Fuel Related Definitions

ASH – "The solid residue left when combustible material is thoroughly burned or is oxidized by chemical means."

The ash content of a fuel is the non-combustible residue found in the fuel. These are organo-metallics from the crude oil, inorganic contaminants or metallic catalyst fines used in the refining process. In heavier fuels, such as marine fuels, there have been over twenty different elements identified as being ash forming with the most common being aluminum, vanadium, sodium, silicon, nickel, and iron.

ASPHALTENES— derived from the root word "asphalt", a sticky tar-like substance found naturally in petroleum crude oil.

Asphaltenes are complex, high molecular weight aromatic compounds suspended within the fuel that have high melting points and high carbon/hydrogen ratios with lower heating values.

During the refining process, a portion of the asphaltenes will be coked and form carbon residue (CCR or MCR). The actual percentage will depend on the refining process. For this reason, the commonly held assumption that asphaltenes in the fuel can be estimated by knowing the CCR is erroneous. In actual fact, the asphaltenes vary widely from CCR levels and have to be analyzed separately.

BIOCIDES – Chemical formulations to eliminate growth of micro-organisms in fuel.

Few fuel users treat their fuels with microbial biocides. One reason for this is the subtle nature of microbial problems, which go undetected until catastrophic failure takes place. Micro-organisms, primarily fungi, bacteria, and yeast, live in the water and feed on the organic molecules (carbon and nitrogen compounds) in the fuel. As the microbes grow and spread, they create a biomass "sludge" which leads to the clogging of lines, filters, pumps and fuel nozzles, thus creating flow restrictions and nozzle wear. The microbes produce organic acids, surfactants and enzymes which contribute to the corrosion of storage tanks.

Oxygen also plays a roll in microbial contamination. The presence of oxygen in a fuel tank is related to the frequency of filling the tank, or turnover time. The shorter the turnover time, the more oxygen introduced into the water phase, allowing aerobic bacteria and fungi to colonize in the tank. In large storage tanks, where turnover is slow the water phase is oxygen free, anaerobic species of bacteria becomes active.

CETANE – the ignition quality of diesel fuels. The normal range is from 35 to 55 (cetane numbers). A relationship exists between cetane number and the cold starting temperature of a diesel engine. The minimum starting temperature with a 50 cetane fuel is approximately 28° F. ASTM D316 test.

CFPP – Cold Filter Plug Point, the temperature at which wax crystal form in a fuel and cause it to plug filters and screens.

CLOUD POINT – The cloud point measurement is used to predict the temperature at which wax in fuel may begin causing operating problems such as filter plugging and blockage of line in fuel systems.

COMPATIBILITY – "capable of existing or operating together in harmony."

Fuel compatibility is not typically a problem within the continental boundaries of the USA, but is becoming a major concern for bunker buyers, or buyers of fuels in our neighboring countries. An incompatible fuel occurs when the asphaltenes in the fuel become unstable, agglomerate and precipitate out of the fuel, forming sediment that will plug fuel filters, purifiers, heaters and fuel lines. Incompatible fuel is harder to burn resulting in deposits to engines and boilers and increased emissions.

Also of concern is the huge increase in the amount of carbon residue and asphaltenes in bunker fuel. Fuels today can have carbon residue as high as 23% and asphaltene levels as high as 17%. Keeping these fuels stable and the carbon residue and asphaltenes dispersed is of critical importance to plant operation. If this fuel becomes incompatible through blending or mixing of fuels in bunker tanks, the sediment formation may result in shutting down the power plant.

CARBON RESIDUE – "in petroleum products, the part remaining after a sample has been subjected to thermal decomposition."

Carbon residue refers to the percentage of material left after a fuel sample is heated to high temperatures. It is also a term often used to describe the deposit forming tendency of a fuel. While the term describes the residue as carbon, it may also contain ash from the fuel.

There are three tests used to measure carbon residue: Conradson Carbon Residue (CCR), Microcarbon Residue (MCR), and Ramsbottom Carbon Residue (used primarily with distillate fuels). CCR and MCR results are closely correlated, though MCR is considered more accurate and is becoming the predominate test procedure in testing labs.

Fuels with high carbon residue have slower burning rates and are more difficult to burn. Slower burning leads to incomplete combustion and high exhaust temperatures which can mean: fouling of the fuel injectors, deposits on the piston crowns, burned exhaust valves, carbon deposits in ring grooves and exhaust ports, excessive use of lube oil, and excessive emissions from the stack.

FUEL ADDITIVES:

There are three general groups of fuel additives: PRE-FLAME ADDITIVES that effect the fuel up to ignition, FLAME ADDITIVES that effect the combustion and POST FLAME ADDITIVES that effect the byproducts or results of combustion. To further complicate the fuel additive choice, there are 14 specific functions that fuel additives can perform (stabilizers, corrosion inhibitors, emulsion breakers are just a few).

PRE-FLAME ADDITIVES

Pre-flame additives comprise the largest number of classes, treating fuel problems that occur from the time of delivery until the fuel sprays through the injector or burner tip. The problems are those of storage and handling and involve fuel tanks, lines, and filters and center on fuel stability, fuel flow, water and microbial contamination. Pre-flame additives can be helpful in reducing these problems and helping deliver optimal fuel to the combustion chamber.

Fuel stability is a problem with all fuels but particularly for those that are heated or stored for any length of time. Stability has become more of a problem in the 90’s because today’s fuel is often a blend of different crudes and cutter stocks, not all of them compatible or desirable. Unstable fuels form gums, particulates, and corrosion causing acids, which impact the fuel. Products used to improve fuel stability include:

> **Dispersants**, which keep sludge from forming and will re-dissolve sludge in the fuel tanks and lines. The effectiveness of a dispersant can be measured using an ASTM test that measures sediment formation (hot filtration test).

Stabilizers, which help keep the fuel from oxidizing and breaking down in the fuel tank prior to combustion. Stabilizers and dispersants are either basic nitrogen or polymerics.

Corrosion inhibitors either film onto metal surfaces or partially neutralize acidic fuel components in the fuel thus providing corrosion protection in fuel tanks and lines.

Detergents coat metal surfaces and keep material from sticking to them. Detergents will also help clean existing deposits from metal surfaces.

FLAME ADDITIVES

Fuel problems that occur during the actual burning process are said to be "combustion related". Combustion, a complex set of reactions involving fuel and air are of one type and one type only; not all of the fuel injected into the cylinder, or through a burner into a boiler, is burned.

Fuel additives for flame are designed to help burn more fuel and they fall into one of three classes:

1. Atomizers that reduce the surface tension of the fuel creating smaller droplets and a finer spray. Since fuel burns as droplets suspended in air, smaller droplets will burn in less time than larger ones.
2. Combustion Catalysts use organo-metallics to provide a chemical method of mixing fuel and air on an ionic level not attainable by mechanical methods.
3. Combustion Improvers, the most notable being cetane improvers, change bulk physical properties of the fuel to those of higher quality, better burning fuel.

POST FLAME ADDITIVES

Post flame problems include engine deposits, corrosion, smoke, and emissions. These problems occur because of incomplete combustion of the fuel due to mechanical and/or fuel quality problems.

Mechanical problems include: worn burner tips or injectors, poor atomization due to fuel pressure or steam atomization pressures too high or low, plugged or improperly placed diffusers, and viscometer problems causing fuel temperatures to be too high or low.

Have the heavier fuels analyzed for viscosity, density, ash constituents, carbon residue, percentage of asphaltenes, and compatibility. This will help in knowing what to expect from burning the fuel and whether using a fuel additive can reduce the effects.

FUEL GRADE: Fuel grade is based primarily upon the viscosity of the fuel and the intended application.

No. 1-D Low Sulfur	Very low pour point fuel for use in high speed engines requiring low sulfur fuel; also low sulfur kerosene applications. Usually considered off-road fuel.
No. 2-D Low Sulfur	High speed engines requiring low sulfur fuel. Usually considered off-road fuel.
No. 1-D	Very low pour point fuel for use in high speed engines utilizing higher sulfur content fuel; also higher sulfur kerosene applications. Primary fuel for on-road applications.
No. 2-D	High speed engines utilizing higher sulfur content fuel. Primary fuel for on-road applications.
No. 4-D	High viscosity fuel for use in medium and low speed engines utilized in sustained load, constant speed applications. Usually used in marine and certain industrial diesel applications.

POUR POINT – The pour point value is used to predict the temperature at which cold fuel will gel and no longer flow

STABILITY -- Fuel stability is an indication of the sediment and gum forming tendency of fuel. Gums and sediment can cause filter plugging, combustion chamber deposits and can result in sticking of pumping and injection system components.