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Title: **Fuel Filters, Winter Additives, and Blending Fuels for Cummins® Engines**

Applies To: **Cummins Engines**

CHANGE LOG

Please refer to the change log text box below for recent changes to this article:

11/17/2020 - Articel updated to include B6.7
02/01/2019 - Auther corrected 3379001 link for feedback Purposes
01/23/2019 - Author updated for feedback purposes
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Introduction

The purpose of this article is to help the user understand proper fuel selection and problems associated with fuel. This article covers the requirements of filtration and general maintenance guidelines, issues with winter fuel, blending fuel with fuel, winter fuel additives, and optional fuel heaters.

NOTE: This article contains static information from February 24, 2014. For further and perhaps more current information about Cummins Inc. Fuel recommendations and specifications, see Cummins Service Bulletin 3379001.

Fuel Cleanliness

This section explains the importance of fuel cleanliness to the successful operation of Cummins® Engines.

Modern fuel systems have been developed to reduce emissions and fuel consumption, and improve engine performance. These high-pressure systems operate at pressures approaching 2100 bar [30,500 psi] and with component match clearances typically from 2 to 5 microns for injectors. At these pressures, very small, hard particles are potential sources of fuel system malfunction.

Excessive contamination of diesel fuel can cause premature clogging of diesel fuel filters and/or premature wear of critical fuel injection system parts. Depending on the size and nature of the particles, this can lead to:

- Reduced component life.
- Component malfunction.
- Fuel system and/or engine failure.

Fuel Filters

Cummins® engines are supplied with the latest in fuel filtration technology from Cummins Filtration™. These systems are designed to remove water and other harmful particles from the fuel before they damage the fuel pump and other engine components.

The fuel system requires the use of two fuel filters. The suction side filter must have the following characteristics as of February 24, 2014:

- **Water-separating**
- **10-micron rating**
- **Water-in-fuel sensor with shunt resistor**
- **Water drain valve**
- **Engine or chassis mounted.**

The pressure side filter must have the following characteristics as of February 24, 2014:

- **5-micron rating**
- **Engine mounted.**

Use the following procedure for fuel filter recommendations. **Refer to Procedure 018-024 in Section V.**

For further information about Cummins Inc. suction fuel filter micron rating requirements and specifications, see 006-066 Fuel Filter Suction in Section 4 of ISX15 CM2350 X101 Operation and Maintenance Manual.

Fuel Filter Maintenance

Fuel filters **must** be changed periodically to prevent restriction of fuel flow from the fuel tank to the fuel pump. Fuel restriction will increase over time as sediment gets collected in the filter media. Sediment could possibly consist of rust, dirt, dust, oxidation products, and biological growth.

Change fuel filters as recommended by the appropriate Cummins® Engine Owner's Manual or Operation and Maintenance Manual. When operating under severe conditions, additional fuel filter changes can be required. To determine if this is necessary, fuel filter restriction **must** be checked. Refer to the appropriate Cummins® Engine Service Manual for fuel filter restriction checking procedures. After checking the restriction a few times, a maintenance schedule for fuel filter changes can be established for each type of operation.

Common Issues With Winter Fuel

This section presents the various winter fuel issues and methods of dealing with them.

Two winter fuel handling issues, wax and ice, have annoyed diesel operators for years. There is no solution to either of these problems that is ideal for all situations, but the better the problem is understood, the less difficult the process of finding a solution becomes. Determining whether a low power complaint is due to a fuel filter plugging complaint is fairly simple: replace the fuel filter with a new filter. If this allows the vehicle to operate normally even for a short period of time, then obviously something in the fuel is plugging the filter and causing the complaint. A simple way of determining whether the filter plugging is caused by wax or ice is to bring the plugged filter into a warm shop, drain out the liquid fuel, place the filter upside down on a piece of paper or in a shallow pan, and allow the filter to warm to room temperature. If there is ice in the filter, it will melt and run out of the filter and the water on the paper or in the pan will be obvious. Most petroleum wax, on the other hand, will **not** melt at room temperature. To speed the analysis process, the filter can be cut open and spread out. Once the cause of the low power complaint is determined, a logical solution can be chosen.

Fuel Wax

All middle (or intermediate) distillate fuels, such as jet fuels, heating fuels, and diesel fuels, contain paraffin wax. Paraffin wax is a solid, crystalline mixture of straight-chain or normal hydrocarbons melting in the approximate range of 40 to 60°C [104 to 140° F]. This paraffin wax occurs naturally in the crude oil from which fuel oils are distilled. The wax content of a distillate fuel varies greatly, depending on the crude oil from which the fuel is produced and in the processing of the fuel. Generally, higher boiling distillate fuels, such as U.S. Number 2-D diesel fuel, have a higher concentration of paraffin wax than lower boiling distillate fuels, such as jet fuel.

Because of the strong relationship between temperature and solubility of wax, wax separation is a problem in handling and using diesel fuel during cold weather. As fuel cools, a temperature is reached at which the soluble paraffin wax in the fuel begins to come out of solution (Cloud Point); any further cooling will cause wax to separate out of solution. The temperature at which a certain fuel will become saturated with wax and causes filter plugging problems is termed the Cold Filter Plugging Point (ASTM D6371). The temperature at which fuel will no longer flow is the Pour Point (ASTM D97). At the pour point, most of the fuel is still liquid, although it is very thick or viscous and trapped in a honeycomb-like network of wax crystals.

Since diesel powered equipment is frequently used at temperatures low enough to cause wax to separate, a number of techniques have been devised to prevent the wax from causing problems by plugging fuel screens, lines, filter, and so on, and preventing fuel flow to the engine. Vehicles designed to operate at very low temperatures have provisions for heated fuel tanks, insulated fuel lines, heated fuel filters and other mechanisms to warm the fuel so that the wax does **not** separate. These more elaborate systems are usually **not** practical in more temperate climates where they are needed **only** a few days a year.

Fuel Blending

There are two different types of fuel blending processes referred to in this section. The first is the blending of used engine lubricating oil to reduce fuel costs and to aid in disposing of used engine oil. This section also discusses the blending of fuel and engine oil in on-highway applications. The second is the blending of heavier fuels with lighter fuels to lower the wax content, cloud point, and pour point, and thus improve cold weather operation. In addition, the effects and hazards of mixing alcohol with diesel fuel are discussed.

Blending Fuel with Fuel

This section presents the effects of blending fuels with other fuels. Biodiesel fuel blends, used and new lube fuel blends, and gasoline, gasohol, or alcohol fuel blends are discussed in a separate section of this service bulletin (Cummins Service Bulletin 3379001).

Cummins Inc. recommends the use of a premium diesel fuel during winter (ambient conditions at -7°C or 20°F or below) operating conditions. Blended fuel **must** meet the specifications in Table 1: Cummins Inc. Required Diesel Fuel Specifications. See the Additives section in this service bulletin.

In cold-weather operation, the most common method of preventing fuel waxing problems is to dilute heavier, higher wax content fuels such as diesel number 2 (D2) with lighter, lower wax content fuels such as diesel number 1 (D1) or jet fuel. This reduces the concentration of wax and thereby reduces both the cloud point and pour point. Blended fuels of this nature are more expensive to use both because they cost more and because they have a lower thermal energy content. A typical blended fuel contains 30 to 60 volume-percent light distillate fuel, usually yielding a 3 to 7°C or 5.4 to 12.6°F drop in cloud point, and a 5 to 11°C or 9 to 20°F drop in pour point. Lower wax content fuels **must** be added BEFORE wax forms to be effective.

Cummins Inc. Required Diesel Fuel Specifications

This section presents the Cummins Inc. required fuel specifications.

Fuels meeting national and international specifications can be used if they observe the specifications listed in Table 1: Cummins Inc. Required Diesel Fuel Specifications. Cummins® engines will operate satisfactorily on fuels meeting all the properties listed in Table 1; however, fuels meeting **only** the required specifications will **not** give the same level of performance, efficiency, reliability, or maintenance costs as premium fuels.

Table 1: Cummins Inc. Required Diesel Fuel Specifications[1.]

Viscosity	1.3 to 4.1 centistokes at 40°C [104°F]
Cetane Number	42 minimum above 0°C [32°F]; 45 minimum below 0°C [32°F] [2]
Sulfur Content	Reference Procedure 018-002 (Fuel Recommendations and Specifications) in Section V of the appropriate Owner's Manual, and/or warranty documentation for specific fuel sulfur content requirements.
Active Sulfur	Copper Strip Corrosion **not** to exceed Number 3 rating after 3 hours at 50°C [122°F].
Water Sediment	**Not** to exceed 0.05 volume-percent.
Carbon Residue	**Not** to exceed 0.35 mass-percent on 10 volume-percent residuum
Density	0.816 to 0.876 grams per cubic centimeter (g/cc) at 15°C [59°F].

Table 1: Cummins Inc. Required Diesel Fuel Specifications[1.]	
Cloud Point	6°C or 11°F below lowest ambient temperature at which the fuel is expected to operate.
Ash	**Not** to exceed 0.02 mass-percent. For vehicles equipped with exhaust aftertreatment, there shall be no detectable ash in the fuel.
Distillation	10 volume-percent at 282°C [540°F] maximum, 90 volume-percent at 360°C [680°F] maximum, 100 volume-percent at 385°C [725°F] maximum. The distillation curve **must** be smooth and continuous.
Lubricity (HFRR) or (SLBOCLE)	High Frequency Reciprocating Rig (HFRR): Maximum of 0.52 mm [0.020 in] Wear Scar Diameter (WSD) at 60°C [140°F]. Scuffing Load Ball-on-Cylinder Lubricity Evaluator (SLBOCLE): Minimum of 3100 grams.

1. In addition to the requirements in Table 1, Cummins Inc. strongly recommends the use of fuel with particle counts less than the ISO 4406 code of 18/16/13. Reference the “Fuel Cleanliness” section of the service bulletin (Cummins Service Bulletin 3379001)for more details.
2. Fuel **must** observe proper flash point requirements to satisfy local safety regulations.
3. Regional, national, or international regulations can require a lower sulfur content than what is listed in Table 1.

Fuel Additives

This section gives information on the use of fuel additives in Cummins® engines.

Cummins Inc. neither approves nor disapproves of the use of any fuel additive, fuel extender, fuel system modification, or the use of any device **not** manufactured or sold by Cummins Inc. or its subsidiaries. Engine damage, service issues, or performance problems that occur due to the use of these products are **not** considered a defect in workmanship or material as supplied by Cummins Inc. and can **not** be compensated under the Cummins Inc. warranty.

There are a number of fuel additives available which reduce the pour point and cold filter plugging point (CFPP) of diesel fuel. These are commonly referred to as pour point depressant additives, cold flow improver additives, wax crystal modifiers, or fluidity improver additives (and can be collectively termed “Winter Additives”). Certain additives can reduce the Pour Point by as much as 21°C [70°F] and the CFPP by as much as -1°C [30°F]. A survey of winter blend fuels by the Bureau of Mines (now a part of the Energy Research and Development Administration) revealed that a large percentage of the commercially marketed diesel fuels had been treated with a winter additive. Before purchasing such an additive to treat fuel, ask the fuel supplier whether the fuel already contains a winter additive. Depending on the amount and type of additive already in the fuel, additional additives will or will **not** be necessary.

These additives alter the size and shape of wax crystals, allowing pumping of fuel at lower temperatures. Although certain additives can be very effective, they are **not** a cure all. Their performance varies depending on the paraffin type and content of the fuel treated. Severe weather applications can require fuel warmers in addition to additives. Although other additives are available that can provide some benefits, Cummins Filtration™ Fleet-tech™ Winter Conditioner and Turbo Diesel All Season Fuel Additives are the **only** fuel additives recommended by Cummins Inc. to help prevent filter gelling in cold weather applications.

Cummins® engines are designed, developed, rated, and built to operate on commercially available diesel fuel as listed in Table 1: Cummins Inc. Required Diesel Fuel Specifications; therefore, it is not our policy to recommend fuel additives.

In certain situations, when available fuels are of poor quality or problems exist which are peculiar to certain operations, additives can be used. However, Cummins Inc. recommends consultation with the fuel supplier or Cummins Inc. Service Engineering Department prior to the use of fuel additives.

Among the situations where additives can prove useful are the following:

1. 

   Cummins Filtration™ Winter Conditioner, and Turbo Diesel All Season Fuel Additive can be used to improve the pour point and cold filter plugging point of diesel fuels in addition to preventing ice formation in wet fuels during cold storage. Although other additives are available that can provide some winter performance benefits, Cummins Filtration™ Winter Conditioner and Turbo Diesel All Season Fuel Additive are the **only** diesel fuel additives approved by Cummins Inc. for winter performance improvements.

2. 

   Cummins Filtration™ Asphaltene Conditioner and Cummins Filtration™ Turbo Diesel All Season Fuel Additive can be used to clean carbon deposits from injectors and improve lubricity in fuels that fall below the recommended lubricity specification in Table 1: Cummins Inc. Required Diesel Fuel Specifications. Although other additives can provide some performance benefits, Cummins Filtration™ Asphaltene Conditioner, and Turbo Diesel All Season Fuel Additive are the **only** diesel fuel additives approved by Cummins Inc. for use with fuels that do **not** meet the lubricity specification in Table 1.

Premium diesel fuels can possibly contain several additives that can accomplish the same as buying additives and adding them to lower quality diesel fuel. Cummins Inc. recommends the use of a premium diesel fuel during winter (ambient conditions at -7° C or 20°F or below) operating conditions.

CAUTION

Over use of fuel additives can cause adverse effects such as fuel filter plugging and reduced aftertreatment life.

NOTE: Cummins Inc. accepts no liability for engine damage resulting from the use of fuel additives that are not specifically approved. Consult your fuel supplier for guidance on additive use.

Standard and Optional Suction Fuel Filter Heaters

Heating diesel fuel just prior to filtration is an excellent method of preventing fuel filter plugging. If cold fuel is warmed sufficiently, the wax crystals will dissolve in the fuel. The dissolving requires warming to a temperature of approximately 11 to 22°C or 20 to 40°F above the fuel's cold filter plugging point.

In order for a fuel heater to reliably prevent fuel filter plugging due to wax, it **must** be capable of supplying enough heat to the fuel at the maximum fuel flow (**not** just fuel consumption) rate to raise the fuel temperature from the lowest expected fuel temperature (probably the lowest expected ambient temperature) to 11 to 22°C or 20 to 40°F above the fuel's cold filter plugging point.

Navistar, Inc. offers different styles of suction fuel filter modules and different style heating elements please refer to the CT400 manual for details on each option avaialble.

For further information about Cummins Inc. Fuel recommendations and specifications, see Cummins Service Bulletin 3379001.

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