UNDERSTANDING ISO CODES

Understanding ISO Codes - The ISO cleanliness code (per ISO4406-1999) is used to quantify particulate contamination levels per milliliter of fluid at 3 sizes 4m[c], 6m[c] and 14m[c]. The ISO code is expressed in 3 numbers (example: 19/17/14). Each number represents a contaminant level code for the correlating particle size. The code includes all particles of the specified size and larger. It is important to note that each time a code increases the quantity range of particles is doubling and inversely as a code decreases by one the contaminant level is cut in half.

ISO 4406:1999 Code Chart		
Range Code	Particles per Milliliter	
	More Than	Up To/Including
24	80000	160000
23	40000	80000
22	20000	40000
21	10000	20000
20	5000	10000
19	2500	5000
18	1300	2500
17	640	1300
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

Particle Size	Particles per Milliliter	ISO 4406 Code Range	ISO Code
$4\mu m_{[c]}$	**151773**	**80000~160000**	**24**
$4.6\mu m_{[c]}$	87210		
$6\mu m_{[c]}$	**38363**	**20000~40000**	**22**
$10\mu m_{[c]}$	8229		
$14\mu m_{[c]}$	**3339**	**2500~5000**	**19**
$21\mu m_{[c]}$	1048		
$38\mu m_{[c]}$	112		
$68\mu m_{[c]}$	2		

Particle Size	Particles per Milliliter	ISO 4406 Code Range	ISO Code
$4\mu m_{[c]}$	**69**	**40~80**	**13**
$4.6\mu m_{[c]}$	35		
$6\mu m_{[c]}$	**7**	**5~10**	**10**
$10\mu m_{[c]}$	5		
$14\mu m_{[c]}$	**0.4**	**0.32~0.64**	**6**
$21\mu m_{[c]}$	0.1		
$38\mu m_{[c]}$	0.0		
$68\mu m_{[c]}$	0.0		

Succeed with a Total Systems Cleanliness Approach

Developing a Total System Cleanliness approach to control contamination and care for fluids from arrival to disposal will ultimately result in more reliable plant operation and save money. Several steps to achieve Total Systems Cleanliness include: evaluate and survey all hydraulic and lubrication systems, establish an oil analysis program and schedule, insist on specific fluid cleanliness levels for all new fluids, establish a baseline and target fluid cleanliness for each system, filter all new fluids upon arrival and during transfer, seal all reservoirs and bulk tanks, install high quality particulate and desiccant breathers, enhance air and liquid filtration on existing systems wherever suitable, use portable or permanent off-line filtration to enhance existing filtration, improve bulk oil storage and handling during transfer, remove water and make a commitment to fluid cleanliness.

The visible cost of proper contamination control and total systems cleanliness is less than 3% of the total cost of contamination when not kept under control. Keep your head above the surface and avoid the resource draining costs associated with fluid contamination issues including:

- Downtime and lost production
- Component repair/replacement
- Reduced useful fluid life
- Wasted materials and supplies ($)
- Root cause analysis meetings
- Maintenance labor costs
- Unreliable machine performance
- Wasted time and energy ($)

HY-PRO FILTRATION

When setting target ISO fluid cleanliness codes for hydraulic and lubrication systems it is important to keep in mind the objectives to be achieved. Maximizing equipment reliability and safety, minimizing repair and replacement costs, extending useful fluid life, satisfying warranty requirements, and minimizing production down-time are attainable goals. Once a target ISO cleanliness code is set following a progression of steps to achieve that target, monitor it, and maintain it will yield justifiable rewards for your efforts. Make an impact on reliability by controlling contamination.

Set the Target.
The first step in identifying a target ISO code for a system is to identify the most sensitive component on an individual system, or the most sensitive component supplied by a central reservoir. If a central reservoir supplies several systems the overall cleanliness must be maintained, or the most sensitive component must be protected by filtration that cleans the fluid to the target before reaching that component.

Other Considerations.
Table 1 recommends conservative target ISO cleanliness codes based on several component manufacturers guidelines and extensive field studies for standard industrial operating conditions in systems using petroleum based fluids. If a non-petroleum based fluid is used (i.e. water glycol) the target ISO code should be set one value lower for each size ($4\mu_{[c]}/6\mu_{[c]}/14\mu_{[c]}$). If a combination of the following conditions exists in the system the target ISO code should also be set one value lower:

- Component is critical to safety or overall system reliability.
- Frequent cold start.
- Excessive shock or vibration.
- Other severe operation conditions.

Recommended* Target ISO Cleanliness Codes and media selection for systems using petroleum based fluids per ISO4406:1999 for particle sizes $4\mu_{[c]}$ / $6\mu_{[c]}$ / $14\mu_{[c]}$

Pumps	Pressure < 138 bar < 2000 psi	Media $\beta x_{[c]} = 1000$ ($\beta x = 200$)	Pressure 138-207 bar 2000 - 3000 psi	Media $\beta x_{[c]} = 1000$ ($\beta x = 200$)	Pressure > 207 bar > 3000 psi	Media $\beta x_{[c]} = 1000$ ($\beta x = 200$)
Fixed Gear	20/18/15	$22\mu_{[c]}$ (25μ)	19/17/15	$12\mu_{[c]}$ (12μ)	-	-
Fixed Piston	19/17/14	$12\mu_{[c]}$ (12μ)	18/16/13	$12\mu_{[c]}$ (12μ)	17/15/12	$7\mu_{[c]}$ (6μ)
Fixed Vane	20/18/15	$22\mu_{[c]}$ (25μ)	19/17/14	$12\mu_{[c]}$ (12μ)	18/16/13	$12\mu_{[c]}$ (12μ)
Variable Piston	18/16/13	$7\mu_{[c]}$ (6μ)	17/15/13	$7\mu_{[c]}$ (6μ)	16/14/12	$5\mu_{[c]}$ (3μ)
Variable Vane	18/16/13	$7\mu_{[c]}$ (6μ)	17/15/12	$5\mu_{[c]}$ (3μ)	-	-
Valves						
Cartridge	18/16/13	$12\mu_{[c]}$ (12μ)	17/15/12	$7\mu_{[c]}$ (6μ)	17/15/12	$7\mu_{[c]}$ (6μ)
Check Valve	20/18/15	$22\mu_{[c]}$ (25μ)	20/18/15	$22\mu_{[c]}$ (25μ)	19/17/14	$12\mu_{[c]}$ (12μ)
Directional (solenoid)	20/18/15	$22\mu_{[c]}$ (25μ)	19/17/14	$12\mu_{[c]}$ (12μ)	18/16/13	$12\mu_{[c]}$ (12μ)
Flow Control	19/17/14	$12\mu_{[c]}$ (12μ)	18/16/13	$12\mu_{[c]}$ (12μ)	18/16/13	$12\mu_{[c]}$ (12μ)
Pressure Control (modulating)	19/17/14	$12\mu_{[c]}$ (12μ)	18/16/13	$12\mu_{[c]}$ (12μ)	17/15/12	$7\mu_{[c]}$ (6μ)
Proportional Cartridge Valve	17/15/12	$7\mu_{[c]}$ (6μ)	17/15/12	$7\mu_{[c]}$ (6μ)	16/14/11	$5\mu_{[c]}$ (3μ)
Proportional Directional	17/15/12	$7\mu_{[c]}$ (6μ)	17/15/12	$7\mu_{[c]}$ (6μ)	16/14/11	$5\mu_{[c]}$ (3μ)
Proportional Flow Control	17/15/12	$7\mu_{[c]}$ (6μ)	17/15/12	$7\mu_{[c]}$ (6μ)	16/14/11	$5\mu_{[c]}$ (3μ)
Proportional Pressure Control	17/15/12	$7\mu_{[c]}$ (6μ)	17/15/12	$7\mu_{[c]}$ (6μ)	16/14/11	$5\mu_{[c]}$ (3μ)
Servo Valve	16/14/11	$7\mu_{[c]}$ (6μ)	16/14/11	$5\mu_{[c]}$ (3μ)	15/13/10	$5\mu_{[c]}$ (3μ)
Bearings						
Ball Bearing	15/13/10	$5\mu_{[c]}$ (3μ)	-	-	-	-
Gearbox (industrial)	17/16/13	$12\mu_{[c]}$ (12μ)	-	-	-	-
Journal Bearing (high speed)	17/15/12	$7\mu_{[c]}$ (6μ)	-	-	-	-
Journal Bearing (low speed)	17/15/12	$7\mu_{[c]}$ (6μ)	-	-	-	-
Roller Bearing	16/14/11	$7\mu_{[c]}$ (6μ)	-	-	-	-
Actuators						
Cylinders	17/15/12	$7\mu_{[c]}$ (6μ)	16/14/11	$5\mu_{[c]}$ (3μ)	15/13/10	$5\mu_{[c]}$ (3μ)
Vane Motors	20/18/15	$22\mu_{[c]}$ (25μ)	19/17/14	$12\mu_{[c]}$ (12μ)	18/16/13	$12\mu_{[c]}$ (12μ)
Axial Piston Motors	19/17/14	$12\mu_{[c]}$ (12μ)	18/16/13	$12\mu_{[c]}$ (12μ)	17/15/12	$7\mu_{[c]}$ (6μ)
Gear Motors	20/18/14	$22\mu_{[c]}$ (25μ)	19/17/13	$12\mu_{[c]}$ (12μ)	18/16/13	$12\mu_{[c]}$ (12μ)
Radial Piston Motors	20/18/15	$22\mu_{[c]}$ (25μ)	19/17/14	$12\mu_{[c]}$ (12μ)	18/16/13	$12\mu_{[c]}$ (12μ)
Test Stands, Hydrostatic						
Test Stands	15/13/10	$5\mu_{[c]}$ (3μ)	15/13/10	$5\mu_{[c]}$ (3μ)	15/13/10	$5\mu_{[c]}$ (3μ)
Hydrostatic Transmissions	17/15/13	$7\mu_{[c]}$ (6μ)	16/14/11	$5\mu_{[c]}$ (3μ)	16/14/11	$5\mu_{[c]}$ (3μ)

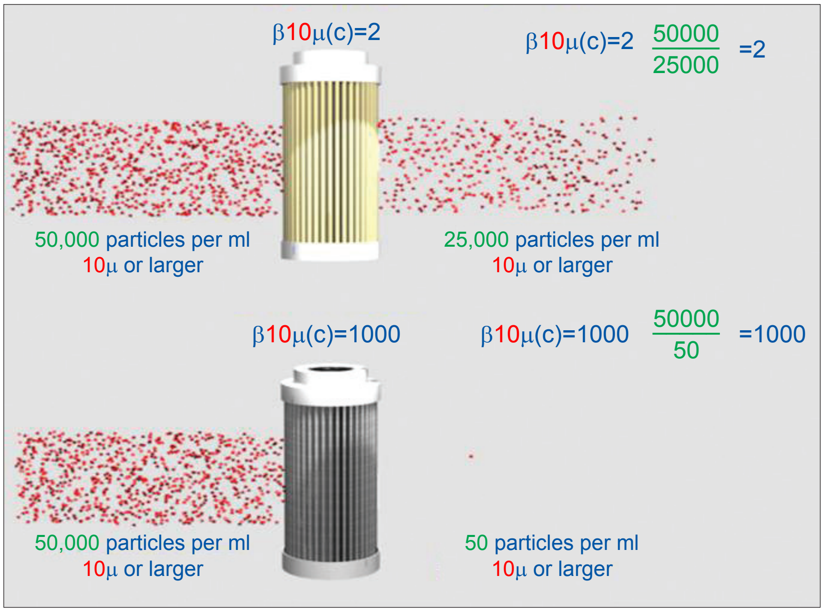
*Depending upon system volume and severity of operating conditions a combination of filters with varying degrees of filtration efficiency might be required (I.e. pressure, return, and off-line filters) to achieve and maintain the desired fluid cleanliness.

Example		ISO Code	Comments
Operating Pressure	156 bar, 2200 psi		
Most Sensitive Component	Directional Solenoid	19/17/14	Recommended Baseline ISO Code
Fluid Type	Water Glycol	18/16/13	Adjust Down One Class
Operating Conditions	Remote Location, Repair Difficult, High Ingression Rate	17/15/12	Adjust Down One Class, Combination of Critical Nature, Severe Conditions

HY-PRO FILTRATION

Hy-Pro G8 Dualglass Upgrade from Cellulose Media

Glass media has superior fluid compatibility versus cellulose with hydraulic fluids, synthetics, solvents, and high water based fluids. Glass media also has a significant filtration efficiency advantage over cellulose, and is classified as “absolute” where cellulose media efficiency is classified as “nominal”.

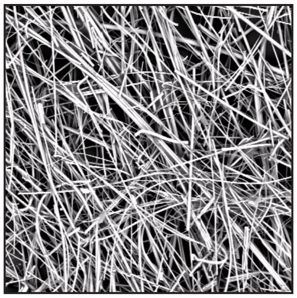


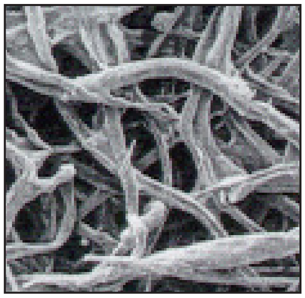
Elements of different media with the same “micron rating” can have substantially different filtration efficiency. Figure 1 provides a visual representation of the difference between absolute and nominal filter efficiency.

The illustrated glass element would typically deliver an ISO Fluid Cleanliness Code of 18/15/8 to 15/13/9 or better depending upon the system conditions and ingression rate. The cellulose element would typically achieve a code no better than 22/20/17.

Runaway contamination levels at $4\mu_{[c]}$ and $6\mu_{[c]}$ are very common when cellulose media is applied where a high population of fine particles exponentially generate more particles in a chain reaction of internally generated contaminate.

Inorganic glass fibers are much more uniform in diameter and are smaller than cellulose fibers. Organic cellulose fibers can be unpredictable in size and effective useful life. Smaller fiber size means more fibers and more void volume space to capture and retain contaminate.



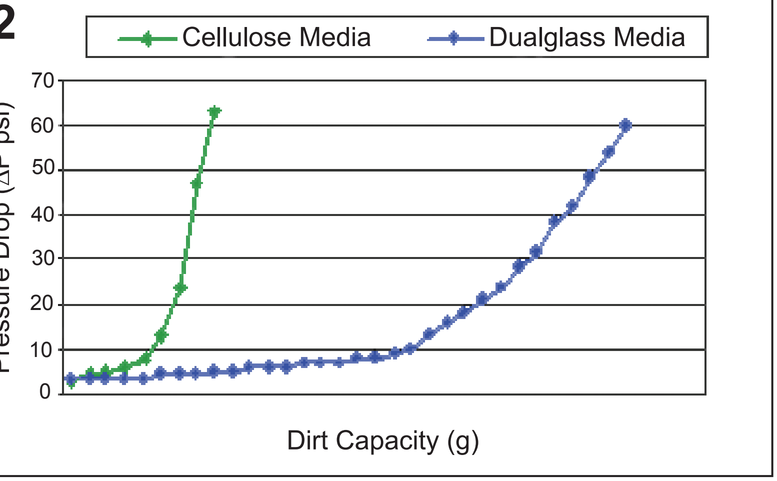


Upgrading to Hy-Pro G8 Dualglass

Glass media has much better dirt holding capacity than cellulose. When upgrading to an absolute efficiency glass media element the system cleanliness must be stabilized. During this clean-up period the glass element halts the runaway contamination as the ISO cleanliness codes are brought into the target cleanliness range. As the glass element removes years of accumulated fine particles the element life might be temporarily short.

Once the system is clean the glass element can last up to 4~5 times longer than the cellulose element that was upgraded as shown in figure 2.

2



HY-PRO FILTRATION

Cleaner Fluid, Longer Component & Fluid Life, More Uptime!

Roller Contact Bearing

Current ISO Code	Target ISO Code	Target ISO Code	Target ISO Code	Target ISO Code
	2 x Life	3 x Life	4 x Life	5 x Life
28/26/23	25/22/19	22/20/17	20/18/15	19/17/14
27/25/22	23/21/18	21/19/16	19/17/14	18/16/13
26/24/21	22/20/17	20/18/15	19/17/14	17/15/12
25/23/20	21/19/16	19/17/14	17/15/12	16/14/11
25/22/19	20/18/15	18/16/13	16/14/11	15/13/10
23/21/18	19/17/14	17/15/12	15/13/10	14/12/9
22/20/17	18/16/13	16/14/11	15/13/10	13/11/8
21/19/16	17/15/12	15/13/10	13/11/8	-
20/18/15	16/14/11	14/12/9	-	-
19/17/14	15/13/10	13/11/8	-	
18/16/13	14/12/9	-	-	
17/15/12	13/11/8	-	-	
16/14/11	13/11/8	-	-	
15/13/10	13/11/8	-	-	
14/12/9	13/11/8	-	-	

Laboratory and field tests prove time and again that Hy-Pro filters consistently deliver lower ISO fluid cleanliness codes.

Improving fluid cleanliness means reduced downtime, more reliable equipment, longer fluid life, fewer maintenance hours, and reduces costly component replacement or repair expenses.

Hydraulic Component

Current ISO Code	Target ISO Code	Target ISO Code	Target ISO Code	Target ISO Code
	2 x Life	3 x Life	4 x Life	5 x Life
28/26/23	25/23/21	25/22/19	23/21/18	22/20/17
27/25/22	25/23/19	23/21/18	22/20/17	21/19/16
26/24/21	23/21/18	22/20/17	21/19/16	21/19/15
25/23/20	22/20/17	21/19/16	20/18/15	19/17/14
25/22/19	21/19/16	20/18/15	19/17/14	18/16/13
23/21/18	20/18/15	19/17/14	18/16/13	17/15/12
22/20/17	19/17/14	18/16/13	17/15/12	16/14/11
21/19/16	18/16/13	17/15/12	16/14/11	15/13/10
20/18/15	17/15/12	16/14/11	15/13/10	14/12/9
19/17/14	16/14/11	15/13/10	14/12/9	14/12/8
18/16/13	15/13/10	14/12/9	13/11/8	-
17/15/12	14/12/9	13/11/8	-	-
16/14/11	13/11/8	-	-	-
15/13/10	13/11/8	-	-	-
14/12/9	13/11/8	-	-	-

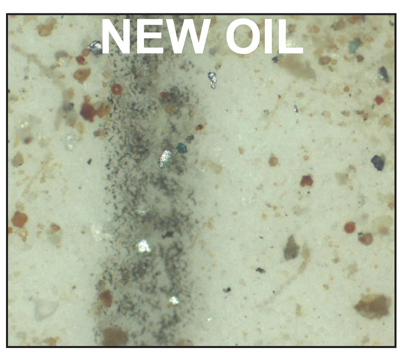
Develop a Fluid Cleanliness Target

Hy-Pro will help you develop a plan to achieve and maintain target fluid cleanliness. Arm yourself with the support, training, tools and practices to operate more efficiently, maximize uptime and save money.

New Oil is Typically Dirty Oil...

New oil can be one of the worst sources of particulate and water contamination.

25/22/19 is a common ISO code for new oil which is not suitable for hydraulic or lubrication systems. A good target for new oil cleanliness is 16/14/11.



HY-PRO FILTRATION