



\$-Smart Blend Optimizer: Step by Step hands On

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1. Installation and Requirements

- Microsoft (MS) Windows 7, 8 or 10
- Apple MAC's: require Windows Emulator
- Microsoft (MS) Office or EXCEL, versions 2007, 2010, 2016, 365
- MS Excel Solver add-in installed

2. Optimizer file names

- SmartBlend-MG for motor gasoline
- SmartBlend-DF for Diesel
- SmartBlend-FO for Bunker Fuel and Fuel Oil

3. Installation Directory

Copy distributed software to any LOCAL directory (not CLOUD or Network)

Preferably root directory of your PC; example: C:/ara/SmartBlend-MG_17_4

NOTE!!!

If you use metric unit specs, please load a metric unit case.

If you use mixed unit specs (British and Metric units), please load a mixed unit case.

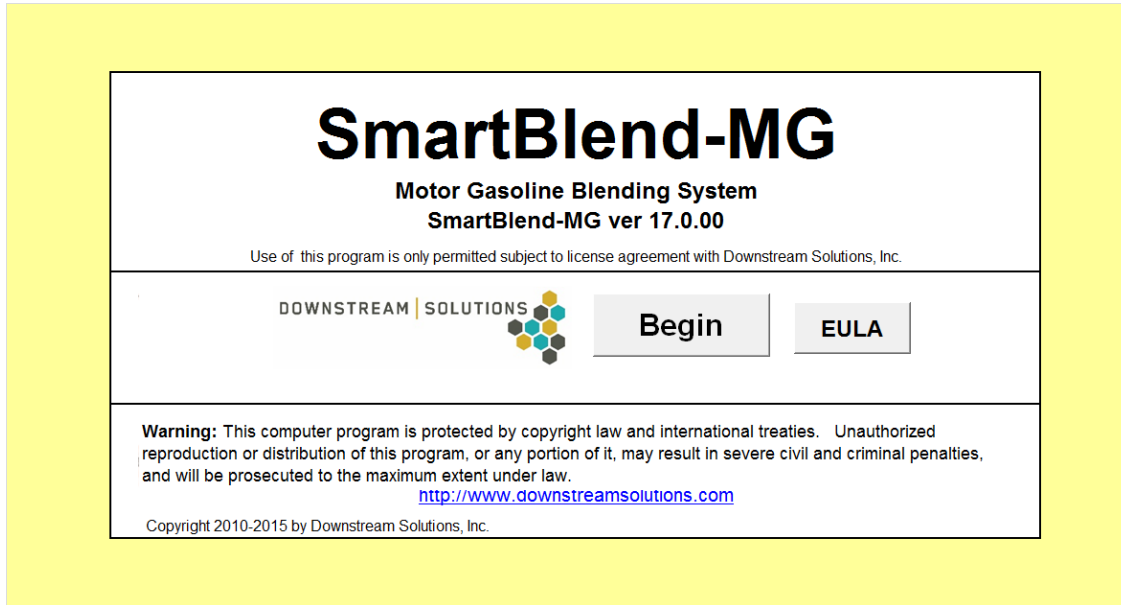
If you use British unit specs, please load a British unit case.

4. To Start Using the Optimizer

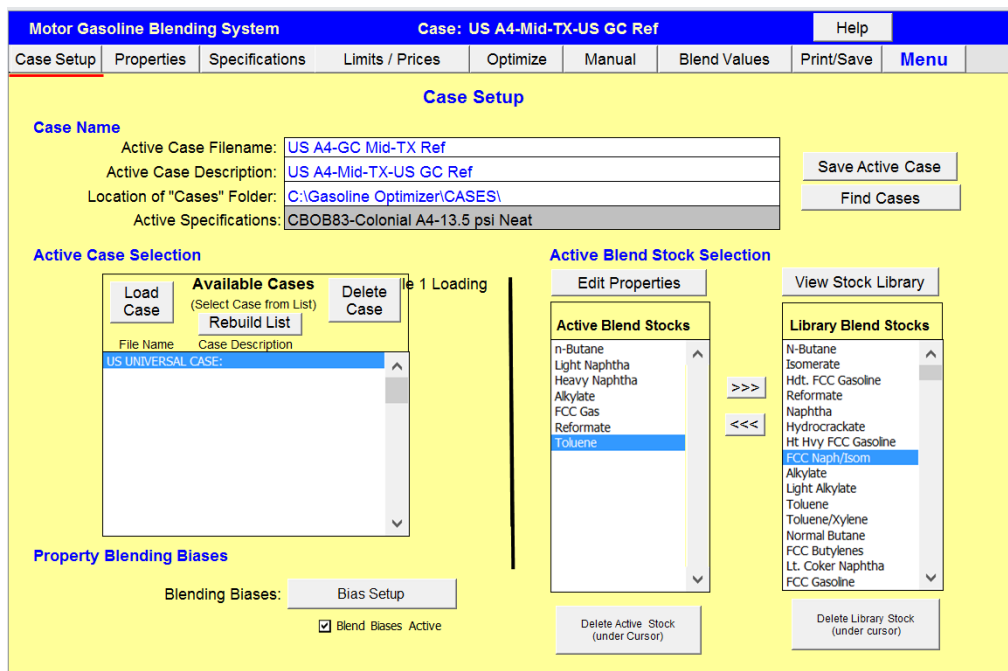
Step 1) Starting the Optimizer

To open, double click on C:/ara/SmartBlend-MG_17_4 You will also see a sub-folder labeled Cases This is where your examples (called "cases") are stored.

A message will ask you to accept EULA license agreement to see the beginning screen. Next click BEGIN button.



The next display allows you to select a case to OPEN, or create a new case.



STEP 2) Create a Case or Open an Existing Case

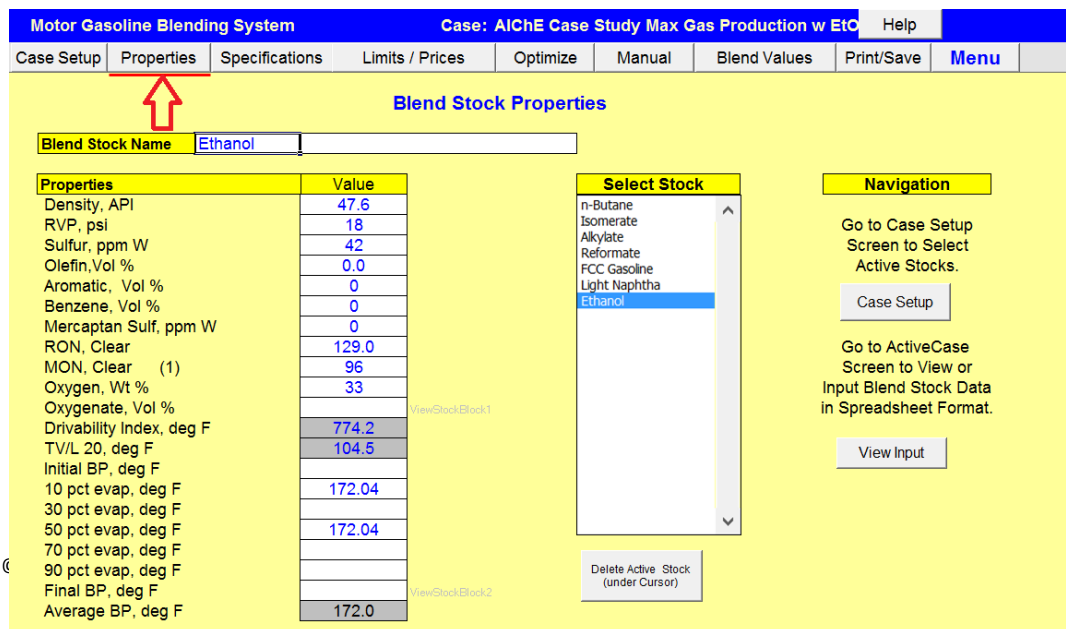
The Optimizer comes with a few customizable cases. You can open one of them and adding your own blend components properties up to 15 components:

Specification Name:	Blend Qualities				Component Qualities																
	Minimum Spec Quality	Maximum Spec Quality	Optimum Blend Qualities	Manual Blend Qualities	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15		
Density, API	51	80	72.9554	64.92941	46.4	75.9	71	42.5	61.8	72	47.6										
RVP, psi	11.000	13.500	11.00	7.80	18.5	13	7.9	4	8.2	6.12	18										
Sulfur, ppm W	0	80	7	52	10	3.5	4.5	0.2	68	53.8	42										
Olefin, Vol %	0	25	0.6	4.7	0.5	0.5	0	1.8	7.81	0.5	0										
Aromatic, Vol %	0	50	2.1	31.5	1.7	0	0	69.9	49.12	4.3	0										
Benzene, Vol %	0	3.8	0.2	0.3	0.06	0.34	0	0.6	0.48	0	0										
Mercaptan Sulf, ppm W	0	20	0.0	-	-	0	0	0	0	0	0										
Clear	-	-	85.2	87.2	129	77.6	93.7	97.6	88.5	77.32	129										
xx	-	-	-	-	-	-	-	-	-	-	-										
Clear	-	-	82.839	79.8	87.80	76.50	91.60	86.90	79.00	74.45	96.00										
xx	-	-	-	-	-	-	-	-	-	75.89	0.00										
xx	-	-	-	-	-	-	-	-	-	0.00	33.00										
Oxygen, wt %	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00										
Oxygenate, Vol %	0	0	0	0	0	0	0	0	0	0	0										
Drivability Index, deg F	-	-	900.377	1111.70	110.0	717.6	1173.0	1402.0	1200.5	815.0											
TV/L 20, deg F	116	-	117.00	141.20	44.3	105.0	143.0	181.2	143.4	136.5											
Initial BP, deg F	-	-	-	92.2	-	88.3	82.4	117	83.3	32											
10 pct evap, deg F	-	-	109.6	124.8	12	107.7	145.1	192	129	114	172.04										
30 pct evap, deg F	-	-	125.5	161.5																	
50 pct evap, deg F	-	-	150.1	197.6	18	129.7	221.7	262	215	142	172.04										
70 pct evap, deg F	-	-	200.1	244.6																	
90 pct evap, deg F	-	-	285.7	331.8	38	167	290.2	328	362	218											
Final BP, deg F	-	-	373.6	407.7	105	216	418.3	402	422	330											

You can add or change the names of your blend components, plus the blend properties like RVP, RON, MON, Sulfur, Aromatic, and so on.

STEP 3) See the Blend Component Properties

Click on "Properties" Tab on the menu bar and you are able to see the Blend Properties just created previously. Here it is possible to add more components or modify any blend properties:



The screenshot shows the "Motor Gasoline Blending System" software interface. The "Case: AICHe Case Study Max Gas Production w EtO" is selected. The "Properties" tab is active, showing a list of blend stock properties for "Ethanol".

Properties	Value
Density, API	47.6
RVP, psi	18
Sulfur, ppm W	42
Olefin, Vol %	0.0
Aromatic, Vol %	0
Benzene, Vol %	0
Mercaptan Sulf, ppm W	0
RON, Clear	129.0
MON, Clear (1)	96
Oxygen, WT %	33
Oxygenate, Vol %	
Drivability Index, deg F	774.2
TV/L 20, deg F	104.5
Initial BP, deg F	
10 pct evap, deg F	172.04
30 pct evap, deg F	
50 pct evap, deg F	172.04
70 pct evap, deg F	
90 pct evap, deg F	
Final BP, deg F	
Average BP, deg F	172.0

The interface also includes a "Select Stock" list with "Ethanol" selected, and a "Navigation" panel with buttons for "Case Setup", "View Input", and "Delete Active Stock (under Cursor)".

STEP 4) Select the Blend Specifications

Click on “Specifications” tab to select the right specifications. The Optimizer comes with 25 built-in Worldwide Specs. You can select the one depending on the location/country/region you are dealing with. If you are dealing with Europe, you can select for example EU95, if you are dealing with Singapore you can select Singapore 95R. It is also possible create your own specifications directly or by cloning an existing one.

Motor Gasoline Blending System Case: US A4-Mid-TX-US GC Ref

Case Setup Properties **Specifications** Limits / Prices Optimize Manual Blend Values Print/Save Menu

Final Product Blend Specification

Name of Blend Specification: CBOB83-Colonial A4-13.5 psi Neat

Property Specifications	Minimum	Maximum	Active in LP?
Density, API	51	70	<input checked="" type="checkbox"/>
RVP, psi	11	13.5	<input checked="" type="checkbox"/>
Sulfur, ppm W	0	80	<input checked="" type="checkbox"/>
Olefin, Vol %	0	25	<input checked="" type="checkbox"/>
Aromatic, Vol %	0	50	<input checked="" type="checkbox"/>
Benzene, Vol %	0	3.8	<input checked="" type="checkbox"/>
Mercaptan Sulf, ppm W	0	20	<input type="checkbox"/>
Research Octane (RON)	0		<input checked="" type="checkbox"/>
Motor Octane (MON)	80		<input checked="" type="checkbox"/>
(R + M)/2	83.5		<input checked="" type="checkbox"/>
Oxygen, Wt %	0	0	<input type="checkbox"/>
Oxygenate, Vol %	0	0	<input type="checkbox"/>
Drivability Index, deg F	-	1220	<input type="checkbox"/>
TV/L 20, deg F	107	-	<input type="checkbox"/>
Distillation Active?			<input checked="" type="checkbox"/>

Library (spreadsheet format) View Library

Spec Form (any spec) View Specs

Library Specifications

Delete Selected Specs Sheet

- EU EN228 Premium
- EU95-Summer 10ppm
- AG95-Summer-UAE
- EU95-Summer 10ppm
- Singapore 95R - 2012
- EU95-Winter-10ppm w MTBE
- EU95-Winter-10ppm
- Sasol R93
- Kurdistan-1
- Qatar 97 RON
- Qatar 90 RON
- Dubai 95 RON - Summer
- Singapore 95R - Platts-2015-500ppmS
- Singapore 95R - Platts-2015-10ppmS

Load Specs <<<

Save Specs >>>

Distillation Specs

% Distilled	Min deg F	Max deg F
IBP	-	-
10	74	131
50	150	235
90	0	365
End Point, deg F	-	430

WORLDWIDE SPECS

SPECS SELECTED

SPECS ACTIVE FOR THE OPTIMIZATION

Here it is very important to select the property specifications that are going to be used during the optimization. For example, checking the MON means that property specification is active for the optimization. Unchecking the Benzene content(%) property specification it means this is not active during the optimization.

STEP 5) Inventory and Price

Click on “Limits/Prices” tab to select the blend component inventory and prices. What you need to do is just add the blend components inventory, Bbl,(1) the blend component prices(2) and the Blend batch size(3) you want to make.

Motor Gasoline Blending System Case: AlChE Case Study Max Gas Production w EtO Help

Case Setup Properties Specifications **Limits / Prices** Optimize Manual Blend Values Print/Save Menu

Blend Stock and Final Product Limits and Prices

Blend Stocks

Blend Component	Quantity, Bbl		Price, \$/bbl
	Minimum	Maximum	
n-Butane	0	12000	20.90
Isomerate	0	4000	42.30
Alkylate	0	16000	61.50
Reformate	0	15000	64.10
FCC Gasoline	0	65000	52.50
Light Naphtha	0	24000	45.50
Ethanol	0	16000	67.20
Total Components		152000	

Final Product Blend

Blend Size	Quantity, Bbl		Price, \$/bbl
	Minimum	Maximum	
Product Blend	1000	152000	55.10

1. Insert the blend components inventory for each component available.

2. Insert the blend prices

3. Insert the blend batch size

4. Optimize

After inserting blend inventory and prices, you are ready to Optimize clicking on the “Optimize” (4) tab.

STEP 5) Optimize

At this point, it is possible to Optimize the blend and analyze the results. Optimize means maximizing blend profit while meeting all the constraints, e.g. specs, batch size, etc.

Motor Gasoline Blending System Case: AICHE Case Study Max Gas Production w EtO Help

Case Setup Properties Specifications Limits / Prices **Optimize** Manual Blend Values Print/Save Menu

Optimum Blend

Blend Ethanol Std LP Report LP Details Blend Values EPA Model Biases

Feasible: Optimized ← Status of the optimization

Objective Function = **35.86** Blend Ethanol before EPA Blend Biases Active?

Last Run at: 03/09/17 12:25 PM Blend Biases: Not Active 4 Limits Hit (***)

Blend Stock	Amount, Bbl	Vol% in Blend	% of Option	Marginal Value	Blend Property	Result at Optimum	Spec Binding
1 n-Butane	63.4	0.91	0.5	0.00	Research Octane Number (RON)	85.0	>0 (NotActive)
2 Isomerate	4,000.	57.24	100.0	8.96	Motor Octane Number (MON)	83.0	>80
3 Alkylate	2,790.2	39.93	17.4	0.00	(RON + MON)/2	84.0	*** >84
4 Reformate	.	0.00	0.0	-14.42	API Gravity	73.3256	51.0 > < 80.0
5 FCC Gasoline	134.4	1.92	0.2	0.00	Sulfur content, ppm W	5	< 80
6 Light Naphtha	.	0.00	0.0	-45.02	Mercaptan sulfur, ppm W	0.000	< 20 (NotActive)
7 Ethanol	.	0.00	0.0	0.00	Reid vapor pressure, psia	11.00	*** 11 > < 13.5
8					10% Distilled, deg F	110	73.9 > < 131
9					50% Distilled, deg F	150	*** 150.1 > < 235
10					90% Distilled, deg F	284	230 > < 365
11					End Point, deg. F	372	< 430
12					Driveability Index, deg F	900	< 1220
13					V/L 20, deg F	117.1	> 116.0 (NotActive)
14					Olefins, volume percent	0.4	< 25 (NotActive)
15					Aromatics, volume percent	1.0	< 50 (NotActive)
					Benzene, volume percent	0.20	< 3.8
					Oxygenates, volume percent	0.0	*** 0 < 0 (NotActive)
					Oxygen, weight percent	0.0	0 > < 0 (NotActive)

Optimized recipe

Total Blend	6,988. Bbl	Cost	49,9684
Blend Minimum	1,000. Bbl	Sales Price	55,1000
		Profit, \$/Bbl	5,1316
		Total Profit, \$k	35,8594

% Evaporated: N/A

E200, %: 70.7

E300, %: 91.8

Octane Blending Method: Ethyl Corr (Regular)

Driveability Index: 900

V/L=20, deg F: 117.1

V/L=20 with 10 %Ethanol, deg F: 130.8

Profit

Notes: The above Specs are for CBOB83-Colonial A4-13.5 psi. *** shows a limiting specification

Warnings: The Ethyl Octane equations are composition dependent. Rerun the optimizer until the Blend Composition does not change significantly.

Specifications selected for the optimization

After the Optimization we can see the “Status” of the Optimization, in this case the optimization is feasible, i.e. Specs, and Batch Size are met.

In this last screen we have the “Optimized Recipe”, the “Specifications selected for the Optimization” and the most important thing, “The Profit”.

STEP 6) Considerations

The \$-Smart Blend Optimizer is a powerful tool, with a friendly interface that allows us to predict in the shortest amount of time if you can have profit with the Blend Components, the Blend Inventory and the Specifications you have. All of them (Blend Properties, inventory, price) are taken into account during the Optimization.

The optimizer can also predict the blend properties after adding Ethanol. The user needs only to click the “Blend Ethanol” tab to open a new window where all the properties are calculated, after selecting different amounts of ethanol to be blended with the BOB.

Motor Gasoline Blending System Case: AICHE Case Study Max Gas Production w ETOH Help

Case Setup | Properties | Specifications | Limits / Prices | **Optimize** | Manual | Blend Values | Print/Save | Menu

Optimum Blend

Blend Ethanol | Std LP Report | LP Details | Blend Values | EPA Model | Biases

Objective Function = **35.86** Blend Ethanol before EPA Blend Biases Active? **Feasible: Optimized**

Last Run at: 03/09/17 12:25 PM Blend Biases: Not Active 4 Limits Hit (***)

Blend Stock	Amount, Bbl	Vol% in Blend	% of Option	Marginal Value	Blend Property	Result at Optimum	Spec Binding
1 n-Butane	63.4	0.91	0.5	0.00	Research Octane Number (RON)	85.0	>0 (NotActive)
2 Isobutane	4,000.	57.24	100.0	8.96	Motor Octane Number (MON)	83.0	>80
3 Alkylate	2,790.2	39.93	17.4	0.00	(RON + MON)/2	84.0	*** >84
4 Reformate	.	0.00	0.0	-14.42	API Gravity	73.3256	51.0><80.0
5 FCC Gasoline	134.4	1.92	0.2	0.00	Sulfur content, ppm W	5	<80
6 Light Naphtha	.	0.00	0.0	-45.02	Mercaptan sulfur, ppm W	0.000	<20 (NotActive)
7 Ethanol	.	0.00	0.0	0.00	Reid vapor pressure, psia	11.00	*** 11><13.5
8					10% Distilled, deg F	110	*** 73.9><131
9					50% Distilled, deg F	150	*** 150.1><235
10					90% Distilled, deg F	284	230><365
11					End Point, deg F	372	<430
12					Driveability Index, deg F	900	<1220
13					V/L 20, deg F	117.1	>116.0 (NotActive)
14					Olefins, volume percent	0.4	<25 (NotActive)
15					Aromatics, volume percent	1.0	<50 (NotActive)
					Benzene, volume percent	0.20	<3.8
					Oxygenates, volume percent	0.0	*** 0<0 (NotActive)
					Oxygen, weight percent	0.0	0><0 (NotActive)

Total Blend: 6,988. Bbl Cost: 49,9684
 Blend Minimum: 1,000. Bbl Sales Price: 55,1000
 Profit, \$/Bbl: 5,1316
 Total Profit, \$k: 35,8594

Notes: The above Specs are for CBOB83-Colonial A4-13.5 psi. *** shows a limiting specification

Warnings: The Ethyl Octane equations are composition dependent. Rerun the optimizer until the Blend Composition does not change significantly.

After the “ Blend Ethanol” tab from the “Optimize” screen is selected, the user has to add the 1) amount of Ethanol to be blended and 2) reads the blend properties after adding Ethanol.

Motor Gasoline Blending System Case: AICHE Case Study Max Gas Production w ETOH Help

Case Setup | Properties | Specifications | Limits / Prices | **Optimize** | Manual | Blend Values | Print/Save | Menu

Ethanol Blending

How Much Ethanol ? 5.7% 10% User Spec. Which Ethanol Correlation? CARB ABAR (Ethanol Then Removed) Which Blend? Optimum Blend Manual Blend

User Specified Ethanol: Vol % **1. Select the amount of ETOH**

Which Ethanol Quality? Standard User **2. Read the blend properties after adding the amount of ethanol selected previously**

EPA Model Blend Ethanol before EPA

User-Defined Ethanol Props (Linear)	Ethanol Std Qualities	Base Blend (Optimizer)	Base BOB (No Alcohol)	Base Blend (w/ Alcohol)	Final Blend Specification	Finished Gasoline Problems vs. Specs ?	New Ethanol Blend Vals
Name: Ethanol	-	-	-	-	-	Only used when EIOH is in the Optimization	
Density, API	46.4000	46.7000	73.3256	73.3256	70.5821	51.0><80.0	OK
RVP, psi	18.5	18.0	11.0	11.0	11.83	*** 11><13.5	OK
Sulfur, ppm W	10.	.	5.3	5.3	5.8	<80	OK
Olefin, Vol %	.5	.	0.4	0.4	0.4	<25 (NotActive)	OK
Aromatic, Vol %	1.70	0.00	1.0	1.0	1.0	<50 (NotActive)	OK
Benzene, Vol %	0.06	0.00	0.2	0.20	0	<3.8	OK
Mercaptan Sulf, ppm W	.	.	0.0	0.0000	0.00	.	.
RON, Clear	129.	.	85.0	85.0	90.9	>0 (NotActive)	-
MON, Clear	96.	.	83.0	83.0	84.0	>80	-
(R + M)/2	112.5	112.5	84.0	84.0	87.5	*** >84	-
Oxygen, Wt %	33.	.	0.0	0.00	3.58	0><0 (NotActive)	*** Oxygen too High
Oxygenate, Vol %	.	.	0.0	0	0.0	*** 0<0 (NotActive)	.
Driveability Index	.	.	899.6	.	868	.	.
T V/L 20	.	.	117.1	.	110.7	.	.
Initial BP, deg F	.	.	.	.	.	.	.
10 pct evap, deg F	172.	172.	110.1	110.1	107.8	73.9><131	.
30 pct evap, deg F	.	.	.	.	125.2	.	.
50 pct evap, deg F	172.	172.	150.1	150.1	135.3	*** 150.1><235	*** 50% too Low
70 pct evap, deg F	.	.	.	.	196.8	.	.
90 pct evap, deg F	.	172.	284.1	284.1	276.7	230><365	OK
Final BP, deg F	.	.	372.4	372.4	372.4	<430	.



STEO 7) Information on the Optimizer

The Optimizer uses Linear Programming. The result of the optimization takes into account simultaneously Blend Properties, Specs, Blend inventory and prices.

It is a single Blend Optimizer, meaning it is optimizing one blend at the time.

All the non-linear blend properties are calculated non-linearly, for example the RON and MON have built-in the RT-70 equation and the RVP the Chevron equation.

The Optimizer has also integrated important features such as:

- 1) Calculating the blend properties after adding Ethanol;
- 2) Analyzing whether the optimized batch meets the EPA rules for reformulated gasoline;
- 3) Manual blending tool where the user can insert manually the blend recipe, and see the expected blend properties.

For Pricing and Info contact lee@refautom.com