Purity classes according to ISO 4406 / NAS 1638

About 80% of hydraulic system failures are caused by contamination of the hydraulic oil. Therefore, in addition to the basic properties such as viscosity and wear protection, the purity of the hydraulic oil is particularly crucial for trouble-free and low-wear operation of the machines. The degree of contamination of the oil is determined by the size and number of particles present in the oil.

Measuring principles

Particle determination is done per 100ml of oil and the number per size class of particles can be done in two different ways. For example, this can be done by microscopic counting or by laser. In microscopic counting, the particles are counted at a 100x magnification and assessed according to size.

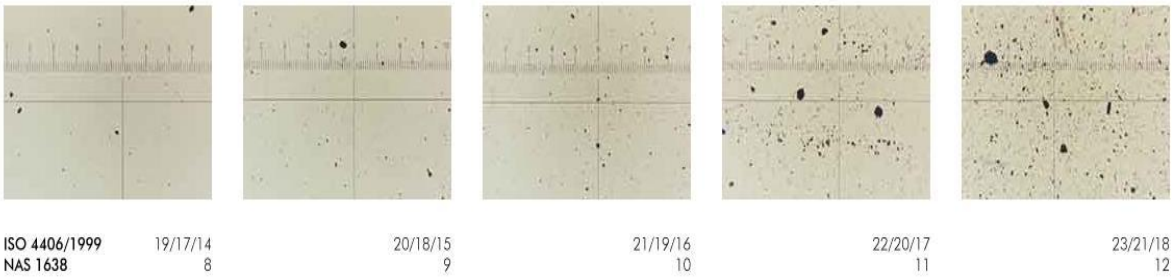

Figure 1: Microscopic particle determination

In the determination with a laser, a laser beam is sent through the flowing sample. The laser beam illuminates the sample material flowing through the measuring cell, and a measuring sensor behind the measuring cell behind the measuring cell then detects the laser light diffracted or scattered by the particles with angular resolution.

Figure 2: Device for particle determination by means of laser

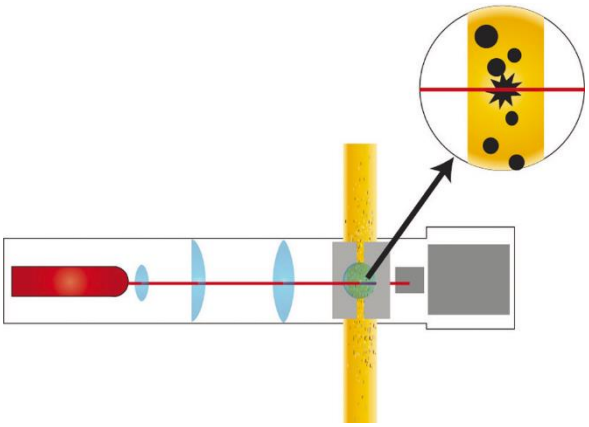

Figure 3: Principle of the laser method

For a simplified assessment of the degree of contamination, a classification into so-called "Purify classes" is carried out. First, the number and size of the particles are determined. The number of particles is then used to assign the oil to a specific purify class. The methods for determining oil purity and the assignment of purity classes are defined in ISO 4406 and NAS 1638. The main difference between these two standards is that ISO and NAS define the size of the particles differently.

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Purity classes according to ISO 4406

The new ISO 4406 (1999) provides for a classification with particle sizes >4 µm, >6 µm and >14 µm. The ISO particle counts are cumulative, i.e. the particle count specified for >6 µm is composed of all particles >6 µm plus the particles >14 µm. Based on the particle counts, ISO/NAS purity classes, oil purity, the particles counted in 100ml of oil per size class are assigned to a purity class and the ISO purity class is given in the following form: 21/18/13.

Purity classes according to NAS 1638

The determination of purity classes according to NAS (National Aerospace Standard) is due to the requirements for modern hydraulic systems of aircraft. Compared to the ISO standard, NAS 1638 also distinguishes particles larger than 15 µm. According to NAS 1638, particles are counted in five size classes and for each size range, a purity class from 00 to 12 is assigned accordingly. However, only the largest (worst) of the 5 individual classes (e.g., 9) is reported as the NAS class. The counting method is differential, i.e. the number of particles actually present in a class is stated. Particles per 100 ml of oil of size (5-15, 15-25, 25-50, 50-100) µm and > 100 µm are counted.

ISO 4406	Number of particles / 100 ml			NAS 1638
	≥ 4 µm	≥ 6 µm	≥ 14 µm	
12/10/06	4'000	1'000	64	
12/10/07	4'000	1'000	130	1
12/10/08	4'000	1'000	250	
13/11/08	8'000	2'000	250	2
14/12/09	16'000	4'000	500	3
15/13/10	32'000	8'000	1'000	4
16/14/11	64'000	16'000	2'000	5
16/14/12	64'000	16'000	4'000	
17/15/12	130'000	32'000	4'000	6
18/16/13	250'000	64'000	8'000	7
19/17/14	500'000	130'000	16'000	8
20/18/15	1'000'000	250'000	32'000	9
21/19/16	2'000'000	500'000	64'000	10
22/20/16	4'000'000	1'000'000	64'000	
22/20/17	4'000'000	1'000'000	130'000	11
22/20/18	4'000'000	1'000'000	250'000	
23/21/18	8'000'000	2'000'000	250'000	12

Table 1: Comparison between ISO 4406 and NAS 1638 and their different evaluation criteria.

STRUB Recommendation

Fresh oils are not at the same time also "pure" or particle-free oils. After the production process, the oil is only filtered normally and only finely filtered for special product groups. Particles can be introduced during decanting, filling and racking, which is why the ISO purity class is rarely better than 21/19/14.

We would like to recommend you to fill your hydraulic system directly via a suitable filter device in order to obtain an optimal, respectively low particle count.
By this filtration you avoid entry of not desired particle sizes into your system and start after the new filling with optimal conditions.

For "older" systems or after approx. 10'000 operating hours, we recommend adding our **STRUB Oil System Cleaner 1200 (Art.-No. 30563)** approx. 5 days before the oil change and let the system continue to run. The System Cleaner helps to remove residues from your system, so that you can achieve less residues and therefore a longer and cleaner lubrication when refilling. For more information, please see the end of this document or contact our sales team at sales@strub-lube.ch.

Recommended minimum cleanliness classes:

Component	Class according to ISO 4406
Servo-hydraulic equipment, servo valves	at least 17/14/11
Proportional and high pressure hydraulics (p>160 bar)	at least 19/16/13
Low and medium pressure hydraulics (p<160 bar)	at least 21/18/13
Vane and piston pumps / motors	at least 18/16/13
Gear pumps / motors	at least 20/17/14
Biohydraulics	at least 19/17/13

STRUB Oil System Cleaner 1200

Oil carbon remover, residue cleaner for mineral oil systems

Art.-No. 30563

Description

STRUB Oil System Cleaner 1200 is a mineral oil soluble active agent concentrate based on synergistically acting additives with synthetic properties. The active ingredients independently clean the entire oil system. Easily dissolves and infiltrates hazardous black sludge, varnish and other deposits. Keeps oil bores, valves and filters clear. Cleans the oil system with the oil change and enables clean and thus economical operation of machines without major effort. Does not attack paint and seals!

Application

For all oil circulation systems which are filled with mineral, semi-synthetic and PAO oils and require periodic cleaning, e.g.: Engine, hydraulic, transmission, heat transfer, metalworking equipment and many others. Also excellent proven for natural gas, gas and marine engines.

Ideally suited also for the flushing oils used as system cleaners prior to initial filling or assembly work.

Add before the last work shift or oil change and leave in operation for at least 1 - 5 days (for engines 10 - 15 minutes at idle speed). Work can be continued without restriction. Then drain system at operating temperature and refill with appropriate oil. The filter unit should be below 60 microns to prevent large metal debris from entering the circulating system.

Dilution

Diesel, gasoline and marine engines	2 - 3	Vol. %
Natural gas and gas engines	1 - 2	Vol. %
Hydraulic systems	1 - 2	Vol. %
Turbines	0.01 - 0.02	Vol. %
Heat transfer systems	3 - 4	Vol. %
Metalworking, Pressing	1 - 2	Vol. %
Compressors, refrigeration systems	0.5 - 1	Vol. %

Transportation

ADR/SDR No dangerous goods

Disposal

LVA VeVA / EAK: 13 02 08

ISO 9001|14001, version 1: 29.01.2015 / MF

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