

ASTM International

Bioethanol Standardization: Standards, Regulations and Global Compatibility

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ASTM International

U.S.-Brazil DVC on Bioethanol Standardization

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About ASTM International

- Largest US domiciled private sector SDO
 - ASTM standards used around the world
 - Over 3000 ASTM standards utilized in at least 60 countries
 - Nearly 8,000 members from 126 countries outside of the US, including Brazil
 - Follow an open and direct process that meets World Trade Organization principles for international standards



ASTM D02 Committee Subcommittee D02.A on Gasoline and Oxygenated Fuels

- SCOPE: Develops specifications, test methods and terminology for auto spark-ignition engine fuel.
 - International participation and technical experts from Brazil's Petrobras and Brasken participate



D02.A STANDARDS

Specifications

- D 4814 Spark-Ignition Engine Fuel
 - D 5798 Fuel Ethanol (E85)
 - D 4806 Ethanol for Fuel Blending
 - D 5797 Fuel Methanol (M85)
 - D 5983 MTBE
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Test Methods

- 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

- RR D02:1347 Reformulated Gasoline



D 4814 –ASTM Gasoline Standard

- Covers gasoline and its blends with oxygenates for spark-ignition engines
 - 0-10 vol% ethanol (US Federal Limit)
- In the U.S., D 4814 is mandated by most States
- Globally, many countries adopt or base gasoline specification on D 4814



ASTM Gasoline Specification



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*

ASTM D 4806 Ethanol

- Ethanol to be used as blendstock in the US must meet ASTM D 4806
 - Issued in 1988, includes Anhydrous denatured fuel ethanol for blending with gasoline
 - Close examination of Brazil's ethanol standard during development.



E85 - ASTM D 5798

- D 5798 for Fuel Ethanol issued in 1996 (E85)
 - ***Covers a fuel blend, nominally 75 to 85 volume % denatured fuel ethanol and 25 to 15 additional volume % hydrocarbon use in ground vehicles with automotive spark-ignition engines***



*ASTM International and
U.S. Federal and State
Regulations for Bioethanol*



Fuel Regulations of the U.S. are Driven by State Agencies

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



37 States Adopt D 4814 (Gasoline/E10)

| | | |
|--|---|---|
| <p>Arizona (D 4814-04a) CBG Phoenix Arkansas¹ California¹ (CaRFG3) Colorado¹ Connecticut¹ Delaware¹ Florida (D 4814-04be¹) Hawaii (1991) Idaho¹ Illinois¹ Iowa (as in effect October 1, 2006) Kansas¹</p> | <p>Kentucky (D 4814-01a) Louisiana¹ Maryland¹ Minnesota (D 4814-04a) Mississippi¹ Missouri¹ Montana¹ Nebraska (D 4814-89) Nevada (D 4814-01a except n. 38th schedule applies statewide) New Hampshire¹ New Mexico¹ New York (D 4814-04a) Suffolk County, NY¹</p> | <p>North Carolina¹ Ohio (Summit County)¹ Oregon (2006 Book of Standards) Rhode Island (D 4814-04b) South Carolina¹ South Dakota (2005 Book of Standards) Tennessee¹ Utah¹ Washington¹ West Virginia¹ Wisconsin (D 4814-04be¹) Wyoming¹</p> <p>www.HermanAssociates.com</p> |
|--|---|---|

¹Adopts most recent version of ASTM D 4814



23 States Adopt ASTM D 4806 (Ethanol)

Arizona (D 4806-04a)

Arkansas¹

California (Based on D 4806-99)

Connecticut¹

Florida (D 4806-04a)

Hawaii (Version in effect as of 1991)

Iowa (Standards in effect as of October 1, 2006)

Kansas¹

Louisiana¹

Michigan (Version in effect as of January 1, 2004; for tax credit purposes only)

Minnesota (D 4806-06c)

Missouri¹

Montana¹

New Hampshire¹

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)

Tennessee¹

Washington¹

Wisconsin (D 4806-04a)

West Virginia¹

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¹Adopts most recent version of ASTM D 4806



17 States Adopt ASTM D 5798 (E85)

Arizona

Arkansas

California

Florida

Indiana

Kansas

Louisiana

Michigan

Minnesota

Missouri

Montana

New Hampshire

Nevada

Ohio (Summit County Only)

Oregon

Tennessee

West Virginia

Wyoming

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State Regulations

- Complex and diverse regulatory environment can be challenging for petroleum companies to service such a diverse market
- National Conference on Weights and Measures (NCWM) serves as a venue for coordination and interfaces at the Federal level thru NIST:
 - http://ts.nist.gov/WeightsAndMeasures/WM_LAW.cfm



For More Information, see Regulations Summary

ASTM D02: 1347

Research Report on Reformulated Spark- Ignition Engine Fuel

- Federal and state reformulated gasoline program requirements and latest government regulations
- Frequently updated....current information
- Available free on ASTM website

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

- Chair: Marilyn Herman – Herman & Assoc.



Global Compatibility of Bioethanol Standards



ASTM and Global Compatibility

- ASTM members have indicated an interest in working with peers from Brazil to:
 - Develop a better understanding of the standards of others in hopes of improving our own
 - Identify areas and properties of standards where there can be more compatibility
 - Identify barriers to compatibility governed by regulations and laws, falling outside of the control of ASTM



Global Cooperation in Bioethanol

- ASTM has engaged in NIST/INMETRO Biofuels workshops (2006-2007)
- ASTM members and staff have developed a technical paper and comparison of ASTM and ABNT standards and properties
 - Circulated to technical experts from Brazil for input
- As part of the International Biofuels Forum, ASTM has formed a bioethanol task group with the goal of ***making existing standards more globally compatible.***



Ethanol Specification Requirements (US, EU, and Brazil)

| Property | US D4806 | Brazil Anhydrous | Brazil Hydrrous | EU prEN 15376 |
|--|------------|------------------|-----------------|---------------|
| Color | - | Yellow | Clear | - |
| Ethanol + C3-C5 sat. alcohols, volume %, min | 92.1 | 99.3 | 92.6 | 98.7 (m%) |
| Ethanol + C3-C5 sat. alcohols, volume %, max | - | - | - | 2.0 (m%) |
| Water content, volume %, max | 1.0 | 0.7 (by diff) | 7.4 (by diff) | 0.3 (m%) |
| Density at 20°C, kg/m ³ , max | - | 791.5 | 807.6 | - |
| Methanol, volume %, max | 0.5 | - | - | 1.0 (m%) |
| Denaturant, volume %, min / max | 1.96 / 5.0 | - | - | ? |
| Hydrocarbons, volume %, max | - | 3.0 | 3.0 | - |

| | | | | |
|-------------------------------------|----------------|-----------------------|-----------------------|--------------|
| Solvent-washed gum*, mg/100 mL, max | 5.0 | - | - | - |
| Resid by Evap, mg/100ml, max | - | - | 5 | 10 |
| Electrical conductivity, µS/m, max | - | 500 | 500 | - |
| Sulfate, mass ppm, max* | 4 | - | 4 | Work |
| Chloride, mg/kg, max | 40 | - | 1 | 20 (mg) |
| Copper, mg/kg, max | 0.1 | 0.07 | - | 0.10 |
| Sodium, mg/kg, max | - | - | 2 | - |
| Iron, mg/kg, max | - | - | 5 | - |
| Acidity, mass % (mg/L), max | 0.007 (56) | 0.0038 (30) | 0.0038 (30) | 0.00 |
| pHe | 6.5 – 9.0 | - | 6.0 – 8.0 | Drop |
| Phosphorus, mg/L, max | - | - | - | 0.5 |
| Sulfur, mass ppm, max* | 30 | - | - | 10 |
| Appearance | Clear & Bright | Clear & No Impurities | Clear & No Impurities | Clear Bright |

Challenges

- The effort is technically challenging
 - Could require additional testing and data
- Scope includes analysis of standard properties and a comparison of test methods
- ASTM experts are volunteers
- ASTM process is scientifically robust and the standards are used globally, so there is little interest in moving this work to another venue
 - Interest in avoiding overlap and duplication of effort



Conclusion

- ASTM bioethanol standards are used globally
- In the U.S., they are embedded in the Federal and State regulatory framework and ensure fuel quality
- ASTM provides a venue, framework and consensus process that ensures fairness to all participants and meets international requirements of the WTO
- ASTM experts welcome to opportunity to work with peers from Brazil with the shared goal of making existing standards more compatible
 - Much can be gained from Brazil's experience and expertise



Thank you!

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