2006 AWMA Mega Symposium

SCR Catalyst Management Enhancing Operational Flexibility

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Agenda

- Background on Catalyst Management
- Catalyst Management Planning
  - Traditional Management Considerations
  - Additional Considerations
- Summary

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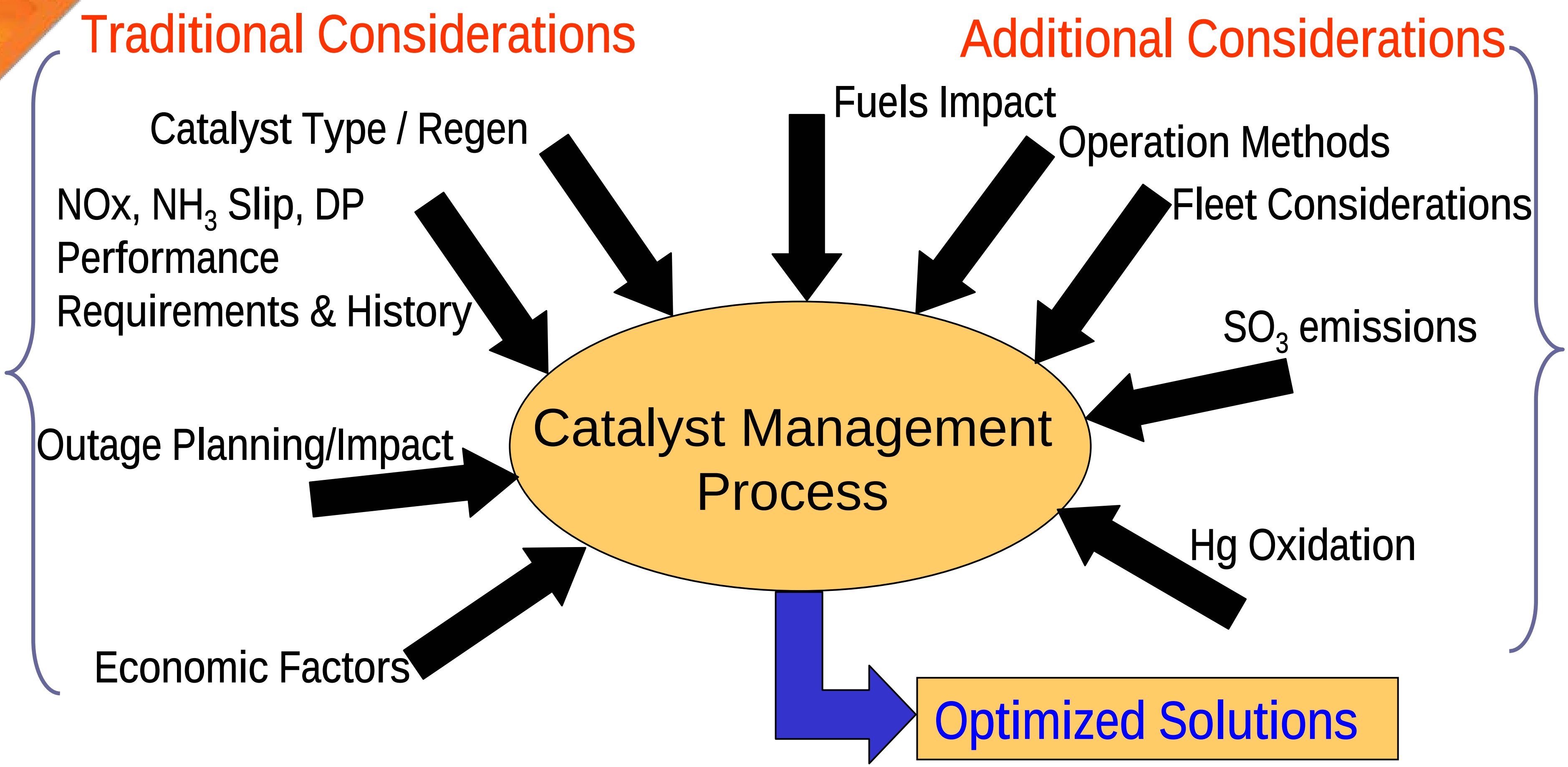
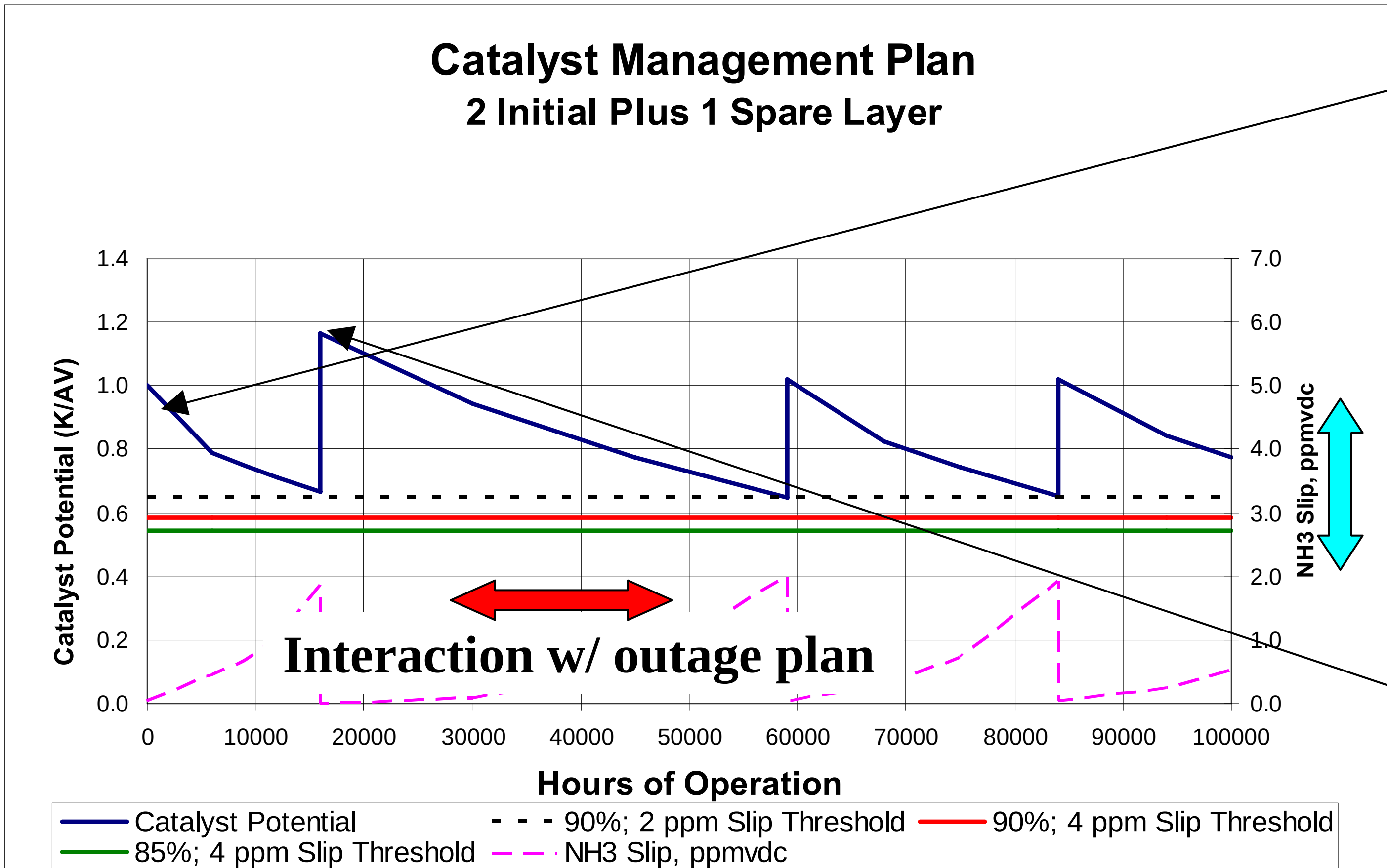
Catalyst Management



Catalyst Management Plan



Rate of catalyst deactivation depends on fuels and position of layers

Threshold moves based on performance requirement and system capability

Level of performance increase depends on needs and methods i.e. SO_2 conv., higher SA, higher activity, etc.

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Performance Requirements & History

- Performance Requirements
  - Catalyst performance vs. expectations
  - Fuels monitoring – current vs. future

Performance Requirements & History

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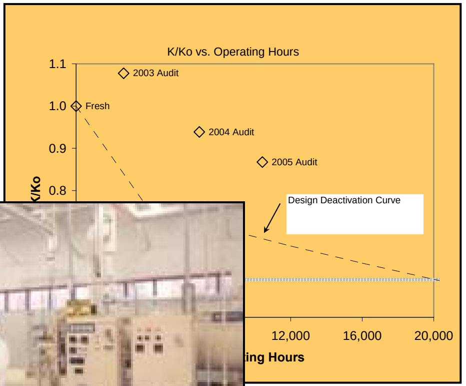
- Catalyst testing & sampling methodology
  - Full elements / plates from each layer
  - Molar ratio 1 vs. design MR
  - SO_2 conversion
    - Appropriate aging of samples
  - Qualification of regeneration process



- AIG Tuning/Distribution Measurement
  - Potential for AIG and mixing optimization

Performance Requirements & History

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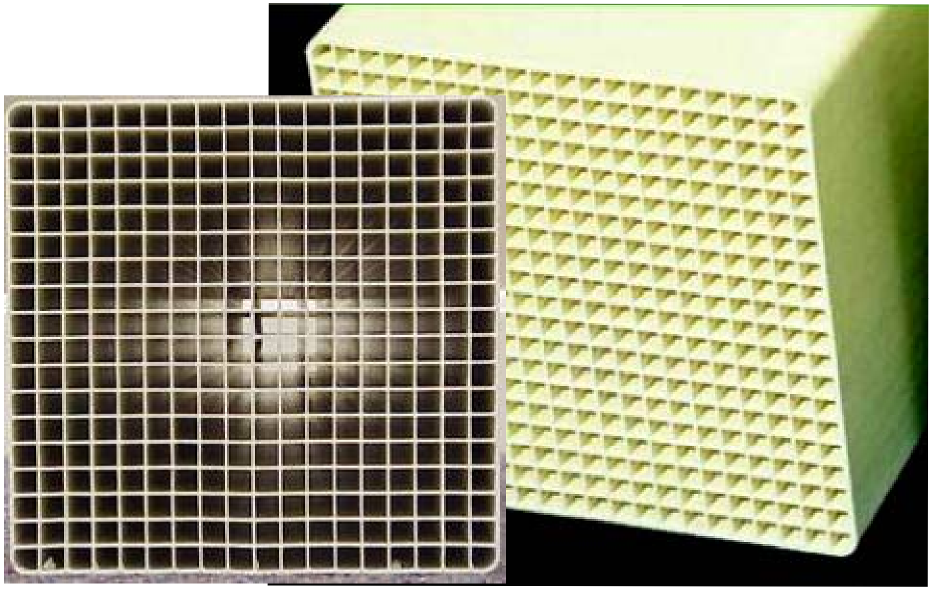
- Catalyst and system inspections
  - LPA mitigation considerations
    - Screen, perforated plate, or aerodynamic design
- Catalyst type and pitch selection
    - Experience
    - Qualification process



New vs. Regeneration

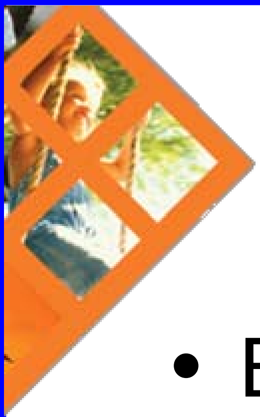
- Case Specific
  - Catalyst type
    - Honeycomb and plate have regeneration history
    - $ per K*SA must be compared
    - Consideration of product advancements
  - Life extension vs. outage cost
    - Regen=more frequent vs. New=less frequent
  - Capabilities vs. Guarantees and Integration
    - Ko, K/Ko, SO_2 conversion, Hg oxidation
    - Maximum NOx removal efficiency

Outage Alignment

- Catalyst Addition/Replacement timing
  - Evaluation very utility dependent
    - Seasonal vs. Year Round
    - Use of SCR Bypass with boiler in operation
    - Cost of outage
    - Flexibility on NOx reduction and NH_3 slip requirements
      - Rate based vs. tonnage based
    - Preparedness for SCR work during forced outage

Economic Impacts

- Utility Specific, e.g.
  - Capital vs. O&M
  - Outage timing and cost
  - Unit capacity factor
  - NOx credit value
  - Ammonia cost
  - SO_3 mitigation cost
  - Catalyst cost per K/AV or K*surface area
  - Near term vs. long term evaluation



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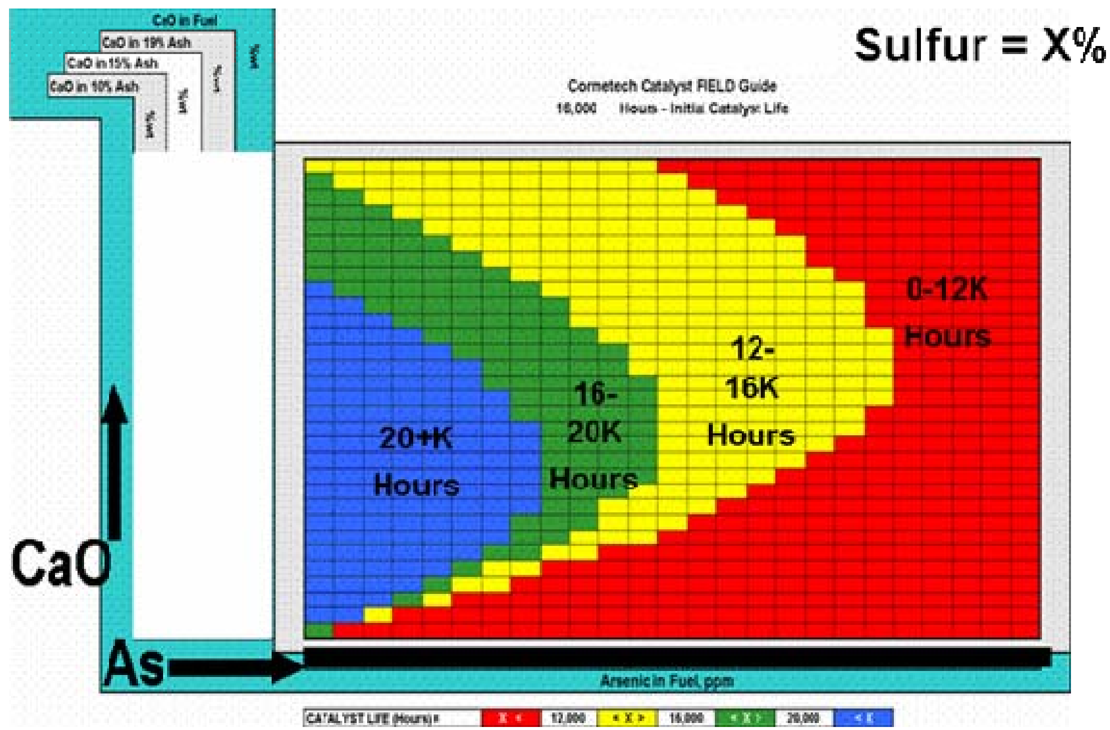
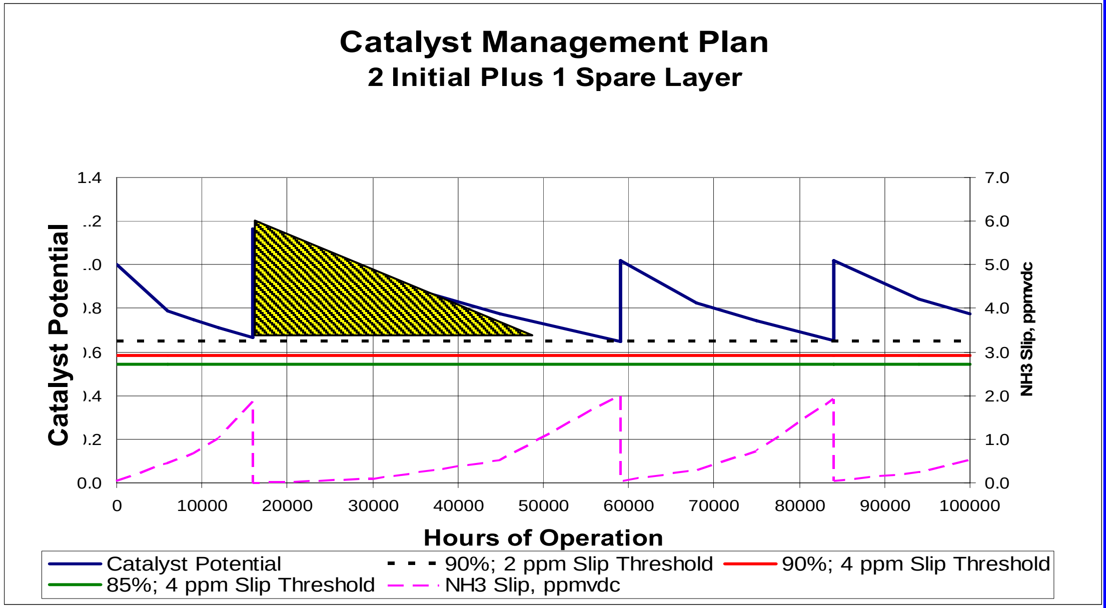
Fuels

- Historical vs. Future
  - Catalyst performance predictability
    - High arsenic fuels
    - PRB
    - Petcoke
  - Optimization of catalyst formulation based on fuel plan
  - Fuel additives



Operation Methodology

- Removal Efficiency vs. Time
  - Take advantage of K/AV installed to achieve lower NOx emissions
    - Applicable to tonnage based emission limits
    - Can increase system flexibility
  - Optimize
    - AIG / Mixer
  - Evaluate
    - Sensitivity to NH_3 slip
      - APH
      - Ash



Operation Methodology

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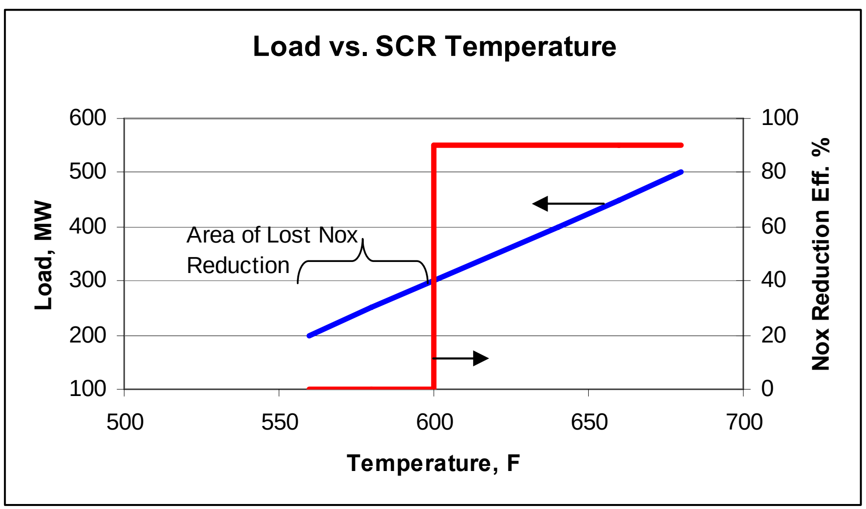
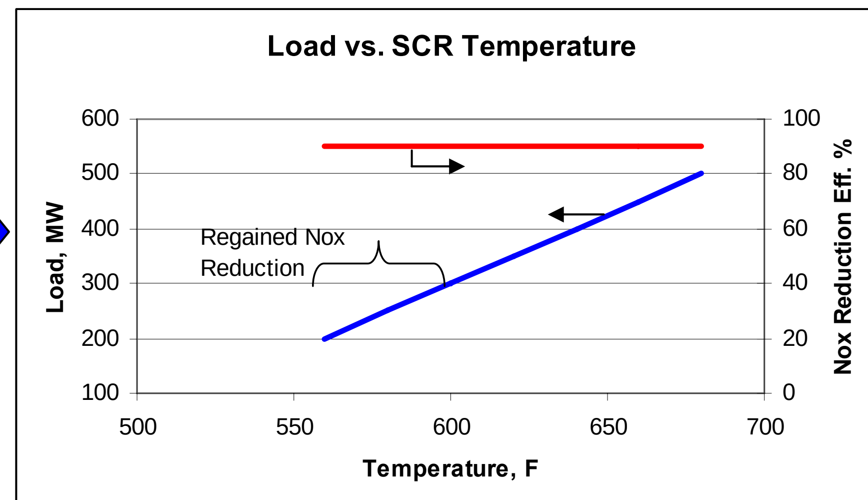
- Expansion of Operating Range
  - Expansion of operating range and flexibility thru allowance of ABS formation on continuing cyclic basis
    - 500 MW plant with a baseline of 0.55 lb/mmbtu and 90% reduction can be worth over $200,000 (ref. $2000/ton NOx credit value) after 200 hours





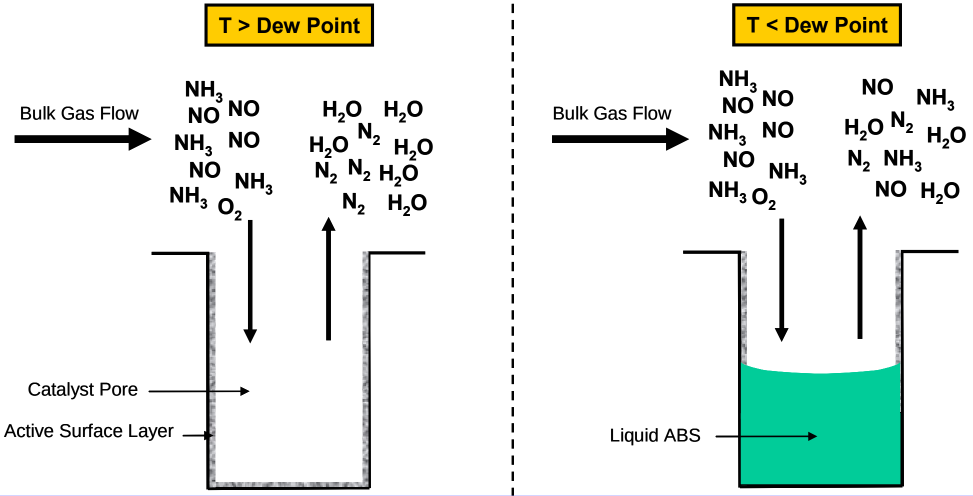
Operation Methodology

- Liquid ABS temporarily reduces activity
  - Catalyst type and properties will influence capability
  - Evaluate performance requirement vs. total K/AV available
    - Kinetic effects
    - Catalyst age
    - Operation time vs. Recovery time
    - Characterization of SO_3 and NH_3 spike during recovery

(ABS)

$$[NH_3(g) + SO_3(g) + H_2O(g) \leftrightarrow NH_4HSO_4(l)]$$

$$P_{ABS} = P_{NH3}\, P_{SO3}\, P_{H2O} = 1/K$$



Fleet Considerations

- Interchangeability
- Common spares
- Alternate product qualification
- Regeneration
- Disposal and recycling options

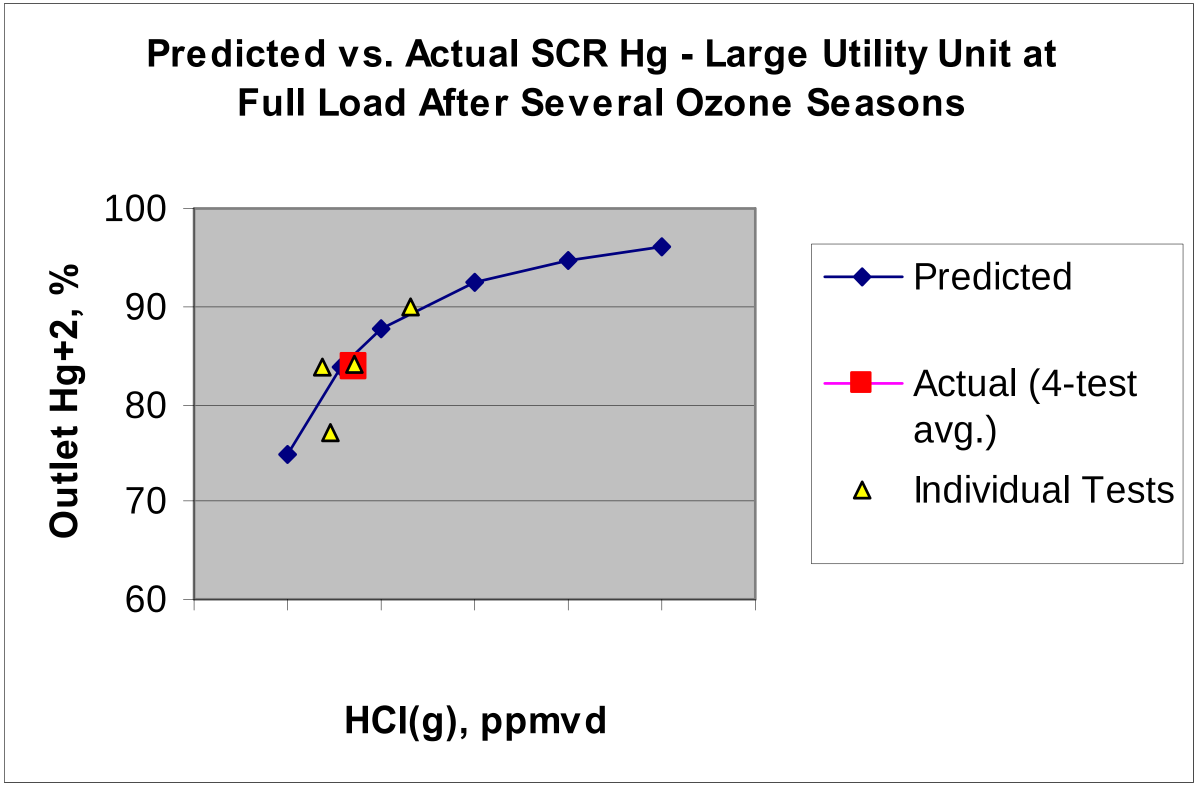
SO_3 Mitigation

- High Performance Catalyst
  - Allows reduced SO_3 emissions with excellent NOx reduction performance
  - Product features conversion rates as low as < 0.1% for single layer additions
  - Further advancements under development
  - Product can be used in combination with in-furnace and post SCR mitigation techniques

	Product			Case 1		Case 2	
Product	Pitch	Opening (mm)	GSA (m2/m3)	Relative Volume Required	Relative Pressure Drop	Relative Volume Required	Relative SO2 Oxidation Required
Conventional	7.4	6.3	445	100%	100%	100%	100%
High Performance	6.9	6.3	539	75%	61%	100%	25%

Hg Oxidation

- Catalyst Life vs. Hg Oxidation Capability
  - Model developed since 2003
  - Predictive capability on range of fuels vs. catalyst life
  - Guarantees available
  - MHI patented approach for low Cl coals



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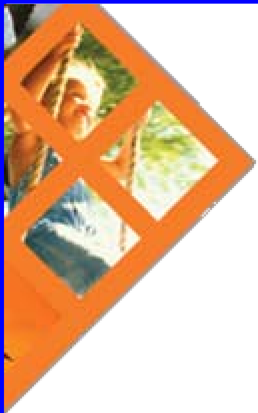
- Traditional Considerations
  - Catalyst Type
    - $ per K/AV or K*SA
  - Costs associated with outages
  - Pressure drop associated with added layer(s)
  - Sensitivity to NH_3 slip
  - New catalyst vs. regeneration
- Additional Considerations
  - Operation and Performance goals (NOx removal, Tmin, etc.)
  - Future fuels
  - Fleet management
  - SO_2 oxidation limits
  - Hg oxidation
  - Catalyst & replacement methodology advancements

Use basic tools for initial evaluation but ……need to keep up with current issues and future technology to optimize process



Thank you!

Questions?