US Bioethanol Standards and Regulations

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Dr. Ben Bonazza NIST-INMETRO Symposium on Biofuels – Washington, DC June 26-29, 2007





ASTM

Subcommittee D02.A on Gasoline and Oxygenated Fuels

- <u>SCOPE</u>: Promotion of knowledge, specifications, test methods and terminology for auto spark-ignition engine fuel.
- Over 260 members with participation from more than 20 countries.
- Active participation from Brazil and Europe.



D02.A STANDARDS

D 4814 Spark-Ignition Engine Fuel

<u>D 5798 Fuel Ethanol (E85)</u>

<u>D 4806 Ethanol for Fuel Blending</u>

- D 5797 Fuel Methanol (M85)
- D 5983 MTBE
- D 5500 IVD Vehicle Test
- D 6201 IVD Dynamometer Test
- D 5598 PFI Vehicle Test
- D 6421 PFI Bench Test
- D 6423 pHe of Ethanol

RR

Test

Methods

Specifi-

cations

RR D02:1347 Reformulated Gasoline



D02 A Organization



Federal and State

Regulations for Bioethanol





1990 CAA Clean Fuels Require Oxygenates

- Oxygenated Gasoline ("Oxy Fuel")
 - Started 1992 to control CO in winter
 - Fuel must contain min. 2.7 mass% oxygen
- Reformulated Gasoline (RFG)
 - Started 1995 in cities with worst smog pollution
 - Control of HC, CO, Evap., NOx & Toxics
 - Originally required min. 2.0 mass % oxygen



Energy Policy Act of 2005 (EPACT)

- Signed into law in August 2005
- Oxygenate repeal
 - Eliminated oxygenate requirement in RFG
- Renewable Fuel Standard (RFS)
 - Requires 7.5 billion gallons/yr of renewable fuels be used in US gasolines by 2012.
 - Ethanol industry will likely meet this by 2007
 - 14 billion gallons/yr EtOH to make all gasoline E10
- Cellulosic biomass provisions
- No ban of MTBE
 - No "safe harbor" caused most refiners to discontinued MTBE use as of the end of 2006



Bush "20 in 10" - AFS

January 23, 2007 State of the Union:

Reduce gasoline consumption 20% in 10 years

- Expand RFS to AFS (Alternative Fuel Std.)
 - Increase in renewable & alternative fuels
 - 35 billion gallons R&A fuels in 2017
 - Will require E85 + other alt. fuels
 - <u>Reduce gasoline use by 15%</u>
- Reform/Modernize CAFE
 - Increase efficiency of PC & LDT 4%/yr beginning in MY2010



Reduce gasoline use 5% by 2017

Great Regulations Summary! D02: 1347

<u>Research Report on Reformulated Spark-</u> <u>Ignition Engine Fuel</u>

- Regulatory Information on RFGs
 - Federal and state reformulated gasoline program requirements
 - Latest government regulations (EPACT/RFS)
- Frequently updated....current information
- Available <u>free</u> on ASTM website

http://www.astm.org/COMMIT/COMMITTEE/D02.htm

• Chair: Marilyn Herman – Herman & Assoc.



State Adoption of ASTM Standards

ASTM's standards are only mandatory when written into regulations/laws or specified in a contract.

- Many states incorporate ASTM standards into their laws...
 - Some states adopt the most recent version
 - Some states adopt older versions
 - Some states adopt only parts of the standard
 - Some states write their own standards



37 States Adopt D 4814 (Gasoline/E10)

Arizona (D 4814-04a) **CBG** Phoenix **Arkansas**¹ **California¹ (CaRFG3) Colorado**¹ **Connecticut**¹ **Delaware**¹ Florida (D 4814- $04be^1$) Hawaii (1991) Idaho¹ *Illinois*¹ lowa (as in effect **October 1, 2006)** Kansas¹

Kentucky (D 4814-01a) Louisiana Maryland¹ Minnesota (D 4814-04a) **Mississippi**¹ Missouri¹ Montana Nebraska (D 4814-89) Nevada (D 4814-01a except n. 38th schedule applies statewide) **New Hampshire**¹ **New Mexico¹** New York (D 4814-04a) Suffolk County, NY¹

North Carolina **Ohio (Summit County)**¹ Oregon (2006 Book of **Standards**) Rhode Island (D 4814-04b) South Carolina¹ South Dakota (2005 Book of **Standards**) **Tennessee**¹ **Utah**¹ *Washington*¹ West Virginia¹ Wisconsin (D 4814-04be¹) Wyoming¹

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¹Adopts most recent version of ASTM D 4814 *TI Automotive*

23 States Adopt ASTM D 4806 (Ethanol)

Arizona (D 4806-04a) Arkansas California (Based on D 4806-**99**) **Connecticut**¹ Florida (D 4806-04a) Hawaii (Version in effect as of 1991) lowa (Standards in effect as of October 1, 2006) Kansas¹ Louisiana Michigan (Version in effect as of January 1, 2004; for tax credit purposes only) Minnesota (D 4806-06c)

Missouri Montana **New Hampshire**¹ North Carolina¹ Ohio (D 4806-88; for tax credit purposes only) **Ohio** (Summit County)^{1} Oregon (2006 Book of Standards) South Dakota (2005 Book of **Standards**) Tennessee Washington¹ Wisconsin (D 4806–04a) West Virginia

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¹Adopts most recent version of ASTM D 4806



17 States Adopt ASTM D 5798 (E85)

Arizona	Montana
Arkansas	New Hampshire
California	Nevada
Florida	Ohio (Summit County Only)
Indiana	Oregon
Kansas	Tennessee
Louisiana	West Virginia
Michigan	Wyoming
Minnesota	
Missouri	

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State Regulations

- Complex and diverse regulatory environment
 - Very difficult for petroleum companies to service such a diverse market
- Splash-blending ethanol
 - The standard is the standard! We can't give a gasoline special consideration because it has ethanol
 - Often a special gasoline must be used if ethanol is to be splash-blended in order to meet volatility requirements.
 - Petroleum companies would rather use a gasolines that already exists in the field.



ASTM Standards for Ethanol and Ethanol Containing Fuels





ASTM Gasoline Specification D 4814

REGULATORY CONTROL

- Vapor Pressure
- Sulfur
- Lead

ASTM CONTROL

- Vapor Pressure
- Distillation
- Driveability Index (DI)
- Vapor Lock Protection
- Silver Corrosion
- Copper Corrosion
- Solvent Washed Gum
- Oxidation Stability
- Workmanship **TI Automotive**



D 4814 – ASTM Gasoline Std

- D 4814 issued in 1988 to replace D 439
- Covers gasoline and its blends with oxygenates for spark-ignition engines
 - 0-10 vol% ethanol (Federal Limit)
 - No special requirements for EtOH containing fuels
 - Not so with Federal requirements
- Scope does not include fuels with oxygenates as the primary component, – E85 or M85
- Many foreign gasoline specifications are based on D 4814

ASTM D 4814 – GASOLINE

<u>Ethanol Items</u>

- References 1 psi EPA & state waivers for EtOH
 8 Additional volatility tables
- Modified Driveability Index (DI) equation to adjust for EtOH:

 $DI = 1.5 T_{10} + 3.0 T_{50} + 1.0 T_{90} + \frac{1.33^{\circ}C \times vol\% EtOH}{R^2 = 0.944}$

- Remove "Water Tolerance" from D 4814
 - D 6422 Water Tolerance test withdrawn due to poor reproducibility
- Review appropriateness of volatility limits
 CRC study may indicate limits are too severe



ASTM D 4806 Ethanol

- D 4806 for Ethanol issued in 1988
 - Anhydrous denatured fuel ethanol for blending with gasoline
 - -0-10 volume % ethanol blends acceptable

TI Automotive

 Close examination of Brazil's ethanol standard during development.



ASTM D 4806 Properties (1)

Ethanol, volume %, min	92.1	D 5501	
Methanol, volume %, max	0.5	D 4815	
Solvent-washed gum,* mg/100 mL, max	5.0	D 381	
Water content, volume %, max	1.0	E 203 / E 1064	
Denaturant content, volume %, min	1.96	 Calc by Difference Looking for a test method. 	
volume %, max*	5.0		
Inorganic Chloride,* mass ppm (mg/L), max	40 (32)	 Value way too high! New test methods D 7319 and D 7328 	



* Recent changes * Under discussion

ASTM D 4806 Properties (2)

Copper, mg/kg, max	0.1	D 1688
Acidity (as acetic acid), mass % (mg/L), max	0.007 (56)	D 1613
рНе	6.5 to 9.0	D 6423
Sulfur, mass ppm, max*	30	Remove D 6428 (Method withdrawn)
Sulfate, mass ppm, max*	4	Added new methods: D7318, D7319, D 7328
Workmanship	Visibly free of suspended or precipitated contaminants Adding caution of Na from glass	

* Recent changes * Under discussion



ASTM D 4806 Interlaboratory Cross-Check

- Establishing Ethanol (D 4806) Interlaboratory Cross-Check Testing Program
 - Provides laboratories with a statistical quality assurance tool enabling them to compare their performance in the use of ASTM test methods against other labs worldwide

- RFA has been instrumental
- Start-Up in August 2007
- Includes testing ten D 4806 properties



ASTM D 5798 - Ed75-Ed85

- D 5798 for Fuel Ethanol issued in 1996
 - Covers 75-85 volume % denatured fuel ethanol + 25-15 additional volume % HC for use in automotive SI engines
- E85 Task Group
 - Initiated June 2006
 - Examine all D 5798 specifications
 - By product is that some of D 4806 specs are also being reviewed
 - Chair: Andy Buczynsky GM



D 5798 Properties (1)

Properties	Class 1	Class 2	Class 3	
Ethanol + higher alcohols, min, volume %	79	74	70	D5501 D4815
Hydrocarbon/aliphatic ether, volume %	17–21	17–26	17–30	Calc by Diff.
Vapor pressure, kPa (psi)	38–59 (5.5–8.5)	48–65 (7.0–9.5)	66–83 (9.5–12.0)	D4953 D5190 D5191
Lead, max, mg/L*	2.6	2.6	3.9	D 5059
Phosphorus, max, mg/L*	0.2	0.3	0.4	D 3231
Sulfur, max, mg/kg	210	260	300	D1266 D2622 D3120 D5453



* Balloted for removal

D 5798 Properties – All Classes (2)

Methanol, volume %, max	0.5	D 5501
Higher alcohols (C ₃ –C ₈), max, vol %	2	D 5501
Acidity, (as acetic acid),mass % (mg/L), max	0.005 (40)	D 1613
Solvent-washed gum,* max, mg/100 mL	5	D 381
рН _е	6.5 to 9.0	D 6423
Unwashed gum, max, mg/100 mL*	20	D 381
Total chlorine as chlorides,max,mg/kg*	2	Eliminated
Inorganic chloride, max, mg/kg	1	D 512
Copper, max, mg/L	0.07	D 1688
Water, max, mass %	1.0	E 203 / E 1064
Conductivity / Detergency	New requirements?	

* Under discussion

ASTM Biofuels Workshop

- Held during June 2007 meeting in Miami.
 - -2 hours for ethanol
 - 2 hours for biodiesel
- Goal: Define test method applicability for our biofuel standards



Test Method Applicability

- Many test methods were written before oxygenates entered the picture.
- Many test methods do not address or are unclear as to whether they apply to ethanol and at what concentrations

- Some methods have terminology issues
- Adjustments are required to:
 - Scopes
 - Precision Information



Example of Test Method Concerns Determining Alcohol Content - D 5501

Current Scope

- Determines ethanol content of denatured ethanol by GC

Problem

- Scope covers only 93-97 vol % ethanol
- Measures fusel oil (impurities) as hydrocarbon/denaturant

Needs

- Need to expand scope to cover E85 (70-83 vol% ethanol)
- Need to modify or develop test method for measuring E85 (70-83 vol.% ethanol) and ethanol ranges from 10-70 vol% ethanol
 - Develop precision statement



Common Fuels for Ethanol Test Method Applicability Study

Ethanol Content, vol %	Rationale for Inclusion in the Program
0	Gasoline Reference
10	Maximum Ethanol Content Under EPA Waiver
20	Proposed Maximum Ethanol Blend by MN
70	Minimum Ethanol Content (Winter) for E85 under D 5798
83	Maximum Ethanol Content for E85 under D 5798
95	Minimum Ethanol Content for Denatured Ethanol under D 4806



Standard Harmonization

- Maybe we should not talk of "harmonization", but instead consider our task an opportunity to work together to...
 - Better understand the standards of others in hopes of improving our own
 - Make contact and friends
- Test methods should be compared before standard properties
- Test method experts and standard experts are most likely different individuals.



Thank You



