NEW FUELS TO MODERN ENGINES

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The internal combustion engines have involved into our daily life in the beginning of the 20. Century and reached widely usage with their mobility and variety. They have been one of the most important tools of the evolution, furthermore the usage of the petroleum became wider with them.

After the first serial production of the legendary Ford 'T' model, a big competition had started to make a high performance engine and fastest car besides fuel economy. In 1970, discussing of the harmful effects of the exhaust emissions have been started and the way of the studies change to their direction to improve high performance but low emission engine. On the other hand national assemblies like EPA (Environmental Protection Agency) in U.S. started to establish new regulations in order to reduce air pollution by the road vehicles. As a result in 1975 using catalytic converters became compulsory in some states in U.S. All this developments and regulations made necessary improving fuel technology to provide clean air solutions. Therefore the short and long term rehabilitation plans have been made for the refineries to meet the requirements of the engine manufacturers.

Beside of this investments, removing of lead compounds and heavy molecules from the fuels makes some troubles like CCD (combustion chamber deposits) and lubricity. Consequently improving and testing the additives became necessary in order to compensate these affects.

Regarding that clean fuels are the first step keeping clean the atmosphere, universities should establish fuel research facilities in order to provide auditing and improving of fuels which are sold at the stations.

YEAR 2000,THE NEW MILESTONE IN FUEL PRODUCTION

In response to the European directive of June 1998 aimed at reducing fuel emissions, all fuels marketed in Europe as of January 1, 2000 must comply with new standards.
The new specifications introduce more stringent environmental demands, pursuing the objective of reducing automobile pollution that was initiated in 1970.

Gasoline Improvements:

The maın implications of the Y2K gasoline specifications have been:

- the reduction of benzene content to one fifth of its previous level
- the reduction of sulfur content 500 to 150 ppm
- the reduction of aromatics content from 40 to 35 %mass
- The reduction of olefins content to %10 mass till 2005 and keeping the oxygen content at 2.8% mass max.

The Elf refineries in Europe have been modified in order to apply new regulations but the following specifications, which had been demanded by ACEA, needs more investments to be done. Additionally, CEN Gasoline specifications are given to compare the critical values. They asserted that the advanced Nox technology makes possible large gains in pollution control only if the fuel has sulfur content below 30 ppm. Necessary explanations are given below of the table to evaluate the charts.

ACEA Gasoline Fuel Charter for 85/95 Unleaded Gasoline

Property	Test Method	Limit	Evolution
Research Octane Number, min	ISO 5164	95	
Motor Octane Number, min	ISO 5163	85	
Oxidation Stability (min) min	ISO 7536	480	
Lead Content (g/l) max	EN 237	0.005	
Sulfur Content (% mass) max	EN 24260/ISO 8754	0.01	0.003
Phosphorus Content (g/l) max	ASTM D3231-89	Nondetectable	
Alcohols Content (% vol) max	ASTM D4815	0[1]	
Oxygen Content (% mass) max	ASTM D4815	2.8	
Olefins Content (% mass) max	NF M 07 086	15	10
Benzene Content (% vol) max	EN 238	2.5	1.0% vol
Aromatics Content (% mass) max	NF M 07 086	40	35
FBP (°C) max	ISO 3405	200	195
Volatility		Note 2	
Carburetor Cleanliness (merit) min	CEC F-03-T-81	8	
Intake Valve Cleanliness I (merit) min	CEC F-04-A-87	9	
Intake Valve Cleanliness II (mg/valve) max	CEC F-05-A-94	50	
Intake Valve Sticking (pass/fail)	CEC F-16-T-96	Pass	
Exhaust Valve Sticking (pass/fail)			CEC PF-026 to be adopted
Fuel Injector Cleanliness		To be defined	
Combustion Chamber Deposits		To be defined	

[1] Residual alcohols up to 1.0% vol are tolerated as a consequence of the use of corresponding ethers.
[2] Refer to"Gasoline Volatility Classes for European Countries."
[3] Identical technical requirements for 98/88 unleaded gasoline.

Gasoline Volatility Classes for European Countries

Volatility Class	A	B	C	D	E
Countries					
Summer	E, GR, I, P,TR	A, B, D, DK, F, FIN, GB, IRL, L, N, NL, S	—	—	—
Intermediate	—	E, GR, I, P,TR	A, B, D, DK, F, FIN, GB, IRL, L, N, NL, S	—	—
Winter	—	—	E, GR, I, P,TR	A, B, D, DK, F, GB, IRL, L NL	FIN, N, S
RVP (kPa)	45-60	50-65	65-80	75-90	80-95
E70 (% vol)	15-45	15-45	25-45	25-47	25-47
VLI, max	850	870	1000	1100	1200
E100 (% vol)	45-60	50-65	50-65	55-70	55-70
Within EN-228 Classes	—	Class 1	Class 3	Class 5	—

[1] Warm-upm driveability index to be developed.
[2] Test method and limits to be included in the near future.

CEN Unleaded Gasoline Specification (EN 228:1993)

Property	Premium	Regular	Test Method[2]
RON, min	95	Note 1	ISO 5164
MON, min	85	Note 1	ISO 5163
Lead (g/l) max	0.013	0.013	EN 237
Benzene (% vol) max	5	5	EN 238
Sulfur (% mass) max	0.05	0.05	EN 24260, ISO 8754
Gum (mg/100 ml) max	5	5	EN 5
Copper Corrosion	1	1	ISO 2160
Appearance	Clear & Bright	Clear & Bright	Visual
Oxidation Stability (min) min	360	360	ISO 7536
Density (kg/m^3)	725-780	725-780	ISO 3675
Oxygenates	As per directive 85/536/EEC		
Water Tolerance	No water segregation		
Acidity	Note 3	Note 3	ISO 1388

Volatility[4]	1	2	3	4	5	6	7	8
RVP (hPa)	350-700	350-700	450-800	450-800	550-900	550-900	600-950	650-1000
E70 (% vol)	15-45	15-45	15-45	15-45	15-47	15-47	15-47	20-50
VLI, max	900	950	1000	1050	1100	1150	1200	1250
E100 (% vol)	40-65	40-65	40-65	40-65	43-70	43-70	43-70	43-70
E180 (% vol) min	85	85	85	85	85	85	85	85
FBP (°C) max	215	215	215	215	215	215	215	215
Residue (%) max	2	2	2	2	2	2	2	2

[1] Must be specified in National standard.
[2] Test methods, with the exception of RVP, to ISO 3405. RVP is tested according to EN 12, which is suitable for oxygenate contents meeting Column A of EU Directive 85/536/EEC.
[3] The acidity of fuel ethanol used as blendstock shall not exceed 0.007% mass (as acetic acid).
[4] The use of dyes, markers and performance additives is allowed, but no phosphorus containing compounds.

The important factors determining the performance of a gasoline in a spark-ignition engine are volatility, antiknock quality, storage stability, component compatibility, and intake system deposit control.

Volatility — Spark-ignition engines need a volatile fuel for ease of starting, rapid warm-up, and good driveability. In practical terms, this means a fuel that boils in the range of 30 to 215°C (85 to 420°F). Too light a fuel leads to poor fuel economy, carburetor icing, and vapor lock in the fuel pump. Too heavy a fuel causes poor cold starting, inferior driveability, engine deposits, and crankcase oil dilution.

Two methods of measuring gasoline volatility are Distillation (ASTM D 86) and Reid Vapor Pressure (EN 12). Distillation measures the boiling range of the hydrocarbons that make up the finished gasoline. Reid Vapor Pressure (RVP) measures the pressure that the fuel exerts under standard conditions at 37.8°C (100°F). From these, the vapor/liquid (V/L) ratio can be calculated using the procedure in ASTM D 2533.

The temperature where V/L = 20 indicates the tolerance of modern cars to vapor lock. The higher the temperature, the less chance of hot weather stalling. At low temperatures, other factors such as driveability must be considered. These factors are also controlled by ASTM D 86.

Antiknock Quality — Under severe service conditions, spark-ignition engines are knock limited. High temperatures, high compression ratios, lean mixtures, and advanced spark settings lead to knock, which is the explosive combustion of the last part of the fuel/air mixture ("end gas") drawn into the cylinder. A gasoline's chemical composition determines its ability to resist knock.

The antiknock value of a gasoline is measured in two standard laboratory engine tests. Both use the same single-cylinder, variable-compression ratio engine attached to a dynamometer. Only the operating conditions are changed.

ISO-5164 measures Research Octane Number (RON) and ISO-5163 Motor Octane Number (MON). In both tests, the compression ratio is adjusted to produce a measured level of knock with the test fuel, and knock intensity with primary reference fuels slightly better and slightly worse is noted. Because the reference fuels are blends of iso-octane (octane number of 100) and n-heptane (octane number of 0), the octane content of the fuel that exactly matches the knock intensity of the test fuel is its Octane Number.

Of the two procedures, the MON test is more severe, correlating with high-speed, high-temperature, part-throttle service in an actual vehicle. The MON for most gasolines is lower than the less-severe RON, which primarily correlates to a gasolines ability to resist run-on, after-run, or dieseling. The difference between the two ratings (R - M) is called the sensitivity.

Such programs require careful vehicle selection because a carís octane requirement is not constant. As a vehicle ages, octane requirement (ONR) can increase from 1 to 13 numbers due to deposit buildup in the combustion space. This increase means that only cars with more than 10,000 km on the odometer should be tested.

Gasoline specifications reflect the ONR of the car population, but they also vary with location and season. Higher ambient temperatures increase ONR, while higher absolute humidity and elevation above sea level decrease it.

Storage Stability — Gasoline deterioration in storage is due mainly to oxidative processes. Oxidation leads to the formation of gum, a varnish-like material that can build up in combustion chambers and intake systems, interfering with efficient engine running. In extreme cases, it can even cause ring sticking and engine seizure. To guard against this problem, refiners include antioxidants and metal deactivators, which reduce the catalytic effect of certain metals in promoting oxidation.

Specifications limit the amount of gum in fresh gasoline to 5 mg/100 ml, and laboratory oxidation tests control the extent to which oxygen will attack gasoline. Compliance with these limits usually ensures that gasolines will remain usable for up to 12 months. Any gasoline known to have been in storage longer than a year should be retested before use. Because the rate of oxidation doubles for every 10°C temperature increase, storage conditions are important.

Component Compatibility — Minor amounts of nonhydrocarbon material found in, or added to, gasolines can have adverse effects on engine life and performance. Sulfur, for instance, causes metal corrosion; phosphorus and lead deactivate oxidation catalysts; and oxygenated materials such as alcohols and ethers can cause seal and fuel-line swelling as well as promote engine rust.

Intake System Deposit Control — The intake system includes either a carburetor, throttle body injector (TBI) or port fuel injector (PFI or MPFI), and intake valve stem, tulip, head, and intake manifold runners. Many gasolines contain unstable components that can lead to deposit formation in these high-temperature areas of the induction system. Valve seat recession can be a serious problem leading to increased emissions, poor idling and loss of power. And since precise valve-to-seat contact is needed for proper exhaust valve cooling, VSR can also result in valve burning, and in rare cases, catastrophic engine failure.

Gasolines for use as fuels in spark-ignition engines must be able to reduce or eliminate deposit formation in critical fuel-delivery system components. Since January 1, 1995, the U.S. Environmental Protection Agency has mandated the use of detergent additives in gasoline to help reduce emissions and improve air quality. Gasoline performance additives are fully-formulated additive packages for gasoline that control combustion chamber, intake valve deposits, port fuel injector and carburetor, protect against wear and oxidation, improve lubricity and emissions performance and ensure storage stability and cold weather flow.

These additives could be applied in refineries or storage depots manually or automatically.

On the other hand, the similar improvement projects have already drawn in TUPRAS Refineries in Turkey and the new isomerisation unit would have been in duty in Izmir Refinery on April,2001 in order to provide unleaded gasoline production with higher octane number. When we talk about sulfur reduction facilities in Tupras Refineries, it seems to be realized hardly on the second half of 2003.

Diesel Evolution:

To meet the new diesel specifications, the main changes at the refineries were to:

- increase the cetane number from 49 to 51,
- reduce sulfur content from 500 to 350 ppm,
- reduce polyaromatics to 11% max
- reduce density from 0.860 to 0.845 gr/cm3 max.

The cetane number and the density of the resulting diesel oil are closely linked to the characteristics of the crude oil used and the way in which the refineries formulate their diesel. Though the new standards do not require specific investments, they do have an on crude oil procurement and on refinery operation. However, The reduction of sulfur content has demanded an increase in the capacity of the desulfuration unit.

The new European specifications and ACEA demand, which were given below with explanations of the critical futures of the gas, oil.

ACEA Diesel Fuel Charter

Property	Test Method	Limit	Evolution[1]
Cetane Number, min	ISO 5165	53	58
Cetane Index, min	ISO 4264	50	54
Density (kg/m^3)	ISO 3675	820[2]-850	820-840
Sulfur Content (% mass) max	EN 24260	0.03	0.003
Total Aromatics Content (% mass) max	CEN/TC 19/N841 (HPLC)	20	10
Polyaromatics Content (% mass) max	CEN/TC 19/N841 (HPLC)	4.0	1.0
Distillation % Vol. Recovery	ISO 3405		
T-95 (°C) max		355	340
FBP (°C) max		370	350
Cold Flow Properties		Note 3	
Oxidation Stability (%) max	IP 306 Mod	3	
Foam Volume (ml)	To be defined		
Foam Vanishing Time (min)	To be defined		
Biological Growth	NF M 07 070	Zero contamination	
Vegetable Derived Esters	To be defined	Nondetectable	
Total Acid Number (mg KOH/g) max	NFT 60 112	0.08	
Corrosion Performance	IP 135	"A"	
Lubricity, HFRR Scar Diameter at 60°C (micron)	CEC F-06-A-96	400	
Injector Cleanliness, Flow Loss (%) at 0.1 mm needle lift, max	CEC PF-023	85	

[1] Refer to ACEA EURO 2 diesel fuel proposal.
[2] For climatic or environmental purposes 810 kg/m^3 min is acceptable.
[3] See "Diesel Fuel Cold Flow Properties for European Countries."

Diesel Fuel Cold Flow Properties for European Countries

Class	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**
Countries							
Summer	All but FIN, N, S	FIN, N, S	—	—	—	—	—
Intermediate[1]	—	D	—	—	—	—	—
Winter	—	—	B, E, GB, GR, I, IRL, L, LN, P,TR	A, CH, D, DK, F	FIN, N, S	FIN, N, S	FIN, N, S
Cloud Point (°C)	—	≤0	≤-5	≤-10	≤-16	≤-22	≤-28
CFPP[2] (°C)	≤0	≤-10	≤-15	≤-20	≤-26	≤-32	≤-38
Pour Point (°C)	≤-3	≤-13	≤-18	≤-23	≤-29	≤-35	≤-41
Within EN-590 Classes	B	D	E	F	1	2	3

[1] Intermediate classes for all countries to be defined.
[2] A new method better correlating to vehicle operability is needed.

CEN Diesel Fuel Specification (EN 590:1993)

Properties Applying to All Grades	**Limit**	**Method**
Flash Point PMCC (°C) min	55	ISO 2719
Ash (% mass) max	0.01	EN 26245
Water (mg/kg) max	200	ASTM D1744
Particulates (mg/l) max	24	DIN 51419
Copper Corrosion (3 h at 50°C) max	1	ISO 2160
Oxidation Stability (g/m^3) max	25	ASTM D2274
Sulfur (% mass) max	0.20[1]	EN 24260/ISO 8754
Carbon Residue (% mass) max	0.30[2]	ISO 10370

Temperate Climate Grades A to F	**Limit**	**Method**
CFPP, max	Note 3	EN 116
Density (kg/m^3) at 15°C	820-860	ISO 3675/ASTM D4052
Viscosity (mm^2/s) at 40°C	2.00-4.50	ISO 3104
Cetane Number, min	49	ISO 5165
Cetane Index, min	46	ISO 4264
Distillation (°C)		ISO 3405
10% vol rec at	Report	
50% vol rec at	Report	
65% vol rec at, min	250	
85% vol rec at, max	350	
95% vol rec at, max	370	

Arctic Grades	**0**	**1**	**2**	**3**	**4**
CFPP, max	-20	-26	-32	-38	-44
Cloud Point (°C) max	-10	-16	-22	-28	-34

Density (kg/m^3) at 15°C	800-845	800-845	800-840	800-840	800-840
Viscosity (mm^2/s) at 40°C	1.50-4.00	1.50-4.00	1.50-4.00	1.40-4.00[4]	1.20-4.00[4]
Cetane Number, min	47	47	46	45	45
Cetane Index, min	46	46	46	43	43
Distillation (°C)					
10% vol rec at, max	180	180	180	180	180
50% vol rec at	Report	Report	Report	Report	Report
95% vol rec at	340	340	340	340	340

[1] Sulfur limit will be reduced toward 0.05% mass maximum, in line with EU directives or national standards.
[2] Based on fuel without ignition improver additives. If a higher value is found, fuel should be tested by ASTM D4046 for presence of nitrates. If present, the limit does not apply.
[3] Six grades, with CFPP limits from +5 to -20°C in 5°C intervals.
[4] Arctic classes may exhibit poor lubricity characteristics and corrective measures (lubricity additives) may have to be used.
[5] EN 590 is currently being revised applying the Unique Acceptance Procedure to include the new sulfur content of 0.05% mass maximum and new lubricity requirement of 460 μ maximum wear scar diameter using test method CEC-F-06-A-96.

Engine Manufacturers Association Recommended Guideline on Diesel Fuel

PURPOSE

This Recommended Guideline of the Engine Manufacturers Association is intended to define a diesel fuel that is superior in quality than the commercial fuel specification ASTM D 975.

The diesel fuel is considered to be "superior in quality" insofar as it may assist in improving the performance and durability of engines currently in use and those to be produced prior to 2004. It is not intended to enable diesel engines to meet 1998 Federal emission standards or, in general, to improve engine exhaust emissions.

The most significant aspects of this Recommended Guideline are its requirements for a minimum fuel lubricity, increased cetane number and improved cold weather performance. These properties, described in detail below, should help address many current customer satisfaction and engine performance issues.

SIGNIFICANCE AND USE OF THE RECOMMENDED PROPERTIES

For the benefit of our customers and other interested parties, the following section summarizes the critical properties of diesel fuel and, where appropriate, the reason for EMA's selection of a particular quality level of that property.

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.

Water and 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 and will cause shortened filter life or plugged fuel filters which can in turn lead to fuel starvation in the engine. In addition, water can have negative impact on fuel corrosion and on microbial growth. It is for that reason we recommend separate analysis and maximum levels.

Distillation

This property provides a measure of the temperature range over which a fuel volatilize or turns to a vapor. 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% or 95%

distillation point is commonly used. EMA prefers the 95% distillation point since its reproducibility is acceptable and it is closer to the fuel's end point than the 90% point currently measured in D 975.

In applications which operate at low loads and frequent idle periods, like bus engines, lower end point is desirable to reduce smoke and combustion deposits. Hence EMA recommends distillation temperature specifications lower than the current D 975 specification to cover those applications.

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 and emissions.

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.

Sulfur

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

Copper Corrosion

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

Cetane Number/Cetane Index

Cetane number is a relative measure of the interval between the beginning of injection and autoignition of the fuel. The higher the number, the shorter the delay interval. Fuels with low Cetane Numbers will cause hard starting, rough operation, noise and exhaust smoke. Current commercial fuel cetane requirements may not adequately address these customer satisfaction issues. Generally, diesel engines will operate better 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 is an approximation of fuel ignition quality through measurement of distillation range and specific gravity. It is not affected by the use of combustion improver additives; therefore it produces an indication of the base cetane number of the fuel.

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.

API Gravity

This is a measure of fuel's specific gravity or density. While specific gravity has no units, density is defined as mass per unit volume and both are temperature dependent. API gravity is defined as follows.

API gravity of diesel fuel has a profound effect on engine power. As a general rule, there is a 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). EMA's recommendation to include a maximum API gravity is based on our understanding of customer needs to maintain engine power, while minimizing fuel consumption

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 somewhat on the lubricating properties of the fuel. Shortened life of engine components such as fuel injection pumps and unit injectors usually can be ascribed to a lack of fuel lubricity and hence is a concern to engine manufacturers. This property is not addressed adequately by ASTM D 975.

ASTM has issued two tests to measure lubricity: the High Frequency Reciprocating Rig (HFRR) and the Scuffing Load Wear

(SBOCLE) test. Current acceptability guidelines for both tests are provided in our chart. Aftermarket additives for improving diesel fuel lubricity should not be necessary and are not covered by this recommended guideline since they may react chemically with other additives causing them to lose their effectiveness, drop out of solution or even plug filters.

Accelerated 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. Although the accelerated stability test is intended to predict primarily storage stability, it can provide indication of overall fuel stability.

Detergency

All diesel fuels which do not contain detergents have a tendency to form carbon deposits on 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 invariability give rise to higher smoke levels in all equipment and in some equipment can limit power by restricting fuel flow. Diesel fuel detergency can be measured using the L10 Injector Depositing test. Passing limits for the test are provided in the attached table. These limits are expressed in terms of a CRC rating for injector cleanliness and a flow loss criterion.

Low Temperature Operability

Several tests are commonly used to characterize the low temperature operability of diesel fuel. These are Cloud Point, Cold Filter Plugging Point (CFPP), and Low Temperature Flow Test (LTFT). Among these, the LTFT is preferred by EMA as providing 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 refinery quality control test, it is listed as our primary recommendation. Low temperature operability of bulk diesel fuel can be negotiated by the customer and fuel supplier. However, in the retail fuel market, low temperature operability is the responsibility of the fuel supplier. It is adjusted on a monthly basis during the winter, or sometimes sooner depending on expected ambient temperatures at the point of sale.

Low temperature flow requirements usually vary depending upon fuel filter media and the presence of fuel heaters. However, to avoid operational problems the selection of a fuel's low temperature properties should be made based on the lowest ambient conditions expected during operation.

Unless specifically recommended by the engine manufacturer or discussed with the fuel supplier in advance, modification of the waxing properties of fuels using aftermarket fuel additives is not recommended as an option for meeting the low temperature operability requirement, because of possible incompatibility with other additives already contained in the fuel.

While EMA has not included any recommendation with respect to Microbial Growth, it should be noted that

microbial growth can cause operational problems, corrosion and sediment build-up in diesel engine fuel systems. The growth of microbes in fuel storage tanks and vehicle/equipment fuel tanks is believed to be related to pipeline and storage techniques and times and cannot be sufficiently addressed in a fuel specification.

As a result, in order to reduce the emissions which had been released to atmosphere from the vehicles and fuels handling facilities are only possible to use the right fuel in the right engine with the high technology. Regarding that the engine conditions as important as fuel quality, the oil companies should use necessary additives to meet customer demands.

Additionally, the universities should establish fuel research and development laboratories in order to control fuel quality in the market, testing effects of the additives and define necessary precautions.

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