# Quantifying Fluid Cleanliness

## QUANTIFYING SOLID PARTICLE CONTAMINATION

### STRUCTURE OF ISO 4406 CODE:

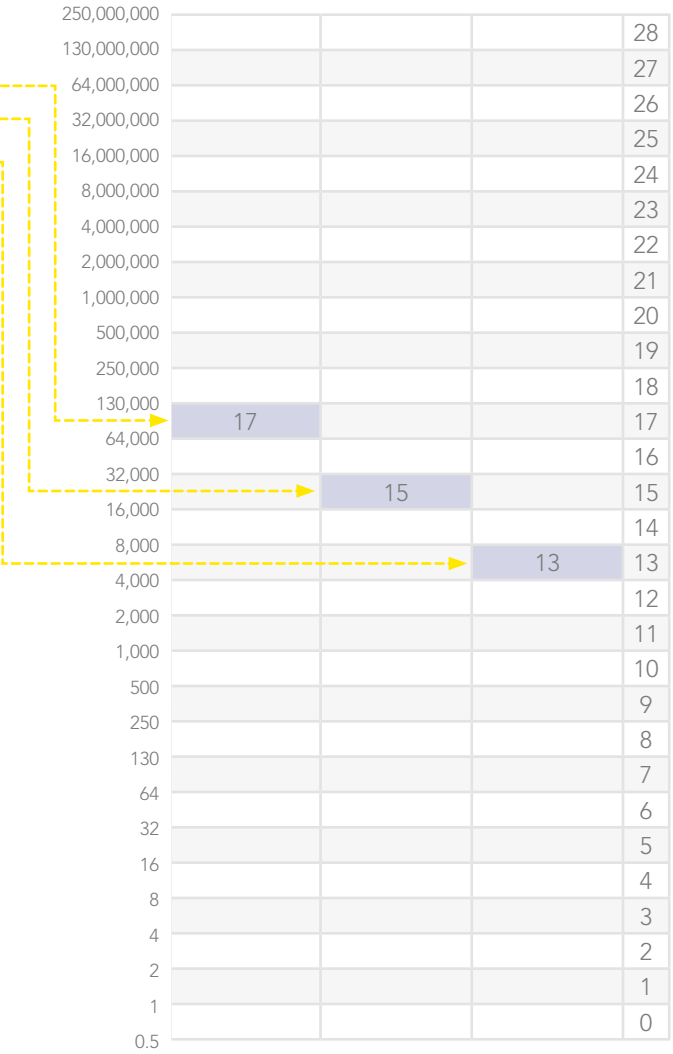
Cleanliness levels are defined by three numbers divided by slashes (/). These numbers correspond to 4, 6 and 14 micron, in that order. Each number refers to an ISO Range Code which is determined by the number of particles for that size (4, 6, 14 micron) and larger present in 100 ml of fluid. Each range is double the range below. Refer to the chart to see the actual ranges.

**EXAMPLE:**

Larger than 4 µm = 125,000

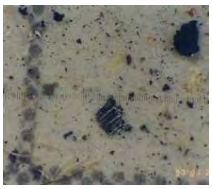
Larger than 6 µm = 29,490

Larger than 14 µm = 4,250




### NAS 1638

Contamination level according to NAS 1638: the contamination classes are defined by a number (from 00-12) which indicates the maximum number of particles per 100 ml, counted on a differential basis in a given size bracket. Most industrial users quote a single code which is the highest recorded in all sizes, e.g. NAS 6.



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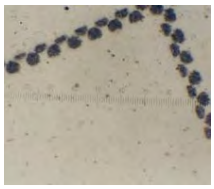
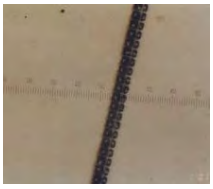


18/15/13



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**NAS CLASSES**

| | 00 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5-15 | 125 | 250 | 500 | 1000 | 2000 | 4000 | 8000 | 16000 | 32000 | 64000 | 128000 | 256000 | 512000 | 1024000 |
| 15-25 | 22 | 44 | 89 | 178 | 356 | 712 | 1425 | 2850 | 5700 | 11400 | 22800 | 45600 | 91200 | 182400 |
| 25-50 | 4 | 8 | 16 | 32 | 63 | 126 | 253 | 506 | 1012 | 2025 | 4050 | 8100 | 16200 | 32400 |
| 50-100 | 1 | 2 | 3 | 6 | 11 | 22 | 45 | 90 | 1801 | 360 | 720 | 1410 | 2880 | 5760 |
| over 100 | 0 | 0 | 1 | 1 | 2 | 4 | 8 | 16 | 32 | 64 | 128 | 256 | 512 | 1024 |


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## SAE AS 4059 REV.E**

## CLEANLINESS CLASSIFICATION FOR HYDRAULIC FLUIDS (SAE AEROSPACE STANDARD)

This SAE Aerospace Standard (AS) defines cleanliness levels for particulate contamination of hydraulic fluids and includes methods of reporting data relating to the contamination levels. Tables 1 and 2 below provide differential and cumulative particle counts respectively for counts obtained by an automatic particle counter, e.g. LPA2.

### TABLE 1 - CLEANLINESS CLASSES FOR DIFFERENTIAL PARTICLE COUNTS
### MAXIMUM CONTAMINATION LIMITS (PARTICLES/100ML)

| CLASSES \ SIZE | 6 TO 14 µm | 14 TO 21 µm | 21 TO 38 µm | 38 TO 70 µm | >70 µm |
|---|---|---|---|---|---|
| 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 | 506 | 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 | 1.440 | 256 |
| 11 | 512.000 | 91.200 | 16.200 | 2.880 | 512 |
| 12 | 1.024.000 | 182.400 | 32.400 | 5.760 | 1.024 |

### TABLE 2 - CLEANLINESS CLASSES FOR CUMULATIVE PARTICLE COUNTS
### MAXIMUM CONTAMINATION LIMITS (PARTICLES/100ML)

| SIZE | >4 µm | >6 µm | >14 µm | >21 µm | >38 µm | >70 µm |
|---|---|---|---|---|---|---|
| CLASSES \ SIZE CODE | A | B | C | D | E | F |
| 000 | 195 | 76 | 14 | 3 | 1 | 0 |
| 00 | 390 | 152 | 27 | 5 | 1 | 0 |
| 0 | 780 | 304 | 54 | 10 | 2 | 0 |
| 1 | 1.560 | 609 | 109 | 20 | 4 | 1 |
| 2 | 3.120 | 1.217 | 217 | 39 | 7 | 1 |
| 3 | 6.250 | 2.432 | 432 | 76 | 13 | 2 |
| 4 | 12.500 | 4.864 | 864 | 152 | 26 | 4 |
| 5 | 25.000 | 9.731 | 1.731 | 306 | 53 | 8 |
| 6 | 50.000 | 19.462 | 3.462 | 612 | 106 | 16 |
| 7 | 100.000 | 38.924 | 6.924 | 1.224 | 212 | 32 |
| 8 | 200.000 | 77.849 | 13.849 | 2.449 | 424 | 64 |
| 9 | 400.000 | 155.698 | 27.698 | 4.898 | 848 | 128 |
| 10 | 800.000 | 311.396 | 55.396 | 9.796 | 1.696 | 256 |
| 11 | 1.600.000 | 622.792 | 110.792 | 19.592 | 3.392 | 512 |
| 12 | 3.200.000 | 1.245.584 | 221.584 | 39.184 | 6.784 | 1.024 |

** The information reproduced on this and the previous table is a brief extract from SAE AS4059 Rev. E revised in May 2005. For futher details and explanations refer to the full Standard.

# RMF ISO Cleanliness Levels

## TO ACHIEVE THE CORRECT CLEANLINESS LEVEL

A combination of filters must be used to achieve the correct cleanliness level in a hydraulic or lubrication system.

RMF Systems offers a comprehensive range of Of f- line f ilters, By -pass filters and Air conditioners (desiccant breathers) to achieve and maintain extremely low contamination levels in hydraulic and/or lubrication systems (water and solid particles).

## SETTING THE CLEANLINESS LEVEL REQUIRED BY A SYSTEM

1. Starting at the left hand column, select the most dirt sensitive component used in the system.
2. Move to the right to the column that describes the system pressure and conditions.
3. Here you will find the recommended ISO class level.

| | LOW/MEDIUM PRESSURE UNDER 140 BAR MODERATE CONDITIONS | HIGH PRESSURE 140-210 BAR SEVERE CONDITIONS | VERY HIGH PRESSURE 210 BAR AND HIGHER. HIGH PRESSURE AND SEVERE CONDITIONS |
|---|---|---|---|
| **PUMPS** | | | |
| Fixed gear/Fixed vane | 20/18/15 | 19/17/14 | 18/16/13 |
| Fixed piston | 19/17/14 | 18/16/13 | 17/15/12 |
| Variable vane | 18/16/13 | 17/15/12 | Not applicable |
| Variable piston | 18/16/13 | 17/15/12 | 16/14/11 |
| **VALVES** | | | |
| Check valves | 20/18/15 | 20/18/15 | 19/17/14 |
| Directional valves | 20/18/15 | 19/17/14 | 18/16/13 |
| Standard flow valves | 20/18/15 | 19/17/14 | 18/16/13 |
| Car tridge valves | 19/17/14 | 18/16/13 | 17/15/12 |
| Propor tional valves | 17/15/12 | 17/15/12 | 16/14/11 |
| Ser vo valves | 16/14/11 | 16/14/11 | 15/13/10 |
| **ACTUATORS** | | | |
| Cylinders, Vane mtors, Gear motors | 20/18/15 | 19/17/14 | 18/16/13 |
| Piston motors, Swash plate, Gear motors | 19/17/14 | 18/16/13 | 17/15/12 |
| Hydrostatic drives | 16/15/12 | 16/14/11 | 15/13/10 |
| Test stands | 15/13/10 | 15/13/10 | 15/13/10 |
| **BEARINGS** | | | |
| Journal bearings | 17/15/12 | Not applicable | Not applicable |
| Industrial gear boxes | 17/15/12 | Not applicable | Not applicable |
| Ball bearings | 15/13/10 | Not applicable | Not applicable |
| Roller bearings | 16/14/10 | Not applicable | Not applicable |

# Cleanliness Selection Guide

## FLUID VISCOSITY

The viscosity of a fluid is an important property in the analysis of liquid behavior and fluid motion near solid boundaries. The viscosity is the fluid resistance to shear or flow and is a measure of the adhesive/cohesive or frictional fluid property. The resistance is caused by intermolecular friction exerted when layers of fluids attempt to slide by one another. Viscosity is a measure of a fluid's resistance to flow. The knowledge of viscosity is needed for proper design of required temperatures for storage, pumping or injection of fluids. There are two related measures of fluid viscosity - known as dynamic (or absolute) and kinematic viscosity.

### VISCOSITY CLASSIFICATION

| ISO VISCOSITY GRADE | MIDPOINT KINEMATIC VISCOSITY $MM^2/S$ AT 40°C (104°F) | KINEMATIC VISCOSITY LIMIT $MM^2/S$ AT 40°C (104°F) MINIMUM | KINEMATIC VISCOSITY LIMIT $MM^2/S$ 40°C (104°F) MAXIMUM |
|---|---|---|---|
| ISO VG 2 | 2.2 | 1.98 | 2.42 |
| ISO VG 3 | 3.2 | 2.88 | 3.52 |
| ISO VG 5 | 4.6 | 4.14 | 5.06 |
| ISO VG 7 | 6.8 | 6.12 | 7.46 |
| ISO VG 10 | 10 | 9.00 | 11.0 |
| ISO VG 15 | 15 | 13.5 | 16.5 |
| ISO VG 22 | 22 | 19.8 | 24.2 |
| ISO VG 32 | 32 | 29.8 | 35.2 |
| ISO VG 46 | 46 | 41.4 | 50.6 |
| ISO VG 68 | 68 | 61.2 | 74.8 |
| ISO VG 100 | 100 | 90.0 | 110 |
| ISO VG 150 | 150 | 135 | 165 |
| ISO VG 220 | 220 | 198 | 242 |
| ISO VG 320 | 320 | 288 | 352 |
| ISO VG 460 | 460 | 414 | 506 |
| ISO VG 680 | 680 | 612 | 748 |
| ISO VG 1000 | 1000 | 900 | 1100 |
| ISO VG 1500 | 1500 | 1350 | 1650 |
| ISO VG 2200 | 2200 | 1980 | 2420 |
| ISO VG 3200 | 3200 | 2880 | 3520 |

### VISCOSITY CONVERSION CHART

| CST (CENTISTOKES) | SUS (SAYBOLT UNIVERSAL SECONDS)* |
|---|---|
| 10 | 46 |
| 20 | 93 |
| 25 | 116 |
| 30 | 139 |
| 32.4 | 150 |
| 40 | 185 |
| 50 | 232 |
| 70 | 324 |
| 90 | 417 |

*Comparisons are made at 100° F (38°C). For other viscosity conversion approximations, use the formula: cSt=SUS/4.635*

*Note: Saybolt universal seconds may also be abbreviated SSU.