Blending of CNG with Hydrogen

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Hythiane® Background

- Invented in 1989 by Frank Lynch and Roger Marmaro
- Studies and demonstrations through 1990s
- By 2003 extensive testing validated the “sweet spot” for heavy-duty Hythane® engines at 7% H₂ by energy (20% by volume)

Montreal 1995

California 2003
Hythane Summary

- 50% less NO\(_x\) with 7% H\(_2\) by energy
- Improvement from Euro II (CNG) to Euro IV (Hythane) emissions reduction demonstrated in 2005
- Inexpensive and available now
- Reasonable range compromise
- Reasonable infrastructure costs
- Creates distributed hydrogen infrastructure
- Hythane System includes everything needed for reliability, safety, and carbon credit documentation
Hydrogen Properties

- Wide flammability range, more than 6 times wider than methane.
- Low ignition energy, about 20 times less than methane.
- High flame speed, about 8 times faster than methane.
- Powerful reducing agent and combustion stimulant
Hydrogen Sources

- Electrolysis and other ‘exotic’ water splitting
- Biological digestion - methane, too
- Industrial waste streams
- Gasification and reforming
Blending Low-Pressure Gaseous Methane and Hydrogen

Simplified Hythane Fuel Supply

* Denotes additions to a standard CNG system
Blending Low-Pressure Gaseous Methane and Hydrogen

- As gases, hydrogen and methane are completely miscible
- Simple fluidic blending schemes provide the lowest-cost Hythane solution
- No additional moving parts added to conventional CNG compressor stations
- Only electronic devices are for supervision and quality control
Blending Low-Pressure Gaseous Methane and Hydrogen*
Blending Low-Pressure Gaseous Methane and Hydrogen

Hythane Company’s blender (50 cfm capacity)

Compressor (10 cfm capacity)

Colorado facility
Blending High-Pressure Gaseous Methane and Hydrogen

- Pumped LNG (LCNG)
- CNG or LNG, hydrogen, and Hythane all dispensed at one station
- Maintenance issues
- Quality control issues
Cryogenic Storage of Methane and Hydrogen Blends

- Homogeneous mixtures of liquid methane and hydrogen are not normally possible.
- Brehon has patented a method using NASA perfected cryogenic storage techniques for mixing and storing a mixture of LNG and hydrogen.
- Storage density is much higher than compressed gas mixtures, at much lower pressures.
Hythane System

- Natural Gas Supply and Equipment
- Hydrogen Supply with Contingency Plan
- Failure Modes and Effects Analysis
- Hythane Blending with Quality Control
- Wireless Vehicle-Dispenser Communications
- Data Logging Service for Fleet Managers (Carbon Credit Documentation)
- Resource Optimization Software
- Optimized Engine Controllers with CNG Fallback