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E15 Fuel Survey: July 2019

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Abbreviations and Acronyms

AKI	Anti-Knock Index
Deg. C	degrees Celsius
Deg. F	degrees Fahrenheit
ASTM	ASTM International
BTU	British thermal unit
CRC	Coordinating Research Council
DIPE	diisopropyl ether
DVPE	dry vapor pressure equivalent
EX	nominally X% ethanol by volume and (100-X)% gasoline or other hydrocarbons
ETBE	ethyl tert-butyl ether
EPA	U.S. Environmental Protection Agency
EVAP	evaporated
FTC	U.S. Federal Trade Commission
kg	kilograms
L	liters
LV%	liquid volume percent
lb	pound
mg/100mL	milligrams per 100 milliliters
MON	Motor Octane Number
MTBE	methyl tert-butyl ether
ppm wt.	parts per million by weight
psi	pounds per square inch
RON	Research Octane Number
RVP	Reid Vapor Pressure
Std Dev	standard deviation
TAME	tert-amyl methyl ether
V/L=X	vapor/liquid where the ratio is X
Vol%	percent by volume
wt%	percent by weight

Executive Summary

Through two separate actions in 2010 and 2011, EPA approved the use of E15 fuel in model year 2001 and newer light duty vehicles. EPA in May 2019 issued a final rule to extend summertime 1 psi RVP waiver (previously provided only to E10) to gasoline ethanol blends up to 15% ethanol. This action facilitated the year-round sale of E15 in conventional gasoline areas.

The properties and qualities of E15 as well as the labels and hose configurations on the retail dispensing equipment used to supply this fuel to vehicle motorists, are important factors for consumers that have not yet been well characterized. This project was performed to improve the understanding of E15 fuel quality and how E15 is marketed and dispensed to the consumer. It documents measurements of selected fuel properties for a limited set of E15 fuel samples in July 2019 collected from 38 out of nearly 1700 retail stations which offer E15. Basic statistical values are provided for each of the measured fuel properties, but the small data sample suggests these statistics should be used only for gross characterization, and readers are strongly cautioned to avoid extrapolating these values outside of the geographic and temporal boundaries of this limited study. Three cities, Kansas City, MO; Las Vegas, NV; and Miami, FL, were anticipated to have stations supplying E15, but stations sampled in these cities were not found to offer E15. Stations in two cities, Atlanta and New Orleans, included in the survey sample dataset were found to be offering fuel that was posted on the retail pump dispenser label as E20. Of the fuels sampled, ethanol content averaged 13%, with a range from 9.2% to 16.8%, and vapor pressure averaged 8.98 psi with a range from 7.00 psi to 10.10 psi.

Photographs taken at several stations revealed no consistent labeling convention. The regulatory E15 warning label was found on most dispensers, however the placement of the label on dispensers varied widely from station to station. Five stations did not post octane ratings. Of the stations posting an octane rating, two samples were found to have a lower octane rating than their posted octane rating.

Introduction

Through two separate actions in 2010¹ and 2011², EPA approved the use of E15 fuel in model year 2001 and newer light duty vehicles. EPA in May 2019³ issued a final rule to extend summertime 1 psi RVP waiver (previously provided only to E10) to gasoline ethanol blends up to 15% ethanol. This action facilitated the year-round sale of E15 in conventional gasoline areas. Federal programs offered funding designed to expand the infrastructure for renewable fuels via the installation of blender pumps. Nearly 1700⁴ retail stations offer E15 in 30 states.

¹ Partial Grant and Partial Denial of Clean Air Act Waiver Application Submitted by Growth Energy to Increase the Allowable Ethanol Content of Gasoline to 15 Percent; Decision of the Administrator. 2010. Federal Register, Vol. 75, No. 213, November 4, 2010, page 68094

² Partial Grant of Clean Air Act Waiver

Application Submitted by Growth Energy to Increase the Allowable Ethanol Content of Gasoline to 15 Percent; Decision of the Administrator. 2011. Federal Register Vol. 76, No. 17, January 26, 2011, page 4662

³ Modifications to Fuel Regulations to Provide Flexibility for E15; Modifications to RFS RIN Market Regulations. 2019. 40 CFR Part 80. Federal Register Vol. 84, No. 111, June 10, 2019. Page 26980

⁴ Alternative Fuels Data Center, Department of Energy, https://afdc.energy.gov/fuels/ethanol_e15.html, accessed March 17, 2020.

EPA requires per 40 C.F.R § 80.1501, “Any retailer or wholesale purchaser-consumer who sells, dispenses, or offers for sale or dispensing E15 shall affix the following conspicuous and legible label to the fuel dispenser.” See Figure 1.



Figure 1. EPA mandated E15 dispenser label

EPA also specifies the placement of the label on the E15 dispenser, “The label shall be placed on the upper two-thirds of each fuel dispenser where the consumer will see the label when selecting a fuel to purchase. For dispensers with one nozzle, the label shall be placed above the button or other control used for selecting E15, or in any other manner which clearly indicates which control is used to select E15. For dispensers with multiple nozzles, the label shall be placed in the location that is most likely to be seen by the consumer at the time of selection of E15.”

While EPA considers E15 a conventional gasoline, the Federal Trade Commission (FTC) classifies E15 as an alternative fuel. On January 14, 2016 the FTC finalized its ethanol fuel amendments within the Automotive Fuel Ratings, Certification and Posting rule.⁵ The FTC rule does not require an octane rating for E15 at the pump. Subsequently, retailers are allowed to label E15 by FTC or EPA’s requirements. Retailers marketing fuels with ethanol content from 10% to 83% are required to post labels with ethanol percentage disclosures. The FTC requires a range level with the label stating the nearest multiple of 10 for ranges of >10%-50%.

E15 fuel properties, quality, and dispenser configuration and labeling are all important factors and are not well characterized. This project was performed to improve the understanding of E15 fuel quality and how E15 is being marketed and dispensed to the consumer. This project analyzes and documents the fuel properties of E15 fuel samples collected during July 2019 from 38 out of nearly 1700 retail stations. The E15 labeling, naming, and dispenser style and configurations are also provided.

Methodology

The E15 Fuel Survey data reflect a single sample “snapshot” of market fuel properties from 38-retail stations sampled in 14-various cities. The number of stations varied from city to city. The cities and stations sampled were not selected to meet statistical criteria, or on the basis of market

⁵ Automotive Fuel Ratings, Certification and Posting, Federal Register. 2016. 16 CFR Part 306

share. They were sampled randomly by volunteers (samplers).

Basic statistical values are provided, but the limited number of measurements on each fuel property suggests these statistics should be used only to characterize this data set as there is a high probability that this sample is not indicative of E15 nation-wide or even in the cities sampled.

Sample Collection and Photographs

Volunteer field fuel samplers collected 38 E15 samples from various retail stations as noted in Table 1. Three cities, Kansas City, MO; Las Vegas, NV; and Miami, FL, were anticipated to have stations supplying E15, but the stations that were visited in these cities were not found to offer or advertise E15 for sale. Stations in two cities, Atlanta and New Orleans, included in the survey sample dataset, were found to be offering fuel that was posted on the retail pump dispenser label as E20.

All samples were collected in July 2019. The test samples were packaged and shipped to Saybolt Petroleum Services in Deer Park Texas for analysis. When the samples arrived at the laboratory, they were assigned a unique lab identification number and held in cold storage until they were tested. Table 2 lists the properties and methods used to test the E15 samples collected. Half the samples were tested for BTU gross, BTU net, and hydrogen content to save project resources.

Table 1. List of Cities and Number of E15 Samples Collected

Cities	E15 Samples Collected
Atlanta, GA	1
Chicago, IL	3
Cleveland, OH	3
Dallas, TX	3
Des Moines, IA	3
Denver, CO	1
Lansing/Grand Rapids, MI	2
Greensboro, NC	3
Houston, TX	3
Kansas City, MO	0
Las Vegas, NV	0
Miami, FL	0
Milwaukee, WI	2
Minn./St. Paul, MN	5
New Orleans, LA	3
Omaha, NE	3
Pittsburgh, PA	3
Total	38



Figure 2. Location of fuel samples collected for this study.

Table 2. List of Properties and Methods used to Test the E15 Samples Collected

Property		Test Method	Number of Samples Tested
Distillation		ASTM D-86	All
Driveability Index		ASTM D-4814	All
Distillation Index		Supplied by the Auto Alliance ¹	All
Vapor Pressure		ASTM D-5191 (EPA Equation)	All
Relative Density, 60/60 Deg F		ASTM D-4052	All
Sulfur		ASTM D-5453	All
Oxygenates		ASTM D-5599	All
Hydrogen-Carbon, Oxygen-Carbon Ratio		Calculated from ASTM D-5599, ASTM D-6379, and ASTM D-6550 results	All
Octane Number	RON	ASTM D-2699	All
	MON	ASTM D-2700	All
Solvent Washed and Unwashed Gums		ASTM D-381	All
Water Content		ASTM E-203	All
Aromatics		ASTM D-6379	All
Olefins		ASTM D-6550	All
Sodium Content		ASTM D-5863 Proc B	All
BTU	Gross	ASTM D-240	19
	Net	Calculation	19
Hydrogen Content		ASTM D-5291	19

¹ Distillation Index = (T10*1.5) + (T50*3) + (T90) + (20 x wt% of oxygen contributed by ethanol)

The samplers were also tasked with taking the following photographs of the pumps:

- Photograph of the pump encompassing the area of the product selection buttons, the display and any labeling and product identification information.
- A view of the entire pump including the hoses

Results and Discussion

Due to the small number of stations visited in this study compared to the total number of retail gasoline fuel stations in the United States, the samples collected are not meant to be representative of national E15 quality, rather a snapshot of E15 fuel quality.

A summary of the data is provided in Appendix A. For raw data, refer to a separate spreadsheet in the crao.org website for project RW-115.

Pump Labeling

The photos of the retail stations are shown in Appendix B. Photographs of the Chicago locations are not available. Two photos were not provided for every site. The overall labeling and descriptions for E15 gasoline varied between retail stations, including variation between different franchise stores in the same city.

E15 was marketed to consumers using various descriptions. Descriptions for E15 observed during the survey were: “Unleaded 88,” “E15,” “Unleaded E15,” “blend,” “E-15,” “Plus,” and “Unleaded Plus.” The EPA mandated E15 label was present on most dispensers. The location of the EPA mandated label varied widely, from near or on the dispenser actuator button, to near the dispenser handle. Two dispensers appeared to be lacking the EPA mandated label. On one dispenser the label was placed below the incorrect actuator button, in this case the unleaded 87 AKI grade, which was not E15. Notably, the small sample of Atlanta and New Orleans pump photos show E20 labels, but measured values of the ethanol content for the fuels sampled at these locations were either closer to or well below 15 vol %.

The photos indicate an octane rating (Antiknock index value) for E15 was not posted on for five pumps. In photos of the remaining retail locations sampled, one pump listed an 86 octane rating and all the other pumps listed an 88 octane rating for E15.

Conclusion

This project improved a general understanding of E15 fuel quality and how E15 is marketed and dispensed to the consumer. This project documented the fuel properties of E15 fuel samples from 38 retail stations. Due to the small number of samples in this study, the samples collected are not meant to be representative of national E15 fuel quality. Each sample was tested for critical operability properties. Basic statistical values are provided, but the small data sample suggests these statistics may be used only to characterize this data as there is a high probability it is not indicative of E15 nation-wide or even in the cities sampled. Three cities, Kansas City, MO, Las Vegas, NV and Miami, FL were anticipated to have stations supplying E15, but stations sampled in these cities were not found to offer E15. Stations in two cities, Atlanta and New Orleans, were found to be offering fuel that was posted on the retail pump dispenser label as E20. Of fuels sampled, ethanol content averaged 13%, with a range from 9.2% to 16.8%, and vapor pressure averaged 8.98 psi with a range from 7.00 psi to 10.10 psi. Five stations did not post octane ratings for E15. Of the stations posting an octane rating, two samples were found to have a lower octane rating than their posted octane rating.

Photographs taken at several stations revealed no consistent labeling convention. The regulatory E15 warning label was found on most dispensers, however the placement of the label on dispensers varied widely from station to station.

Appendix A: Summary Data

TEST DESCRIPTION	Units	Method	Maximum	Minimum	Average	Std Dev	Kurtosis	Skew	
RELATIVE DENSITY 60/60 Deg. F	kg/L	ASTM D-4052	0.7476	0.7354	0.7413	0.0032	-0.7872	0.0274	
VAPOR PRESSURE	psi	ASTM D-5191 (EPA)	10.10	7.00	8.98	1.18	-1.24	-0.79	
DISTILLATION									
	IBP	Deg. F	ASTM D-86	108	90	97	6.3	-1.12	0.76
	5% EVAP	Deg. F	ASTM D-86	131	109	117	7.6	-1.22	0.76
	10% EVAP	Deg. F	ASTM D-86	138	119	125	6.9	-1.19	0.75
	20% EVAP	Deg. F	ASTM D-86	145	127	135	5.7	-1.12	0.66
	30% EVAP	Deg. F	ASTM D-86	152	137	143	4.7	-1.09	0.57
	40% EVAP	Deg. F	ASTM D-86	156	146	151	3.3	-1.18	0.53
	50% EVAP	Deg. F	ASTM D-86	182	154	159	5.5	7.79	2.46
	60% EVAP	Deg. F	ASTM D-86	227	160	190	26.5	-1.83	0.20
	70% EVAP	Deg. F	ASTM D-86	258	232	242	6.4	-0.58	0.26
	80% EVAP	Deg. F	ASTM D-86	293	262	275	7.5	-0.62	0.33
	90% EVAP	Deg. F	ASTM D-86	334	306	321	8.2	-1.01	-0.23
	95% EVAP	Deg. F	ASTM D-86	371	334	355	9.9	-0.89	-0.19
	FBP	Deg. F	ASTM D-86	426	388	406	9.2	-0.67	-0.10
	RECOVERED	Vol %	ASTM D-86	98.1	96.6	97.2	0.32	1.088	0.764
	RESIDUE	Vol %	ASTM D-86	1.3	1.0	1.1	0.07	1.211	0.582
	LOSS	Vol %	ASTM D-86	2.3	0.9	1.7	0.31	0.742	-0.556
	E158	Vol %	ASTM D-86	56.5	43.1	50.6	3.98	-1.143	-0.518
	E200	Vol %	ASTM D-86	66.5	53.0	60.1	4.08	-1.432	-0.327
	E212	Vol %	ASTM D-86	67.4	55.5	61.8	3.65	-1.407	-0.353
	E266	Vol %	ASTM D-86	80.8	72.5	77.6	1.98	-0.362	-0.283
	E300	Vol %	ASTM D-86	88.8	82.0	85.8	1.75	-0.844	-0.013
	E330	Vol %	ASTM D-86	94.5	89.2	91.7	1.55	-1.181	0.173
	E338	Vol %	ASTM D-86	95.3	90.9	92.9	1.32	-1.145	0.119
DRIVEABILITY INDEX		ASTM D-4814	1189	1003	1076	38.4	0.827	0.546	
DISTILLATION INDEX		Supplied by Alliance	1133	1045	1082	27.3	-1.186	0.559	
VAPOR/LIQUID RATIO									
	TEMP V/L=4	Deg. F	ASTM D-4814	137	116	123	8.0	-1.171	0.837
	TEMP V/L=10	Deg. F	ASTM D-4814	140	119	126	8.0	-1.195	0.816
	TEMP V/L=20	Deg. F	ASTM D-4814	141	120	128	7.8	-1.258	0.774
	TEMP V/L=45	Deg. F	ASTM D-4814	147	120	129	8.3	-0.900	0.801
OXYGENATES									
	METHANOL	Vol %	ASTM D-5599	0.0	0.0				
	ETHANOL	Vol %	ASTM D-5599	16.8	9.2	13.0	1.43	2.109	-0.440
	MTBE	Vol %	ASTM D-5599	0.0	0.0				
	ETBE	Vol %	ASTM D-5599	0.0	0.0				
	TAME	Vol %	ASTM D-5599	0.0	0.0				
	DIPE	Vol %	ASTM D-5599	0.0	0.0				
AROMATICS	LV%	ASTM D-6379	22.5	14.8	18.4	1.94	-0.553	0.158	
OLEFINS	LV%	ASTM D-6550	12.5	1.8	8.3	2.42	0.158	-0.244	
SODIUM CONTENT	ppm wt.	ASTM D-5863	0.50	0.03	0.21	0.174	-1.400	0.506	
SULFUR CONTENT	ppm wt.	ASTM D-5453	22	2	14	4.6	-0.213	-0.386	
WATER CONTENT	ppm wt.	ASTM E-203	2788	1246	1900	245.6	4.763	0.880	
RESEARCH OCTANE NUMBER		ASTM D-2699	95.4	91.6	93.5	0.77	1.384	-0.109	
MOTOR OCTANE NUMBER		ASTM D-2700	84.8	82.2	83.5	0.63	-0.570	-0.021	
ANTI-KNOCK INDEX AS FOUND		(R+M)/2	89.8	87.0	88.5	0.60	1.006	-0.435	
POSTED AKI		Observed	88.0	88.0	88.0	0.0			
UNWASHED GUM	mg/100mL	ASTM D-381	12.2	3.8	6.8	2.07	0.327	0.909	
SOLVENT WASHED GUM	mg/100mL	ASTM D-381	1.0	0.2	0.4	0.22	1.557	1.261	
HYDROGEN-CARBON RATIO		Derived From Oxy & Aromatics	2.13	1.99	2.06	0.037	-0.807	-0.093	
OXYGEN-CARBON RATIO		Derived From Oxy & Aromatics	0.058	0.031	0.045	0.0053	1.546	-0.375	
STOICHIOMETRIC AIR/FUEL RATIO		Derived From Oxy & Aromatics	14.27	13.68	13.94	0.119	1.082	0.566	
BTU, Gross	BTU/lb	ASTM D-240	18824	18263	18576	158.0	-0.180	-0.478	
BTU, Net	BTU/lb	CALCULATED	17558	16971	17297	154.0	0.317	-0.561	
HYDROGEN CONTENT	Wt%	ASTM D-5291	14.27	13.37	13.74	0.223	0.333	0.458	

Appendix B: Station Photographs

Location: Atlanta, GA

Store: Racetrac



Location: Cleveland, OH

Store: Sheetz 465



Location: Cleveland, OH

Store: Sheetz 533



Location: Cleveland, OH

Store: Sheetz 552



Location: Dallas, TX

Store: Murphy



Location: Dallas, TX

Store: Quik Trip 922



Location: Dallas, TX

Store: Quik Trip 975



Location: Denver, CO

Store: Kum N Go

Note: One photo provided



Location: Des Moines, IA

Store: HyVee



Location: Des Moines, IA

Store: Kum N Go



Location: Des Moines, IA

Store: Kwik Star



Location: Detroit, MI

Store: NuVu Ionia



Location: Detroit, MI

Store: NuVu Rockford



Location: Greensboro, NC



Store: Sheetz, one representative set of photos for the three stores sampled.



Location: Houston, TX

Store: Buckys



Location: Houston, TX

Store: Murphy 7575



Location: Houston, TX

Store: Murphy 7576



Location: Milwaukee, WI

Store: Jetz



Location: Milwaukee, WI

Store: Quik Trip



Location: Minneapolis/St. Paul, MN

Store: Holiday

Note: One photo provided



Location: Minneapolis/St. Paul, MN

Store: Minnoco

Note: One photo provided



Location: Minneapolis/St. Paul, MN

Store: Stop N Shop

Note: One photo provided



Location: Minneapolis/St. Paul, MN

Store: Tesoro

Note: One photo provided



Location: Minneapolis/St. Paul, MN

Store: Winner

Note: One photo provided



Location: New Orleans, LA

Store: Racetrac 2430

Note: One photo provided



Location: New Orleans, LA

Store: Racetrac 2469

Note: One photo provided



Location: New Orleans, LA

Store: Racetrac 2493

Note: One photo provided



Location: Omaha, NE

Store: Casey's

Note: One photo provided



Location: Omaha, NE

Store: Kum N Go

Note: One photo provided



Location: Omaha, NE
Note: One photo provided

Store: Pump & Pantry



Location: Pittsburgh, PA

Store: Sheetz189



Location: Pittsburgh, PA

Store: Sheetz360



Location: Pittsburgh, PA

Store: Sheetz500

