Meeting the World Energy Challenge.

CoaLogix™

CoaLogix™

October 21, 2010

Catalyst Selection Hot Topic Hour

Michael Mattes – Chief Operating Officer

Regeneration Experience

	Cubic Meters	Projects
➢ USA since 2003	24,600	84
➢ European since 1998	17,000	210
➢ Combined	41,500	294

➢ ~ 22,000 catalyst modules

Catalyst Selection Considerations

Meeting the World Energy Challenge.

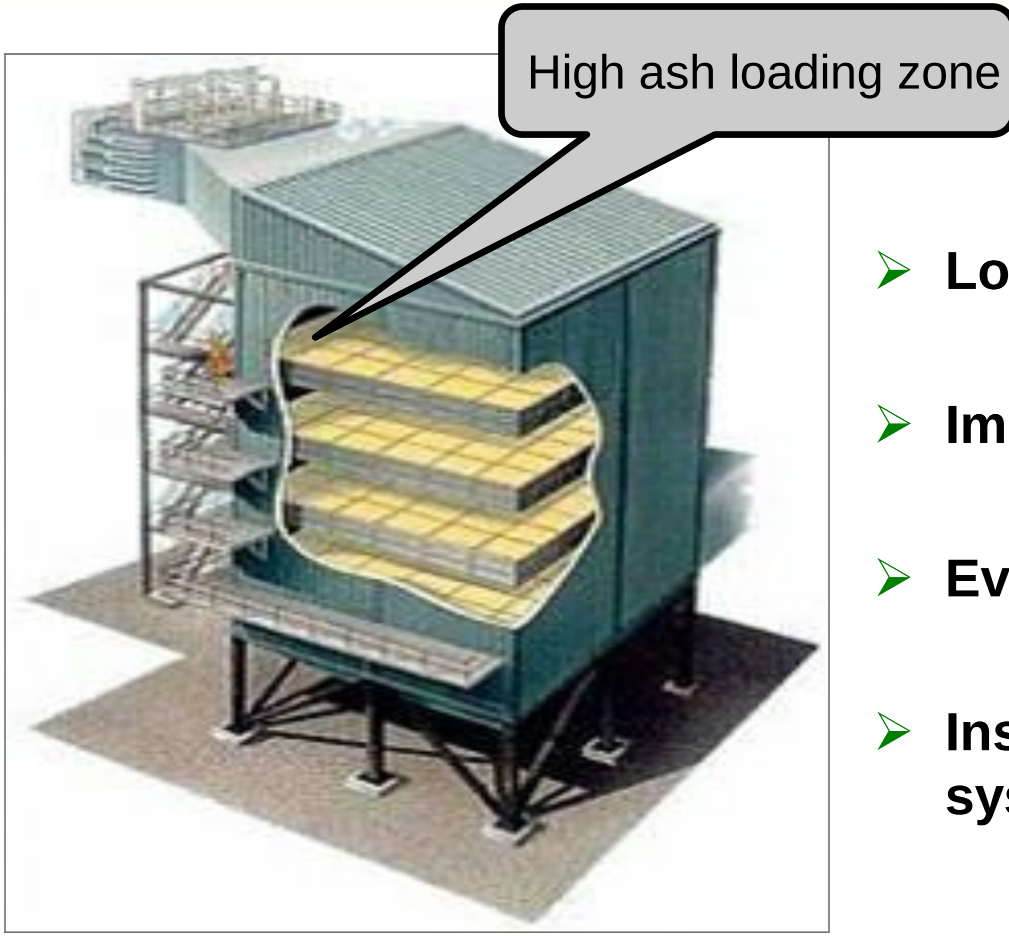
- Pluggage resistance
- Erosion resistance
- SO_2 conversion
- Pressure drop
- Mercury oxidation
- Low temperature operation
- Regenerability of catalyst (avoid wall thickness < 0.6mm)
- DeNOx potential (Catalyst Life) per $

Catalyst Selection – Prevent Pluggage

- “Fix System” problems so the catalyst can perform as designed:
  - Large Particle Ash (LPA) filtration
  - Ash distribution
  - Flow distribution
  - NH_3/NO_x ratio distribution
  - Temperature distribution
- Pick your catalyst pitch and type based on success in “Fixing System” above
- Fixing the pluggage problem will fix the erosion problem

Don’t use your catalyst investment for Ash/LPA filtration

Reduce Pluggage Potential



- **Load catalyst from bottom up**
- **Improve flow distribution**
- **Evaluate impact of load swings**
- **Install effective LPA filtration system**

Catalyst Definitions

$$AV = \frac{Nm^3}{hr} \Big/ m^2$$

Area Velocity (m/hr) = Gas Flow / Catalyst Visible Surface Area

$$Potential = -\ln\left(1 - \left(\frac{NOx_{in} - NOx_{out}}{NOx_{in}}\right)\right) = \frac{K}{AV}$$

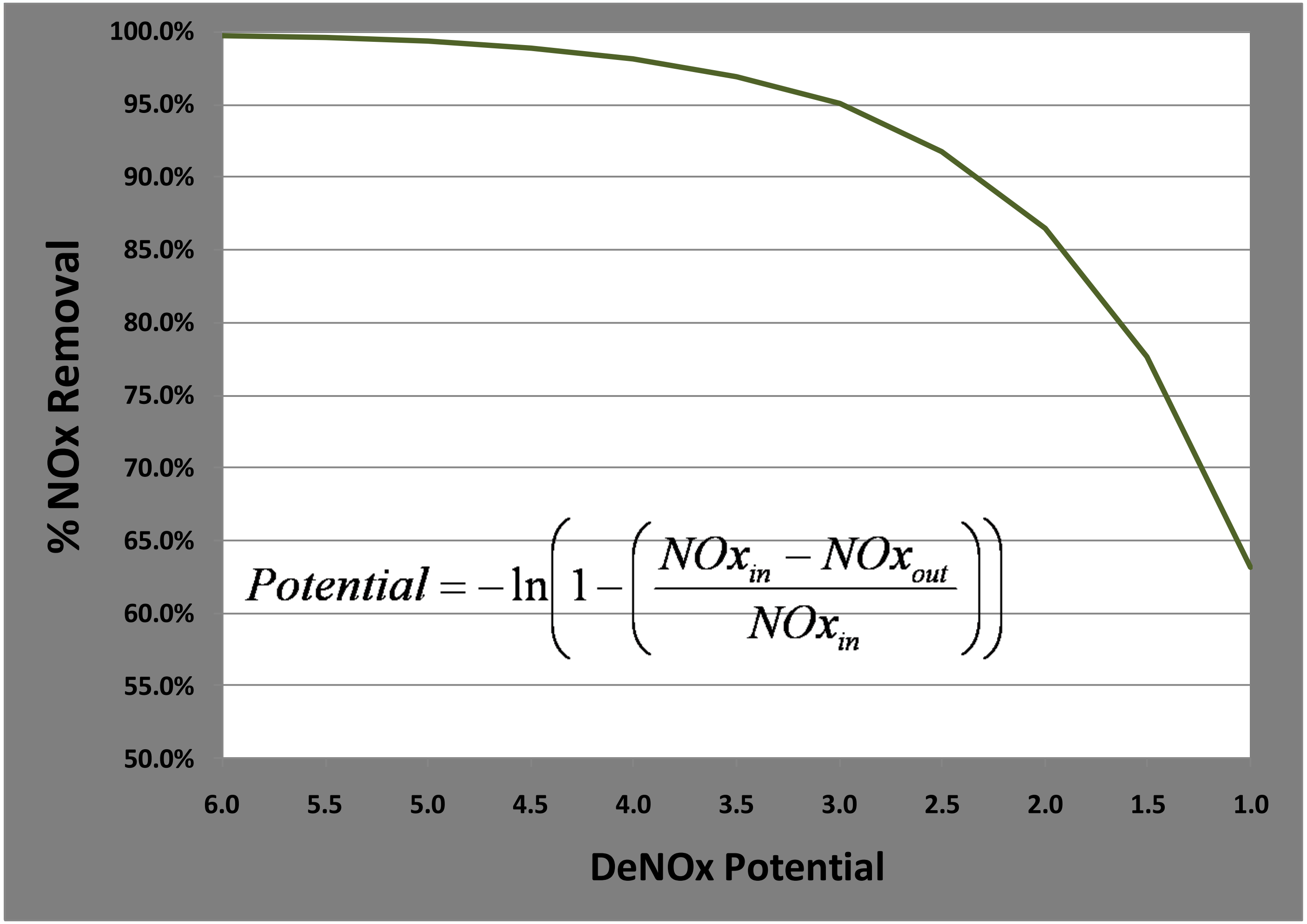
$$K = AV \cdot -\ln\left(1 - \left(\frac{NOx_{in} - NOx_{out}}{NOx_{in}}\right)\right)$$

DeNOx Activity (m/hr) K = AV * Potential

Potential Vs. % NOx Removal

CoaLogix™

Meeting the World Energy Challenge.

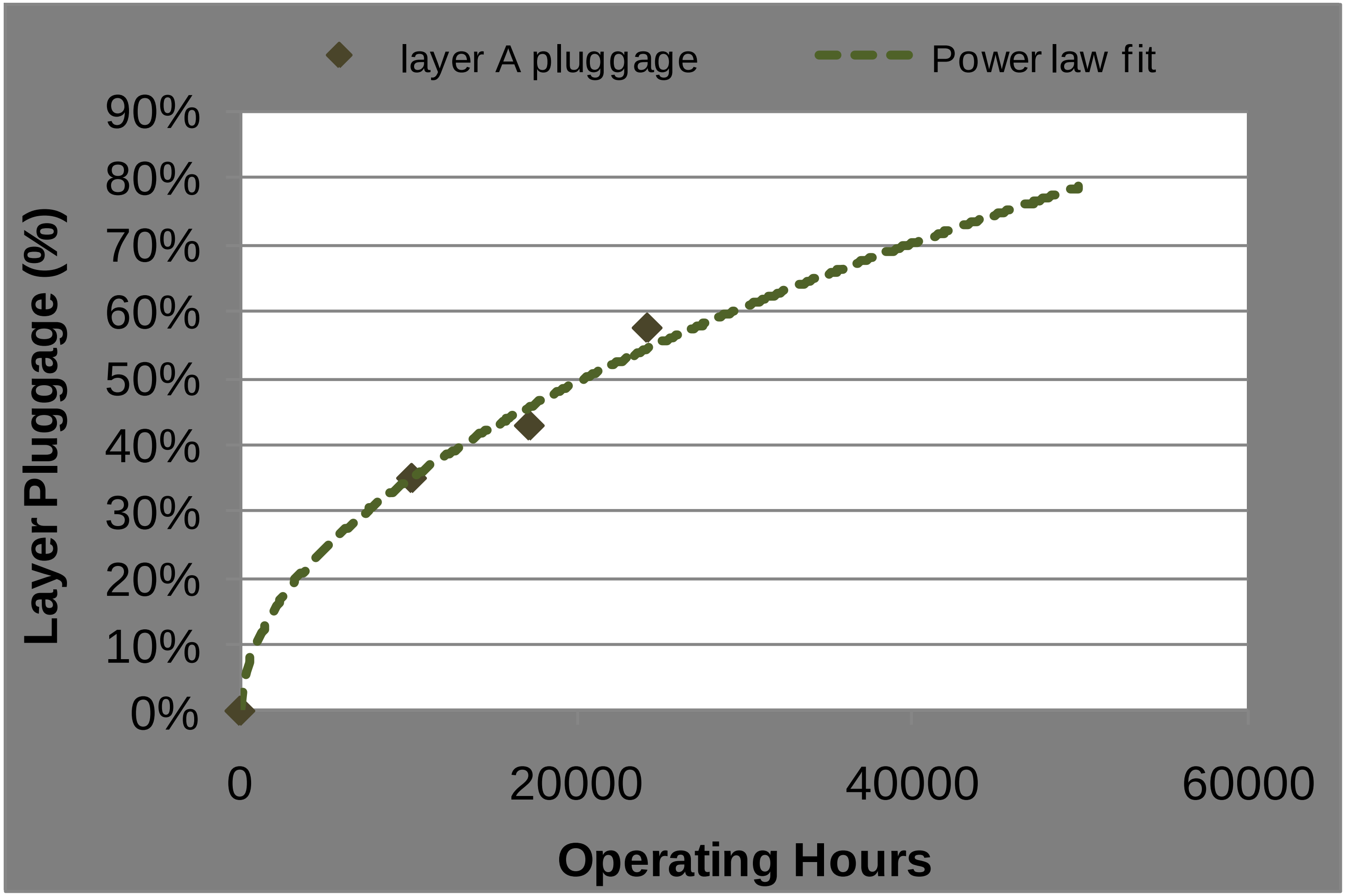


$$Potential = -\ln\left(1-\left(\frac{NOx_{in} - NOx_{out}}{NOx_{in}}\right)\right)$$

Potential Vs % NOx Removal is not linear

SCR Catalyst Pluggage

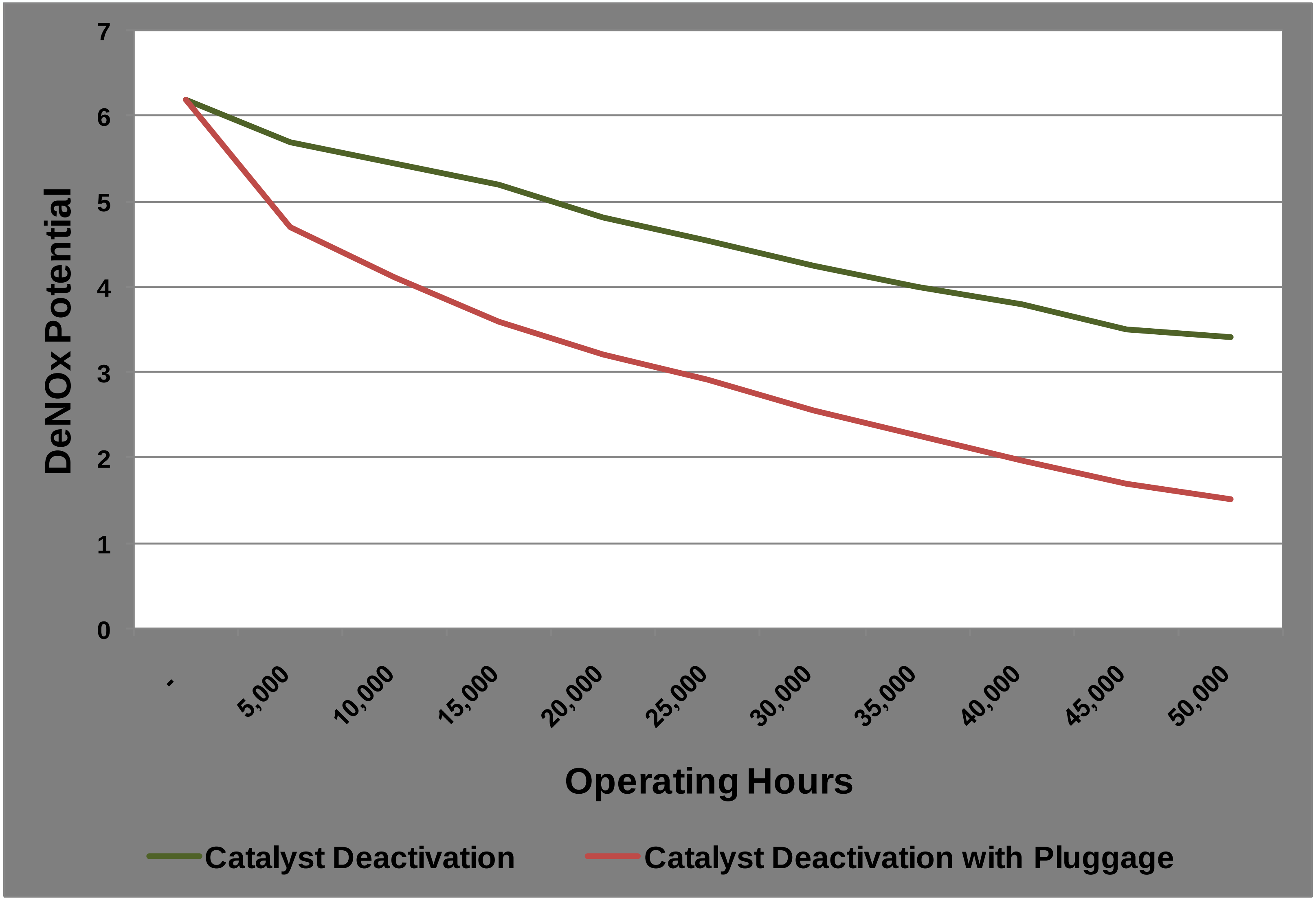
Meeting the World Energy Challenge.



Pluggage eliminates catalyst and reduces residence time

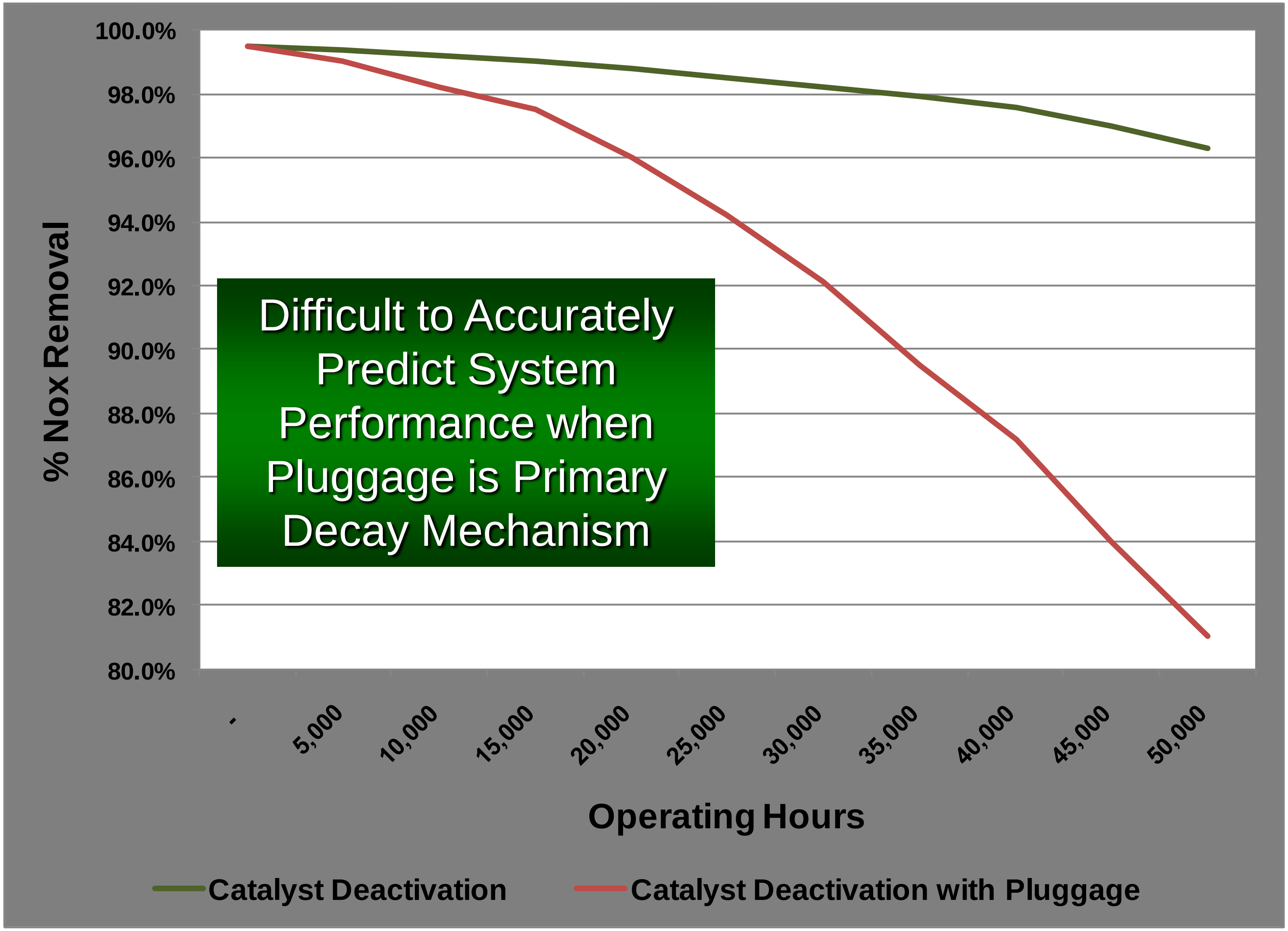
Affects of SCR Catalyst Pluggage

Meeting the World Energy Challenge.



Affect of SCR Pluggage

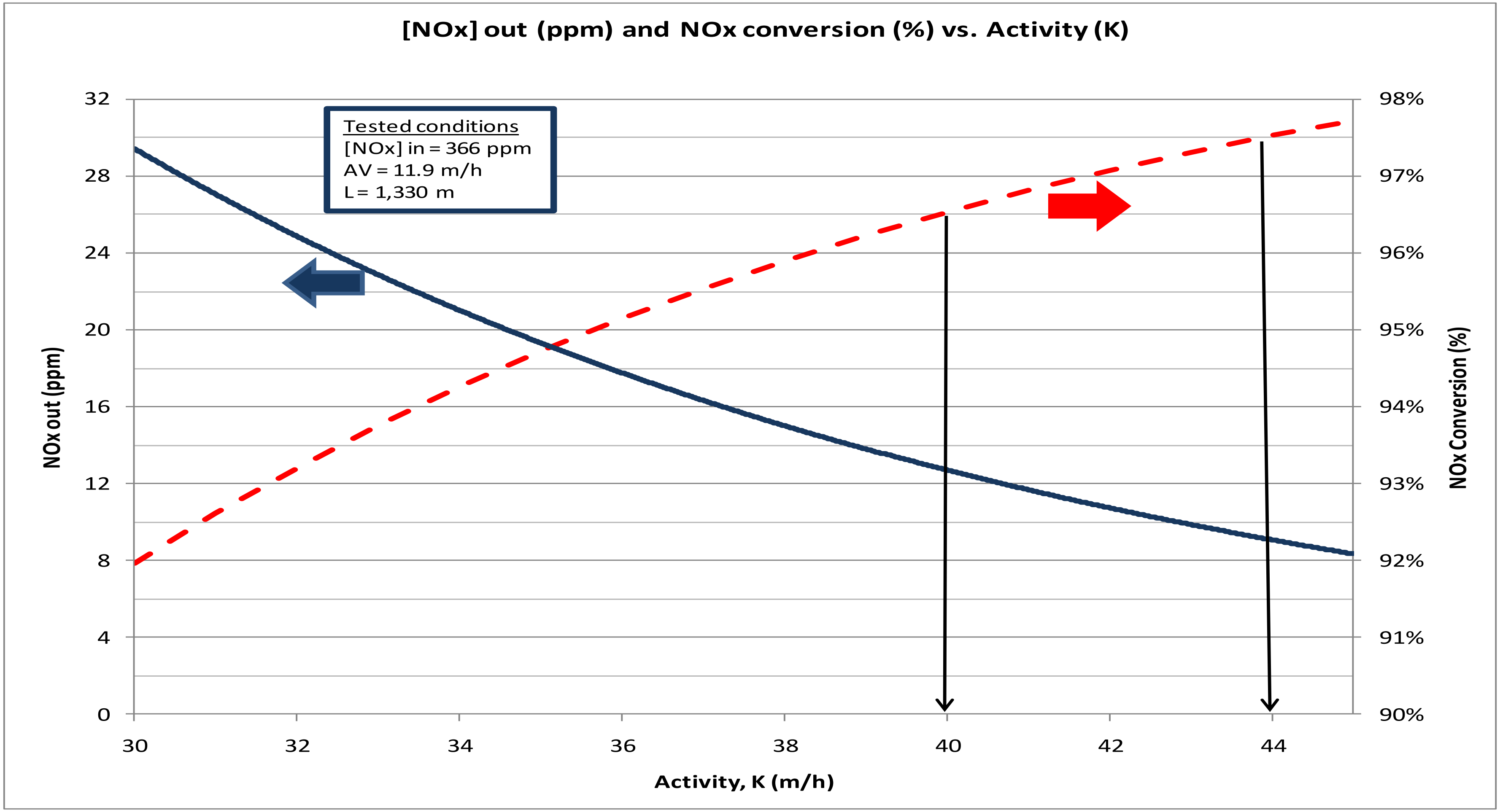
Meeting the World Energy Challenge.



DeNOx Activity Vs % NOx Removal

CoaLogix™

Meeting the World Energy Challenge.



Focus on % NOx Removal

SCR Vs Catalyst Performance

CoaLogix™

Meeting the World Energy Challenge.

Affected By

SCR Performance
- % Catalyst Pluggage - Typically Major Affect
- % Flue Gas By-pass
- **Catalyst Performance**
  - Decay Rate Confirmed by Routine Testing
    - Flue Gas Impurities
    - Operating Conditions - Temperatures < 570° F
  - Temperature
  - Flue Gas Velocity
  - NH_3 to Nox Molar Ratio

Catalyst Comparison

	Plate	Honeycomb	Corrugated
Ability to Regenerate if Not Mechanically Damaged	Very Good	Very Good	Very Good
Erosion Resistance with Low Pluggage	Very Good	Very Good	Very Good
Ability to Chemically Clean Outside the SCR Reactor	Very Good	Very Good	Very Good
Potential per M3	Varies by Pitch and Catalyst Formulation		
Erosion Resistance with < 30% Pluggage	Very Good	Very Good	Very Good
Erosion Resistance with > 30% < 50% Pluggage	Fair	Fair	Fair
Erosion Resistance with > 50% Pluggage	Marginal	Poor	Poor
Ability to Mechanically Clean Outside the SCR Reactor	Very Good	Fair	Fair
Ability to Mechanically Clean In-situ	Poor	Poor	Poor

Catalyst Comparison

Meeting the World Energy Challenge.

CoaLogix™

Pluggage Resistance	Varies by Pitch
Pressure Drop	Varies by Pitch, Length and Flue Gas Velocity
SO2 Conversion	Varies by Operating Conditions and Catalyst Design
DeNOx Life	Varies by Operating Conditions and Catalyst Design

Specific Surface Area (m^2/m^3) vs. Pitch

CoaLogix™

Meeting the World Energy Challenge.

Honeycomb		Corrugated		Plate-Type	
Pitch	m2/m3	Pitch	m2/m3	Pitch	m2/m3
7.1	495	6.4	455	5.7	350
7.4	470	7.4	445	7	280
8.2	425	8.4	435	7.5	270
9.2	380				

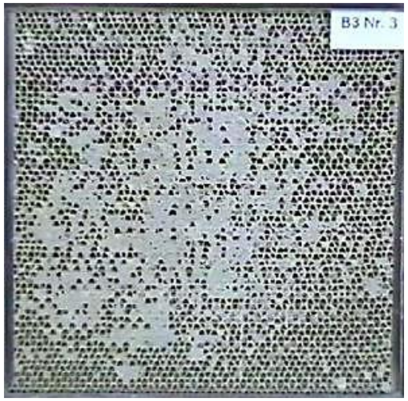
Balance Pluggage Resistance with $DeNO_x$ Potential

All Catalyst Types Regenerable

Meeting the World Energy Challenge.

	Corrugated	Honeycomb	Plate

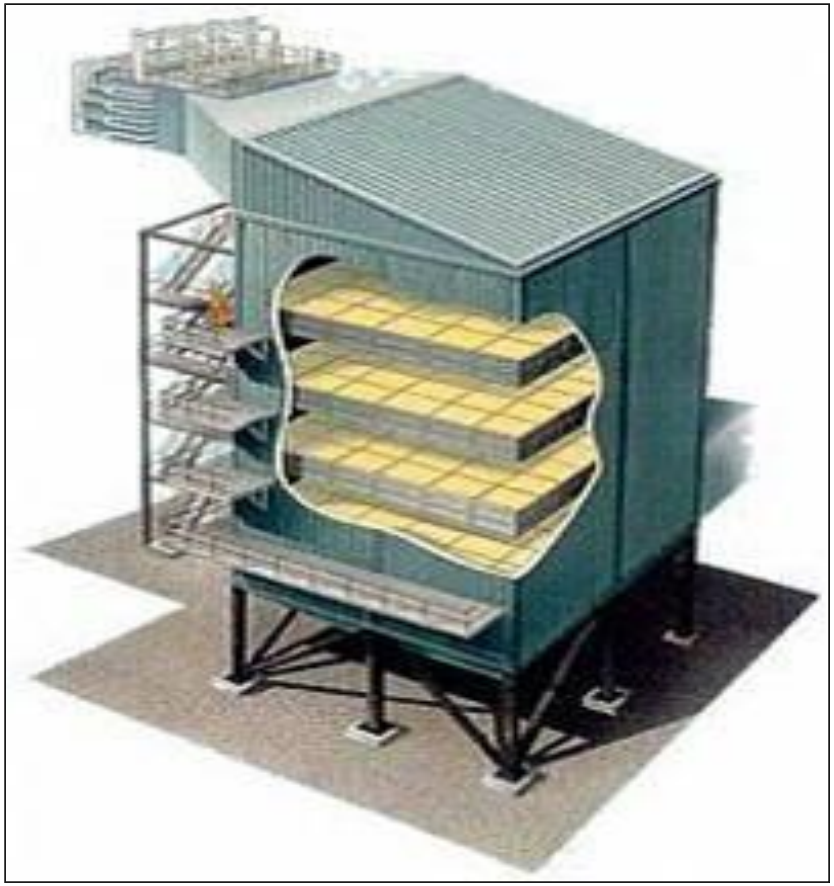
<u>Before</u>




<u>After</u>


Summary

Meeting the World Energy Challenge.



- Reduce system pluggage potential
- Select catalyst with proper pitch and erosion resistance
- Select catalyst potential (length, number of layers) to meet outage and environmental requirements
- Evaluate catalyst based on $ per DeNOx potential Vs $ per layer