

Diesel Fuel Additives

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- [Final report available at
http://acep.uaf.edu/media/85297/Additives-Report-9-23-13-
phase-one-final fp Hard-copy-version.pdf](http://acep.uaf.edu/media/85297/Additives-Report-9-23-13-phase-one-final_fp_Hard-copy-version.pdf)

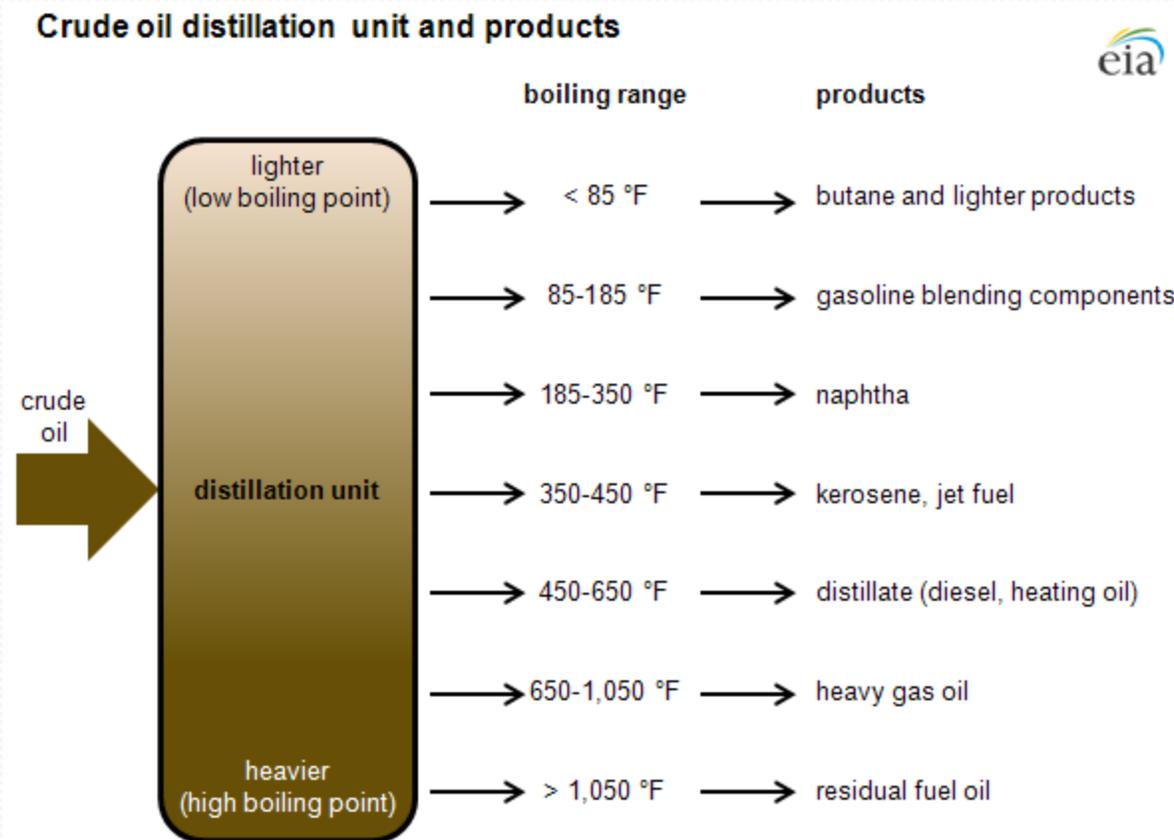


Who is buried in Grant's tomb?

- Diesel fuel—is the fuel you put in a diesel engine (a fuel intended for sustained use in a diesel engine)
- Heating fuel—the fuel you put in a heater
- Jet fuel—the fuel you put in a jet engine
- Additive--Something you put in something else to change the properties,
 - hopefully for the better—
 - like the lime in a Gin and Tonic
- Bunker fuel—in my case, lunch, with an occasional ethanol additive.

What's the difference between heating fuel and diesel fuel?

- Not much--both are distillate products from crude oil, with about the same range of components





So what is diesel fuel?

- Diesel fuel is a “distillate fuel”, meaning that it is distilled from crude oil
- It is comprised of a wide variety of hydrocarbon molecules—anything with a boiling point between about 200 and 350C
- It is a mixture—contains many different compounds, depending on where the crude comes from
- “Diesel fuel” is defined by the additive package and the way it is handled



So what makes it a diesel fuel?

- It has to work in a diesel engine
 - It has to ignite at the right temperature (not too soon— not too late)
 - It has to burn at the right temperature (prevent NOX)
 - It has to provide cooling and lubrication to the fuel injection system
 - It has to have a low flash point (for safety reasons)
 - It has to flow at ambient temperatures
 - It has to burn cleanly (no soot, no carbon buildup)

How do we know the diesel fuel we buy actually does these things?

- Diesel fuel has specifications—and a lot of them—to make sure it works in our diesel engines—requiring that the fuel have properties within certain values
- ASTM D975 is the US specification for diesel fuel
- If you buy fuel labeled “diesel fuel” at the pump in the US, it means that it meets all the specifications of ASTM D975
- If you are an Alaskan electric utility, and write your own contract to buy fuel, it is almost certainly based on ASTM D975 specifications
- International fuel specifications are similar—partly because the US military buys diesel fuel around the world, and uses a ASTM D975 based spec
- It is the job of the refinery and fuel supplier to make sure their fuel meets these specifications—not the customer
- Engine manufacturers design their engines to operate on fuel that meets ASTM D975 specs



The “Necessary” Additives

- Sometimes (often) additives are necessary to bring fuels “into spec”
- For example, low sulfur fuels tend to have low lubricity—fuels used to be adequately lubricated by the sulfur compounds in them
- An additive is needed to bring the ULSD fuel up to an adequate lubricity level
- Most common lubricity additives tend to attract water out of the atmosphere—are added when the fuel is pumped from the barge to bulk fuel storage tanks. (Dryden)
- If your barge company offers you a lubricity additive—take it—and there should be no additional charge—this is a necessary additive to meet ASTM D975 specs
- There appears to be no benefit from adding more than what is required to meet ASTM D975—so you don’t need to add more, or pay for more (although there is probably no harm in doing so)
- Conductivity is also adjusted by an additive in low-sulfur fuels, at the refinery



The “Alaska Necessary” additives

- ASTM defines “pour point” (when fuel gels) and “cloud point” (when paraffin particles form) specifications based on climate
- Alaska is the coldest part of the US—we get our own zones
- The best (cheap and effective) additives for pour point are mixed into the fuel at the refinery while it is hot (pour point is specified in contract)
- These pour point suppressants cost less than a penny per gallon when added to hot fuel
- It cost considerably more to add a pour point suppressant to cold fuel at a bulk storage facility, and it usually doesn’t work as well (poor mixing, cold fuel reacts more slowly)
- Alaska electric utilities generally don’t worry about cloud point—the fuel is heated before being put in the generators



Additional Additives???

- If the fuel delivered to a customer meets ASTM D975, does this mean that there is no use for any other additives?
- Fuel properties change in storage—additives are sometimes useful for helping with long term storage (just because your fuel was good when you bought it doesn't mean it's good when you want to use it)
- Diesel engines sometimes can benefit from additives intended to improve their performance

Long term storage of diesel fuel issues

- Water management—
 - Tanks are vented
 - Air enters the tanks—and contains a tiny bit of water vapor
 - At night, the water vapor in the air condenses on the tank walls
 - Since the water is denser than the fuel, it sinks to the bottom
 - Once on the bottom, it does not evaporate
 - The tiny bits of water eventually accumulate to form a pool of water, and all kinds of nasty things happen in that pool of water—biological growth, corrosion
 - Every bulk fuel storage system should have a water management system and operations plan, part of which may be use of appropriate additives
 - All engine manufactures have sections of their manuals devoted to the issue of water management in diesel fuel storage tanks (and some engines are much more susceptible to water damage)



Storage Additives

- Water management additives (different for diesel fuel and gasoline engines)
 - Gasoline engines use methanol to allow water to mix with fuel and pass through the engine
 - Diesel engines tend to be more intolerant of water—depending on your engine—so additives may be used to help the water separate out from the fuel more readily
- Biocides
 - Used to kill microbes that live in the inevitable water at the bottom of tanks—
 - Used most often in marine locations, by many bulk fuel storage facilities (Dryden indicated that use of biocides is common in Alaskan coastal communities)
- Corrosion inhibitors—associated with the water problem
- Stabilizers—prevent oxidation of the fuel—usually not a problem with petroleum based diesel fuel, but definitely a problem with bio-fuels

Common Additives

Additive Type	Function	ASTM D975	Utility
• Biocide	Kill biological growth in fuel tanks	Permitted	AK
• Cetane Boost	Increase the Cetane number of a fuel	Permitted	Rare
• Conductivity	Prevent static discharge	Required ULSD	Refinery
• Cloud Point	Decrease Cloud point	Permitted	(1)
• Efficiency Boost	Increase the efficiency of an engine	Not addressed	Rare
• Emissions	Reduce pollutant emissions	Not addressed	Rare
• Injector Cleaner	Clean fuel injectors	Not addressed	(2)
• Lubricity	Increase fuel lubricity	Required ULSD	AK Use
• Pour Point	Decrease the pour point	Permitted	AK Use
• Stabilizer	Improve the storage stability of fuel	Permitted	Rare
• Water Disperser	Disperse water in fuel.	Not Recommended	NR

• Notes

- (1) Most Alaskan utilities adjust pour point to allow fuel transfer to day tanks, but warm fuel before sending to engine—no need for cloud point additive
- (2) Injector cleaners may be warranted if injector fouling is suspected, but generally this can be addressed by other maintenance procedures



The “Snake Oil” Additives

- Increasing diesel engine efficiency is a major objective (huge savings for the state)
- Some people try to market additives or devices that claim to improve engine efficiency, sometimes dramatically
- Are these claims credible?



Varieties of Snake Oil

- Additives that claim to improve combustion efficiency
 - Platinum
 - Ferrocene based additives
- Hydrogen added to air stream
- Magnetic devices
- Water misting devices



Helpful sources

- EPA site on testing of additives and devices for gasoline engines
 - Not diesel engines, but many products or devices claim to work in both
 - EPA runs a program to test these additives, at the expense of the product developer
 - Incredibly rigorous control over testing protocol to make sure that test results are defensible
 - Has been operating this program since 1972
 - Has yet to find a single device or additive that has resulted in statistically significant improvement in engine performance



Engine Manufacturer's Web Sites

- Recommend using diesel fuel that meets ASTM D975 specs
- Do not recommend the use of any additional additives
- But if you are going to use additives, here's our product line, use them...
- Specifically recommend against the use of additives that create metallic coatings inside the engine—abrasion and coating of Tier 4 exhaust treatment catalyst.



Diesel Engines

- Modern diesel engines are amazingly efficient and clean, compared to engines of 40 years ago
- A well maintained engine burns nearly all the fuel injected into the cylinder (perhaps .5% unburned), so claims of improved efficiency by “burning more of the fuel” are very suspect
- Diesel engines are designed to limit the maximum combustion temperature to limit Nox production (burning the nitrogen in the air),
- More power can be extracted from the engine by changing the injection timing—essentially a software change—but engines operated this way will not meet emissions tests.
- Injector fouling can be readily detected by monitoring exhaust manifold temperature

Does this mean that we should never use fuel additives?

- Put that question to Bob Dryen—
- He talked about putting additives in his boat fuel tank—he only uses the boat occasionally, so the engine runs cold some of the time, water might get in the gas—and he doesn't want to get stranded
- After working on this project, I put some injector cleaner in my Toyota 4Runner, and saw about a 10% increase in fuel mileage



Survey of Alaskan Utilities

- Chandler Kemp attempted to contact every diesel generating utility, and business in the fuel supply chain in Alaska with a survey
- Got a very good response—most people were happy to talk
- Most Utilities are knowledgeable about fuel issues, and are not using unnecessary additives
- A few were confused by the lubricity additive procedures, and the proper use of pour point additives
- A few have experimented with additives or devices to improve engine efficiency, but none were ready to recommend their wider use



Conclusions

- Additives are often used in diesel fuel to bring it into spec
- USLD fuel requires the addition of a lubricity additive, which is often added when the fuel is being transferred to the village bulk storage facility
- Additives can be used to help manage issues with long term storage, but water management is critical
- Engine manufacturers do not recommend putting anything into the engine except fuel that meets ASTM D975
- There are specific recommendations against additives that leave metallic compounds inside the engine