

Appendix B. Data Used in Volume and Energy Calculations

Table B1. Summary of Volume and Energy Impacts of Conventional Gasoline Being Blended with Ethanol							
	C₄ Removed	C₅ Removed	CG Used	Denaturant	Ethanol Added	Total	Percent Change from 9.0 RVP No Ethanol
9.0 RVP No Ethanol			1.0000			1.0000	
9.0 with Waiver							
Volume (1)			1.0000	0.0053	0.1058	1.1111	11.1
Energy Equivalent			1.0000	0.0053	0.0699	1.0752	7.5
9.0 Without Waiver							
Volume (1)	0.0165	0.0159	0.9676	0.0051	0.1024	1.0751	7.5
Energy Equivalent			0.9722	0.0051	0.0677	1.0450	4.5
7.8 with Waiver							
Volume	0.0024	0.0045	0.9931	0.0053	0.1051	1.1035	10.3
Energy Equivalent			0.9940	0.0053	0.0695	1.0687	6.9
7.8 without Waiver							
Volume (1)	0.0064	0.0739	0.9197	0.0049	0.0973	1.0219	2.2
Energy Equivalent			0.9292	0.0049	0.0643	0.9984	-0.2
7.0 With Waiver							
Volume (1)	0	0.0253	0.9747	0.0052	0.1031	1.0830	8.3
Energy Equivalent			0.9776	0.0052	0.0682	1.0509	5.1
7.0 Without Waiver							
Volume (1)	0	0.1078	0.8922	0.0047	0.0944	0.9914	-0.9
Energy Equivalent			0.9044	0.0047	0.0624	0.9716	-2.8

Note: CG – Conventional Gasoline. Volumes are measured relative to a volume of “1.0” for gasoline before ethanol is added. Volumes of gasoline are reduced as high-RVP material is removed to counter the RVP increase of adding ethanol. The calculations of these volumes are shown in tables B3 through B5. Denaturant is assumed to be gasoline.

Source: Energy Information Administration

Table B2. Lower Heating Values

Component	Gasoline Energy Equivalent	Heating Value Btu per Gallon
Gasoline	1.0000	115,000
Ethanol	0.6609	76,000
C4's	0.8301	95,500
C5's	0.8867	102,000

Source: Energy Information Administration, *Alternatives to Traditional Transportation Fuels, An Overview*, (Washington DC: June 1984), Table 22.

Table B3. Volume Adjustments for 9.0 psi Gasoline When Adding Ethanol With and Without the 1-Pound RVP Waiver

		Percent C4/(C4+C5) Removed	Percent C5/(C4+C5) Removed	Original Gasoline RVP	C4's Removed	C5's Removed	Base Gasoline Requirement
9.0 RVP GASO	RVP (psi)			9.0000	52.0000	17.0000	9.0000
w/ Waiver	Blending RVP Index (1)			15.6000	138.0000	34.5000	15.6000
	Assumed C4/C5 Proportions Removed (2)	0	0.0				
	Volume Fractions				0.0000	0.0000	1.0000
	Volume x Blending RVP			0.0000	0.0000	0.0000	15.6000
	10% Blend Ethanol Volume						0.1111
	Ethanol Volume Excl Denaturant (3)						0.1058
9.0 RVP GASO	RVP (psi)			9.0000	52.0000	17.0000	7.9000
w/out Waiver	Blending RVP Index (1)			15.6000	138.0000	34.5000	13.2000
	Assumed C4/C5 Proportions Removed (2)	51	49.0				
	Volume Fractions			1.0000	0.0165	0.0159	0.9676
	Volume x Blending RVP			15.6000	2.2800	0.5476	12.7724
	10% Blend Ethanol Volume						0.1075
	Ethanol Volume Excl Denaturant (3)						0.1024

Note: (1) Blending indices are used to estimate the final RVP of a mixture of components in order to approximate the non-linear behavior of RVP.
(2) Assumed relative amounts of high-RPV material being extracted to balance the RVP in order to determine the volumes of C4's and C5's that must be removed.

(3) Ethanol denaturant is assumed to be gasoline. See <http://www.hartenergy.com/motorfuels/federal/doc/reg/atf/summary.htm>

Source: Energy Information Administration

Table B4. Volume Adjustments for 7.8 psi Gasoline When Adding Ethanol With and Without the 1-Pound RVP Waiver

		Percent C4/(C4+C5) Removed	Percent C5/(C4+C5) Removed	Original Gasoline RVP	C4's Removed	C5's Removed	Base Gasoline Requirement
7.8 RVP GASO	RVP (psi)			7.8000	52.0000	17.0000	7.6000
w/ Waiver	Blending RVP Index (1)			13.0000	138.0000	34.5000	12.6000
	Assumed C4/C5 Proportions Removed (2)	35	65				
	Volume Fractions			1.0000	0.0024	0.0045	0.9931
	Volume x Blending RVP			13.0000	0.3324	0.1543	12.5133
	10% Blend Ethanol Volume						0.1103
	Ethanol Volume Excl Denaturant (3)						0.1051
7.8 RVP GASO	RVP (psi)			7.8000	52.0000	17.0000	6.5000
Without Waiver	Blending RVP Index (1)			13.0000	138.0000	34.5000	10.4000
	Assumed C4/C5 Proportions Removed (2)	8	92				
	Volume Fractions			1.0000	0.0064	0.0739	0.9197
	Volume x Blending RVP			13.0000	0.8865	2.5486	9.5649
	10% Blend Ethanol Volume						0.1022
	Ethanol Volume Excl Denaturant (3)						0.0973

Note: (1) Blending indices are used to estimate the final RVP of a mixture of components in order to approximate the non-linear behavior of RVP.
(2) Assumed relative amounts of high-RPV material being extracted to balance the RVP in order to determine the volumes of C4's and C5's that must be removed.
(3) Ethanol denaturant is assumed to be gasoline. See <http://www.hartenergy.com/motorfuels/federal/doc/req/atf/summary.htm>
Source: Energy Information Administration

Table B5. Volume Adjustments for 7.0 psi Gasoline When Adding Ethanol With and Without the 1-Pound RVP Waiver

		Percent C4/(C4+C5) Removed	Percent C5/(C4+C5) Removed	Original Gasoline RVP	C4's Removed	C5's Removed	Base Gasoline Requirement
7.0 RVP GASO	RVP (psi)			7.0000	52.0000	17.0000	6.7000
w/ Waiver	Blending RVP Index (1)			11.4000	138.0000	34.5000	10.8000
	Assumed C4/C5 Proportions Removed (2)	0	100.0				
	Volume Fractions			1.0000	0.0000	0.0253	0.9747
	Volume x Blending RVP			11.4000	0.0000	0.8734	10.5266
	10% Blend Ethanol Volume						0.1083
	Ethanol Volume Excl Denaturant (3)	0.9524					0.1031
7.0 RVP GASO	RVP (psi)			7.0000	52.0000	17.0000	5.6000
Without Waiver	Blending RVP Index (1)			11.4000	138.0000	34.5000	8.6100
	Assumed C4/C5 Proportions Removed (2)	0	100.0				
	Volume Fractions			1.0000	0.0000	0.1078	0.8922
	Volume x Blending RVP			11.4000	0.0000	3.7178	7.6822
	10% Blend Ethanol Volume						0.0991
	Ethanol Volume Excl Denaturant (3)						0.0944

Note: (1) Blending indices are used to estimate the final RVP of a mixture of components in order to approximate the non-linear behavior of RVP.

(2) Assumed relative amounts of high-RPV material being extracted to balance the RVP in order to determine the volumes of C4's and C5's that must be removed.

(3) Ethanol denaturant is assumed to be gasoline. See <http://www.hartenergy.com/motorfuels/federal/doc/req/atf/summary.htm>

Source: Energy Information Administration