EPA 420-F-95-003
August 1995
EPA Office of Mobile Sources

Fuel Economy Impact Analysis of RFG

- The Environmental Protection Agency (EPA) evaluated fuel economy impacts of reformulated gasoline (RFG) using a number of reliable studies (including the $40 million joint research program by the auto and oil industries) involving approximately 4000 individual observations.
- EPA found that the use of oxygenated fuels and RFG causes a small decrease (1-3%) in fuel economy.
- EPA determined that a vehicle's fuel economy depends on the energy content of the gasoline on which it runs. This conclusion matches what would be expected based on combustion theory.
- This determination is also supported by similar conclusions drawn by industry through their own studies (both laboratory and on-road testing).
- Therefore, the following points focus on energy content more than fuel economy. The impact of fuel changes on fuel economy should be very similar to the impact of fuel changes on the energy content.

Conventional Gasoline

- It is important to note that the energy content of gasolines varies from season to season. The table below shows that typical summer conventional gasolines contain 1.7% more energy than typical winter conventional gasolines.

Average Energy Content (btu per gallon)

Summer	Winter	Difference
114,500	112,500	1.7%

- The energy content of conventional gasolines also varies widely from batch to batch and station to station. The table below shows this variation within each season.

Energy Content (btu per gallon)

	Minimum	Maximum	Difference
Summer	113,000	117,000	3.4%
Winter	108,500	114,000	4.8%

Conventional Gasoline vs RFG

- A gallon of RFG contains about 1-3% less energy than a gallon of conventional gasoline. This difference is considerably smaller than the differences in energy content among conventional gasolines described above.

- RFG contains oxygenates, which contain less energy per unit volume than conventional gasoline. The table below outlines the differences in energy content between RFG and conventional gasoline based on the three most widely used oxygenates.

Oxygenate	Energy Content of Oxygenate (btu/gallon)	Volume of Oxy-genate in RFG	Energy Content of RFG (btu/gallon)*	Difference in Energy Content (RFG vs Conventional)
Ethanol	76,100	5.71%	111,836	1.9%
ETBE	96,900	12.8%	111,811	1.9%
MTBE	93,500	11.0%	111,745	2.0%

* Assumes base gasoline has energy content of 114,000 btu/gallon

- Other than oxygenates, there are other minor differences between RFG and conventional gasoline that also impact the energy content of the fuel. These impacts are different in summer and winter.

- Summer RFGs contain approximately 1.0% less energy than summer conventional gasolines.
  - This is expected to reduce fuel economy on average by 1.0% during the summer.
  - For example, a car that gets 25 miles per gallon with conventional gasoline may get 24.75 miles per gallon with RFG.

- Winter RFGs contain approximately 3.0% less energy per gallon than winter conventional gasolines.
  - This is expected to reduce fuel economy on average by 3.0% during the winter.
  - For example, a car that gets 25 miles per gallon with conventional gasoline may get 24.25 miles per gallon with RFG.

- A March 1995 study conducted in Wisconsin confirmed a 2.8% reduction in average fuel economy with winter RFG. This study used eight private vehicles of various makes, designs, and ages, four different retail gasolines (including conventional and reformulated gasolines), and 12,800 miles of driving on city streets.

Other Fuel Economy Factors

- While all analyses to date show RFG has a minimal direct effect on fuel economy, there are many other factors that can dramatically affect fuel economy. The table on page 4 outlines these factors and their potential impacts on fuel economy. The majority of these factors reduce fuel economy more than only the use of RFG.

- Drivers experiencing a consistent, drastic change in fuel economy (i.e., reductions far greater than the expected 1-3%) that is not the result of the other mitigating factors described in the table on page 4, should consider that the reduction may be a maintenance problem or other issue unique to the vehicle.

Fuel Economy and Pollution

- Common sense suggests that the slight reduction in fuel economy from RFG would be associated with an increase in pollution. Fuel economy and pollutants emitted are not always directly related, however, because vehicles are designed to meet the emission standards on a basis of pollutant per mile.

- Hydrocarbon emissions and other pollutants such as carbon monoxide and oxides of nitrogen depend mainly on how much the vehicle is driven and how well the emission controls are functioning. There is little connection between these emissions and fuel consumption, although it

is to some extent dependent on the circumstances causing the difference in fuel economy. If, for example, a vehicle suddenly experiences a dramatic change in its fuel economy due to something going wrong with the vehicle, there is likely to also be a significant impact on the vehicle's emission performance. But if that problem does not affect the vehicle's emission control system, then there may be little or no impact on emissions.

- On the other hand, carbon dioxide (CO2) emissions are always linked to fuel consumption because CO2 is the ultimate end product of burning gasoline. The more fuel a car burns, the more CO2 it emits.
- For those situations where fuel economy changes merely as a result of driving habits, driving conditions, or fuel composition (as is the case with RFG), and vehicle performance remains unaffected, the emission performance of the vehicle is also likely to remain unaffected.

Effect	Conditions	Average Fuel Economy Reduction	Maximum Fuel Economy Reduction
Temperature*	20F vs 77F	5.3%	13%
Head Wind	20 mph	2.3%	6%
Hills/Mountains	7% road grade	1.9%	25%
Poor road conditions*	Gravel, curves, slush, snow, etc.	4.3%	50%
Traffic Congestion	20 vs 27 mph average speed	10.6%	15%
Highway speed	70 vs 55 mph	N/A	25%
Acceleration Rate	"Hard" vs "Easy"	11.8%	20%
Wheel Alignment	1/2 inch	<1%	10%
Tire Type	non-radial vs radial	<1%	4%
Tire Pressure*	15 psi vs 26 psi	3.3%	6%
Air Conditioning	Extreme Heat	21%	N/A
Defroster*	Extreme Use	Analogous to A/C on some vehicle	
Idling/Warmup*	Winter vs Summer	Variable with Driver	20%
Windows	Open vs Closed	Unknown but likely small	

* These factors, with their respective reduction in fuel energy content, can decrease fuel economy in the winter season relative to summer by 20 percent or more independent of whether the RFG program is in effect.

For More Information:

The Office of Mobile Sources is the national center for research and policy on air pollution from highway and off-highway motor vehicles and equipment. You can write to us at the EPA National Vehicle and Fuel Emissions Laboratory, 2565 Plymouth Road, Ann Arbor, MI 48105. Our phone number is (313) 668-4333.