

FILTERCAKE ANALYSIS

CENTRIFUGAL OIL FILTRATION – SOS15

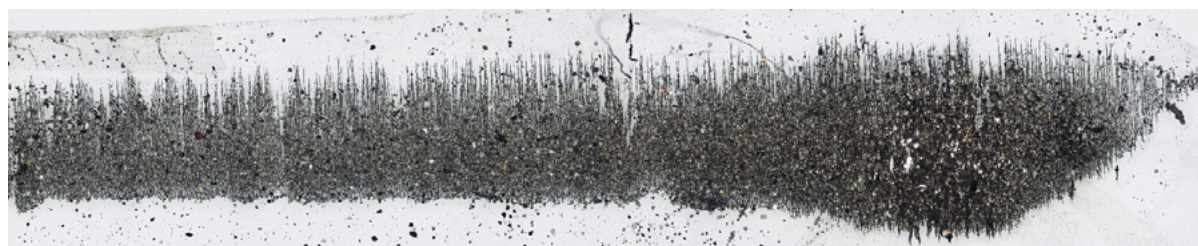


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Laboratory Services

Wear debris analysis is one of the key techniques to evaluate particulate matter contained within a fluid compartment. Standard oil analysis has a good track record of detecting early hour component distress, however the inclusion of centrifugal oil filtration (COF) systems on engines has proven in some instances to mask some of the wear debris through the enhanced filtration efficiency of these units. Hastings Deering Laboratory Services have developed an inhouse test suite to cater to this unique problem whereby the wear debris is extracted from the soot filter cake and analysed via ferrographic microscopy analysis to ascertain concentration, severity and composition of the wear particles. A health assessment is then performed and report constructed based upon the wear debris and available component history. This test method is best served by trend analysis of the debris with regular samples from an engine required to monitor the quantity & severity of wear overtime.

Analysis	Fluid Analysis	Ferrography
Wear debris	Limited	Yes
Dust ingress	Limited	Yes
PQ (ferrous content)	Limited	Yes
Viscosity	Yes	No
Additives	Yes	No
Oil condition	Yes	No
Fuel dilution	Yes	No
Coolant entry	Yes	No

Filtercake analysis together with standard oil analysis gives a complete picture of component condition.



Example of prepared ferrography slide before magnification under microscope



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CASE STUDY 1
CUMMINS QSK78 | SOS oil sample report for a QSK 78 Cummins engine.



Table with 4 columns: TRUCK ENGINE PRIMARY - DIESEL, UNIT INFORMATION (M/M: KOMATSU 960E, S/N, LOC), COMPONENT INFORMATION (Make: CUMMINS, Model: QSK78, S/N), and SHOP SEGMENT.

Condition Monitoring Centre Express Post Satchels can be recycled. Please return any unused satchels.

Table with 6 columns: A, NO ACTION REQUIRED, DATE (06/09/2021), LCN (16492226), and two empty cells. Includes viscosity and suggested action text.

Table with 6 columns: CURRENT SAMPLE (TOOK 5 DAYS TO REACH LAB), INTERPRETED BY, ANALYSED BY, and MAINTENANCE.

Table with 6 columns: A, NO ACTION REQUIRED, DATE (06/09/2021), LCN (16461935), and two empty cells. Includes viscosity and suggested action text.

Table with 6 columns: CURRENT SAMPLE (TOOK 3 DAYS TO REACH LAB), INTERPRETED BY, ANALYSED BY, and MAINTENANCE.

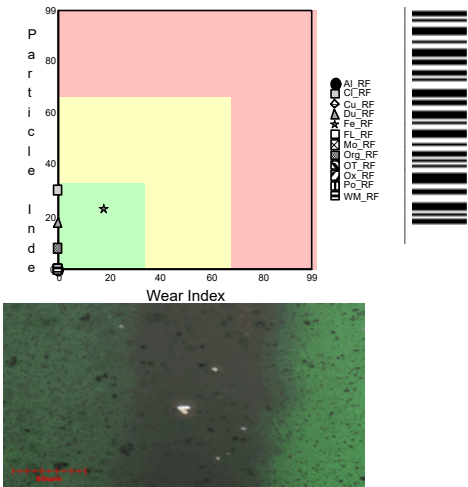


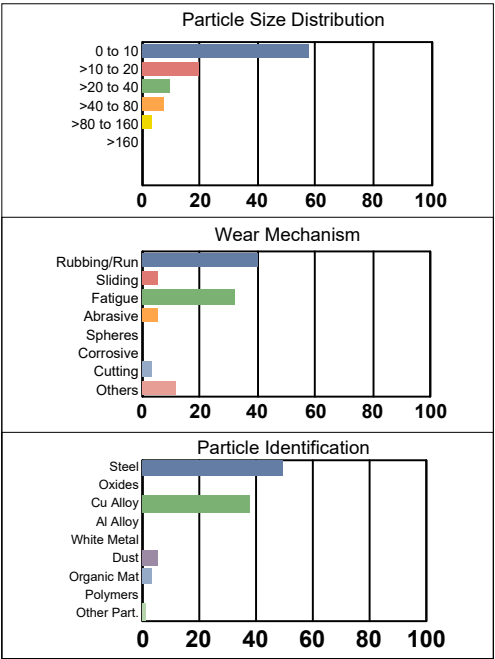
Table with 28 columns: IDENT, SAMPLE INFORMATION, FTIR ANALYSIS, and MISC. Contains multiple rows of test data.

Table with 28 columns: IDENT, FLUID CHARACTERISTICS, PHYSICAL TESTING, and PARTICLE ANALYSIS. Contains multiple rows of test data.

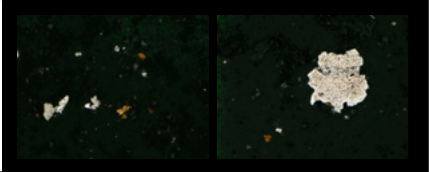
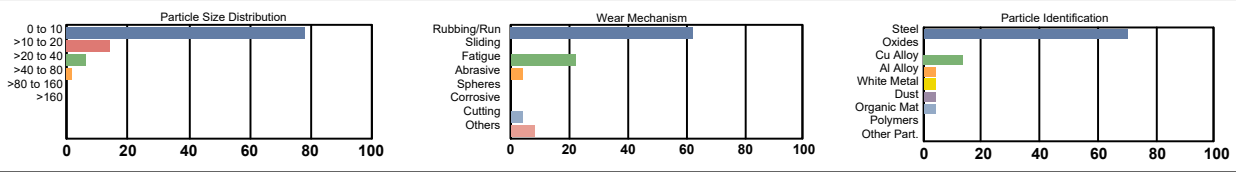
Note the oil sample above with a history of A samples and no indicators of trouble. However the wear debris images below show a different story, this engine was in advancing stages of distress however the material was being removed and deposited within the COF.

CASE STUDY 1
FILTERGRAM REPORT : QSK78 - COF

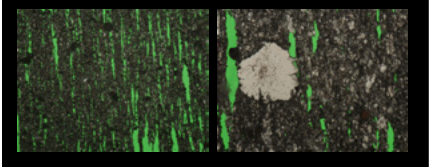
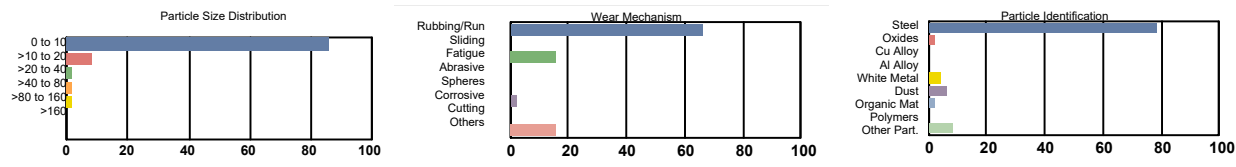
LCN 16074401 EVALUATION X



PREVIOUS # 1
LCN: 15597830
DATE SAMPLED: 09/01/2021
EVALUATION: B



PREVIOUS # 2
LCN: 15104714
DATE SAMPLED: 13/08/2020
EVALUATION: B



DISCLAIMER: This analysis should not be relied upon to predict mechanical wear, mechanical breakdown or maintenance planning, but should be used as an adjunct to your normal maintenance routine for the care of your machinery. All care will be taken in the processing of the oil sample/samples supplied by the user but no responsibility will be accepted for failure of any machinery or part or parts of machinery where oil samples have been taken for analysis by Scheduled Oil Sampling. The user remains responsible for proper maintenance and care of the subject machinery

CASE STUDY 2

CATERPILLAR 793C | Engine with COF. Std SOS3 oil report.

TRUCK ENGINE PRIMARY - DIESEL	UNIT INFORMATION										COMPONENT INFORMATION										SHOP SEGMENT									
	M/M : CATERPILLAR 793C										Make :																			
	S/N :										Model :																			
	LOC :										S/N :																			

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A	NO ACTION REQUIRED	DATE	04/06/2021	LCN	16133111
Viscosity is consistent with oil grade indicated. A low amount of non-metallic foreign material was observed. Wear levels below the 5 micron range appear acceptable. All other test results appear acceptable. Suggested action: Continue sampling at the recommended interval. Sample Notes:					

CURRENT SAMPLE	TOOK 7 DAYS TO REACH LAB	INTERPRETED BY	ANALYSED BY	MAINTENANCE
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B	CORRECTIVE ACTION MAY BE REQUIRED	DATE	01/06/2021	LCN	16101112
Viscosity is consistent with oil type indicated. Lead is slightly high. Other wear levels in the 5 micron range appear ok. All other test results appear acceptable. Suggested Action: Inspect the used oil filters for abnormal debris. Continue sampling at the recommended interval. Sample Notes:					

CURRENT SAMPLE	TOOK 2 DAYS TO REACH LAB	INTERPRETED BY	ANALYSED BY	MAINTENANCE
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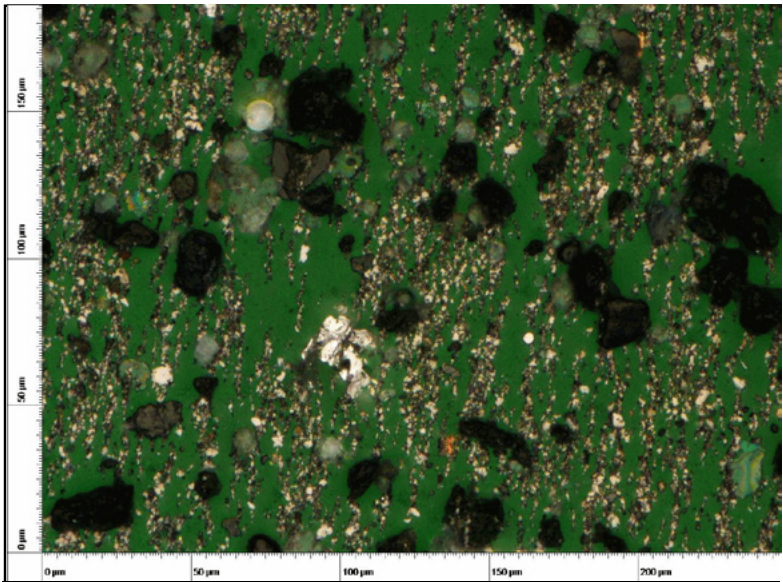
IDENT		SAMPLE INFORMATION							SAMPLE INFORMATION													FTIR ANALYSIS				MISC						
SMU	E	CMU	FMU	C	SAMPLE DATE	LAB DATE	LCN	OIL ADD	Cu Copper	Fe Iron	Cr Chromium	Pb Lead	Al Aluminium	Si Silicon	Sn Tin	N Nickel	Mn Magnesium	V Vanadium	Ti Titanium	Ag Silver	Sb Antimony	S Sulfur	UST Scot	UOXI Oxidation	UNIT Nitration	USUL Sulfation	TAN Acid #	TBN Base #	COL Colour	RULER Life %	MPC Membrane Patch Colourimetry	RPVOT Pressure Vessel Oxidation
86979	A	86,979	65	Y	040621	110621	16133111		<1	1	<1	<1	<1	1	<1	<1	<1	<1	<1	<1	<1	4370	<1	8	5	14						
86914	B	86,914	209	Y	010621	030621	16101112		4	3	<1	3	<1	2	<1	<1	<1	<1	<1	<1	1	3794	2	10	7	18						
86914	B	86,914	209	Y	010621	030621	16100915		4	3	<1	3	<1	2	<1	<1	<1	<1	<1	<1	<1	3973	2	10	8	21						
86705	B	86,705	282	Y	200521	240521	16062204		9	4	<1	4	<1	2	<1	<1	<1	<1	<1	<1	<1	4077	3	11	8	21						
86423	B	86,423	224	Y	060521	120521	16018909		6	4	<1	4	<1	2	<1	<1	<1	<1	<1	<1	<1		3	11	8	19						
86199	A	86,199	344	Y	240421	300421	15979703		5	4	<1	3	<1	3	<1	<1	<1	<1	<1	<1	<1	3397	6	11	8	20						

IDENT		FLUID CHARACTERISTICS												PHYSICAL TESTING										PARTICLE ANALYSIS									
SMU	E	OIL BRAND			OIL GRADE	Ca Calcium	Mg Magnesium	Zn Zinc	P Phosphorus	Mo Molybdenum	B Boron	Ba Barium	Cd Cadmium	V40 Vis. 40C	V100 Vis. 100C	F Fuel %	Na Sodium	K Potassium	WAT Water	WKF Water PPM	OH Hydroxyl	Li Lithium	PQ PQ Index	DEP Deposits	GLYC Glycol	PC4 > 4 µm	PC6 > 6 µm	PC14 > 14 µm	PC38 > 38 µm	PC50 > 50 µm	ISO Zinc	ISO 4407	AN Acid Number
86979	A	TOTAL RUBIA WORKS 40			15W40	2304	6	993	888	<1	<1	<1	<1	109	14.2	<2.0	2	1	<0.1			<1	2	L-FB									
86914	B	TOTAL RUBIA WORKS 40			15W40	2267	5	970	832	<1	<1	<1	<1	107	14.0	<2.0	2	1	<0.1			<1	<1	N-B									
86914	B	TOTAL RUBIA WORKS 40			15W40	2331	5	990	858	<1	<1	<1	<1	108	13.9	<2.0	2	1	<0.1			<1	<1	N-B									
86705	B	TOTAL RUBIA WORKS 40			15W40	2224	6	989	849	<1	<1	<1	<1	106	14.1	<2.0	2	1	<0.1			<1	1	N-B									
86423	B	TOTAL RUBIA WORKS 40			15W40	2299	6	976	850	<1	<1	<1	<1	109	14.2	<2.0	2	1	<0.1			<1	<1	N-B									
86199	A	TOTAL RUBIA WORKS 40			15W40	2206	6	982	820	<1	<1	<1	<1	109	14.0	<2.0	2	1	<0.1			<1	2	L-FB									

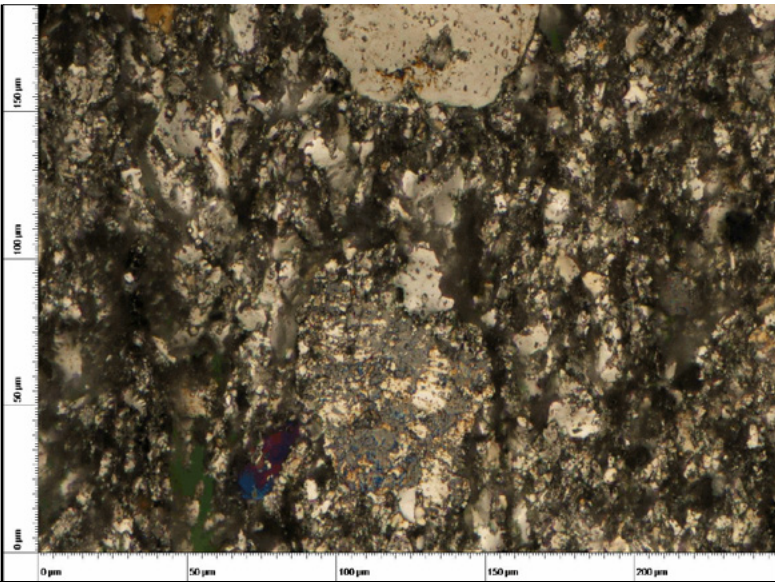
The oil samples show some traces of lead present however not at levels typical of concern. The wear debris within the COF however was showing a significant uptick in copper wear. The end result was a failing auxiliary drive owing to it thrusting towards the timing gear thrust washers.

CASE STUDY 2
FILTERGRAM REPORT : 793C - COF

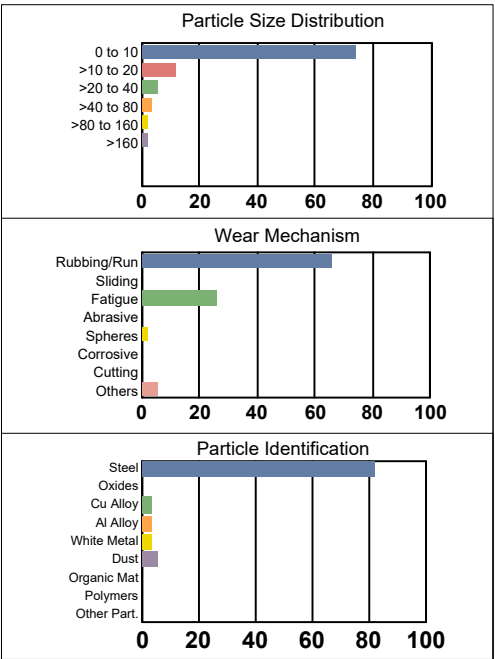
LCN 16478034 EVALUATION C



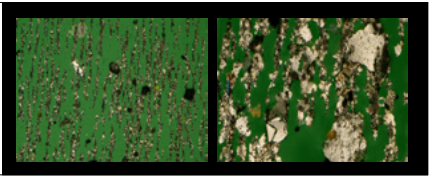
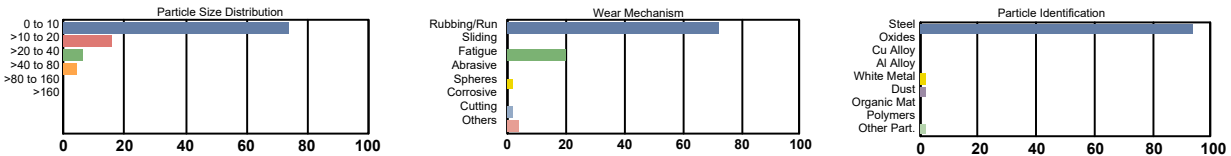
Ferrous rubbing fatigue. Copper and bearing related material. Agglomerated combustion by-products (soot)



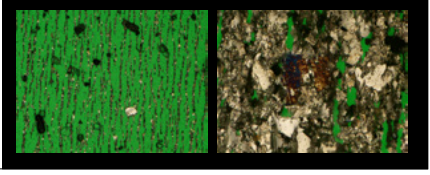
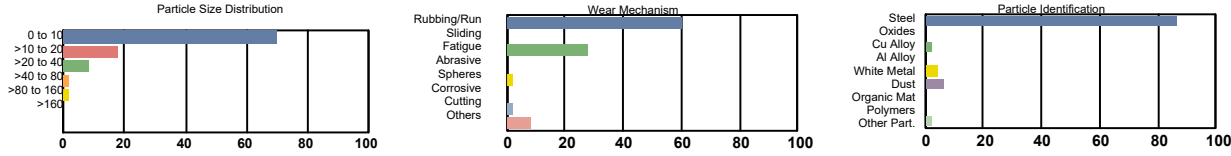
Extremely large ferrous fatigue and heat-affected bearing material



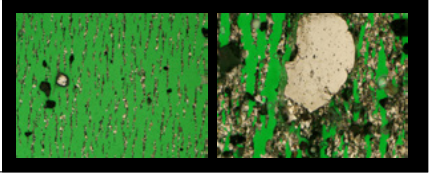
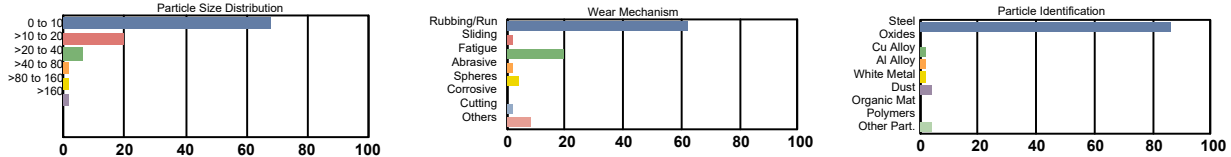
PREVIOUS # 1
LCN: 16478024
DATE SAMPLED: 16/09/2021
EVALUATION: B



PREVIOUS # 2
LCN: 16478023
DATE SAMPLED: 16/09/2021
EVALUATION: B



PREVIOUS # 3
LCN: 16478022
DATE SAMPLED: 16/09/2021
EVALUATION: B



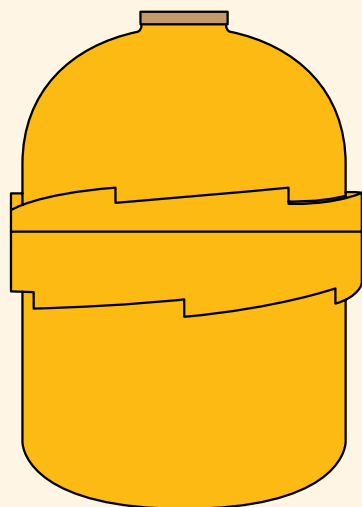
DISCLAIMER: This analysis should not be relied upon to predict mechanical wear, mechanical breakdown or maintenance planning, but should be used as an adjunct to your normal maintenance routine for the care of your machinery. All care will be taken in the processing of the oil sample/samples supplied by the user but no responsibility will be accepted for failure of any machinery or part or parts of machinery where oil samples have been taken for analysis by Scheduled Oil Sampling. The user remains responsible for proper maintenance and care of the subject machinery

SOS15 FILTERCAKE ANALYSIS

CENTRIFUGAL OIL FILTRATION (COF) NON-CAT ROTOR SAMPLING INSTRUCTION



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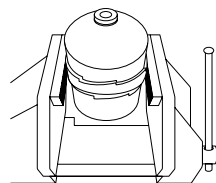
The following are specific tools and equipment required to complete the task:

- 1 x Drain trolley
- 1 x Workshop vice
- 1 x 51mm hole saw bit and drill
- 1 x Reciprocating saw with medium/fine coarse blade
- 1 x Hammer
- 1 x Small flat blade prybar
- 1 x Spatula

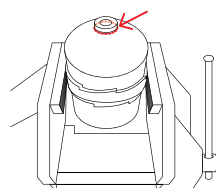
Specific PPE required for the task:

- Hearing protection when using tools to cut.
- Gloves and safety glasses to be worn at all times.

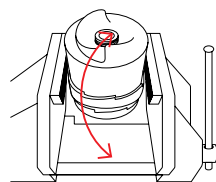
INSTRUCTIONS



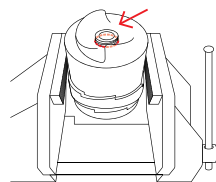
1. Place COF on an oil drain bench/trolley allowing surplus residual oil to drain out for 30 mins. Place COF in upright position in vice and secure as shown. Wipe down COF to ensure the hole saw does not slip on the COF shell.



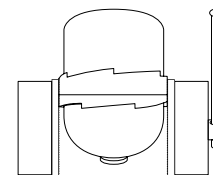
2. Using a 51mm hole saw, cut the COF shell approximately to 15mm depth around the top bushing.



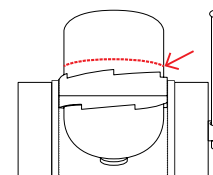
3. Remove COF from vice and rotate COF upside down and secure in vice.



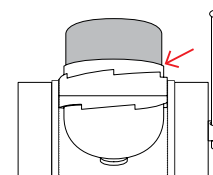
4. Wipe down COF to ensure the hole saw does not slip on the COF shell and using a 51mm hole saw, drill approximately 5-10mm.



5. Remove COF from vice and place horizontally and secure in vice as shown; wipe down COF to ensure the reciprocating saw does not slip on the COF shell.



6. Using reciprocating saw cut around the entire circumference of the COF to a depth of 5mm.



7. Using a hammer and small flat blade prybar, tap around the cut and separate the two halves exposing the filtercake.

8. Using a clean spatula, carefully extract the filtercake segments keeping as whole segments if possible. Do not use a scraper or any instruments that will introduce contaminants into the filter cake. Place extracted filtercake into supplied SOS15 bag.

9. Create sample label and place filtercake sample into SOS15 box and seal in prepaid mailing satchel.



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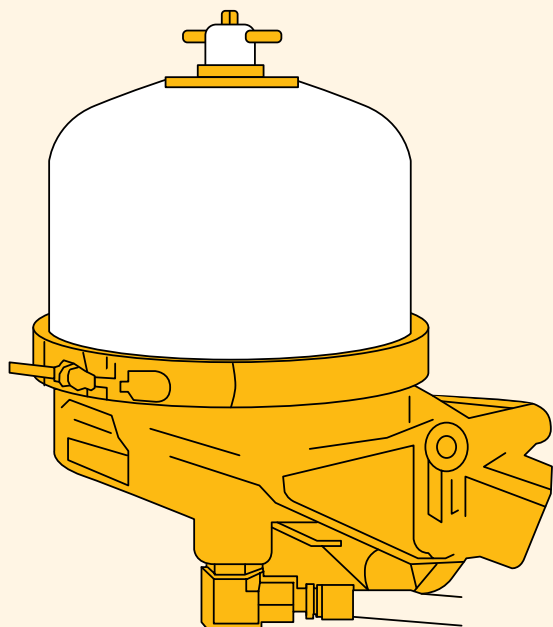
SOS15 FILTERCAKE ANALYSIS

CENTRIFUGAL OIL FILTRATION (COF) CAT® ROTOR SAMPLING INSTRUCTION



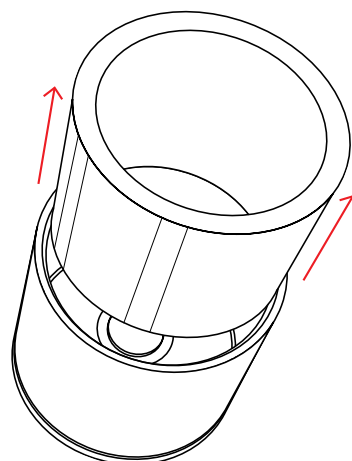
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INSTRUCTIONS

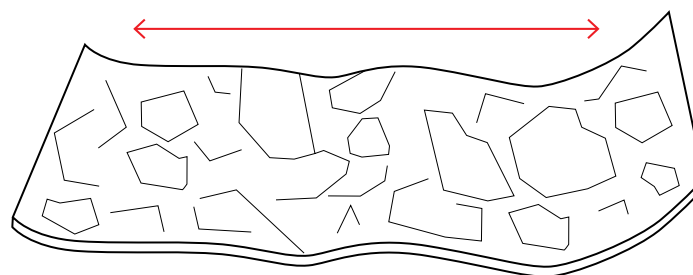


Specific PPE required for the task:

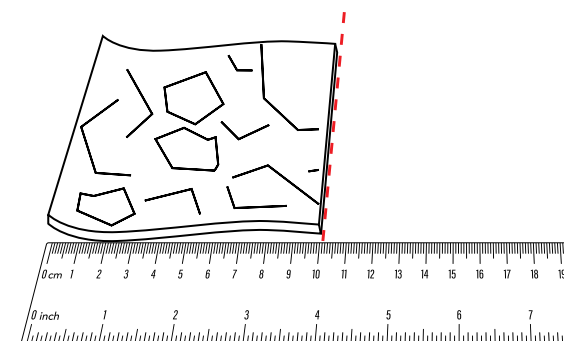
Gloves and safety glasses to be worn at all times.



1. Remove used COF filter paper from unit per Caterpillar Operation and Maintenance Manual instructions.



2. On a clean bench, cut vertically down to open up the filter.



3. Measure horizontally 10cm along the cake and make an additional vertical cut.
4. Insert the 10cm by 10cm COF segment into the sample bag provided ensuring it remains in one piece.
5. Place the sample bag containing the filter, flat in the bottom of the SOS15 box.
6. Ensure all relevant information is included on sample label and placed in the SOS15 box.
7. Seal box and place into mail satchel.



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