Paper Machine Lubrication

Dry End Filter Element Upgrade

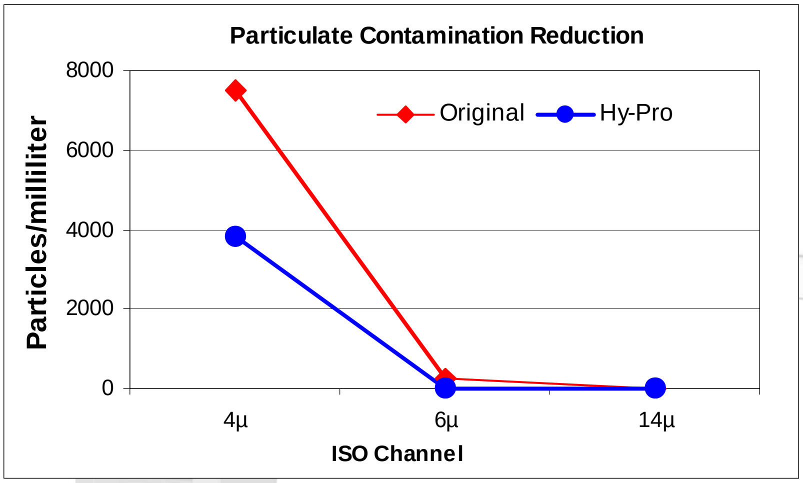
The system supplying filtered and cooled lube oil to the roller bearings on the paper mill dry end was consuming a substantial amount of filter elements. Thus, a better fluid filtration solution was sought to keep things rolling longer while improving bottom line profitability. OEM specified original elements had been in use, but it was anticipated that Hy-Pro elements could provide better ISO fluid cleanliness codes plus longer element life.

Operating Pressure	**~75 PSI**
Operating Temperature	**135℉**
Fluid Type	**Exxon PM320**

Filter Element Upgrade - The original element ($\beta 7_{[c]} > 1000$) was replaced with a Hy-Pro upgrade element (HP8314L39-6LB) which is specifically designed to optimize fluid cleanliness and element life in a high viscosity fluid where differential pressure indicators signal the need for element change at low Δp ranging from 18~25 psid (1,3 ~ 1,7 Δbar).

Test Protocol - Fluid cleanliness was analyzed before and after the fluid passed through the filter housings with an on-line particle counter calibrated to ISO11171 (ISO codes per ISO4406:1999). No bottle samples were used and on-line samples were continuously taken until at least three consecutive identical samples were yielded to ensure that the sample ports were properly flushed ensuring no false counts due to dirty sample ports.

The Results - On-line particle counting was used to quantify the fluid cleanliness after the Hy-Pro upgrade. The Hy-Pro elements yielded substantial improvement in ISO fluid cleanliness codes visible in the tables and graph below. With the Hy-Pro elements there was a **49.3% reduction in particles $4\mu_{[c]}$ and larger, a 93.7% reduction in particles $6\mu_{[c]}$ and larger and a 85.2% reduction in particles $14\mu_{[c]}$ and larger**.



Original Elements	$4\mu_{[c]}$	$6\mu_{[c]}$	$14\mu_{[c]}$
ISO Code (per 4406:1999)	20	15	9
Actual Particles per Milliliter	~7500	~240	~3.8

Hy-Pro Upgrade	$4\mu_{[c]}$	$6\mu_{[c]}$	$14\mu_{[c]}$
ISO Code (per 4406:1999)	19	11	6
Actual Particles per Milliliter	~3800	~15	~0.56

Element Life - The original element had a clean element ΔP of 10 psid and lasted approximately 41 days. The Hy-Pro clean element ΔP was 7 psid then 8 psid and 10 psid after 21 days and 31 days respectively. The Hy-Pro elements have been lasting 60~65 days under normal operating conditions. The improvement in fluid cleanliness translates into increased component life and greater reliability. Element & Oil purchases would decrease as the element life in this application has been increased by roughly 50% and the oil is cleaner which will extend the useful life of the oil making this element upgrade a substantial money-saver.

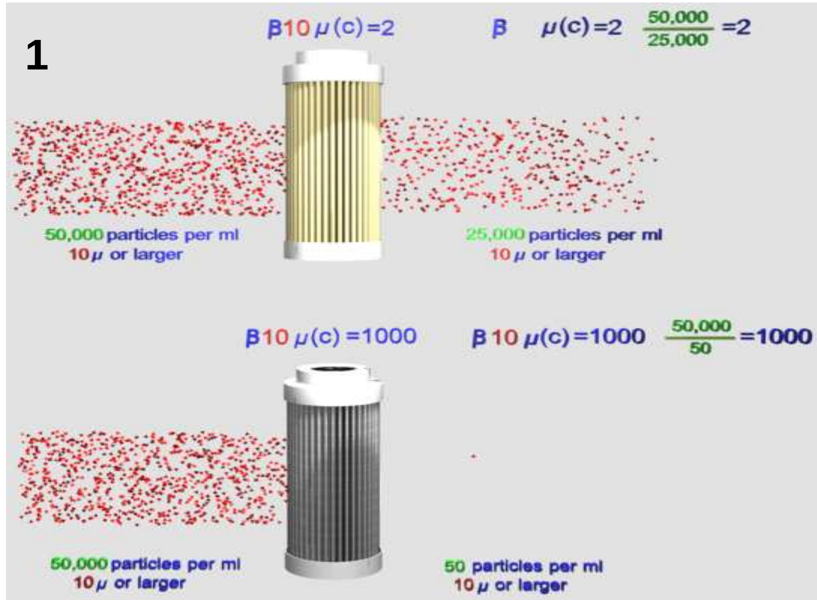
Improvements in ISO fluid cleanliness codes can sometimes be deceiving since what appears to be only a one or two number decrease in any channel is actually a significant improvement. Take as an example the $6\mu_{[c]}$ channel in the two tables above: the original cleanliness code was 15, while the same code after upgrade was a 11. This might seem like a minor improvement but a closer look at the actual data reveals the magnitude:

- The actual number of particles $6\mu_{[c]}$ and larger reduced by a multiple of 16 from 240 to 15 particles / ml.
- There were 93.7% fewer particles $6\mu_{[c]}$ in the fluid causing additive depletion and generating wear particles.

A table and further explanation of the ISO cleanliness ratings is included on the last page.

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".

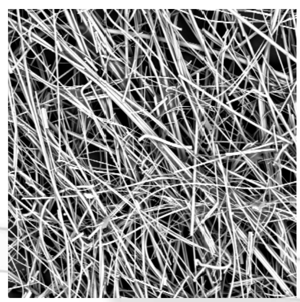


Elements of different media with the same "micron rating" can have substantially different filtration efficiency. Figure 1 provides a visual representation of the difference between absolute and nominal filter efficiency.

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.

Glass Fiber

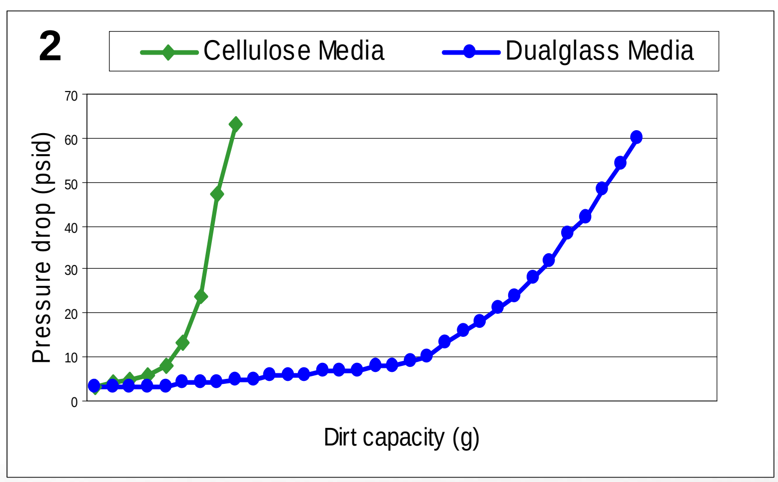


Cellulose

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.

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	-	-	-

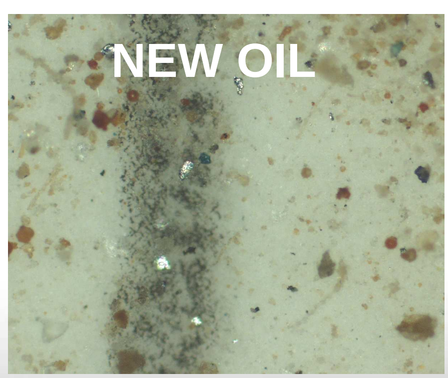
Develop a Fluid Cleanliness Target

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

Understanding ISO Codes - The ISO cleanliness code (per ISO4406-1999) is used to quantify particulate contamination levels per milliliter of fluid at 3 sizes 4µ$_{[c]}$, 6µ$_{[c]}$ and 14µ$_{[c]}$. 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

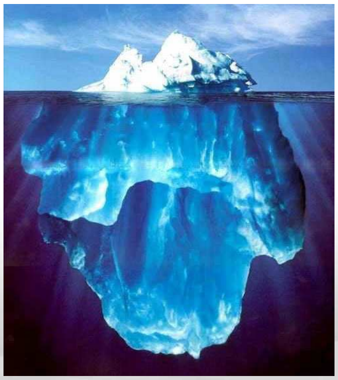
Particle Size	Particles per milliliter	ISO 4406 Code range	ISO Code
4µm$_{[c]}$	**151773**	**80000~160000**	**24**
6µm$_{[c]}$	**38363**	**20000~40000**	**22**
10µm$_{[c]}$	8229		
14µm$_{[c]}$	**3339**	**2500~5000**	**19**
21µm$_{[c]}$	1048		
38µm$_{[c]}$	112		

Particle Size	Particles per milliliter	ISO 4406 Code range	ISO Code
4µm$_{[c]}$	**492**	**320 ~ 640**	**16**
6µm$_{[c]}$	**149**	**80 ~ 160**	**14**
10µm$_{[c]}$	41		
14µm$_{[c]}$	**15**	**10 ~ 20**	**11**
21µm$_{[c]}$	5		
38µm$_{[c]}$	1		

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 ($)
- Root cause analysis meetings
- Maintenance labor costs
- Unreliable machine performance
- Wasted time and energy ($)