**Calculating Gasoline RVP Seasonal Change Giveaway Economics**

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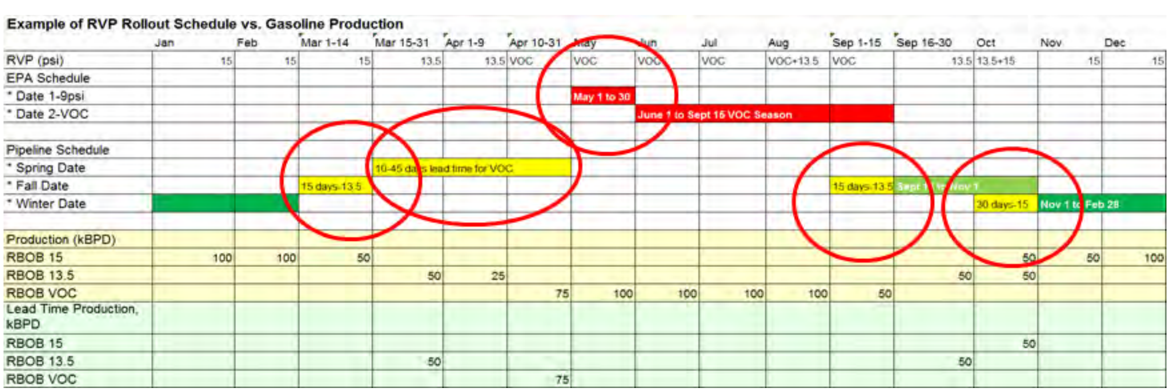
## 1. Introduction and Summary

US is in the middle of a glut of gasoline despite high demand, and depressed refining margins. This causes a rush to convert Summer gasoline to cheaper Winter gasoline hoping that using cheap Butane and higher RVP specs will increase refining profits. Same thing happens with rushing to convert Winter gasoline to Summer gasoline in mid-March rather than the usual mid-April. But do they? No, they don't. A summary of the economics of RVP rollover for a 100 kBPD AC refinery is shown below. We elaborate more in the subsequent secions.

**Summary of RVP Seasonal Transition Economics**
(Basis: 100KBPD Gasoline Production, US Refining)

| | Description | $'s | |
|---|---|---|---|
| 1 | Delta $ Cost of Conversion of non-compliant to compliant RVP | | |
| | Case 1: 20,000 bbl batch-13.5 to VOC | 20,000 | per batch |
| | Case 2: 70,000 bbl batch-13.5 to VOC | 70,000 | per batch |
| 2 | Forced early non-optimal blends loss to meet pipeline schedule (14 vs. 30 days) | 5,536,000 | 14 days |
| 3 | Forced P/L early blends inventory interest and storage costs | 2,238,000 | per year |
| 4 | Supply Chain Flushing of 2.4 Mbbls non-compliant fuel (2x/yr) if sold downgraded | 7,625,000 | per year |

The US produces and consumes about 9 MBPD of gasoline [1], most of it CBOB (~60%) and RBOB (~32%), and ~8% Conventional. The US EPA and common carrier pipelines mandate seasonal volatility specs [2] and transition calendars [3] [4], and they are out of synchronization. Because of the current glut and hangover of Summer gasoline, pipelines insist on earlier than normal shipments dates for e.g. Winter gasolines. These rules, regulations, and pipeline schedules don't allow the production and transportation of gasolines that do not meet both the EPA <u>and</u> pipeline volatility schedule during the transition times, and it clearly carries a cost to produce blend components with the right RVP, physical blend of lower RVP gasoline, store it (time value of money for inventory and tank storage space costs), transport it, and distribute it.



**Example of RVP Rollout Schedule vs. Gasoline Production**

| | Jan | Feb | Mar 1-14 | Mar 15-31 | Apr 1-9 | Apr 10-31 | May | Jun | Jul | Aug | Sep 1-15 | Sep 16-30 | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RVP (psi) | 15 | 15 | 15 | 13.5 | 13.5 | VOC | VOC | VOC | VOC | VOC+13.5 | VOC | 13.5 | 13.5+15 | 15 | 15 |
| EPA Schedule | | | | | | | | | | | | | | | |
| * Date 1-9psi | | | | | | | May 1 to 30 | | | | | | | | |
| * Date 2-VOC | | | | | | | | June 1 to Sept 15 VOC Season | | | | | | | |
| Pipeline Schedule | | | | | | | | | | | | | | | |
| * Spring Date | | | | 10-45 days lead time for VOC | | | | | | | | | | | |
| * Fall Date | | | 15 days-13.5 | | | | | | | | 15 days-13.5 | Sept 1 to Nov 1 | | | |
| * Winter Date | | | | | | | | | | | | | 30 days-15 | Nov 1 to Feb 28 | |
| Production (kBPD) | | | | | | | | | | | | | | | |
| RBOB 15 | 100 | 100 | 50 | | | | | | | | | | 50 | 50 | 100 |
| RBOB 13.5 | | | | 50 | 25 | | | | | | | 50 | 50 | | |
| RBOB VOC | | | | | | 75 | 100 | 100 | 100 | 100 | 50 | | | | |
| Lead Time Production, kBPD | | | | | | | | | | | | | | | |
| RBOB 15 | | | | | | | | | | | | | 50 | | |
| RBOB 13.5 | | | | 50 | | | | | | | | 50 | | | |
| RBOB VOC | | | | | | 75 | | | | | | | | | |

Fig. 1 EPA, Typical Pipeline, and a US Atlantic Coast (AC) refinery RVP Schedules

US EPA rollover schedule in 40CFR80.27 mandates [2] all Summer gasoline introduced in commerce in May has to be a maximum of 9 psi, and be compliant on June 1st through September 15 with the local specs (VOC, 7.8, etc.).

Various common carrier pipelines (e.g. Buckeye, Colonial, etc.) publish seasonal RVP schedules which contain an additional time buffer of approximately 15 to 45 days before the EPA "drop – dead" schedule, depending on the degree of gasoline inventory level "glut". In addition, the volatility transition is not instantaneous to meet EPA and pipeline "drop-dead" RVP schedule, and it strongly depends on the length of the overall "supply chain" and carries a cost in flushing out non-compliant gasoline with compliant gasoline, or by converting gasoline RVP to be compliant.

## 2. Analysis of Conversion of Existing Non-Compliant Heels to RVP Compliant

The analysis uses a single blend optimizer to calculate the conversion from current RVP to required RVP.

The optimizer requires the following data (see Appendix I):

- Blend component and heel properties
- Blend component and heel prices
- Finished gasoline specs
- Heel and blend component inventory
- Blend tank maximum size (net pumpable)

The optimizer calculates the optimum recipe to bring the heel on spec, the cost of the blend ($/bbl) and total blend batch profit, and blend properties neat and with 10% Ethanol, and VOC reduction.

### 2.1 Assumptions

We assume that the gasoline to be converted to be RVP compliant is RBOB, which is the most challenging in terms of Summer VOC environmental specs. CBOB is similar to RBOB except it does not have environmental specs.

The following case are simulated:

- Case_1: RBOB_VOC >>>>>>> RBOB 13.5
- Case_2 RBOB 13.5 >>>>>>>> RBOB 15
- Case_3 RBOB 13.5 >>>>>>> RBOB VOC

In case_1 the assumption is that the refinery has a Summer heel that needs to be converted to transition grade for sale on September 16.

In case_2 the refinery has 13.5 transition gasoline heel to be converted in Winter grade for sale on November 1st.

In case_3 the refinery has transition 13.5 gasoline heel grade to be converted to Summer VOC grade for sale on April 16.

### 2.2 Example of Blending RBOB VOC to Transition 13.5 psi grade

The simulation calculates:

- the minimum blend batch to make a 20,000 bbl RBOB VOC heel compliant with RBOB 13.5 specs,
- the profitability of a 100,000 blend batch using the 20,000 bbl RBOB VOC heel as a blend component,
- the blend batch size using 20,000 bbl RBOB VOC heel for maximum profitability.

We repeat the same calculation for a nearly full gasoline product tank with a “heel” of 70,000 bbls of non-compliant RBOB VOC.

The results are summarized in Fig. 3:

| Case_1 | | Non-compliant bbls | $-Loss if No Conversion | Fixed 100k blend batch [bbl] | Profit [$] | Min Break-even batch [bbl] | Profit [$] | Min Profitable batch [bb] | Profit [$] |
|---|---|---|---|---|---|---|---|---|---|
| VOC>>13.5 | | | | | | | | | |
| | | 20,000 | -106000 | 100,000 | 199,400 | 31,500 | 240 | 48,000 | 48,450 |
| | | 70,000 | -371000 | 100,000 | -32,390 | 110,000 | 102 | 170,000 | 175,410 |

Fig. 3 Economics of Case 1 to Convert RBOB VOC Gasoline to RBOB 13.5 Compliant

The RVP compliance is obtained by injecting butane in the RBOB VOC to raise its RVP. Depending on the existing RBOB VOC heel size, the amount of injected butane in the blend could be as high as 12 to 13 vol%.

The optimizer calculation results are shown in Fig. 4.

**Optimum Blend**

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

**Feasible: Optimized**

**Objective Function =** 188.10 ☑ Blend Ethanol before EPA ☐ Blend Biases Active?

Last Run at: 08/25/16 10:13 AM Blend Biases: Not Active **5 Limits Hit (***)**

| Blend Stock | Amount, Bbl | Vol% in Blend | % of Option | Marginal Value |
|---|---|---|---|---|
| 1 LSR | 17,836.5 | 17.84 | 6.5 | 0.00 |
| 2 Alkylate | 14,736.3 | 14.74 | 16.6 | 0.00 |
| 3 Raffinate | . | 0.00 | 0.0 | -2.75 |
| 4 n-Butane | 8,877.3 | 8.88 | 68.3 | 0.00 |
| 5 Reformate | . | 0.00 | 0.0 | -4.85 |
| 6 FCC LCN | 28,389.2 | 28.39 | 26.5 | 0.00 |
| 7 FCC HCN | . | 0.00 | 0.0 | -7.60 |
| 8 Cat Gas | . | 0.00 | - | 0.00 |
| 9 HN-Ref Feed | 10,160.6 | 10.16 | 4.4 | 0.00 |
| 10 Heel-RBOB 15 | . | 0.00 | - | 0.00 |
| 11 Heel RBOB 13.5 | . | 0.00 | - | 0.00 |
| 12 Heel RBOB VOC | 20,000. | 20.00 | 100.0 | 0.00 |
| 13 | | | | |
| 14 | | | | |
| 15 | | | | |

| Blend Property | Result at Optimum | Spec Binding |
|---|---|---|
| Research Octane Number (RON) | 87.8 | >0 (NotActive) |
| Motor Octane Number (MON) | 80.2 | >80 |
| (RON + MON)/2 | 84.0 | *** >84 |
| API Gravity | 71.1566 | 50.0><80.0 |
| Sulfur content, ppm W | 64 | <80 |
| Mercaptan sulfur, ppm W | 0.000 | <20 (NotActive |
| Reid vapor pressure, psia | 12.50 | *** 11.5><12.5 |
| 10% Distilled, deg F | 100 | *** 100><158 |
| 50% Distilled, deg F | 156 | 150><250 |
| 90% Distilled, deg F | 296 | 200><374 |
| End Point, deg. F | 380 | <430 |
| Driveability Index, deg F | 914 | <1220 |
| V/L 20, deg F | 109.9 | >107.0 |
| Olefins, volume percent | 25.0 | *** <25 |
| Aromatics, volume percent | 6.7 | <80 |
| Benzene, volume percent | 0.57 | <1.3 |
| Oxygenates, volume percent | 0.0 | *** 0<0 (NotAc |
| Oxygen, weight percent | 0.0 | 0><0 (NotActiv |

| | | | | |
|---|---|---|---|---|
| **Total Blend** | 100,000. Bbl | | Cost | 45.8190 |
| Blend Minimum | 70,000. Bbl | | Sales Price | 47.7000 |
| | | | **Profit, $/Bbl** | 1.8810 |
| | % Evaporated | | **Total Profit, $k** | 188.1015 |
| | N/A | | | |
| E200, % | 60.7 | | Driveability Index: | 914 |
| E300, % | 90.5 | | V/L=20, deg F: | 109.9 |
| | | | V/L=20 with 10 %Ethanol, deg F: | 123.6 |

Notes: The above Specs are for 87RBOB-13.5 psi-neat (no ETOH)
*** shows a limiting specification

**Warnings:**

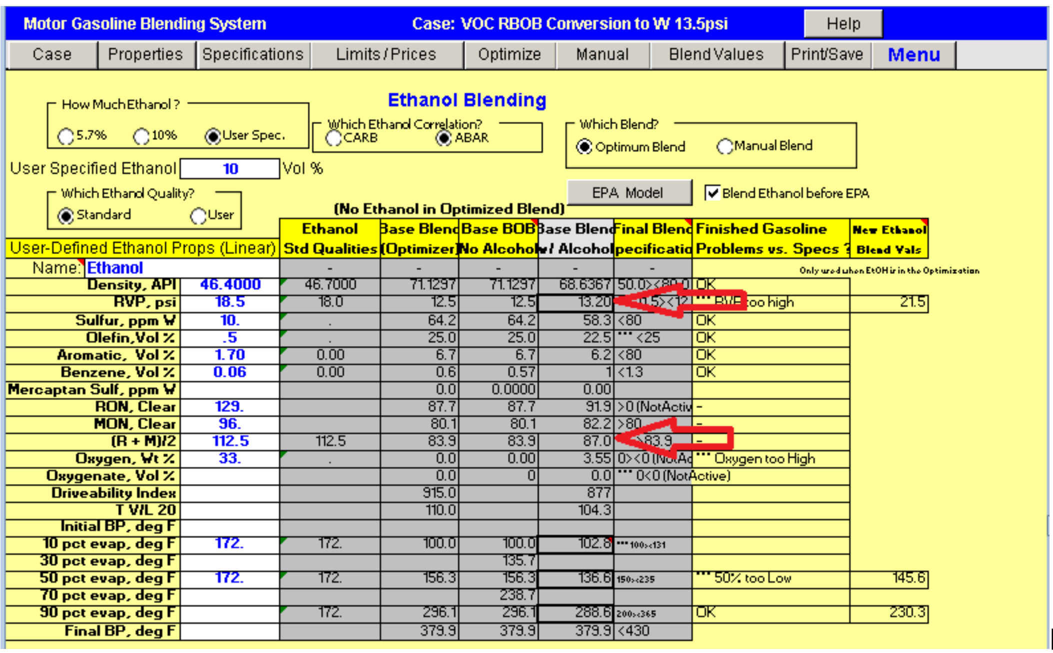
Fig. 4 Optimizer results to Convert RBOB VOC Gasoline to neat RBOB 13.5 Compliant

To verify that the RBOB 13.5 meets the specs AFTER the addition of 10% Ethanol, the optimizer built-in Ethanol blend calculator is used to determine the boosted specs for RVP and octanes.

The RBOB13.5 neat properties, and properties after adding 10% EtOH are shown in Fig. 5.

For the 70,000 bbl heel, we can add enough butane to meet the constraints of a 100,000 bbl blend tank, but it is not profitable. To make it profitable (~$2/bbl), we need to make a blend batch of about 170,000 bbls.

The profitability is linearly related to previous case of 20,000 bbls heel conversion. The 100,000 bbl blend tank simply is too small to accept additional blend components to make it profitable and spec compliant by just adding ~30,000 bbls on top of the 70,000 bbl heel. The break-even blend is 110,000 bbls, and the blend batch becomes profitable at 170,000 bbls.




| User-Defined Ethanol Props (Linear) | Name: Ethanol | 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 |
|---|---|---|---|---|---|---|---|---|
| | | - | - | - | - | - | | |
| Density, API | 46.4000 | 46.7000 | 71.1297 | 71.1297 | 68.6367 | 50.0><8[illegible] | OK | |
| RVP, psi | 18.5 | 18.0 | 12.5 | 12.5 | 13.20 | [illegible] | *** RV[illegible] too high | 21.5 |
| Sulfur, ppm W | 10. | . | 64.2 | 64.2 | 58.3 | <80 | OK | |
| Olefin, Vol % | .5 | . | 25.0 | 25.0 | 22.5 | *** <25 | OK | |
| Aromatic, Vol % | 1.70 | 0.00 | 6.7 | 6.7 | 6.2 | <80 | OK | |
| Benzene, Vol % | 0.06 | 0.00 | 0.6 | 0.57 | 1 | <1.3 | OK | |
| Mercaptan Sulf, ppm W | | | 0.0 | 0.0000 | 0.00 | | | |
| RON, Clear | 129. | | 87.7 | 87.7 | 91.9 | >0 (NotActiv | - | |
| MON, Clear | 96. | | 80.1 | 80.1 | 82.2 | >80 | - | |
| (R + M)/2 | 112.5 | 112.5 | 83.9 | 83.9 | 87.0 | [illegible]83.9 | - | |
| Oxygen, Wt % | 33. | . | 0.0 | 0.00 | 3.55 | 0><0 (N[illegible] | *** Oxygen too High | |
| Oxygenate, Vol % | | | 0.0 | 0 | 0.0 | *** 0<0 (NotActive) | | |
| Driveability Index | | | 915.0 | | 877 | | | |
| T V/L 20 | | | 110.0 | | 104.3 | | | |
| Initial BP, deg F | | | | | | | | |
| 10 pct evap, deg F | 172. | 172. | 100.0 | 100.0 | 102.8 | *** 100><131 | | |
| 30 pct evap, deg F | | | | 135.7 | | | | |
| 50 pct evap, deg F | 172. | 172. | 156.3 | 156.3 | 136.6 | 150><235 | *** 50% too Low | 145.6 |
| 70 pct evap, deg F | | | | 238.7 | | | | |
| 90 pct evap, deg F | | 172. | 296.1 | 296.1 | 288.6 | 200><365 | OK | 230.3 |
| Final BP, deg F | | | 379.9 | 379.9 | 379.9 | <430 | | |

Fig. 5

Optimizer RBOB 13.5 Neat and with 10% Ethanol blend properties

### 2.3 Example of Blending RBOB 13.5 to Winter 15 psi grade

This case is straight forward, since we are simply adding more “cheap” butane to the RBOB 13.5 heel, a little more than 16 vol% in the blend.

The simulation calculates:

- the minimum blend batch to make a 20,000 bbl RBOB 13.5 compliant with RBOB 15 specs,
- the profitability of a 100,000 blend batch using the 20,000 bbl RBOB 13.5 heel as a blend component,
- and the blend batch using 20,000 bbl RBOB 13.5 heel for maximum profitability.

| Case_2 | | Non-compliant bbls | $-Loss if No Conversion | 100k blend batch [bbl] | Profit [$] | Min Break-even batch [bbl] | Profit [$] | Min Profitable batch [bb] | Profit [$] |
|---|---|---|---|---|---|---|---|---|---|
| 13.5>>15 | | | | | | | | | |
| | | 20,000 | -22,000 | 100,000 | 198,720 | 21,600 | 11,020 | 25,500 | 26,530 |
| | | 70,000 | -77,000 | 100,000 | 132,060 | 74,300 | 7,930 | 85,600 | 85,560 |

Fig. 6 Economics of Case 2 to Convert RBOB 13.5 Gasoline to RBOB 15 Compliant

### 2.4 Example of Blending RBOB 13.5 to Summer RBOB VOC grade

This case is more complicated since we have to meet

- EPA Complex Model VOC %-reduction specs, and simultaneously "RVP-bucking" specs such as VOC (itself a function of RVP), TVL, and DI (Fig. 7).
- RBOB VOC+10% EtOH finished gasoline specs

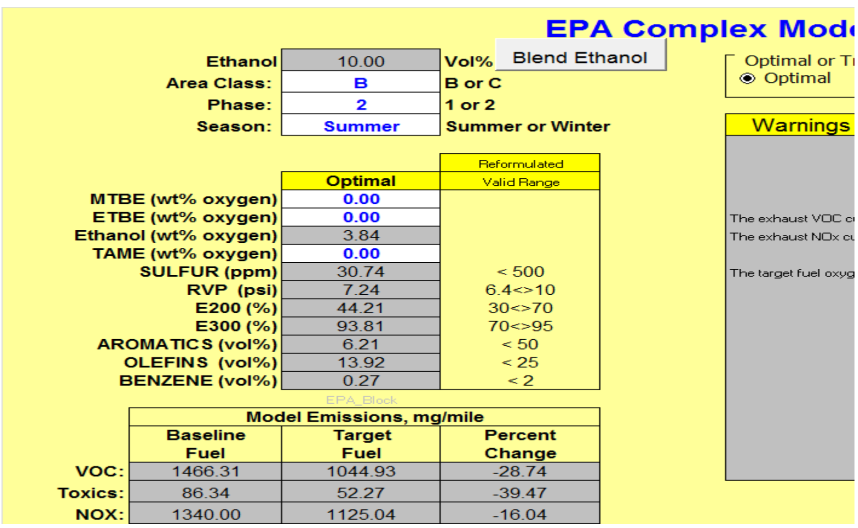



Fig. 7 Insuring RBOB is VOC Compliant

The choices we have are not economically attractive:

- we can't use cheap butane, and have to use more expensive low RVP blend components like reformate and alkylate to make the heel VOC-compliant
- we can store the RBOB 13.5 until the next season (incurring storage costs and interest on inventory)
- sell it in a geographic areas where it is compliant
- export it to countries where it will be RVP-compliant

The simulation calculates:

- the minimum blend batch to make a 20,000 bbl RBOB 13.5 compliant with RBOB VOC specs,
- the profitability of a 100,000 blend batch using the 20,000 bbl RBOB 13.5 heel as a blend component,
- the blend batch using 20,000 bbl RBOB 13.5 heel for maximum profitability.

| Case_3 | | Non-compliant bbls | $-Loss if No Conversion | 100k blend batch [bbl] | Profit [$] | Min Break-even batch [bbl] | Profit [$] | Min Profitable batch [bb] | Profit [$] |
|---|---|---|---|---|---|---|---|---|---|
| 13.5>>VOC | | | | | | | | | |
| | | 20,000 | N/A | 100,000 | 453,320 | 70,000 | 272,750 | 70,000 | 272,750 |
| | | 70,000 | N/A | 100,000 | infeasible | 250,000 | 997,060 | 250,000 | 997,060 |

Fig. 8 Economics of Case 3 to Convert RBOB 13.5 Gasoline to RBOB VOC Compliant

In the case of a 70,000 bbl heel of RBOB 13.5, we need a larger blend tank than the assumed 100,000 bbl net pumpable tank to Convert RBOB 13.5 Gasoline to RBOB VOC Compliant.

## 3. Refiner RVP Seasonal Forced Early Blend Loss to Meet Pipeline & EPA Schedules

There is a second profit loss due to lost “blend economic optimization” by doing earlier than needed blends to meet the pipeline-required RVP seasonal specs, which themselves are earlier (not in sync) with the EPA RVP schedule (Fig. 1 on 1st page).

For making VOC Summer blends, this requires adjusting refinery operating modes and targets, with some adjustments to make more of low RVP blend components, while storing high RVP components like Butane for use in Winter. For example, a refiner might be forced to make RBOB-VOC in April although EPA’s “drop-dead” date is June 1. If a refinery produces blendstocks to make 100 kBPD, this forces the refiner to split the production to continue selling 13.5 psi between April and June 1st, while using part of that production to make RBOB VOC just to be able to ship via pipeline. The split is determined by refiner’s supply chain length and transit time constants, and each refiner is different.

To illustrate a simplified economic impact, let’s assume 2 “extreme” cases: we make 100 KBPD RBOB VOC 30 days earlier than needed, or only 14 days earlier than needed (we assumed supply chain “flushing” takes about 14 days). We used August 1, 2016 prices to calculate blend components prices, as shown in Table 3. The price differential between RBOB VOC and RBOB 13.5 was $3.46/bbl. If we make RBOB VOC 30 days earlier than needed, the additional cost is about $10.38 millions, and if we can reduce the lead time to 14 days (the assumed supply chain length), it drops to$4.88 millions, saving about $5.5 million.

| **Refiner RVP Seasonal Forced Early Blend Cost** | | **Interest cost** | **Storage lease** |
|---|---|---|---|
| | | | |
| **Blend>>>>** | **RBOB VOC** | | |
| | **Summer** | | |
| Blend cost current seasonal (VOC) grade, $/bbl | 48.35 | | |
| Blend cost for earlier grade (13.5) to meeet P/L schedule $/bbl | 44.89 | | |
| Delta Cost (RBOB VOC - RBOB13.5 spec), $/bbl | 3.46 | | |
| **Cost of "P/L forced" Early Blends, assume batch size of** | **100** | KBPD | |
| Cost of Early VOC Blends, 100KBPD, k$ | 4,835 | | |
| Cost of 13.5 psi Blends, 100KBPD, k$ | 4,489 | | |
| **Cost Difference between VOC and 13.5 psi for 100KBPD/day, k$** | 346 | | |
| Delta Cost of making VOC vs. 13.5 early by 30 days, k$ | 10,380 | 39 | 1,050 |
| Delta Cost of making VOC vs. 13.5 early by 14 days SCM length, k$ | 4,844 | 8 | 229 |
| **Difference between VOC 30 day lead time and 14 days lead, k$** | **5,536** | **31** | **821** |

Fig. 3 Simple Profit Balance Sheet with Two Different Early Barrels

The blend cost for current seasonal grade, is the cost to make directly the RBOB for each season (VOC, 13.5 and 15); using the same blend components, same properties and prices
The Delta cost is the difference between the blend cost of the RBOBVOC and the blend cost for the RBOB13.5.

The blend schedule using a particular rollout schedule as described in section 2 becomes quite complicated, even with simplifications. The official EPA VOC season starts from June 1st while requiring May 1 for preparation and shipping time, but the refinery makes VOC blends before this time, in order to ship via pipeline on time to have summer gasoline available at retail for sales. The VOC early blends start from April 1-9 when the refinery makes 50k bbls (the assumption is the refinery makes 100 kBPD of blendstocks) for 9 days plus 50k bbls of 13.5 although we are still in the transition season. From April 10-31 the refinery makes only VOC blends; the total is 100 kBPD for 21 days. Taking into account only the earlier VOC blends, the total is 50 kBPD times 9 plus 100 kBPD times 21, i.e. 2,550,000 bbls of early VOC blends.
For the 13.5 transition time, the refinery makes 50 kBPD from March 1-14, in order to be prepared for changeover from winter 15 to 13.5 for a total of 14 days. In the Fall, from September 1-15 (15 days) the refinery does the reverse, makes earlier 13.5 blends when moving from VOC to 13.5. The total is 50 kBPD times 14 plus 50 kBPD times 15, i.e. 1,450,000 bbls of early 13.5 blends.
The winter 15psi early blends are made only one time a year, in October. when for 30 days the refinery makes 30 times 50 kBPD, i.e. 1,500,000 bbls of early winter 15psi blends.

## 4. Existing Non-Compliant Supply Chain Inventory Conversion to Required RVP

The rollover affects the gasoline supply chain “time to market”, directly impacts the amount of inventory to be converted (rolled over) from Winter RVP to Summer RVP, and vice-versa.

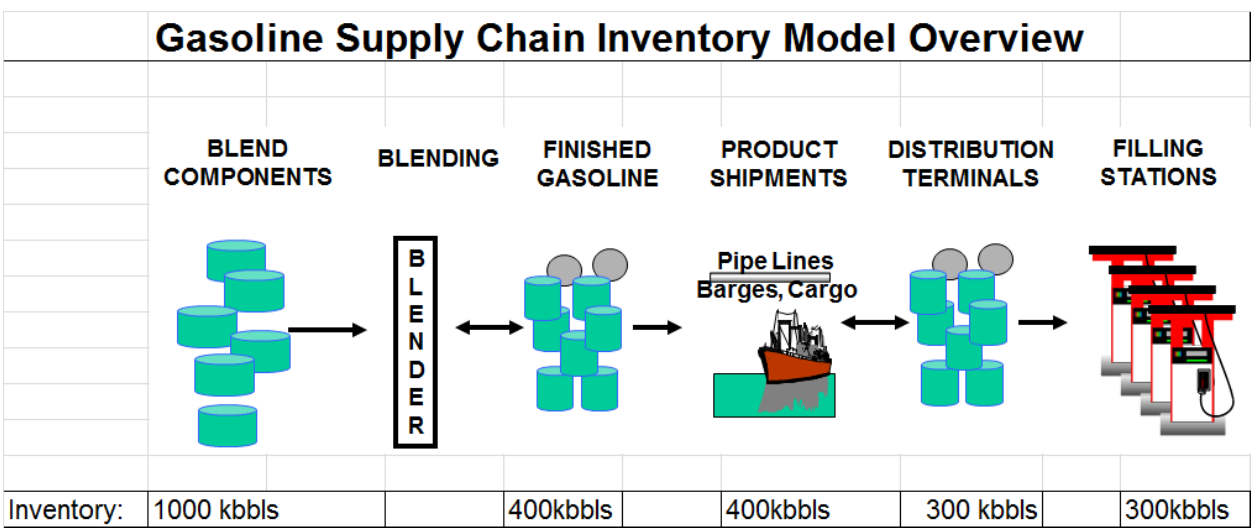



Fig. 9 Simplified Supply Chain Model (1 refinery, US AC)

### 4.1 The supply chain inventory model estimates

Model includes (see Fig. 9 above):

- Refinery gasoline blend component tankage inventory (10 days of gasoline production)
- Refinery finished gasoline tankage inventory (4 days)
- Inventory in means of transport, e.g. pipeline, barge (4 days)
- Inventory at marketing/distribution terminals (3 days)
- Inventory at retail filling stations (3 days)

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Total Supply Chain Inventory= ~ 24 days of refinery gasoline production

A typical refiner might have 18 to 24 days supply in the pipeline and distribution terminals on the way to market, depending on the length of the supply chain. This is gasoline inventory that needs to be accounted for when calculating the cost and amount of RVP conversion. For example, if refinery-X produces 100 kBPD of gasoline, the amount to be converted might be 100kBPD X 24 days=2.4 Mbbls, a non-trivial amount to be converted, worth about $15.25 million. Assuming that half of the inventory is converted to compliant RVP and the other half is sold as “downgraded” gasoline, and adding 4.5 caring and storage costs, it adds up to another ~$9.3 million.

### 4.2 The supply chain inventory time constants:

- A typical 100,000 bbl gasoline with 5000BPH in-line blend takes about 1 day
- A typical 100,000 bbl gasoline with manual blend takes about 2 days
- Sampling and the Lab “finaling” the tank to release to sales = 1 day
- Average time to convert a non-compliant RVP gasoline tank= ~3 days
- Average in-transit times via pipeline or coastal barge/tanker=~3 to 5 days

## 5. Putting It All Together

With traders and pipeline pressures to move RVP schedules earlier and earlier, the lead time costs refiners money in downgrading the value of blendstock produced to make the finished gasoline, plus the costs of carrying and storing inventory. Finally, the supply chain “flushing” of non-compliant gasoline with compliant has additional carrying and storage costs.

Looking at a typical AC 100 kBPD gasoline refinery RVP transition and pipe line lead times (Fig.10) , we have the estimated RVP transition economics, plus the added the costs of flushing out supply chain non-compliant gasoline with compliant gasoline is approximately $20 million/year, as follows:

- Inventory carrying costs at 4.5% APR interest= ~ $417 k
- Tanks storage rental costs or equivalent for 2.4Mbbls=~$1.36 million
- Forced early VOC blend profit differential (30 days vs. 14 days)=~$5.536million
- Flushing and partial downgrading 2.4 MBBLS “caught” in supply chain=~$7.625 million

**Example of RVP Rollout Schedule vs. Gasoline Production**

| | Jan | Feb | Mar 1-14 | Mar 15-31 | Apr 1-9 | Apr 10-31 | May | Jun | Jul | Aug | Sep 1-15 | Sep 16-30 | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RVP (psi) | 15 | 15 | 15 | 13.5 | 13.5 | VOC | VOC | VOC | VOC | VOC+13.5 | VOC | 13.5 | 13.5+15 | 15 | 15 |
| **EPA Schedule** | | | | | | | | | | | | | | | |
| * Date 1-9psi | | | | | | | May 1 to 30 | | | | | | | | |
| * Date 2-VOC | | | | | | | | June 1 to Sept 15 VOC Season | | | | | | | |
| | | | | | | | | | | | | | | | |
| **Pipeline Schedule** | | | | | | | | | | | | | | | |
| * Spring Date | | | | 10-45 days lead time for VOC | | | | | | | | | | | |
| * Fall Date | | | 15 days-13.5 | | | | | | | | 15 days-13.5 | Sept 16 to Nov 1 | | | |
| * Winter Date | | | | | | | | | | | | | 30 days-15 | Nov 1 to Feb 28 | |
| | | | | | | | | | | | | | | | |
| **Days of production** | 30 | 30 | 14 | 16 | 9 | 21 | 30 | 30 | 30 | 30 | 15 | 15 | 30 | 30 | 30 |
| **Production (kBPD)** | | | | | | | | | | | | | | | |
| RBOB 15 | 100 | 100 | 50 | | | | | | | | | | 50 | 100 | 100 |
| RBOB 13.5 | | | 50 | 100 | 50 | | | | | | 50 | 100 | 50 | | |
| RBOB VOC | | | | | 50 | 100 | 100 | 100 | 100 | 100 | 50 | | | | |
| **Lead Time For Early Production, days** | | | | | | | | | | | | | | | |
| RBOB 15 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 30 | 0 | 0 |
| RBOB 13.5 | | | 14 | | | | | | | | 15 | 0 | | | |
| RBOB VOC | | | | | 9 | 21 | | | | | | | | | |

| Lead Times for | Lead time Days | | Production kBPD | No of Transitions | Lead Time Inventory | | Days Interest | | Avg Lead Inventory, kbbls | Inventory Avg Outright value k$ | Interest for Lead Time k$ | Lead Time Storage cost, k$ | Price, $/bbl | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **RBOB 15** | 30 | days | 50 | | 1500 | kBPD for | 30 | days | 750 | 37,500 | 139 | 675 | 50 | | |
| **RBOB 13.5** | 29 | days | 50 | 2X/ yr | 1450 | kBPD for | 29 | days | 725 | 36,250 | 130 | 631 | 50 | | |
| **RBOB VOC-1 (after 4/1)** | 9 | days | 50 | | 450 | kBPD for | 9 | days | 225 | 11,250 | 12 | 61 | 50 | | |
| **RBOB VOC-2 (after 4/10)** | 21 | days | 100 | | 2100 | kBPD for | 21 | days | 1050 | 52,500 | 136 | 662 | 50 | | |
| **Total, k$** | | | | | | | | | | 137,500 | 417 | 1,367 | Total, k$/yr>>> | | 1,783 |

Fig. 10 Simplified RVP Schedule vs. Gasoline Rollover Lead Time (1 AC refinery, 100kBPD, )


| Lead Times for | Lead time Days | | Production kBPD | No of Transitions | Lead Time Inventory | | Days Interest | | Avg Lead Inventory, kbbls | Inventory Avg Outright value k$ | Interest for Lead Time k$ | Lead Time Storage cost, k$ | Price, $/bbl | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **RBOB 15** | 30 | days | 50 | | 1500 | kBPD for | 30 | days | 750 | 37,500 | 139 | 675 | 50 | | |
| **RBOB 13.5** | 29 | days | 50 | 2X/ yr | 1450 | kBPD for | 29 | days | 725 | 36,250 | 130 | 631 | 50 | | |
| **RBOB VOC-1 (after 4/1)** | 9 | days | 50 | | 450 | kBPD for | 9 | days | 225 | 11,250 | 12 | 61 | 50 | | |
| **RBOB VOC-2 (after 4/10)** | 21 | days | 100 | | 2100 | kBPD for | 21 | days | 1050 | 52,500 | 136 | 662 | 50 | | |
| **Total, k$** | | | | | | | | | | 137,500 | 417 | 1,367 | Total, k$/yr>>> | | 1,783 |


To reduce early blend RVP rollover giveaway losses by half, including conversion, carrying costs and interest, and storage rental costs requires a reasonable, not rigorous modeling of the Supply Chain using a multi-blend, multi-time period optimizer tool for planning and scheduling of the oil movements, blending, and storage facilities, and integration with the refinery LP-based long range plan.

References:


[1] US EIA Statistics, Week of July 8, 2016
[2] EPA 40CFR80.27
[3] Buckeye Pipe line RVP Schedule
[4] Colonial Pipeline RVP Schedule
[5] OPIS Full Day Refined Spot Price Bulletin Sample; Aug. 1, 2016
[6] Barsamian, A., Curcio, L.E., “Report RAIL-8-19-16: Estimating Gasoline RVP Seasonal Change Giveaway”, Internal Report, August 2016