The Battle for Octane: Ethanol or Aromatics?

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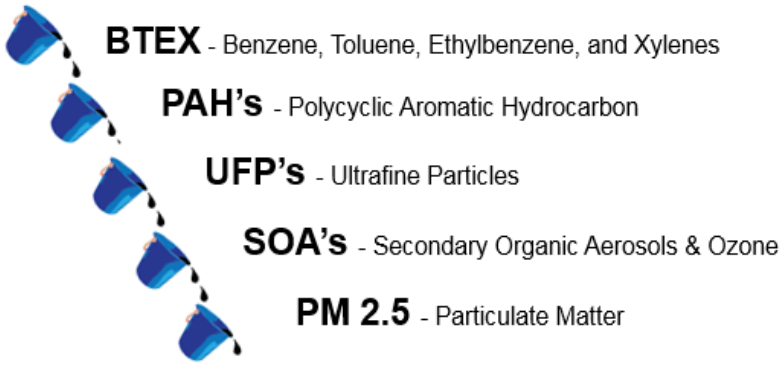
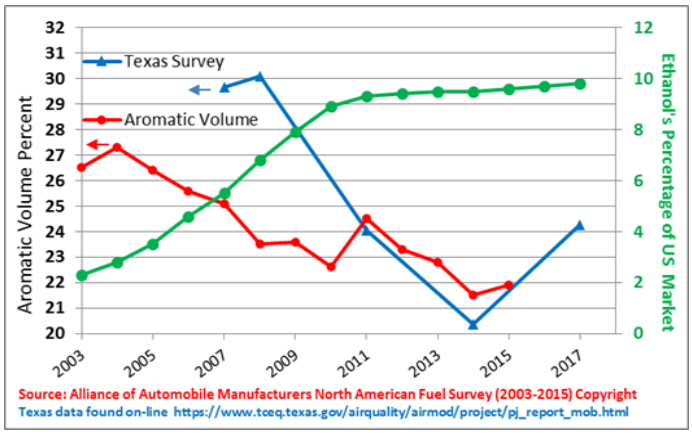
After learning about the clean octane benefits of ethanol, you may wonder why oil refineries still choose the toxic octane source of aromatics. A big reason is due to the fact that aromatics are considered the highest octane value for any given hydrocarbon produced at an oil refinery. And since aromatics are a product refiners own they prefer to use it over increasing levels of ethanol. On average, a gallon of gas contains 25% aromatics, which is any chemical built on a benzene structure.

Aromatics also have the highest emission rate per any hydrocarbon found in gasoline. In several studies that identify specific tailpipe emissions, aromatics can have three times the emission rate as compared to ethanol. For example, in a fuel that contains 10% ethanol and 10% toluene which is the most common aromatic in gasoline, testing shows 3X's the amount of toluene coming out the tailpipe compared to ethanol. In addition, toluene, and aromatics in general have three times the ozone forming potential.



The problem doesn't stop there because aromatics are the building blocks for Polycyclic Aromatic Hydrocarbons (PAH's) which then create Ultra-Fine Particulates (UFP's). As the chart on your left illustrates, aromatics in our gasoline represents a huge contribution to vehicle emissions.

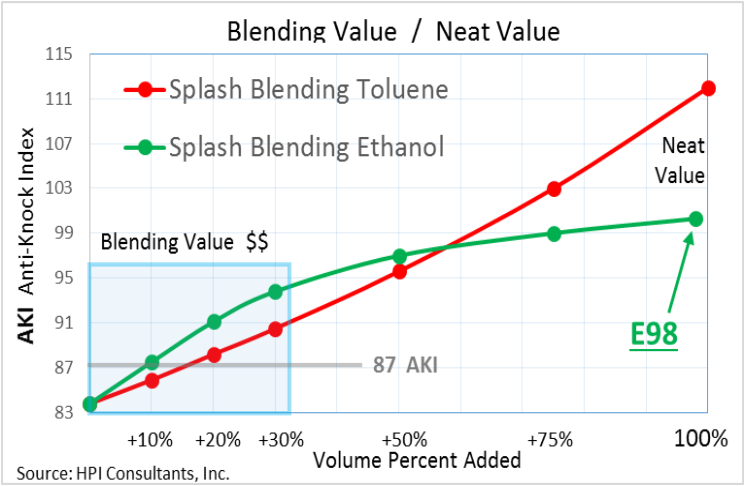


So why do aromatics make up 25% of gasoline today? It is estimated that roughly half of the aromatic content in gasoline comes straight out of the crude oil supply. The other half is produced at an oil refinery, to provide the necessary octane to meet the minimum octane demands of gasoline.

Fifteen years ago when ethanol entered the marketplace at 10%, aromatic content dropped (red and blue lines) while ethanol increased (green line). However when it comes to increasing ethanol above 10% for its octane value, oil refiners don't want to give up their market share.

So how effective is ethanol at displacing aromatics in our gasoline supply? To start, there is a big different between the octane value of toluene and ethanol on their own, which is known as the neat value compared to what happens in the real world when blended into gasoline. For instance, when testing 100% toluene, the octane value will equal about 112AKI. And for pure ethanol, the octane value is about

100 AKI. While toluene is slightly higher on its own, the true octane benefit of ethanol comes into play when it is blended with gasoline. The reason for this octane difference between neat value and real world is due to an antiquated testing method used in laboratories.



Since it is very unlikely we won't see vehicles running on 100 toluene or ethanol anytime soon, we should focus on real world fuels. In the figure to the right, you can see that if you add 30% ethanol to E0 gasoline, you have a higher octane than if you add 30% toluene to the same fuel. Note that toluene needs to increase nearly 20 percent to meet the same increase in octane compared to just 10% ethanol. This has been a key economic driver for the E10 market since there was nothing in the oil refineries production that could beat ethanol's octane based on volume.

So in the end, we believe that ethanol's clean octane value will drive change. Since aromatics are more costly and energy intensive to produce and also have higher tailpipe emissions, ethanol will become the solution when it comes to meeting demand for higher octane.