

Fuel Oil Primer

Fuel oil comes in a variety of grades from the easily burned No. 2 to the high maintenance No. 6. This article will explain some of the differences between the grades and how to burn them successfully.

Oil Grades

The American Society for Testing and Materials (ASTM) ([link www.astm.org](http://www.astm.org)) has standardized five basic grades of oil. They are designated as Nos. 1,2,3,4,5 and 6. Of those grades only three are commonly used in heating boilers. They are Nos. 2,5 and 6.

No. 2 fuel oils are *distillate oils*, which are very fluid, flowing like water at room temperature. No. 2 oil does not require preheating to pump or burn. At the other end of the spectrum is No. 6 fuel oil. At room temperature, No. 6 (often called bunker C) is a black, thick, gummy material that requires preheating to pump and burn. Another common type of oil is No. 5. No. 5 is seldom produced in a refinery. It is created by blending No. 6 oil with distillate oils to meet certain viscosity requirements. On the West Coast, No. 5 heavy oil is often referred to as PS 300. PS 300 or Pacific Standard 300 is an old standard that is no longer used by the industry. No. 5 heavy oil may require preheating in the storage tank to pump and will probably require preheating at the burner.

Viscosity

There are many ways to characterize fuel oils. One of the most important is viscosity. Viscosity is the measure of a materials resistance to flow. Heavier oils are very viscous or “thick”. The viscosity of distillate oils such as No. 2 is low but for the heavier oils viscosity is the most important specification. No. 6 fuel oil, for example, requires preheating for both pumping and burning. Preheating “thins” the oil making it easier to pump and burn. See Table 1 for oil heating recommendations.

The most common way to measure viscosity is by measuring how fast (in seconds) a standard volume of oil at a specific temperature drains through a small hole of known diameter. The Saybolt Universal (SSU) viscometer is a common instrument to measure the viscosity of fluids. It is necessary when measuring viscosity to refer to both the type of instrument and the temperature of the test. For example a viscosity of 150 SSU at 100 means it took an oil sample at 100 °F, 150 seconds to run completely through a Saybolt Universal viscosimeter. Heavy oil is often purchased on a viscosity basis to ensure uniform quality and minimize burner adjustments. Most burners require oil viscosity at the burner to be between 100-200 SSU @ 100 °F to burn properly. Oil viscosity less than this range will require preheating.

Different grades of oil also have different heating values. Heavier oils have more energy per gallon than lighter oils. A summary of the range of heating values is given in Table 1.

Table 1

Characteristics of Common Heating Oils

Oil Grade	Heating value (Btu/gal)	Viscosity SSU @ 100 ° F	Min. tank oil temperature to pump	Burner preheat temperature
No. 2	137,000-142,000	32-38 seconds	No minimum	No minimum
No. 5, heavy (PS 300)	149,000-152,000	300 seconds to 900 seconds	30-50 °F 60-80 °F	128 °F 165 °F
No. 6 (Bunker C)	151,000-156,000	900 seconds to 9000 seconds	60-80 °F 120-140 °F	165 °F 230 °F

Stack Condensation and Corrosion

Sulfur is a small but important element in the composition of fuel oils. The percentage of sulfur by mass usually ranges from 0.25 to 4.0 %. The heavier the grade of oil, the higher the percentage of sulfur. The sulfur combines with the water vapor in the combustion gases to produce sulfur oxides that are extremely corrosive to metal chimneys. To reduce the potential for sulfur induced corrosion in the stack, maintaining chimney temperatures above 240 °F is recommended.

The Energy Cost of Fuel Oil

A major factor in selecting the fuel to be burned is its cost per Btu. Knowing the combustion efficiency of the fuel, its heating value and price allows you to estimate different fuel's cost per million Btu.

Table 2
Estimating the Cost of Fuels

Fuel Type	Ave. Heating Value	Ave. Combustion Efficiency	Multiplication factor to get cost per million Btu
No. 2 oil	140,000 Btu/gallon	86%	8.3
No. 5, heavy (PS 300)	150,000 Btu/gallon	87 %	7.7
No. 6 (Bunker C)	155,000 Btu/ gallon	87%	7.4
Natural Gas	100,000 Btu/Therm	82%	12.2

To determine the estimated cost per million Btu of a fuel, multiply its cost per gallon for oil or cost per Therm for natural gas by its multiplication factor.

Example: Compare the cost of No. 2 fuel oil at \$.99 per gallon to No. 5, heavy fuel oil at \$.80 per gallon.

Solution:

No. 2: $$.99 \times 8.3 = \8.22 per million Btu

No. 5: $$.80 \times 7.7 = \6.16 per million Btu

Note: The lower cost of heavier oil is often offset by higher handling and maintenance costs.