FTPT

Filtertechnik Patch Test Kit

User Manual

February 2019

V1.01

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Registered in England No: 03969985 VAT No: 760 821 731

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Component Identification

1.) Scientific microscope with LED lamp	9.) 25mm membrane filters
2.) 600ml squat form beaker	10.) Membrane filter forceps
3.) Patch filter holder	11.) 3-piece 25mm membrane holding funnel
4.) 120ml, 450mm funnel	12.) 250ml dispensing bottle with nozzle
5.) Vacuum sampling pump	13.) 100ml sampling bottles
6.) 8mm tubing	14.) 250ml plastic bottle
7.) 47mm gridded membrane filters	15.) 500ml plastic bottle
8.) Contamination analysis slides	

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Preparing Washdown Fluid

When carrying out a patch test the equipment will need to be washed using the 250ml dispensing bottle containing a suitable washdown fluid such as Evolve CH10. This should be prefiltered to prevent the addition of any foreign contaminants on the patch slide.

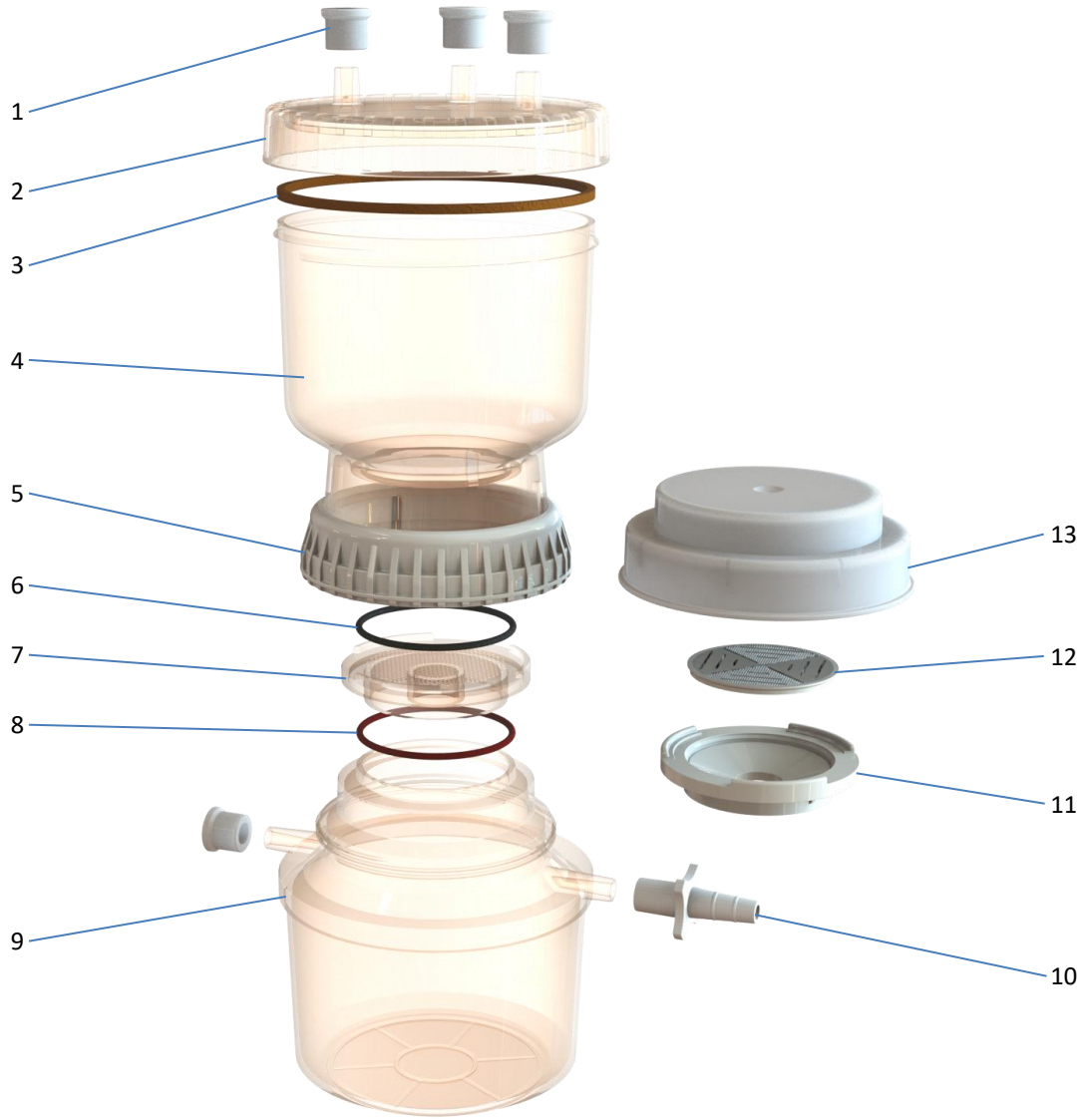
To filter the washdown fluid, use the filter forceps to place one 25mm membrane filter inside the 3-piece funnel as shown below.

Remove the nozzle from the 250ml dispensing bottle, insert the filter funnel and fill with the washdown fluid.

If this method proves to be too slow it's possible to use the patch filter holder and draw the washdown fluid through a 47mm patch using the hand pump.

The filtered washdown fluid should be used for cleaning all equipment before and after pulling a patch for analysis.

Patch Filter Holder



1.) Cap (TPE)	8.) Support plate O-ring (silicone rubber)
2.) Upper chamber cover (PSF)	9.) Receiver/lower chamber (PSF)
3.) Cover O-ring (silicone rubber)	10.) Tube adapter (PP)
4.) Upper chamber (PSF)	11.) Analytical support plate base (PSF)
5.) Locking Ring (white PSF)	12.) Analytical support plate insert (PSF)
6.) Support plate O-ring (silicone rubber)	13.) Receiver cover (PP)
7.) Patch membrane support plate (PSF)	

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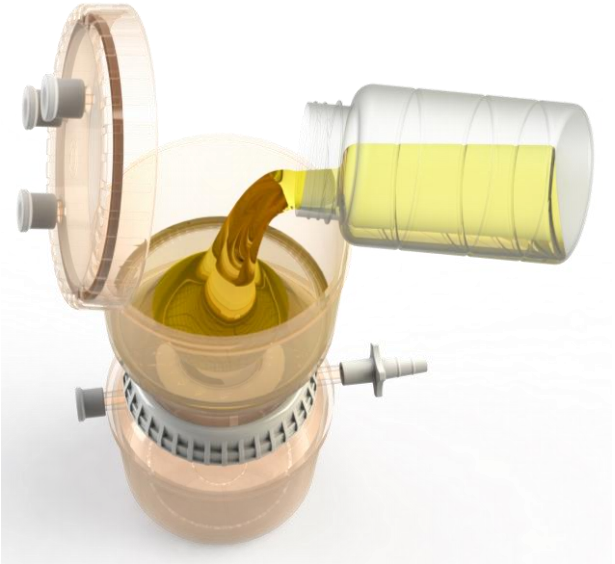
Pulling a Patch for Analysis

1. Remove a 47mm gridded membrane from between the blue separator paper

2. With the patch filter holder set up, using the membrane support plate (not the analytical support plate) centrally place a 47mm gridded membrane onto the receiver.
   Place the upper chamber on top of the membrane patch and gently screw the locking ring to fasten the two sections together.

3. Remove the lid from the upper chamber and pour in the 100ml sample. Rinse out any residual contaminants from the 100ml sample bottle using the dispensing bottle filled with washdown fluid.



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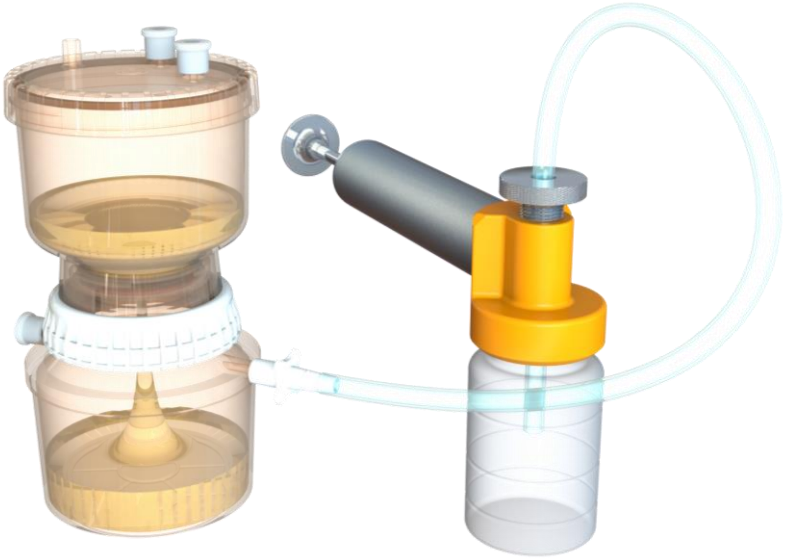
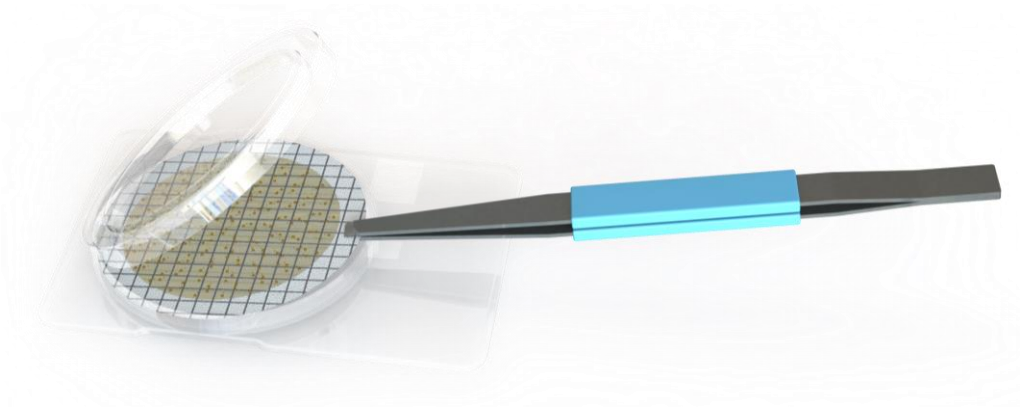
4. Attach the sampling pump to the patch filter holders tube adapter using the 8mm clear tube. All ports must be capped except for one on the top lid.
   Use the sampling pump to create a vacuum within the patch filter holder. This will pull the 100ml sample through the patch.

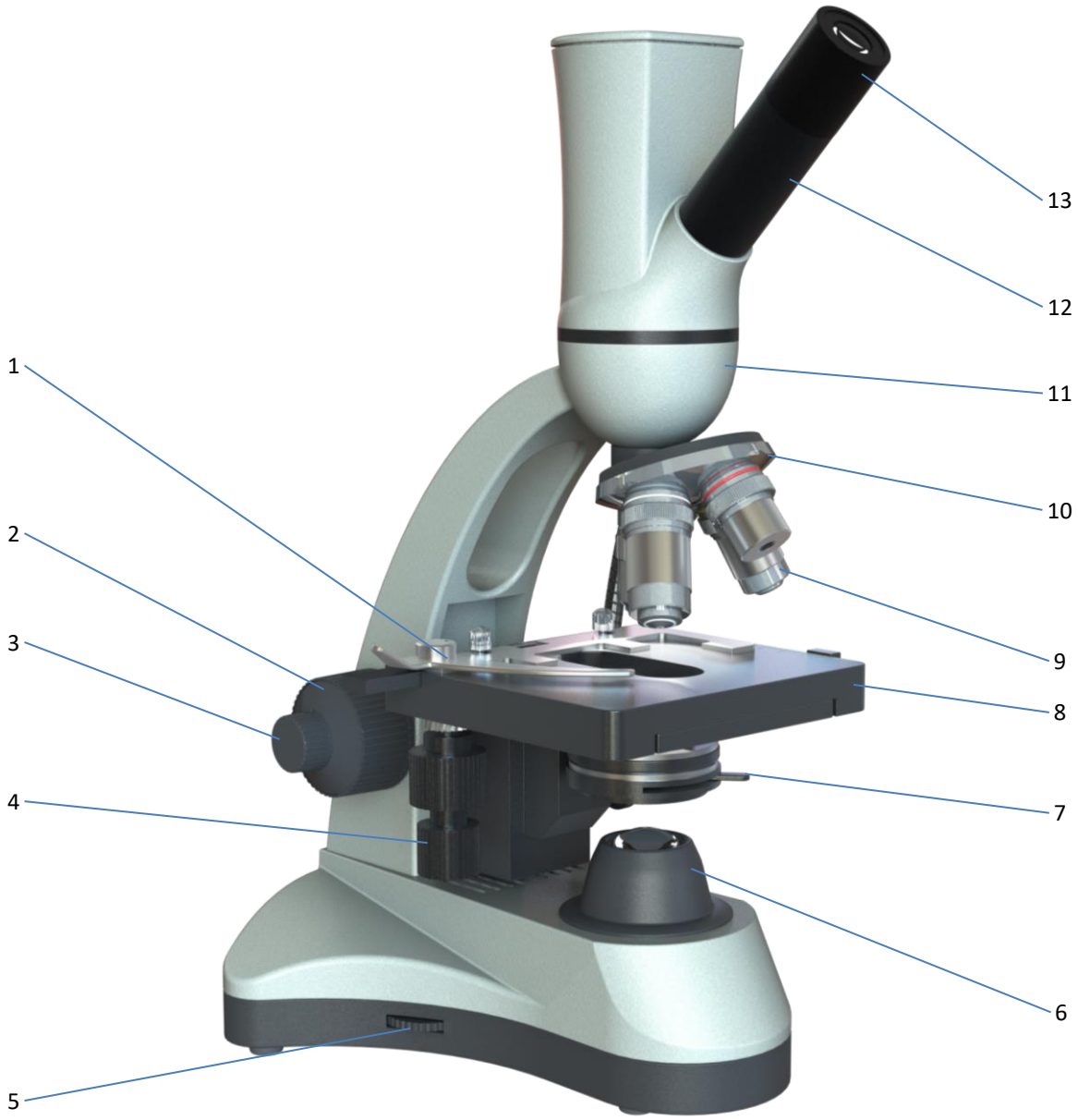


   Remove the lid from the upper chamber and rinse the walls with washdown fluid. Note that passing the washdown fluid over the patch may dissolve any soft contaminants, which may or may not be required for analysis.

5. Unscrew the locking ring to remove the upper chamber and using the forceps place the filter membrane onto a contamination slide. Always keep the lid on the slide to prevent any airborne contaminants gathering on the membrane.



Microscope



1.) Slide grip	8.) Stage
2.) Coarse focus	9.) Objective lenses
3.) Fine focus	10.) Nosepiece (turret)
4.) Stage movement controls	11.) Head
5.) Lighting rheostat controls	12.) Eyepiece tube
6.) Illuminator	13.) Eyepiece (ocular)
7.) Iris	

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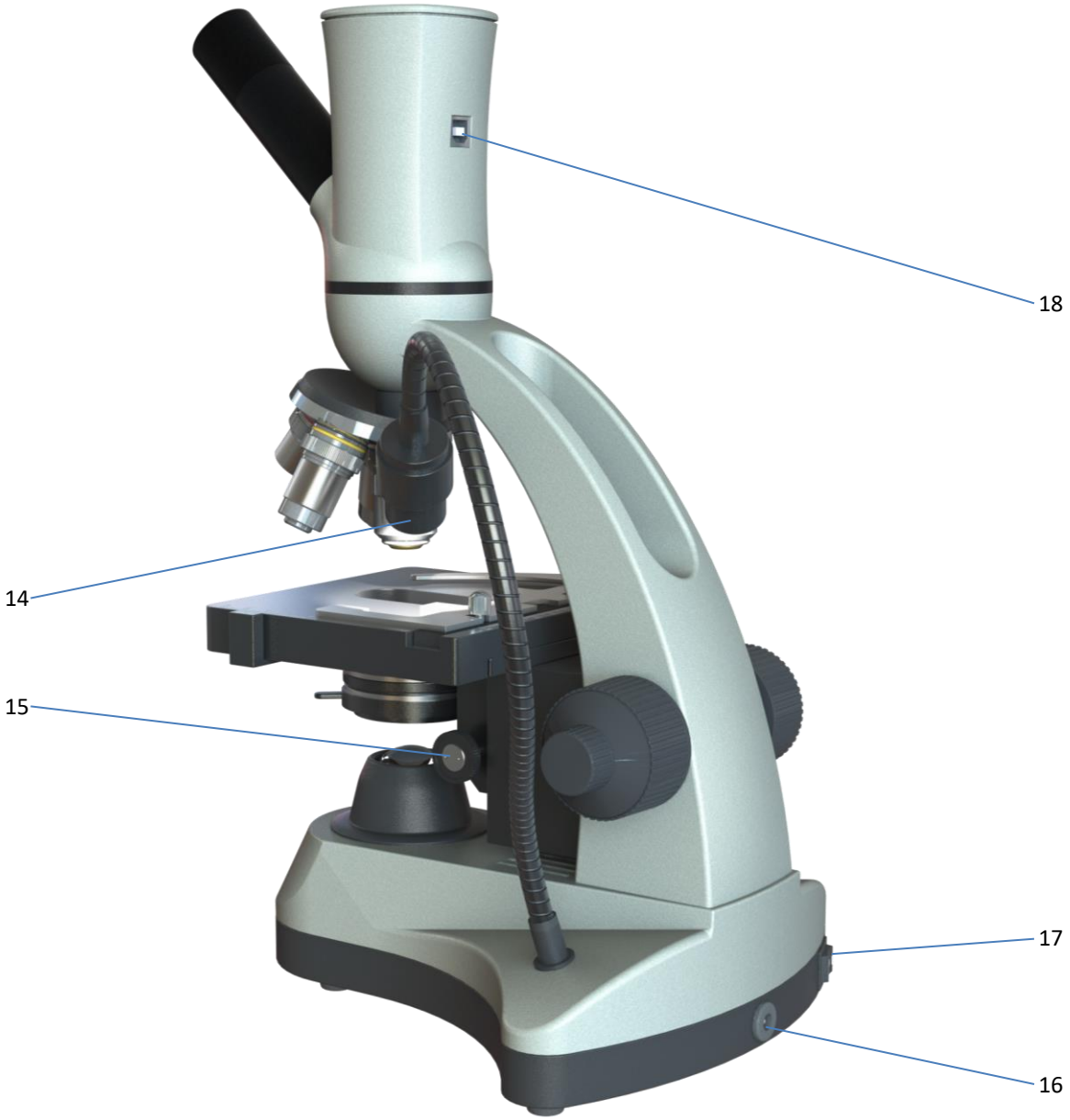

14.) LED lamp	17.) Switch
15.) Condenser focus	18.) USB port
16.) Power port	

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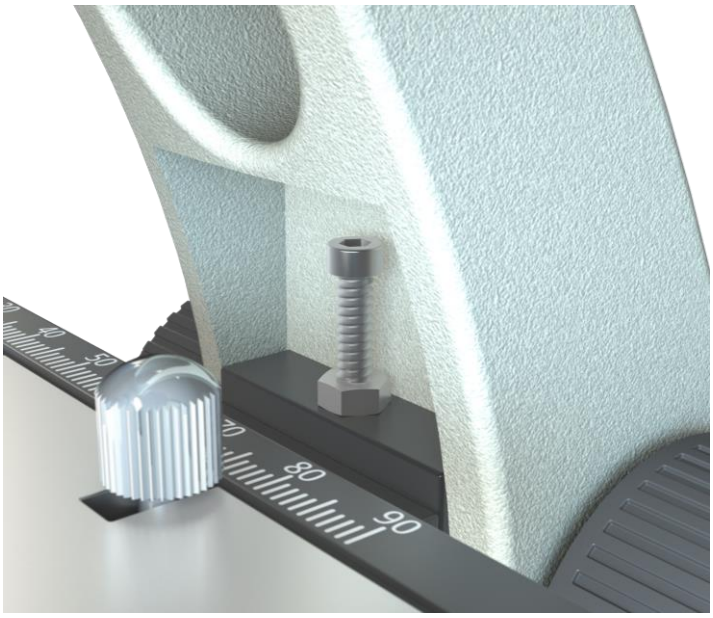
Specifications

Specification	Detail
Monocular head	Inclined 45°
Sensor	CMOS, 1/3”, 3MP, USB2.0, auto/manual white balance
Eyepiece	X10 plan eyepiece, 25mm focal length, 18mm field diameter
Objectives	Achromatic, parfocal x4, x10, x40, x100 (oil immersion only)
Stage	Mechanical stage, focusing condenser with iris
Illumination	LED incident & transmitted variable

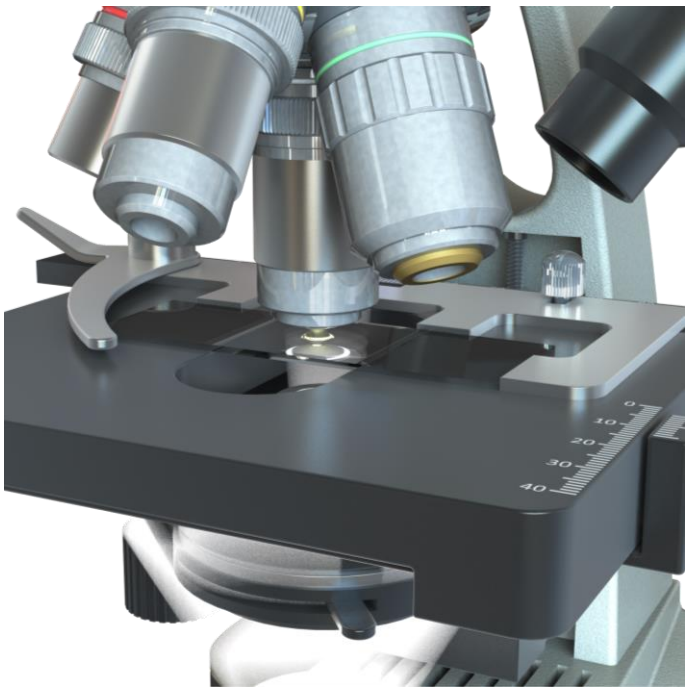


The safety stop should be checked to ensure the objectives will not impact the stage or contamination slides.

The microscope can be connected to a mains adapter, providing power to the illuminator and LED lamp for analysing contamination slides. Connecting the power adapter will charge the internal batteries, allowing illumination for up to 48 hours on a full charge.

There is a frosted filter in the filter holder of the condenser, this should be left in place to ensure that the LED gives even field illumination.

The x100 objective is an oil immersion lens and only used with glass slides. A large drop of oil is placed onto the slide and the objective placed on top, immersed in the oil. This technique is not commonly required for analysing contaminants on a patch membrane.



Analysing a Contamination Slide

1. Select the required objective, typically starting with the x4.
2. Place the contamination slide onto the microscope stage.
3. Switch on the LED lamp and adjust the position and brightness to illuminate the patch membrane.
4. Use the coarse and fine focus controls to bring the slide into focus. The fine focus control has a scale, allowing simple attempts at depth measurement. Each division is equal to 2 microns.
5. Adjust the LED lamp again to achieve the best view of contaminants on the patch membrane.
6. Use the stage controls to view different areas of the patch membrane. The stage has a double vernier scale, so the exact position of contaminants can be noted.

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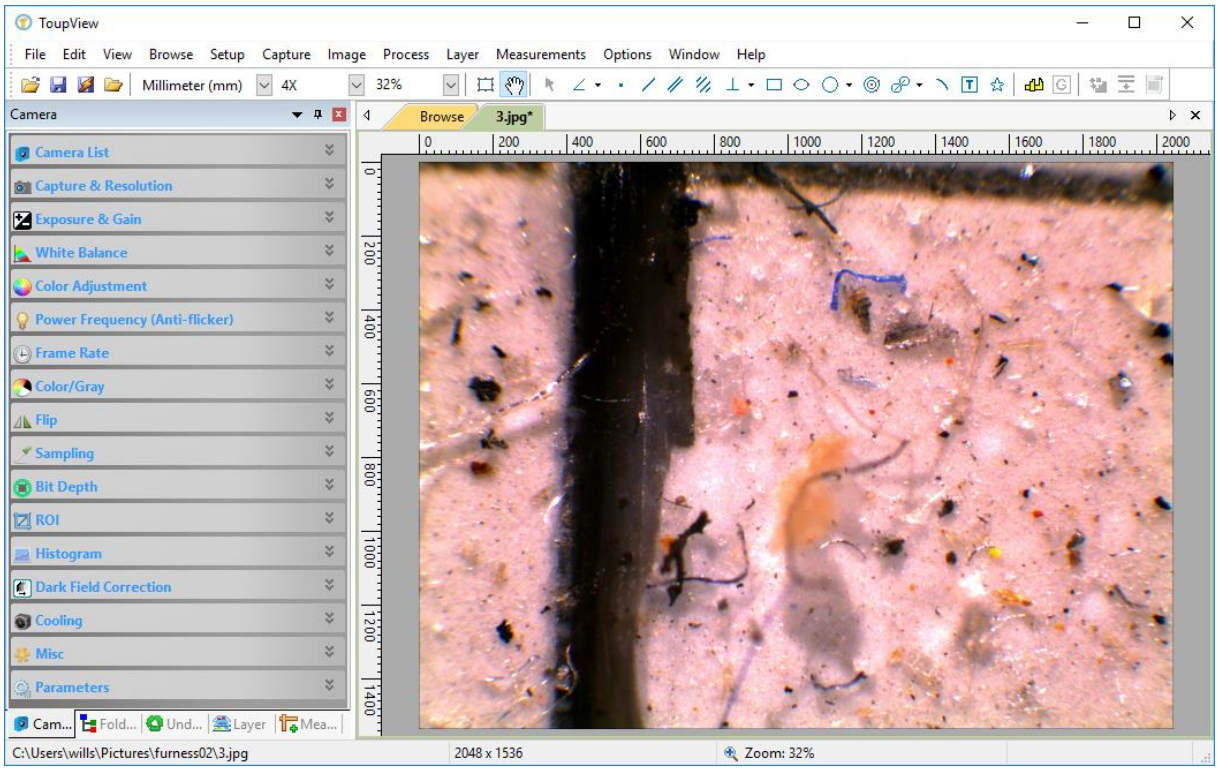
USB Port for Digital Analysis

The microscope includes a USB port enabling connection to a PC for detailed digital analysis of contamination slides.

Making use of the software provides the following advantages:

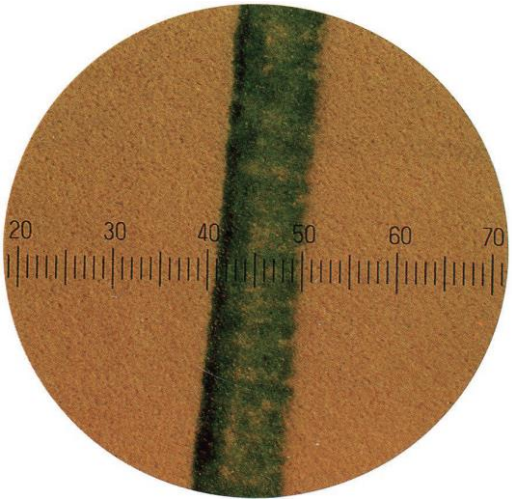
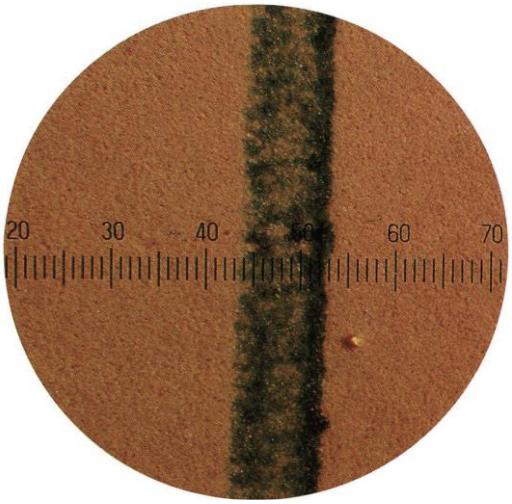
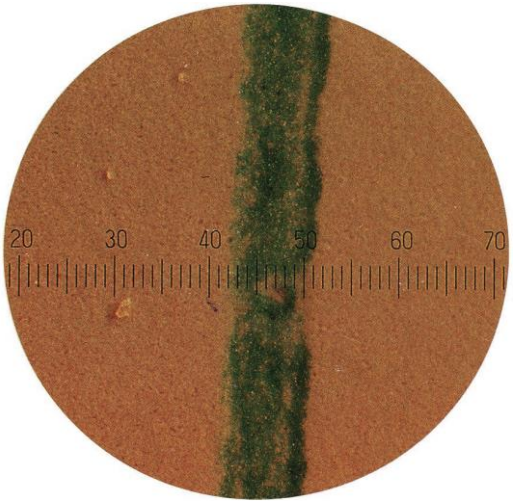
- Luminance calibration
- Measurement of contaminants
- Image capture
- Image stitching
- Video capture
- Video watermarking
- Extended depth of field
- Colour composition



For the full list of features and how to use the software refer to the detailed ToupView manual on the USB stick help files found within the software.

Contamination Reference Guide

ISO 4406 Visual Guide

	Clean membrane. No contaminants present. Too clean to evaluate.
	Very little contamination present. The visible particle is silica. ISO Code: 13/12/10
	Visible contamination is silica. ISO Code: 15/14/12

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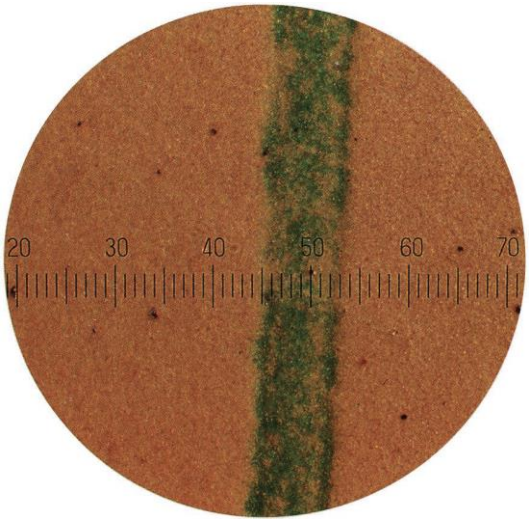
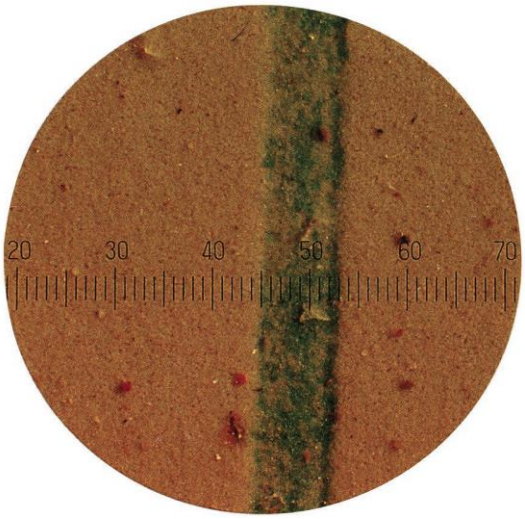
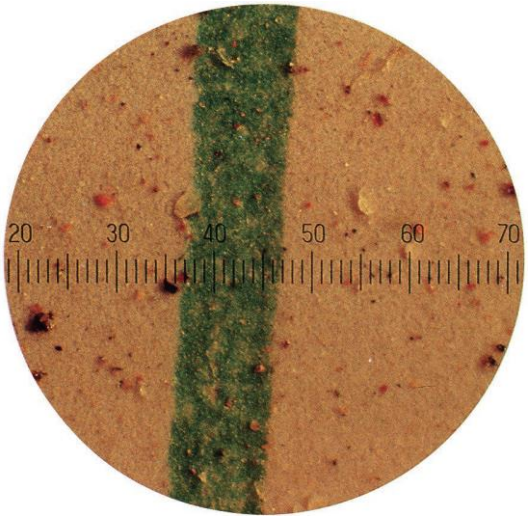
	The visible contamination is mostly metallic with some silica particles. ISO Code: 16/15/13
	The visible contamination is mostly silica with some metallic and rust particles. ISO Code: 18/16/14
	The visible contamination includes silica, metallic and rust particles. ISO Code: 19/17/15

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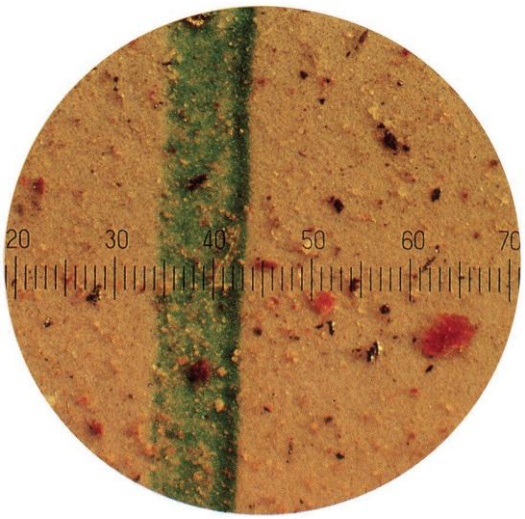
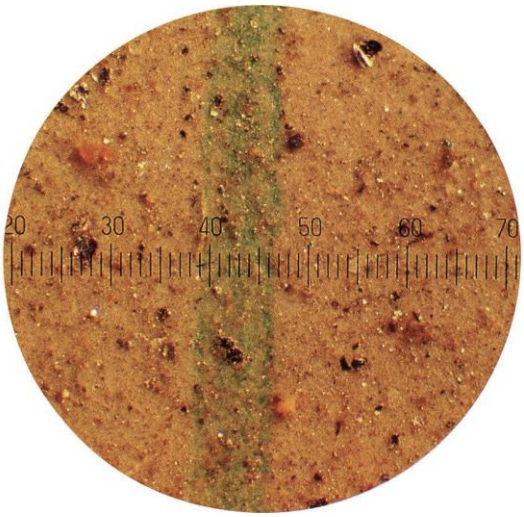
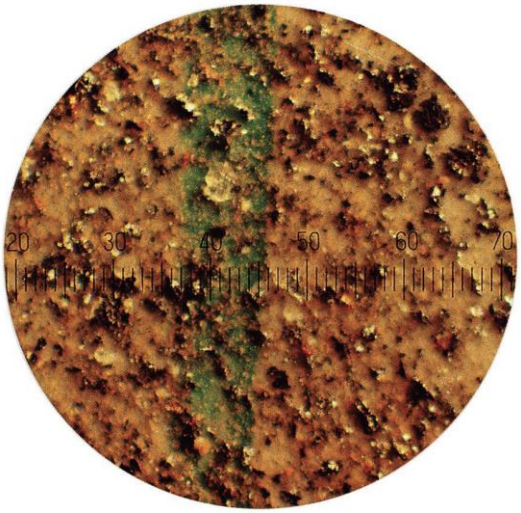
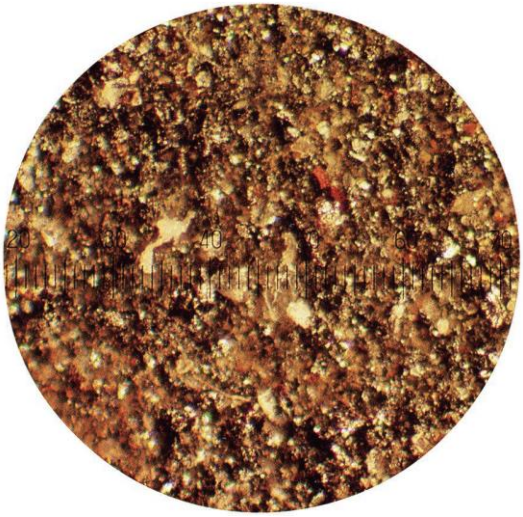
	Contamination includes silica, metallic and rust particles. ISO Code: 20/19/17
	Contamination is mostly silica, with some metallic and rust particles. A single fibre is visible. ISO Code: 21/20/18
	Contamination is mostly metallic, with some silica and a few rust particles. ISO Code: 23/22/20

	Contamination is mostly metallic, with some silica and a few rust particles. ISO Code: 26/24/22
	Sample is grossly contaminated with metallic, silica and some rust particles. The contamination level in the sample is too high to evaluate.

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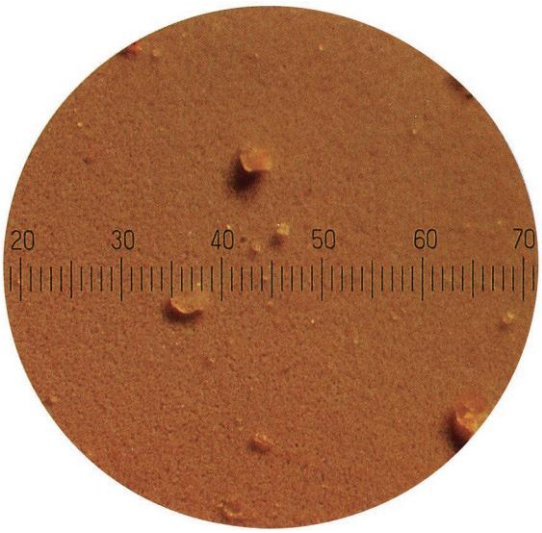
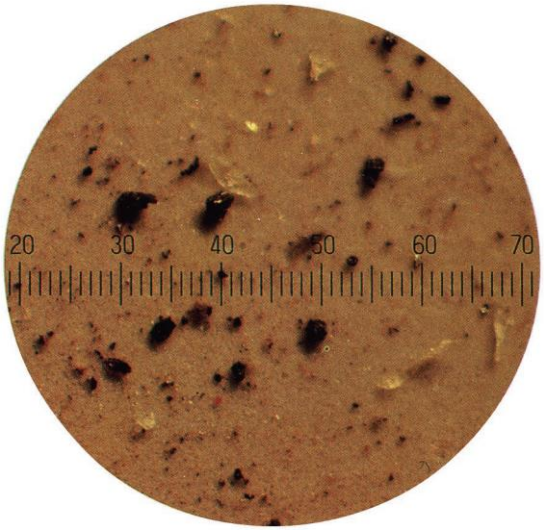
Types of Contamination

	Silica Hard, translucent particles often associated with atmospheric and environmental contamination e.g. sand, dust.
	Bright Metal Shiny metallic particles, usually silver or gold in colour, generated within the system. Generated contaminants are products of wear and often cause additional component wear and accelerated fluid breakdown.
	Black Metal Oxidized ferrous metal inherent in most hydraulic and lubricating systems; built-in contaminant and generated within the system by wear.

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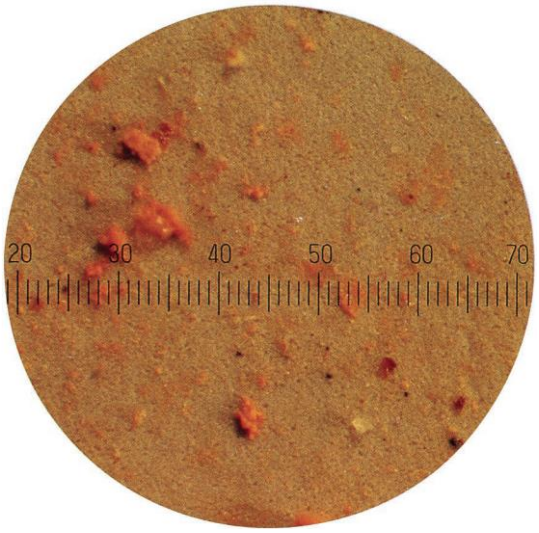	Rust Dull orange/brown particles often seen in oil from systems where water may be present, e.g. oil storage tanks
	Fibres Contaminants most commonly generate from paper and fabrics e.g. shop rags.
	Cake of Fines Very large concentrations of small-size particles coat the analysis membrane and build up into a cake. The cake obscures the larger particles on the membrane making contamination evaluation impossible.

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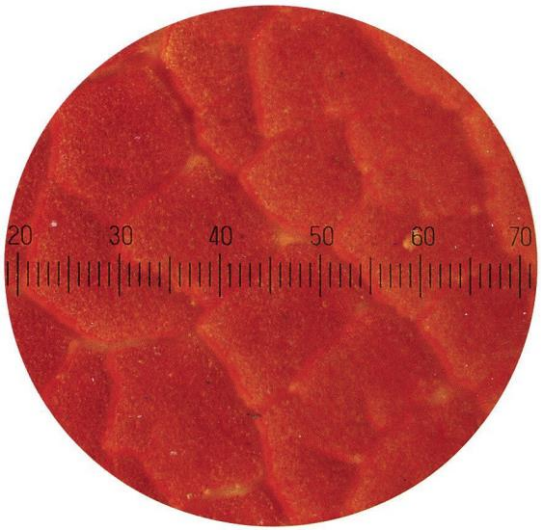
	Gel Cake A thick build-up of gels on the analysis membrane making particle contaminant evaluation impossible.
	Precipitate Particulate contaminant uniform in size and colour (often white). Precipitates generally occur when an oil's additive package breaks down and 'drops out' of solution. In this condition, the additive is a contaminant and no longer performs as originally intended.

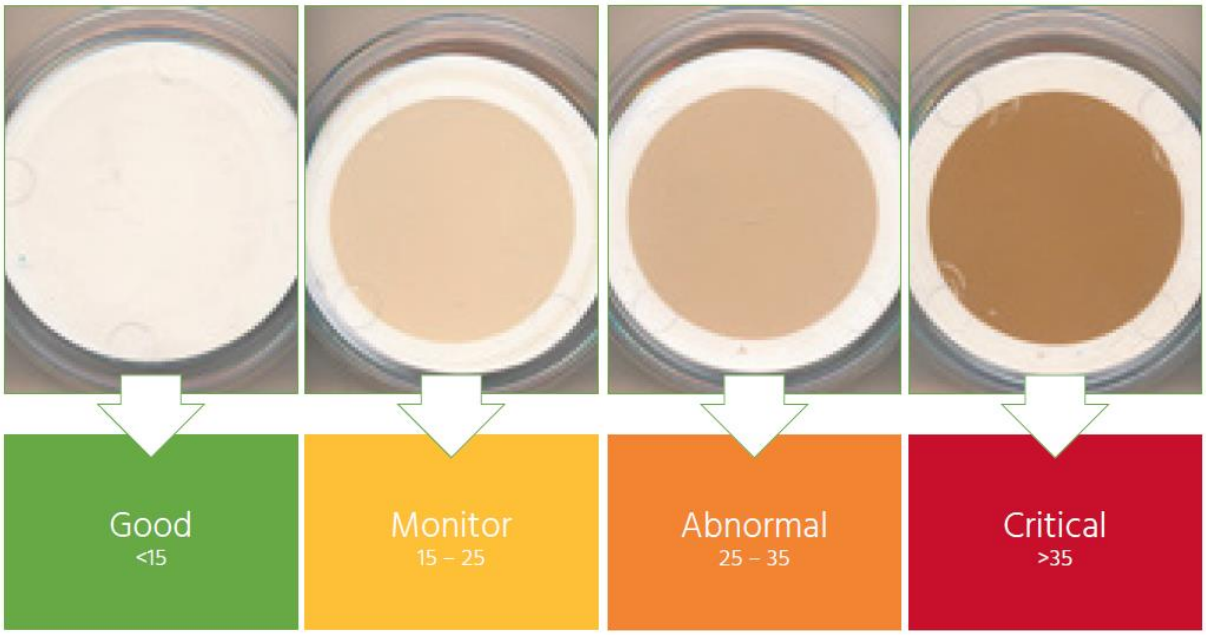
MPC Varnish Potential Testing (Optional)

Membrane Patch Colorimetry is used to measure the colour of insoluble contaminants in lubricating oils to ASTM D7843. This can determine the propensity for lubricating oils to form varnish deposits on components, leading to increased wear, component failure and costly downtime.

MPC testing is particularly important in applications such as:

- Hydraulic systems
- Gas turbines
- Compressors
- Steam turbines
- Bearing lube systems

It is advised for MPC testing to be carried out monthly and for MPC values to be maintained at ΔE<15 to prevent deposit formation.



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Appendix A - Particle Count and Other Codes

ISO Codes (ISO4406)

The table below shows the ISO 4406 codes by number of particles per 1 ml of fluid sampled.

ISO 4406 Code	Counts/mL	
	Greater than	Up to/including
0	0	0.01
1	0.01	0.02
2	0.02	0.04
3	0.04	0.08
4	0.08	0.16
5	0.16	0.32
6	0.32	0.64
7	0.64	1.3
8	1.3	2.5
9	2.5	5
10	5	10
11	10	20
12	20	40
13	40	80
14	80	160
15	160	320
16	320	640
17	640	1300
18	1300	2500
19	2500	5000
20	5000	10000
21	10000	20000
22	20000	40000
23	40000	80000
24	80000	160000
25	160000	320000
26	320000	640000
27	640000	1300000
28	1300000	2500000
29	2500000	∞

Filtertechnik 4406 Codes

The table below shows the Filtertechnik 4406 codes that are based on ISO 4406.

To change Filtertechnik codes to ISO codes, delete all the digits to the right of the decimal point. Do not change the value either up or down. For example, a Filtertechnik code readout of 7.2 is equivalent to an ISO code of 7. A Filtertechnik code of 7.8 is also equivalent to an ISO code of 7.

Set the sample time to get a statistically significant number of particles in the sample. For expected ISO code ranges that are greater than or equal to 12 A, a 1-minute sample time should be sufficient. For code ranges less than 12 A, multiply the sample time by 2 for each ISO code level. For example, use a 2-minute sample time at ISO code 11.

Code	Counts/mL	Code	Counts/mL	Code	Counts/mL	Code	Counts/mL	Code	Counts/mL
5	0.16	10	5	15	160	20	5000	25	160000
5.1	0.176	10.1	5.5	15.1	176	20.1	5500	25.1	176000
5.2	0.192	10.2	6	15.2	192	20.2	6000	25.2	192000
5.3	0.208	10.3	6.5	15.3	208	20.3	6500	25.3	208000
5.4	0.224	10.4	7	15.4	224	20.4	7000	25.4	224000
5.5	0.24	10.5	7.5	15.5	240	20.5	7500	25.5	240000
5.6	0.256	10.6	8	15.6	256	20.6	8000	25.6	256000
5.7	0.272	10.7	8.5	15.7	272	20.7	8500	25.7	272000
5.8	0.288	10.8	9	15.8	288	20.8	9000	25.8	288000
5.9	0.304	10.9	9.5	15.9	304	20.9	9500	25.9	304000
6	0.32	11	10	16	320	21	10000	26	320000
6.1	0.352	11.1	11	16.1	352	21.1	11000	26.1	352000
6.2	0.384	11.2	12	16.2	384	21.2	12000	26.2	384000
6.3	0.416	11.3	13	16.3	416	21.3	13000	26.3	416000
6.4	0.448	11.4	14	16.4	448	21.4	14000	26.4	448000
6.5	0.48	11.5	15	16.5	480	21.5	15000	26.5	480000
6.6	0.512	11.6	16	16.6	512	21.6	16000	26.6	512000
6.7	0.544	11.7	17	16.7	544	21.7	17000	26.7	544000
6.8	0.576	11.8	18	16.8	576	21.8	18000	26.8	576000
6.9	0.608	11.9	19	16.9	608	21.9	19000	26.9	608000
7	0.64	12	20	17	640	22	20000	27	640000
7.1	0.706	12.1	22	17.1	706	22.1	22000	27.1	706000
7.2	0.772	12.2	24	17.2	772	22.2	24000	27.2	772000
7.3	0.838	12.3	26	17.3	838	22.3	26000	27.3	838000
7.4	0.904	12.4	28	17.4	904	22.4	28000	27.4	904000
7.5	0.97	12.5	30	17.5	970	22.5	30000	27.5	970000
7.6	1.036	12.6	32	17.6	1036	22.6	32000	27.6	1036000
7.7	1.102	12.7	34	17.7	1102	22.7	34000	27.7	1102000

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7.8	1.168	12.8	36	17.8	1168	22.8	36000	27.8	1168000
7.9	1.234	12.9	38	17.9	1234	22.9	38000	27.9	1234000
8	1.3	13	40	18	1300	23	40000	28	1300000
8.1	1.42	13.1	44	18.1	1420	23.1	44000	28.1	1420000
8.2	1.54	13.2	48	18.2	1540	23.2	48000	28.2	1540000
8.3	1.66	13.3	52	18.3	1660	23.3	52000	28.3	1660000
8.4	1.78	13.4	56	18.4	1780	23.4	56000	28.4	1780000
8.5	1.9	13.5	60	18.5	1900	23.5	60000	28.5	1900000
8.6	2.02	13.6	64	18.6	2020	23.6	64000	28.6	2020000
8.7	2.14	13.7	68	18.7	2140	23.7	68000	28.7	2140000
8.8	2.26	13.8	72	18.8	2260	23.8	72000	28.8	2260000
8.9	2.38	13.9	76	18.9	2380	23.9	76000	28.9	2380000
9	2.5	14	80	19	2500	24	80000	>29	2500000
9.1	2.75	14.1	88	19.1	2750	24.1	88000	–	–
9.2	3	14.2	96	19.2	3000	24.2	96000	–	–
9.3	3.25	14.3	104	19.3	3250	24.3	104000	–	–
9.4	3.5	14.4	112	19.4	3500	24.4	112000	–	–
9.5	3.75	14.5	120	19.5	3750	24.5	120000	–	–
9.6	4	14.6	128	19.6	4000	24.6	128000	–	–
9.7	4.25	14.7	136	19.7	4250	24.7	136000	–	–
9.8	4.5	14.8	144	19.8	4500	24.8	144000	–	–
9.9	4.75	14.9	152	19.9	4750	24.9	152000	–	–

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NAS Codes (NAS 1638)

Class	Particle Size Range (Particles/100 mL)	
	5 to 15 µm	15 to 25 µm
00	125	22
0	250	44
1	500	89
2	1,000	178
3	2,000	356
4	4,000	712
5	8,000	1,425
6	16,000	2,850
7	32,000	5,700
8	64,000	11,400
9	128,000	22,800
10	256,000	45,600
11	512,000	91,200
12	1,024,000	182,400

SAE Codes (SAE AS4059)

	Maximum Contamination Limits (Particles/100 mL)					
Size, ISO 4402 calibration, or optical microscope count[1]	> 1 µm	> 5 µm	> 15 µm	> 25 µm	> 50 µm	> 100 µm
Size, ISO 11171 calibration, or electron microscope[2]	> 4 µm(c)	> 6 µm(c)	> 14 µm(c)	> 21 µm(c)	> 38 µm(c)	> 70 µm(c)
Size Code	**A**	**B**	**C**	**D**	**E**	**F**
Class 000	195	76	14	3	1	0
Class 00	390	152	27	5	1	0
Class 0	780	304	54	10	2	0
Class 1	1560	609	109	20	4	1
Class 2	3120	1220	217	39	7	1
Class 3	6250	2430	432	76	13	2
Class 4	12,500	4860	864	152	26	4
Class 5	25,000	9730	1730	306	53	8
Class 6	50,000	19,500	3460	612	106	16
Class 7	100,000	38,900	6920	1220	212	32
Class 8	200,000	77,900	13,900	2450	424	64
Class 9	400,000	156,000	27,700	4900	848	128
Class 10	800,000	311,000	55,400	9800	1700	256
Class 11	1,600,000	623,000	111,000	19,600	3390	512
Class 12	3,200,000	1,250,000	222,000	39,200	6780	1020

[1] Particle size based on the longest dimension.
[2] Particle size based on the projected area equivalent diameter.

Conversion between Standards

ISO 4406 Code 4µm / 6µm / 14µm	Mil Std. NAS 1638	Mil Std. 1246A	ACFTD Gravimetric Level mg/L	SAE Level
21/19/16	10			
20/18/15	9			6
19/17/14	8	300		5
18/16/13	7		1	4
17/15/12	6			3
16/14/12		200		
16/14/11	5			2
15/13/10	4		0.1	1
14/12/9	3			0
13/11/8	2			
12/10/8		100		
10/10/7	1			
12/10/6			0.01	
11/9/6				

Cleanliness Standards Conversion

Equivalent ISO 4406 Code (approx.)	NAS Code	Size Range in Microns (µm)				
		5-15	15-25	25-50	50-100	>100
-	00	125	22	4	1	0
-	0	250	44	8	2	0
12/10/7	1	500	89	16	3	1
13/11/8	2	1,000	178	32	6	1
14/12/9	3	2,000	356	63	11	2
15/13/10	4	4,000	712	126	22	4
16/14/11	5	8,000	1,425	253	45	8
17/15/12	6	16,000	2,850	506	90	16
18/16/13	7	32,000	5,700	1,012	190	32
19/17/14	8	64,000	11,400	2,025	360	64
20/18/15	9	128,000	22,800	4,050	720	128
21/19/16	10	256,000	45,600	8,100	1,440	256
22/20/17	11	512,000	91,200	16,200	2,880	512
23/21/18	12	1,024,000	182,400	32,400	5,760	1,020

ISO 4406 vs NAS 1638 Contamination

Appendix B - Required Cleanliness Codes for Fluid Power Components

Component	Type	ISO Target Level		
		High Pressure <130 bar	Medium Pressure 130 - 200 bar	High Pressure 200 - 1000 bar
Pump	Fixed Gear or Fixed Valve	20/18/15	19/17/14	18/16/13
	Fixed Piston	19/17/14	18/16/13	17/15/12
	Variable Vane	18/16/13	17/15/12	N/A
	Variable Piston	18/16/13	17/15/12	16/14/11
Valve	Check Valve	20/18/15	20/18/15	19/17/14
	Directional (Solenoid)	20/18/15	19/17/14	18/16/13
	Standard Flow Control Valve	20/18/15	19/17/14	18/16/13
	Cartridge Valve	19/17/14	18/16/13	17/15/12
	Proportional Valve	17/15/12	17/15/12	16/14/11
	Servo Valve	16/14/11	16/14/11	15/13/10
Actuator	Cylinder, Vane Motor, Gear Motor	20/18/15	19/17/14	18/16/13
	Piston Motor, Swash Plate Motor	19/17/14	18/16/13	17/15/12
	Hydrostatic Drive	16/14/11	16/14/11	15/13/10
	Test Stand	15/13/10	15/13/10	15/13/10
Bearing	Journal Bearing	17/15/12	N/A	N/A
	Industrial Gear Box	17/15/12	N/A	N/A
	Ball Bearing	15/13/10	N/A	N/A
	Roller Bearing	16/14/11	N/A	N/A

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