

EMA Consensus Position

JOINT EMA/TMC PUMP GRADE SPECIFICATION FOR PREMIUM DIESEL FUEL

PURPOSE:

This Consensus Position is intended to define premium diesel fuel marketed commercially at retail fueling stations and truck stops.

It is the belief of the Engine Manufacturers Association (EMA) and The Maintenance Council (TMC) that equipment users look to premium diesel fuel at the pump as a significant opportunity for improving fuel-related performance issues or solving problems related to fuel. As such, premium diesel fuel should be a fuel broad in scope, offering improvements in many areas so as to satisfy the needs of as many end users as possible. The recommendations in the attached table are intended to produce performance benefits that are noticeable to equipment users.

This diesel fuel recommendation is considered to be "premium" insofar as it may assist in improving the performance and durability of engines currently in use and those expected to be produced prior to 2004. It is not intended to enable engines to meet any emissions standard or, in general, to improve exhaust emissions. Nor does it preclude centrally fueled fleets from negotiating with their fuel supplier for fuel that they feel fits their unique needs. It is intended as a "living document" in that, as other needs or test procedures are identified, the recommendation will be upgraded.

The most significant aspects of this Consensus Position are its requirements for a minimum fuel lubricity, increased cetane number, improved cold weather performance, detergency, thermal stability, minimum energy content, and specifications regarding overall fuel "cleanliness". These properties, described in detail below, should help address many current customer satisfaction issues.

SIGNIFICANCE AND USE OF THE RECOMMENDED PROPERTIES:

API Gravity or Energy Content

API Gravity is a measure of a fuel's density (or weight per gallon). The higher the API gravity, the less a gallon of fuel weighs and the less energy it contains. API gravity of diesel fuel has a profound effect on engine power. As a general rule, there is a three to five percent (3-5%) decrease in the thermal energy content of fuel for every 10 degree increase in API gravity. This decrease in energy content will result in roughly the same percentage decrease in engine power. Use of fuels with higher API gravity will also result in higher fuel consumption (lower mpg). Our recommendation includes a maximum API gravity based on equipment user needs to maintain engine power, while minimizing fuel consumption. As an alternative, this Consensus Position includes an equivalent minimum energy content specification to help insure acceptable performance.

Low Temperature Operability

Several tests are commonly used to characterize the low temperature operability of diesel fuel. These are Cloud Point, Low Temperature Flow Test (LTFT), and Cold Filter Plugging Point (CFPP). Among these, the LTFT provides the best overall correlation with field performance. However, for non-additized fuel, Cloud Point and LTFT correlate very well. Since Cloud Point is more practical as a quality control test, it is listed as the primary recommendation. CFPP is not

recommended as an indicator of low temperature operability by ASTM. However, if data emerges that shows universal correlation with the recommended procedures for all vehicle types, EMA/TMC will consider including that procedure in a future version of this Consensus Position.

Actual temperature targets should be adjusted monthly based on latitude using ASTM D975 10th percentile minimum ambient temperature data. EMA and TMC agree with the Canadian approach in recommending 2.5 percentile temperature for cold flow properties as providing the necessary protection for a "premium" grade fuel, but since 2.5 percentile data is not available in the US, setting the recommended level 4 ° C below the 10th percentile is designed to approximate the 2.5 percentile level of protection.

Cetane Number/Cetane Index

Cetane Number is a relative measure of the interval between the beginning of injection and autoignition of the fuel. Cetane Number is a year-round concern. The higher the number, the shorter the delay interval. Fuels with low Cetane Numbers will cause hard starting, rough operation, noise and increased smoke opacity. Current commercial fuel cetane requirements may not adequately address these customer satisfaction issues.

Generally, diesel engines will operate better year-round on fuels with Cetane Numbers above 50, compared to fuels with cetane numbers of the national average of approximately 45. Cetane Number may be increased through the refining process or the blending of combustion ignition-improving additives by fuel suppliers.

Cetane Index approximates fuel ignition quality through correlation with other fuel properties. Since it is not affected by the use of combustion improver additives, Cetane Index estimates the fuel's base Cetane Number.

Lubricity

Lubricity describes the ability of a fluid to minimize friction between, and damage to, surfaces in relative motion under loaded conditions. Diesel fuel injection equipment relies on the lubricating properties of the fuel. Shortened life of engine components such as fuel injection pumps and unit injectors usually can be attributed to a lack of fuel lubricity and, hence, lubricity is of concern to engine manufacturers. This property is not addressed adequately by ASTM D 975.

Additional lubricity information can be found in Society of Automotive Engineers (SAE) Technical Papers 952372, "ISO Diesel Fuel Lubricity Round Robin Program" and 981363, "Continued Evaluation Of Diesel Fuel Lubricity By Pump Rig Tests". To contact SAE, call (412)776-4841 [www.sae.org]

Detergency

Some diesel fuels which do not contain detergents have a tendency to form carbon deposits on certain fuel injectors. It has generally been found that low sulfur fuels and thermally unstable fuels have a greater tendency to form these deposits. Detergent additives will prevent carbon deposits, which interfere with fueling and fuel spray patterns, from forming.

Dirty injectors will invariably give rise to higher smoke levels in all equipment and, in some equipment, can limit power by restricting flow. Diesel fuel detergency is measured using the L10 Injector Deposit Test. Passing limits for the test are shown in the attached table. These limits are expressed in terms of a CRC rating for injector cleanliness and a flow loss criterion.

Please refer to Cummins L10 Injector Depositing Test to Evaluate Diesel Fuel Quality SAE Paper for further support and explanation of the detergency issue.

Water & Sediment

Diesel fuel should be clear in appearance and free of water and sediment. The presence of these materials generally indicates poor fuel handling practices. Water and sediment can shorten filter life or plug fuel filters which can lead to engine fuel starvation. In addition, water can promote fuel corrosion and microbial growth. It is for that reason we recommend separate analysis and maximum levels.

The level of water specified in the attached table is within the solubility level of water in fuel and, as such, does not represent free water.

ASTM D6217 is the preferred test method which covers the determination of the mass of particulate contamination in middle distillate fuels by filtration. However, since D6217 is a newer test which might not be accessible to all, D2276 and D5452 are also included in the specification.

**A quick field test for visually checking water and sediment is ASTM D4176. If free water or sediment is observed, laboratory testing should be conducted to determine when the recommendations specified in the attached table are being met.

Bacteria & Fungus

This represents an additional specification designed to minimize fuel contamination that has resulted from the presence of free water either in transport, storage, or vehicle tanks. Microbes do not live in fuel, they live in the interface that forms between the fuel and free water. The presence of microbes is indicative of contamination problems in the above areas. The presence of microbes can cause operational problems, corrosion, and sediment build-up in diesel fuel systems. Note, however, that the absence of microbes in fuel received at filling stations does not ensure the absence of microbes in fuel storage tanks or vehicle fuel systems.

Accelerated Thermal Stability

Diesel fuel should be stable under normal storage and use conditions. Unstable fuel will darken and form black particulate materials which will cloud fuels and create gum residues in the fuel system. The accelerated thermal stability test is intended to predict the resistance of fuel to degradation at normal engine operating temperature and to provide an indication of overall fuel stability.

Distillation

This property provides a measure of the temperature range over which a fuel volatilizes or turns to a vapor. Volatility is one of the primary factors which distinguish #1 from #2 diesel fuel. No. 1 diesel typically has greater volatility than No. 2. The highest temperature recorded during distillation is called the end point. Ideally, one would specify an end point in the definition of fuel properties. However, because a fuel's end point is difficult to measure with good repeatability, the fuel's 90 percent or 95 percent distillation point is commonly used. The 95 percent distillation is the preferred point since its reproducibility is acceptable and it is closer to the fuel's end point than the 90 percent point currently measured in D 975. In addition, reporting the 10 percent distillation and 50 percent distillation points is recommended because they are part of the Cetane Index calculation.

Equipment in applications which operate at low loads and frequent idle periods should benefit from a lower end point.

Sulfur

To assist diesel engine manufacturers in meeting mandated limits for particulate matter in diesel engine exhaust, sulfur content is limited by U.S. Federal law to 0.05% for diesel fuel used in on-highway applications.

Copper Corrosion

The copper strip corrosion test indicates potential compatibility problems with fuel system components made of copper alloys such as brass or bronze. The limit requires that the fuel not darken these parts under the test conditions.

Flash Point

The flash point temperature of diesel fuel is the minimum temperature at which the fuel will ignite (flash) on application of an ignition source under specified conditions. Flash point varies inversely with the fuel's volatility. Flash point minimum temperatures are required for proper safety and handling of diesel fuel. Due to its higher flash point temperature, diesel fuel is inherently safer than many other fuels such as gasoline.

Aromatics

This property is listed simply as a reminder that there are both Federal and State limitations on diesel fuel aromatics content.

Kinematic Viscosity

Viscosity affects injector lubrication and fuel atomization. Fuels with low viscosity may not provide sufficient lubrication for the precision fit of fuel injection pumps or injector plungers resulting in leakage or increased wear. Fuels which do not meet viscosity requirements can lead to performance complaints. Fuel atomization is also affected by fuel viscosity. Diesel fuels with high viscosity tend to form larger droplets on injection which can cause poor combustion and increased exhaust smoke.

Ramsbottom Carbon Residue

The Ramsbottom Carbon residue test is intended to provide some indication of the extent of carbon residue that results from the combustion of a fuel. The limit is a maximum percentage of deposits by weight.

Ash Content

Ash is a measure of the amount of metals contained in the fuel. High concentrations of these materials can cause injector tip plugging, combustion deposits and injection system wear. Soluble metallic materials cause deposits while abrasive solids will cause fuel injection equipment wear and filter plugging.

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PROPERTY	TEST METHOD	RECOMMENDED VALUE
API GRAVITY***	D287*	39 MAX.
or		
BTU CONTENT***, GROSS	D2382	136,000 MIN.
CLOUD POINT, °C	D2500	4° C BELOW 10th percentile minimum ambient temperature
or		
LTFT	D4539	4° C BELOW 10th percentile minimum ambient temperature
CETANE INDEX	D4737	45 MIN.
CETANE NUMBER	D613	50 MIN.
LUBRICITY	D6078	3100g. MIN.
or	D6079	0.45mm dia. wear scar, max. @ 60°C
DETERGENCY	L10 - Injector	CRC Rating <= 10
	Deposit Test	% Flow Loss <= 6
WATER, PPM	D1744	200 MAX.
SEDIMENT, G/M ³	D6217	10 MAX.
or		
SEDIMENT, MG/L	D2276 or 5452	10 MAX.
BACTERIA & FUNGUS	**	0 cfu/ml
ACCELERATED THERMAL STABILITY	OCTEL, F21	80% Reflectance
DISTILLATION, °C:	D86	
10%		REPORT
50%		REPORT
90%		332 MAX.
95%		355 MAX.

SULFUR, WT %	D2262	0.05 MAX. OR LEGAL
COPPER CORROSION	D130	3b MAX.
FLASH POINT, °C***	D92	52°C MIN. OR LEGAL (38 °C for winter)
AROMATICS, VOL.%	D1319	LEGAL
VISCOSITY, cST.@ 100F (40°C)***	D445	1.9 - 4.1 (1.7 for winter)
RAMSBOTTOM RESIDUE, %	D524	0.15 MAX.
ASH CONTENT, % WT.	D482	0.01 MAX
APPEARANCE	D4176	2 or less and no visible free water or sediment

*Numbers preceded by a 'D' refer to ASTM Standards; ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959

** Appropriate test procedures for bacteria and fungus are available from the American Society from Microbiology (ASM), 1325 Massachusetts Ave. N.W., Washington D.C.

*** In Extreme cold climate conditions described by ASTM 10th percentile temperatures below -10C in December, January, and February, the gravity, BTU, flash point and viscosity specification may be waved and the flash point and viscosity may deviate to the indicated values to achieve the desired cold flow performance.