expectations

Agenda

- Part I – A changing World
  - Engines and oils
  - Coolants
  - Hydraulics and Fluids
  - Fuel
  - DEF Diesel Exhaust Fluid
- Part II – The power of CBM tools
  - Oil analysis
  - Coolant analysis
  - Fuel Analysis
  - Inspections
  - Telematics

Part I
A changing world

What has changed?

Engines

Hydraulics

Fluids

Modern Engines
T3, IT4, FT4

Top ring location and cooled piston head

Series turbocharging

Cooled EGR

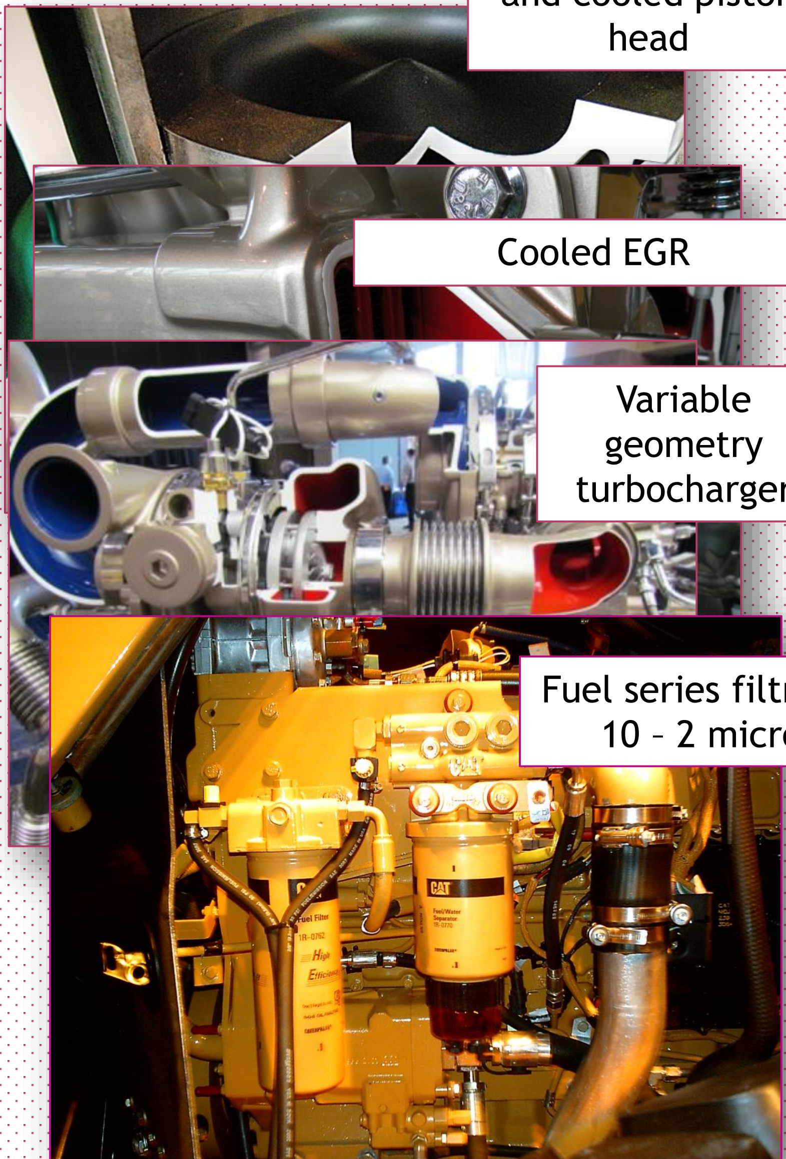
High Pressure Common Rail

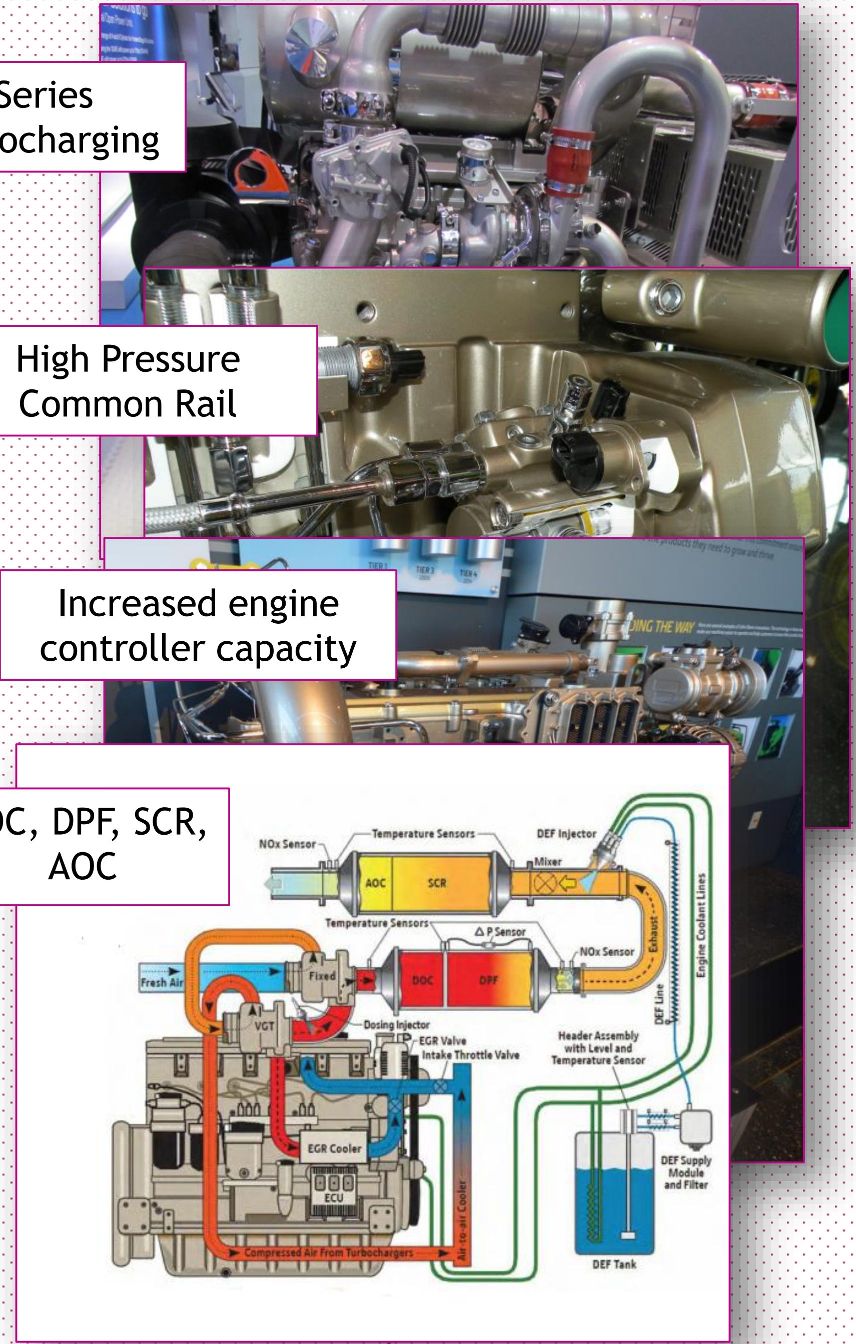
Variable geometry turbocharger

Increased engine controller capacity

DOC, DPF, SCR, AOC

Fuel series filtration 10 – 2 micron





Engine Changes

Over The Years

Cooled Turbocharger

- Pilot injection and ramp-up injection are feasible thanks to electronics, in pursuit of stoichiometric combustion
- For this reason, engines run hotter

- Engines breathe better through additional valves and more advanced turbocharging
- Room for mistakes in maintenance has narrowed, especially on engine overheating tolerance, TBN/TAN ratio and fuel cleanliness

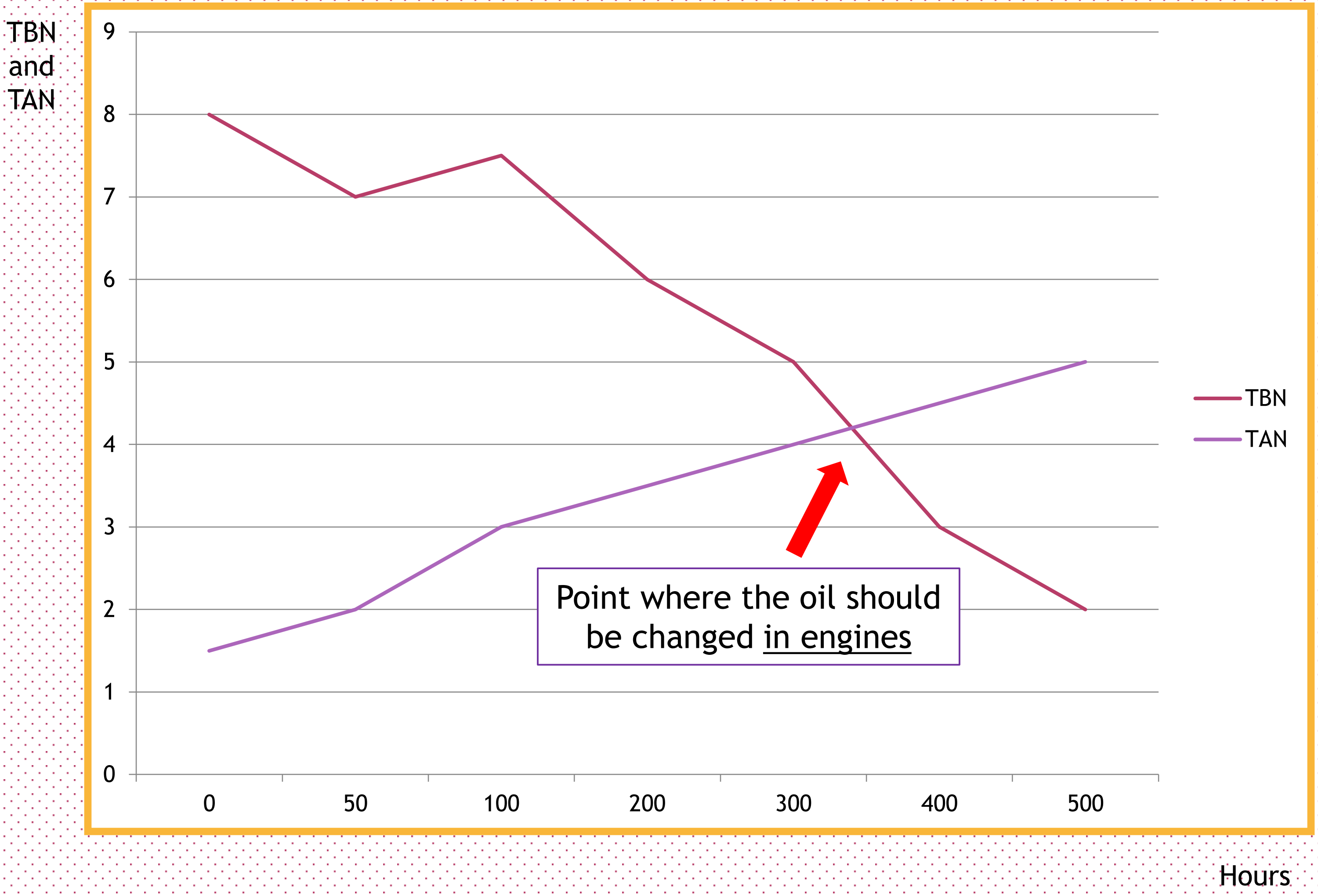
Fluid Changes
Over The Years

- Oils contain less TBN and still need to cope with increased acid neutralization and oxidation resistance requirements
- Oil flow has increased so it can be used to complement cooling
- Coolants- Because of added heat, they new coolants are the norm
- Fuel is injected at pressures that are 12 times higher than 20 years ago and at speeds that exceed 1250 MPH.
- Fuel needs to be much cleaner than hydraulic fluid
  - Fuel dilution is occurring
  - Fuel relies on additives to protect injection system
- Soot formation could be a challenge
- DEF is now in the equation

The rules of the game in maintenance have changed!

Tan and TBN

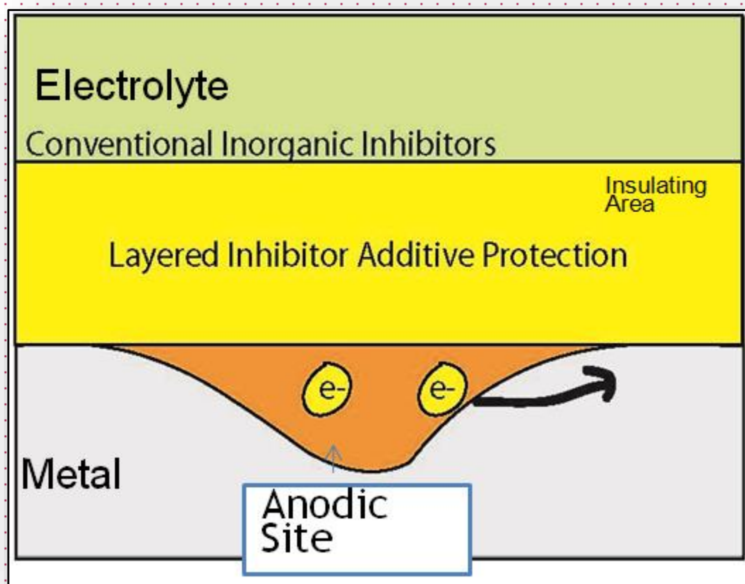
Current Engine Oils Have Less TBN

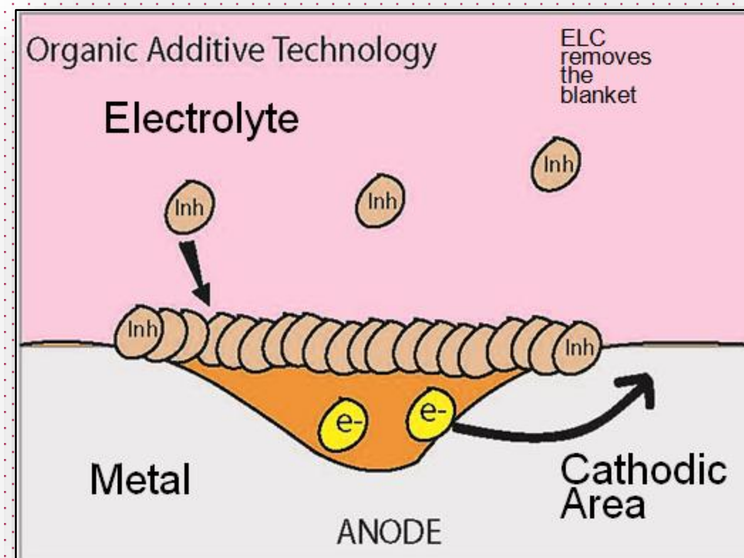


New Coolants
Technology

Can you really mix them?

- Nitrite Based Coolant
- OA Coolants





Anodic

Cathodic

Application Impact

- Engines need to cope with light loads and long idling periods
- They need to perform in high altitudes
- They need to cope with intermittent or stable continuous loads
- They might experience fuel dilution as part of application and/or design
- They might produce soot

Consequences
In a Changed World

Liner Cavitation

Soot

Consequences
In a changed world

Piston Delamination

Injector Failure

Engine
Areas to Watch - Summary

- Temperature/Air filters
- Oil TBN/TAN
- Coolant type/Water harness
- Fuel type and cleanliness
- DEF quality and contamination
- Watch for fuel dilution, coolant leaks, soot and dirt ingestion
- Watch for critical metal generation. (Copper is no longer critical)

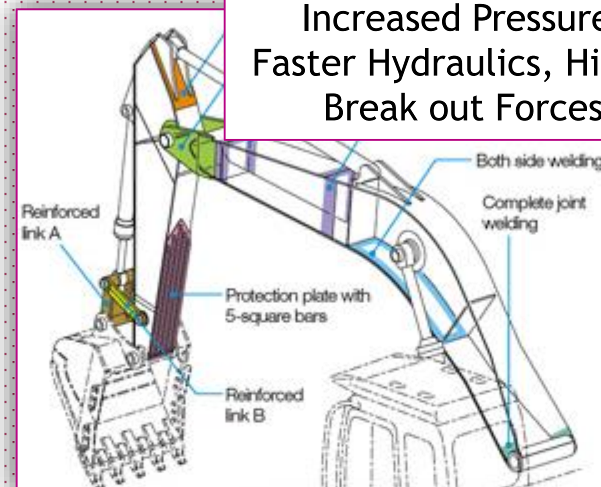
Hydraulic Changes

Modern
Hydraulics

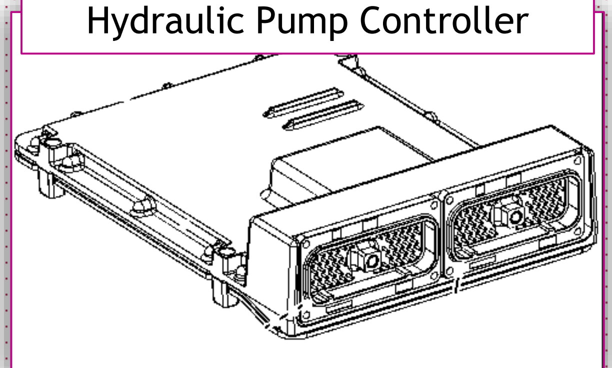
High Pressure Tandem Axial Flow Pumps

Smaller Reservoirs

Increased Pressure, Faster Hydraulics, Higher Break out Forces



Hydraulic Pump Controller



Use of attachments

New fluids

Hydraulic Systems
Changes Over The Years

Increased Pressure

- Increased pressures
  - Increased break-out forces
- Smaller reservoirs
  - Fluid has less time to cool and release air
- More environmental concerns with fluids
- Hydraulic electronic control
  - Squeezes the power of engine and hydraulics
- Room for mistakes in maintenance has narrowed
  - Especially on fluid cross contamination
  - Water tolerance
  - Fluid temperature and external contaminants

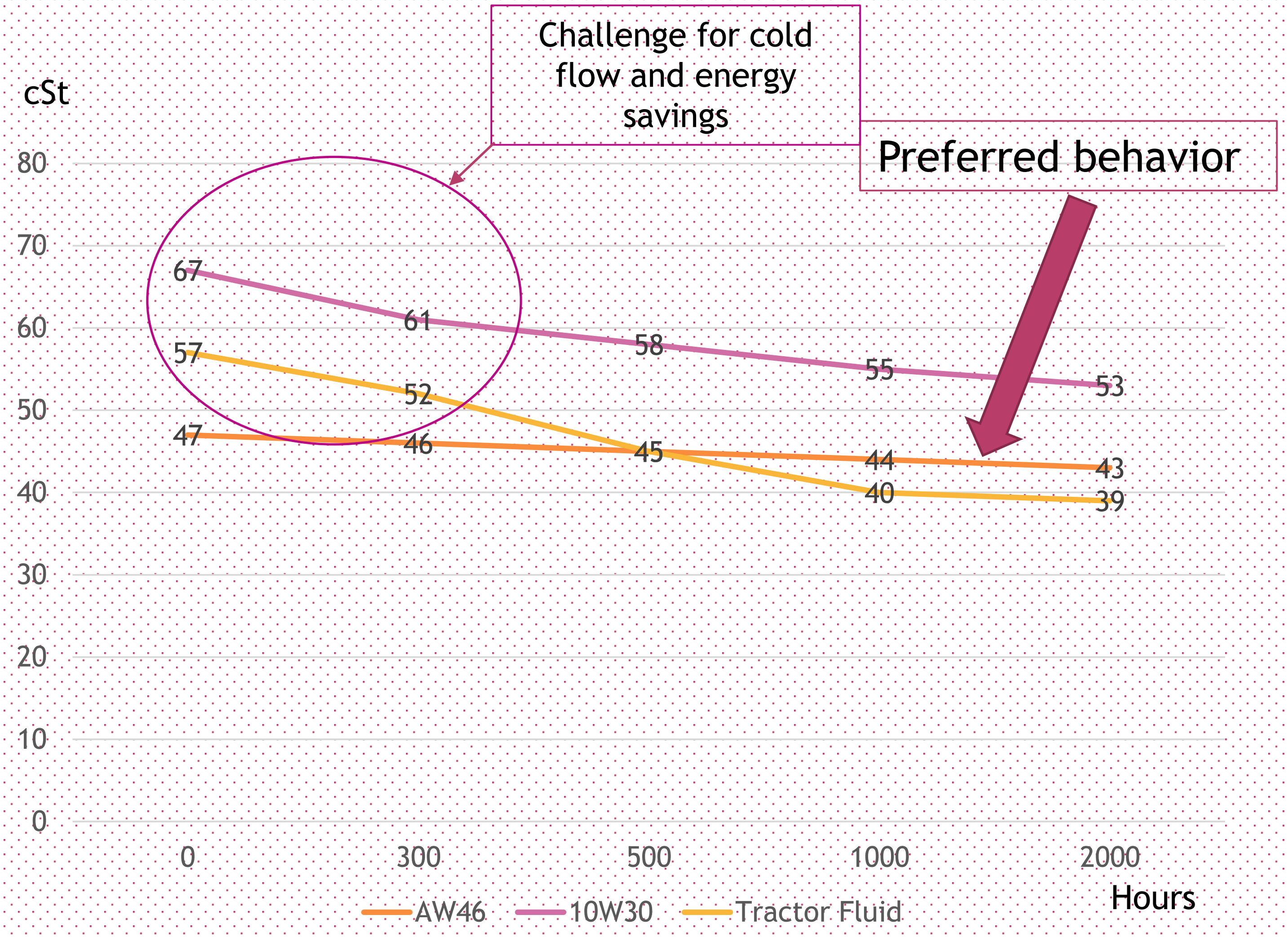
Fluid Changes
Over The Years

- Fluid needs to release air in shorter times
- Fluid needs to be much cleaner
- Fluid need to cope with increased temperature and acids/oxidation resistance requirements
- New fluids are becoming popular
  - Zinc free
  - Bio degradable
  - All season
  - Fire resistant

The rules of the game in maintenance have changed!

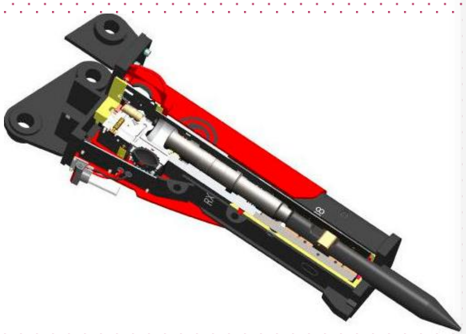
Viscosity Curves

Different hydraulic fluids



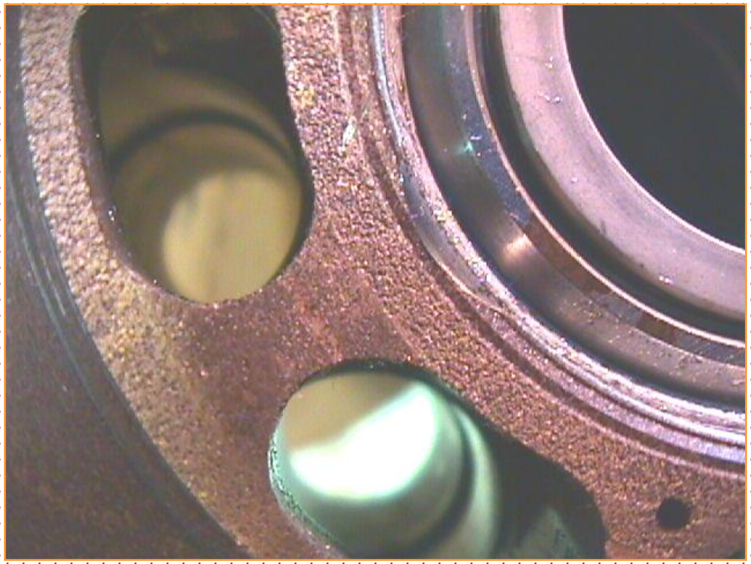
Application

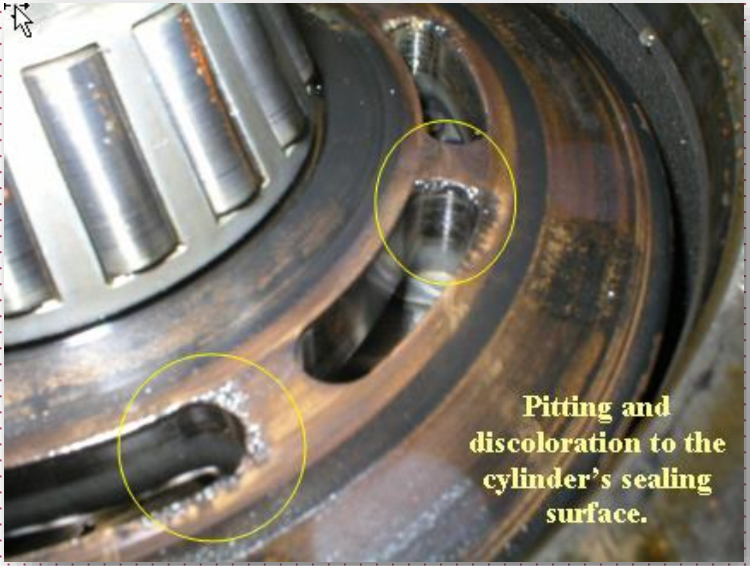
Impact



- Hydraulics need to perform in extreme arctic temperatures
- Hydraulics need to cope with high loads and high temperature periods
- Hydraulics are exposed to humid conditions
- Hydraulics may be used with high impact tools like hydraulic hammers
- Hydraulics need to cope with corrosive environment

Improper use of Fluids
or Caused by the Environment?





Etching by Lubricant

Pitting by water/air

Hydraulics
Areas to Watch Closely

- Mixing issues, type of fluid
  - Watch for fluid signature
- Watch for copper readings
  - Aeration/Cavitation
- Watch for water
  - Karl-Fischer test
- Attachments
  - Cross utilization, dirty couplings

Part II
Tools

Standard Deviations
Wear Tables
Oil analysis
Coolant analysis
Fuel analysis
DEF testing

Standard Deviations

Without Them, Oil Analysis is Useless

Median Value

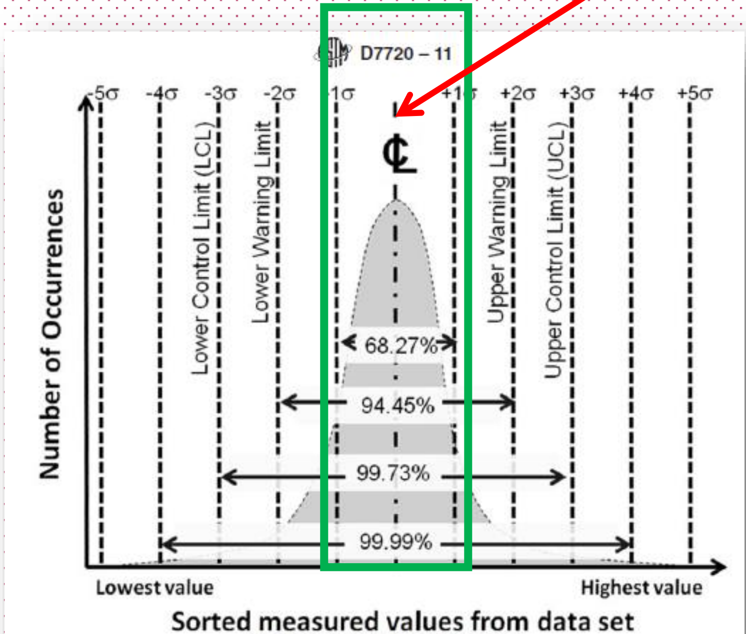


FIG. 1 SPC Parametric, Normal Distribution

- The ideal distribution of wear values follows the bell shape curve as in the graphic
- In the example, 68.27% of the population falls within 1 StdDev+ and 1 StdDv-
- These values are considered normal
- The critical values start beyond +/- 2 StdDev

The Standard Deviation is a measure of **how spread out numbers are**

Wear Sample Data Distribution

Wear Tables

By Machine Model

Otherwise your results have no real meaning

Do you or you lab have the tables for your fleet?

EX850 Hydraulic Excavators			
500 hours			
Filtered System	Normal	Abnormal	Critical
*Fe (Limit If Hrs are unknown is same as cri	<32	32	>60
Pb	<5	5	>10
Cu	<15	15	>27
Cr	<5	5	>10
Al* (Limit If Hrs are unknown is same as critical	<7	7	>11
Ni (Report Only)	<6	6	>8
Ag (Report Only)	<5	5	>8
Sn (Report Only)	<5	5	>10
Na	<21	21	>30
K	<30	30	>50
Ti (Report Only)	<5	5	>10
*Si (Limit If Hrs are unknown is same as criti	<16	16	>25

Hydraulic Sealed (Axial Pumps) Excavators (270D)			
1000 Hours			
Filtered System	Normal	Abnormal	Critical
*Fe (Limit If Hrs are unknown is same as critical lev	<100	100	>150
Pb	<7	7	>15
Cu	<10	10	>20
Cr	<9	9	>15
Al* (Limit If Hrs are unknown is same as critical level)	<9	9	>15
Ni (Report Only)	<5	5	>8
Ag (Report Only)	<5	5	>8
Sn (Report Only)	<5	5	>10
Na	<21	21	>30
K	<30	30	>50
Ti (Report Only)	<5	5	>10
Silicon Excavators* HN46	<11	11	>22

- Each type of hydraulic or engine is like a different child, each type with its application needs a dedicated table

Fleet Management
Smart Tools

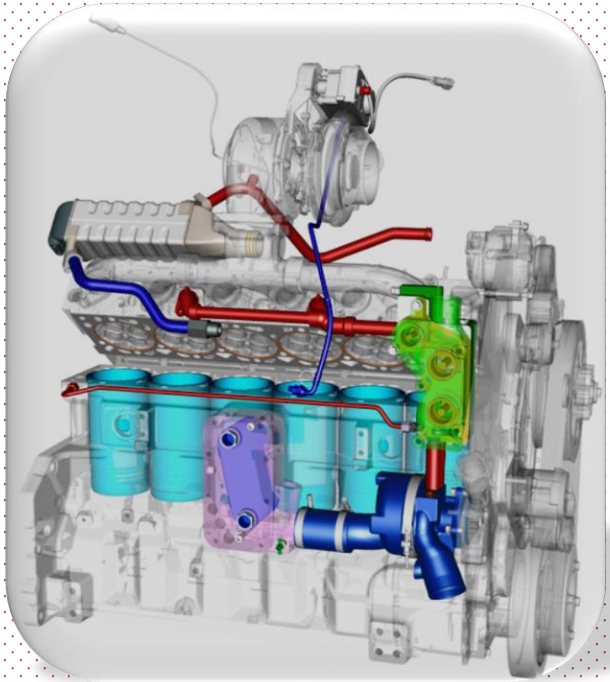
Oil Analysis Results and Grouping Statistics

Have your lab calculate those for you

Understanding
The Messages

Engine with Coolant contamination

- ❑ Can have several sources
- ❑ Constituents allow identification

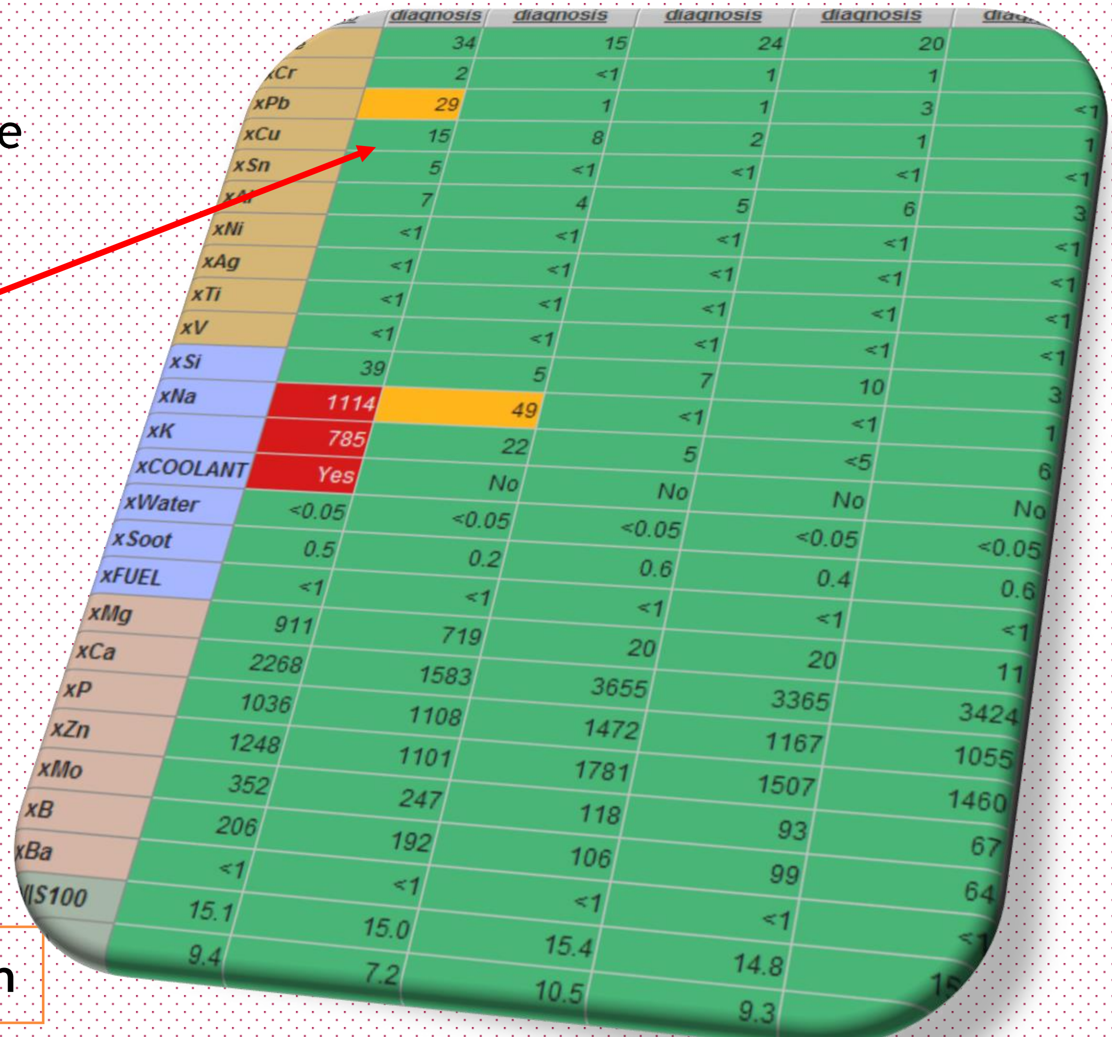


… ON UNIT	Hrs	7533	6920
TIME ON OIL	Hrs		
OIL BRAND		John Deere	Unidentified
OIL TYPE		Plus-50	Unidentified
OIL GRADE		Unknown	Unknown
OIL ADDED			
FILTER		Not Applicable	
OIL CHANGED		Not Changed	Not Provided
WO NUMBER			
Metals (ppm)			
Iron (Fe)		11	7
Chromium (Cr)		1	<1
Lead (Pb)		3	1
Copper (Cu)		22	29
Tin (Sn)		<1	<1
Aluminium (Al)		<1	2
Nickel (Ni)		<1	<1
Silver (Ag)		<1	<1
Titanium (Ti)		<1	<1
Vanadium (V)		<1	<1
Contaminants (ppm)			
Silicon (Si)		7	10
Sodium (Na)		445	172
Potassium (K)		255	54
Water (%)		<0.05	<0.05
Coolant		Yes	Yes
Fuel (%)		<1	<1
Soot (%)		0.6	0.03
Additives (ppm)			
Magnesium (Mg)		748	61
Calcium (Ca)		1277	3632
Barium (Ba)		<1	<1
Phosphorus (P)		800	1436
Zinc (Zn)		1123	1685
Molybdenum (Mo)		38	107
Boron (B)		31	132
Physical Tests			
Viscosity (cSt 100C)		13.6	15.4
Physical / Chemical			
Base Number (mgKOH/g)		9.4	10.4
		STOP	STOP

Key Observations

Where is the leak? - Coolant

- How to recognize it?
- How do you determine if the leak is through liners?
- Reduced copper readings



	diagnosis	diagnosis	diagnosis	diagnosis	diag
	34	15	24	20	
xCr	2	<1	1	1	
xPb	29	1	1	3	<1
xCu	15	8	2	1	1
xSn	5	<1	<1	<1	<1
xA	7	4	5	6	3
xNi	<1	<1	<1	<1	<1
xAg	<1	<1	<1	<1	<1
xTi	<1	<1	<1	<1	<1
xV	<1	<1	<1	<1	<1
xSi	39	5	7	10	3
xNa	1114	49	<1	<1	1
xK	785	22	5	<5	6
xCOOLANT	Yes	No	No	No	No
xWater	<0.05	<0.05	<0.05	<0.05	<0.05
xSoot	0.5	0.2	0.6	0.4	0.6
xFUEL	<1	<1	<1	<1	<1
xMg	911	719	20	20	11
xCa	2268	1583	3655	3365	3424
xP	1036	1108	1472	1167	1055
xZn	1248	1101	1781	1507	1460
xMo	352	247	118	93	67
xB	206	192	106	99	64
xBa	<1	<1	<1	<1	<1
IS100	15.1	15.0	15.4	14.8	15
	9.4	7.2	10.5	9.3	

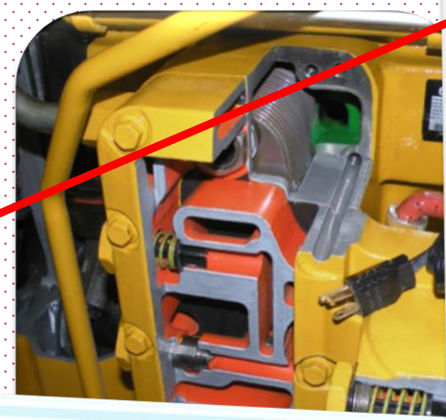
Coolant leaks by liner cavitation

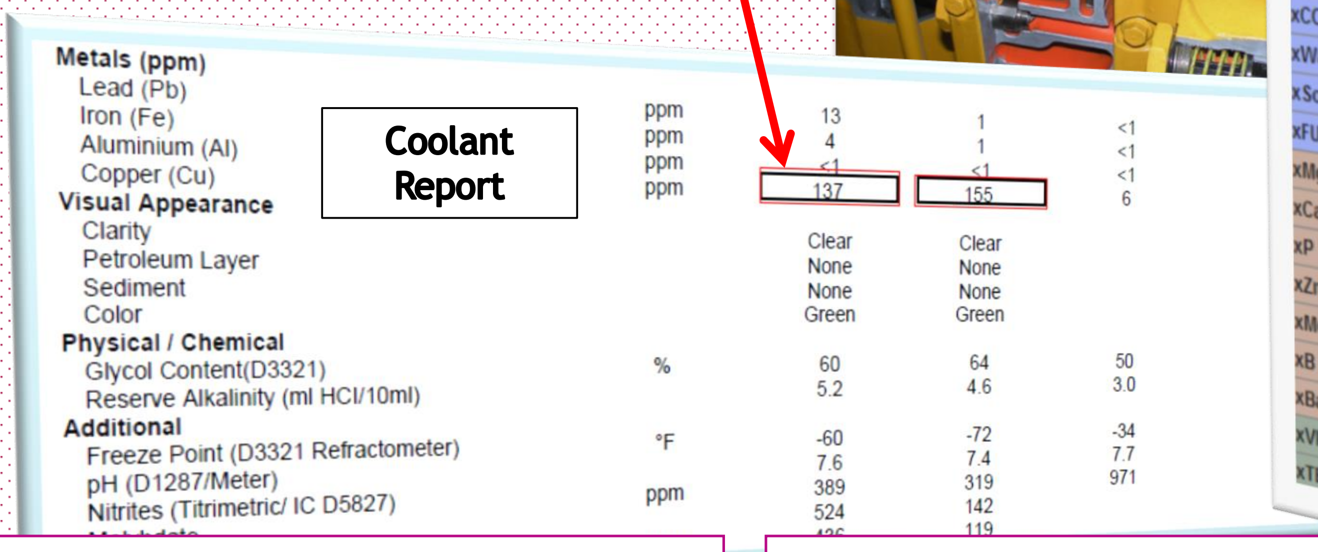
Key Observations

Contamination - Coolant

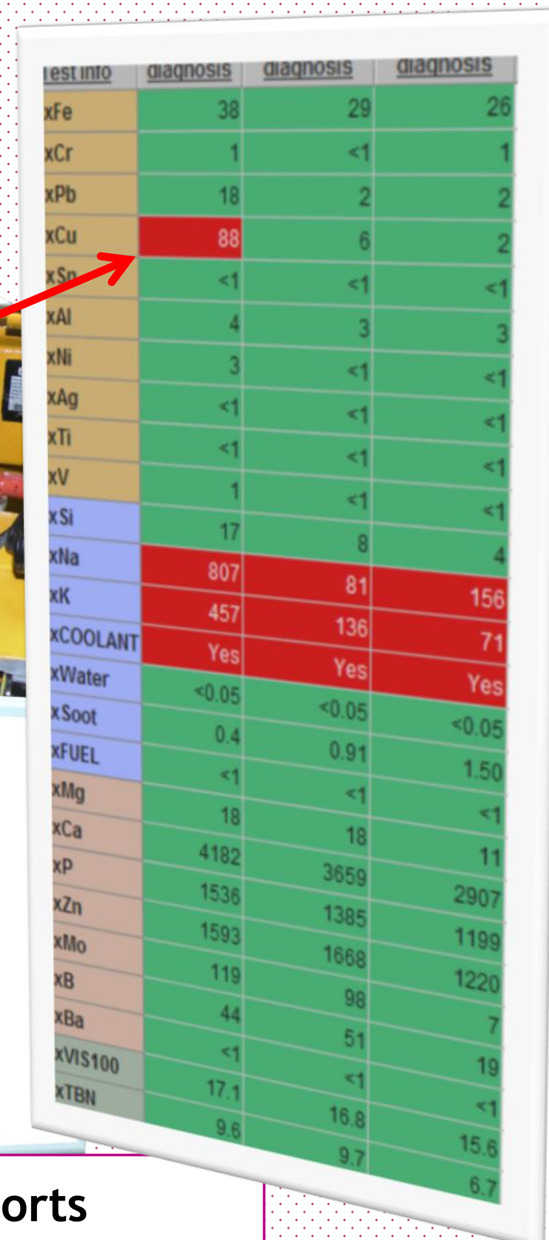
- How do you determine the coolant leak is through oil cooler…

  By the high readings of copper in both, coolant and oil analysis





Metals (ppm)				
Lead (Pb)	ppm	13	1	<1
Iron (Fe)	ppm	4	1	<1
Aluminium (Al)	ppm	<1	<1	<1
Copper (Cu)	ppm	137	155	6
Visual Appearance				
Clarity		Clear	Clear	
Petroleum Layer		None	None	
Sediment		None	None	
Color		Green	Green	
Physical / Chemical				
Glycol Content(D3321)	%	60	64	50
Reserve Alkalinity (ml HCl/10ml)		5.2	4.6	3.0
Additional				
Freeze Point (D3321 Refractometer)	°F	-60	-72	-34
pH (D1287/Meter)		7.6	7.4	7.7
Nitrites (Titrimetric/ IC D5827)	ppm	389	319	971
		524	142	



Test Info	diagnosis	diagnosis	diagnosis
xFe	38	29	26
xCr	1	<1	1
xPb	18	2	2
xCu	88	6	2
xSn	<1	<1	<1
xAl	4	3	3
xNi	3	<1	<1
xAg	<1	<1	<1
xTi	<1	<1	<1
xV	1	<1	<1
xSi	17	8	4
xNa	807	81	156
xK	457	136	71
xCOOLANT	Yes	Yes	Yes
xWater	<0.05	<0.05	<0.05
xSoot	0.4	0.91	1.50
xFUEL	<1	<1	<1
xMg	18	18	11
xCa	4182	3659	2907
xP	1536	1385	1199
xZn	1593	1668	1220
xMo	119	98	7
xB	44	51	19
xBa	<1	<1	<1
xVIS100	17.1	16.8	15.6
xTBN	9.6	9.7	6.7

Coolant Leaks Through Oil Cooler

Matching Reports

Glycol or no Glycol

That is the Question

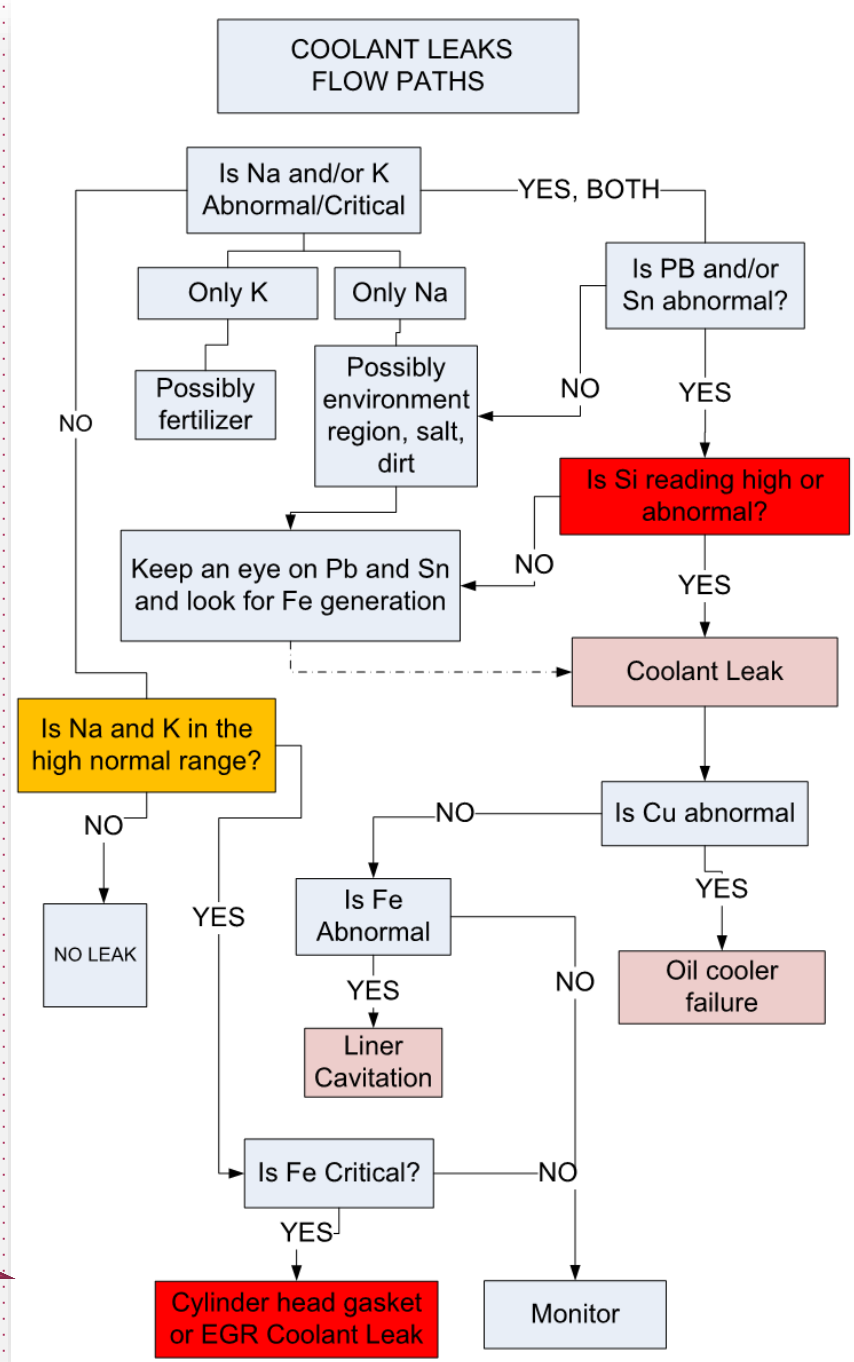
<u>Na (Sodium)</u> could be many things:

- ❑ Coolant
- ❑ Dirt
- ❑ Salt

K (Potassium) could be:

- ❑ Coolant
- ❑ Fertilizer
- ❑ Soap

Is your lab going to the trouble of interpreting this flow for you?



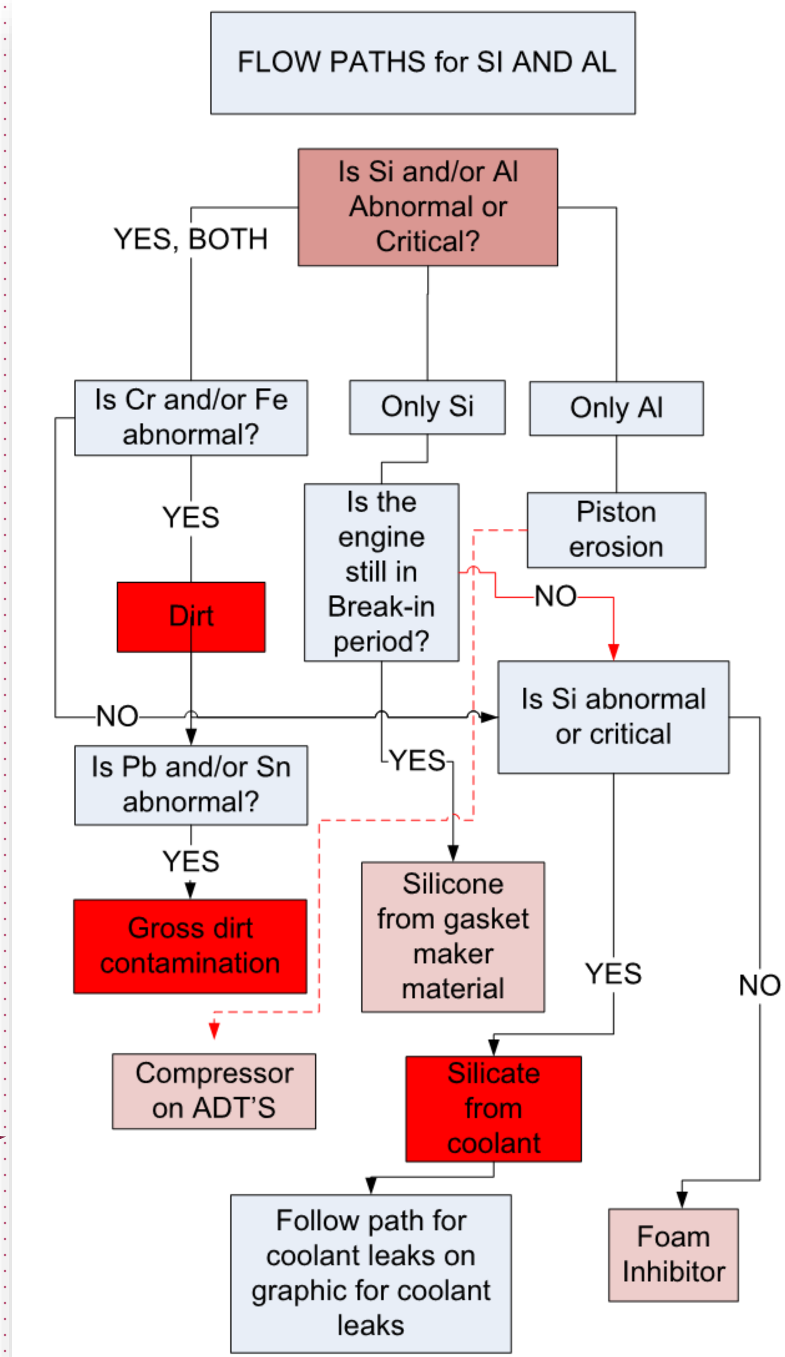
Dirt or not Dirt

That is the Question

Si can be several things:
- ❑ Dirt
- ❑ Silicone gasket maker
- ❑ Anti foaming additive
- ❑ Coolant silicates

Al could be:
- ❑ Piston material
- ❑ Dirt

Is your lab up to speed on complex interpretations?



Oil Analysis

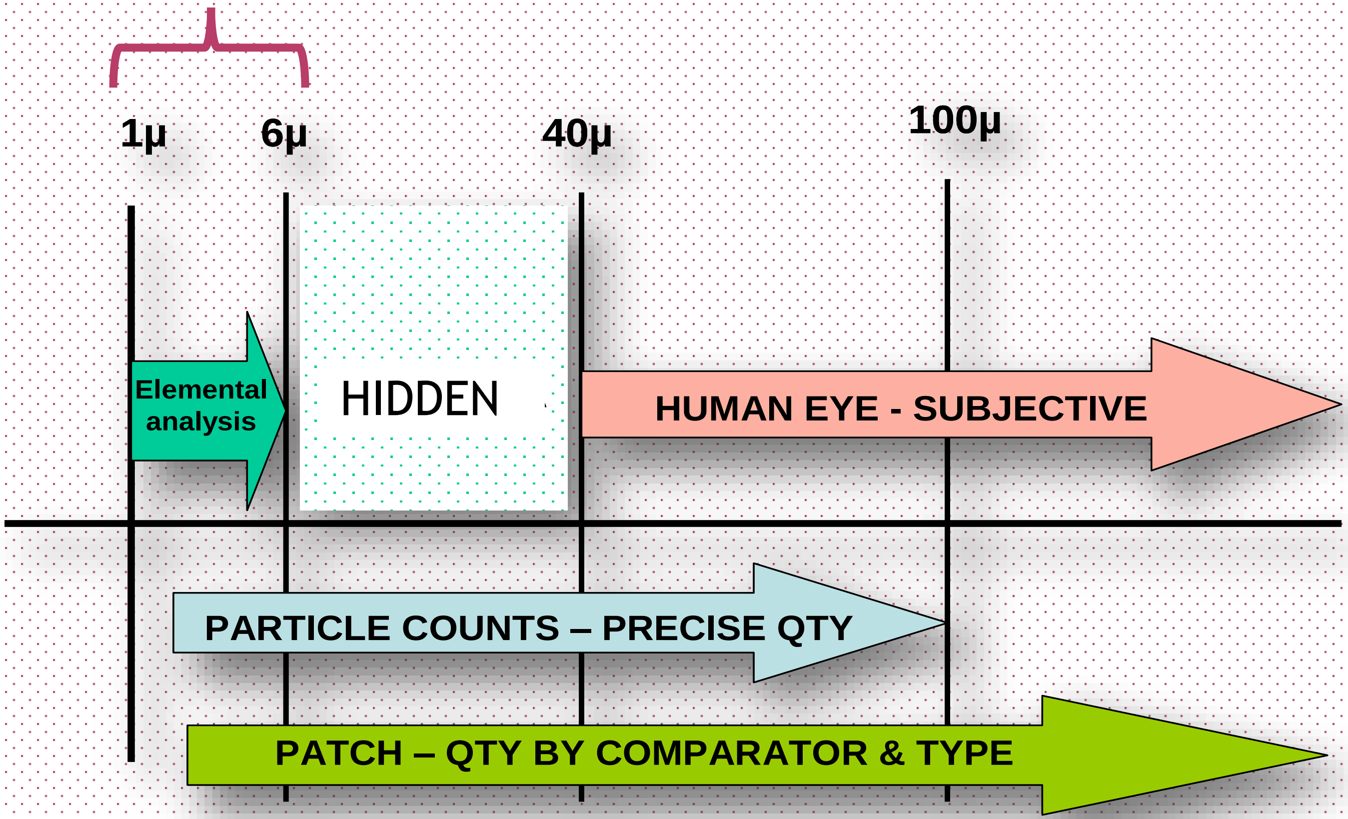
Hydraulic's Example

- What are these readings?
- Should we worry about the copper readings?
- Should we worry about the silicon readings?
- What relation does silicon readings have to the type of fluid?
- What could be causing the high particle counts

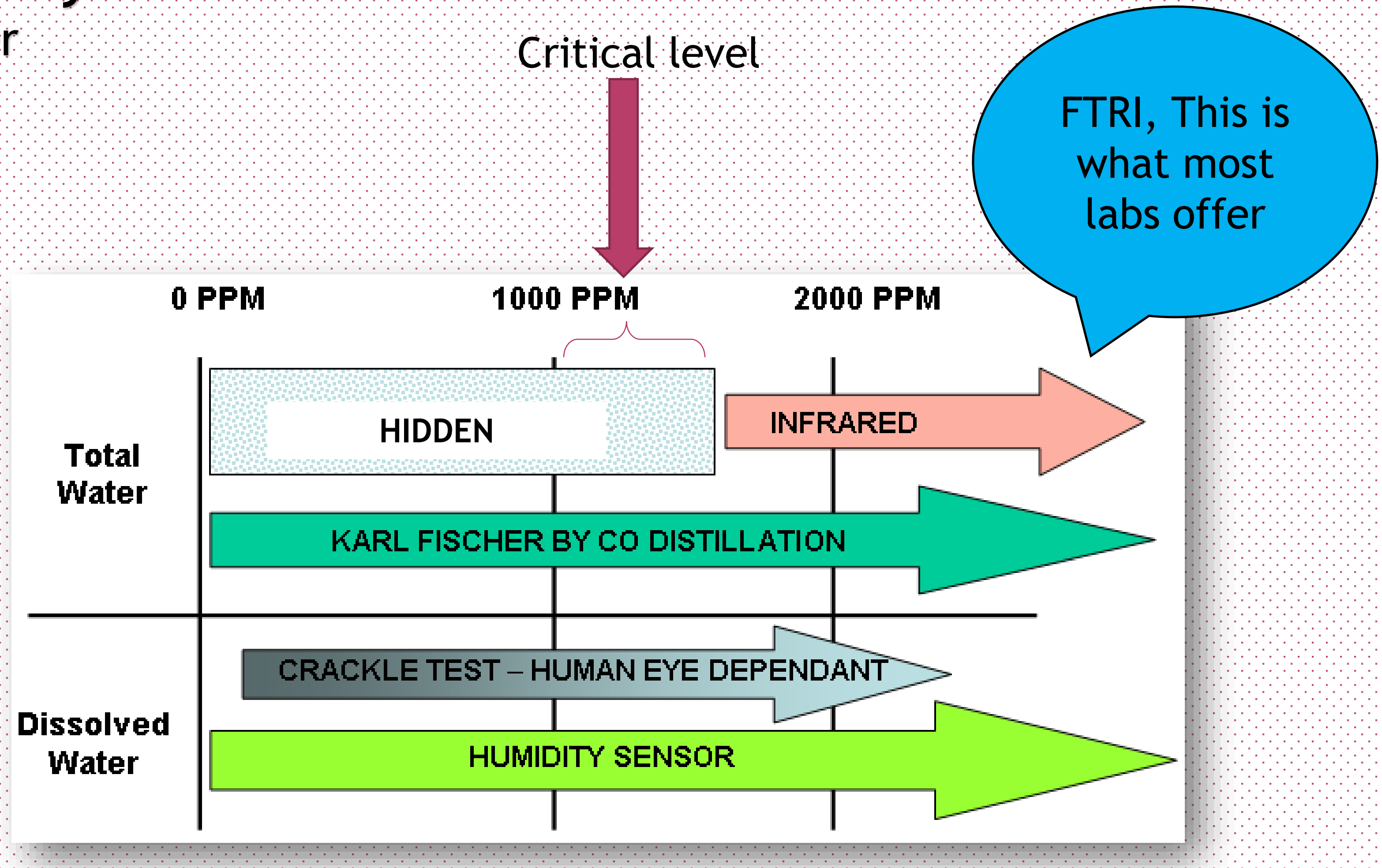
TIME ON UNIT	Hrs	3602
TIME ON OIL	Hrs	3602
OIL BRAND		Shell
OIL TYPE		Donax TD
OIL GRADE		SAE 10W30
OIL ADDED		
FILTER		Not Applicable
OIL CHANGED		Not Provided
WO NUMBER		
Metals (ppm)		
Iron (Fe)		3
Chromium (Cr)		<1
Lead (Pb)		<1
Copper (Cu)		27
Tin (Sn)		<1
Aluminium (Al)		<1
Nickel (Ni)		<1
Silver (Ag)		<1
Titanium (Ti)		<1
Vanadium (V)		<1
Contaminants (ppm)		
Silicon (Si)		9
Sodium (Na)		2
Potassium (K)		<5
Water by Karl Fischer %		<0.01
Solids (%)		0.1
Additives (ppm)		
Magnesium (Mg)		10
Calcium (Ca)		1831
Barium (Ba)		1
Phosphorus (P)		1131
Zinc (Zn)		1049
Molybdenum (Mo)		<1
Boron (B)		<5
Physical Tests		
Viscosity (cSt 40C)		34.4
Physical / Chemical		
Acid Number (mgKOH/g)		1.03
Particle Count		
ISO 4406 Rating		23/19/11
> 4 Micron (particles/ml)		47027
> 6 Micron (particles/ml)		4674
> 14 Micron (particles/ml)		19
> 23 Micron (particle/ml)		6
> 50 Micron (particles/ml)		1

SIZE OF METALS

Particles that the ICP/OES can see



Visibility
to water



Dust,

dirt and water by Karl-Fischer

FLUID ANALYSIS

UIN 0319FCE

Hydraulic System

Unit No. T0850JX181479

Unit:

Make	John Deere
Model	850J
Serial No.	T0850JX181479
Site	DM10003

Compartment:

Name	Hydraulic System
Make	
Model	
Serial No.	
Capacity:	Ltrs

Customer:

DIAGNOSIS

High level of water present. Viscosity low for specified oil grade. Note: Particle count levels appear to be high. High silicon {abrasives}-check for source of entry. Elevated chromium-possible valve and/or cylinder rod wear. High iron readings suggest some hydraulic cylinder wear or rust. Copper level exceeds values for this component. Contact your dealer for additional information. Hydraulic pump wear is indicated. Recommend use of off-line filtration cart.

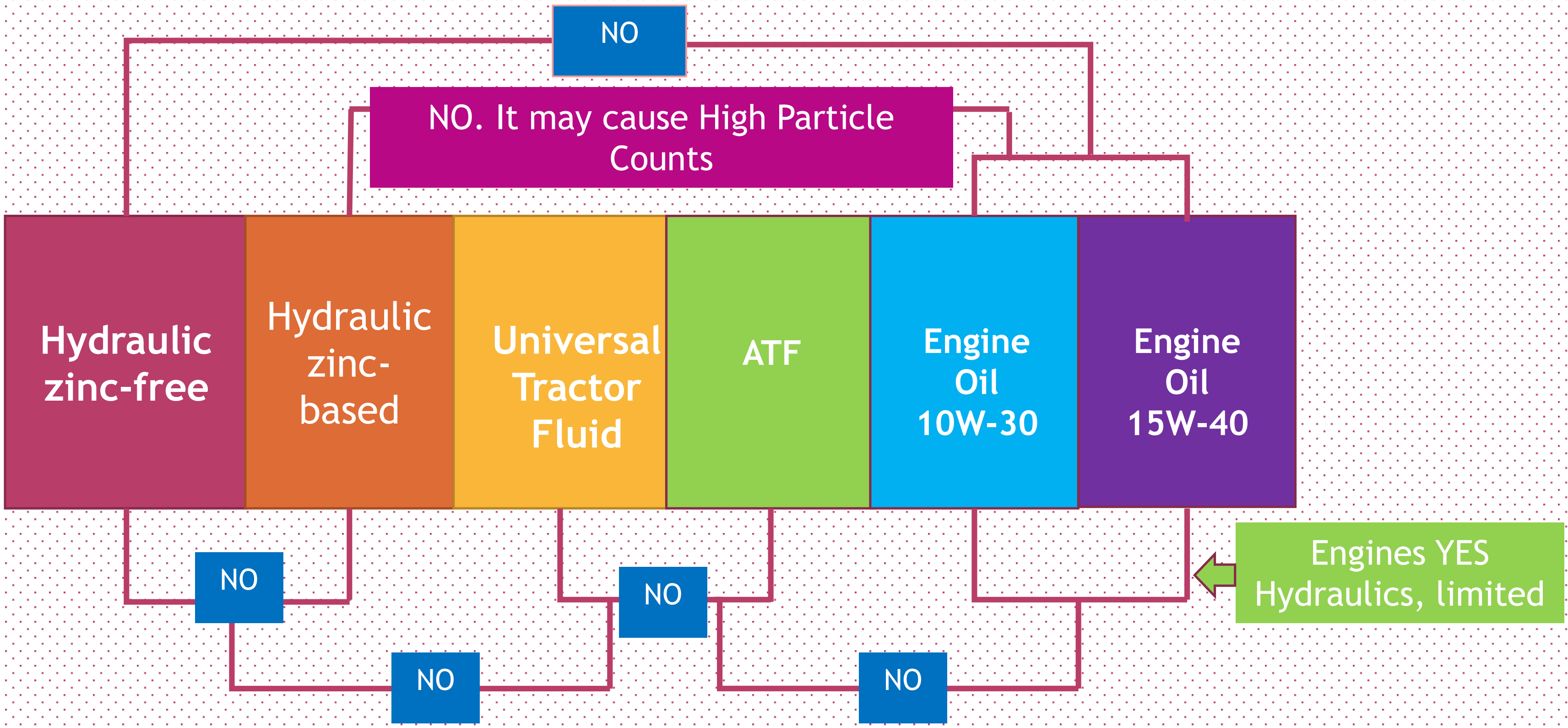
ANALYST: Ed.Matthews

DATE SAMPLED	18-Feb-13
DATE RECEIVED	20-Feb-13
DATE REPORTED	22-Feb-13
LAB NO.	44020696904
SIF NO.	12285866
TIME ON UNIT	5972
TIME ON OIL	
OIL BRAND	John Deere
OIL TYPE	Plus-50 II
OIL GRADE	SAE 15W40
OIL ADDED	
FILTER	Not Applicable
OIL CHANGED	Not Changed
WO NUMBER	W29962
Metals (ppm)	
Iron (Fe)	121
Chromium (Cr)	12
Lead (Pb)	1
Copper (Cu)	107
Tin (Sn)	4
Aluminium (Al)	83
Nickel (Ni)	3
Silver (Ag)	<1
Titanium (Ti)	6
Vanadium (V)	<1
Contaminants (ppm)	
Silicon (Si)	205
Sodium (Na)	13
Potassium (K)	10
Water by Karl Fischer % (E203/D6304)	0.13
Solids (%)	0.1
Additives (ppm)	
Magnesium (Mg)	116
Calcium (Ca)	3150
Barium (Ba)	<1
Phosphorus (P)	1138
Zinc (Zn)	1477
Molybdenum (Mo)	16
Boron (B)	146
Physical Tests	
Viscosity (cSt 40C)	53.6
Physical / Chemical	
Acid Number (mgKOH/g)	2.15
Particle Count	
ISO 4406 Rating	25/25/23
> 4 Micron (particles/ml)	212418
> 6 Micron (particles/ml)	185574
> 14 Micron (particles/ml)	53589
> 23 Micron (particle/ml)	4092
> 50 Micron (particles/ml)	24

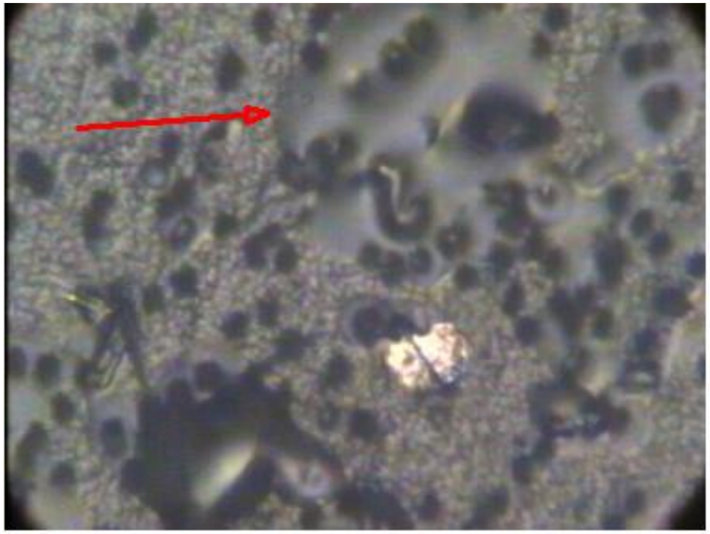
You won’t catch this water with infrared only

This odd particle count readings are telling you there is water

Fluid
Compatibility



Impact
of Fluid Mixing



10 micron particle with gelatinous fluid mixing
View 400X

Mixing	Water	Impact of Addtives
24/22/18	22/22/22	Engine oil 22/18/13
22/20/16	20/20/20	Hydraulic fluid19/15/12

How mixtures and water impact readings

Coolant
Analysis

	Detroit 16V 159
Tolyltriazole, %wt	0.11
Benzoic acid, %wt	<0.01
Sebacic acid, %wt	0.02
Toluic acid, %wt	<0.01
Ethylhexanoic acid, %wt	<0.01
Octanoic acid, %wt	<0.01
Tert-Butyl Benzoic acid, %wt	<0.01
Benzotriazole, % wt	<0.01
Mercaptobenzothiazole, %wt	<0.01
Total	0.13

	Detroit 16V 159
Chloride (mg/kg)	205
Nitrite (mg/kg)	708
Nitrate (mg/kg)	<10
Phosphate (mg/kg)	<10
Sulfate (mg/kg)	11
Aluminum (mg/kg)	<2
Iron (mg/kg)	<2
Lead (mg/kg)	<2
Copper (mg/kg)	<2
Boron (mg/kg)	35
Potassium (mg/kg)	11
Sodium (mg/kg)	758
Molybdenum (mg/kg)	<2
Molybdate	<2
Silicon (mg/kg)	<2
Silicate	<2
Calcium (mg/kg)	<2
Magnesium (mg/kg)	<2
Zinc (mg/kg)	<2
pH	**9.3**
Freeze Point	32
Percent Glycol/Antifreeze	0
Reserve Alkalinity	1.3
Visual Assessment	Clear
Sediment	Trace

Organic Additives

Inorganic Additives

Coolant Analysis

Water Quality

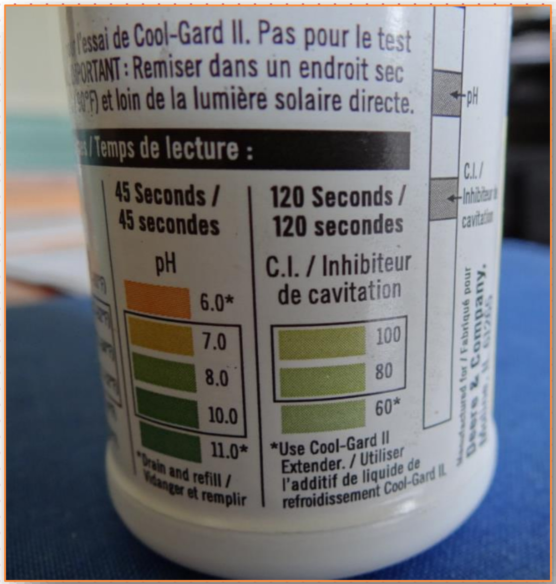
Sample from engine	Lab Results
Chlorates	**322**
Sulfates	<10
Sodium	114
PH	7.3
Total Dissolved Solids	410
Hardness	11.1

	Caterpillar	Cummins	Detroit	John Deere	ASTM
Chlorates	50	100	40	5	40
Sulfates	50	100	100	5	100
Total dissolved solids TDS	250	500	340	10	340
Total Hardness	100	300	170	5	40

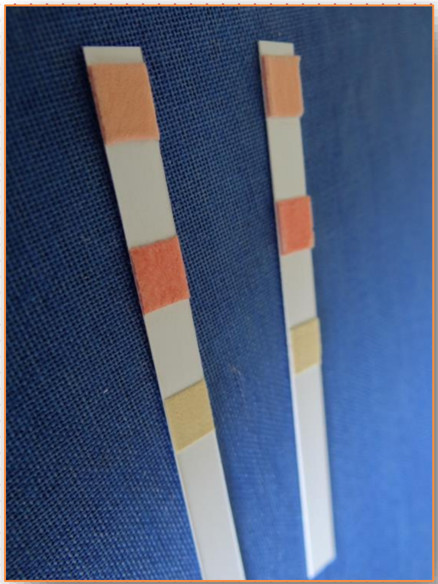
OEM's versus ASTM's

Field Tests for OA ELC
PH, Organic Acid and Glycol Concentration

Still, you need to check for mixing and for the presence of metals using a formal lab test



ELC Coolant

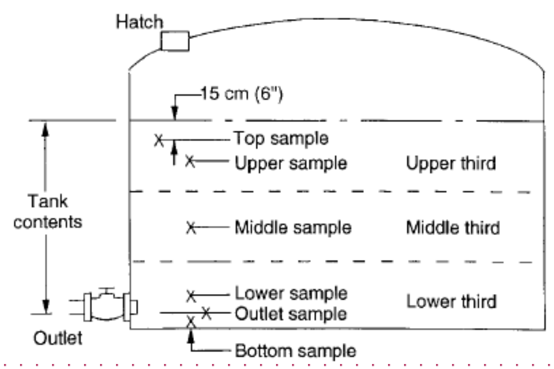


Three ways sticks

Fuel - The Ghost Can Be Very Elusive!
Where and When to Take Fuel Samples?

Bulk Thanks ASTM D4057-06

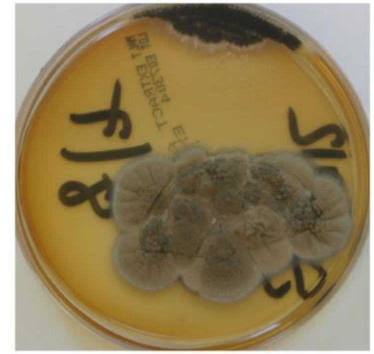
- After refueling is best
  - Do it at the middle of the tank
  - Indicate that in the sample information form (SIF)
- If done it before refueling…
  - Do it in lower third
  - Not in outlet level
  - Indicate that in the sample information form (SIF)



Machines

- Fuel gets cleaner during engine operation
  - Timing is of importance to catch contamination
    - Collect sample during first hour after refueling
    - Indicate time of sample collection on sample information form

Fuel Analysis Report



Water, particulate, bacteria, sulfur, distillation, cetane index, bio diesel

Appearance-Distillate Fuel (ASTM D4176)		
Clear and Bright	**Hazy**	
Free Water	**Excessive**	
Particulate	**Excessive**	
Distillation (ASTM D86)		
Initial Boiling Point	365	°F
10% Recovered	403	°F
50% Recovered	500	°F
90% Recovered	620	°F
End Point	665	°F
% Recovered	97.1	Volume %
Physical / Chemical		
API Gravity @ 60F (ASTM D287)	35.9	° API
Calculated Cetane Index (ASTM D4737)	46.2	CCI
Cold Filter Plugging Point (IP309/D6371)	12	°F
Water by Karl Fischer (ASTM E203/D6304)	**1695**	ppm
Sulfur (ASTM D4294/D5453/D7039)	18	ppm
Water by Distillation (ASTM D95)	0.3	Volume %
Biodiesel Blend Content (ALS 2001)	1.6	Volume %
Acid Number (mgKOH/g)	0.07	mgKOH/g
Cloud Point (ASTM D2500)	N/A	°F
Additional		
Total Particulate (ASTM D5452/D6217)	**32.0**	mg/L

Fuel with
Gasoline Contamination

Appearance-Distillate Fuel (ASTM D4176)		
Clear and Bright	Pass	
Free Water	Pass	
Particulate	Pass	
Distillation (ASTM D86)		
Initial Boiling Point	102	°F
10% Recovered	192	°F
50% Recovered	400	°F
90% Recovered	555	°F
End Point	619	°F
% Recovered	98.0	Volume %
Physical / Chemical		
API Gravity @ 60F (ASTM D287)	53.8	° API
Calculated Cetane Index (ASTM D4737)	69.0	CCI
Cold Filter Plugging Point (IP309/D6371)	<-60	°F
Water by Karl Fischer (ASTM E203/D6304)	17	ppm
Sulfur (ASTM D4294/D5453/D7039)	16	ppm
Water by Distillation (ASTM D95)	<0.1	Volume %
Biodiesel Blend Content (ALS 2001)	<0.1	Volume %
Acid Number (mgKOH/g)	0.01	mgKOH/g
Cloud Point (ASTM D2500)	-35	°F
Additional		
Total Particulate (ASTM D5452/D6217)	<1	mg/L

Fuel Additives
Dependency

Protect Fuel - Diesel Fuel Conditioners, features:

- Detergent
- Dispersant
- Stability Improver
- Oxidation Inhibitor
- Cetane Improver
- Lubrication Improver
- Water Control
- Cold Flow Improver
- Anti-Settling Agent Wax

Normal Use

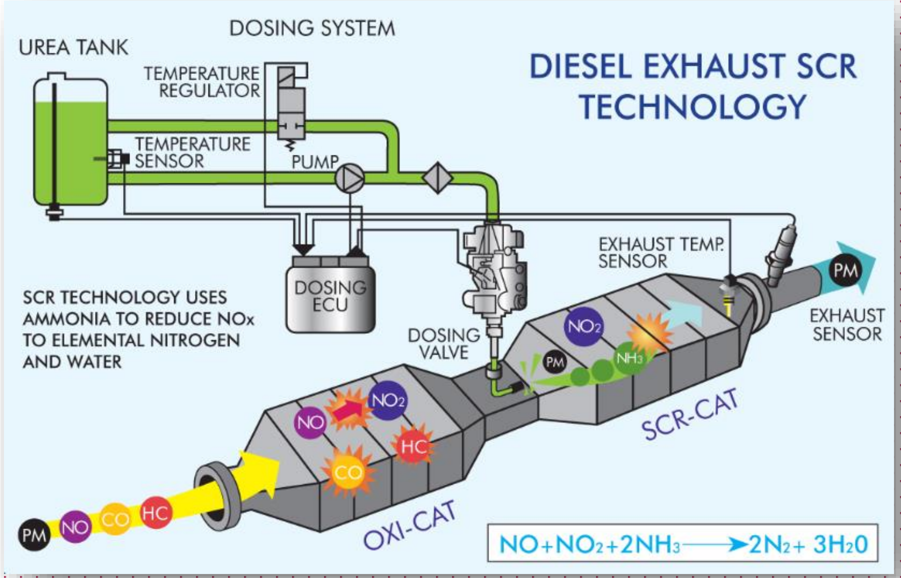
Protect Fuel - Keep Clean features:

- Detergent
- Dispersant
- Stability Improver
- Oxidation Inhibitor

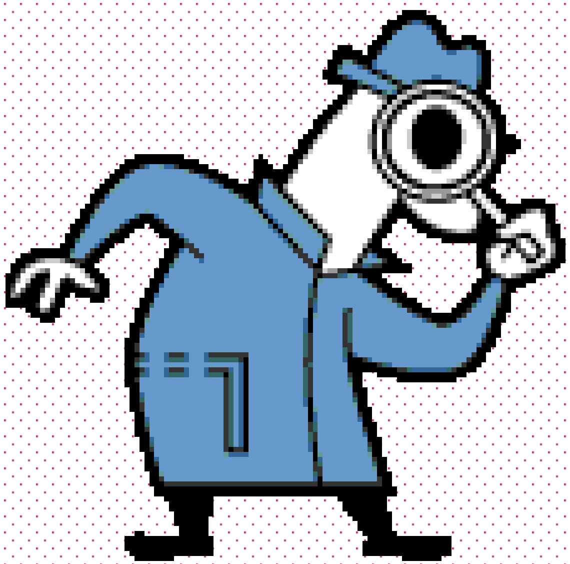
Strong Cleaner

Diesel Exhaust Fluid (DEF)

- Major issues arise from mistakes
  - Fuel in the DEF tank
  - Coolant the DEF tank
  - Wrong concentration
  - Particle contamination
- Keeping DEF in check can save the SCR catalyst



Inspections



- Are machine inspections done?
- Are you checking the right areas?
- Are you uploading the inspections to a maintenance application?
- Are inspections crossed over oil analysis or telematics data?

Inspections

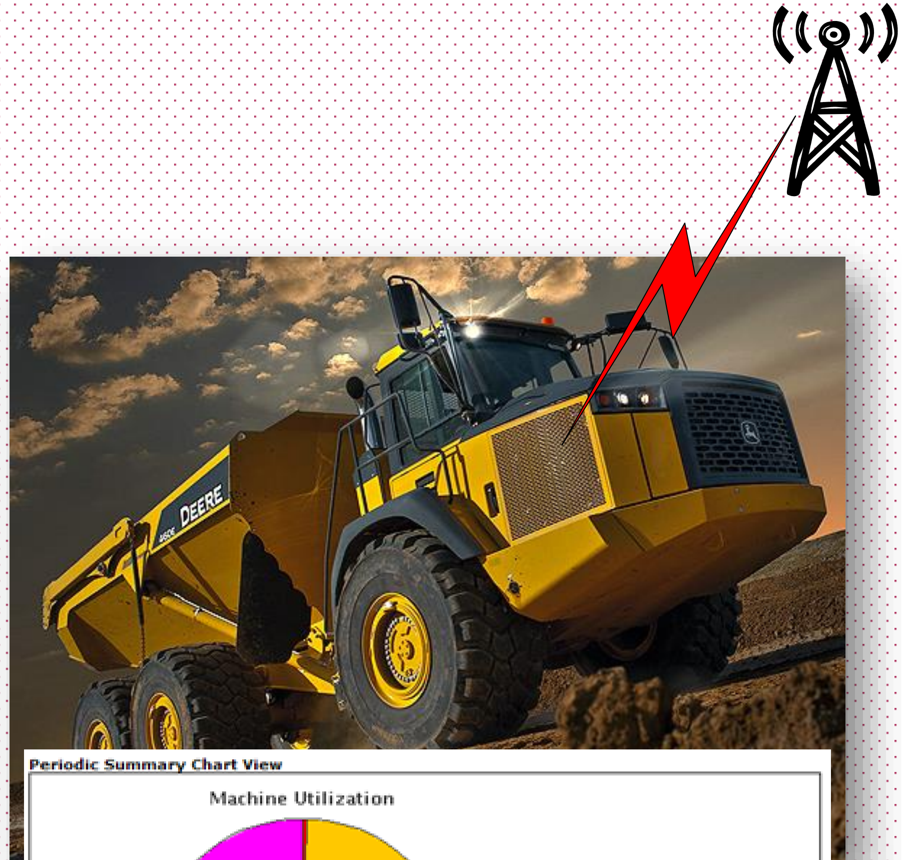
Leaking roller

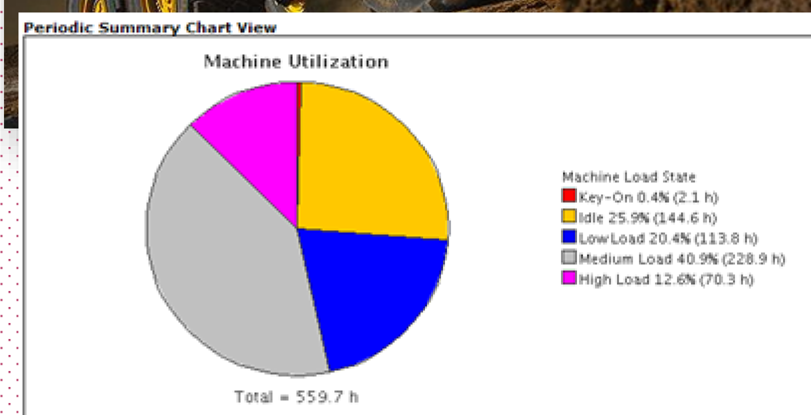
Hidden enemy. Not only radiators need to be cleaned?

Telematics

Get what is Usable

- Get power utilization
- Get high temperature occurrences
- Cross <u>machine information</u> over to fluid analysis
- Cross <u>inspection results</u> to telematics/fluid analysis





What is usable

Machine Utilization

New Challenges

- A deeper knowledge on machine health interpretation is needed
- We cannot continue doing what we have been accustomed to doing
- There are new rules in the game that you are expected to play by

Challenges

- A better fluid analysis interpretation from labs and users is a must!
- The right wear tables make the difference
- A better use of Telematics is a must
- Boost the power of telematics by crossing it to inspections and fluid analysis

Opportunities

Remember

A machine is talking to you…Learn the correlations!

The torque converter lock- up is sending fault codes

The transmission shows high aluminum

The brakes are chattering

The differential oil lacks LS additive

There is a leak in boom cylinder

The hydraulics have high particle counts and dirt

Inspection reports high oil level

The engine is having oil dilution beyond 5%

Telematics show high idle utilization

The engine is developing soot

The engine oil appears milky

The coolant PH is too high and it is low in OA

Questions?