American Chemistry Council's Petroleum Additives Panel's Fuel Additives Task Group

Overview of Diesel Additives & Filtration Issues
March 2018

Introduction

The American Chemistry Council's (ACC) Fuel Additive Task Group (FATG), a task group of the Petroleum Additives Panel, is comprised of fuel additive manufacturers. This document was jointly prepared by the members of the ACC's FATG. Members of the FATG include: Afton Chemical, BASF, Chevron Oronite, Infineum, Innospec, and The Lubrizol Corporation.

Fuel additives impart additional chemical properties to fuel hydrocarbons, which in turn leads to improved function and performance. Diesel additives have been used for almost 100 years at all points in the diesel distribution system. These additives allow fuel producers, distributors, and marketers to not only meet certain basic specification requirements[1] for engines, but also to provide additional protection to critical distribution and vehicle components, and to improve the overall performance of the fuel in the diesel engine.

Various filtration points are set up along the diesel fuel's distribution chain, from the fuel refinery to the vehicle, and filter blocking issues may occur at any of these points. Additives may be observed during surface analysis of slow-running or blocked filters, but they are likely not the root cause of the filter blocking issue.

The purpose of this document is to help increase understanding of diesel additives, their addition to diesel fuel, and common filtration issues.

The following information is contained in this document:

- Information on Additive Types
- Where Filtration Can Become an Issue
- Guidance for Blending Diesel Additives into Fuel

Information on Typical Diesel Additive Types

The most common performance-enhancing diesel additives currently used in the United States include cold flow improvers, lubricity improvers, injector, and fuel system detergents (additional diesel additive types are listed in Table 1 of this document). Often additive suppliers combine these and other components into customized multi-functional diesel additive packages in order to simplify additives injection and storage needs. In this way, additive suppliers are able to assess the storage stability of the individual components with each other in order to address compatibility issues. Also, the physical properties of multifunctional diesel additives and individual component additives can be tailored for optimum mixing according to the mode of addition into the fuel, such as:

[1] For example ASTM D975, EN590.

- heated injection or injection into hot fuel (e.g. at a refinery);
- ambient injection into a high flow stream of fuel (e.g. at a terminal); or
- splash blending into a bulk fuel truck, or, into a vehicle fuel tank.

Where are Diesel Additives Used?

The modern fuel distribution system is very diverse and complex as described in CRC Report No. 671 "Diesel Fuel Low Temperature Operability Guide." It states as follows:

> Fuel distribution can include movements from refinery to terminal, terminal to pipeline, pipeline to terminal, terminal to delivery truck, and tankage to service station pump (Figure 10). There are also specialized applications such as transfer from tankage to railroad engine fuel tanks. Fuel distribution covers very large systems moving thousands of barrels of fuel daily to very small systems containing just a few hundred gallons.[2]

Diesel additives can be used at all points in the distribution system and are generally sub-divided according to their point of application. It is not uncommon for individual components to be added to diesel fuel. However, customized multi-functional diesel additive packages can simplify additives injection and storage needs.

Table 1: Diesel Additives and Possible Points of Application.

	Refinery	*Pipeline, Terminal*	*Fleet/Distributor Jobbers/Aftermarket End User*
Metal Deactivators	✓		
Stabilizers	✓	✓	✓
Corrosion Inhibitors	✓	✓	✓
Cetane Improvers	✓	✓	✓
Cold Flow Improvers	✓	✓	✓
Conductivity Improver		✓	✓
Diesel Detergents		✓	✓
Lubricity Improvers		✓	✓
Marker Dyes		✓	✓
Demulsifiers and Dehazers		✓	✓
De-icers		✓	✓

[2] Coordinating Research Council. Diesel Fuel Low Temperature Operability Guide. Report No. 671. (2016) pg. 23.

Where Can Filtration Become an Issue?

Historically, blocking of bulk filters in the diesel fuel distribution chain has been linked to various contaminants (water, dirt, biomass, metal salts, biodiesel impurities) but now fuel additives are being mentioned[3] as potential contributors. But, unlike fuel contaminants, fuel additives are meant to be in the fuel, have been used for decades, and are typically necessary to make distillates fit for purpose.

Housekeeping[4] is a vital element in a diesel fuel quality program. There is increased industry focus and desire toward controlling particle contamination at various points in the fuel system especially as the diesel engine base continues to implement high pressure common rail injection technology. Tighter filtration has become the norm, and it is not unusual for 2 micron filters to be used on-board vehicles for final polishing of fuel.

Many diesel fleets and other large end-user groups have increased filtration at intermediate diesel bulk storage facilities in order to reduce particulates upstream of vehicles. It is now not uncommon for a mine or fleet site to install filtration on the inbound side of an onsite fuel tank to augment the outbound filters. With more filters in the fuel system using smaller pore size filter media, upstream filter blocking is an area of increased focus.

Examples of possible issues and guidance associated with filter blocking as related to use of additives in diesel fuel are listed in the next section of this document.

Examples of Possible Issues and Guidance for Blending Diesel Additives into Fuel

1. Possible Issue: Insufficient Mixing of Diesel Additive into Fuel

Fuel additive injection equipment and their mixing effectiveness vary across the spectrum of commercial applications. This can range from bulk fuel treatment, for example at refineries, to downstream fuel terminals or truck fleet depots, or to an operator pouring a bottle of aftermarket additive into a vehicle fuel tank. Bulk fuel treatment typically employs dedicated injection systems (additive storage tanks, injection pumps and quills, additive and fuel flowmeters to establish desired treat rate, etc.). This variety in how additive is introduced into the fuel can give rise to inadequate solubilizing of the diesel additive by the fuel, which can in turn lead to issues with concentrated additives accumulating on filter media.

Guidance

Proportional additive injection into the flowing diesel fuel in transit to a storage tank or a delivery tank-wagon is preferred. Best practice is co-current diesel additive injection in the direction of fuel flow via a quill at the pipe center point while the fuel is in turbulent flow. Consider the use of a static mixer following diesel additive injection when fuel flow rate is not consistently turbulent or if additive is being inducted to a stagnant storage tank via a pump-around loop. In cases where splash blending is the only option, match the diesel additive viscosity and density to the fuel viscosity and density as closely as possible.

[3] Goertz, M.; Moravec, D.; Dallas, A.; "Potential Problems of High Efficiency Fuel Filtration and Cold Flow Improver Additives; IASH 2015", the 14th International Symposium on Stability, Handling and Use of Liquid Fuels.

[4] Housekeeping practices are described in CRC Report No. 667 and CRC Report No. 672.

2. Possible Issue- Impacts of Fuel Temperature on Diesel Additive Mixing in Fuel

As temperature decreases, effective mixing can be compromised by a number of factors. Generally, diesel additive solubility in fuel is diminished as temperature decreases. Furthermore, increased diesel additive viscosity can inhibit good dispersion and blend homogeneity.

In the case of winter fuel and cold flow improvers, injection into cold fuel (below cloud point) may not allow for dissolution of the diesel additive, *rendering it ineffective,* and may increase the tendency for filter blocking. In this situation, additional injections of flow improver additive in an attempt to achieve/improve cold flow performance, will not be effective and may further degrade filterability.

Guidance

Diesel additive injection into warm fuel (~30°C/~80°F) offers the widest range of permissible additive dilutions. However, in areas where wide fuel temperature fluctuations are common, select the highest diesel additive dilution to provide good mixing at the lowest expected temperature. For example, aftermarket bottle additives are typically very dilute formulations to account for a variety of mixing situations and temperature conditions.

In the special case of cold flow improvers, common industry practice is to inject additives into a fuel with a temperature that is at least 10°C (18°F) above its cloud point. This enables wax crystal modification by the diesel additive and helps ensure good filterability performance.

3. Possible Issue- Additive Treat Rate: "More is better"

The misconception can exist that if for example 100ppm is recommended, then 500ppm will perform five-times better. However, poor filterability may result when portions of a fuel batch deliver an extremely high diesel additive treat rate that do not follow the additive supplier's recommendations whether due to an intentional over-treat or from poor dispersion/mixing. .

Guidance

The proper addition of a diesel additive to diesel fuel is just as important as its selection to impart the desired performance enhancing attribute. A diesel fuel additive is most effective when it is injected into the fuel so that it is thoroughly dispersed and mixed, and the additive supplier's recommended treat rate is achieved homogeneously throughout the entire batch of fuel. Following the additive supplier's recommended treat rate helps ensure the additive's maximum performance and minimizes potential filtration issues. Therefore, follow the additive supplier's recommended treat rate to dose diesel fuel and do not exceed the additive supplier's maximum registered EPA treat rate.

Additional Resources

- ATC Document 113- Fuel Additives: Use and Benefits
- CRC Report No. 667- Diesel Fuel Storage and Handling Guide
- CRC Report No. 671- Diesel Fuel Low Temperature Operability Guide
- CRC Report No. 672- Preventive Maintenance Guide for Diesel Storage and Dispensing Systems
- ASTM D975- Standard Specification for Diesel Fuel Oils
- Refer to additive supplier's materials

Legal and Copyright Notice

The information presented in the Overview of Diesel Additives & Filtration Issues is a general composite of best practices. The information provided should not be considered as a directive or as an industry standard that readers must adopt or follow. Instead, the information is intended to provide helpful ideas and guidance that users may wish to consider in a general sense. It is not intended to be a "how-to," nor is it a prescriptive guide. Users must independently determine what constitutes appropriate practices relative to their own needs and circumstances. In making this determination, users should consider information contained in this document, as well as other relevant information. Users have an independent obligation to ascertain that their actions are in compliance with their current country, federal, state and local laws and regulations and should consult with legal counsel concerning such matters. Any mention of specific products in this document is for illustration purposes only and is not intended as a recommendation or endorsement of such products by ACC or its member companies. Many items in this document may be trademarked, which may or may not be noted in this document. Neither the American Chemistry Council (ACC), nor the individual member companies of the Petroleum Additives Panel, nor its Fuel Additives Task Group, nor any of their respective directors, officers, employees, subcontractors, consultants, or other assigns, makes any warranty or representation, either express or implied, with respect to the accuracy or completeness of the information contained in this; nor do the ACC or any member companies assume any liability or responsibility for any use or misuse, reliance on any information in the document, or the results of such use or misuse, of any information, procedure, conclusion, opinion, product, or process disclosed in this document. New information may be developed subsequent to publication of the document that renders information contained herein incomplete or inaccurate. It cannot be assumed that all necessary warnings and precautionary measures are contained in this document or that other additional measures may not be required or desirable due to particular or exceptional conditions or circumstances, or because of applicable, federal, state or local laws. Users should consult with their own legal counsel concerning such matters. NO WARRANTIES ARE GIVEN; ALL IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE ARE EXPRESSLY EXCLUDED. Should you have specific questions, you may contact the American Chemistry Council's Fuel Additives Task Group or the identified Panel member companies for further information.