



Because many people assume they're buying quality fuel that meets the required specifications, diesel fuel cleanliness is seldom questioned. But higher fuel system operating pressures, lower system tolerances, tighter filtration and the EPA's ultra low sulfur requirements have pushed fuel cleanliness into the maintenance spotlight.

Engine manufacturers are realizing that diesel fuel cleanliness can have great impact on overall engine performance. In fact, many are now recommending that diesel fuel that does not meet an ISO Cleanliness Code of 18/16/13 should be filtered before introduction to the fuel system.

Engine fuel systems made in the 1960's operated at around 400 - 500bar, had tolerances of around 50µm (microns) and filtration systems with a micron rating of around 25µm. The fuel systems of the 1990's ran at pressures of around 1300 - 1500bar, tolerances of 35µm and filtration micron ratings of 15µm. But today, operating pressures have increased to as much as 1800bar, tolerances of 2µm and filtration micron ratings of only about 3µm. This means that with control valve operating clearances of only 1-3 µm, today's injectors are a lot less tolerant to particulates than they once were - particulates that are now moving through the system at over four times the pressure.

Fuel system pumps and injectors are most susceptible to contamination from water, micro-organisms, wax, asphaltines, dirt, sediment and rust. Water, usually due to condensation, not only contaminates the fuel, it also provides a breeding ground for micro-organisms that feed on the fuel's hydrocarbons. The formation of wax crystals is the result of exposure to low temperatures while asphaltines are the result of exposure to high temperatures. Dirt, sediment and rust are typical of poor maintenance practices.

These particulates will quickly clog fuel filters, erode injectors and cause valves to stick and damage or clog injector spray nozzles causing irregular spray patterns that can lead to over-fueling, inefficient combustion and piston crown wear. Performing an ISO Particle Count can extend fuel filter life and maximize injector performance by identifying both the size and concentration of contaminant particles present. See Table 1.



Table 1: Reference Chart for Establishing ISO Cleanliness Codes

A small amount of fuel is passed through an optical laser counter. Any particles are counted and reported by the number of particles present in each of eight micron ranges, typically up to 100 microns. An ISO Cleanliness Code is then assigned based on the number of particles present at the 4, 6, and 14 micron levels.

ISO/Range Code	Min particles /ml	Max particles /ml
1	0	0.02
2	0.02	0.04
3	0.04	0.08
4	0.08	0.15
5	0.15	0.3
6	0.3	0.6
7	0.6	1.3
8	1.3	2.5
9	2.5	5
10	5	10
11	10	20
12	20	40
13	40	80
14	80	160
15	160	320
16	320	640
17	640	1,300
18	1,300	2,500
19	2,500	5,000
20	5,000	10,000
21	10,000	20,000
22	20,000	40,000
23	40,000	80,000



24	80,000	160,000
25	160,000	320,000
26	320,000	640,000
27	640,000	1,300,000
28	1,300,000	2,500,000
29	2,500,000	5,000,000
30	5,000,000	10,000,000

ISO Particle Count Data for a #2 Ultra-Low Sulfur Diesel Fuel

Source: POLARIS Laboratories Statistical Analysis*

ISO Code	Low	1 st Quartile	Median	3 rd Quartile	High	Average	Std. Deviation	Number of samples
ISO 4µm	13	16	18	20	22	17	2	162
ISO 6µm	11	13	15	17	21	15	2	162
ISO 14µm	8	9	10	11	15	9	1	162
>4µm	43	524	1373	5943	37083	4654	6766.38	162
>6µm	13	72	177	907	18619	993	2442.53	162
>10µm	4	10	18	50	2234	86	250.49	162
>14µm	2	3	6	11	172	13	19.80	162
>21µm	0	1	2	3	33	3	4.46	162
>38µm	0	0	0	1	6	0	0.75	162
>70µm	0	0	0	0	1	0	0.11	162
>100µm	0	0	0	0	0	0	0.00	162

*This analysis is based on test results for 162 #2 ultra-low diesel fuel samples processed by POLARIS Laboratories.

The above median ISO Cleanliness Code of 18/15/10 illustrates that 50% of the samples in this analysis are at or below 18/15/10. That means that about 50% of the samples tested do not meet the OEM ISO Cleanliness Code recommendation of 18/16/13. By these numbers, half of the fuel you will purchase should be pre-filtered. The only way to know for sure, is to have it tested. So, how clean is your fuel?