POLARIS Laboratories

stleNashville
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BRIDGING THE GAP: FILTER DEBRIS ANALYSIS

Henry Neicamp | 5.22.19

About the Speaker

HENRY NEICAMP|POLARIS LABORATORIES®

Henry Neicamp

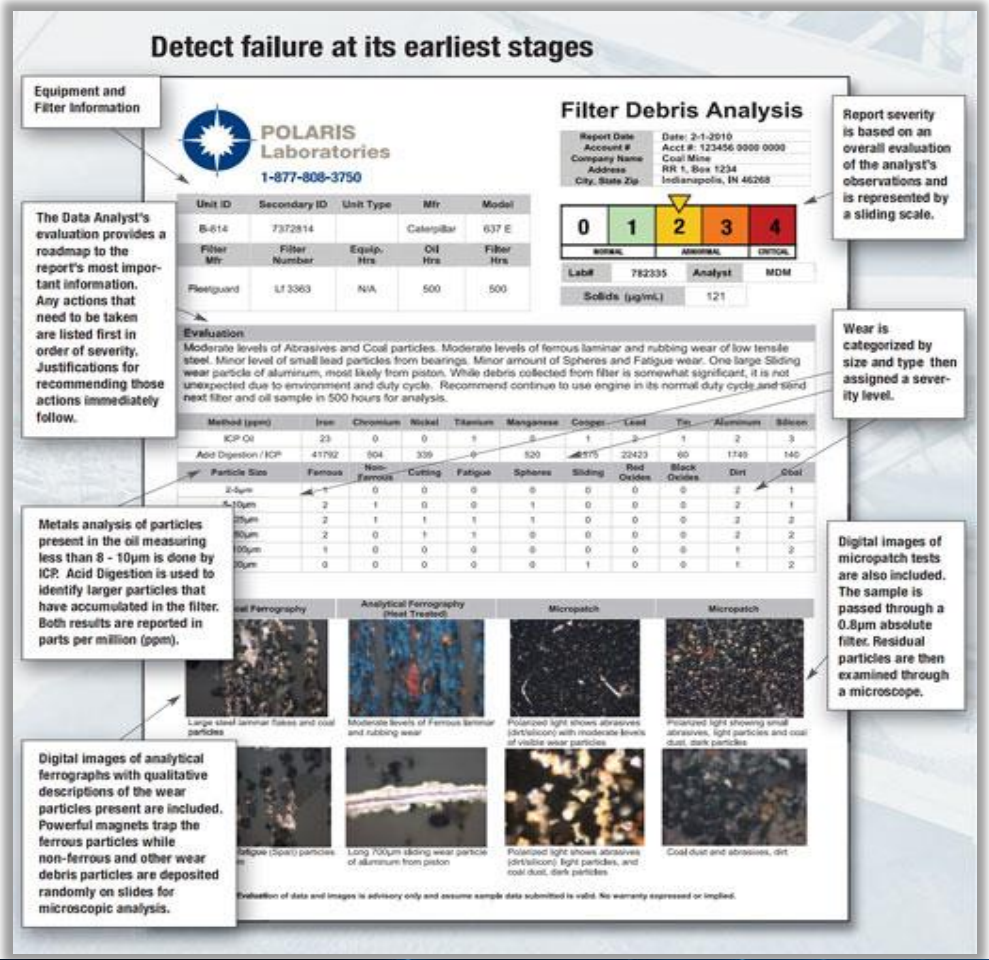
Technical Business Consultant

Industry Experience

- B.S. General Engineering/Mining Engineering University of Illinois
- More than 35 years technical sales, engineering and management experience in the petroleum industry and lubricants marketplace
- Well Logging Engineer with Seismograph Service Corporation and Dresser Industries
- Sales Engineer and Technical Services Manager with Pennzoil-Quaker State Company
- Sales/Technical Engineer with Warren Oil Company
- Field Services Manager; Midwest Territory Sales Manager; Technical Business Consultant with POLARIS Laboratories®
- CLS/OMA certified by STLE

FILTER DEBRIS ANALYSIS

Detect failure at it's earliest stages!



WHAT IS FILTER DEBRIS ANALYSIS (FDA)?

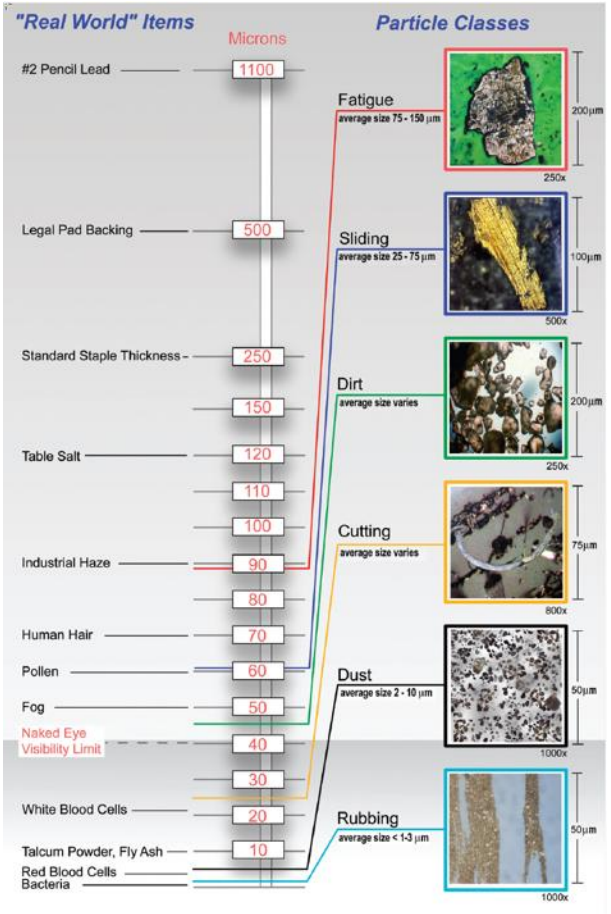
- FDA is a way to determine what particles (data) are being captured by the filters
- Filters by nature capture all large particles so these particles are excluded from routine oil analysis
- FDA on large particles provides valuable insight on how the machine is functioning
- Originated in the mining industry
  - Estimate equipment life expectancy, monitor wear

WHY DO FILTER DEBRIS ANALYSIS (FDA)?

- **Your filter can tell you things your oil can't!**
  - Filter Debris Analysis (FDA) identifies "MISSING DATA", such as contaminants and wear mechanisms not detected by traditional elemental analysis

WHAT PARTICLES ARE BEING CAUGHT BY YOUR FILTER?

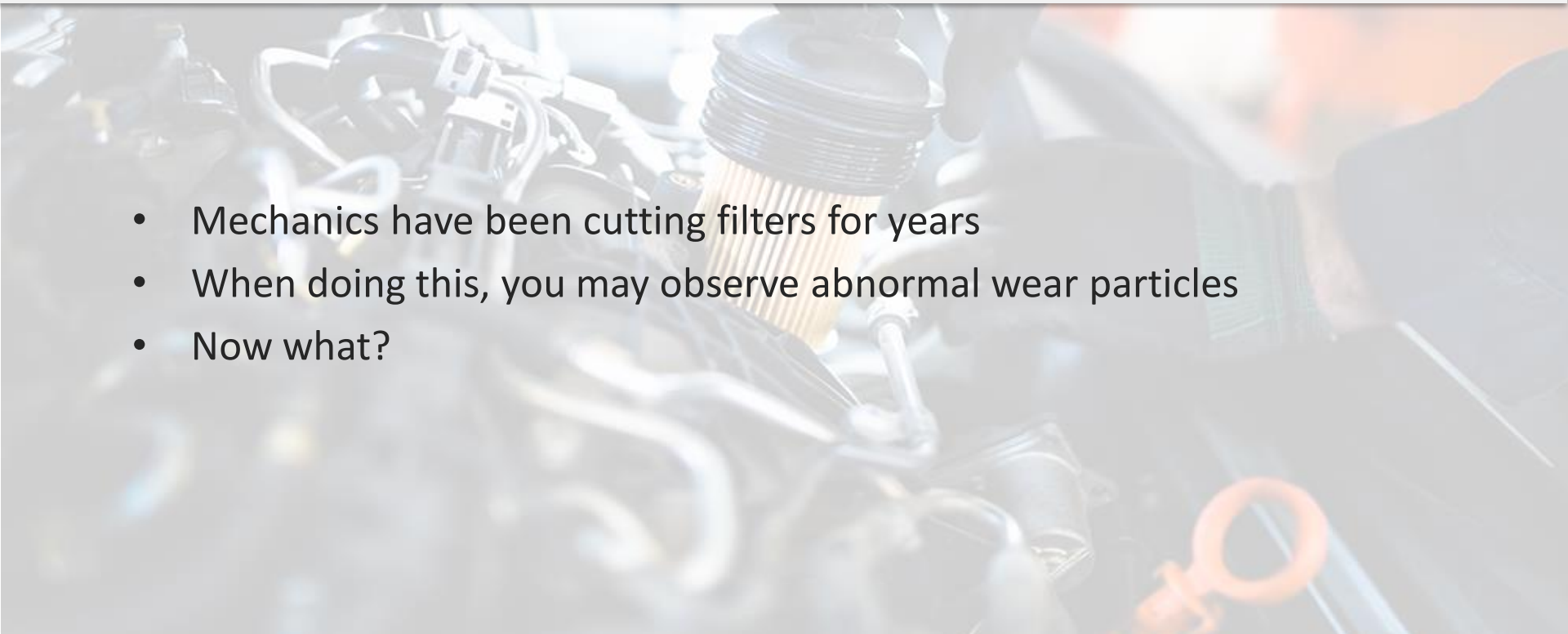
What data is your filter "catching"



WHAT ARE THE BENEFITS?

- Detects early stages of component failure
- Bridges gap between elemental analysis & Particle Count (PC) / Particle Quantifier (PQ)
- Determines particle size, type & wear mechanism
- Tell you what is causing filter plugging
- Facilitates root cause analysis

FIELD TESTING



- Mechanics have been cutting filters for years
- When doing this, you may observe abnormal wear particles
- Now what?

WHAT FILTERS CAN BE TESTED?

YES

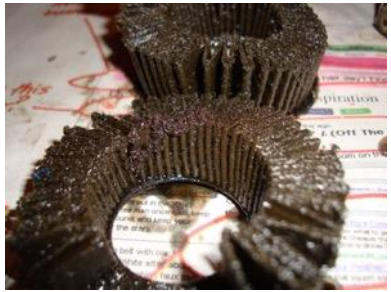
Spin-On Filter

Canister Filter

Up to 8” in diameter and 6-21 inches long

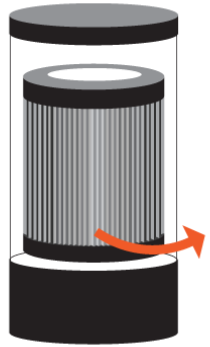
NO

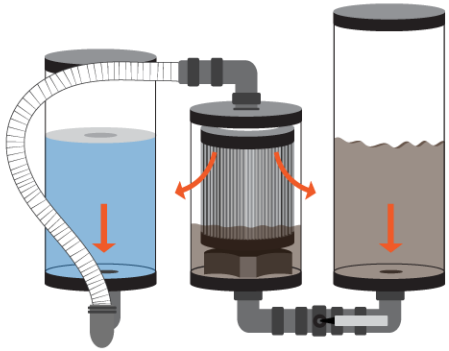
Filters that have been cut



HOW IS FDA PERFORMED?

1. Filter is received and prepared for flushing
2. Filter is installed in flushing apparatus & flushed w/solvent
3. Flushed solvent is collected and prepared for: acid digestion and microscope analysis
4. Spectral analysis is preformed on prepared fluid then microscopic analysis is performed
5. Report is generated with data analyst's observation and sent to the customer





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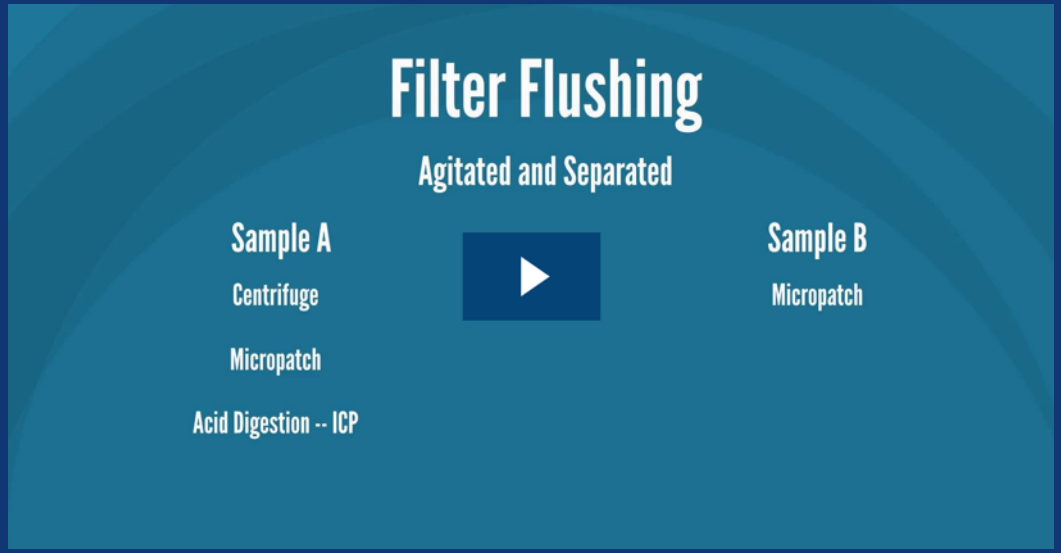

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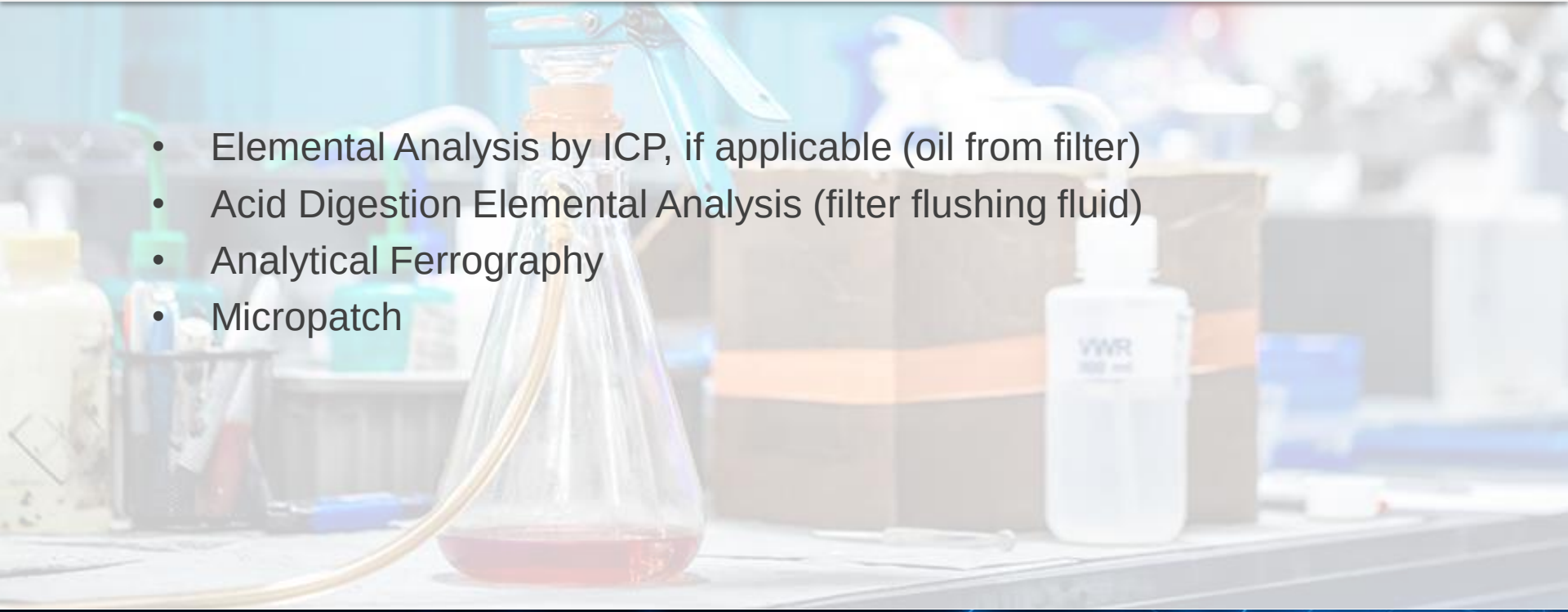
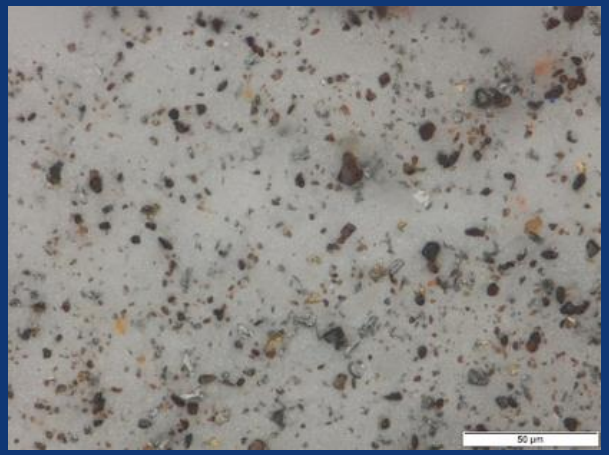
FDA TESTS PERFORMED



- Elemental Analysis by ICP, if applicable (oil from filter)
- Acid Digestion Elemental Analysis (filter flushing fluid)
- Analytical Ferrography
- Micropatch

FDA WEAR DEBRIS

ANALYTICAL FERROGRAPHY



MICROPATCH

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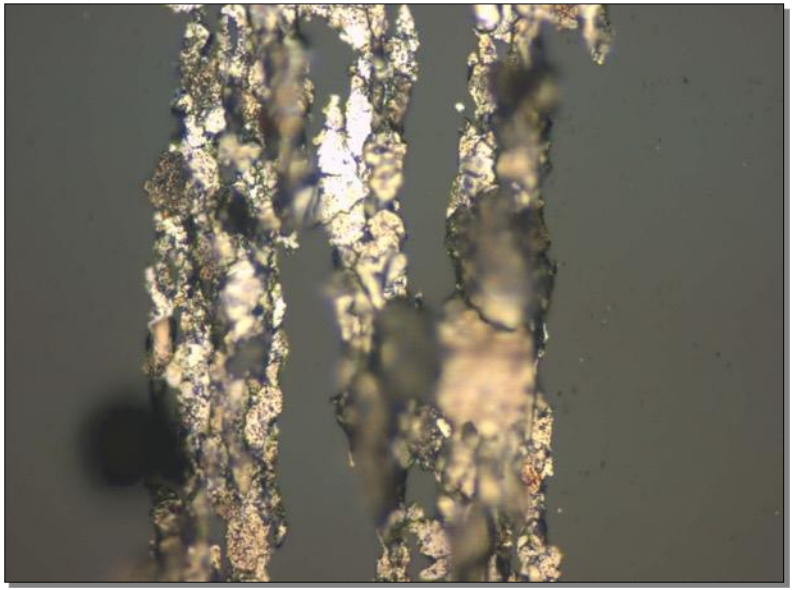
WHAT CAN FDA IDENTIFY THAT STANDARD TESTING CANNOT?

Analytical Ferrography

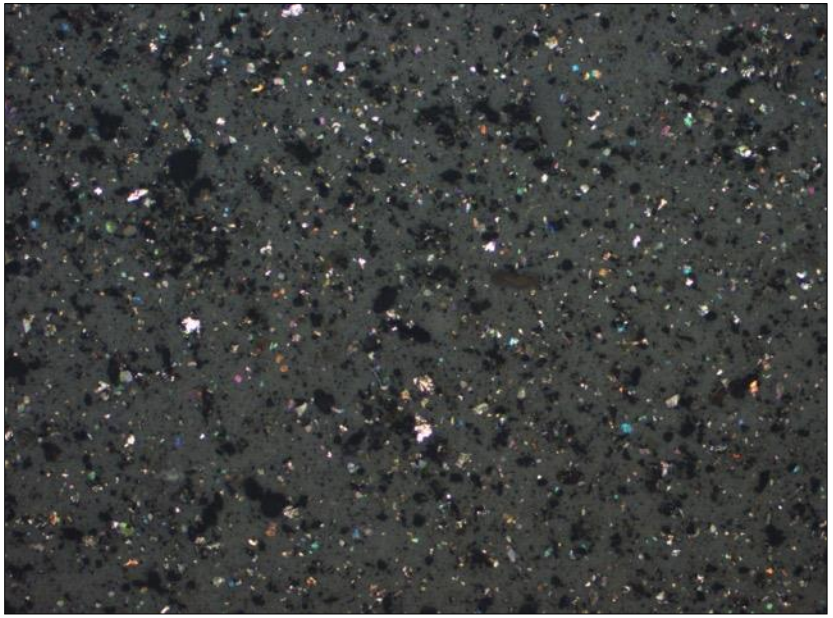
- Ferrous metals
- Type of wear
- How much
- How large
- Typically for boundary lubrication



WHAT CAN FDA IDENTIFY THAT STANDARD TESTING CANNOT?

Micropatch

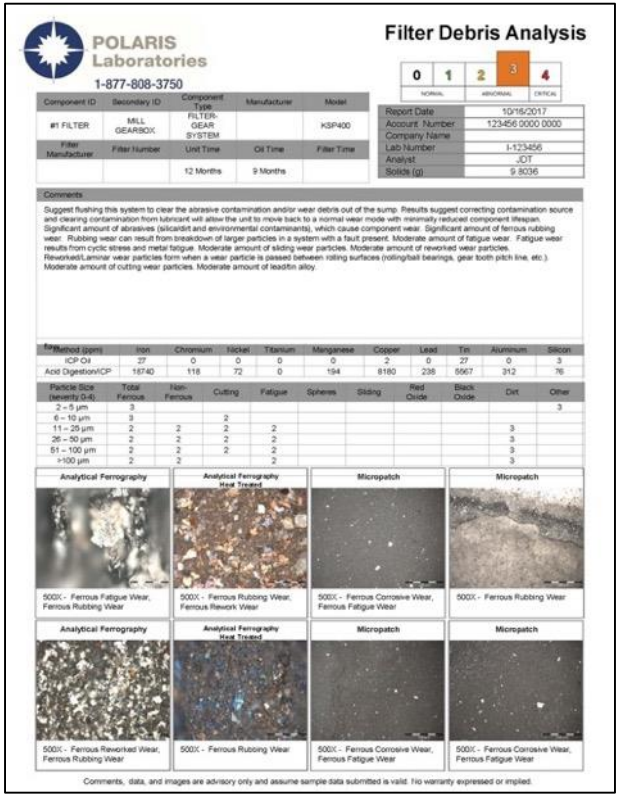
- Non-Ferrous metals
  - Bronze
  - Lead
- Soot agglomerations
- Metallic debris
- Dirt
- Black oxides
- Red (rust) oxides



OIL SAMPLING VS. FDA

Testing provides	Routine Oil Analysis	Filter Debris Analysis
Particle wear up to 10 micron	●	●
Particle wear greater than 10 micron		●
Provide information on type of wear		●
Maintenance recommendations	●	●
Lubricant additive information	●	
Detailed photographs of magnified wear particles		●
Detect and identify contamination outside of the standard / routine 24 element spectroscopy		●

INTERPRETING A REPORT



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1-877-808-3750

Filter Debris Analysis

0	1	2	3	4
NORMAL		ABNORMAL		CRITICAL

Component ID	Secondary ID	Component Type	Manufacturer	Model
#1 FILTER	MILL GEARBOX	FILTER-GEAR SYSTEM		KSP400

Filter Manufacturer	Filter Number	Unit Time	Oil Time	Filter Time
		12 Months	9 Months	

Report Date	10/16/2017
Account Number	123456 0000 0000
Company Name	
Lab Number	I-123456
Analyst	JDT
Solids (g)	9.8036

Comments

Suggest flushing this system to clear the abrasive contamination and/or wear debris out of the sump. Results suggest correcting contamination source and clearing contamination from lubricant will allow the unit to move back to a normal wear mode with minimally reduced component lifespan. Significant amount of abrasives (silica/dirt and environmental contaminants), which cause component wear. Significant amount of ferrous rubbing wear. Rubbing wear can result from breakdown of larger particles in a system with a fault present. Moderate amount of fatigue wear. Fatigue wear results from cyclic stress and metal fatigue. Moderate amount of sliding wear particles. Moderate amount of reworked wear particles. Reworked/Laminar wear particles form when a wear particle is passed between rolling surfaces (rolling/ball bearings, gear tooth pitch line, etc.). Moderate amount of cutting wear particles. Moderate amount of lead/tin alloy.

Method (ppm)	Iron	Chromium	Nickel	Titanium	Manganese	Copper	Lead	Tin	Aluminum	Silicon
ICP Oil	27	0	0	0	0	2	0	27	0	3
Acid Digestion/ICP	16740	118	72	0	194	8180	238	5567	312	76

Particle Size (severity 0-4)	Total Ferrous	Non-Ferrous	Cutting	Fatigue	Spheres	Sliding	Red Oxide	Black Oxide	Dirt	Other
2 – 5 µm	3									3
6 – 10 µm	3		2							
11 – 25 µm	2	2	2	2					3	
26 – 50 µm	2	2	2	2					3	
51 – 100 µm	2	2	2	2					3	
>100 µm	2	2		2					3	

Analytical Ferrography

500X - Ferrous Fatigue Wear, Ferrous Rubbing Wear

Analytical Ferrography Heat Treated

500X - Ferrous Rubbing Wear, Ferrous Rework Wear

Micropatch

500X - Ferrous Corrosive Wear, Ferrous Fatigue Wear

Micropatch

500X - Ferrous Rubbing Wear

Analytical Ferrography

500X - Ferrous Reworked Wear, Ferrous Rubbing Wear

Analytical Ferrography Heat Treated

500X - Ferrous Rubbing Wear

Micropatch

500X - Ferrous Corrosive Wear, Ferrous Fatigue Wear

Micropatch

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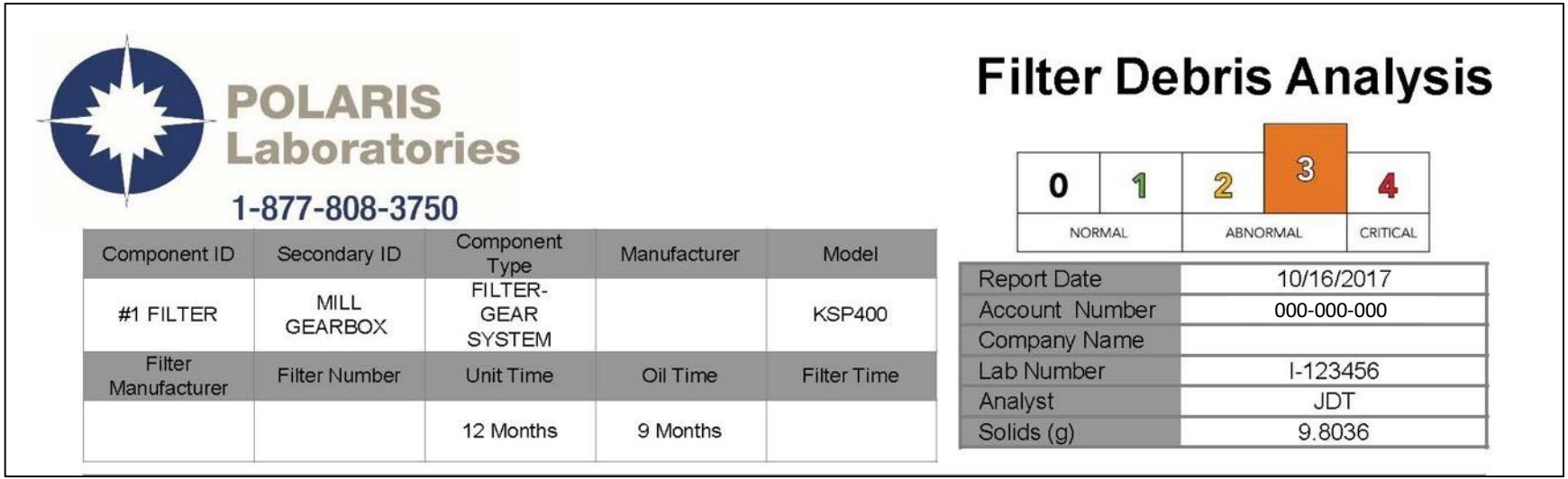
Comments, data, and images are advisory only and assume sample data submitted is valid. No warranty expressed or implied.

INTERPETING A REPORT



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Filter Manufacturer	Filter Number	Unit Time	Oil Time	Filter Time
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Filter Debris Analysis

0	1	2	3	4
NORMAL		ABNORMAL		CRITICAL

Report Date	10/16/2017
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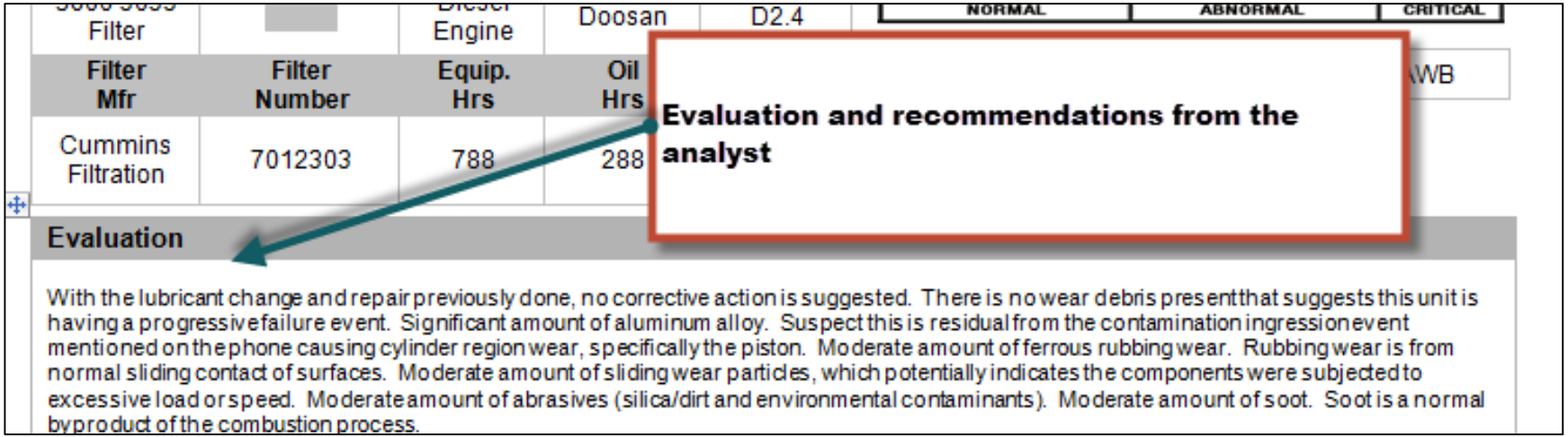

Filter		Diesel Engine	Doosan	D2.4	NORMAL	ABNORMAL	CRITICAL

Filter Mfr	Filter Number	Equip. Hrs	Oil Hrs	WB
Cummins Filtration	7012303	788	288	

Evaluation and recommendations from the analyst

Evaluation

With the lubricant change and repair previously done, no corrective action is suggested. There is no wear debris present that suggests this unit is having a progressive failure event. Significant amount of aluminum alloy. Suspect this is residual from the contamination ingression event mentioned on the phone causing cylinder region wear, specifically the piston. Moderate amount of ferrous rubbing wear. Rubbing wear is from normal sliding contact of surfaces. Moderate amount of sliding wear particles, which potentially indicates the components were subjected to excessive load or speed. Moderate amount of abrasives (silica/dirt and environmental contaminants). Moderate amount of soot. Soot is a normal by product of the combustion process.

INTERPETING A REPORT

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Method (ppm)	Iron	Chrome	Nickel	Titanium	Manganese	Copper	Lead	Tin	Aluminum	Silicon
ICP Oil	NES	NES	NES	NES	NES	NES	NES	NES	NES	NES
Acid Digestion / ICP	213910	900	2823	0	866	2163	0	0	4210	0

Particle Size	Ferrous	Non-Ferrous	Cutting	Fatigue	Spheres	Sliding	Red	Black	Dirt	Soot
2-5µm	2	2	0	0						2
5-10µm	2	3	0	0						2
11-25µm	1	3	0	0						2
25-50µm	0	1	0	0						2
51-100µm	0	0	0	0						0
>100µm	0	0	0	0						0

Elemental analysis of the oil from the filter if applicable

Elemental of the debris flushed from the filter after Acid Digestion

INTERPETING A REPORT

Evaluation

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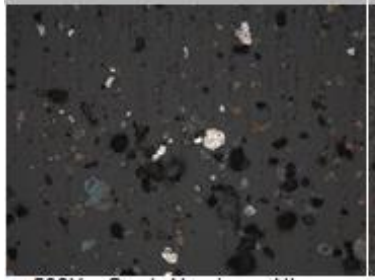
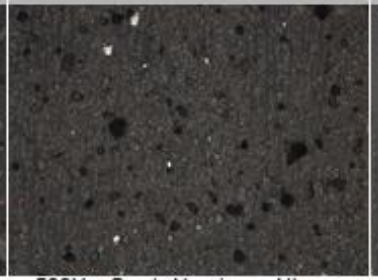
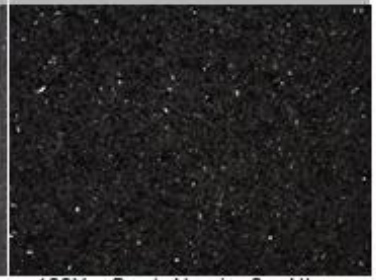
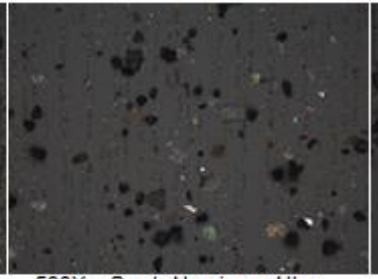
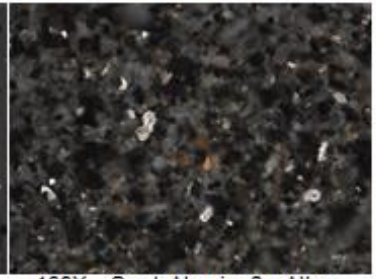
Microscope analysis of the debris flushed from the filter by Type and Wear Mechanism

Microscope analysis sizing of the debris flushed from the filter by severity

Method (ppm)	Iron	Chrome	Nickel	Titanium	Man					
ICP Oil	NES	NES	NES	NES	N					
Acid Digestion / ICP	213910	980	2823	0	866	2163	0	0	4210	0

Particle Size	Ferrous	Non-Ferrous	Cutting	Fatigue	Spheres	Sliding	Red Oxides	Black Oxides	Dirt	Soot
2-5µm	2	2	0	0	0	1	0	0	2	2
5-10µm	2	3	0	0	0	2	0	0	2	2
11-25µm	1	3	0	0	0	2	0	0	2	2
25-50µm	0	1	0	0	0	1	0	0	1	2
51-100µm	0	0	0	0	0	0	0	0	0	0
>100µm	0	0	0	0	0	0	0	0	0	0

DEBRIS: MICROSCOPE PHOTOS

Analytical Ferrography	Analytical Ferrography	Analytical Ferrography (Heat Treated)	Micropatch
			
500X – Soot, Aluminum Alloy, Abrasives, Ferrous Rubbing Wear	500X – Soot, Aluminum Alloy, Abrasives, Ferrous Rubbing Wear	500X – Abrasives & Ferrous Rubbing Wear	100X – Soot, Aluminu8m Alloy, Ferrous RubbingWear
			
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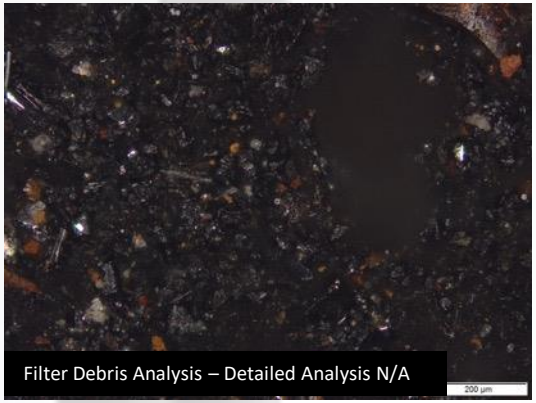
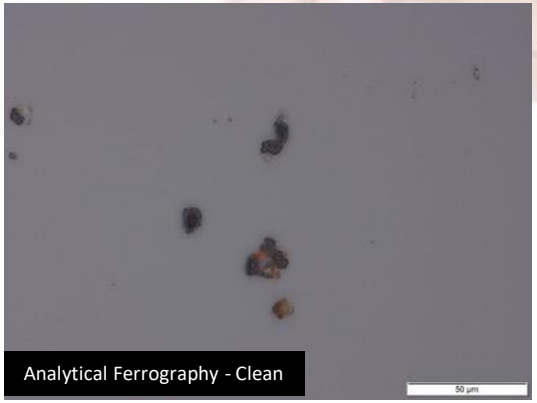
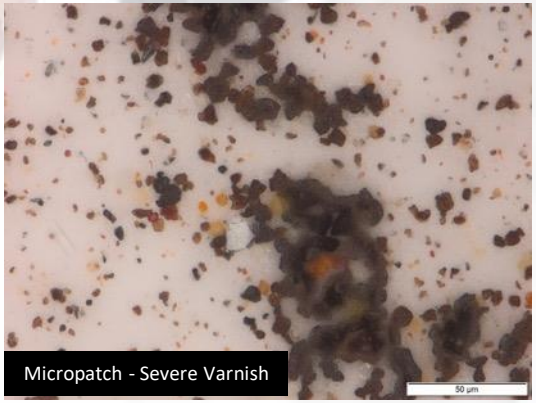
SUCCESS STORY

- ABC Company with large expensive gearbox(s) was experiencing failures
- FDA – Detailed Analysis Impossible; AF – Clean; Micropatch – Severe Varnish
- Company is flushing gearboxes and switching to an oil with better oxidative stability
- Gearbox(s) costs $250K apiece and the company has many of these gearbox(s)







QUESTIONS AND DISCUSSION

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