Mid-Blend Ethanol Fuels – Implementation Perspectives

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Mercedes-Benz Research & Development North America

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CUSTOMER PERSPECTIVE

Mid-Blend Ethanol Fuels
Customers are told this….
But hear this…

According to colleagues at Porsche, this is not true…

Automaker Positions on E15 in Non Flex-Fuel Vehicles

DO NOT APPROVE
- BMW/Mini
- Chrysler
- Honda/Acura
- Hyundai
- Jaguar Land Rover
- Kia
- Mazda
- Mercedes-Benz
- Mitsubishi
- Nissan/Infiniti
- Subaru
- Toyota/Scion/Lexus
- Volkswagen/Audi
- Volvo

APPROVE IN NEWER MODELS
- Ford (model year 2013)
- General Motors (model year 2012 and newer)

APPROVE
- Porsche (model year 2001 and newer)
Is E85 making “cents” yet?  RIN $$$ changing that…

- E85 has 28% less energy than E0
- E85 delivers 25% fewer miles due to combustion differences
- Compared to E10, E85 delivers 21.5% fewer mpg than E10 but...
- E85 is really E74 (eia.gov basis) so it delivers \textbf{18.5\%} fewer mpg than E10

But will customers figure it out?

http://e85prices.com/
What Octane Should I Use?

Now I Have to Choose the Right Ethanol?
Octane is the Single Most Important Fuel Property

High Octane is the key enabler for higher torque, power and efficiency.
Octane + Mid Blend Ethanol (E20+) is a Powerful Fuel

- Ethanol is naturally very high octane 109 RON
- Ethanol has high cooling effect which provides additional benefits for higher “effective” octane – 4x greater than E0.
- E20+ added to various “base” blends of gasoline can provide > than 102 RON
E20 Optimization Can Minimize Customer FE Loss While Improving CO2
FVV Joint Project “Future Fuels for Gasoline DI-Engines”

Vehicle Data:
Ford Focus ST
Curb weight: 1392 kg
Transmission: 6-speed manual

Gasoline/Ethanol blend E20 with RON 102 is a good compromise between CO₂ benefit and fuel economy
Vehicles “Optimized” for Mid-Blend Ethanol and Octane Can Enjoy Both Power and Efficiency

• Ethanol + Octane benefit is further amplified in smaller, turbocharged engines over octane alone

• Vehicles with small 4 cylinder engines “dedicated” for high octane and ethanol blend levels can perform like are they V8-equipped, yet exhibit fuel economy of smaller engines.

• 2014 Mercedes-Benz AMG CLA 45
  • 2.0L 4 cylinder
  • 350+ HP
  • 98 RON required
  • 7 L/100 km Euro cycle
  • 33 mpg equivalent
Mid-Blend Ethanol Fuels

REGULATORY PERSPECTIVE
How the US Regulators See Ethanol:

Biofuels can play several different roles in the very complex market for motor fuels

- Ethanol competes, or could compete, in three distinct market segments, with very different economic characteristics:
  - Octane source
  - Volume extender
  - Energy content provider

- Ethanol is facing significant challenges in moving beyond its current roles as a source of both octane and volume
  - Blend wall
  - Availability of E85 and other high percentage blends
  - Challenging economics of pricing of E85 and other high percentage blends to be competitive on an energy content basis

Howard Gruenspecht
January 24, 2013
RFS2 is Driving Higher Ethanol Blend Fuels but….

- E10 is at a retail fuel “Blend Wall”
- E15 is the answer to the question nobody asked
- E85 has no market penetration
- GHG Rulemaking removes incentives for OEMs to produce FFV vehicles
Mid Blend Certification Fuel Addressed in Tier 3 Proposal

Which comes first – certification or market fuel?
"But first, a distraction."
Ethanol and Fuel Economy: What is the R-Factor?

“R factor is a value that describes change in fuel economy that accompanies a change in the volumetric heating value of the fuel being used.”

Note: the above are “gross heating values”

*Energy Information Administration

Table 6. Energy Content of Various Fuels *

<table>
<thead>
<tr>
<th></th>
<th>Btu per Gallon</th>
<th>Relative Percent Btu (gas 100%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gasoline</td>
<td>124,000</td>
<td>100%</td>
</tr>
<tr>
<td>Ethanol</td>
<td>83,333</td>
<td>67%</td>
</tr>
</tbody>
</table>

*“Net heating values” below are more representative.

Gasoline: 115,000 BTU/gallon (100%)
Ethanol: 76,000 BTU/gallon (66%)

The R factor is the proportion of the energy loss due to ethanol addition or aromatics reduction for which the EPA fuel economy equation compensates.

For example: E30 has ~10% less energy than E0 and 6% is recovered via R = 0.6 so OEMs suffer > 4% penalty in certification fuel economy for using E30.
R factor should = 1.0

“The current factor of 0.6 which is called out in CFR is clearly too low, and a proper factor for modern vehicles is closer to unity, as might be expected from improved air/fuel ratio control common for more modern vehicles.”

- R factor 0.6 vs 1.0: 4.7% penalty in certification fuel economy for using E30
  2.4% penalty in certification fuel economy for using E15
- Removing aromatics from base oxygenate blend and substituting ethanol as octane enhancer doubly penalizes automaker as long as R factor < 1.0


E20 FE vs energy density: 7.7% drop in fuel economy as compared to E0

So, How To Get Automakers and Producers Interested in Ethanol?
EPA Needs to Develop a Strategy to Encourage Automakers and Oil Producers to Produce of Mid-Blend Ethanol Fuels and Dedicated Vehicles.

- GHG/CO2 Burden Reduction incentive for automakers based on ethanol blend level at which vehicle is optimized

- Federal Fuel Tax rebate, RIN multiplier or other incentive to oil producers based on ethanol blend level
No Manufacturer Would Voluntarily Certify on Any Ethanol Fuels with R < 1.0

So, how well did E30 work out for you?
Mid-Blend Ethanol Fuels

MERCEDES-BENZ PERSPECTIVE
Proposal – Reallocation of Current Ethanol Pool into Tier III-Dedicated High Octane Fuel

Tier III Ethanol Pool Scenarios

<table>
<thead>
<tr>
<th>Regular</th>
<th>Mid-Grade</th>
<th>Premium</th>
<th>Tier III</th>
<th>Tier III Octane*</th>
</tr>
</thead>
<tbody>
<tr>
<td>E7</td>
<td>X</td>
<td>E10</td>
<td>E30</td>
<td>101 RON</td>
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<tr>
<td>E8</td>
<td>X</td>
<td>E10</td>
<td>E25</td>
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</tr>
<tr>
<td>E8.5</td>
<td>X</td>
<td>E10</td>
<td>E20</td>
<td>99 RON</td>
</tr>
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*based on 92 RON Premium BOB

Assumptions:
- Based on 2 tank retail system
- Mid-Grade eliminated
- Premium is blended from Tier III and Regular
- Tier III volume initially is equal to Mid-Grade volume eliminated
## Current Gasoline Blends and Consumption

### Current Fuel Pool*

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<tr>
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<th>Regular</th>
<th>Mid Grade</th>
<th>Premium</th>
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<tbody>
<tr>
<td></td>
<td>87 AKI – E10</td>
<td>89 AKI – E10</td>
<td>91 AKI – E10</td>
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</table>

*excluding 85-86 AKI, 93-94 AKI, E15 and Flex-Fuels

### Current Blend Consumption Mix*

|          | 86%             | 6%               | 8%              |

*based on [www.eia.gov](http://www.eia.gov) 2011 annualized sales volumes and blend consumptions
Proposal – Reallocation of Current Ethanol Pool into Tier III-Dedicated High Octane Fuel

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Additional gasoline in each gallon of E8 regular + Tier III gasoline volume for E25 blend recovers 6% gasoline volume previously occupied by Mid-Grade fuel.
Daimler Supports Mid-Blend Ethanol Fuels with Increased Octane

**Gasoline fuels**

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<tr>
<td><strong>Main Grade</strong></td>
<td>E10 (from 2010 applicable for all new models)</td>
<td>E20-E25 with octane increase</td>
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<tr>
<td><strong>Protection Grade</strong></td>
<td>E10 in US/E5 in EU (EU needed until at least 2016)</td>
<td>E10</td>
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It’s almost 2014…what if Mid-Blend Ethanol Fuels Need More Time to Market?
Proposal: Super-Premium E10 as Interim Step to “Tier 3” Fuel

• Fuel can be used by all vehicles immediately

• Replaces current premium grade with 96AKI E10 fuel

• Provides future “protection grade” for vehicles dedicated to high octane, mid-blend ethanol “Tier 3” fuel as fuel penetration ramps up

• Can be implemented more quickly and as interim step to mid-blend ethanol Tier 3 fuels.

• Gets customers used to the reality of a new fuel introduction with the concept with which they already are familiar – OCTANE.
What We Get:

• EPA Provides early GHG Burden Reduction or CAFE Credits based on CO2 Reduction as compared to 91 AKI Certification Fuel

• Higher Octane market fuel to assess field performance of Tier 3 hardware prior to mid-blend ethanol introduction

What Petroleum Producers Get:

• “Improved” fuel for which there is a current market at potentially higher margin
• Experience with base fuel to which higher ethanol amounts may be blended in the future

What EPA Gets:

• Early implementation of Tier 3 vehicles for quicker GHG and criteria emission reduction.