The Argonne Catalytic Fuel Processor for Automotive and Small Fuel Cell Power Systems

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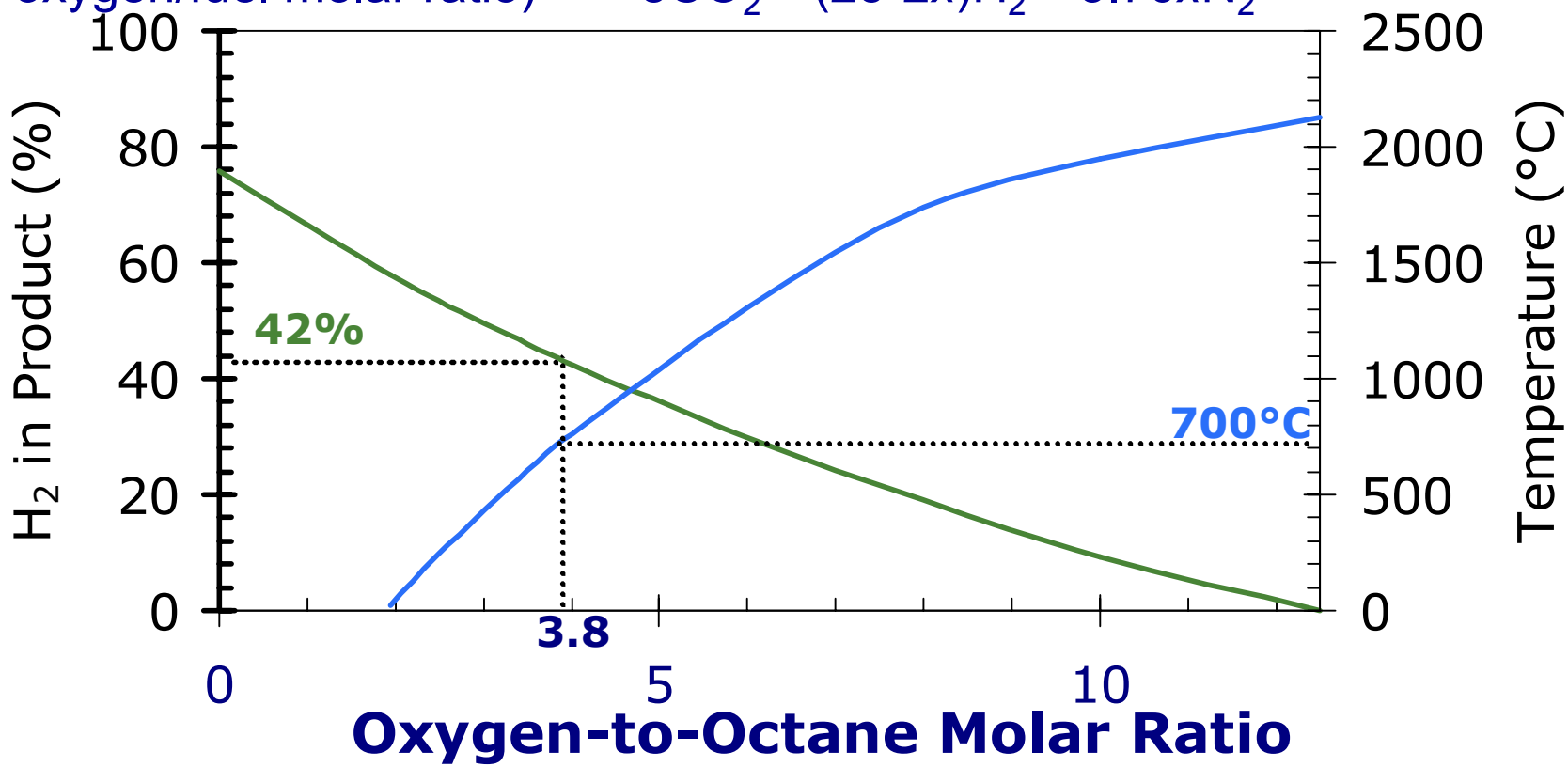
Objective

- Develop and demonstrate fuel processors
  - Fuel flexible and suitable for PEFCs
  - Can convert gasoline, methanol, ethanol, natural gas, diesel, etc.
  - For use onboard a light-duty vehicle
    - Compact, lightweight, capable of rapid start, dynamically responsive
  - For small, stationary power generation

Oxygen-to-Fuel Ratio Determines Hydrogen Yield, Reactor Temperature

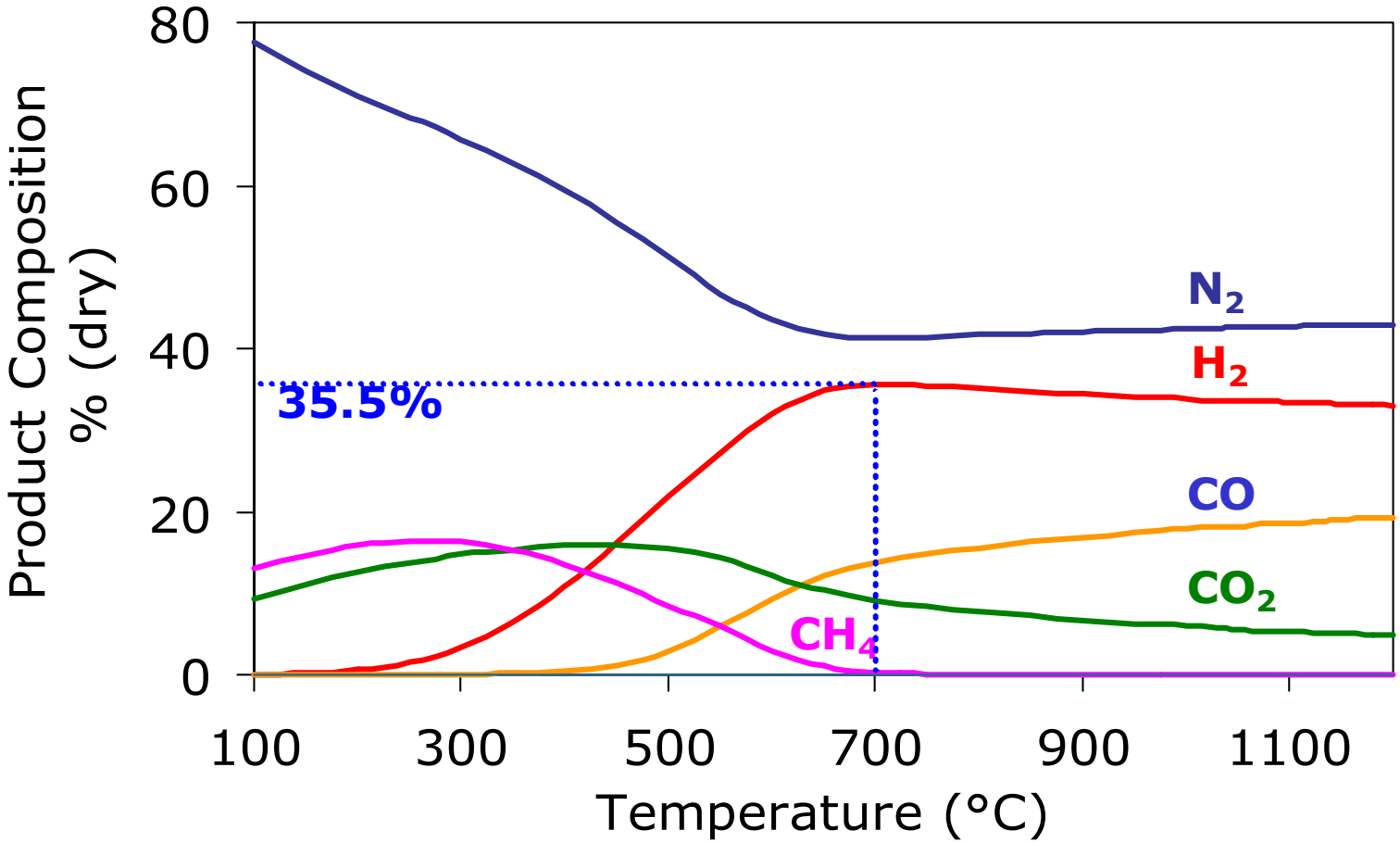
$C_8H_{18}(g) + x(O_2+3.76N_2) + (16-2x)H_2O(g)$

(x = oxygen/fuel molar ratio) $= 8CO_2 + (25-2x)H_2 + 3.76xN_2$

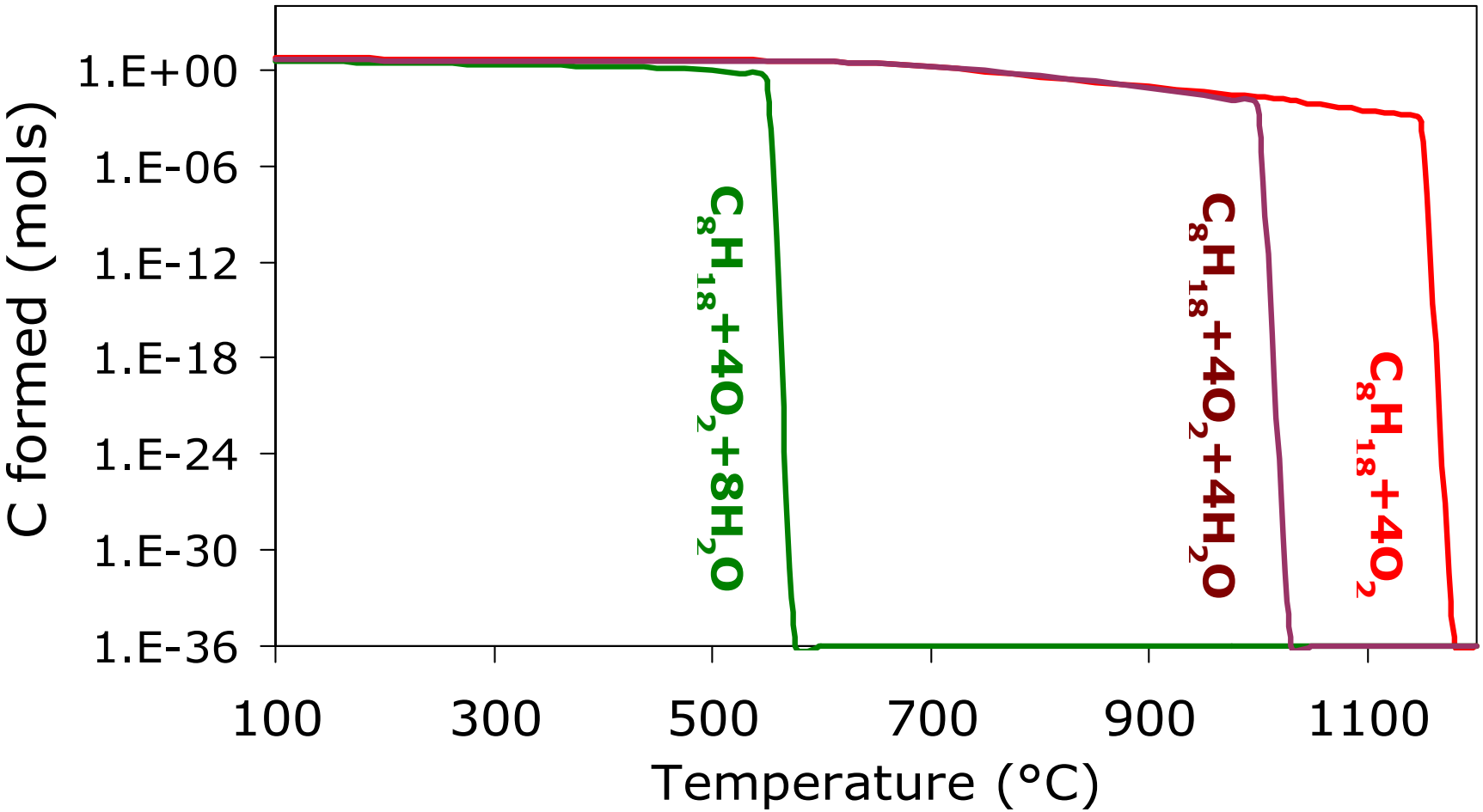


Hydrogen Concentration Peaks at ~700°C

$C_8H_{18} + 3.8(O_2 + 3.76N_2) + 8.4H_2O$ *equilibrium* →

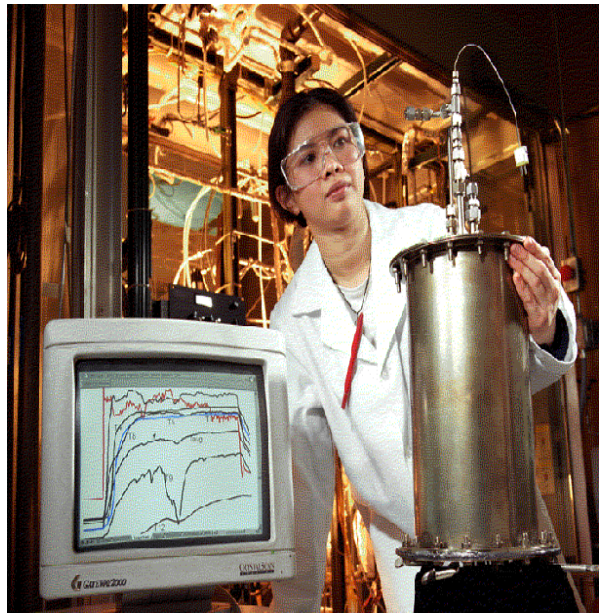


Autothermal Reforming Avoids Coke Formation at Lower Temperatures



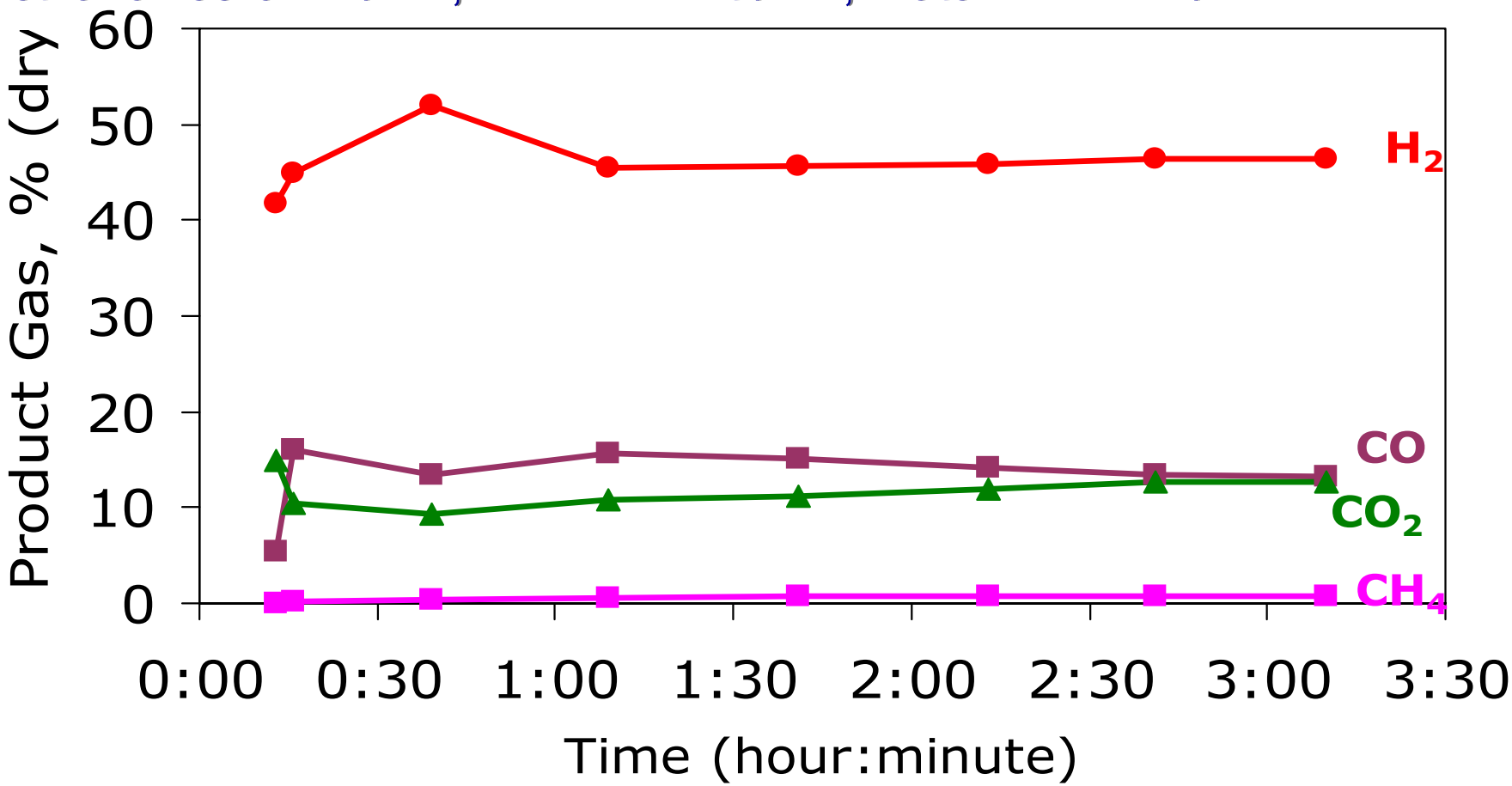
The Integrated Fuel Processor Designed for High-H2 & Low-CO

- Autothermal (ATR) Reformer
- H2S scrubber
- Shift reactor
- Volume = 7 Liter



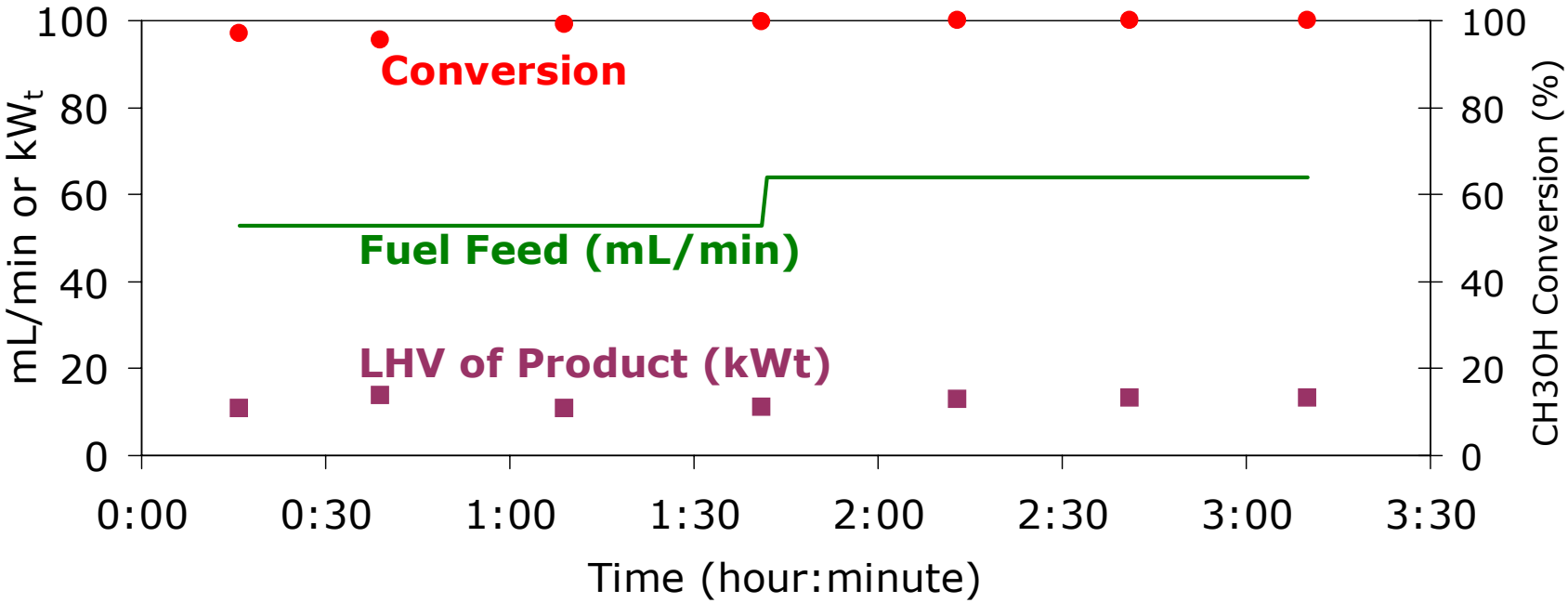
H2 Concentration from Methanol Auto-thermal Reforming Will Exceed 50%

Methanol=53-64 ml/min, Air=1.4-1.7 ft^3/min, Water=14-24 ml/min



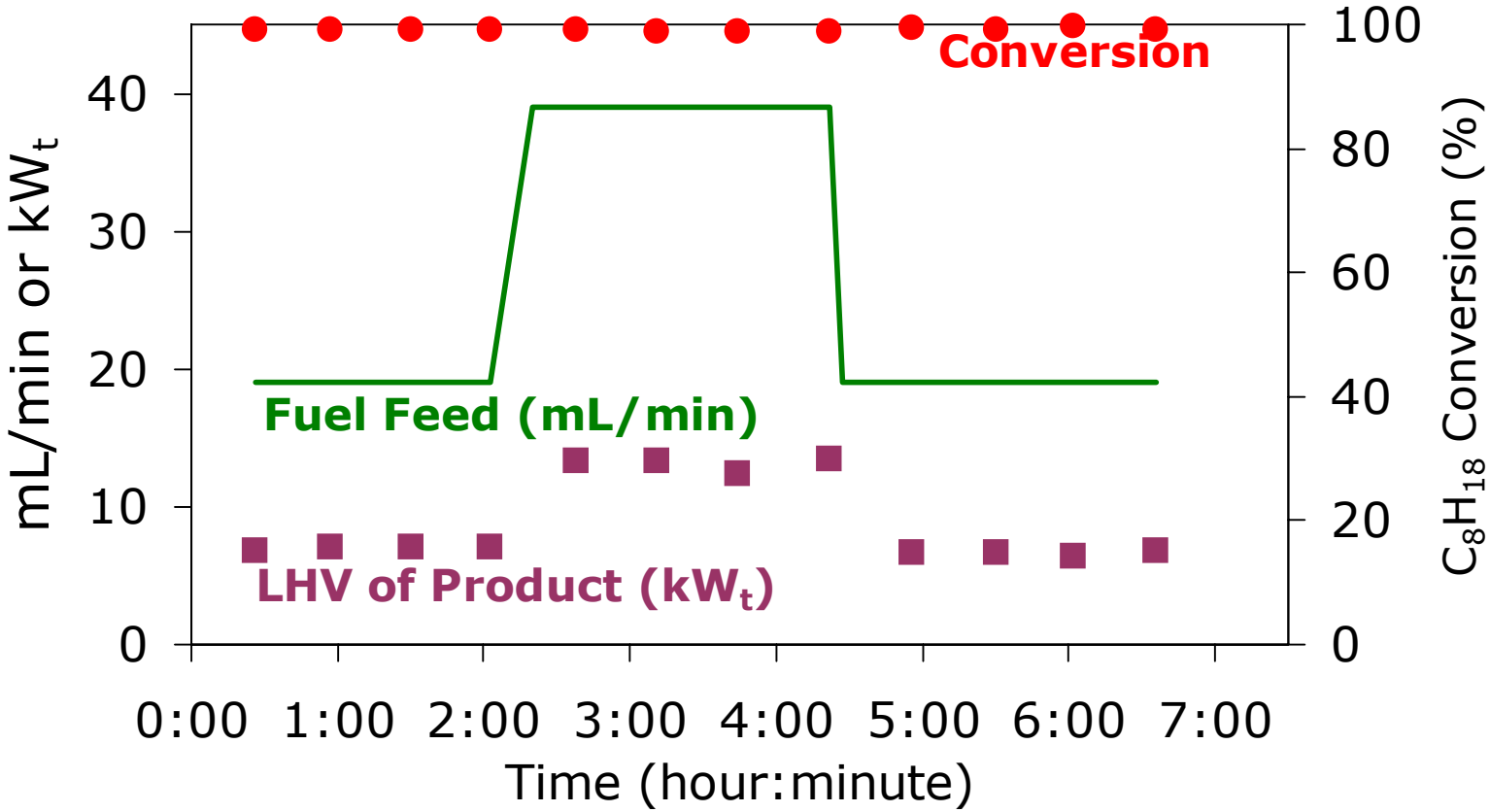
Complete Methanol Conversion Demonstrated up to 5.6 kW(e)

Methanol=53-64 ml/min, Air=1.4-1.7 ft3/min, Water=14-24 ml/min



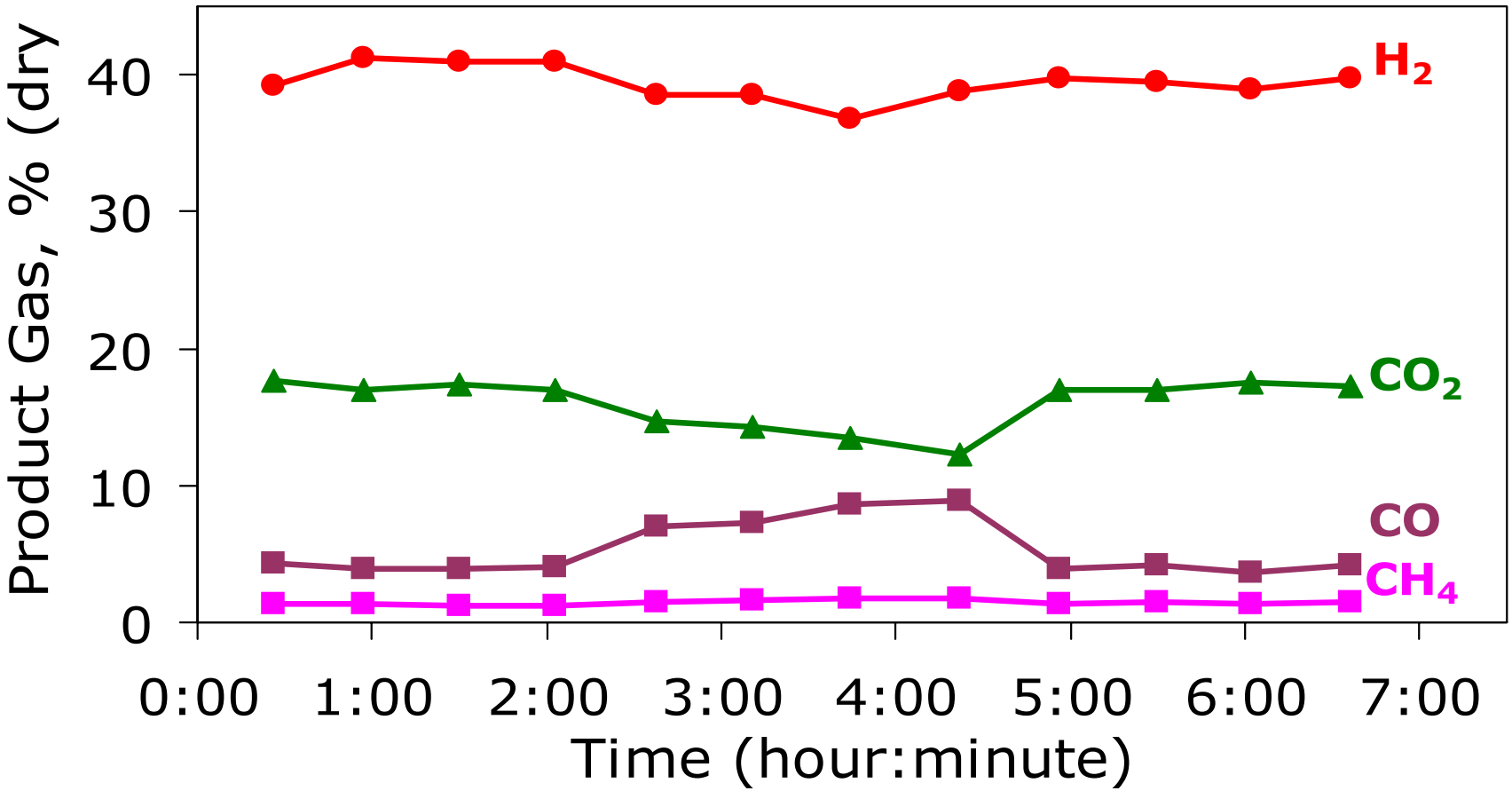
Iso-Octane Completely Converted up to 5.4 kWe

Iso-Octane=32-64 ml/min, Air=1.4-2.9 ft3/min, Water=29-61 ml/min

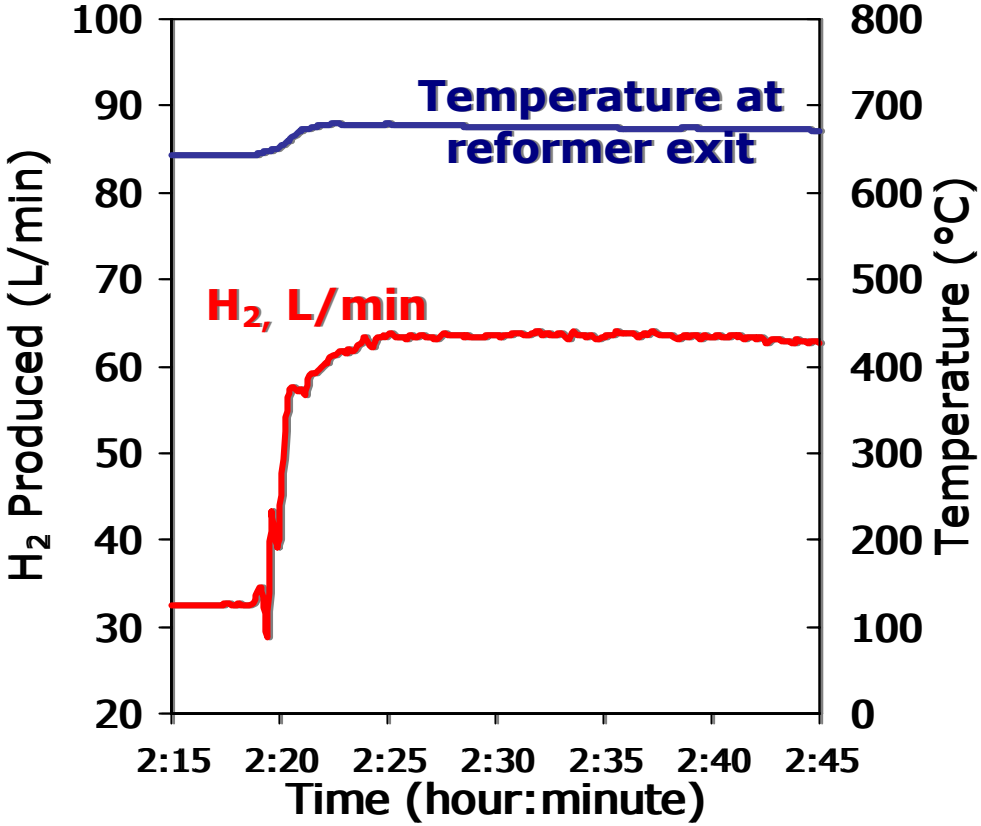


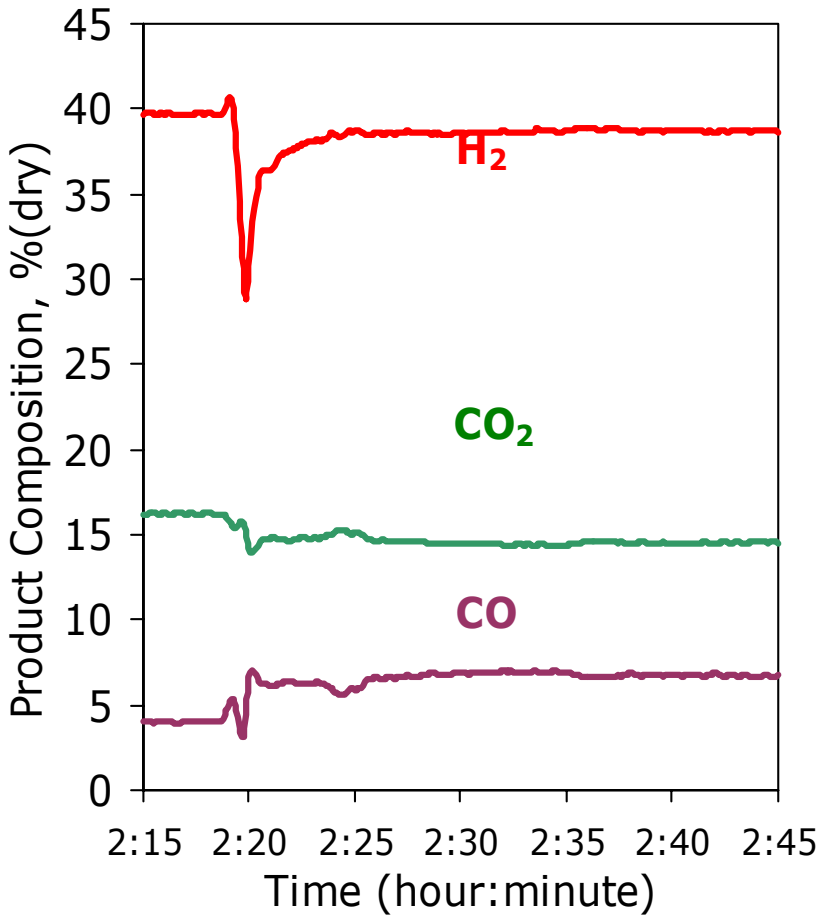
Product Contained 41% H_2; Will Increase after Complete Shift

Iso-Octane=32-64 ml/min, Air=1.4-2.9 ft3/min, Water=29-61 ml/min



Step Change in Feed Rates Indicates Quick Response; Will Improve with Optimization





Conclusions

- Autothermal reforming inhibits coke formation
- Argonne reforming catalyst is fuel flexible
- An integrated fuel processor design is being evaluated with gasoline, methanol, ...
  - with Argonne (reforming and shift) catalysts
  - 5 kW(e) demonstrated
- Structured catalysts being developed, expected to shrink reformer by order(s) of magnitude