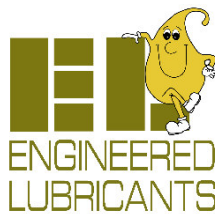
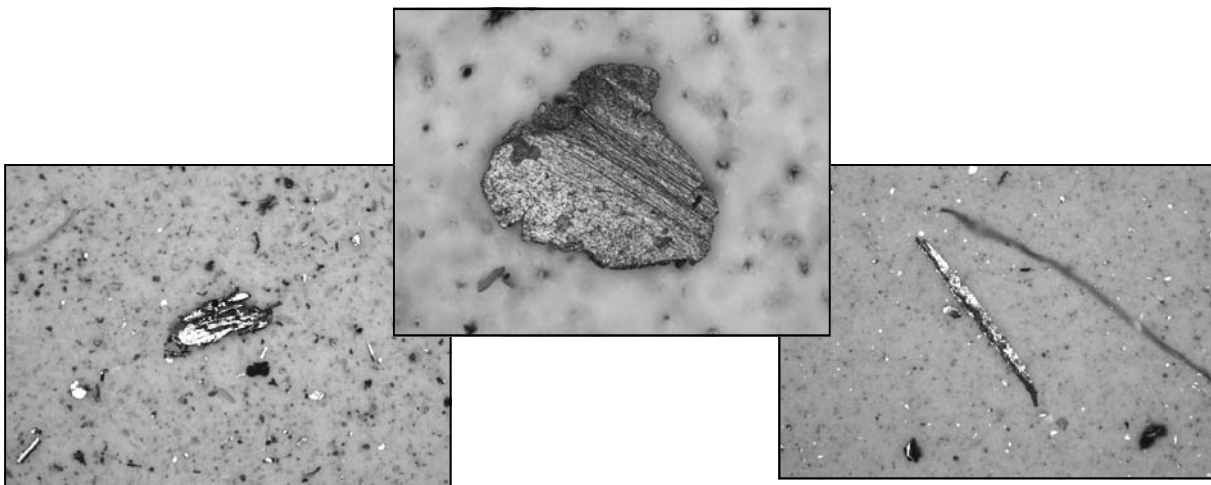
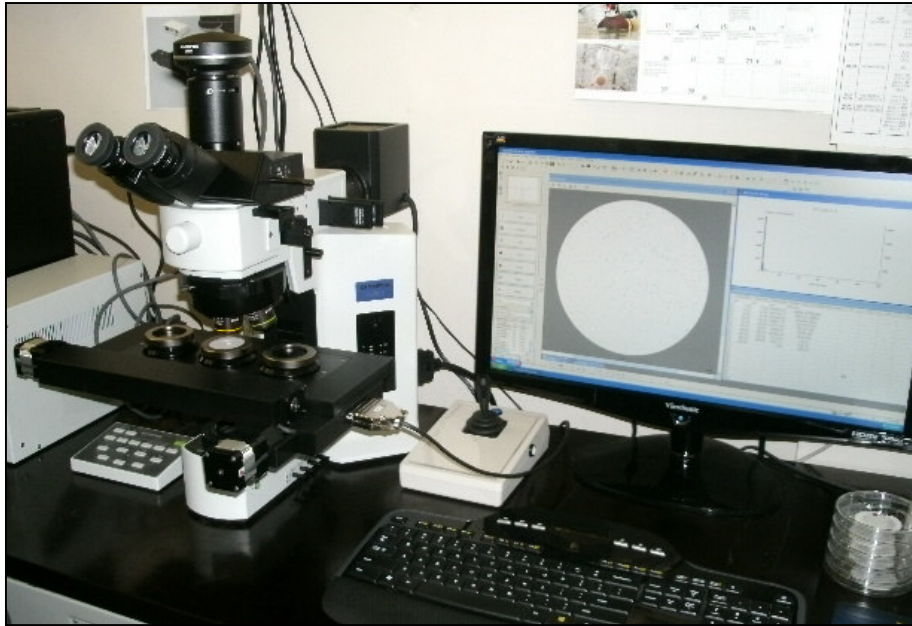


Particle Counting and Analysis by Optical Microscope



Engineered Lubricants Company * 11525 Rock Island Court * Maryland Heights, MO 63043
www.englube.com * phone: 314-872-9540 * fax: 314-872-9544



Particle Counting and Analysis
by Optical Microscope
Documentation of the Filter Inspection

1102-00230

3/7/2011

Customer: COMPANY ABC
Lab Number: 1102-00230
Sample ID: USED LUBRICANT

Filter Size (um): 0.8
Sample Volume (ml): 10.0
Debris Weight (mg): 0.58
Method: ISO 4406-99
Rinse Fluid: filtered hexane
Lot Number: 110212A
Scanned area (mm²): 972.2
Flow-through area (mm²): 960.0

Comments: THIS IS AN EXAMPLE REPORT

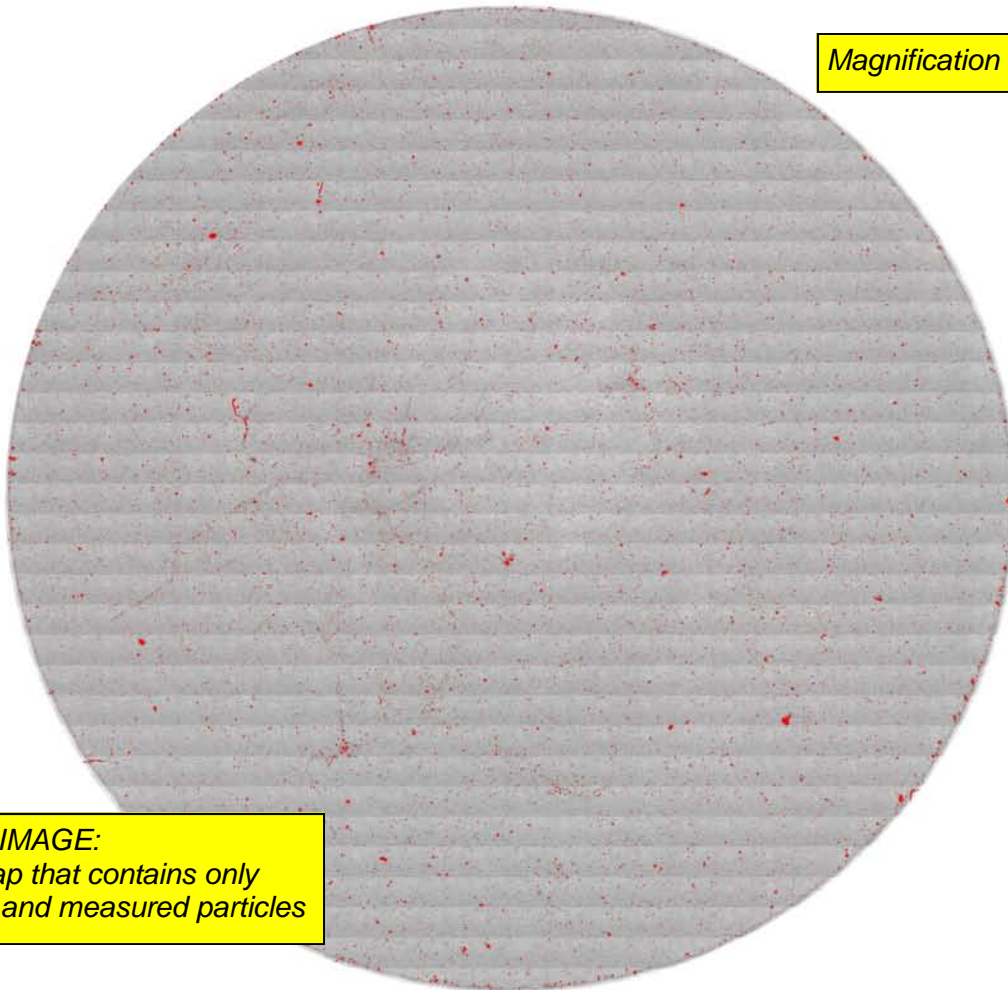
ISO 4406-99 - code

21/20/18

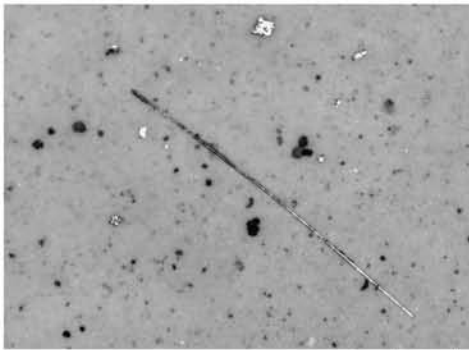
Cleanliness Code per International Standard

10.00 x

Magnification used for analysis



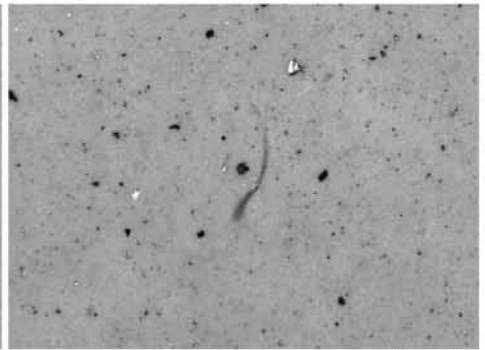
OVERVIEW IMAGE:
Graphical map that contains only
the detected and measured particles



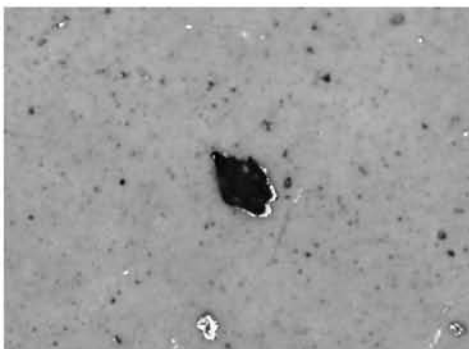
200 μm



200 μm



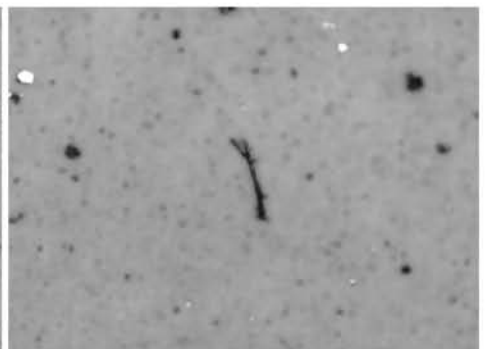
200 μm



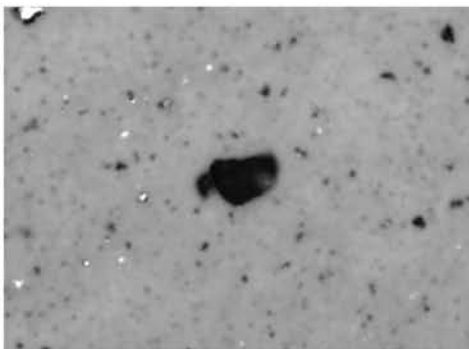
200 μm



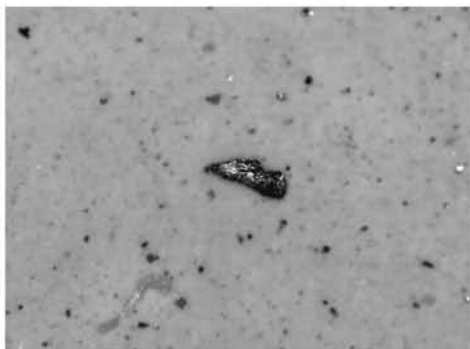
200 μm



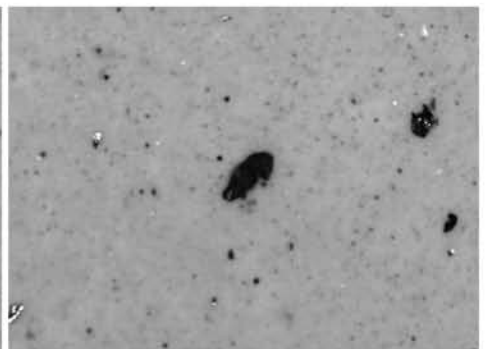
200 μm



200 μm



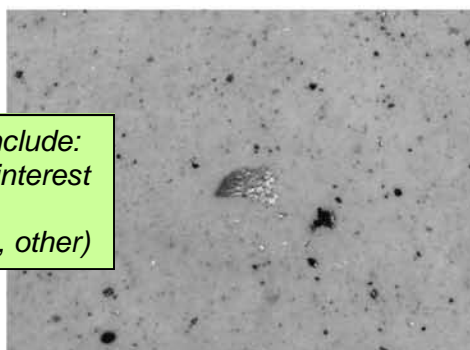
200 μm



200 μm

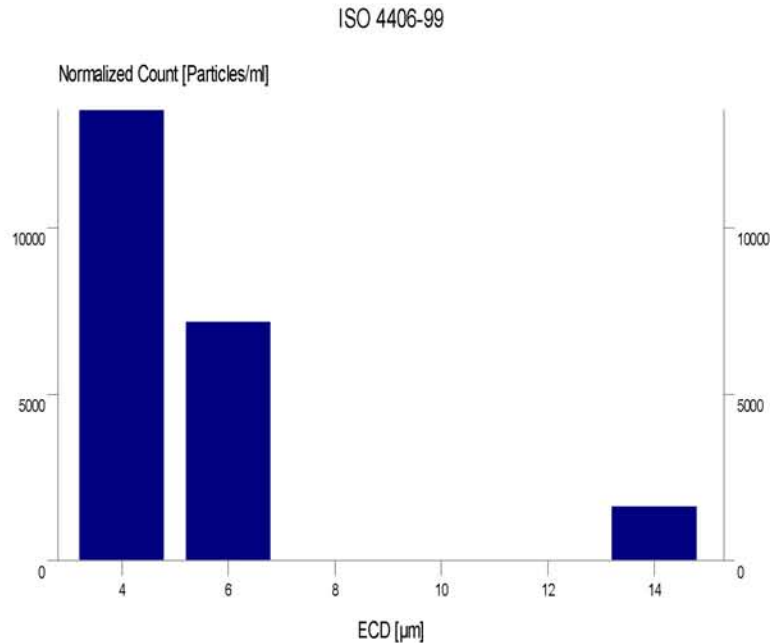
Biggest Particles

- This page may be customized to include:*
- as many or as few particles of interest*
 - any particle type of interest (smallest, largest, metallic only, other)*



200 μm

Graphical Visualisation of the Cleanliness Code - ALL PARTICLES



Particle Size Classes

ALL PARTICLES

ISO 4406-99					
	ECD	Class Area	Particle Count	Normalized Count	ISO 4406-99 code
	µm	µm ²	Particles	Particles/ml	
1	4.00	14611305.86	135411.00	13541.10	21
2	6.00	13435305.85	71733.00	7173.30	20
3	14.00	10071615.31	16432.00	1643.20	18

ECD (EQUIVALENT CIRCLE DIAMETER):
diameter of a circle which has the same
area as the particle



PARTICLE COUNT:
total number of particles on
the filter membrane in each
size range

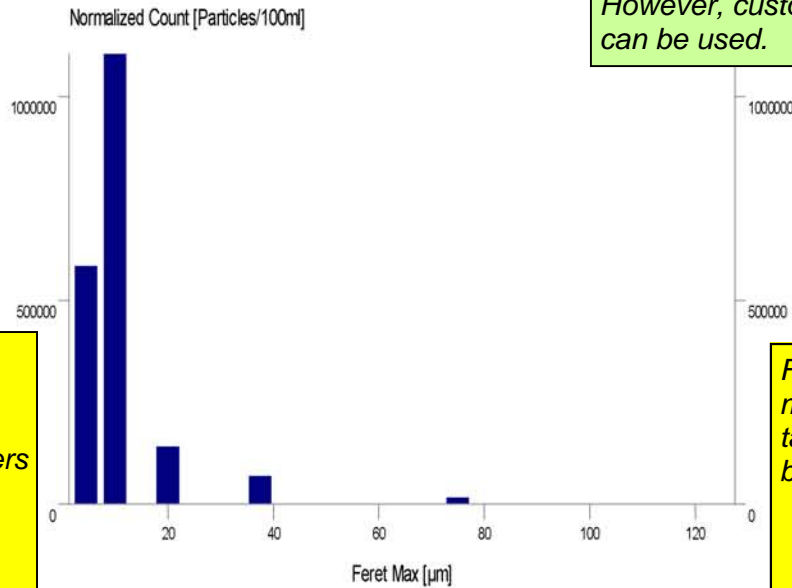
NORMALIZED COUNT:
Number of particles in a
standardized volume; used for
comparing samples that require
different volumes for preparing
a usable filter membrane

Frequently reported as
Particles/100ml or Particles/ml

Graphical Visualisation of the Cleanliness Code - ALL PARTICLES

ISO 4407-2002

Some standards require specific
PARTICLE SIZE CLASSES.
However, customized class ranges
can be used.



FERET MAX:
maximum distance of
parallel tangents at
opposing particle borders

FERET MIN
minimum distance of parallel
tangents at opposing particle
borders

Particle Size Classes

ALL PARTICLES

ISO 4407-2002_H4					
	Feret Max	Feret Max	Class Area	Particle Count	Normalized Count
	µm	µm	µm ²	Particles	Particles/100ml
1	4.00	5.00	557517.91	58462.00	584620.00
2	5.00	15.00	3722883.75	110547.00	1105470.00
3	15.00	25.00	2447920.37	14220.00	142200.00
4	25.00	50.00	3769201.21	6947.00	69470.00
5	50.00	100.00	3129449.69	1711.00	17110.00
6	100.00		1499484.54	238.00	2380.00

Particle Results		Parameters of the Biggest Particles			
	Feret Max	Feret Min	Area	Particle class	
	µm	µm	µm ²	A - reflective B - fiber	
1	838.27	53.14	11619.59		
2	558.08	129.61	18928.14	B	
3	283.90	44.54	3019.74	B	
4	276.61	172.81	30346.62	A	
5	273.89	59.20	8683.47	B	
6	273.42	54.76	6952.91	B	
7	271.41	168.10	33841.60		
8	266.65	112.48	21997.62	A	
9	224.49	117.62	16836.65		
10	218.53	115.00	14808.68	A	



ENGINEERED
LUBRICANTS

LABORATORY ANALYSIS

Company
Address

Department

Product
Equipment SEE SAMPLE ID BELOW
Equipment No...:
Make
Model
System
Filtration
XEM:

Test Number	New	425
Lab Number	(Typical)	1102-00230
Date of Sample		02/03/11
Oil Addition		UNK
Last Drain Date		UNK
Months on Sample		
Last Filter Service		UNK

COMMENTS

VISCOSITY @ 100F or 40C (ASTM D-445)

SSU Vis. @ 100F	251.2
cSt Vis. @ 40C	48.64

% WATER - KARL FISCHER (ASTM D4377)

% Water (KF)	0.019
ppm Water (KF)	190

TOTAL ACID NUMBER (NEUT. NO.)(ASTM D974)

TAN, mg KOH/gm	1.92
----------------	------

PARTICLE COUNT (PER 100 ML) NAS CLASSIFICATION & ISO CODE

ISO Code	24/22/17
4-5 Micron	4,990,770
5-15 Micron	3,776,900
Class	>12
15-25 Micron	88,500
Class	11
25-50 Micron	20,870
Class	12
50-100 Micron	3,630
Class	12
>100 Micron	300
Class	11

These laboratory test results are intended to be helpful and informative. They are based on our best experience, current industry testing procedures, and information provided with the sample, which we believe to be reliable. We cannot assume responsibility for any loss or accident that may result from use of the information given.

LABORATORY ANALYSIS

Company
Address

Department

Product
Equipment SEE SAMPLE ID BELOW
Equipment No...
Make
Model
System
Filtration **XEM:**

Test Number	New	425
Lab Number	(Typical)	1102-00230
Date of Sample		02/03/11
Oil Addition		UNK
Last Drain Date		UNK
Months on Sample		
Last Filter Service		UNK

COMMENTS

ICP - OILS (REPORTED IN PARTS PER MILLION)

Aluminum (Al)	<1
Antimony (Sb)	<1
Cadmium (Cd)	<1
Chromium (Cr)	<1
Cobalt (Co)	<1
Copper (Cu)	<1
Iron (Fe)	<1
Lead (Pb)	<1
Manganese (Mn)	<1
Molybdenum(Mo)	<1
Nickel (Ni)	<1
Silver (Ag)	<1
Tin (Sn)	287
Titanium (Ti)	<1
Vanadium (V)	<1
Barium (Ba)	<1
Boron (B)	<1
Calcium (Ca)	<1
Magnesium (Mg)	<1
Phosphorus(P)	105
Silicon (Si)	<1
Zinc (Zn)	<1

ENERGY DISPERSIVE X-RAY FLUORESCENCE SCAN

Scan Number 110216AA*
 Test#425 - *XRF ON 0.8 MICRON FILTER

These laboratory test results are intended to be helpful and informative. They are based on our best experience, current industry testing procedures, and information provided with the sample, which we believe to be reliable. We cannot assume responsibility for any loss or accident that may result from use of the information given.

LABORATORY ANALYSIS

Company: ()
Address: | ()
 | ()
Department:

Product:
Equipment: SEE SAMPLE ID BELOW
Equipment No...
Make:
Model:
System:
Filtration: **XEM:**

Test Number	New	425
Lab Number	(Typical)	1102-00230
Date of Sample		02/03/11
Oil Addition		UNK
Last Drain Date		UNK
Months on Sample		
Last Filter Service		UNK

COMMENTS

ENERGY DISPERSIVE XRF - PPM (*BELOW MINIMUM DETECTION LIMIT)

Aluminum (Al)	*
Antimony (Sb)	*
Cadmium (Cd)	*
Chromium (Cr)	*
Cobalt (Co)	*
Copper (Cu)	*
Iron (Fe)	*
Lead (Pb)	*
Manganese (Mn)	*
Molybdenum(Mo)	*
Nickel (Ni)	*
Potassium (K)	*
Tin (Sn)	*
Titanium (Ti)	*
Vanadium (V)	*
Barium (Ba)	*
Calcium (Ca)	*
Magnesium (Mg)	*
Phosphorus(P)	*
Silicon (Si)	*
Zinc (Zn)	*
Chlorine (Cl)	*
Sulfur (S)	*

These laboratory test results are intended to be helpful and informative. They are based on our best experience, current industry testing procedures, and information provided with the sample, which we believe to be reliable. We cannot assume responsibility for any loss or accident that may result from use of the information given.



Cleanliness Analysis

Documentation of the Filter Inspection

1010-01093

3/3/2011

Customer: COMPANY XYZ

Lab Number: 1010-01093

Sample ID: USED OIL

Filter Size (um): 60um nylon net

Sample Volume (ml): 750 (total sample)

Debris Weight (mg): 2.53

Method: ISO 16232

Rinse Fluid: filtered hexane

Lot Number: 110212A

Comments: total sample volume plus container rinse

Scanned area (mm²): 1006.2

Flow-through area (mm²): 960.0

ISO 16232-10 (n)_100 - code F274/G229/H274/I32/J17/K3

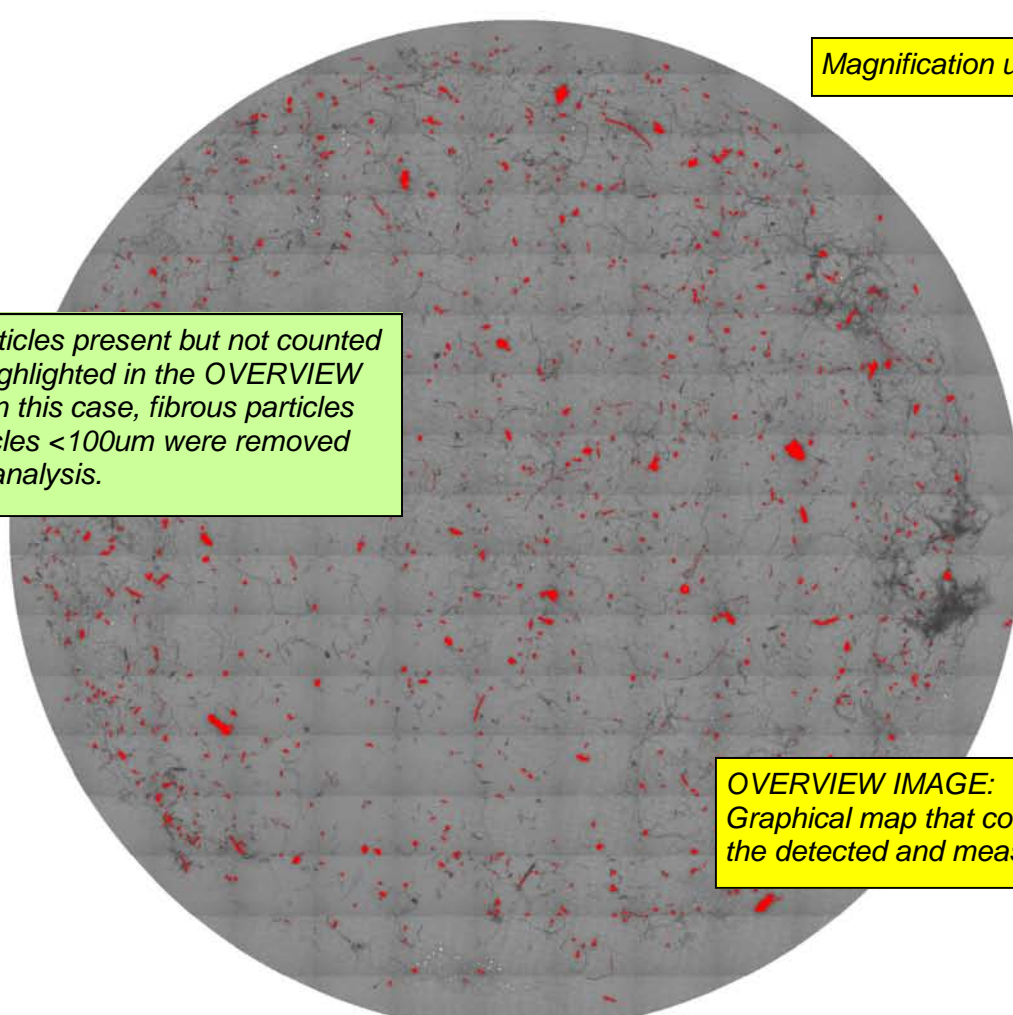
Cleanliness Code per International Standard

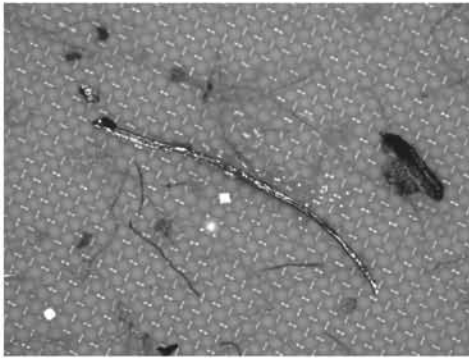
5.00 x

Magnification used for analysis

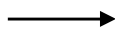
Note: Particles present but not counted are not highlighted in the OVERVIEW IMAGE. In this case, fibrous particles and particles <100um were removed from the analysis.

OVERVIEW IMAGE:
Graphical map that contains only the detected and measured particles

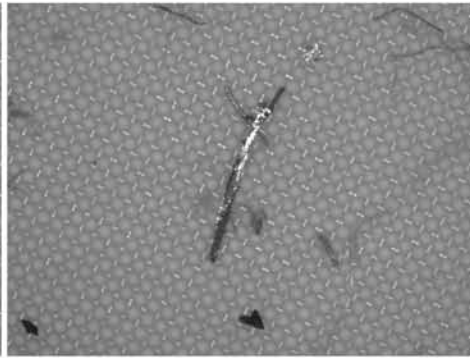




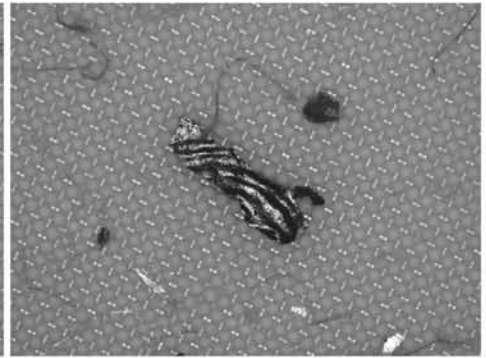
Scale Bar



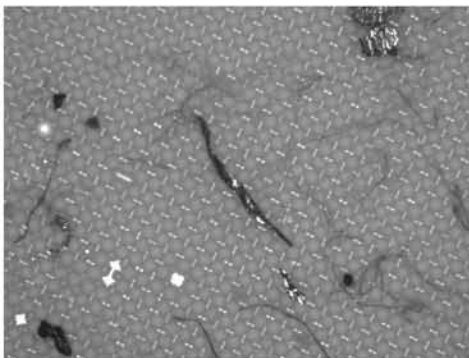
500 μm



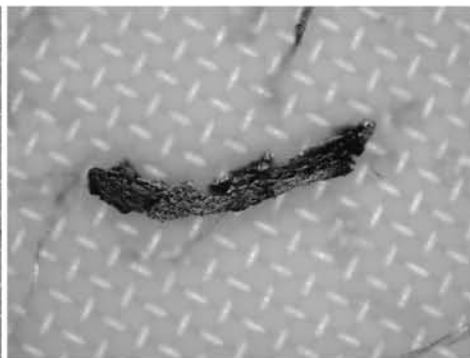
500 μm



500 μm



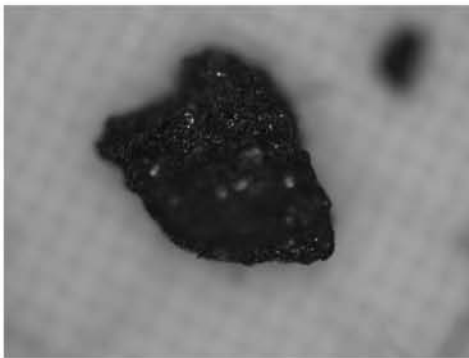
500 μm



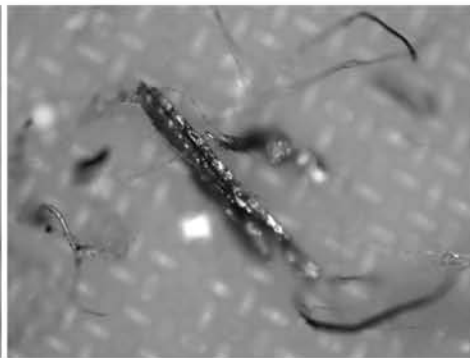
200 μm



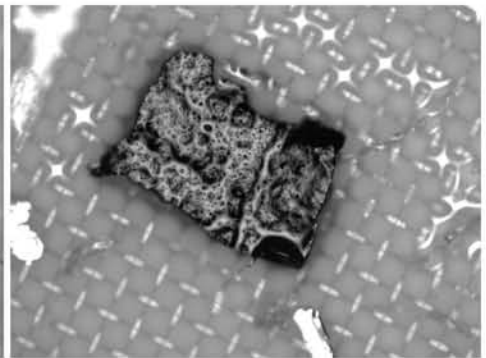
200 μm



200 μm



200 μm



200 μm

Biggest Particles



200 μm

Note: Pay attention to the Scale Bar under each photo. Images may be taken at magnifications other than that used during the analysis.



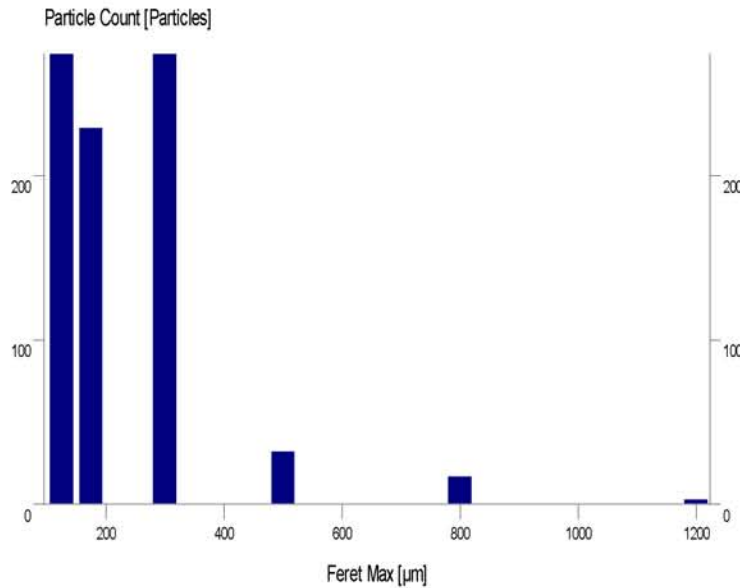
Cleanliness Analysis

Documentation of the Filter Inspection

1010-01093

Graphical Visualisation of the Cleanliness Code - ALL PARTICLES NOT FIBERS

ISO 16232-10 (n)_100 - not Fibers



APPROVAL:
An approval test for the cleanliness code can be executed with defined limits

Particle Size Classes

ISO 16232-10 (n)_100 - not Fibers						
	Feret Max	Feret Max	Class Area	Particle Count	ISO 16232-10(n) code1	Approval
	µm	µm	µm ²	Particles		
1	100.00	150.00	1621277.50	274.00	F274	OK
2	150.00	200.00	2371899.25	229.00	G229	OK
3	200.00	400.00	5714566.90	274.00	H274	OK
4	400.00	600.00	1402244.66	32.00	I32	NOK
5	600.00	1000.00	1803311.72	17.00	J17	OK
6	1000.00		393151.24	3.00	K3	OK

Particle Results

Parameters of the Biggest Particles

	Feret Max	Feret Min	Area	Particle class
	µm	µm	µm ²	ALL PARTICLES NOT FIBERS
1	2017.10	290.81	99381.44	
2	1083.20	159.77	59045.59	
3	1016.36	333.58	234724.20	
4	970.23	122.86	39562.12	
5	882.77	210.40	91508.13	
6	874.77	343.26	206075.03	
7	829.21	554.89	320794.98	
8	809.22	132.55	61243.49	
9	786.16	499.09	277797.85	
10	776.37	363.94	115587.20	

LABORATORY ANALYSIS

Company
Address

Department: R & D

Product
Equipment: SEE SAMPLE ID BELOW
Equipment No...:
Make
Model
System
Filtration: XEM:

Test Number	New	12
Lab Number	(Typical)	1010-01093
Date of Sample		08/11/10
Oil Addition		UNK
Last Drain Date		UNK
Months on Sample		
Last Filter Service		UNK

COMMENTS

ENERGY DISPERSIVE XRF - PPM (*BELOW MINIMUM DETECTION LIMIT)

Aluminum (Al)	*
Antimony (Sb)	*
Cadmium (Cd)	*
Chromium (Cr)	*
Cobalt (Co)	*
Copper (Cu)	*
Iron (Fe)	103
Lead (Pb)	*
Manganese (Mn)	*
Molybdenum(Mo)	*
Nickel (Ni)	*
Tin (Sn)	*
Titanium (Ti)	147
Vanadium (V)	*
Barium (Ba)	*
Calcium (Ca)	51
Magnesium (Mg)	*
Phosphorus(P)	*
Silicon (Si)	*
Zinc (Zn)	*
Chlorine (Cl)	*
Sulfur (S)	*

Test#12 - Debris on 60um nylon net filter.

Minimum Detection Limits (MDL's) are based on oil standards. X-ray fluorescence is matrix sensitive, results relative only.

These laboratory test results are intended to be helpful and informative. They are based on our best experience, current industry testing procedures, and information provided with the sample, which we believe to be reliable. We cannot assume responsibility for any loss or accident that may result from use of the information given.