

Ethanol's Octane Advantage



OCTANE IS ONE OF THE MOST IMPORTANT GASOLINE PROPERTIES FOR FUEL SUPPLY CHAIN STAKEHOLDERS.

The higher the octane, the better the knock resistance.

When ethanol is less expensive than petroleum-based gasoline, refiners can blend it with a lower octane base gasoline leading to higher profits.



Most countries have more than one gasoline grade, each meeting a minimum octane rating, e.g. “regular” gasoline has a lower octane than “premium” gasoline. Using a gasoline with an octane rating higher than required will not have a negative impact on performance and may even improve performance if the engine is designed to benefit from higher octane.

In most countries in Europe, Africa and Asia, the regulated fuel specification is the “Research Octane Number” (RON). In the U.S., the regulated specification is the “Anti-Knock Index” (AKI) – the average of RON and the “Motor Octane Number” (MON).

The octane increase from ethanol depends on the starting gasoline properties. However, based on U.S. experience with ethanol blending, the general guidelines shown in the table below have been developed for blending at levels from 5.7 vol% to 15 vol% ethanol.^[4]

AKI* Increase	Ethanol by vol %
1.0 – 1.5	5.7%
1.5 – 2.5	7.5%
2.0 – 3.5	10%
3.0 – 4.5	15%

*AKI = (RON+MON)/2

Source: Fuel Ethanol Industry Guidelines, Specifications and Procedures (RFA, 2010)

Benefits to the Refinery or Blender:

- 1 Lower ethanol pricing reduces the blended gasoline price**
 - When the cost of ethanol is lower than regular gasoline, the addition of ethanol reduces the price of the blended fuel.
 - The higher the concentration of ethanol, the greater the price reduction.
- 2 Higher ethanol octane reduces the required subgrade gasoline octane**
 - Ethanol's higher octane allows a lower subgrade octane to be blended, and the blended fuel achieves its desired final octane requirement.
 - The lower octane subgrade is less expensive for a refinery to produce and less expensive for a blender to procure.
 - This octane benefit can sometimes be higher than the pricing benefit.
- 3 The use of ethanol creates human health and environmental GHG emissions benefits**
 - Ethanol contains no harmful aromatics and essentially no sulfur.
 - Ethanol could reduce refinery operational costs or investments.

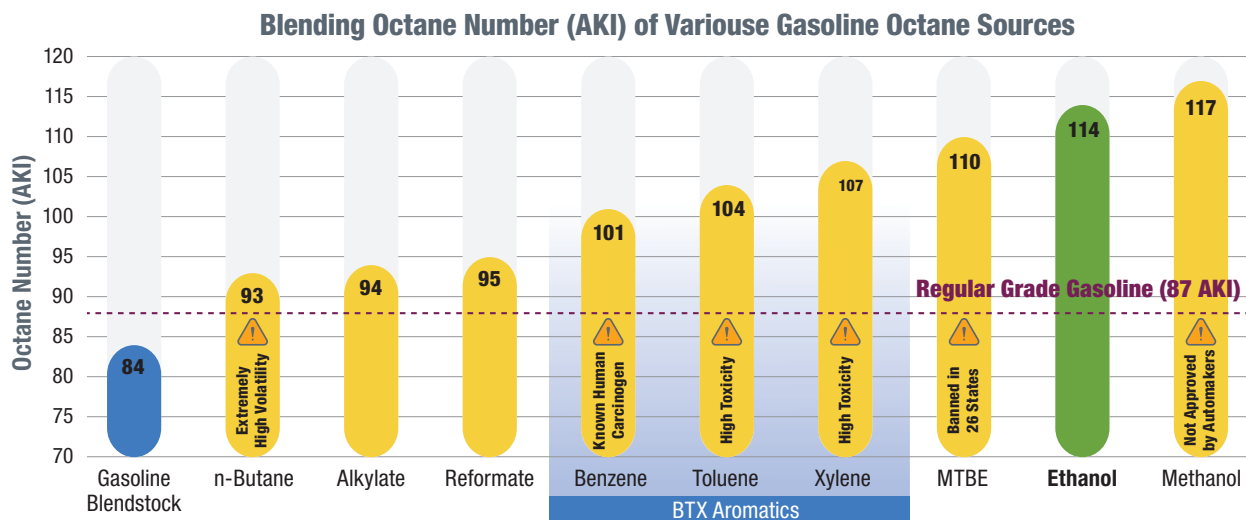
Ethanol as an Octane Booster

Ethanol was first used in gasoline in the U.S. in the late 1970's as an octane booster, when lead-based gasoline was phased out.

Blend stocks with higher octane relative to a "regular" grade of gasoline in the U.S. (red dotted line) can be used as octane enhancers to meet the minimum 87 AKI.

Ethanol has distinct advantages over most of these other octane sources.

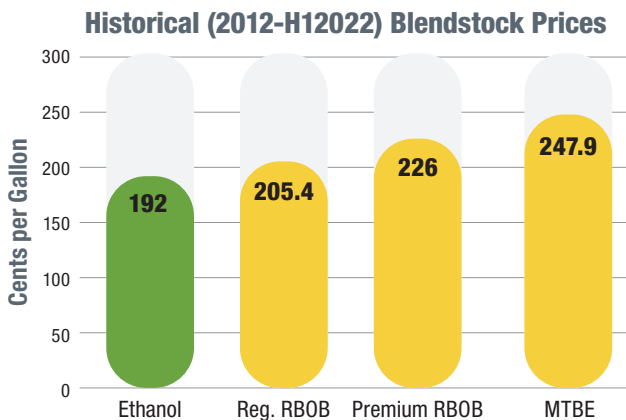
It's less volatile than butane, and it's not harmful to human health, like benzene, toluene, xylene, MTBE and methanol.



Source of data: Fuel Ethanol Industry Guidelines, Specifications and Procedures (RFA, Jul 2018)

Economic Value of Ethanol

When ethanol on average is less expensive than gasoline, it can be an economic replacement for gasoline, as the figure below shows.



Historical spot price of blendstocks for the period 2012-1H2022) in the U.S. Gulf Coast

(Source of data: S&P Global Platts quotations as reported in "Fuel Ethanol Cost-Benefit Analysis Study" by John Mayes, Samuel Davis, Michael Leger, Turner, Mason & Co., October 2022.

Ethanol is one of the most economical ways to increase gasoline octane.

In an internal octane cost analysis, Turner Mason Corporation found the addition of ethanol would have decreased gasoline production costs based on data from 2012 to

1H2022. The graph above is a comparison of the cost to increase a regular gasoline (RON = 90) by using ethanol, MTBE and toluene based on average prices during the 10.5-year period.

Reference: "Fuel Ethanol Cost-Benefit Analysis Study" by John Mayes, Samuel Davis, Michael Leger, Turner, Mason & Co., October 2022. (Source: TMC Octane Cost Analysis)

