



PARTICLE COUNTERS HANDBOOK

Measurement techniques and particle analyzer devices

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**THE COMPLETE
HYDRAULIC FILTRATION
& ACCESSORY RANGE**



Contamination Monitoring Products

...because contamination costs!

**70-80% of all failures
on hydraulic systems and up to 45%
of all bearing failures are due
to contaminants in the hydraulic fluid**



In hydraulic fluid power systems, power is transmitted and controlled through a liquid under pressure within an enclosed circuit. The liquid is both a lubricant and a power transmitting medium.

The presence of solid contaminant particles in the liquid inhibits the ability of the hydraulic fluid to lubricate and causes wear to the components. The extent of contamination in the fluid has a direct bearing on the performance and reliability of the system. **It is necessary to control solid contaminant particles to levels that are considered appropriate for the system concerned.**

A quantitative determination of particulate contamination requires precision in obtaining the sample and in determining the extent of contamination. **MP Filtri's range of Automatic Particle Counters (APC)** work on the light-extinction principle. This has become an accepted means of determining the extent of contamination.

WHY PARTICLE COUNTING TECHNOLOGY IS VITAL TO A CLEAN SYSTEM

The presence of particles in hydraulic fluid is the primary cause of failure; reliability and performance issues; and shorter component life in hydraulic systems.

This results in reduced lifespans of complex equipment; increased service levels and maintenance costs, and increased amounts of costly unplanned downtime.

Real-time fluid condition monitoring delivers an instant, comprehensive hydraulic health check, which alerts operators to the precise state of contamination in their systems and flags up potential issues and cleanliness trends.

A LITTLE CONTAMINATION GOES A LONG WAY

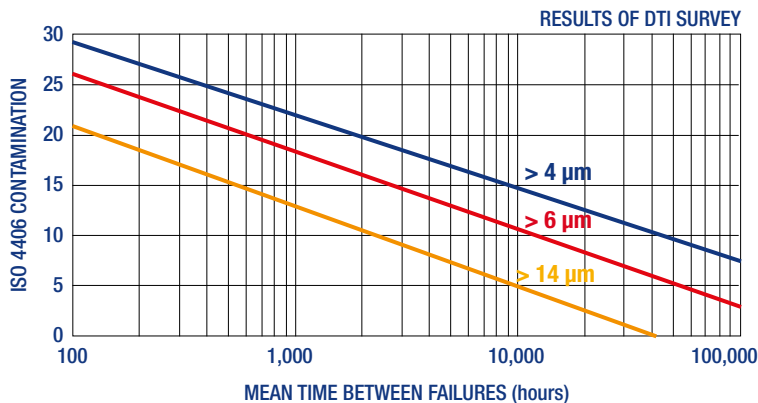
Only 10 grams of particulate is needed to raise the contamination level of 10.000 Liters (2.641 gallons) of perfectly clean hydraulic fluid to an ISO 4406 value of 19/17/14 (the minimum acceptable level in hydraulic and lube systems).

The life and reliability of hydraulic systems is greatly affected by the presence of particulate contamination in the lubricant. The cleaner the fluid, the more reliable the system or process, and the longer the lifespan of the components.

Contamination monitoring of hydraulic fluids is the simplest and most cost-effective monitoring technique and should be a frontline technique in any maintenance regime.

THE SCALE OF THE PROBLEM

- Between 70 and 80 percent of hydraulic failures are caused by contamination build-up
- An estimated 82 percent of wear and tear is caused by contamination
- A survey by the UK Department of Trade and Industry quantified the relationship between the level of reliability of systems and the quantity of dirt levels in the system as represented by the ISO 4406 Solid Contamination Code



THE IMPORTANCE OF PREVENTIVE CLEANLINESS MAINTENANCE

The aim of more traditional forms of monitoring (vibration, noise, chip detection etc) is the awareness of system degradation so that the component can be taken out of service before catastrophic failure. In most cases, the component must be replaced because it is damaged beyond economic repair.

In contamination monitoring, the philosophy is completely different. System fluid samples are analyzed for any significant increase in particulate contamination and actions promptly implemented to correct the situation e.g via the use of high-performance hydraulic filtration to improve the system cleanliness to a predefined recommended cleanliness level (RCL), and rapidly reduce system wear and tear in the shortest possible time frame. This way, the aims of reliable operation and long component life will be achieved.

KEY REQUIREMENTS FOR A FLUID CONTAMINATION MONITOR

- Needs to be able to measure concentrations of smaller contamination particles i.e. $< 10 \mu\text{m}$
- Needs to measure a wide range of particle sizes and concentrations
- Can present data in standard reporting formats recognized in industry e.g. to cleanliness coding systems such as ISO 4406 or AS4059 [10]
- Have proven accuracy and repeatability
- Provide results 'immediately' or at least in a short time period so that corrective actions can be actioned with the minimum delay
- Can analyze a wide range of fluid types, e.g. hydraulic, lubrication, wash, and solvent fluids
- Have an 'acceptable' cost

WHAT SIZE ARE THE PARTICLES THAT NEED TO BE MONITORED?

The generally accepted size range of interest in fluid systems is 4 to $70 \mu\text{m}_{(c)}$ and most Cleanliness Classification systems feature these sizes.

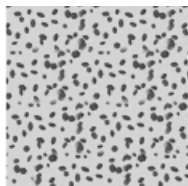
Substance	Microns	
	from	to
BEACH SAND	100	2,000
LIMESTONE DUST	10	1,000
CARBON BLACK	5	500
HUMAN HAIR (diameter)	40	150
CARBON DUST	1	100
CEMENT DUST	3	100
TALC DUST	5	60
BACTERIA	3	30
PIGMENTS	0.1	7
TOBACCO SMOKE	0.01	1

1 Micron* = 0.001 mm

25.4 Micron* = 0.001 inch

* correct designation = Micrometer

For all practical purposes, particles of 1 micron size and smaller are permanently suspended in air.



4 - 14 μm

**TYPICAL
CONTAMINANT
DIMENSION
IN A HYDRAULIC CIRCUIT**

HOW PARTICLE COUNTERS WORK

Our particle counters use a light-extinction principle to identify particles in hydraulic fluids.

The process involves light from a collimated source passing through optics and then through the oil flow onto a photodiode.

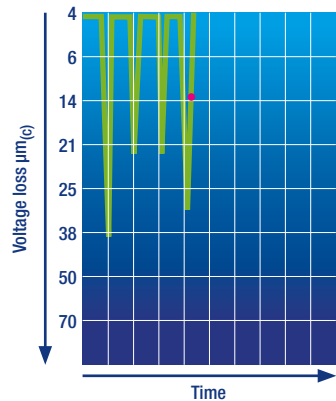
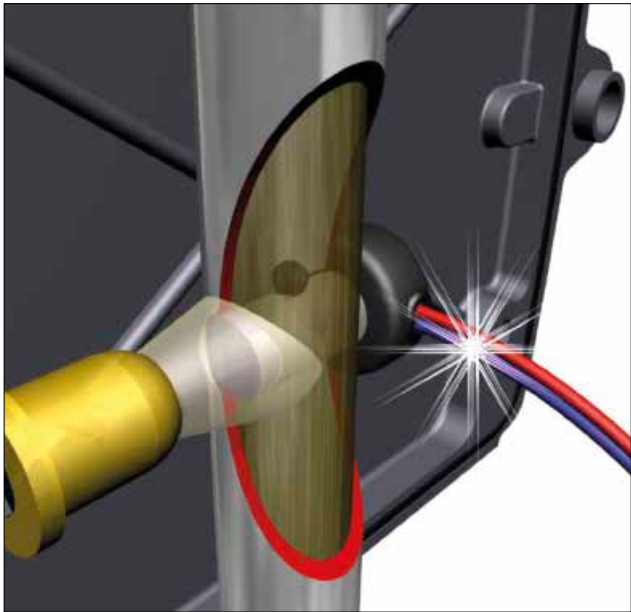
As particles pass through the light source, they block the light – creating a ‘shadow’ (voltage loss) that equates to the size of each particle.

This is measured in signal peaks that can be broken down into 4, 6, 14, 21 $\mu\text{m}_{(c)}$ and greater.

Area = $78.5 \mu\text{m}^2$

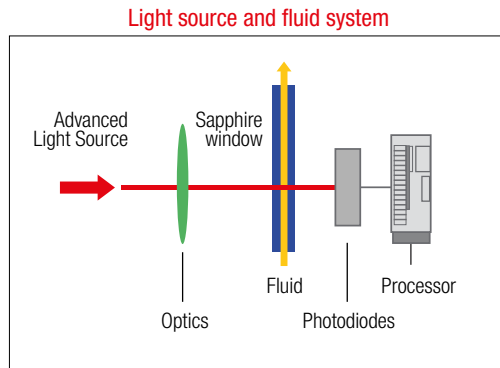
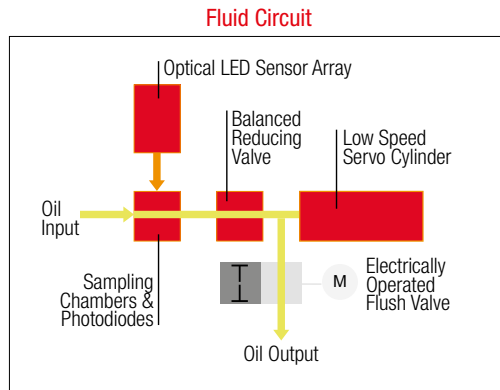
Sized by APC calibrated as per current calibration standards with light extinction particle counters

Equivalent size
 $d = 10 \mu\text{m}$



MP Filtri utilizes two different methods of light obscuration technology for its automatic particle counters: LED and Twin-Laser particle analyzers.

TECHNOLOGY - LED (LPA3)



THE FLUSHING PROCESS

The LPA2 and LPA3 both have a pre-flush valve built into the product design, which enables the user to flush the particle counters prior to commencing the analysis procedure, ensuring there is little external influence on the final analysis reading.

The process allows the user to flush both the sampling point on the system and the microbore hose that connects the system to the Particle Counter.

If this procedure is not carried out prior to an analysis, these components could have an influence on the final analysis reading. This is due to the fact that the user may not know how much contamination the test point and microbore hose has left over from previous usage, or the effect that would have on the overall particle count and result.

The flushing process is controlled by system pressure. This pressure forces the fluid through the optical sensor. The internally fitted pressure-reducing valve reduces any high pressure from the system to a minimal 1 bar; this ensures the flushing process does not allow system pressure directly through the oil return line of the particle counter back to a waste container. The viscosity and temperature determine the time that is required to flush the particles prior to starting the test. Typically, this can be between one and two minutes.

THE ANALYSIS PROCESS

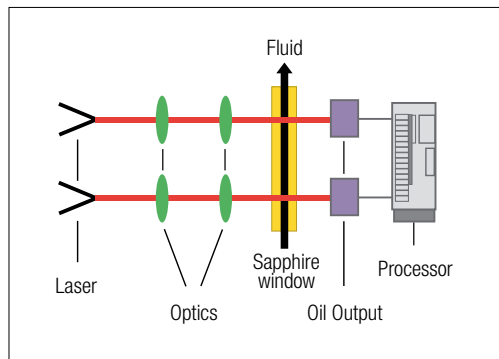
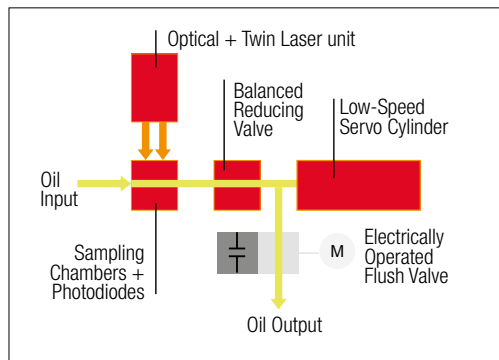
The oil input arrives directly at the optical sensor arrangement, meaning that there is minimal pipework and no dynamic components before the oil is analyzed and the particle counter has been flushed.

This reduces the effect that any components or pipework may have on the overall particle count. The oil flow across the sensor is controlled by the low-speed electrohydraulic low-speed syringe pump.

The pump has two purposes:

1. To control the speed of the oil that is being analyzed. Optical particle counter-technology requires the particles to travel at a specific velocity for the light source and analysis procedure to count the particles accurately.
2. To measure the quantity of oil the particle counter is analyzing. This is achieved using a motor tacho unit measuring the quantity of revolutions of the pump cylinder. The media is drawn in through the optical sensing arrangement and balancing valve until the selected volume is achieved. This is selected by the user prior to starting the test.

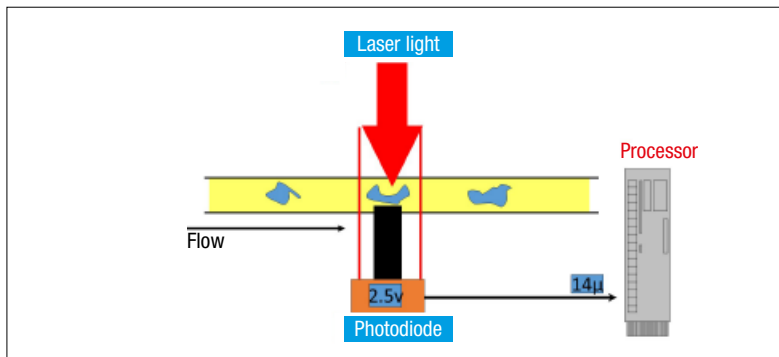
TECHNOLOGY - TWIN-LASER (LPA2, CML 2)



- A single point high accuracy laser designed to measure contamination between $4\text{ }\mu\text{m}$ - $6\text{ }\mu\text{m}_{(c)}$
- A standard accuracy laser designed to measure system contaminants between $6\text{ }\mu\text{m}_{(c)}$ and $70\text{ }\mu\text{m}_{(c)}$

HOW PARTICLE COUNTERS WORK

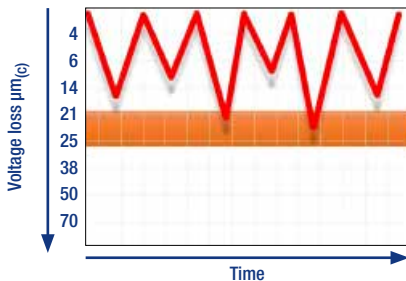
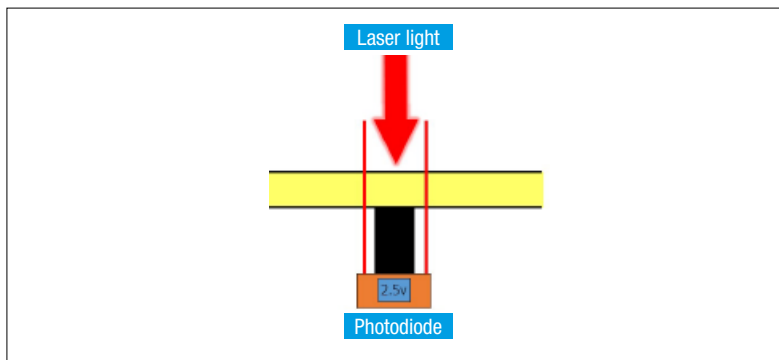
Laser Technology



As the particle passes through the laser beam, the loss of light is directly proportional to the size of the particle.

LPA

Voltage drop = Size of particle



TEST DUST

Original particle counting methods were performed using optical microscopes (ARP 598) utilizing the NAS1638 reporting format.

When Automatic Particle Counters (APCs) first came to market, these provided a faster method of analyzing samples, but required a method of calibration. The original method was the ISO 4402 calibration format and utilized ACFTD (Air Cleaner Fine Test Dust) as the media.

Since then, an improved test dust had been created replacing the now defunct ACFTD. This is known as ISO Medium Test Dust (ISO MTD): ISO 12103-A3.

It is the test dust utilized for calibration of light extinction-based APCs to calibration standards ISO 11171 and ISO 11943.

It also forms the basis for the NIST certified standard reference materials – SRM2806 and RM8631.

There is a slight difference between particle measurements from the two methods. To retain the same cleanliness standard, calibrations using ISO MTD are corrected to the following particle scale.

Converting:		Converting:	
from ACFTD size ISO 4402	to NIST size (ISO 11171)	from NIST size (ISO 11171)	to ACFTD size ISO 4402
µm	µm _(c)	µm _(c)	µm
1	4.2 4	4	Undefined
2	4.6	5	2.7
3	5.1	6	4.3
5	6.4 6	7	5.9
7	7.7	8	7.4
10	9.8	9	8.9
15	13.6 14	10	10.2
20	17.5	15	16.9
25	21.2 21	20	23.4
30	24.9	25	30.1
40	31.7	30	37.3

These size alterations prompted revisions of the reporting formats for ISO 4406 (new revision). NAS1638 became part of SAE AS4059 rev E (at the time of writing this reporting, format is at revision F).

The International Organization for Standardization standard ISO 4406 is the preferred method of quoting the number of solid contaminant particles in a sample. The level of contamination is defined by counting the number of particles of certain dimensions per unit volume of fluid. The measurement is performed by Automatic Particle Counters (APCs Automatic Particle Counter or PCMs Particle Contamination Monitor). Following the count, the contamination classes are determined, corresponding to the number of particles detected in the unit of fluid. The most common classification methods follow the ISO 4406 and SAE AS 4059 standards.

ISO 4406 Classification example:

The code refers to the number of particles of the same size or greater than 4, 6 or 14 μm in 1ml of fluid.

Class	Number of particles per ml / fl oz	
	Over	Up to
28	1,300,000	2,500,000
27	640,000	1,300,000
26	320,000	640,000
25	160,000	320,000
24	80,000	160,000
23	40,000	80,000
22	20,000	40,000
21	10,000	20,000
20	5,000	10,000
19	2,500	5,000
18	1,300	2,500
17	640	1,300
16	320	640
15	160	320
14	80	160
13	40	80
12	20	40
11	10	20
10	5	10
9	2.5	5
8	1.3	2.5
7	0.64	1.3
6	0.32	0.64
5	0.16	0.32
4	0.08	0.16
3	0.04	0.08
2	0.02	0.04
1	0.01	0.02
0	0	0.01

$\geq 4 \mu\text{m}_{(c)} = 350$ particelle

$\geq 6 \mu\text{m}_{(c)} = 100$ particelle

$\geq 14 \mu\text{m}_{(c)} = 25$ particelle

16 / 14 / 12

HOW TO READ AN ISO CODE

What exactly does an ISO 4406 reading mean?

The numbers represent a code which identifies the number of particles of certain sizes in 1ml of fluid.

Each code number has a particular size range, **the first scale number** represents the number of particles equal to or larger than $4 \mu\text{m}_{(c)}$ per milliliter of fluid;

the second scale number represents the number of particles equal to or larger than $6 \mu\text{m}_{(c)}$ per milliliter of fluid;

the third scale number represents the number of particles equal to or larger than $14 \mu\text{m}_{(c)}$ per milliliter of fluid.

Let us say the result is code 16/14/12.

By checking the code range in the table below, the operator can find the size and number of particles identified in the fluid.

CLEANLINESS CODE COMPARISON

Although ISO 4406 is used extensively within the hydraulics industry, other standards are occasionally required, and a comparison may be requested. MP Filtri's particle counters measure other standards simultaneously with ISO 4406, but the table below may be used as a very broad comparison tool. Sometimes no comparison is possible due to the different classes and sizes involved.

ISO 4406	SAE AS4059 - Table 2	SAE AS4059 - Table 1	NAS 1638
> 4 µm(c) > 6 µm(c) 14 µm(c)	> 4 µm(c) > 6 µm(c) 14 µm(c)	4-6 6-14 14-21 21-38 38-70 >70	5-15 15-25 25-50 50-100 >100
23 / 21 / 18	13A / 12B / 12C	12	12
22 / 20 / 17	12A / 11B / 11C	11	11
21 / 19 / 16	11A / 10B / 10C	10	10
20 / 18 / 15	10A / 9B / 9C	9	9
19 / 17 / 14	9A / 8B / 8C	8	8
18 / 16 / 13	8A / 7B / 7C	7	7
17 / 15 / 12	7A / 6B / 6C	6	6
16 / 14 / 11	6A / 5B / 5C	5	5
15 / 13 / 10	5A / 4B / 4C	4	4
14 / 12 / 9	4A / 3B / 3C	3	3

NAS 1638 CLEANLINESS CLASSIFICATION STANDARD

The NAS system was originally developed in 1964 to define contamination classes for the contamination contained within aircraft components.

The application of this standard was extended to industrial hydraulic systems simply because nothing else existed at the time.

The coding system defines the maximum number of contamination particles at various size intervals (differential counts) rather than using cumulative counts as in ISO 4406. Although there is no guidance given in the standard on how to quote the levels, most industrial users quote a single code which is the highest recorded in all sizes, and this convention is used on MP Filtri APCs.

The contamination classes are defined by a number (from 00 to 12) which indicates the maximum number of particles per 100 ml, counted on a differential basis, in a given size bracket.

Maximum Contamination Limits per 100 ml / 3.38 fl oz					
Class	5 - 15	15 - 25	25 - 50	50 - 100	>100
00	125	22	4	1	0
0	250	44	8	2	0
1	500	89	16	3	1
2	1,000	178	32	6	1
3	2,000	356	63	11	2
4	4,000	712	126	22	4
5	8,000	1,425	253	45	8
6	16,000	2,850	506	90	16
7	32,000	5,700	1,012	180	32
8	64,000	11,400	2,025	360	64
9	128,000	22,800	4,050	720	128
10	256,000	45,600	8,100	1,440	256
11	512,000	91,200	16,200	2,880	512
12	1,024,000	182,400	32,400	5,760	1,024

Size Range Classes (in microns)
5 - 15 µm = 42,000 particles
15 - 25 µm = 2,200 particles
25 - 50 µm = 150 particles
50 - 100 µm= 18 particles
> 100 µm = 3 particles
Class NAS 8

SAE AS4059 - REV. E

CLEANLINESS CLASSIFICATION FOR HYDRAULIC FLUIDS (SAE AEROSPACE STANDARD)

This SAE Aerospace Standard (AS) defines cleanliness levels for particulate contamination of hydraulic fluids and includes methods of reporting data relating to the contamination levels. Tables 1 and 2 below provide differential and cumulative particle counts, respectively, for counts obtained by an automatic particle counter, e.g. LPA3.

Class for differential measurement

Table 1

Class	Dimension of contaminant Maximum Contamination Limits per 100 ml / 3.38 fl oz				
	6-14 $\mu\text{m}_{(c)}$	14-21 $\mu\text{m}_{(c)}$	21-38 $\mu\text{m}_{(c)}$	38-70 $\mu\text{m}_{(c)}$	>70 $\mu\text{m}_{(c)}$
00	125	22	4	1	0
0	250	44	8	2	0
1	500	89	16	3	1
2	1,000	178	32	6	1
3	2,000	356	63	11	2
4	4,000	712	126	22	4
5	8,000	1,425	253	45	8
6	16,000	2,850	506	90	16
7	32,000	5,700	1,012	180	32
8	64,000	11,400	2,025	360	64
9	128,000	22,800	4,050	720	128
10	256,000	45,600	8,100	1,440	256
11	512,000	91,200	16,200	2,880	512
12	1,024,000	182,400	32,400	5,760	1,024

6 - 14 $\mu\text{m}_{(c)}$ = 15,000 particles

14 - 21 $\mu\text{m}_{(c)}$ = 2,200 particles

21 - 38 $\mu\text{m}_{(c)}$ = 200 particles

38 - 70 $\mu\text{m}_{(c)}$ = 35 particles

> 70 $\mu\text{m}_{(c)}$ = 3 particles

SAE AS4059 REV E - Class 6

Class for cumulative measurement

Table 2

Class	Dimension of contaminant Maximum Contamination Limits per 100 ml / 3.38 fl oz					
	>4 $\mu\text{m}_{(c)}$	>6 $\mu\text{m}_{(c)}$	>14 $\mu\text{m}_{(c)}$	>21 $\mu\text{m}_{(c)}$	>38 $\mu\text{m}_{(c)}$	>70 $\mu\text{m}_{(c)}$
000	195	76	14	3	1	0
00	390	152	27	5	1	0
0	780	304	54	10	2	0
1	1,560	609	109	20	4	1
2	3,120	1,217	217	39	7	1
3	6,250	2,432	432	76	13	2
4	12,500	4,864	864	152	26	4
5	25,000	9,731	1,731	306	53	8
6	50,000	19,462	3,462	612	106	16
7	100,000	38,924	6,924	1,224	212	32
8	200,000	77,849	13,849	2,449	424	64
9	400,000	155,698	27,698	4,898	848	128
10	800,000	311,396	55,396	9,796	1,696	256
11	1,600,000	622,792	110,792	19,592	3,392	512
12	3,200,000	1,245,584	221,584	39,184	6,784	1,024

> 4 $\mu\text{m}_{(c)}$ = 45,000 particles

> 6 $\mu\text{m}_{(c)}$ = 15,000 particles

> 14 $\mu\text{m}_{(c)}$ = 1,500 particles

> 21 $\mu\text{m}_{(c)}$ = 250 particles

> 38 $\mu\text{m}_{(c)}$ = 15 particles

> 70 $\mu\text{m}_{(c)}$ = 3 particles

SAE AS4059 REV E
6A/6B/5C/5D/4E/2F

The information reproduced on this and the previous page is a brief extract from SAE AS4059 Rev.E, revised in May 2005. For further details and explanations, refer to the full Standard.

PRODUCT OVERVIEW

MP Filtri designs and manufactures a complete range of contamination control solutions aimed at increasing the lifespan and productivity of hydraulic circuits.

The advanced technology incorporated within the company's contamination monitoring product range allows for preventive and predictive maintenance, guaranteeing consistent performance, a longer life cycle for the components, and a reduction in service, maintenance, and replacement costs.

MP Filtri's CMP range delivers a perfect solution for stationary, portable, and laboratory support applications.

PORTABLE PRODUCTS

Light but durable, MP Filtri's portable particle counters allow operators to take the lab with them wherever they go, performing comprehensive hydraulic health checks with instant results, market-leading accuracy, and storage space for up to 4.000 tests in memory.

Ideal for the offshore, aviation, and mobile sectors, as well as remote work environments where getting samples to and from a laboratory would be both time-consuming and laborious, the portable particle counter ensures the best in speed, flexibility and functionality in multiple applications and systems.

The range includes:



LPA3



**LPA2
Aviation Edition**



CML2

PERMANENTLY MOUNTED PRODUCTS

Created for a single system, MP Filtri's range of inline particle counters delivers highly accurate results in real time, providing a detailed analysis of fluid cleanliness which can be accessed 24/7/365.

The latest incarnation of this technology is Wi-Fi-enabled so operators can access results anywhere in the world via the company's sophisticated analysis software downloading them to customers' own cloud systems or MP Filtri's easy-to-master mobile app.

This technology is ideal for monitoring trends and gaining a complete picture of the current and past state of contamination of each individual hydraulic system in operation.

The range includes:

**Wi-Fi-enabled
ICM 4.0**



ICM 2.0



ICU



ACMU



LABORATORY APPLICATIONS

MP Filtri's 110ml and 500ml bottle samplers are suitable for offline and laboratory applications where fluid sampling at point of use is inaccessible or impractical. A fluid de-aeration facility comes as standard.

The product is compatible with various hydraulic fluid types depending on the version being used, and is also compatible with a wide range of fluid viscosities.

The range includes:



BS110 & BS500

PORTABLE PRODUCTS

Product comparison

Product/Specification	LPA3	LPA2 Aviation Edition	CML2
Particle Counting technology	LED Particle Counter	Twin-Laser Particle Analyzer	Twin-Laser Particle Analyzer
Measuring principle	Optical Light Obscuration	Optical Light Obscuration	Optical Light Obscuration
Light source	LED	Twin-laser Optical diode detectors	Twin-laser Optical diode detectors
Calibration	ISO MTD	ISO MTD	ISO MTD
Report formats	ISO 4406 (4, 6, 14) NAS AS4509	ISO 4406 (4, 6, 14) NAS AS4059	ISO 4406 (4, 6, 14) NAS AS4059
Keyboard	Full-size QWERTY (Touchscreen)	Full-size QWERTY	No
Display	10.1" touchscreen	Yes - LCD	Yes - LCD
Integrated flush valve	Manual and automatic	Manual and automatic	Manual and automatic
Measuring channels	8 channel measurement 4, 6, 14, 21, 15, 38, 50, 70	8 channel measurement 4, 6, 14, 21, 15, 38, 50, 68	8 channel measurement 4, 6, 14, 21, 15, 38, 50, 68
Viscosity	1-420 mm ² /s	1-400 mm ² /s	1-400 mm ² /s
Fluid Temperature [°C / °F]	Minimum: +5°C / 41°F Maximum: +80°C / 176°F	Minimum: +5°C / 41°F Maximum: +80°C / 176°F	Minimum: +5°C / 41°F Maximum: +80°C / 176°F
Ambient Temperature [°C / °F]	Minimum: -10°C / +14°F Maximum: +80°C / 176°F	Minimum: -10°C / +14°F Maximum: +60°C / 140°F	Minimum: -10°C / +14°F Maximum: +60°C / 140°F
Pressure / flow affected / temp	Unaffected by system flow, pressure, temp fluctuations	Unaffected by system flow, pressure, temp fluctuations	Unaffected by system flow, pressure, temp fluctuations
Fluid compatibility	Mineral Oils, Phosphate, Ester, Skydrol, Kerosene, Water-based media	Mineral Oils, Phosphate, Ester, Skydrol, Kerosene, Water-based media	Mineral Oils, Phosphate, Ester, Skydrol, Kerosene, Water-based media
Flush Facility	Yes	Yes	Yes
Sample Volumes	max 100 ml per pump stroke	8-30 ml	8-30 ml
Bottle sampler facility	Yes, 120V with vacuum	Yes, 120V with vacuum	Yes, 120V with vacuum
Bottle sampler options	110 and 500 ml	110 and 500 ml	110 and 500 ml
De-aeration facility	Yes	Yes	Yes
Software supplied	Yes - LPA View	Yes - LPA View	Yes - LPA View
Memory (no. of tests stored)	4000	600	600
Environmental protection	IP66 (Lid Closed) IP54 (Lid Open)	IP51 (Lid Open)	IP51 (Lid Open)
Dimensions [mm / inch]	435 x 292 x 155 17" x 11 1/2" x 6"	500 x 600 x 400 19.7" x 23.6" x 15.7"	354 x 298 x 150 14" x 11 1/2" x 6"
Net weight [kg / lbs]	10 kg / 22 lbs	18.5 kg / 40 lbs	6 kg / 13 lbs 4 oz
Options	Memory stick download, Pressure transducer Moisture and temperature		

LPA3

The latest in a new generation of portable particle counters. Whether an operator is working in the lab or in the field, the LPA3 delivers a fast, accurate and reliable hydraulic health check in a robust yet portable package.

Its real-time monitoring and predictive maintenance technology safeguards machinery; enhances performance and productivity; and reduces costs and downtime.

Featuring the latest breakthroughs in optical and photodiode technology, the LPA3 enhances the reliability and longevity of complex hydraulic systems and is ideal for quality control of in-house manufacturing applications. The LPA3 is compatible with MP Filtri's range of bottle samplers.

Key features

- Fully programmable to meet end-user applications
- Larger and variable sample volumes (up to 100 ml) for optimum accuracy
- Live trend analysis
- Full-color, high-resolution 10.1" (256 mm) touchscreen display
- Greater storage capacity - store up to 4,000 tests
- Automatically download test results via USB connection
- Enhanced long-life rechargeable lithium-ion battery
- Robust and durable copolymer case
- High-speed sample times
- Perfectly portable at just 10 kg (22 lbs)
- Live trend-analysis
- Measures and displays core ISO 4406, NAS, AS 4059, GBT and GJB standards
- Moisture (%RH), Temperature (deg C/F) and pressure indicator (bar/psi) options
- Key performance information at a glance
- Integrated printer
- Calibrated to relevant ISO standards
- Full 8-channel measurement
- Compatible with various hydraulic fluids, lubrication, subsea, and water-based fluids
- S model is compatible with phosphate esters and aggressive fluids
- LPA View Software (Windows-based) included



PORTABLE PRODUCTS

LPA2 AVIATION EDITION

A highly precise, lightweight, and portable instrument suitable for both on-site and lab applications. The LPA2 can automatically measure and display particle contamination, moisture and temperature levels in a variety of hydraulic fluids.

The LPA2 can be connected to MP Filtri's range of bottle samplers to enable lab-based particle counting.

It is an ideal solution for online monitoring of contamination in hydraulic fluid, providing an immediate health check analysis. It employs predictive maintenance procedures to help reduce downtime and costs.

Key features

- Airbus-approved for aviation industry
- Portable and lightweight
- Full size QWERTY keyboard and onboard thermal printer
- Calibrated to relevant international ISO standards
- Features specialist Airbus adapter and robust travel case
- Free windows-based software included



CML2

A portable, accurate, and compact instrument, suitable for 'on-site' applications. The CML2 can automatically measure and display particulate contamination, moisture, and temperature in a variety of hydraulic fluids.

Weighing in at just 6 kg (13 lbs), it is lightweight, yet robust, and ideally suited for portability.

Key features

- Compact Design
- Lightest machine in its class (6 kg - 13 lbs 4 oz)
- Calibrated to relevant ISO standards
- Compatible with various hydraulic fluids
- Stores up to 600 test results in memory
- Full accessories kit included
- Affordable solution for tight budgets



PERMANENTLY MOUNTED PRODUCTS

Product comparison

Product/Specification	ICM 2.0	ICM 4.0 Wifi Enabled	ICU
Particle Counting technology	LED Particle Counter	LED Particle Counter	LED Particle Counter
Measuring principle	Optical Light Obscuration	Optical Light Obscuration	Optical Light Obscuration
Light source	LED	LED	LED
Calibration	ISO MTD	ISO MTD	ISO MTD
Particle Sizing	>4, >6, >14, >21, >25, >38, >50, >70 $\mu\text{m}_{(c)}$	>4, >6, >14, >21, >25, >38, >50, >70 $\mu\text{m}_{(c)}$	4, 6, 14 $\mu\text{m}_{(c)}$
Analysis Range	ISO 4406: Code 0 to 24; NAS 1638 Class 00 to 12; AS4059/ISO11218 Rev E, Table 1 Size Codes 2-12; AS4059/GJB420B Rev E, Table 2 Size Codes A-F 000-12; AS4059 Rev F, Table 1 Size Codes 2-12; AS4059 Rev F, Table 2 Size Codes, cpc[000 to 12]	ISO 4406: Code 0 to 24; NAS 1638 Class 00 to 12; AS4059/ISO11218 Rev E, Table 1 Size Codes 2-12; AS4059/GJB420B Rev E, Table 2 Size Codes A-F 000-12; AS4059 Rev F, Table 1 Size Codes 2-12; AS4059 Rev F, Table 2 Size Codes, cpc[000 to 12]	ISO 4406: Code 0 to 20;
Accuracy	$\pm 1/2$ code for 4, 6, 14 $\mu\text{m}_{(c)}$ ± 1 code for larger sizes	$\pm 1/2$ code for 4, 6, 14 $\mu\text{m}_{(c)}$ ± 1 code for larger sizes	$\pm 1/2$ code for 4, 6, 14 $\mu\text{m}_{(c)}$
Viscosity Range	Up to 1,000 cSt	Up to 1,000 cSt	Up to 1,000 cSt
Fluid Temperature [°C / °F]	Minimum: -25°C / -13°F Maximum: +80°C / +176°F	Minimum: -25°C / -13°F Maximum: +80°C / +176°F	Minimum: -25°C / -13°F Maximum: +60°C / +140°F
Ambient Temperature [°C / °F]	Minimum: -10°C / +14°F Maximum: +55°C / +135°F	Minimum: -10°C / +14°F Maximum: +55°C / +135°F	Minimum: 0°C / 32°F Maximum: +60°C / +140°F
Pressure [bar / PSI]	Minimum: 0.5 bar / 7 PSI Maximum: 420 bar / 6,091 PSI	Minimum: 0.5 bar / 7 PSI Maximum: 420 bar / 6,091 PSI	Minimum: 25 bar / 363 PSI Maximum: 350 bar / 5,076 PSI
Sample Volume	Adjustable 10 - 3,600 sec. Factory set to 120 sec. Start delay & programmable test intervals available as standard	Adjustable 10 - 3,600 sec. Factory set to 120 sec. Start delay & programmable test intervals available as standard	Adjustable 10 - 3,600 sec.
Data Storage	Up to 4,000 tests	Up to 4,000 tests	No internal memory
Environmental Protection	IP64 versatile IK04 Impact Protection	IP64 versatile IK04 Impact Protection	N/A
Power	Voltage 9-36V DC	Voltage 9-36V DC	24VDC $\pm 20\%$
Net weight [kg / lbs]	1.6 kg / 3.85 lbs	1.6 kg / 3.85 lbs	1.4 kg / 3.08 lbs
Product Dimensions [mm / inch]	Width: 123 mm / 4.8" Height: 142 mm / 5.6" Depth: 65 mm / 2.6"	Width: 123 mm / 4.8" Height: 142 mm / 5.6" Depth: 65 mm / 2.6"	Width: 50 mm / 2" Height: 93 mm / 3 1/2" Depth: 70 mm / 2 3/4"

ICM 2.0

An in-line contamination monitor that automatically measures and displays particulate contamination, moisture, and temperature levels in a variety of hydraulic fluids. Designed to be permanently mounted into systems where ongoing measurement is essential.

Key features

- Full 8-channel measurement and display
- Measures ISO 4406, NAS 1638, and AS 4059E standards
- Moisture and temperature sensing (fluid dependent)
- Data logging with 4,000 test result memory
- Manual, automatic, and remote-control flexibility
- Multicolor display indicators and LED with output alarms
- Robust die-cast aluminum construction
- LPA View Software included (Windows-based)
- Max pressure 420 bar (6090 psi)
- Compatible with various hydraulic fluids, lubrication, subsea, and water-based fluids
- Environmental protection IP65/67 Versatile
- Secondary connector allows for simultaneous control and download of results during operation
- 4-20mA analog output



ICM 4.0

MP Filtri's highly acclaimed Inline Contamination Monitor has raised the bar again - adding full Wi-Fi connectivity to its market-leading feature set, accuracy, and repeatability.

A 24/7 real-time monitoring and critical early warning system, the ICM 4.0 delivers the ultimate in hydraulic health checks – with all data accessible via a sophisticated software suite and an innovative new mobile phone app.

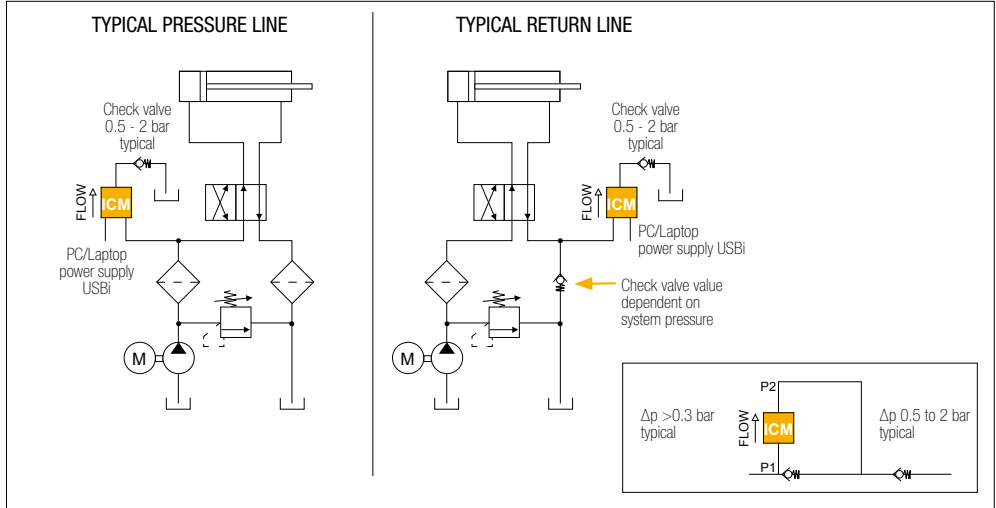
Designed to be permanently mounted into systems where ongoing measurement is essential.

Key features

- Outstanding connectivity using the latest Wi-Fi technology
- Full 8-channel measurement and display
- Measures ISO 4406, NAS 1638, and AS 4059E standards
- Moisture and temperature sensing (fluid dependent) option
- Data logging with 4,000 test result memory
- Manual, automatic, and remote-control flexibility
- Multicolor display indicators and LED with output alarms
- Robust die-cast aluminum construction
- LPA View Software included (Windows-based)
- Max pressure 420 bar (6090 psi)
- Compatible with various hydraulic fluids, lubrication, subsea, and water-based fluids
- Environmental protection IP65/67 Versatile
- Non Wi-Fi Connections also available as standard
- Modbus, CAN bus, 4-20mA signal, and switched alarm relay outputs



ICM 2.0 and ICM 4.0 Hydraulic Circuit



ICU

The ICU automatically measures particulate contamination levels in various hydraulic fluids and is designed especially for industrial applications. An affordable solution for industry, it has been created to be manifold mounted and is ideal for applications where ongoing measurement and analysis is required and space and costs are limited.

Key features

- Manifold mounting
- 3-channel measurement
- Measures ISO 4406
- Robust construction
- CMP View Software included
- Max pressure 350 bar (5075 psi)
- Ingress Protection IP65/67 versatile
- 4-20mA analog output



ACMU

Incorporating ICM technology, the ACMU can offer Wi-Fi connectivity.

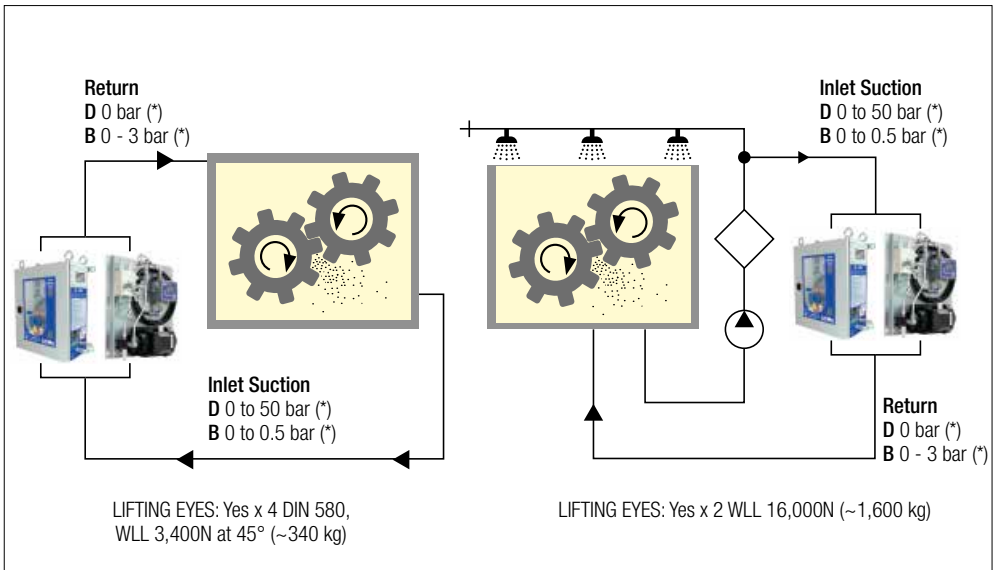
It is designed for measuring aerated, viscous, and unpressurized hydraulic and lubrication systems in the wind, tidal and wave energy sectors; gearbox applications and monitoring; offshore and maritime systems; lubrication and oil systems; mobile equipment, and test benches.

Key features

- Choice of ICM 2.0 and ICM 4.0 inline contamination monitoring technology
- Wi-Fi capabilities
- Full 8-channel measurement
- Measures ISO 4406, NAS 1638, and AS 4059E standards
- Manual, automatic, and remote-control flexibility
- Robust construction
- Ideal for entrained air and turbulent flows, as well as high-viscosity fluids and unpressurized systems
- Easy to retrofit
- Reliable and accurate performance
- Cabinet and plate versions available
- LPA View Software (Windows-based)



Type of applications



(*) Gauge pressure

STATIC OFFLINE PRODUCTS: BS110 (110 ML) / BS500 (500 ML)

MP Filtri bottle samplers are suitable for offline and laboratory applications where fluid sampling at the point of use is inaccessible or impractical. A fluid deaeration facility comes as standard.

Key Features

- Vacuum feature for deaeration of fluids
- Compatible with all MP Filtri portable particle counters
- Strong laboratory aesthetic
- Transparent outer layer for visual indication
- Full accessories kit
- Compatible with various hydraulic fluids, lubrication, subsea, and water-based fluids
- Protective carry case (BS110 only)



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