HTCD Program

Heavy Duty Diesel Aftertreatment Program - Caterpillar/DOE

S.A. Faulkner, A. Chanda, E. Fluga
- Caterpillar Engine Research
Introduction - HTCD

- Caterpillar/DOE joint funded program (50/50)
- 5 years (2000-2005)
- Achieve 2002 and 2007 on highway exhaust emissions
- 50% overall system thermal efficiency
- Field Demonstrations
- Partnerships with key research organizations, suppliers, Universities and National Labs.
Overall Program - HTCD

• Technologies for high efficiency low exhaust emission diesel engine configuration:
  – HCCI
  – Nitrogen enrichment of intake air
  – Low friction technology
  – Exhaust Aftertreatment System
Exhaust Aftertreatment

• Main subject for this presentation
• Discuss plans/methodologies putting together for aftertreatment to address overall HTCD objectives for emissions and efficiency
Exhaust Aftertreatment

- >90% reduction in NOx and PM needed.
- Much work done on DOC, DPF, SCR, Plasma etc. and this work has been published elsewhere
- These systems will not achieve targets, when considering full engine operating range, not to exceed, durability, cost and sulfur constraints
- Breakthrough needed to achieve emission goals within these constraints
Exhaust Aftertreatment

• Need to take advantage of best scientific knowledge, facilities, Nat labs etc.
• Need to consider in a structured way possible approaches and progressively downselect
• This program will pursue less well developed and emerging technologies that show promise for low overall emissions with good system efficiency
Key Partners - Aftertreatment

- Arthur D. Little
- Degussa
- Universities and National Labs
Key Aftertreatment Elements

- On-board Desulfurization
- On-board Reagent Generation
- Particulate trap
- NOx Trap
- Systems Integration - Controls, OBD.
Aftertreatment System

Engine Concepts

Desulfurization

Reagent Formation

PM Trap

NOx Trap

Exhaust

Fuel

Air
On-board Desulfurization

- Small quantities of sulfur from fuel or oil can rapidly degrade known NOx traps
- Breakthrough required in aftertreatment technology at 15ppm Sulfur to allow an effective NOx reduction capability for life of HD truck
- Range of concepts to be explored -
  - Continuous
  - Intermittent - trap and release periodically.
On-board Reagent Generation

- Range of concepts to be explored
- Develop for ‘good’ reductants without sooting
- High conversion efficiencies required for good overall system efficiency
- Concepts such as flashing, catalytic reaction
Particulate Trap

• Some new concepts to be explored
• Much emphasis on integration with the rest of the aftertreatment system
• Whole field of investigation is ensuring NOx and Pm trap chemistry is complimentary.
NOx Trap

• Range of concepts to be explored
• System choice dependant on effectiveness of reagent generation and desulfurization
• Trap type system with periodic regeneration and continuous systems being considered
Project Structure

- Concept generation
- Screening
- Simulation
- Flow tube reactor tests
- Engine dynamometer tests
- Field demonstration
Planning Process

• Concept Generation
• 4 workshops to be held by Caterpillar and partners - August to October 2000.
  – Reagent generation and Energy Conversion
  – Lean NOx Catalysts and Desulfurization
  – System Concepts, Controls and Sensors
  – Selection of concepts

Engine Research
Summary - HTCD

- Technologies being developed for high efficiency low exhaust emission diesel engine configuration:
  - HCCI
  - Nitrogen enrichment of intake air
  - Low friction technology
  - Exhaust Aftertreatment System
- Program started June 2000