Fueling the Future ™

Diesel Reformers for On-board Hydrogen Applications

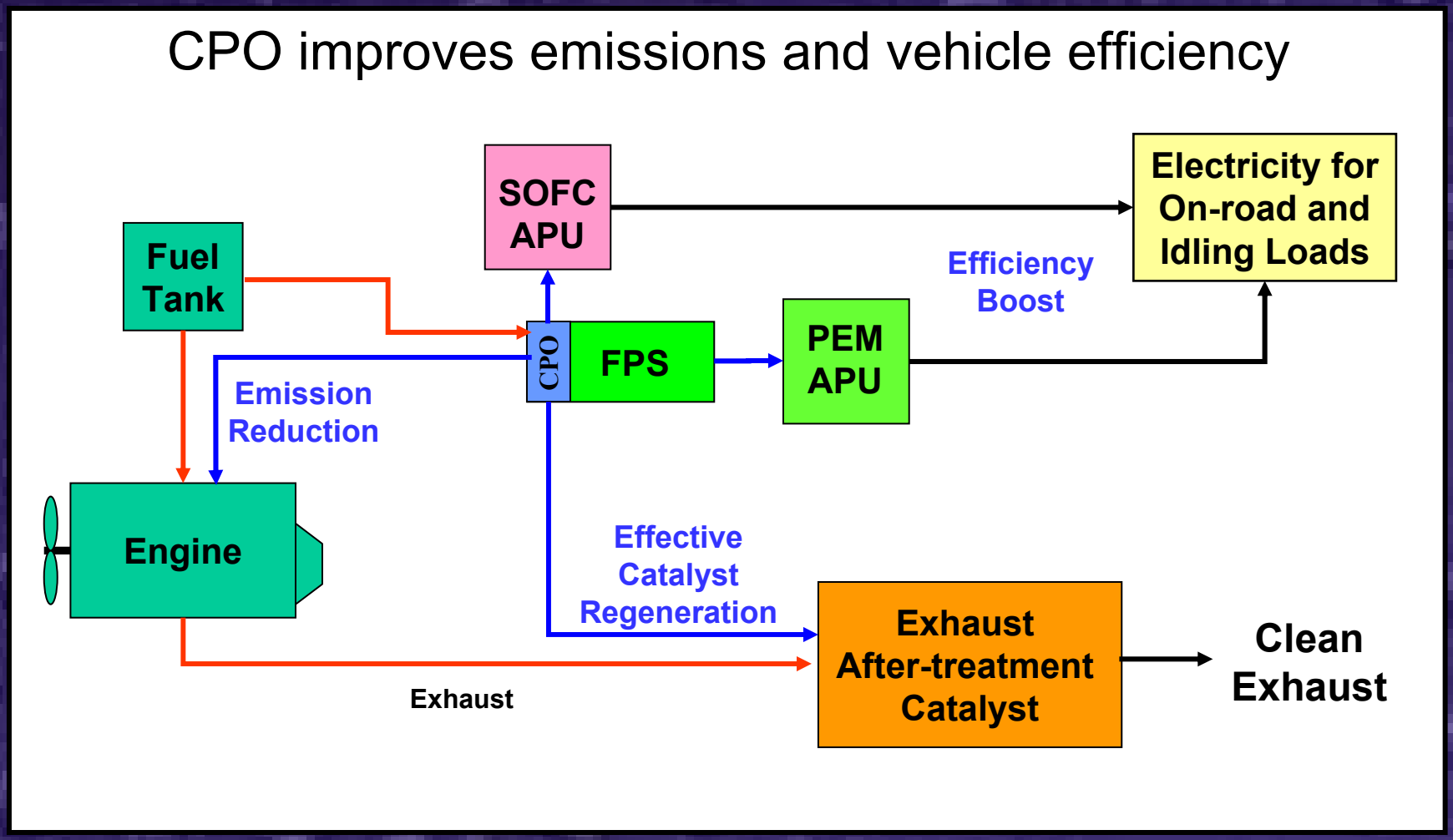
2003 DEER Conference
2003-08-28

HydrogenSource Background

Created in 2001

Develop, manufacture and sell
Fuel Processors

Reformers for On-board H_2 Applications



Initial Syngas LNT Regeneration Test

- **Test Objective**
  - Determine feasibility of using CPOx syngas for LNT regeneration
- **Demonstration Test Configuration**
  - Naphtha used for reformer fuel rather than diesel
  - Air used as oxidant rather than engine exhaust
  - Steady state engine & reformer operation
  - One leg of dual leg system
  - Fixed NOx trapping & regeneration cycles

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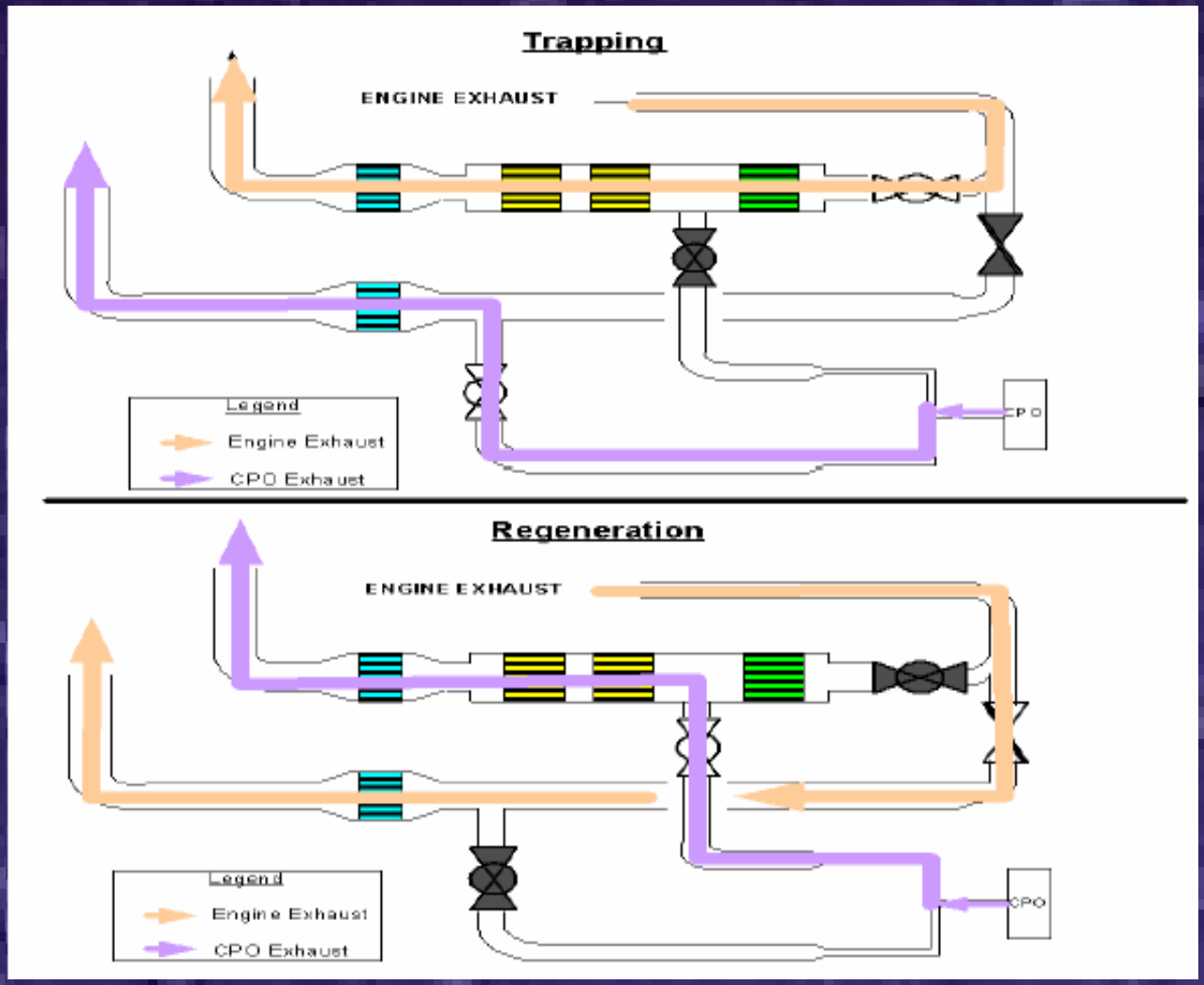
Initial Syngas LNT Regeneration Test

Test Configuration



- 5.9L engine
- 14L LNT
- Naphtha Syngas:
  - 33% H2
  - 18% CO
  - 6% CO2
  - 42% N2
  - <1% THC

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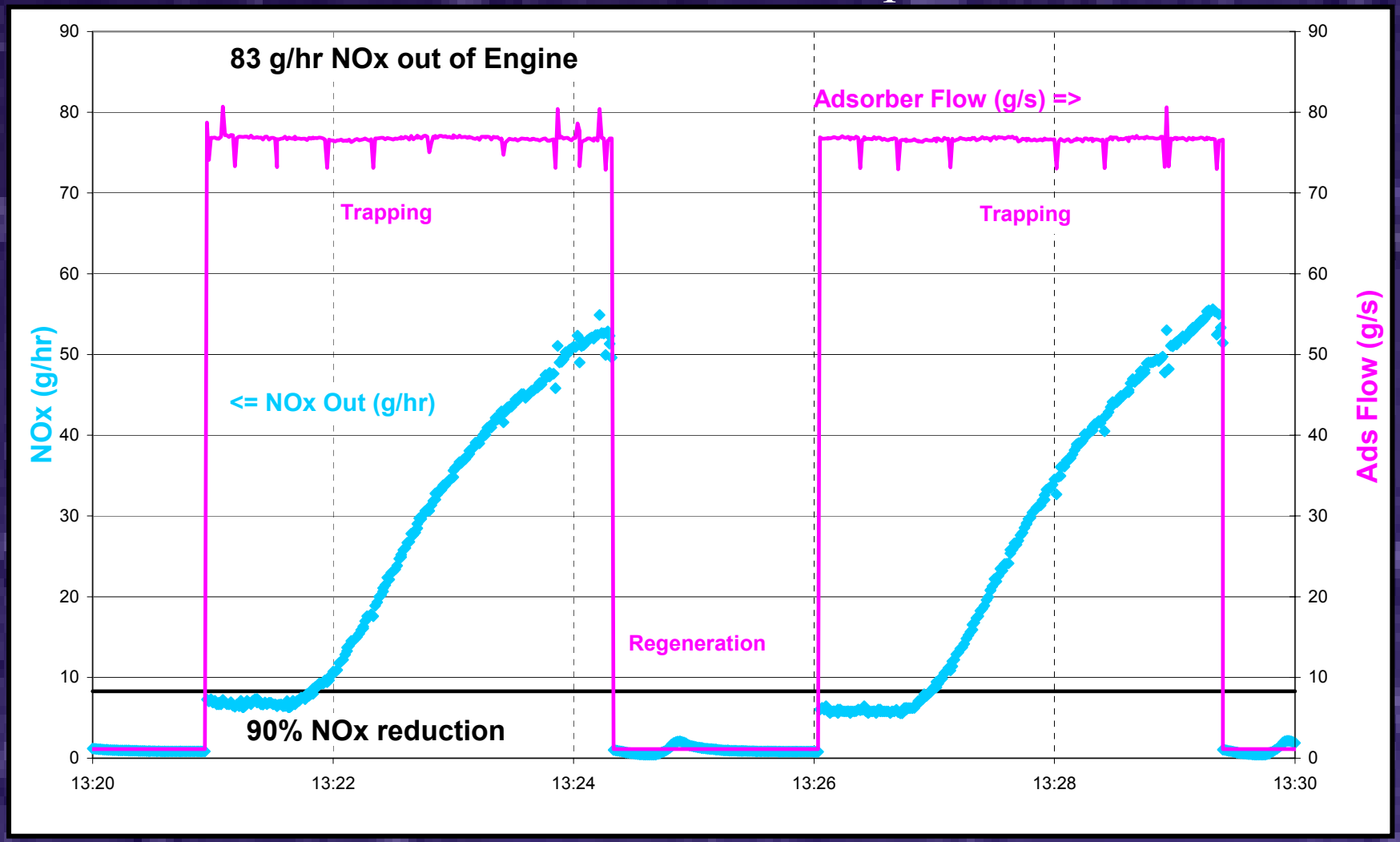
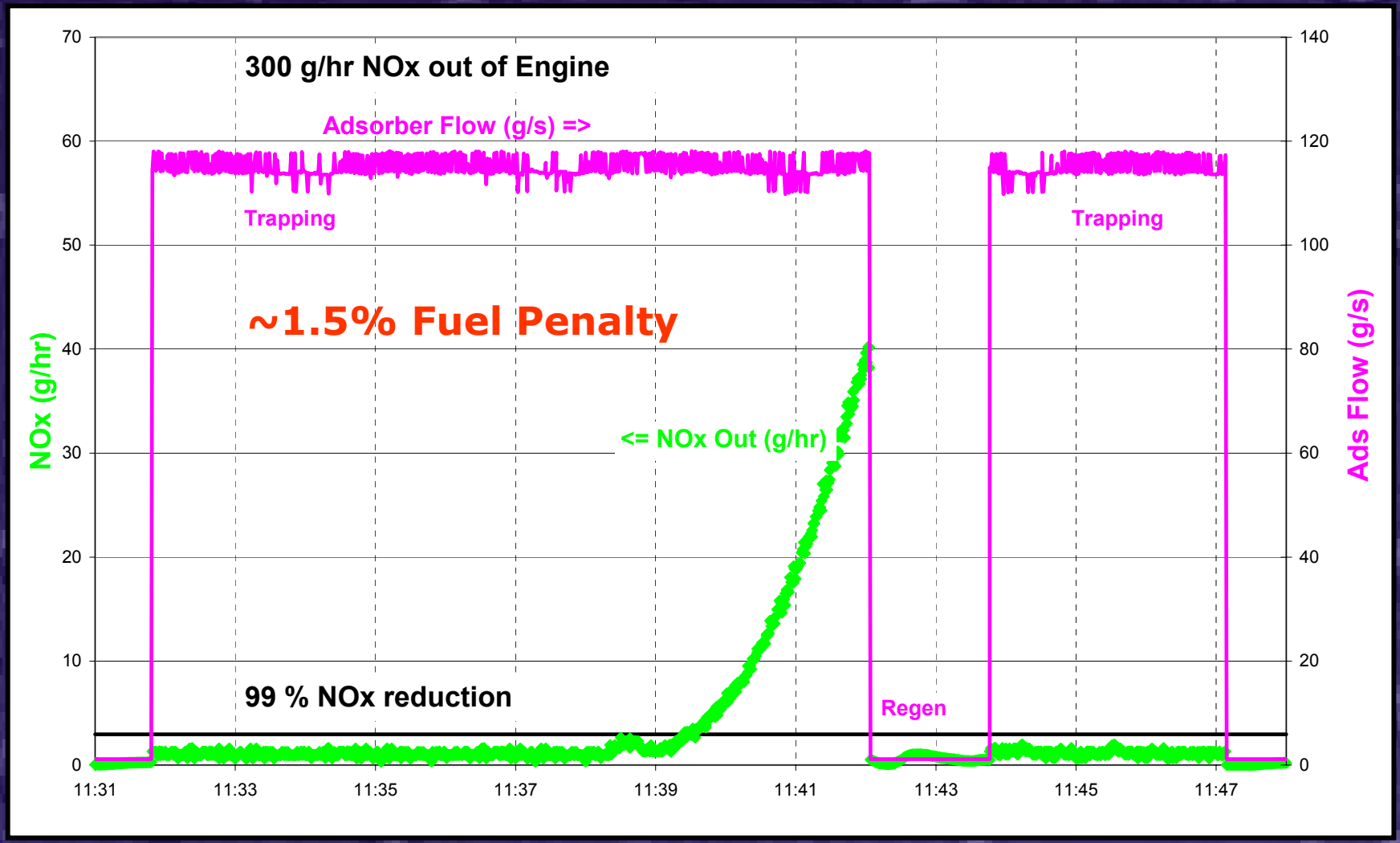
Syngas LNT Regeneration Test

90 % NOx Reduction at 150°C LNT Temperature



Syngas LNT Regeneration Test

99 % NOx Reduction at 300°C LNT Temperature



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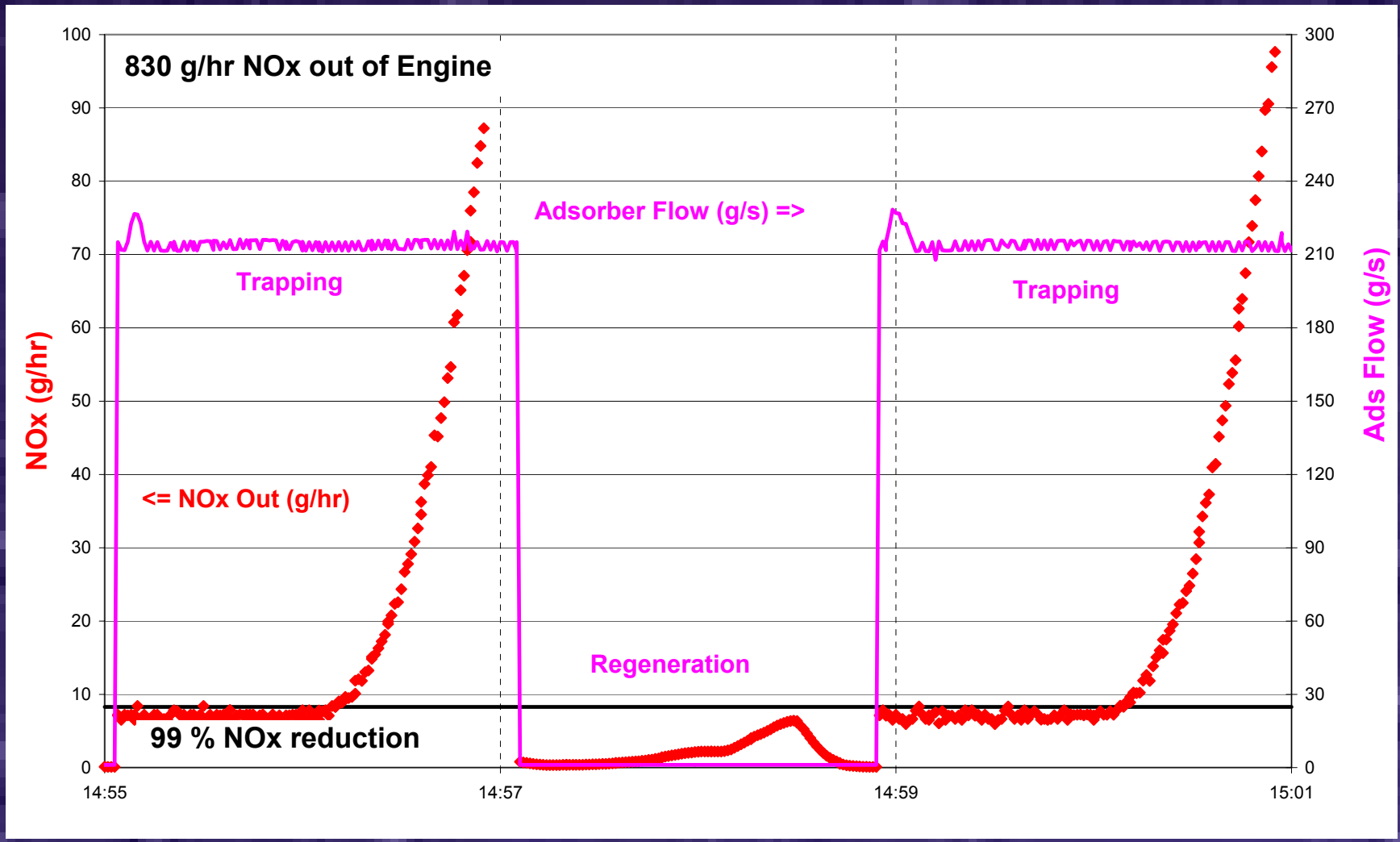
Syngas LNT Regeneration Test

99 % NOx Reduction at 450°C LNT Temperature



Challenges for CPOx Reformer

- **Durability**
  - Operation on engine exhaust
  - Thermal cycling for operating temperatures >800°C
  - Long-term durability

- **Total System Cost**
  - CPOx catalyst cost not expected to be an issue
  - Exhaust system configuration needs better definition to estimate CPOx cost (e.g. regeneration time & frequency, control implementation)

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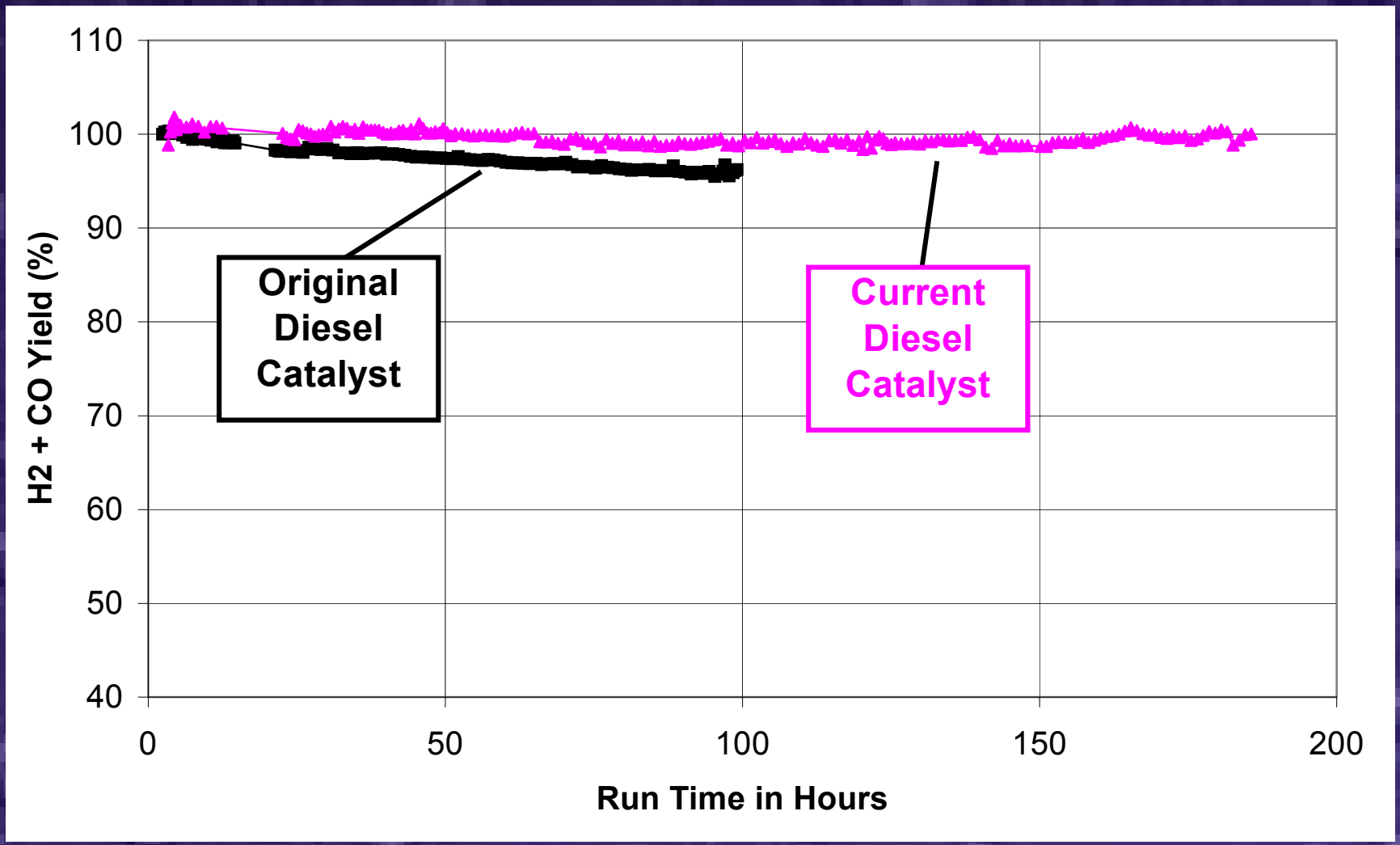
Stable Diesel CPOx Reforming

15ppm Sulfur Diesel Reformed using Air as Oxidant



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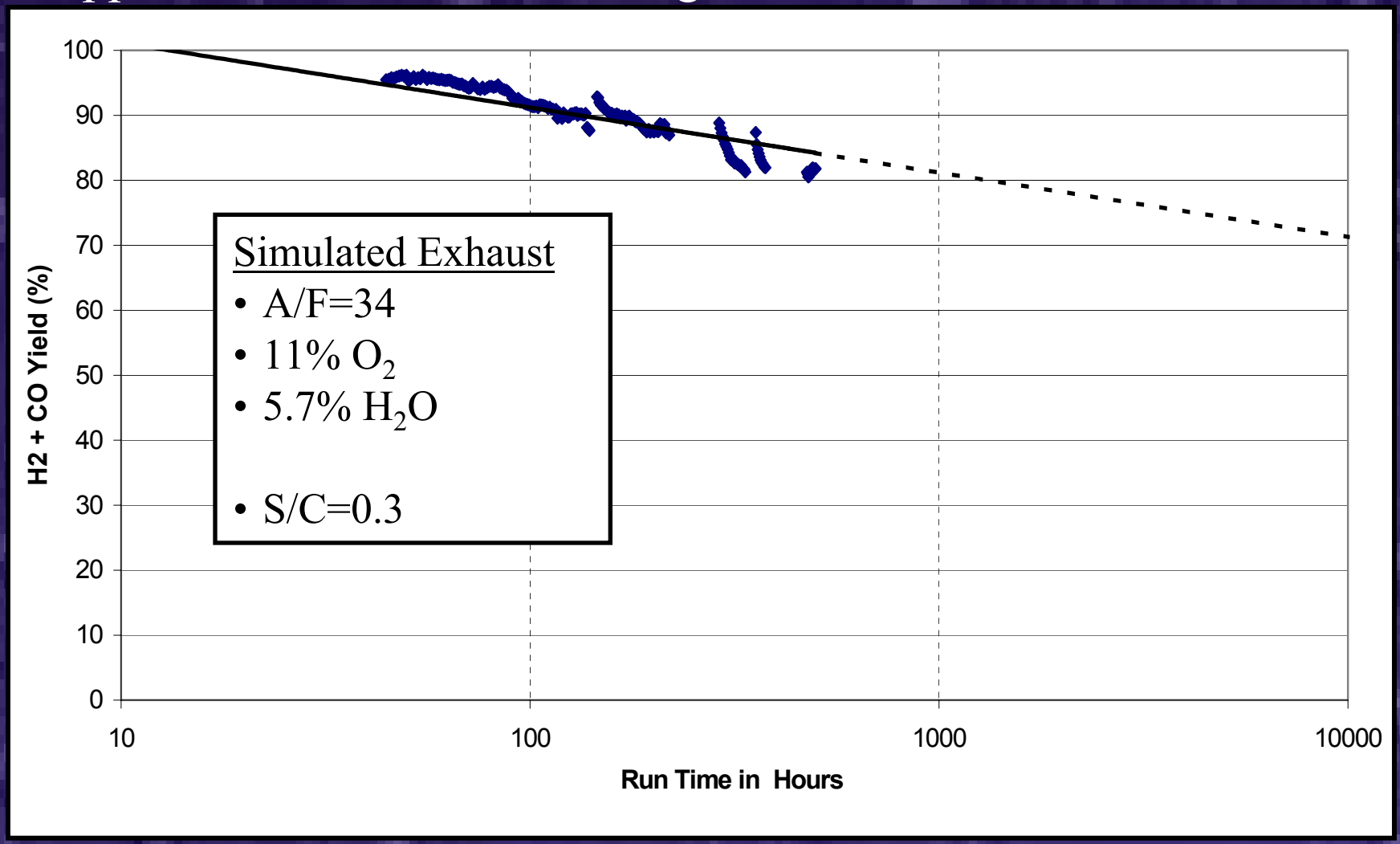
Stable Diesel CPOx Reforming

15ppm S Diesel Reformed using Simulated Exhaust as Oxidant



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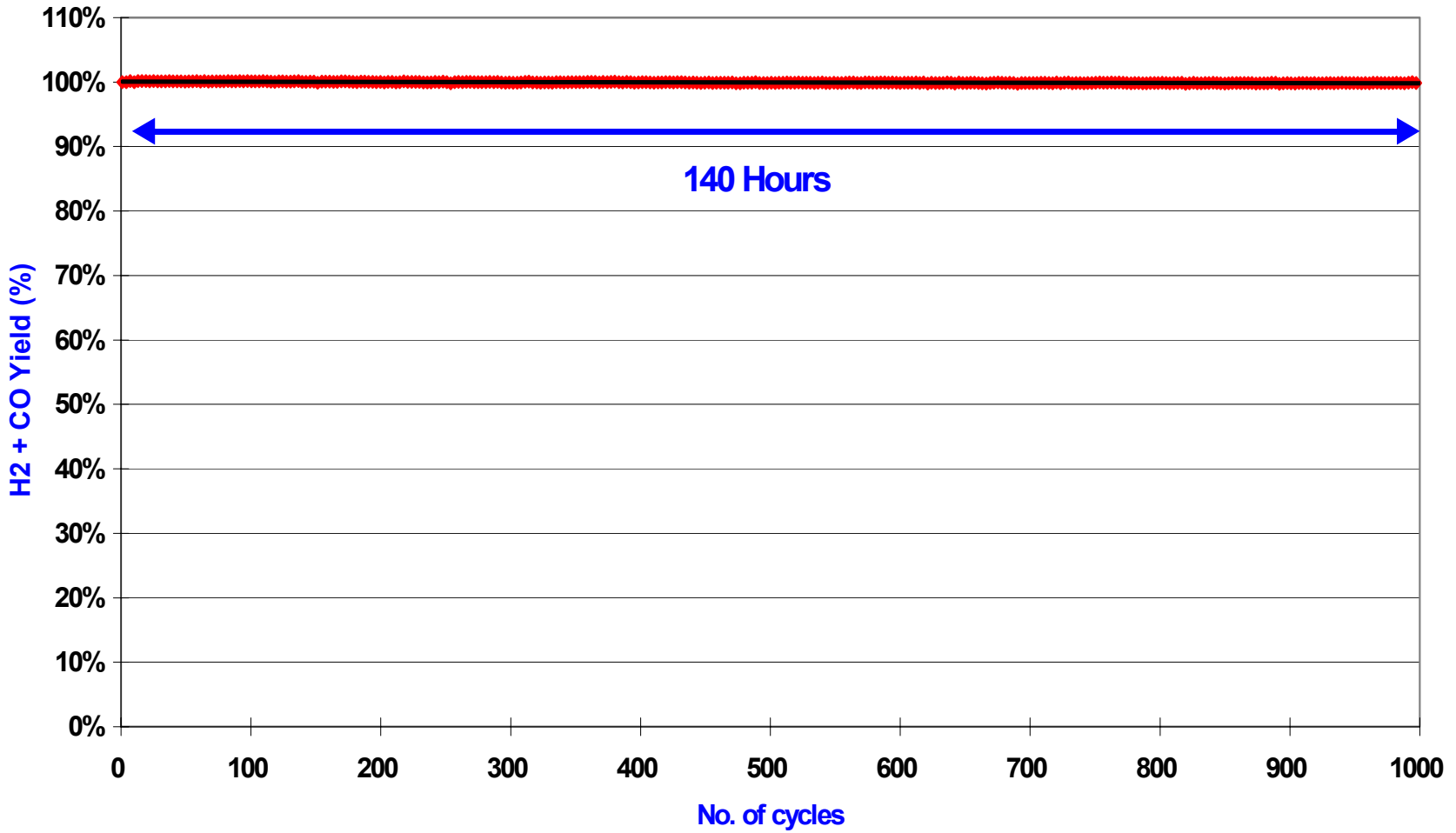
CPOx Thermal Cycling Data on Methane

800°C Thermal Shock Cycling



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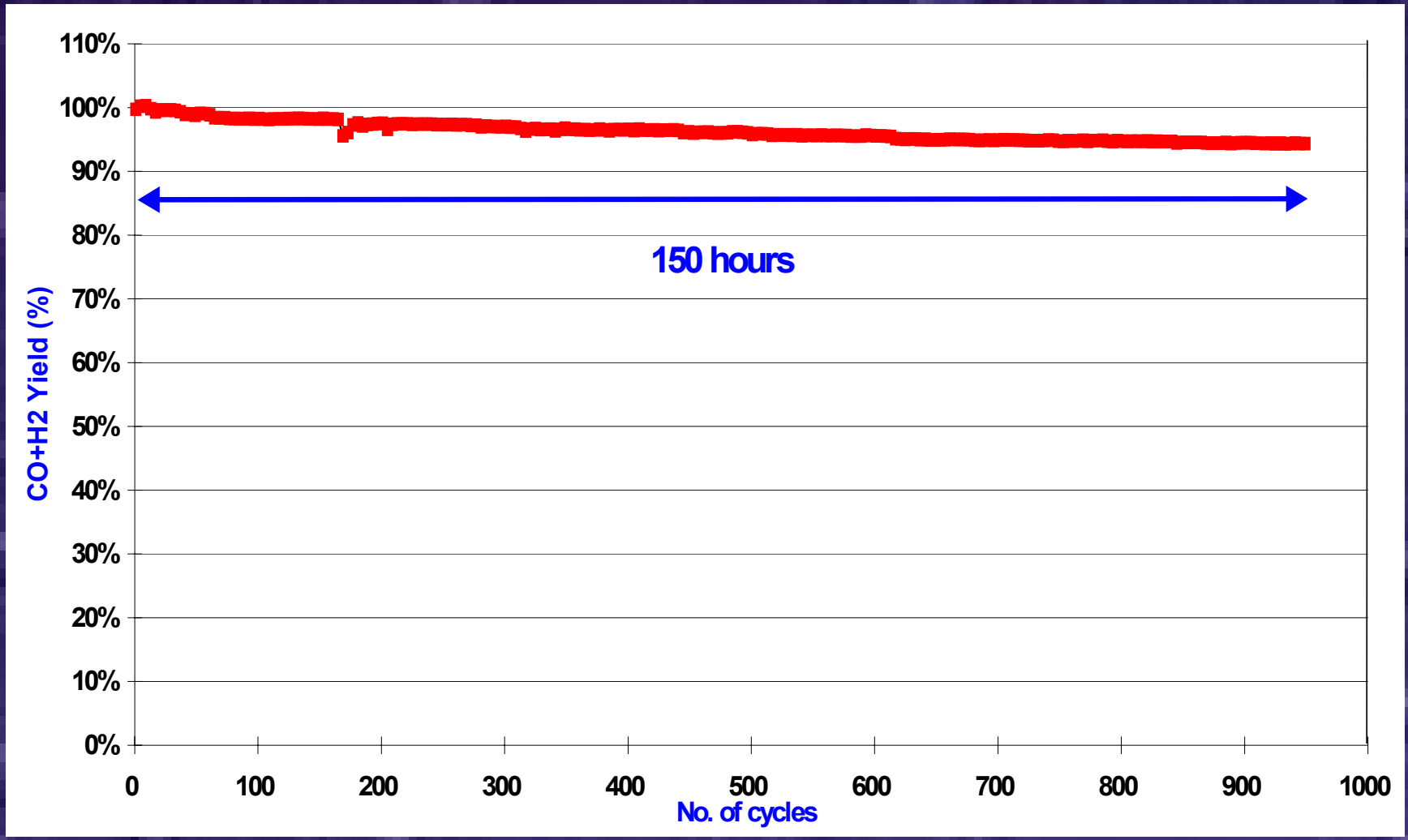
CPOx Thermal Cycling Data on Naphtha

800°C Thermal Shock Cycling



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Benefits of Syngas Regeneration of LNT

- **Demonstrated Benefits**
  - Low Temperature Regeneration
  - >90% NOx Conversion from 150°C to 450°C
- **Expected Benefits**
  - Rapid exhaust catalyst light-off & thermal control
    - CPOx exotherm provides hot syngas flow (~800°C)
    - H_2 combustion on low temp noble metal catalysts
  - Faster or lower temperature desulfation
  - Lower fuel penalty
  - Smaller, more durable LNT system

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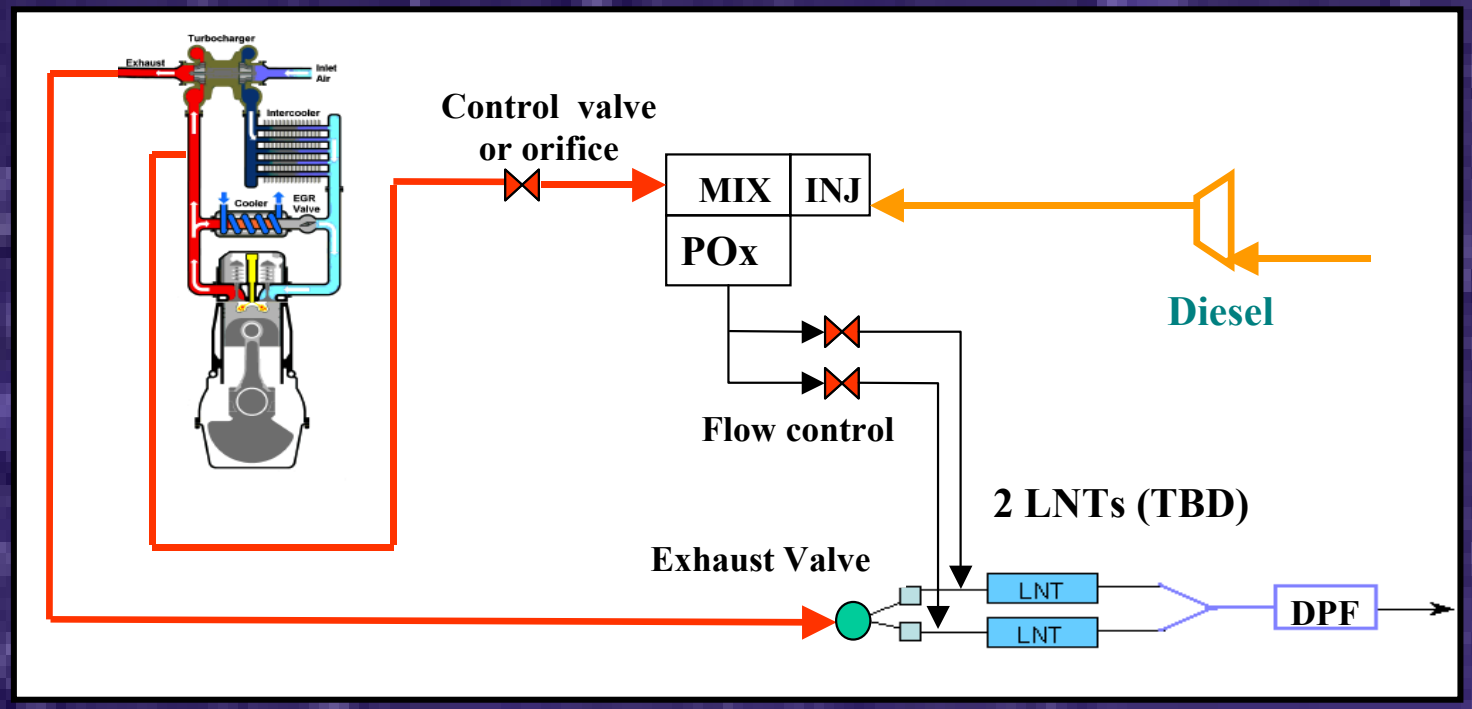
Next Steps

- **Demonstration LD truck**
  - Complete vehicle integration December 2003
  - Drive cycle testing Q1 2004



Next Steps

- **Exhaust System with CPOx Reformer**
  - Demonstrate benefit for desulfation
  - Demonstrate rapid exhaust light-off
  - Cyclic & steady state durability testing
  - Optimize configuration for cost and performance

- **CPOx Reformer**
  - Longer term cyclic & steady state durability testing

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