



CITGO Technical Bulletin

Understanding ISO Cleanliness Rating System for Hydraulic Fluids (ISO Standard 4406)

It is estimated that 70-80% of hydraulic component wear can be traced to solid particle contamination. The most common sources of these are wear debris from pumps, valves, cylinder rods, the sticking of valves, and oxidation. A primary step toward gaining control over wear problems is to determine how many, and what size particles are present in the hydraulic fluid.

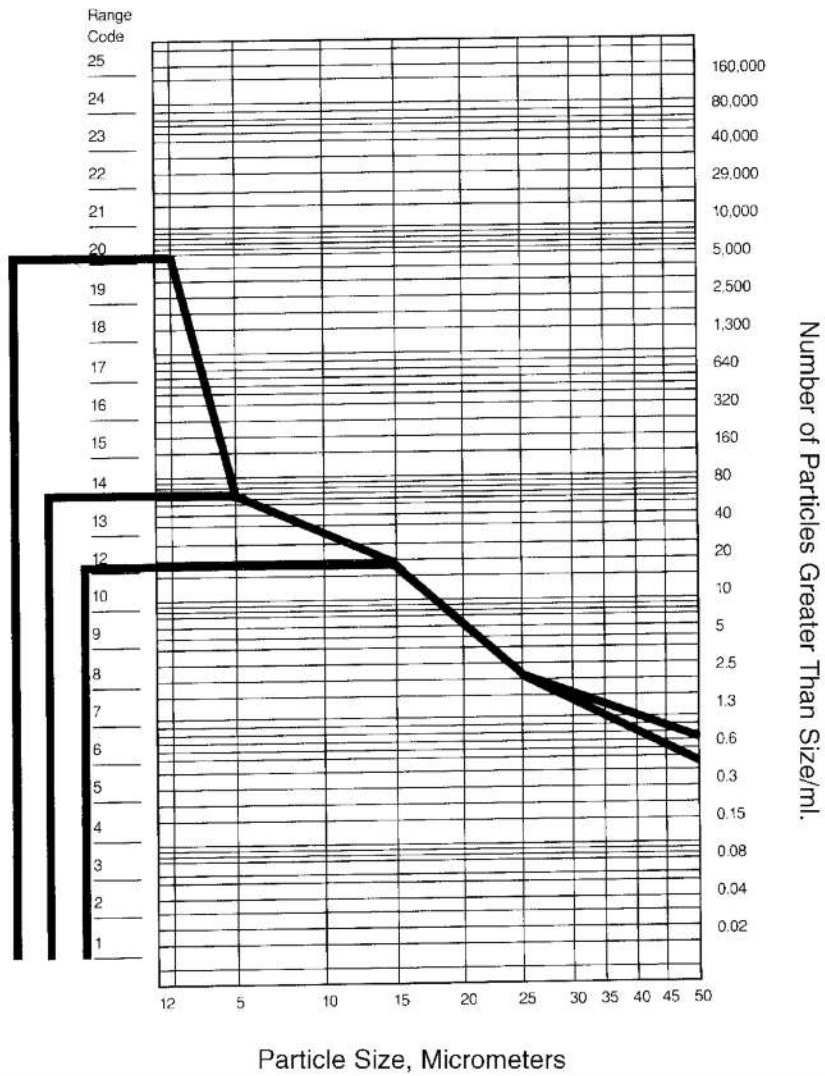
The means most widely used to represent fluid cleanliness is the ISO Code Level of the ISO Cleanliness Rating System. This method of identifying the level of contaminants in a fluid uses a two digit XY code where X represents particles larger than 5um and Y represent particles larger than 15um. Using Chart 1 you can determine the cleanliness level of a given fluid. If, for example, a fluid had x (>5um) = 1895 particles per milliliter and Y (>15um) = 152 particles per milliliter, the fluid would have an ISO cleanliness rating of 18/14. The lower the code numbers, the cleaner the fluid.

Some organizations have extended the two standard code (XY) to three levels by including a code level for (>2um) particles as well. This three level system is illustrated in Chart 2. The three level system is being considered by the ISO committee that oversees this standard.

Chart 3 illustrates some recommended cleanliness code levels for selected types of hydraulic components. Some caution should be taken when extracting samples for particle counting of any fluid. The sample should be as representative of the entire hydraulic system as possible, and the sample container should be glass and super clean. Many containers are certified clean but are not clean from solid particulate; they are biologically clean (sterile) but may contain many particles. ISO Standard 3722 should be followed for certifying bottle cleanliness.

Chart 1 ISO 4406 Code Levels		
ISO Code	Particle count range (per ml)	
	Minimum (included)	Minimum (excluded)
1	0.01	0.02
2	0.02	0.04
3	0.04	0.08
4	0.08	0.16
5	0.16	0.32
6	0.32	0.64
7	0.64	1.3
8	1.3	2.5
9	2.5	5.0
10	5.0	10
11	10	20
12	20	40
13	40	80
14	80	160
15	160	320
16	320	640
17	640	1300
18	1300	2500
19	2500	5000
20	5000	10,000
21	10,000	20,000
22	20,000	40,000
23	40,000	80,000
24	80,000	160,000
25	160,000	320,000
26	320,000	640,000
27	640,000	1,300,000
28	1,300,000	2,500,000

Chart 2. Cleanliness Code Chart



Particle Count Results for Example Fluid

<u>Particle Size, micrometers</u>	<u>Particles Greater than Size in 1-ml of Test Fluid</u>	<u>Range Code</u>
2	5120	20
5	89	14
10	43	X
15	20	12
25	3	X
50	0.4	X

Particles are counted and charted to determine hydraulic fluid cleanliness. In this example the particle results are shown in the table and are spotted on the chart. The three-level cleanliness code for this example fluid is 20/14/12.

Chart 3. Recommended Cleanliness Code Levels

Pump Type	PRESSURE, PSI		
	<2000	2000-3000	>3000
Fixed gear	20/18/15	19/17/15	18/16/13
Fixed vane	20/18/15	19/17/14	18/16/13
Fixed piston	19/17/15	18/16/14	17/15/13
Variable vane	18/16/14	17/15/13	–
Variable piston	18/16/14	17/15/13	16/14/12

Valve Type	PRESSURE, PSI	
	2000	>3000
Directional (solenoid)	20/18/15	19/17/14
Pressure control (modulating)	19/17/14	18/16/13
Flow control (standard)	19/17/14	19/17/14
Check	20/18/15	20/18/15
Cartridge (screw-in)	18/16/13	17/15/12
Cartridge (slip-in)	20/18/15	19/17/14
Proportional directional (throttle)	18/16/13	17/15/12
Proportional pressure control	18/16/13	17/15/12
Proportional cartridge	18/16/13	17/15/12
Servo	16/14/11	15/13/10

Actuator Type	PRESSURE, PSI		
	1000	2000	>3000
Cylinder	20/18/15	20/18/15	20/18/15
Vane motor	20/18/15	19/17/14	18/16/13
Axial piston motor	19/17/14	18/16/13	17/15/12
Gear motor	21/19/17	20/18/15	19/17/14
Radial piston motor	20/18/14	19/17/13	18/16/13