ISO 4406 Oil Cleanliness Codes & Particle Counters

cBallast Technical Sourcing · Oil condition monitoring · issued 2026-11-09 · cballast.com/documents/iso-4406-oil-cleanliness-codes-particle-counters

The ISO 4406 cleanliness code decoded digit by digit: the scale-number table (particles per millilitre at 4, 6 and 14 micron), target codes per hydraulic component from servo valves to gear pumps, the NAS 1638 relationship, how online and portable particle counters like the Parker icountLCM20 fit into a monitoring programme, bottle sampling discipline that does not contaminate the result, and what a cleanliness spec means for filter purchasing.

The short version

An ISO 4406 code like 18/16/13 is three scale numbers: cumulative particle counts per millilitre at ≥4 μm / ≥6 μm / ≥14 μm. Each step of one scale number doubles the allowed count — so 19/17/14 is twice as dirty as 18/16/13, and "one code cleaner" is a halving, which is why single-digit improvements are worth real money in component life.

Targets are component-driven: servo valves want the cleanest oil (16/14/11 class), proportional valves 17/15/12, piston pumps and motors 18/16/13, vane 19/17/14, gear pumps and general industrial hydraulics 20/18/15 class. The dirtiest-tolerant component does not set the target — the most sensitive one does.

Particle counters turn the code from a lab result into an operating gauge: online/inline units such as the Parker icountLCM20 report ISO codes continuously on a live system, catching ingress and filter breakthrough in hours instead of at the next oil analysis. (Airborne counters such as the Fluke 985 are a different instrument for cleanroom/HVAC air — same word, different world.)

New oil is not clean oil: fresh drums commonly arrive several codes dirtier than a servo system's target. Filtration on fill is not optional, and the cleanliness line on the lubricant's certificate is worth reading before it goes anywhere near a proportional valve stack.

The code is a purchasing instrument: it specifies what filters must achieve (β-ratios), what new oil must arrive at, what a flushing contractor must hand back, and what a warranty claim will be judged against. Written into RFQs it converts "clean oil" from a wish into an acceptance criterion.

1. The scale-number table

Scale number | Particles/ml (more than – up to) | Scale number | Particles/ml (more than – up to) |

24 | 80,000 – 160,000 | 16 | 320 – 640 |

23 | 40,000 – 80,000 | 15 | 160 – 320 |

22 | 20,000 – 40,000 | 14 | 80 – 160 |

21 | 10,000 – 20,000 | 13 | 40 – 80 |

20 | 5,000 – 10,000 | 12 | 20 – 40 |

19 | 2,500 – 5,000 | 11 | 10 – 20 |

18 | 1,300 – 2,500 | 10 | 5 – 10 |

17 | 640 – 1,300 | 9 | 2.5 – 5 |

Reading 18/16/13 with the table: up to 2,500 particles/ml at ≥4 μm, up to 640 at ≥6 μm, up to 80 at ≥14 μm. The three sizes exist because they damage differently — silt-size (4–6 μm) particles wear servo spools and lap valve clearances, the ≥14 μm fraction scores pumps and jams poppets. Two codes with the same middle number can behave very differently at the ends; report and specify all three digits.

2. Target cleanliness by component

Most sensitive component in the system | Typical target (ISO 4406) | Notes |

Servo valves (motion control, test rigs) | 16/14/11 | Manufacturer lists govern; some demand cleaner still at high pressure |

Proportional valves (e.g. D1VW-class directional stacks with proportional trim) | 17/15/12 | The common industrial "clean" target |

Axial piston pumps/motors, variable displacement | 18/16/13 | The workhorse target for modern hydraulics |

Vane pumps, fixed piston units | 19/17/14 | — |

Gear pumps, cylinders, general industrial | 20/18/15 | Still twice as clean as typical uncontrolled systems |

New oil as delivered (typical, unfiltered) | Often 21/19/16 class or worse | Filter on fill; verify, do not assume |

Raise the target one code (cleaner) for any of: pressure above ~250 bar, safety-critical function, high duty cycle, or expensive downtime — the halving-per-code arithmetic means each step buys a disproportionate life extension in rolling-contact and sliding parts. Published component-life models and filter makers' field data agree on the direction and roughly on the magnitude: moving two codes cleaner commonly doubles hydraulic component life in dirty baselines.

3. Measuring: online counters, portables and bottles

Method | Instrument class | Strengths | Limits |

Permanent online monitoring | Inline laser counters — Parker icountLCM20 class | Continuous ISO codes on live pressure

lines, trends and alarms; catches ingress events and filter breakthrough as they happen | Needs correct sampling point and flow/pressure window; water and aeration read as particles if the installation ignores them |

Portable survey counters | Service-case laser counters (icountPD class and peers) | One instrument audits a whole plant or fleet; before/after proof for flushing jobs | Operator discipline decides repeatability |

Bottle sampling to a lab | Sample pump + certified-clean bottles | Full oil analysis alongside the count (wear metals, water, additives) | Days of latency; one dirty bottle or sloppy draw invalidates the count |

Airborne counting (for completeness) | Fluke 985 class | Cleanrooms, HVAC commissioning, filter leak surveys | Not an oil instrument — listed here because search engines and storerooms confuse the two |

Bottle discipline, because most "failed" samples are sampling failures: draw from a live, agitated system at operating temperature, never from the tank bottom or a dead leg; flush the sampling valve and tubing generously before the bottle opens; use certified-clean bottles only; fill two-thirds and cap immediately in clean surroundings; label with running hours and point ID. One ritual, every time, or trend data is noise. For online units, mount per the maker's pressure/flow window, and give the commissioning survey a portable cross-check so the baseline is believed.

4. NAS 1638 and the conversions people actually ask for

NAS 1638 class | Rough ISO 4406 neighbour | Context |

NAS 5 | ≈ 16/14/11 | Servo-grade cleanliness |

NAS 6 | ≈ 17/15/12 | Proportional-grade |

NAS 7 | ≈ 18/16/13 | Modern piston-pump target |

NAS 8 | ≈ 19/17/14 | General industrial |

NAS 9 | ≈ 20/18/15 | Uncritical systems |

The honest caveat every conversion table owes you: NAS classes count particles in differential size bands, ISO 4406 counts cumulatively at three thresholds — the mapping is a practised approximation, not an equation, and specifications should be written in one system rather than converted back and forth. Legacy aviation and some OEM documents still speak NAS; modern industrial practice, and every current counter including the icount family, speaks ISO 4406.

5. Cleanliness as a purchasing specification

Where the code belongs in your paperwork: filter RFQs — specify the target code at the component and let the filtration (β-ratio at the sizes that matter, e.g. β5 or β7 ≥ 200 class elements) be selected to hold it, including offline/kidney-loop capacity for systems with high ingression — our MRO primer and CJC-class offline filtration lines serve exactly this; new-oil purchasing — state delivered cleanliness and require the certificate; flushing contracts — acceptance = measured code at named points, witnessed, not hours pumped; warranty files — a logged trend from an online counter is the difference between a goodwill discussion and a paid claim; and commissioning — new builds and refits sign off at the target code, because construction debris is the dirtiest oil a system will ever see. Monitoring hardware for all of this is quotable equipment: icountLCM20 online counters, portable survey units, sampling hardware and bottles, and the filtration to act on what they find.

How buying works at cballast. We quote counters, sampling equipment, filter elements and offline filtration against a stated target code, and we put the code on the quote line so acceptance is measurable. Accounts are vetted at onboarding; first order prepaid; established accounts on credit terms with repeat discounts; public bodies and utilities invoiced against purchase order from the first order. RFQs to sales@cballast.com.

Frequently asked questions

What does ISO 4406 18/16/13 mean?Up to 2,500 particles per millilitre at ≥4 μm, up to 640 at ≥6 μm and up to 80 at ≥14 μm — the standard cleanliness target for modern piston-pump hydraulics. Each scale number step halves or doubles the count, so 19/17/14 is twice as dirty in every band.
What cleanliness does a servo valve need?The 16/14/11 class as a working rule, with the valve maker's own list governing. That is roughly four times cleaner than the piston-pump target in every size band — and the reason servo systems filter on fill, run fine filtration continuously and monitor rather than assume.
What is the difference between NAS 1638 and ISO 4406?NAS classes count particles in differential size bands per 100 ml; ISO 4406 counts cumulatively per ml at 4/6/14 μm thresholds. Conversions (NAS 7 ≈ ISO 18/16/13) are practised approximations for reading old specs — write new ones in ISO 4406 and keep instruments and targets in one language.
What is a Parker icountLCM20?An inline laser particle counter that lives on a hydraulic or lube system and reports ISO 4406 codes continuously — the monitoring layer that turns cleanliness from an annual lab figure into a live operating parameter with alarms. It is the online complement to portable survey counters and bottle analysis.
Why does my new hydraulic oil fail the cleanliness spec?Because drums and IBCs are filled, stored and decanted through equipment that was never servo-clean — new oil routinely arrives at 21/19/16 class or worse. Filter on fill through a filter cart rated tighter than the system target, and verify with a count before the system runs.
Can water or air bubbles affect a particle count?Yes — optical counters register water droplets and entrained air as particles. Good installations sample where the oil is a single phase, and good analysts check water content alongside the count. A suddenly "dirty" trend with no mechanical explanation is often moisture announcing itself, which is its own finding.
Who supplies particle counters and clean-oil equipment?cballast.com quotes online and portable counters, sampling hardware, filter elements and offline filtration units against your target codes. Write to sales@cballast.com with the system and the code you need to hold.

References and related guides

Standards and sources referenced: ISO 4406 (coding), ISO 11171 (counter calibration), ISO 11500 (counting method), NAS 1638 (historic classes); component-manufacturer cleanliness requirements and filter manufacturers' β-ratio data.

Parker D1VW directional valve model codes

Hydraulic hose reference

Process calibrator selection

Industrial MRO distribution primer

Mechanical seal identification & selection

Questions on a target code, a counter installation or a failing trend: write to sales@cballast.com. We answer whether or not you buy from us.

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