Seizing the Opportunity for Methanol in Heavy-Duty Vehicles

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EPA’s Methanol Advocacy in the late 80’s

- **1985:** EPA (Charles Gray) published “Moving America to Methanol”
- **1989:** EPA (Gray) published “The Case for Methanol” in Scientific American.
- **1989-1990:** EPA position advocated for methanol blends to reduce air toxics and smog.
- **Late 1980’s-early 1990’s:** auto industry (Ford) leads the way for adoption of flex-fuel vehicles
  - EPA continues to develop the “counterpoint” to flex-fuel: the dedicated-fuel methanol engine, in cooperation with FEV engine technology (Pischinger), industry partners.
  - Several technical papers published on methanol use.
Early 1990’s: Methanol hit a wall in passenger vehicle fuel market
- Oil prices drop after the first Persian Gulf conflict - Undercutting investment in alternative fuels
- Reformulated gasoline obviated the environmental need for methanol
- Late 1990’s: volume of methanol production declines - Support by oil majors lacking, sales of FFV’s rise, dedicated fuel vehicles disappear

By 2000: EPA dedicated fuel engine technology attracted little interest
- No supporting policy initiatives
- No partnerships: auto industry favored FFV’s (heavy-duty engines not in the picture)
- No momentum: EPA methanol technology development program decelerated

By 2005: EPA shifted focus to high-efficiency, clean heavy-duty engines
- 2007: EPA published work on heavy-duty methanol engines
- 2008: EPA met with Shanxi Province to cooperate on methanol engine technology
- 2012: EPA demonstrates diesel/methanol dual-fuel UPS delivery truck
Looking Ahead: New Opportunities and Challenges for Methanol

- **An immense, unique opportunity for methanol**
  - An emerging “Golden Age” for alternative fuels
  - Availability of cheap domestic feedstocks (shale gas)
  - Diminished threat of a steep drop in oil price – stable investment outlook for alternative fuels market
  - Growing consumer demand for alternative fuel vehicles in light- and heavy-duty (CNG/LNG, EV’s, alcohols)

- **But...there is a challenging road ahead for methanol**
  - Competition in alternative fuel market (huge market, but many players)
    - Ethanol, methanol, CNG, LNG, Electricity, Propane, DME, Hydrogen, etc.
    - Renewables vs. alternatives
  - Competition in natural gas market (both feedstock availability and end use)
    - Stationary power, export market
    - Methanol engines not available yet to compete against CNG/LNG in transportation
  - Climate change, environmental concerns (investment risks)
  - **Technology competition** (diluted engineering resources)
    - Many options for using methanol, many competing approaches
    - Need for greater coordination
Opportunity for Heavy-Duty Methanol Engines

- **Fuel Price advantage in North America**
  - Shale gas market remains strong
  - Increasing global competition for diesel fuel, particularly with Asia
    - New refinery capacity for middle distillate lagging behind demand
    - Portends tighter supply, greater price volatility

- **Growing market for alternative fuels in Heavy-Duty trucks**
  - DOE/EIA projects around 15% annual growth in NG consumption by HD trucks out to 2040
  - But...an affordable, widely available alt-fuel solution for Class 8 trucks is still needed
  - “The Solution” must displace significant amounts of diesel fuel, have reasonable onboard storage requirements, and address tailpipe emissions
  - **Methanol can be “The Solution”**

- **Few barriers to technology introduction**
  - Modest vehicle add-on cost
  - No “miracles” needed for commercialization
  - Refueling infrastructure barriers can be overcome: captive fleets, refueling corridors
Near-Term Technology for Heavy-Duty: Diesel/Methanol Dual Fuel Engines

- **Methanol-Diesel Dual Fuel Concept**
  - Burns neat methanol (M100) simultaneously with diesel fuel
  - Methanol consumption is controlled based on several vehicle use factors
  - Highest methanol use with heavy over-the-road trucks (~60%)
  - Ultra-low exhaust emissions (US 2010 or lower)

- **Proven Technology**
  - Similar technology used in CNG/LNG trucks for many years
  - Combustion technology developed in US universities and DOE national laboratories
  - Field trials of diesel/methanol dual fuel engines in China (~50% diesel substitution, Euro 4 emissions)
  - **EPA demonstrated dual fuel with low emissions in a Class 6 UPS truck**
Dual-Fuel Vehicle Demonstration

Initial Results of Field Tests
Class 6 UPS truck evaluation – Fall/Winter 2012/13

- Initial results (circled in red) of EPA’s proof-of-concept 4.8 liter dual-fuel engine installed in a class 6 UPS package car running on diesel and methanol (as alcohol fuel).
- Diesel substitution expected to increase with recent injection strategy improvements.

<table>
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<th>Test Date</th>
<th>Weight (lbs)</th>
<th>Route</th>
<th>Distance (miles)</th>
<th>Diesel (gal)</th>
<th>Methanol (DGE)</th>
<th>Subst. Ratio</th>
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- Demonstrated potential for up to 65% methanol/35% diesel for on-highway driving
- Next step would be a proof-of-concept demonstration of a 13-15 liter engine in a Class 8 over-the-road truck.
Concluding Remarks

- **Unique opportunities exist now**
  - Natural gas windfall created cost-effective sources for methanol
  - Heavy-duty engine technology exists: diesel/methanol dual-fuel
  - Multiple organizations with methanol and engine experience
  - Need to demonstrate high-impact, commercially-feasible technologies
  - Potential for successful environmental, energy and economic business cases

- **Coordinated technology and policy direction would help those working in this area**
  - Create a coalition to promote and showcase projects
  - Develop a common roadmap for light-duty & heavy-duty