Cleanliness classes in accordance with ISO 4406 and NAS 1638

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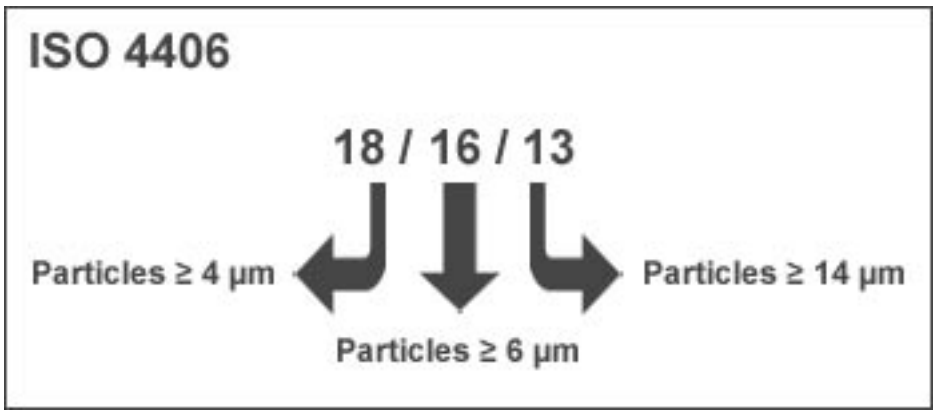
Most branches of industry refer to ISO 4406 as a standard of cleanliness. The new version of this standard evaluates the number of particles above 4 µm, 6 µm and 14 µm per 100 ml volume. The number of particles above 4 µm and 6 µm is used as the reference point for suspended particles. The amount above 14 µm indicates the quantity of large particles that are primarily responsible for irreparable system failures.



Note: The older version of the ISO standard is still used. This version deals with particle sizes of 5 µm and 15 µm. (For example: ISO-Code 16/13 refers to particles sizes of 5 µm and 15 µm).

Example
A particle count yields:
number of particles ≥ 4 µm: 30,000 particles
number of particles ≥ 6 µm: 6,000 particles
number of particles ≥ 14 µm: 800 particles

This translates into an code of: (see table)
30,000 between 20,000 and 40,000, i.e. code 22
6,000 between 5,000 and 10,000, i.e. code 20
800 between 640 and 1,300, i.e. code 17

➔ Cleanliness class according to ISO 4406 = 22/20/17

Number of particles larger than	Number of particles up to and including	ISO class code
2,500,000		>28
1,300,000	2,500,000	28
640,000	1,300,000	27
320,000	640,000	26
160,000	320,000	25
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
2.5	5	9
1.3	2.5	8
0.64	1.3	7
0.32	0.64	6
0.16	0.32	5
0.08	0.16	4
0.04	0.08	3
0.02	0.04	2
0.01	0.02	1
0.00	0.01	0

Since it would not be very economical to purify hydraulic liquids with the finest possible filters, contamination classes have been introduced. These contamination classes reflect the characteristics of the utilized components.

An “Omega Test” was developed based on wear tests at Oklahoma University, USA. It is expected that a specific amount of particles of a specific size influences the wear of hydraulic components. The following table shows a classification with five particle sizes and their relationship to the classes. The number and sizes of the particles are determined microscopically from a sample of 100 ml. The number of particles per size is compared with the values in the tables.

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Example

Number of counted particles:

Particle size	> 5 µm	> 15 µm	>25 µm	>50 µm	>100 µm
Counted particles	497,444	73,560	7,651	1,320	42

This means a code of: (see table)

Table value	512,000	91,000	8,100	1,140	64
NAS Code	11	11	10	10	8

Filter class	Particle size in µm 5 to 15	15 to 25	25 to 50	50 to 100	> 100
00	125	22	4	1	0
0	250	44	8	2	0
1	500	89	16	3	1
2	1,000	178	32	6	1
3	2,000	356	63	11	2
4	4,000	712	126	22	4
5	8,000	1,425	253	45	8
6	16,000	2,850	508	90	16
7	32,000	5,700	1,012	180	32
8	64,000	11,400	2,025	360	64
9	128,000	22,800	4,050	720	128
10	256,000	45,600	8,100	1,140	256
11	512,000	91,200	16,200	2,880	512
12	1,024,000	182,000	32,400	5,760	1,024

The following table shows the contamination classes compared with the retention rate and different applications of hydraulic systems. The assignment to the classes in NAS 1638 and ISO 4406 is only approximate.

The specifications of the filter rating / retention rates correspond with a beta value of ≥ 75. An optimized strategy is therefore required to attain the cleanliness class.

Hydraulic system	Retention rates $ß_x \geq 75$	NAS 1638	ISO 4406 (old)
Extremely precise servomechanisms, aerospace	3	4 to 5	13/10
General servomechanisms, high-pressure systems, systems with long service periods, aerospace, machine tools	5	7 to 8	17/13
High-quality, reliable systems, general mechanical applications	10	9	18/14
General applications, heavy machinery construction	20 to 25	9 to 11	19/15
Systems with large tolerances	25 to 40	12	21/17

ISO Code	Particles per ml ≥ 2 µm	≥ 5 µm	≥ 15 µm	NAS 1638 (since 1964)	SAE (invalid since 1963)
23/21/18	80,000	20,000	2,500	12	-
22/20/18	40,000	10,000	2,500	-	-
22/20/17	40,000	10,000	1,300	11	-
22/20/16	40,000	10,000	640	-	-
21/19/16	20,000	5,000	640	10	-
20/18/15	10,000	2,500	320	9	6
19/17/14	5,000	1,300	160	8	5
18/16/13	2,500	640	80	7	4
17/15/12	1,300	320	40	6	3
16/14/12	640	160	40	-	-
16/14/11	640	160	20	5	2
15/13/10	320	80	10	4	1
14/12/9	160	40	5	3	0

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