



# Fuel 401 – Lab Testing Diesel Fuel and How to Interpret Results



Understanding how to test your fuel today is different from days past. As we learned in Fuel 101 through 301, the manufacturing or blending of fuel is much different than it was 10 years ago. Would it surprise you to know that 87% of UST owners who store diesel fuel do not know what testing is required or needed and 94% do not know how to interpret the tests.

Throughout this education, we will look at some of the most important aspects of testing that address long term stability/storability of diesel fuel. Each test section will describe the test, what is the normal range and what does it indicate.

## 1) API Gravity (ASTM D1298):

- a. API Gravity refers to the density or how heavy the hydrocarbon chain is in relation to water. Anything above 10 will usually float and anything below 10 will sink to the bottom. Crude oil can range from close to zero for the heaviest and go all the way to 70 for the lightest.
- b. The API gravity for #2 Diesel fuel is typically between 32 and 38.
- c. The lower the API Gravity – the heavier the fuel and harder to burn. Conversely, the higher the API Gravity – the lighter the fuel and easier to burn. For every increase of 10, there is a reduction in thermal energy, power of the engine, and lower mpg.

## 2) Corrosion Copper Strip (ASTM D12004):

- a. Corrosion copper strip assess the relative degree of corrosivity of a petroleum product. Essentially this test will tell you how corrosive your fuel will be to the metal parts within your fuel system such as pipes, lines, pumps, floats, etc.
- b. The test will be classified from 1a being good to 4c indicating very corrosive. This is the class and designation of the results.

Class	Designation
1a	Slight Tarnish
1b	
2a	Moderate Tarnish
2b	
2c	
2d	
2e	
3a	Dark Tarnish
3b	
4a	Corrosion & Pitting
4b	
4c	



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- c. Indications of what each class will tell you regarding your fuel:
  - i. Class 1: Your fuel is good.
  - ii. Class 2a – 2e: You should start becoming concerned and taking action.
  - iii. Class 3a – 3b: This is the maximum allowable result. Take action now.
  - iv. Class 4a – 4c: Your fuel is damaging your equipment – replacement of fuel will be necessary.

### 3) Distillation 90% Recovery (ASTM D86):

- a. This test indicates the vaporization tendencies of the fuel, which is the range that the fuel turns to a vapor or volatilizes. Volatility is the main difference between #1 and #2 diesel. Volatility and flash point are inversely related.
- b. The ranges for #2 diesel fuel should be between 282 – 338 °C.
- c. The higher the number the better the vaporization and utilization.

### 4) Flash Point (ASTM D93):

- a. This test determines the minimum temperature at which the fuel will ignite. It is primarily used in determining safety for handling and use.
- b. The minimum flash point is 52 °C.

### 5) Sulfur (ASTM D5453):

- a. Sulfur is one of the elements in diesel fuel that is both good and bad. It is good in that it has always been a source of stability for the fuel, making the environment inhospitable to bacteria/microbes. EPA regulation reduced the sulfur content from 1500 ppm to 15 ppm which has decreased emissions and deposits on injectors.
- b. The maximum sulfur content is 15 ppm.
- c. If your fuel is over 15 ppm it must be removed, it is no longer allowed by law.

### 6) Sediment & Water (ASTM D2709):

- a. This test determines the volume of free water and sediment (as a percentage of the sample) that is suspended in the fuel.
- b. The maximum value is 0.05 % (volume).
- c. Increasing amounts of sediment and free water can cause issues within the fuel system and even fouling of the injectors. Accumulation of sediment in storage



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tanks, filter screens, and lines can obstruct the flow of fuel to the engine. Free water can cause corrosion, microbial growth, and enhance formation of acids.

### 7) Suspended Water by Karl Fischer (ASTM D6304):

- a. This test determines the amount of water that is suspended/absorbed in the fuel mixture.
- b. There is no maximum value, this just tells you the parts per million (ppm) mixture.
- c. Water can cause a multitude of problems such as premature corrosion, increased wear, decreased lubrication, premature plugging of filters, support bacterial growth, and decrease effectiveness of most additives among other problems. Keeping your fuel clean and dry is critical to long term storage.

### 8) Cetane:

The specification for new diesel fuel (ASTM D975) indicates manufactured fuel must have a minimum cetane rating of 40 and all manufactured fuel does meet this requirement when manufactured. However, as fuel starts to deteriorate, the cetane decreases as well.

- a. Cetane Index (ASTM D976): if above 40
  - i. This is the first test to determine cetane and is the least expensive. It will use a calculation based on specific gravity to determine cetane content of the fuel. As long as the number is above 40 you are all set.
- b. Cetane Number (ASTM D613): if below 40 index
  - i. If you receive a number at or below 40 on the Cetane Index **AND** the fuel is being treated with additives that address cetane testing for the actual cetane number will be necessary. Since additives and cetane improvers does not alter the specific gravity of the fuel the actual cetane number is the only way to validate the cetane content of the fuel.

### 9) Particle Count (ASTM D6217):

- a. This test counts and measures the size of dispersed dirt particles, water droplets and other particles in the fuel.
- b. There is no maximum value, this just tells you the particle count in your fuel ranging from 4  $\mu\text{m}$  to 100  $\mu\text{m}$ .
- c. Keep in mind that the High Pressure Common Rail (HPCR) engines have tolerances in the injectors of 2 – 3  $\mu\text{m}$  and if you have 4  $\mu\text{m}$  or more it can cause catastrophic damage to the engine. Older engines can handle larger particles but



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check with your engine manufacturers warranty to see what size particle count voids the warranty.

### 10) Microbial Growth:

- a. This test identifies the presence of fungus/bacteria/microbes in your fuel.
- b. This is reported as either Positive or Negative.
- c. An indication of Positive will indicate the bottom of your fuel tank contains water and significant biological growth. You will need to take action in order to remove contaminates before it further degrades your fuel and causes physical damage to your engine.

### 11) Cold Filter Plug Point, CFPP (ASTM D6371):

- a. This indicates the temperature at which a filter becomes clogged by was as the fuel is cooled.
- b. There are no set limits for this test and is reported in °C.
- c. The use of the results will indicate, based upon region and climate, at what temperatures you will experience a problem in order to use anti-gelling additives.

As you have seen, understanding how fast your fuel is degrading will be critical to maintaining operability in the time of crisis. Understanding how to react to these and other situations with your fuel will be addressed in Fuel 501 – Solutions.