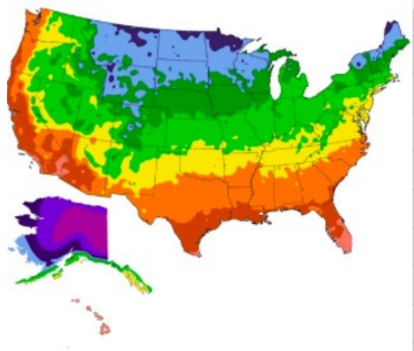
# Thriving This Winter: Dynamic Treatment Methods to Better Treat Modern Fuel

## Introduction

Fuel refiners are constantly working to improve methods in order to optimize output and improve profitability. Even though changes in refining methods and new sources of crude stock can be economically advantageous, they routinely require new characterization for cold weather operation, i.e., more extensive lab testing and treatment response.

Weather-related failures could often occur at higher than expected temperatures in addition to those that come with the extreme cold. Sometimes these issues occur even when users presumably treat fuel properly for the winter. If you use #2 diesel and live in regions north of the yellow areas in the map to the right, then, you've probably experienced issues with diesel fuel-operability (wax separation, icing, gelling).



| Zone | Average minimum Temperature |
|---|---|
| 1 | Below -50°F |
| 2 | -40°F through -30°F |
| 3 | -30°F through -40°F |
| 4 | -20°F through -30°F |
| 5 | -10°F through -20°F |
| 6 | 0°F through -10°F |
| 7 | 0°F through 10°F |
| 8 | 10°F through 20°F |
| 9 | 20° through 30°F |
| 10 | 30°F through 40°F |
| 11 | Above 40°F |

Source: Plowbox/Seattle Seed Co.

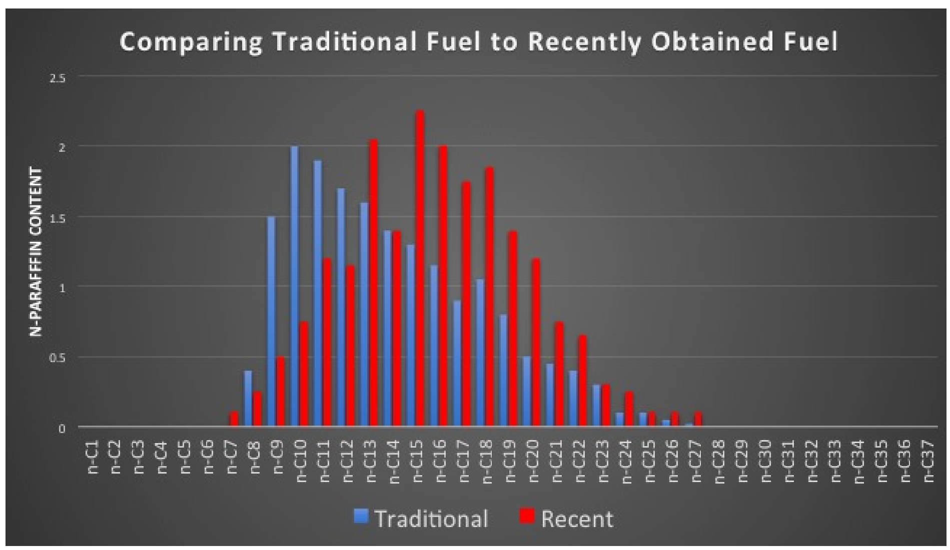
## Fuel Characterization

We now know that traditional winter treatment methods are not always effective in modern fuels but answering why is not always simple. In order to correctly identify the proper treatment program, more thorough and comprehensive testing methods can be used. For instance, testing for n-paraffin distribution can greatly help to classify different fuel sources.

Diesel is composed of about 75% saturated hydrocarbons. Traditionally, typical refined ultra-low sulfur diesel would have an even distribution of n-paraffin carbon chains gradually increasing and peaking around C-16 to C-20, then gradually decreasing.

The n-paraffin wax distribution diagrams to the right show the variability between different sources of fuel. Gaining a better understanding of your fuel is essential in order to determine the best cold weather fuel additive treatment options.

The n-Paraffin Distribution Plot 1 shows a contrast in a traditional fuel (blue) vs. a recently obtained fuel (red). The recently obtained fuel shows a significant increase in wax content starting at n-C15 level and after. In this case the higher concentration (red bars) of n-paraffin waxes along with the longer carbon chains (to the right) cause this to be more difficult to deal with in cold weather.




## Summary of Findings

After running a number of n-paraffin distribution content curves (as seen above) it was found that fuel wax content varied greatly from sample to sample across the US. Therefore, determining the proper fuel treatment protocol varies from region to region and fuel to fuel. Understanding how the fuel you handle reacts to treatment will help determine the proper winterization method(s).

# Fuel Additive Treatment Options

## 1. Blend with Kerosene or #1 Diesel

### Diluting the overall wax content

Blending with kerosene or #1 diesel will offer you a certain amount of protection by thinning out n-paraffin wax content and lowering the cloud point of the base fuel.

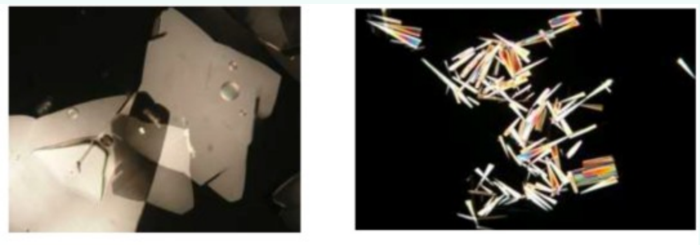
Though blending with #1 can be effective, it is also a very expensive option. The use of #1 is most effective when combined with proper winter additive chemistry.

## 2. Blend with Anti-gel

As diesel fuel cools, wax particles (n-paraffins) start to bond together and grow larger. As they grow, they can eventually become so large that they will not fit through fuel filters resulting in filter plugging. When your fuel is blended with anti-gel, the anti-gel will modify the shape and size of the wax particles to prevent growth. This modification will help your fuel flow through filters at lower temperatures than untreated fuel. See Image 1 for Wax Modification with Cold Flow Improver (CFI Treated Fuel).

Image 1

Source: Coordinating Research Council Report No. 671 "Diesel Fuel Low-Temperature Operability Guide" (2016)




## 3. Blend with Anti-gel and Wax Anti-settling Additives (WASA)

As fuels sit static for long durations in cold temperatures at or below the cloud point, wax particles can start to become denser and fall to the bottom of equipment/storage tanks. The combination of both Anti-Gel and WASA modify the shapes, sizes, and densities of wax crystals to prevent gelling and Wax Fallout. See Image 2 for Wax Modification with WASA and Cold Flow Improver (CFI Treated Fuel).

Image 2

Source: Coordinating Research Council Report No. 671 "Diesel Fuel Low-Temperature Operability Guide" (2016)


## 4. Blend with Anti-gel, WASA and #1

The use of all three above methods together is most effective because it dilutes the amount of wax with #1 fuel while also using winter additive chemistry to prevent gelling and wax fallout. Keep in mind that blending #1 from the same hard to treat #2 blendstock can produce diminishing returns. This is where competent fuel testing can help to determine proper responses and ratios.

## 5. Summary

Many factors, including modern fuel refining processes and new crude sources, have resulted in harder to treat fuels throughout the nation. These fuels contain irregular or unpredicted concentrations of n-paraffin waxes and require additional methods to effectively test and treat for cold weather operability. Higher concentrations of anti-gel and WASA are commonly required, and often the use of #1 fuel is also necessary.

## Fuel Additive Facts you should Know

1) The CFPP temperature is not the only measure of a fuel's cold flow performance.

2. Do not focus 100% on the CFPP. As many now have seen, operability failures almost always occur before reaching a CFPP test number. You may better understand CFPP as an indication of whether or not additives are effectively attacking the waxes and whether a fuel source is harder to treat than normal.

3. When the difference between Cloud Point and CFPP is not as expected in a treated fuel, it indicates further testing or analysis be completed for best recommendations of cold flow additives and or blending.

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Note: WASA does not typically affect the CFPP testing performance but can greatly improve operability.

For additional information about this topic, please contact your ET sales rep or call 800-325-5746.

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