Premium Diesel Fuel: Why the Controversy?

In the second of this three-series, Texaco Additives expert Roger L. Leisenring, Jr., describes the tug-of-war over fuel quality standards, the role of additives and the facts that consumers need to get the right product.

Additives are part of the challenge
In the February issue, Roger Leisenring described the process used in manufacturing diesel fuel, as well as the properties of regular diesel fuel (as defined in standards of the American Society for Testing and Materials—ASTM) in his article ("The Changing Face of Diesel Fuel Today," page 10) on diesel fuel practices within the US. This first article was meant to set the stage for a better understanding of why certain questions and concerns have arisen, which have led to extensive debate on the composition of both regular and premium diesel fuel. That subject is covered in this article. In April, Roger will look at some specific additive properties and explain their performance benefits. For instance, how much of a fuel economy penalty is associated with kerosene blending when this practice is used for preventing fuel gelling in the winter?

Photo courtesy of
Texaco Additives International.

Foam can form in diesel fuel when subjected to turbulent flow conditions. Such foaming causes the nozzle to "kick off" during fueling, and occurs in diesel-fueled vehicles that use fill pipes, such as light-duty trucks and passenger cars.. A chemist performs the Diesel Foam Test to measure how long it will take for this foam to dissipate. Foaming can be controlled with additives.

Imagine for a moment that you are riding along any major US highway, and it is time to fill up your diesel tank. What do you see advertised on the pump toppers? Probably such words as "Regular," "Premium," "Better than Regular," "Reduces," "Proven," "Exceeds," "Restores," "Contains," "Prevents," "Increases" and "And More."

Next, you enter the convenience store. You see products on the shelf making such proclamations as "Scuffing BOCLE by up to 30%"; "more power up to 10%"; "down to –40F CFPP"; "superior Cummins L10 test"; "fuel economy restored up to 12%"; "lower maintenance costs"; and "extended storage life." Then you glance down and see magazines announce headlines on diesel policy changes by such

organizations as EPA, NCWM, TMC, EMA and World-Wide Fuel Charter. Confused? Who wouldn't be?!

Who's watching the hen house?

Fuel marketers, from both large companies and small, have jumped on the bandwagon to offer products that will differentiate them from the pack. Unfortunately, or fortunately—depending on how you look at it—the use of premium diesel fuel and additives is growing. However, the consumer has been left in the abyss of diesel fuel terminology. With US sales of diesel fuel growing rapidly and exceeding 38 billion gallons annually, you would naturally assume that some government agency must be watching the "hen house."

Well, you would be partly right. As of October 1993, the Environmental Protection Agency (EPA) mandated that all diesel fuel sold for on-highway use must (1) contain no more than 0.05 weight percentage of sulfur; and (2) have a minimum cetane index of 40 (40 CFR Part 80). This is the only federally mandated diesel fuel specification—just two properties—for the entire US. Individual mandates for diesel fuel are left to individual states.

Herein lies the problem. Not all states require a specification for regular diesel fuel. Worse, only one or two states have a specification for premium diesel fuel. And, even in these states, a higher cetane number is the only additional requirement needed for the fuel to qualify as premium diesel rather than regular diesel.

Although numerous organizations and industry groups have developed fuel specifications, these specifications rarely, if ever, get adopted for use by the fuel manufacturers—except specifications made by the American Society for Testing and Materials (ASTM). Notably, one specification is followed: the ASTM D 975 Diesel Fuel Specification.

Organized in 1898, ASTM has grown into one of the largest voluntary standards development systems in the world. ASTM writes US standards for materials, products, systems and services that have been adopted as manufacturing specifications by the oil industry. However, ASTM only defines regular diesel fuel. The definition of premium diesel has been left up to other organizations—one of which is the National Conference on Weights and Measures (NCWM). NCWM is sponsored by the National Institute of Standards and Technology (NIST), which is under the US Department of Commerce.

The NCWM is a national professional organization that develops consensus standards in such areas as weighing-and-measuring device regulation, commodity regulation, motor-fuel quality and administration of regulatory weights-and-measures programs. NCWM is comprised of more than 3,500 state, county and city weights-and-measures officials, and associated business, federal and consumer representatives.

Regulatory weights-and-measures activities are aimed at maintaining equity in the marketplace so that (1) businesses can compete fairly and (2) buyers and sellers can make informed decisions in trade.

NCWM standards do not automatically become state law. In fact, only two states automatically adopt

the NCWM fuel specification recommendations into their state laws. Eleven states use NCWM standards as a basis for adoption, which then requires formal state adoption. The remaining states have no laws or regulations on fuels (NIST Handbook 130).

The membership of NCWM became involved in defining premium diesel fuel when it became apparent that consumers were being increasingly exposed to the term “premium” on their grade panels—and needed to know exactly what they were purchasing.

Initially, NCWM recommended that ASTM Committee D 02 on Petroleum Products and Lubricants be monitored for progress on defining premium diesel (the Engine Manufacturers Association was proposing an EMA-developed specification for ASTM consideration at that time). However, it soon became clear that no formal progress toward a premium diesel specification was taking place within ASTM. Consequently, in 1996, NCWM’s Laws and Regulations Committee assigned the task of defining premium diesel to its Petroleum Subcommittee.

Who stands where?

Broad-spectrum premium fuel recommendations exist today in the public forum. There is, for instance, the World-Wide Fuel Charter and EMA’s FQP-1A consensus position on diesel fuel (see sidebar at right). The Maintenance Council (TMC) of the American Trucking Association (ATA) has also defined a pump grade premium fuel. These recommendations, so their organizations state, address multiple properties in a single premium fuel—thus, maximizing the potential benefits to consumers.

Engine Manufacturers Association—EMA is comprised of domestic and international manufacturers of internal combustion engines for trucks and buses, locomotives, marine vessels and construction and utility equipment. EMA has 35 member companies that build the engines, ranging in size from one to more than 7,000 horsepower.

In August 1995, EMA published a Consensus Position Statement on premium diesel fuel. EMA wrote the statement to define a fuel that would be superior in quality to the commercial fuel specification ASTM D 975. EMA’s aim was to improve the performance and durability of diesel engines currently in use and also for those engines that would be produced before 2004.

American Trucking Association—ATA is the national trade association of the trucking industry. Established in 1933, ATA’s membership includes more than 3,800 trucking companies and industry suppliers of equipment and services. ATA operates seven technical councils that offer trucking managers advanced education, specialized training and detailed technical information. The Truck Maintenance Council (TMC) is one of these seven councils.

The TMC publishes the Recommended Maintenance Practices Manual, which consists of Recommended Practices (RP) that can be used by the trucking industry. Two of these RPs are RP304A (preferred) and RP304B (minimum) Diesel Fuel Specifications, which represent the TMC’s opinion of what is required for a regular diesel fuel.

Recently, the TMC proposed a Joint TMC/EMA Pump Grade Fuel Specification for Premium Diesel

(RP340T). This proposal represents a combined effort by the TMC and the EMA in recognition that equipment users look to premium fuel at the pump as a significant opportunity to improve fuel-related performance and solve problems related to the engine performance in terms of its maintenance and wear.

World-wide Fuel Charter—The Charter represents specifications for gasoline and diesel fuel that have been established by the world's leading motor vehicle manufacturers. The World-Wide Fuel Charter was developed in recognition of the impacts that the fuel quality of gasoline and diesel have on vehicle drivability, fuel efficiency, durability and the environment.

Over the last two years, representatives from American, European and Japanese automotive manufacturers have developed fuel specifications that are recommended for application worldwide. Consistent fuel quality is necessary to market high-quality automotive products that match worldwide customer performance expectations and environmental needs. All major motor vehicle manufacturers—including those from Canada, Korea, China and South Africa—support the Charter.

In discussing the responses of various organizations, it is important to re-emphasis, however, that, only the federal low sulfur [regular] diesel fuel specification is required as a minimum for all the states. Thereafter, each state decides whether it will require further specifications for diesel fuel. This choice is not decided by the ASTM, EMA or NCWM.

What's a consumer to do?

In my article last month, I discussed regular grade diesel fuel ("The Changing Face of Diesel Fuel Today"). The fact that the EMA has re-emphasized the need for lubricity and low temperature operability has placed a tremendous burden on the user. This is because ASTM has not incorporated these requirements, along with several other fuel properties (e.g., higher cetane), into ASTM D 975 Diesel Fuel Specification.

ASTM is not delinquent in its responsibilities—far from it. Actually, the opposite is true. ASTM provides a forum for producers, users, ultimate consumers and those having a general interest (representatives of government and academia) to meet on common ground and write standards for materials, products, systems and services.

From the very beginning of the process, ASTM requires a full consensus approach. The organization brings together people with diverse backgrounds, expertise and knowledge—and provides strict balloting and due-process procedures that guarantee a technically acceptable standard. As consensus is the strength of ASTM, it is also its Achilles heel. The process takes time, and often the engine manufacturers and consumers cannot wait.

Here lies the crux of the problem: what is a consumer to do? Diesel fuel additives and premium diesel fuel have never played a more important role in the market than they do today.

There are three things to keep in mind as you look for a premium diesel fuel or an additive:

- If something sounds too good to be true, it probably is.
- Your marketer of fuels or additives must earn your trust. If not, find another.
- You'll save money if you become an educated consumer.

This article will help you become an educated consumer.

The Engine Manufacturers Association (EMA)
Expresses Concerns on Diesel

November 5, 1998

To: Steven Westbrook, Chairman of Subcommittee E N. David Smith, Chairman, D02 on Petroleum Products and Lubricants

This letter is being written to alert ASTM that the Engine Manufacturers Association believes that there are important diesel fuel quality issues that need immediate action within ASTM. These issues are lubricity and cold flow.

Although there are two ASTM tests for lubricity, D 6078 and D 6079, many fuel suppliers have indicated they do not use them because they feel that they may have to "over-additize" their fuels to provide adequate end-user protection based on these procedures. The result is that end-users, especially in winter months when there is a significant amount of No. 1 diesel fuel, inherently lower in lubricity, blended with No. 2 diesel fuels, are not receiving adequate lubricity protection in cold climates. ASTM should immediately initiate a "fast-track" process to develop a lubricity test that all agree provides adequate equipment protection and additive response. Once such a test is developed, a lubricity specification providing adequate end-user protection
(based on the judgment of end users) should be written into ASTM D 975.

There is an additional concern regarding the prediction of cold flow by the LTFT test [Low Temperature Flow Test] (ASTM D 4539) because some engine manufacturers are now marketing engines equipped with 2 micron porosity fuel filters and the LTFT uses a filter of significantly larger porosity. ASTM needs to assess the effect of this change on LTFT results and whether the procedure, as currently written, still provides adequate end-user protection. Since fuel suppliers using additives to provide cold flow protection use this test as a measure of performance, it is important that it reflect equipment in use. There is the potential for a significant increase in the number of incidents of winter filter plugging due to wax if this issue is not dealt with promptly.

Please do not hesitate to contact EMA with any questions you may have regarding the enclosed information.

Sincerely,
Ken Murphy,
EMA Fuel Quality Committee Chair

cc: Glenn Keller, EMA Executive Director
EMA Fuel Quality Committee
Roger Leisenring, Jr.

History of diesel fuel additives

The use of diesel fuel additives has increased in recent years due to many factors. They include refining modifications to increase output; the changing technology of diesel engines; environmental requirements; and consumer needs.

1950s—In the 1950s, the use of pour point depressant additives in No. 2 heating oils was widely accepted. **Pour point depressant additives are typically ethylene- vinyl-acetate copolymers (EVAs)**. A relatively small amount of pour point depressant additive seemed to give the same cold flow properties formerly attainable only by large-volume dilution with kerosene.

1960s—In the 1960s, industry turned its attention to the use of pour point depressants in No. 2 diesel fuels, and soon recognized, however, that vehicle operability could not adequately be predicted by pour point measurements. To provide a better test method for predicting low temperature performance of a diesel fuel in a vehicle, the Cold Filter Plugging Point test (CFPP) was developed. This test is widely accepted and used in Europe. By the late 1960s, another test method, the Low Temperature Flow Test (LTFT ASTM D 4539), was developed for US-type fuels.

1970s—During the late 1970s, refineries increased diesel volume production by blending low cetane distillate cuts from catalytic crackers into the final diesel blend. This practice required the use of cetane-improving additives to improve cetane numbers. This practice still remains today.

1980s—During the late 1980s, the Cummins Engine Company began to experience severe injector carboning problems with its 1988 L10 engines. These engines had been redesigned to meet Federal emissions standards that resulted in higher gas temperatures in and at the fuel injectors.

The injector carboning caused engines in the field to rapidly lose maximum power capability—by as much as 15 percent in as little as 40,000 miles of operation. Cummins addressed this problem by redesigning the fuel injector and developing a test to evaluate fuels and detergent additives for their ability to keep fuel injectors clean of power-robbing deposits.

The turbulent ‘90s

1991—During the early 1990s, concerns over US diesel fuel lubricity surfaced. The Society of Automotive Engineers (SAE) Technical Committee expressed its concern during the 1991 SAE Annual Congress. One of the committee’s conclusions was that fuels suspected of causing lubricity-related problems were primarily low sulfur No. 1 type fuels with sulfur content below 0.05 weight percent, and with viscosities below 2.0 cSt at 40 degrees C.

Subsequent to this meeting, several reports emphasized that the common element in all fuel pump

failures appeared to come from fuels with low cloud points for winter operation and very low sulfur content, typically around 0.01 weight percent. In addition, the problem was reported to be more troublesome in the Spring. This is when daytime temperatures can suddenly increase and a dual effect exists of low lubricity and low viscosity.

In 1991, SAE and the International Standards Organization (ISO) formed a joint working group to address worldwide lubricity concerns, but especially to address the increasing worry over the pending introduction of US legislation on low sulfur diesel fuels. These heightened concerns were generated because, in 1991, Sweden enacted legislation that resulted in two especially-stringent diesel fuel regulations; and the US planned to follow suit with lower sulfur regulations to go into effect in 1993. However, the US sulfur reduction was not as extreme as the Swedish specification.

The Swedish regulations stated that there would be two low sulfur diesel fuel Classes: Class 1—a maximum sulfur of 0.001 weight percent (10 ppm) and a maximum aromatics of 5 percent; and Class 2—a maximum sulfur of 0.005 weight percent (50 ppm) and a maximum aromatics of 20 percent. In comparison, a typical on-highway low sulfur diesel fuel for 1998 averaged 0.034 weight percent sulfur and 37 percent aromatics.

To produce fuels to these very stringent specifications, it was necessary to apply severe hydrotreating conditions. The hydrotreating process has been shown to have the potential for reducing the lubricity properties of diesel fuel. Hydrotreating reduces trace components, such as oxygen- and nitrogen-containing compounds, as well as polycyclic aromatics. These naturally occurring polar compounds adsorb onto metal surfaces to form a protective low-friction layer.

When these hydrotreated fuels were marketed in Sweden, approximately 70 light-duty vehicles, which were equipped with rotary/distributor type fuel pumps, failed catastrophically! At about the same time, diesel fuel injection equipment manufacturers had concerns about both the EPA Federal diesel fuel requirement and the California Air Resources Board (CARB) aromatic content requirement of 10 percent—both of which were going to be required in the market starting October 1993.

1993—In October 1993, reports of lubricity- and O-ring seal-related equipment failures proliferated throughout the US. The State of California experienced an enormous number of these complaints. In February 1994, California recommended to petroleum manufacturers that they add lubricity-enhancing additives to the diesel fuels marketed in California with a scuffing load capacity of less than 3,000 grams, as measured by the Scuffing Load Ball On Cylinder Lubricity Evaluator Test Method (SLBOCLE – ASTM D 6078).

In October 1993, the US EPA mandated a 40 cetane index minimum. The cetane index is a mathematical calculation using the density and distillation temperatures of the fuel as variables in the equation. Consequently, using an additive cannot raise a cetane index. Nevertheless, some refiners are using cetane-improving additives to meet the ASTM 40 cetane number minimum specification as well as the recently announced diesel fuel definitions from various organizations.

1995—In August 1995, the EMA printed the first engine manufacturers' Consensus Position Statement (FQP-1) on premium diesel fuel. The updated FQP-1A was released during September of 1997. Some of the properties specified in the FQP cannot be satisfied by ASTM D 975 alone; therefore, the only solution for marketers who want to meet this specification is to use a formulated additive package that would typically be injected into the fuel at the terminal rack. For example, the Table on page 14 indicates a detergency requirement for fuels meeting the FQP-1A; however, ASTM does not have a detergent requirement. Formulated additive packages are available from various reputable fuel additive vendors, such as Texaco Additives International and Valvetect.

Premium Diesel Fuel Table

A Comparison of ASTM 975-97 Performance Requirements for [Regular] Diesel Fuels with the EMA, TMC and NCWM Recommendations for Premium Diesel Fuels.

Property	ASTM LOw Sulfur No. 2-D	EMA FQP-1A	NCWM Effective for state adoption 1/1/2000	TMC Proposed RP340 Pump Grade	ASTM Test Method
API Gravity, max.		39		39 or Heating Value	D 287
Heating Value, gross, Btu/gal, min.			138,700	136,000	D 240
Kin. Viscosity, mm2/sec @ 40C	1.9 min/4.1 max	1.9 min/4.1 max	1.9 min/4.1 max	1.9 min/4.1 max	D 446
Ramsbottom Carbon on 10% residue, %mass, max.	0,35	0,15	0,35	0,15	D 524
Ash % mass, max.	0.01	0.01	0.01	0.01	D 482
Cetane Index Or Aromaticity, % vol., max.	40 35	45	40 35	45	D 976 D 1319
Cetane Number, min.	40	50	47	50	D 613
Destillation Temp., 90% Pt.	282 min/ 338 max	332 max	282 min/ 338 max	332 max	D 86
Destillation Temp., 95% Pt.		335 max		335 max	D 86
Flash Point, C, min.	52	52	52		D 93
Sulfur	0.05	0.05	0.05		D 2622
Thermal Stability, min.			80% Reflectance	80% Reflectance	F21-180 minutes
Accelerated Stability, mg/L, max		15			D 2274

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