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Exceptional distillate performance starts here! ___

Fuel Basics, by *W.R. 'Bud' McClintock*, G.M., ADT Fuel Additives

The Problem with Fuels…

Most distillate operability problems revolve around two central issues- the affects of ***time*** and ***temperature*** on fuel*.* Petroleum products, like all organic compounds, have a shelf-life, and will degrade over ***time****. And,* as everyone is aware, ***low temperatures*** can be a major hindrance to both heating oil and diesel operation when winter temperatures exceed product specifications, especially when fuels are stored outdoors.

Time is of the essence

What's the last thing you do before you store gas-powered equipment for the winter? Yep, treat the gas tank with a fuel stabilizer, so that solids, gums and other impurities don't precipitate into the tank clogging carburetors or injectors. Why does this happen? Because ***time*** is the enemy of fuel stability. Even though federal regulations require that all gasoline contain an EPA-approved detergent additive to minimize fuel system deposits that affect vehicle performance and emissions*,* stability remains a problem as fuels *age*.

Fortunately, gasoline is rarely stored for extended periods. But <u>middle distillates</u>, especially *heating oil* and off-road fuels, are routinely degraded by prolonged storage; leading to oxidative instability, molecular re-polymerization, and the harmful effects of interactions with numerous impurities, metal debris and corrosive acids. This is often the result of a lengthy distribution chain, especially in Northeast markets. Supply into New York Harbor (NYH) for example, can take weeks for pipeline deliveries and even longer for cargo vessels. These fuels then enter commingled storage[1] for long periods before being loaded onto barges and shipped to distant petroleum terminals, where they remain until resold to distributors or consumers.

Other East Coast markets now see more imported and Gulf Coast sourced products, lengthening the ***time*** from fuel manufacture to use. The bottom line is ***time*** degrades all fuels- *no exceptions*. But, what happens to fuels over ***time*** and what operability problems does ***time*** affect? A high percentage of distillates are manufactured by 'molecular cracking' processes, whereby long hydrocarbon chains[2] are literally *cracked* to form smaller, lighter molecules. This allows refiners to convert heavy residual fuels (with little demand) into higher-valued products like heating oil, diesel and gasoline. As chemical bonds are broken, these 'cracked' molecules become 'reactive,' causing heavier less stable materials to form. These larger molecules drop to the bottom of storage tanks and join with other impurities (including sediments, microbes, water and metal debris) to form sludge, which can clog supply lines, filters or nozzles, resulting in fuel-related service calls[3].

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[1] Commingled fuels are almost always *less stable* than those from a "single source" of manufacture. Stability tests clearly show *mixed* fuels to be less stable than their individual components.

[2] Residual fuel molecules are generally 80+ carbon atoms long. These long-chain molecules when *cracked*, produce middle distillates in the 14-20 carbon atom range in length.

[3] NORA (National Oilheat Research Alliance) indicates half of all service calls are *fuel-related,* requiring service technicians to respond to as many fuel quality issues, as any other problem.

Low temperature operability

Ever go to a service station and ask the attendant "will this gasoline work when it gets cold?" Of course not! That's because gasoline specifications virtually guaranty operation in the environment in which it is sold. But not so for distillates- because both heating oil and diesel products are sold as *fungible* (interchangeable) fuels. This means that there is no assurance of operability greater than commodity-grade specifications.

And, what are these requirements in terms of ***temperature***? The pertinent distillate specifications relating to cold flow are- *Pour Point*[4] *(D97), Cloud Point*[5] *(D2500) and Cold Filter Plugging Point*[6] *(D6371, IP309). Pour Point* is simply the lowest *temperature* at which fuel will flow. *Cloud Point* is the temperature at which wax crystals (haze) first appear in fuel, and *Cold Filter Plugging Point* (CFPP) is the temperature at which wax crystals agglomerate sufficiently on a filter or in a fuel line to restrict fuel flow to the engine. The respective seasonal NYH distillate ***temperature*** specifications are as follows:

Pour Point: **0° F. (-18°C.)** from Aug 1 through Mar 14/ **+10° F. (-12°C.)** from March 15 through July 31

Cloud Point: **+15° F. (- 9°C.)** from Aug 1 through Mar 14/ **+20° F. (- 7°C.)** from March 15 through July 31

CFPP: **Varies** by base fuel, but usually **3-5° F. below** the *Cloud Point*

The specification most important to heating oil operation is *Pour Point*, the ***temperature*** at which fuel stored in outdoor tanks will *not* pump. Generally with heating oil "*if it flows it burns.*" The necessity is to get fuel from containment, through a supply line, to ignition. *Cloud point,* however, is predominantly a diesel specification, because, in addition to flowing at low temperatures, fuel must pass through a filtration device for continued operation. *Cloud Point* for #2 Diesel on the East Coast is +15 degrees Fahrenheit. So, at some ***temperature*** below the fuel's *Cloud Point* (where wax crystals first appear) but above its *Cold Filter Plugging Point,* (where fuel will no longer filter), resellers or consumers must intervene to assure low ***temperature*** fuel performance.

What intervention is needed for low ***temperature*** fuel operation? Historically, kerosene blending was used to ensure winter operation in both heating oil and diesel applications. But kerosene use is impractical today, both difficult to find and *prohibitively* expensive. If that weren't enough, *kerosene* reduces *lubricity*, and lowers the Btu (energy) value of fuel. Fortunately, winter fuel additives are very effective in reducing operating ***temperatures*** in both heating oil and diesel fuel. *Pour Point* depressants for heating oil can reduce cold flow (by as much as 40° F.), very inexpensively. And, at a fraction of the cost of kerosene blending, cold flow improvers can significantly lower operating ***temperatures*** in diesel fuel by modifying the size and shape of wax crystals, permitting fuels to flow and filter at temperatures well below commodity specifications.

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[4] Pour Point, ASTM D97: The lowest temperature at which a fuel is observed to flow when cooled at a specific rate. Pour point is a useful guide to the lowest temperature at which fuel can be pumped from containment vessel.

[5] Cloud Point, ASTM D2500: The temperature at which a haze of wax crystals form within a fuel sample. The cloud point relates to filter plugging at cold temperatures, varying depending on the origin, type and volatility range of the fuel and its paraffin content.

[6] Cold filter plugging point (CFPP) is the lowest temperature at which a given volume of fuel can pass through a standardized filtration device within a specified time when cooled under prescribed conditions.

In Summary

Distributors of distillate fuels must be aware of the operating limits and specifications of the products they sell. The affects of ***time*** and ***temperature*** on fuel performance, if ignored, will lead to operational problems. In the case of heating oil, it is well-documented that fuel additives can be very effective in mitigating the affects of *sludge,* accumulated in storage tanks over ***time,*** by 1) stabilizing fuels in storage 2) dispersing existing sludge and impurities through the system, without impacting burner performance, 3) cleaning the fuel supply system, 4) protecting tanks from rust and corrosion, and, 5) keeping metal particles from causing damage.

Cold weather fuel performance is an equally important operational concern in winter as ***temperatures*** approach the *Cloud Point* or *Pour Point* of distillates. If heating oil stored in outdoor tanks reaches its *Pour Point,* it will *not* move or pump, requiring unnecessary intervention to restore operation. Fortunately, *Pour Point* depressants are very effective in lowering cold flow ***temperatures*** and are easy and inexpensive to use.

Diesel fuel resellers and users must also remain vigilant of fuel specifications as ***temperatures*** approach the *Cloud Point* of fuel. Fuels reaching their *Cold Filter Plugging Point* will result in vehicle down-time. Straight No.2 diesel fuel won't get you through most winters, so have a plan for low ***temperature*** fuel performance.

A few words on bio-fuels

The renewable components in bio-derived fuels raise both the *Pour Point* and *Cloud Point* of blended products. The affect on winter operability depends on the specific feed-stock and the percentage of the blend, but be aware that bio-blended fuels, even in low doses, pose operational challenges in cold weather, especially in outside tanks. *Monoglycerides* found in biodiesel are similar to paraffin waxing- so just like with petroleum products, know the *Pour Point* and *Cold Filter Plugging Point* of the blended fuels you use.

Increasingly higher levels of biodiesel blended with *ULSD (15 ppm S.)* have also raised concerns by both engine manufacturers and fuel storage operators. Bio-fuels derived from vegetable oils or animal fats *age rapidly* during storage, leading to aggressive contaminants that react with storage tanks or engine parts, causing corrosion. Be aware that ULSD fuels hold *two times* (2X) more water than LSD (500 ppm S.), while *B100* can entrain *10 times* (10X) *more water*, so even small amounts of renewable components blended with ULSD can dramatically increase water related issues. As a recent EPA study noted, water in ULSD fuels has been a persistent problems, leading to significant corrosion in ULSD storage tanks and dispensing equipment. Finally, Additionally, the presence of higher volumes of water in ULSD and biofuels encourages microbial growth and microbial induced corrosion.

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