

Supply Impacts of an MTBE Ban

**Table B-1.
 West Coast Refinery Results**

| Case | Gasoline Production | | Pentane Sales BPD | Ethanol (MTBE) BPD | Isobutane Purchased BPD | Incremental Alkylate Production BPD | Process Capacity Changes* |
|------|---------------------|----------------|-------------------|--------------------|-------------------------|-------------------------------------|---------------------------|
| | Pool Volume BPD | Change percent | | | | | |
| Base | 123,172 | | 0 | (13,243) | 0 | Base | |
| II | 103,516 | -16.0 | 8,321 | 6,286 | 1,737 | +2,466 | 1,2,4,6,7 |
| III | 101,833 | -17.3 | 9,310 | 6,184 | 2,872 | +4,386 | 1,2,3,6,7 |
| IV | 114,321 | -7.2 | 1,471 | 7,815 | 5,473 | +11,528 | 1,4,5,6,7 |

BPD = barrels per day
 *Process Capacity Notes:
 1. New light straight run (LSR) Depentanizer
 2. Expand Isomerization
 3. Expand Distillate Hydrocracking
 4. Expand FCC Gasoline Hydrotreating
 5. New FCC Gasoline Depentanizer
 6. Olegin Treating (mercaptan removal and selective hydrogenation)
 7. Expand Alkylation

Source: "Refining Options for MTBE-Free Gasoline" NPRA AM00-53, presented at NPRA's Annual Meeting in 2000. <http://www.stratco.com/pdf/RefiningOptionsPaper.pdf>

Table B2. MTBE Ban Impacts on CARB Gasoline Production 100MB/D Illustrative California Refinery

| Case: | Base Case | | Case 2 | | Case 3 | | Case 4 | | Case 5 | |
|-------------------------------------------------------------------|------------------|-------|-----------------------------------------------------|-------|----------------------------------------------|-------|-----------------------------------------------|-------|----------------------------|-------|
| | CARB with MTBE | | 5.7% Ethanol, Reduce C ₅ 's, | | Increase Alkylate Purchase over Case 2 | | Restore Full Production | | Restore Full Production | |
| | | | C ₃ Alkylate Production + Purchase | | Restore Some Light & Heavy Components | | Increase Alkylate, Iso-Octane & Ethanol | | 5.7% Etanol & Alkylate | |
| | Volume (MB/D) | Vol % | Volume (MB/D) | Vol % | Volume (MB/D) | Vol % | Volume (MB/D) | Vol % | Volume (MB/D) | Vol % |
| Production | | | | | | | | | | |
| LSR | 7.5 | 13.0 | 4.7 | 9.2 | 5.0 | 9.2 | 5.5 | 9.5 | 5.3 | 9.1 |
| Isomerate | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Reformate | 16.9 | 29.1 | 15.5 | 30.4 | 16.0 | 29.5 | 16.7 | 28.8 | 16.6 | 28.8 |
| FCC Gasoline | 16.5 | 28.5 | 15.7 | 30.8 | 15.7 | 28.9 | 15.7 | 27.1 | 15.7 | 27.1 |
| Alkylate | 9.5 | 16.4 | 11.5 | 22.5 | 11.5 | 21.2 | 11.5 | 19.8 | 11.5 | 19.8 |
| n-Butane | 1.0 | 1.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Refinery | 51.4 | | 47.4 | | 48.2 | | 49.4 | | 49.1 | |
| Purchases | | | | | | | | | | |
| MTBE | 6.5 | 11.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Ethanol | 0.0 | 0.0 | 2.9 | 5.7 | 3.1 | 5.7 | 4.1 | 7.0 | 3.3 | 5.7 |
| C ₄ Alkylate | 0.0 | 0.0 | 0.7 | 1.4 | 3.0 | 5.5 | 2.0 | 3.5 | 5.5 | 9.5 |
| C ₃ /C ₄ Alkylate | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Iso-Octane | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 2.5 | 4.3 | 0.0 | 0.0 |
| Total Purchases | 6.5 | | 3.6 | | 6.1 | | 8.6 | | 8.8 | |
| Total Gasoline | 57.9 | | 51.0 | | 54.3 | | 57.9 | | 57.9 | |
| Properties | | | | | | | | | | |
| Octane: (R+M)/2 | 88.6 | | 88.3 | | 88.5 | | 89.1 | | 88.8 | |
| RVP: psi | 6.5 | | 7.0 | | 7.0 | | 7.0 | | 6.98 | |
| Benzene: vol % | 0.32 | | 0.36 | | 0.34 | | 0.32 | | 0.32 | |
| Aromatics: vol % | 25.0 | | 25.7 | | 24.8 | | 24.0 | | 23.9 | |
| Olefins: vol % | 7.6 | | 8.5 | | 8.0 | | 7.5 | | 7.5 | |
| Sulfur: ppm | 12 | | 12 | | 11 | | 11 | | 11 | |
| ASTM D86 T50 | 196 | | 208 | | 209 | | 209 | | 209 | |
| ASTM D86 T90 | 335 | | 326 | | 326 | | 329 | | 327 | |
| CARB | PASSES | | PASSES | | PASSES | | PASSES | | PASSES | |
| Predicted Percent Change In Emissions (Candidate vs Reference) | | | | | | | | | | |
| NO _x | -1.14 | | -0.29 | | -0.79 | | -0.36 | | -1.29 | |
| Exhaust THC | -0.19 | | -0.12 | | 0.01 | | 0.01 | | -0.14 | |
| POT.TOX. | -9.24 | | -6.69 | | -8.22 | | -9.49 | | -9.67 | |

Definition of abbreviations and technical terms:

LSR = light straight run;
FCC = fluid catalytic cracking;
ppm = parts per million;
psi = pounds per square inch;
vol% = volume percent;
MB/D = thousand barrels per day;
MTBE = methyl tertiary butyl ether;
RVP = Reid vapor pressure;
THC = total hydrocarbons;
POT, TOX. = potency weighted toxins.

Source: Energy Information Administration

| Table B-3. Stillwater Associates Study for California Energy Commission on Impact of MTBE Ban (Thousand Barrels per Day) | | |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------|------|
| CARB Reformulated Gasoline Production Using MTBE | | |
| | RFG Production | 935 |
| | Ethanol Based CARB RFG | 110 |
| | MTBE Based CARB RFG | 825 |
| | MTBE Required @ 11% | 91 |
| MTBE Supply | | |
| | MTBE Foreign Imports | 75 |
| | MTBE Gulf Coast Net Receipts | 17 |
| | MTBE Production | 10 |
| | Total MTBE Supply | 102 |
| | Excess MTBE | 11 |
| Direct Impact with MTBE Ban | | |
| | Removal of MTBE | -102 |
| | Ethanol Addition for Oxygen Requirements | 55 |
| | Removal of Butanes and Pentanes | -46 |
| | Other Losses to meet distillation specs | -10 |
| | Net Loss * | -103 |
| <p>* Net loss is the volume to be filled by refinery modifications to increase gasoline production and imports of blending components and finished CARB reformulated gasoline. Source: Finizza, Anthony J. et al, MTBE Phase Out in California, Draft, Stillwater Associates for the California Energy Commission, March 14, 2002</p> | | |

| Table B-4. Net Change in Volume If Ethanol Were Used in CARB RFG in 2002 (Thousand Barrels per Day) | | |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|-------------|
| | Stillwater Analysis | EIA |
| MTBE Removal | -102 | -102 |
| Ethanol Addition | +55 | +55 |
| Loss of Light & Heavy Components to Balance Ethanol Properties | -56 | -68 |
| Net Impact on Volume | -103 | -114 |
| <p>Note: The Stillwater analysis estimated yield impacts for the MTBE to ethanol shift in California reformulated gasoline. This table showed the effect of those yield reductions using end of 2002 demand and refinery production. The study then indicated that the impacts likely would increase by 2004, when the ban is currently scheduled to begin. The EIA result column applied EIA's refinery yield reductions to the same volumes.</p> <p>Sources: Finizza, Anthony J. et al, MTBE Phase Out in California, Draft, Stillwater Associates for the California Energy Commission, March 14, 2002; Energy Information Administration.</p> | | |