Hydraulic & Lube Oil Contamination Reference Chart

Appearance of Water in Oil

Dissolved Water- Oil appears bright and clear. Water can only be removed by vacuum dehydration.

500 ppm 1000 ppm 2500 ppm 5000 ppm 10000 ppm

Emulsified Water- Very small droplets dispersed in oil. Oil viscosity may go up and appear cloudy and milky. Tiny amounts of detergent engine oil can contaminate industrial oils.

Free Water- Large drops that readily settle out.

Harmful Effects of Water in Oil

Contamination Related Failure

Water is one of the most common and most damaging contaminants found in a lube or hydraulic system. Continuous or periodic high water levels can result in damage such as:

- Metal Etching (Corrosion)
- Abrasive Wear in Hydraulic Components
- Dielectric Strength Loss
- Fluid Breakdown
- Additive Precipitation and Oil Oxidation
- Reduction in Lubricating Properties

Component Life Extension by Removing Water

New Moisture Level PPM (%)

Current Moisture Level PPM

	1000 (0.1%)		500 (0.05%)		250 (0.025%)		100 (0.01%)		50 (0.005%)	
	Rolling Element	Journal Bearing	Rolling Element	Journal Bearing	Rolling Element	Journal Bearing	Rolling Element	Journal Bearing	Rolling Element	Journal Bearing
5000	2.3	1.6	3.3	1.9	4.8	2.3	7.8	2.9	11.2	3.5
2500	1.6	1.3	2.3	1.6	3.3	1.9	5.4	2.4	7.8	2.9
1000			1.4	1.2	2	1.5	3.3	1.9	4.8	2.3
500					1.4	1.2	2.3	1.6	3.3	1.9
250							1.5	1.3	2.3	1.6
100									1.4	1.2

Component Life Extension by Removing Water*

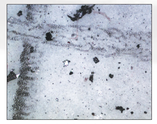
*Courtesy of Noria

VUD Vacuum Dehydrator
Rapidly removes free, emulsified and dissolved water to < 50 PPM (0.005%). Turbine oil, AW Hydraulic and lube oil up to ISO VG680.

COT Turbine Oil Coalesce Skid-
Rapidly removes free and emulsified water to < 150 ppm (0.015%) with high single pass efficiency. Turbine oil and diesel fuels up to ISO VG68.

HY-PRO

www.hyprofiltration.com



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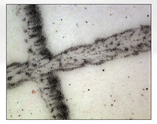

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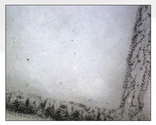

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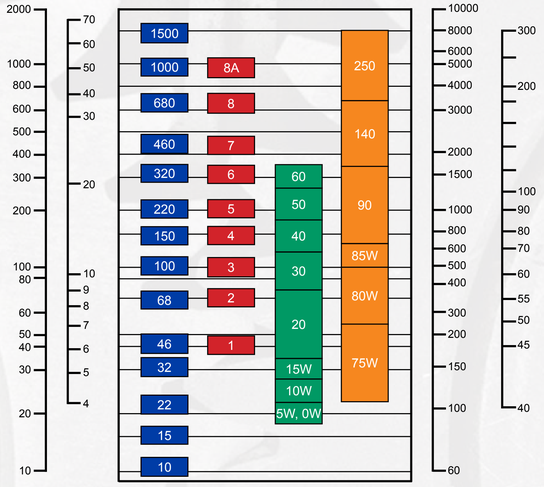
PTK1

Lowering Your ISO Codes:
Oil Analyses Filter Patches
Understanding the condition of your fluid is the first step toward improving your system cleanliness. Establish your current ISO code, set a target and a plan of action, and finally trend your progress to your goal.

Viscosity Grading Systems



Understanding ISO Codes

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
$4\mu_{[c]}$	151773	80000~160000	24
$6\mu_{[c]}$	38363	20000~40000	22
$10\mu_{[c]}$	8229		
$14\mu_{[c]}$	3339	2500~5000	19
$21\mu_{[c]}$	1048		
$38\mu_{[c]}$	112		

Particle Size	Particles Per Milliliter	ISO 4406 Code Range	ISO Code
$4\mu_{[c]}$	492	320 ~ 640	16
$6\mu_{[c]}$	149	80 ~ 160	14
$10\mu_{[c]}$	41		
$14\mu_{[c]}$	15	10 ~ 20	11
$21\mu_{[c]}$	5		
$38\mu_{[c]}$	1		

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.

FCLCOD

Filter carts for particulate removal, water absorption, coalescence, and diesel conditioning. Compatible with fluids up to ISOVG680.

Component Life Extension Tables

DFE Rated Filter Elements Lower ISO Codes and Improve Reliability

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
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
22/22/19	20/18/15	16/16/13	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	-	-	-

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.

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
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	-	-	-

Target ISO Codes

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

	Pressure < 140 bar < 2000 psi	Media $\beta x_{[c]} = 1000$ ($\beta x = 200$)	Pressure 212 bar 3000 psi	Media $\beta x_{[c]} = 1000$ ($\beta x = 200$)	Pressure > 212 bar > 3000 psi	Media $\beta x_{[c]} = 1000$ ($\beta x = 200$)
Pumps						
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	7µ[c] (6µ)	17/15/12	$7\mu_{[c]}$ (6µ)	16/14/11	$5\mu_{[c]}$ (3µ)
Servo Valve	16/14/11	7µ[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.**

FSL

Dedicated filtration skids and panels for gearbox and side-loop reservoir conditioning.

FPL