ETHANOL AND OCTANE

American Coalition for Ethanol
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Octane

- History and Level of Octane
- Who regulates octane?
- Vehicle Octane Needs
- Ethanol and Octane
- EPA’s New Certification Fuels
- Future Fuels and Octane
Octane Rating

• First measurements of “engine knock” date back to 1910s.
• Octane rating, pump octane, Automotive Fuel Rating.
• U.S.: Antiknock Index: \( \text{AKI} = \frac{(R+M)}{2} \)
  - Mathematical average of Research Octane Number (RON) and Motor Octane Number (MON)
• E.U.: reports RON
Who Regulates Octane?

• Not Federal Trade Commission (FTC): FTC regulations describe how octane is measured and communicated to consumers.

• Not EPA or any other Federal agency.
  • EPA has developed a petition process for auto manufacturers to request a new fuel for vehicle certification. 40CFR1065.701(c)

• No octane requirement in ASTM gasoline specification.
  • D4814 does not have an octane requirement.
  • It’s predecessor, D439, did have an octane requirement.

• Some state regulations have a minimum requirement.
  • Only 19 of the 50 United States include an octane requirement in their regulations.

So, really it’s up to the states to ensure a proper level of octane is offered to consumers.
FTC Regulations and Labeling

Gasoline

- §306.10
- Gasoline’s automotive fuel rating is octane.
- Must post octane rating.
- Provides lab methods for measuring octane.
- Posted octane considered a minimum.

Ethanol Flex Fuels

- §306.12
- Ethanol’s automotive fuel rating is the ethanol %.
- May post AKI if “competent and reliable” criteria can be met.
- May post exact ethanol %, or
- May post ethanol % rounded to the nearest 10, or
- Post range 51-83%.
State Regulations and Octane

- States can adopt model regulations or specifications into law. (Example NIST Handbook 130)
- Adopt original language for grade terms and minimum octane levels.
- States with no octane requirement: Alaska, Colorado, Delaware, Hawaii, Idaho, Indiana, Kansas, Massachusetts, Mississippi...

<table>
<thead>
<tr>
<th>Term</th>
<th>Minimum Antiknock Index</th>
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<tbody>
<tr>
<td></td>
<td>ASTM D4814 Altitude Reduction Areas IV and V</td>
</tr>
<tr>
<td>Premium, Super, Supreme, High Test</td>
<td>90</td>
</tr>
<tr>
<td>Midgrade, Plus</td>
<td>87</td>
</tr>
<tr>
<td>Regular Leaded</td>
<td>86</td>
</tr>
<tr>
<td>Regular, Unleaded (alone)</td>
<td>85</td>
</tr>
<tr>
<td>Economy</td>
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</tbody>
</table>

(Table 1. Amended 1997)
Altitude and Octane

- Controversy over oil industry’s legacy offering of low octane fuels in high altitude areas.
- Pre-1984 vehicles (carbureted, vehicles without a knock sensor) could operate on suboctane like 85, 86; today’s vehicles are designed to operate on the same octane at all altitudes.
- ASTM International D02 Petroleum Products, Liquid Fuels and Lubricants voting on an octane minimum for D4814 gasoline specification.
  - Oil industry representatives joining ASTM by the dozens and all opposing this effort.

| TABLE 2 Detailed Requirements for all other than Volatility Classes$^{A,B}$ |
|------------------|------------------|------------------|
| Property         | Limit            | ASTM Test Method |
| Antiknock Index, min | 87.0             | D2699, D2700 or D2885 |
Oh the hypocrisy…

• Nearly every vehicle manufactured since 1984 requires a minimum of 87 octane—this is stated in the Vehicle Owner’s Manual.

• Oil refiners continue to offer 85, 86 octane in the mountain regions—voiding the warranty of every vehicle that fills up on this low octane fuel!
Many oil refiners have lowered the target octane of gasoline leaving the refinery to take advantage of subsequent blending of ethanol downstream from the refinery. We estimate that approximately 80-85% of all gasoline leaving the oil refineries in the United States is around 83-84 octane (AKI).

Most recent analysis indicates that ethanol can add upwards of 5 octane points, when the olefin content of gasoline is around 10% or less.
Comparing Octane Improvers

Octane Choices:
- Tetra ethyl lead has serious negative health effects.
- MMT has negative effects on vehicle emission systems.
- MTBE contaminated ground water supplies.
- Alkylate contains aromatics like benzene (carcinogen) and is expensive.

Comparing Ethanol:
- Ethanol has well-known, understood health effects.
- Ethanol does not negatively impact vehicle emission systems.
- Ethanol does not pollute ground water supplies, readily biodegradable.
- Ethanol does not contain benzene and is more economical.
DOE’s Co-Optima Research Program

- Focus on sustainable transportation.
- Multi office, Multi lab, Multi year Initiative.
- Approach: Co-optimize fuels and engines.
- Fuel market introduction by 2025.
Ethanol’s Future Fuel

Today’s Fuel
• Primarily fossil (hydrocarbon) based.
• “Regular” minimum octane offering 85, 87 AKI.
• **Ethanol content: 0-10%**
• Thermal efficiency:
  Compression Ignition engine dominates Spark Ignition.
  • CI:~45%
  • SI:~30%

Tomorrow’s Fuel
• Renewable, clean burning based.
• Octane >95 AKI.
• **Ethanol content: 20-40%**
• Thermal efficiency: Parity!
  Spark Ignition achieves significant gain.
  • CI:~50%
  • SI:~50%
EPA and Octane Regulation

- In the Tier 3 rulemaking, EPA developed new regulations for auto manufacturers wanting a different certification fuel. 40CFR1065.701(c)
- An example of this is a high octane, higher ethanol fuel for dedicated vehicles... These requirements are difficult to achieve...
- Requirements for new fuel:
  - Show that your engines will only use the designated fuel.
  - Show that this type of fuel is commercially available.
  - Show that operating the engine on the EPA certification fuel is not appropriate.
Summary

• By in large, octane goes unregulated in the United States.
• Only some states are regulating octane by adopting language into state statute.
• FTC only regulates how octane is measured and communicated to consumers.
• EPA has approved a new pathway for auto manufacturers to petition for a new certification fuel. This process is arduous, requiring a ton of data for approval.
• Support industry research- we need facts to continue ethanol’s role as a motor fuel.
QUESTIONS?

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