

ISO Cleanliness Guidelines for Hydraulic & Lube Oils

Studies show that approximately half of lost machine life is due to mechanical wear and approximately 80% of mechanical wear is caused by particle contamination in the oil. When oil is kept clean, wear rates go down and component service life goes up.

What is Cleanliness?

When we speak in terms of cleanliness, we often refer to the ISO particle count of the oil. According to the ISO 4406 standard, the ISO particle count is a measure of the number of particles greater than 4, 6, and 14 microns in every milliliter of fluid. The number of particles is then converted to what is referred to as the ISO Code or Range Code. The range code represents the number of particles of a given

size in one milliliter of sample. Results from an oil cleanliness testing are typically reported in a three number format such as 18/16/13, where 18 represents the range code representing the number of particles that are 4 microns and larger, 16 the range of particles that are 6 microns and larger, and 13 represents particles 14 microns and larger.

HOW CAN WE MEASURE HOW MUCH PARTICLE CONTAMINATION IS IN AN OIL?

Particle contamination is measured using the ISO 4406 (c) standard.

Particle Count Data	
Size in Microns	Number of Particles Larger than Size per mL
4	1654
6	495
10	122
14	52
20	21
50	1.3
75	0.22
100	0.05

Number of Particles / mL		Range Number
More Than	Less Than or Equal To	
80,000	160,000	24
40,000	80,000	23
20,000	40,000	22
10,000	20,000	21
5,000	10,000	20
2,500	5,000	19
1,300	2,500	18
640	1,300	17
320	640	16
160	320	15
80	160	14
40	80	13
20	40	12
10	20	11
5	10	10

R4/R6/R14
ISO 18/16/13

The ISO 4406 (c) standard gives a range code corresponding to the number of particles per milliliter in three difference size ranges:

- particles > 4 micron
- particles > 6 micron
- particles >14 micron

A Cleanliness Code is great, but why do these numbers really matter? Won't the contaminant be visible in the oil?

The reality is that 4, 6 and 14 micron particles simply cannot be seen with the naked eye. In fact, it's not until particles get as large as 40-50 microns that we can see them without a microscope.

By the time you can see contaminants in your oil, the oil cleanliness has well exceeded what the oil laboratories particle counter can count. This effectively means your oil is not meeting standards and is TOO DIRTY.

How Clean Should Your Oil Be? Set Your Targets.

	Low/Medium Pressure Under 2000 psi (moderate conditions)		High Pressure 2000 to 2999 psi (low/medium with severe conditions)		Very High Pressure 3000 psi and over (high pressure with severe conditions)	
	ISO Target Levels	Filtration Rating ($\beta_{x(c)} \geq 1000$)	ISO Target Levels	Filtration Rating ($\beta_{x(c)} \geq 1000$)	ISO Target Levels	Filtration Rating ($\beta_{x(c)} \geq 1000$)
Pumps						
Fixed Gear or Fixed Vane	20/18/15	22	19/17/14	10	18/16/13	7
Fixed Piston	19/17/14	10	18/16/13	7	17/15/12	7
Variable Vane	18/16/13	7	17/15/12	7	N/A	N/A
Variable Piston	18/16/13	7	17/15/12	7	16/14/11	5
Valves						
Check Valves	20/18/15	22	20/18/15	22	19/17/14	10
Directional (solenoid)	20/18/15	22	19/17/14	10	18/16/13	7
Standard Flow Control	20/18/15	22	19/17/14	10	18/16/13	7
Cartridge Valve	19/17/14	10	18/16/13	7	17/15/12	7
Proportional Valve	17/15/12	7	17/15/12	7	16/14/11	5
Servo Valve	16/14/11	5	16/14/11	5	15/13/10	5
Actuators						
Cylinders, Vane Motors, Gear Motors	20/18/15	22	19/17/14	10	18/16/13	7
Piston Motors, Swash Plate Motors	19/17/14	10	18/16/13	7	17/15/12	7
Hydrostatic Drives	16/15/12	5	16/14/11	5	15/13/10	5
Test Stands	15/13/10	5	15/13/10	5	15/13/10	5
Bearings						
Journal Bearings	17/15/12	7	N/A	N/A	N/A	N/A
Industrial Gearboxes	19/16/13	12	N/A	N/A	N/A	N/A
Ball Bearings	15/13/10	5	N/A	N/A	N/A	N/A
Roller Bearings	16/14/11	5	N/A	N/A	N/A	N/A

- A teaspoon of dirt in a 55 gallon drum will yield a particle count of 19/17/14; way too dirty for most critical applications. At 19/17/14, a hydraulic system would be considered to be highly contaminated and pump life could potentially be cut in half.
- In one year, an ISO 19/17/14 oil in a 50 gpm pump will circulate approximately 1,500 pounds of contaminant through the system!
- **NEW OIL IS NOT CLEAN OIL.** Perhaps one of the most common misconceptions in maintenance and reliability is that the new oil we buy is clean enough for immediate use. New oil from drums or bulk deliveries usually contains anywhere from 2 to 20 times the amount of particles that is acceptable for most lubricated equipment.

Keep a Lubricant Clean Throughout Its Lifecycle			
Arrival	Storage	Transfer	In-Use
If it comes in drums, each drum can be filtered using portable compact filtration units like filter carts or drum toppers. If drum storage is not desired, the oil can be transferred to a storage unit. The storage unit will allow for filtration at any point of its residency in the unit.	The "Lube Room" provides a dedicated storage area where lubricants can be adequately prepared and maintained for service. This includes a place to pre-filter, store, and kit for routine preventive maintenance tasks. It also provides a method for usage control.	It is critical to isolate your oil and equipment with a transfer container that is equipped with quick connects so they can be filled without exposing the container to the outside environment. The trigger should also be self-closing so that the container is always sealed when not in use.	Continuous dedicated filtration ensures cleanliness is maintained at the ISO code it was when it entered the equipment. Desiccant breathers also protect the equipment from contaminants entering the system.