Differences in Gasoline and Ethanol Engines for Automobiles

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Outline

- How does an ICE work?
- Fuel comparison
- Gasoline
- Ethanol
- Flex-Fuel
- Future Designs
- My opinion on the use of biofuels...
Internal Combustion Engine

http://labman.phys.utk.edu/phys136/modules/m3/heatpump.htm
4 cylinder engine, inline configuration,
http://auto.howstuffworks.com/engine2.htm
Octane Number & Knocking

• Octane number measures how much compression a fuel can take before detonating.
• Higher compression engines generally have higher performance (87 vs. 89 or 91)
• Knocking, or engine knock, occurs when the fuel self-ignites before the piston is in the optimal position.
Gasoline vs. Ethanol

<table>
<thead>
<tr>
<th>Property</th>
<th>Gasoline</th>
<th>100% Ethanol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Density</td>
<td>35 MJ/L</td>
<td>24 MJ/L</td>
</tr>
<tr>
<td>Octane Number</td>
<td>87 - 91</td>
<td>~110</td>
</tr>
<tr>
<td>Heat of vaporization</td>
<td>349 kJ/kg</td>
<td>846 kJ/kg</td>
</tr>
</tbody>
</table>

Gasoline Engines

• Able to run on 10% Ethanol with no alteration
• Operates on an 8-10:1 compression ratio\(^1\)
• Better fuel economy than ethanol

\(^1\)http://www.howstuffworks.com/diesel1.htm
Ethanol Engines

- Extra cost is relatively insignificant; manufacturer generally absorbs cost
- Ethanol has higher octane number (~110) and higher heat of vaporization than gasoline
- Burns cooler in the engine
- Can operate on a 14.5-16:1 compression ratio²
- Ethanol may corrode inner workings of regular gasoline engines, so different metals and alloys can be used or additives can be added to ethanol to prevent corrosion

Flex-Fuel Engines

- Capable of utilizing any blend of gasoline and ethanol
- Slightly less efficient than gasoline engines
- Electronic sensors adjust fuel injection and spark timing automatically to fuel blend
- Brazil: engines initially contained small gas reservoir for cold weather starting; since 2009, new technology eliminated need for secondary tank
Future Engine Designs

EBDI (Ethanol Boosted Direct Injection) engine by Ricardo, Inc.

• Goal: to match the performance of a 6.6L turbo-diesel engine in power while bettering it in fuel efficiency
• Optimized for both ethanol and gasoline
• Proposed benefits: 17% gain in fuel economy, 1.5x the torque of a diesel engine, 300-400 lbs lighter

EBDI Prototype

- 3.2-liter V6 engine
- For use in heavy trucks to replace diesel engine
- Prototype released in 2009
- Still in progress?

The Biofuel Question

**Yes**, biofuels are worth investing in

- CO$_2$ outputs are generally much better with biofuels (considering life-cycle analysis)
- We can run biofuels on existing (and improving) technologies as other solutions such as fuel cells and batteries are developed
Questions?