

## Dinosaurs to Donuts and the ASTM D975

What is the difference between gasoline, kerosene, and diesel? Well, the crude oil that is pumped out of the ground is a black liquid that contains aliphatic hydrocarbons. Aliphatic, by definition, is an organic compound whose carbon atoms are linked together in open chains that are either straight or branched. Hydrocarbons are molecules that contain aliphatic chains of carbon and hydrogen. For example, methane is a hydrocarbon with 1 carbon atom and 4 hydrogen atoms for a chemical make up of  $\text{CH}_4$ . As the chains get longer they get heavier. The first four chains are gases. They are methane  $\text{CH}_4$ , ethane  $\text{C}_2\text{H}_6$ , propane  $\text{C}_3\text{H}_8$ , and butane  $\text{C}_4\text{H}_{10}$ . All of these gases boil at very low temps from -161 F for methane to -1 F for butane. The chains up to  $\text{C}_{18}\text{H}_{38}$  are all liquids at room temperature and the chains above  $\text{C}_{19}\text{H}_{40}$  are solids at room temperature.

The different chain lengths all have different boiling points, so they can be separated by distillation. This is what happens at an oil refinery. The crude oil is heated

and the different chains are pulled out according to their varied vaporization temperatures. The distillation process occurs in the “cracking towers”. As the gases rise they are extracted according to their different weights. The hydrocarbons with chains of 5 to 7 carbon atoms are called naphthas. These substances are used as solvents and cleaners and dry very quickly. Chains from 7 to 11 carbon atoms are blended together for the various grades of gasoline, and boil at temperatures below the boiling point of water. Next in line is kerosene in the 12 to 15 carbon atom range, and lastly are the diesels and fuel oils (like home heating oil) and these range through 18 carbon atoms.

The leftovers from the distilling process are the lubricating oils. These no longer vaporize at normal temperatures, and they range from very light penetrating oils to semi solid gear greases. (Vaseline falls in there somewhere.) The chains above 20 carbon atoms are solids and include paraffin wax, tar, and asphaltic bitumen. As-

phalt? Yes! And the only difference between all of these things is the length of the carbon chain in their hydrocarbon molecule.

In the United States, diesel fuel has 5 different grades and are regulated by the American Society for Testing and Materials (ASTM). The ASTM standard for diesel is written in the D975-97. The standard D975-97 describes a limited number of properties that diesel fuels must meet and these requirements are all performance based. They do not mandate the composition of the fuel, only the specific performance related requirements. These grades consist of 1-D, Low Sulfur 1-D, 2-D, Low Sulfur 2-D, and 4-D.

The diesel grades between the regular D and Low Sulfur D are basically the same, with the exception that the

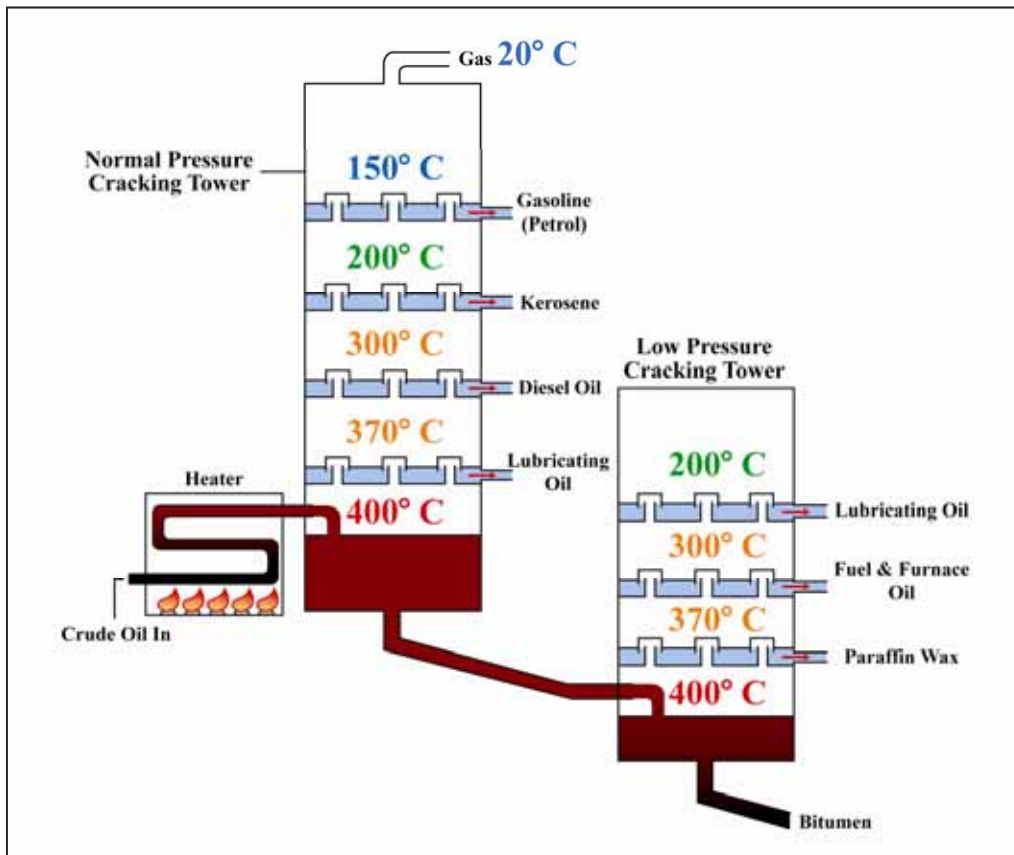


Figure 1 - Cracking Tower

Continued on Page 2...

regular D can have a sulfur content up to .50%, and the Low Sulfur D will have a sulfur content below .05% (Off road and Highway). The 1-D fuels are lighter, and have a lower flash point (100.4 F). These are used in engines with fluctuating loads and speeds (small trucks and buses). The specifications for this fuel are very close to kerosene and jet fuel and are usually produced from the same base stock. The primary use of 1-D is blending with 2-D for use in winter for improved cold flow properties. The 2-D fuels are a middle distillate that do not require the higher volatility fuel. The flash point of 2-D is at 125.6 F and are typically used in high-speed engines that operate for extended periods at high loads. 4-D is the heavy weight of the group and may require fuel heating for proper atomization. This one is typically used in low to medium speed engines and the flash point of the fuel is at 131 F.

Now, biodiesel is a totally different animal, or vegetable, so to speak. Take anything that you can fry a donut in and it will consist primarily of triglyceride molecules. These triglycerides are changed through a transesterification process by exchanging the alcohol group of an ester compound with another alcohol. The addition of either acids or bases are used to promote the catalyzing process. Acids will catalyze by adding a proton to the carbonyl group and bases will catalyze by removing a proton from the alcohol. What you end up with is a compound that mimics the burn and viscosity characteristics of regular diesel fuels. There are so many different things that you can make biodiesel out of that it truly boggles the mind, but as long as it passes the regulations stated in ASTM D975-97 it is good to go.

The amazing thing about ASTM D975-97 is the lack of actual requirements for the fuel specifications. They mention flash point, water and sediment percentages, viscosity, carbon, ash and sulfur percentages and cetane minimums. They never mention the actual composition of the fuel or the source from which it is derived. I have often wondered if Rudolf Diesel's peanut powered machine was the reason for these regulations or lack of regulations.



Figure 2 Rudolph Diesel

Jeff Bogue, Assistant Production Supervisor

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