Hydraulic Valve Manufacturing

Element & System Upgrades Reduce Failures

A manufacturer of mobile, multi-function valves for heavy lifts and cranes was battling hydraulic fluid contamination related failures on four operating production lines. A four month trial was conducted in which one entire production line was upgraded to Hy-Pro elements and one of the remaining three lines was chosen to represent the originally specified filter element supplier. Head-to-head testing such as this facilitates an excellent opportunity to compare real-time fluid cleanliness. The ISO fluid cleanliness code target of 17/15/13 was established before the testing began..

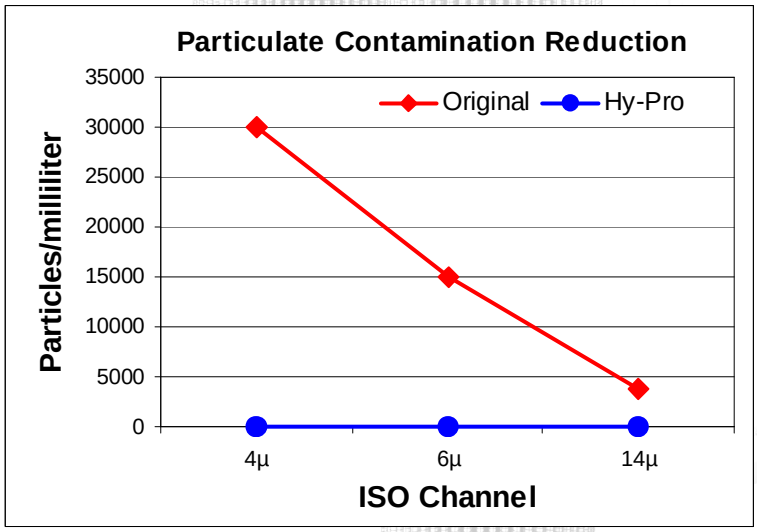
Several conditions had prompted the search for better systems cleanliness, including:

- Twenty-five hydraulic pump replacements in a single year due to wear and failure.
- Final product consistently tested below quality specifications.
- Fluid was consistently measured above suitable ISO fluid cleanliness levels.

Adjustments made prior to the trial:

- Install high efficiency Hy-Pro breather on scavenge tank, replace lids/tank seals.
- Magnom filter on the scavenge tank was removed for a thorough cleaning.
- Repair unchecked bypass over the relief valve in the cooling circuit.

Filter Element Upgrade - The Original filter elements were rated $\beta 7_{[c]} > 1000$ and $\beta 12_{[c]} > 1000$, but these were proving to be insufficient for the application. To replace these elements on the production line being tested in the upgrade, Hy-Pro elements: HP60L4-12MB HP83L16-12MB; HP60L13-12MB were installed. 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 **99.9% reduction in particles $4\mu_{[c]}$ and larger, a 99.9% reduction in particles $6\mu_{[c]}$ and larger and a 99.9% reduction in particles $14\mu_{[c]}$ and larger**.



Original Elements	$4\mu_{[c]}$	$6\mu_{[c]}$	$14\mu_{[c]}$
ISO Code (per 4406:1999)	22	21	19
Actual Particles per Milliliter	~30,000	~15,000	~3750

Hy-Pro Upgrade	$4\mu_{[c]}$	$6\mu_{[c]}$	$14\mu_{[c]}$
ISO Code (per 4406:1999)	12	11	7
Actual Particles per Milliliter	~30	~15	~.97

99.9% reduction in particles $6\mu_{[c]}$ and larger

ISO fluid cleanliness ratings can sometimes be deceiving because what appears to be a 10 number decrease in any channel is actually monumental in terms of improvement. Take as an example the 4µ channel in the two tables above: the original ISO code was a 22 while the same code after upgrade was a 12 This ten point improvement actually represents:

- The actual number of particles dropped by a factor of 1000 from 30,000 to 30 particles per milliliter.
- There were 99.9% fewer particles $4\mu_{[c]}$ and larger 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 FILTRATION

SYSTEM CLEAN UP

The Results - The Hy-Pro elements coupled with the maintenance practice improvements vastly exceeded the target cleanliness numbers and outperformed the originally specified filters in the same time frame. Hy-Pro elements are now used on all four production lines. The samples taken from the production lines consistently achieve their cleanliness code targets, and the product consistently achieves its quality standard.

Downtime in the manufacturing process has been significantly reduced.

Productivity levels are higher.

Fluid leakage and hydraulic equipment replacements have been virtually eliminated.

Cleanliness Protocol - This production clean-up is a great example of how Hy-Pro filtration equipment and some care for fluid cleanliness can greatly improve the bottom line for a manufacturer. The protocol established and used for this specific case represents a good guideline for future projects:

- Step 1 . . . Contact Hy-Pro for assistance with you total system cleanliness approach to reliability.
- Appropriate test points must be designated that will provide consistent and reliable sample accuracy.
- As completely as possible, a history of the oil cleanliness prior to the upgrade needs to be established and documented.
- A reasonable target ISO cleanliness number should be chosen with the goal being to provide for optimum service life and reliability of system components.
- Two samples should be taken on a weekly basis during trials: one for the manufacturer's lab to analyze and the other to be analyzed by a Hy-Pro lab.
- Oil tests should consist of particle counts only, and the results will be compared after each monthly cycle of testing is complete.

For each production line - In the end, each production line received other upgrades and had guidelines applied to maintain the newly-developed system cleanliness:

- ISO cleanliness targets were established for each major component in each production line.
- Sample ports were fitted into appropriate locations.
- System components were inspected during downtime for performance, leakage and wear.
- All existing air breathers were also replaced with Hy-Pro breather elements to eliminate small particulate contaminants from entering through the air.

Hy-Pro Distributor Support & Commitment - Even after the trial was finished and all four production lines were upgraded to Hy-Pro elements, the Hy-Pro distributor maintained their commitment to system cleanliness and their method is an excellent demonstration of how to maintain fluid cleanliness in a production situation. The primary aspects of the distributor's continued involvement include:

- Regular fluid analysis and trending of the results presented to the end user.
- Stock of elements on-site in cabinets specific to each machine line with a chart detailing which element fits in each respective housing.
- In case of emergency, a "back-up" store of elements are also held.
- With the fluid analysis, the distributor can predict element change-out prior to reaching the by-pass condition.
- Become an integral part of the "Lube Team" within the plant providing invaluable expertise.

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	-	-	-

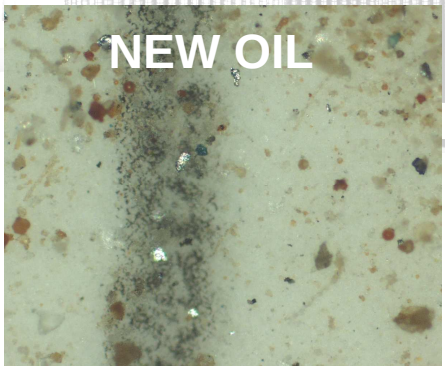
Develop a Fluid Cleanliness Target

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.



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 $4\mu_{[c]}$, $6\mu_{[c]}$ and $14\mu_{[c]}$. 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

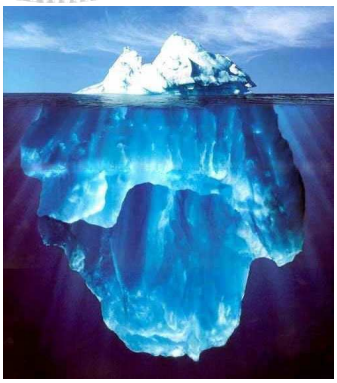
Particle Size	Particles per milliliter	ISO 4406 Code range	ISO Code
$4\mu m_{[c]}$	**151773**	**80000~160000**	**24**
$6\mu m_{[c]}$	**38363**	**20000~40000**	**22**
$10\mu m_{[c]}$	8229		
$14\mu m_{[c]}$	**3339**	**2500~5000**	**19**
$21\mu m_{[c]}$	1048		
$38\mu m_{[c]}$	112		

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

HY-PRO FILTRATION

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