Feasibility of Using an Ethanol/87 Gasoline Mixture in Place of High Octane Fuel in Automotive Internal Combustion Engines

Class Project for:
F SC 431
Dr. Randy Vander Wal
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By Dylan Humenik
Internal Combustion Engines

Compression

Gasoline Engine
• Air and fuel mixture compressed
• Spark plug ignites mixture
• Combustion of fuel pushes piston back down

Diesel Engine
• No spark plug
• Heat of compression alone ignites fuel

Engine Knock can Occur in Gasoline Engine
• Heat of compression ignites fuel before spark plug fires
• Quickly leads to engine damage
Octane Rating

Definition
• Fuel’s ability to resist engine knocking
• Compared to volumetric mixture of iso-octane and n-heptane

Measurement
• Done experimentally
• Rating Scales
  • Research Octane Number (RON)
  • Motor Octane Number (MON)
  • Anti-Knock Index (AKI) or (R+M)/2
• Pure iso-octane = 100; Pure n-heptane = 0

Example
• 87 gasoline from pump should have the same octane rating as 87% iso-octane and 13% heptane.
Ethanol

Properties

• RON of 108.6; MON of 89.7; AKI of 99.15
• Produced by sugar fermentation; sources:
  • Polysaccharidic: corn, sugarcane
  • Cellulosic: switchgrass, wood
• Used in alcoholic beverages
• Used as fuel in transportation industry

As a Fuel…

• Advantages
  • Renewable
  • Clean burning
• Disadvantages
  • Uses food/land supply
  • Less energy content

Ethanol

C₂H₅OH
## Is Ethanol a Viable Octane Enhancer?

### Analysis

**Using E85...**

93 octane = \( x \cdot 87 + y \cdot 95 \)

<table>
<thead>
<tr>
<th>Octane Rating (AKI)</th>
<th>87 Gasoline (gallons)</th>
<th>E85 (gallons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>93</td>
<td>3.75</td>
<td>11.25</td>
</tr>
<tr>
<td>91</td>
<td>7.5</td>
<td>7.5</td>
</tr>
<tr>
<td>89</td>
<td>11.25</td>
<td>3.75</td>
</tr>
</tbody>
</table>

*abbreviated version of slide. See [YouTube presentation](#) or [PowerPoint Format](#) for full version.*
Conclusion

Yes, technically ethanol can be used with standard gasoline to increase octane rating. However, other issues exist that must be considered, including:

- **Advantages**
  - Costs less than higher grade octane gasoline

- **Disadvantages**
  - Less power output
  - Rubber seals in engine break down with ethanol exposure over time
  - Increased engine wear, reduced engine lifespan
  - Ethanol absorbs water from the air over time – bad for engine

What will happen?

First few times, probably nothing. After that, engine lifespan will start to drop.

Is it worth it? No.