EPRI'S 2011 Workshop on SCR
Austin, Texas

Meeting the World Energy Challenge.

Results of Catalyst Regeneration Process to Lower SO_2 Conversion

October 11, 2011

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Agenda

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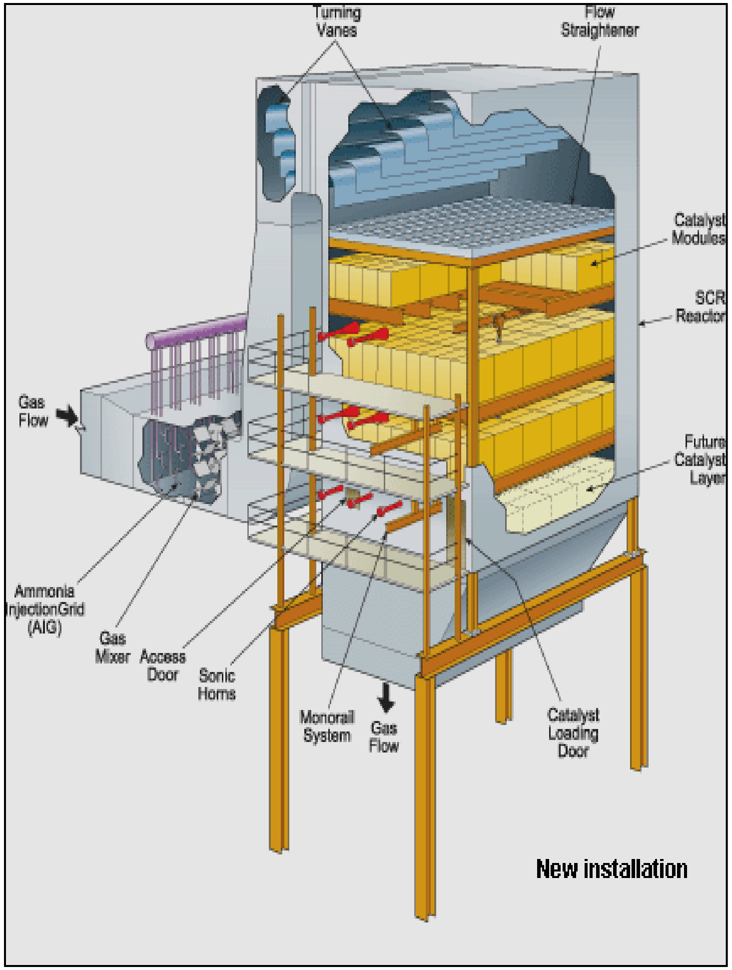
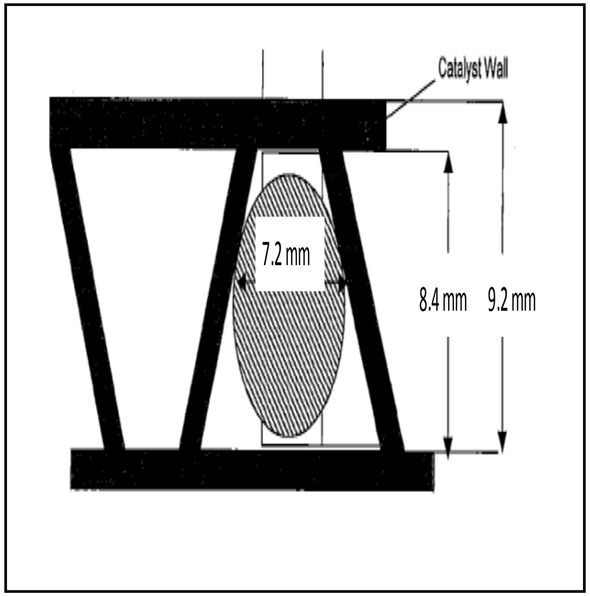
- Background
- Goals
- How Regeneration Works
- Regeneration Study Results



Initial Catalyst Loading

Catalyst type		Corrugated Plate
Catalyst Formulation		DNX-774
Chemical composition		TiO_2 / V_2O_5 / WO_3
Nominal Catalyst geometry	Plate pitch, P_p, mm	9.2
	Wall thickness, t, mm	0.9 to 1.0
	Void, %	> 79
	Specific area, m^2/m^3	> 400
Module type		VE422EE
Number of elements, Each module		4 × 2 × 2
Catalyst Activity, Ko		> 35 m/hr
SO_2 to SO_3 conversion rate @ layer		0.85%



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Operating Conditions

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Plant Unit	Undisclosed Undisclosed
Fuel Type	100% Lignite
Flow, lbs/hr	7,155,300
Flow, ACFM	3,929,969
Flue Gas Temperature (design), degrees F	780
Inlet NO_x, ppmvd @ 3% O_2	145
Required NOx Emission, ppmvd @ 3% O_2	29
Required Ammonia Slip, ppmvd @ 3% O_2	2.0
SO_2, lb/hr	24,741
SO_3, lb/hr	315
Particulate, mg/Nm^3	36,000

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Catalyst Condition at Removal

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Catalyst Activity, $K_{at\ removal}$	Reactor A, Layer 1	> 37
	Reactor A, Layer 1	> 34
	Reactor B, Layer 2	> 36
SO_2 to SO_3 conversion rate		0.85% per layer
Percentage of plugged channels		< 1%

Note: Little to no deactivation of catalyst

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New Replacement Catalyst

Catalyst type		Corrugated Plate
Catalyst Formulation		DNX-174
Chemical composition		TiO_2 / V_2O_5 / WO_3
Catalyst geometry	Plate pitch, P_p, mm	9.2
	Wall thickness, t, mm	0.9 to 1.0
	Void, %	> 80
	Specific area, m^2/m^3	> 400
Module type		VE422EE
Number of elements, Each module		4 × 2 × 2
Catalyst Activity, Ko		> 27 m/hr
SO_2 to SO_3 conversion rate @ layer		0.25%

Goal of the Regeneration Study

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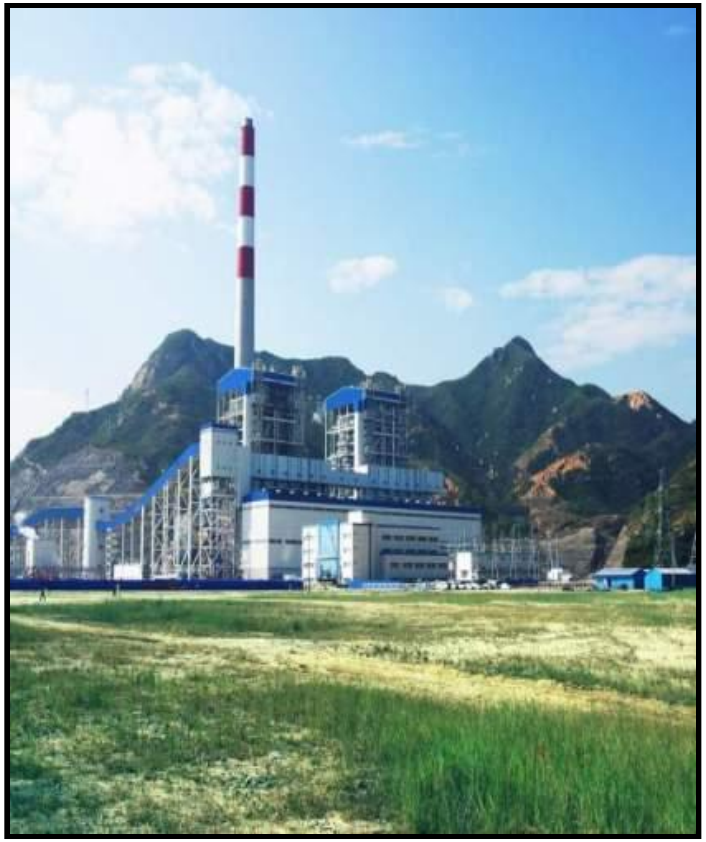
- **Regenerate Haldor Topsoe 774 catalyst to performance similar to 174**

	DeNOx Activity (m/h)	SO_2 to SO_3 conversion per layer
New 774	**> 35**	**0.85%**
New 174	**> 27**	**0.25%**
Alpha (α)for activity testing was 1		
Alpha (α) for conversion testing was 0		
No SO_3 was used in the flue gas simulation		



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How Does Regeneration Work?

Common Terms

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Term	Definition
Dry Mechanical Cleaning	Utilizes compressed air and vacuum to removed loose fly ash.
Rejuvenation	Wet process to primarily remove "physical " pluggage. No addition of active ingredient(s).
Regeneration	Wet process to remove desired compounds (decay chemicals and/or active ingredients). Followed by re-impregnation of active ingredient(s) .
Re-impregnation	Addition of active ingredient(s). May be one or more ingredients applied separately or simultaneously.
Drying	Removes free water. Normally at temperatures < 250 ^{o} F.
Heat Treatment	Removes the required bound water and properly activates the added active ingredient(s). Temperature varies by regeneration process used.
Calcination	One time event performed by catalyst OEM's to produce its "catalytic" surface area, strength and performance properties.

Temperature Zones

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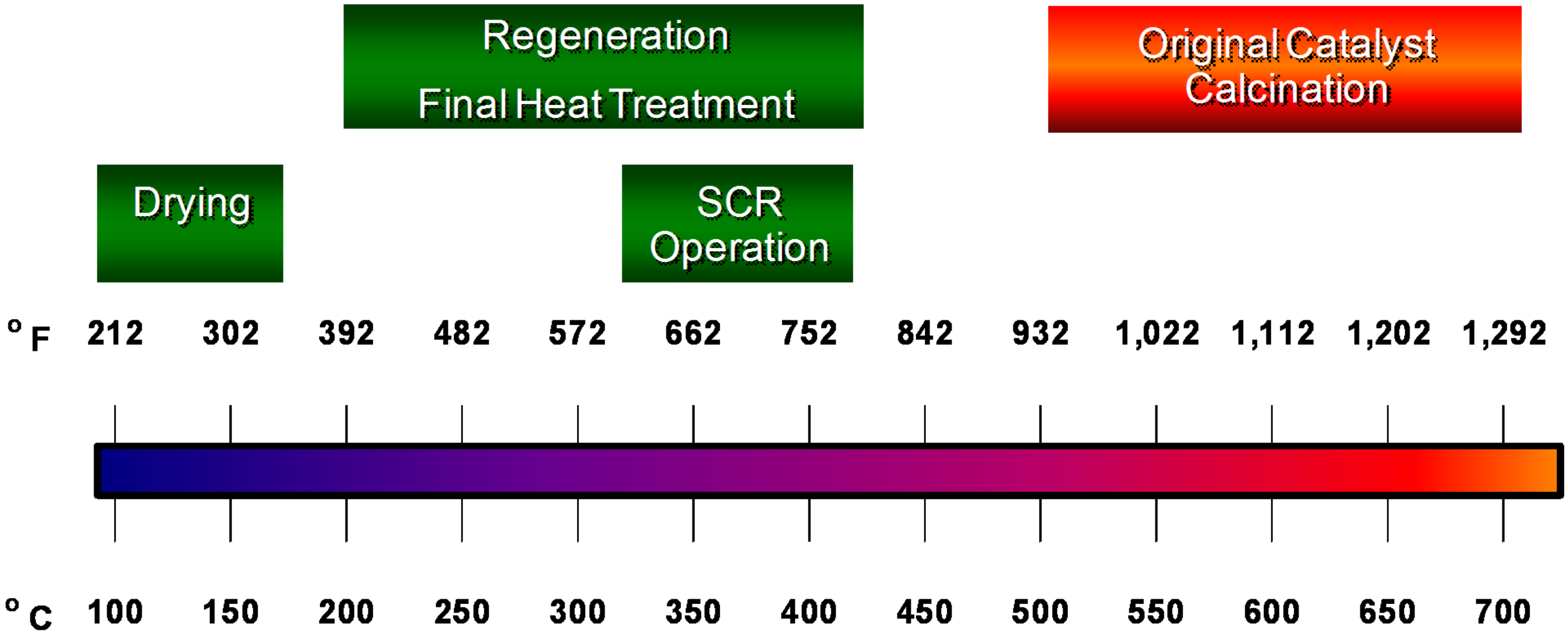

Avoid OEM Calcination Temperatures

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How Does Regeneration Work?

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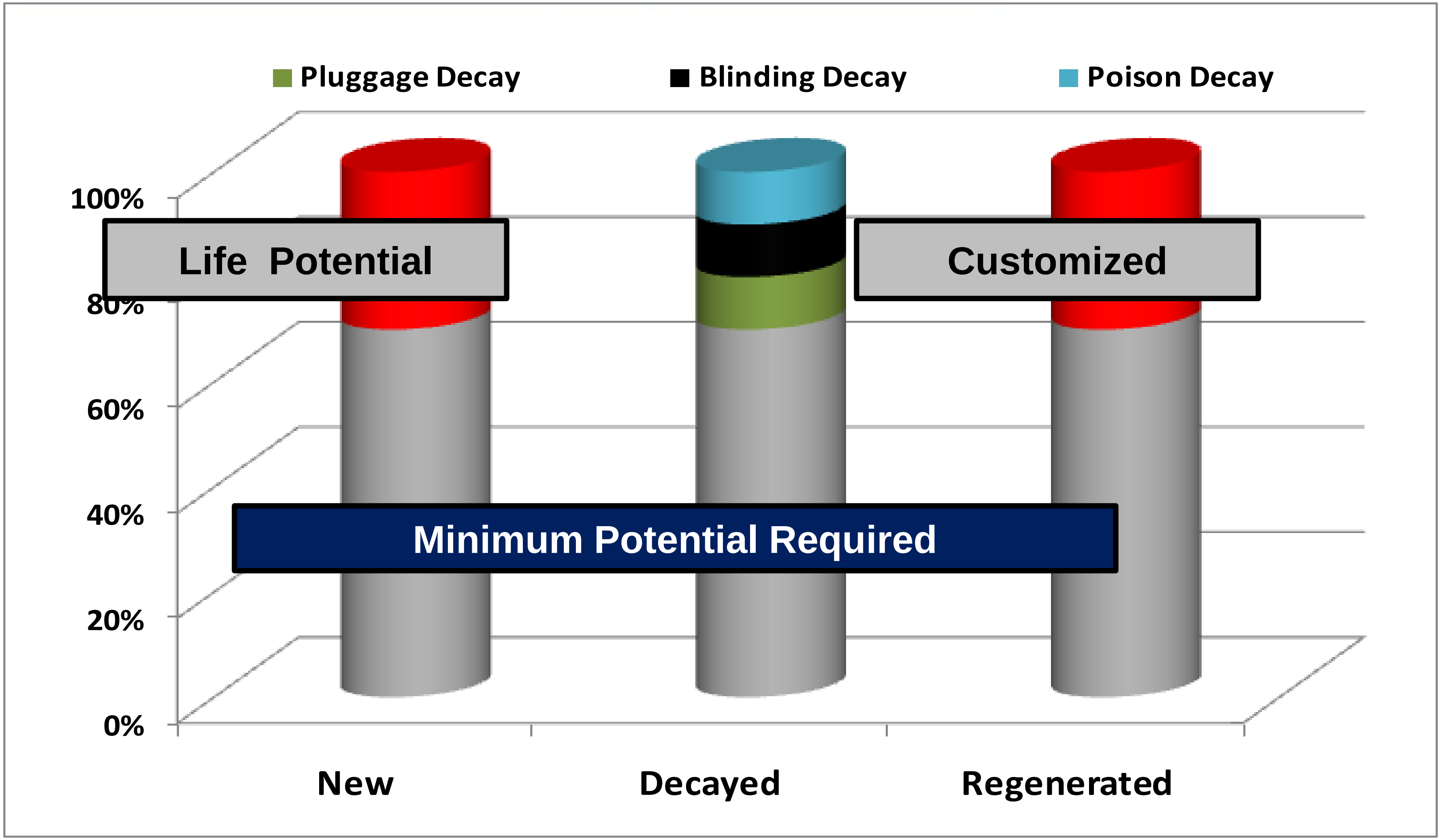

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Regeneration Process

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Dry Mechanical Cleaning	Plate catalyst disassembled. Can hold > 2,000 lbs. of fly ash
Wet Chemical Treatment	Precise control, mild chemicals, removes remaining physical pluggage
Ultrasonic Treatment	Utilized as required. Allows removal of difficult contaminants with mild chemicals.
Pre-Drying	Removal of all cleaning compounds and impurities. Critical to catalyst performance. Especially SO_2 conversion.
Drying	Removal of free water. Amount varies by catalyst type and size. Can be > 100 gallons per module.

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Regeneration Process

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Drying	Continuation
Re-impregnation	Customized to meet requested performance. Primarily places chemicals in the $DeNO_x$ and Hg oxidation vs. SO_2 Conversion zone.
Final Heat Treatment	Removes bound water, properly activates the added ingredient(s) and strengthens catalyst. Temperature varies by regeneration process used.
Repairs	Module casings and catalyst elements or cassettes.
Storage	Weather controlled. Capacity for > 12,000 modules.

Regenerated Study Results

% SO_2 Conversion

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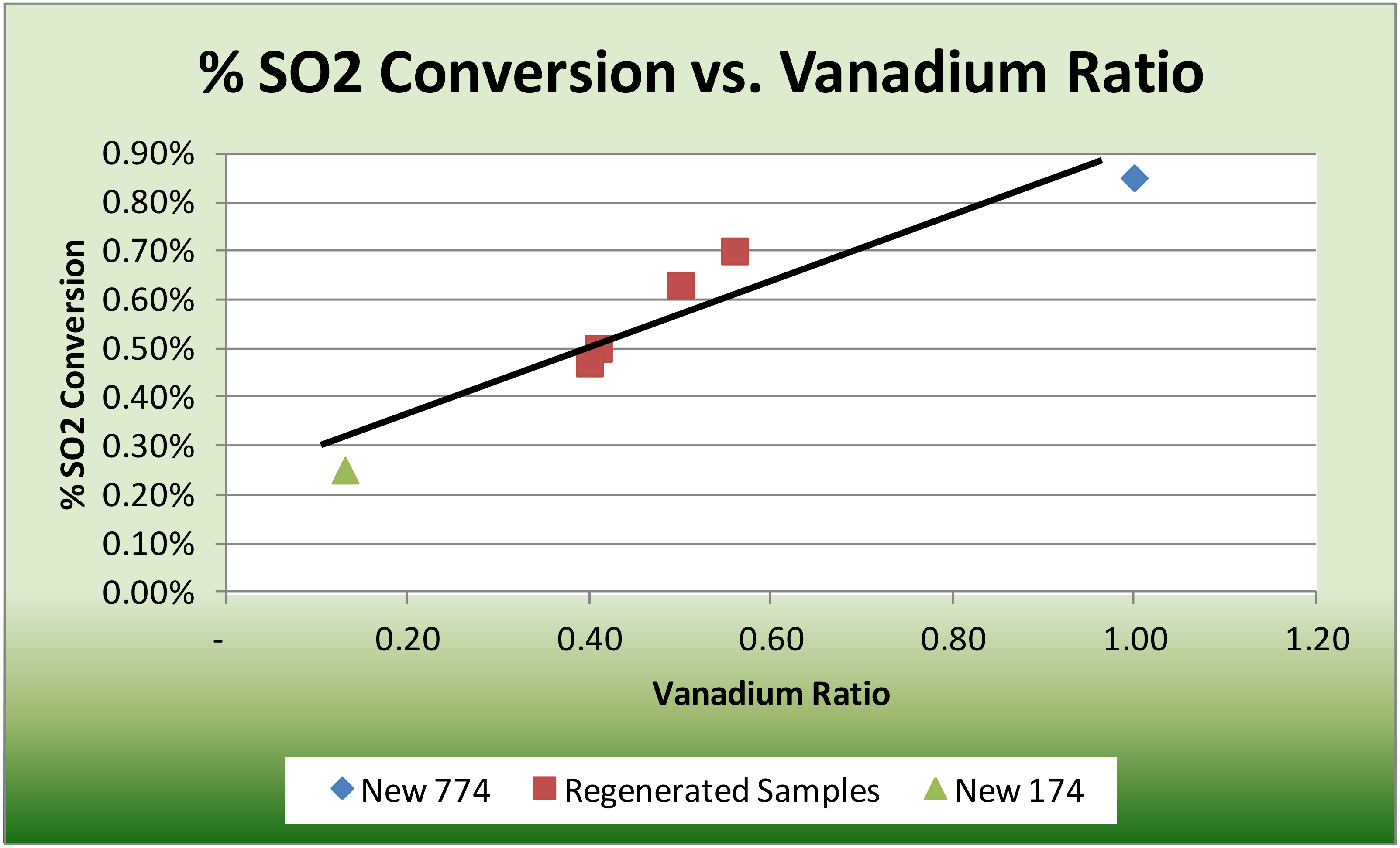

DeNOx Activity

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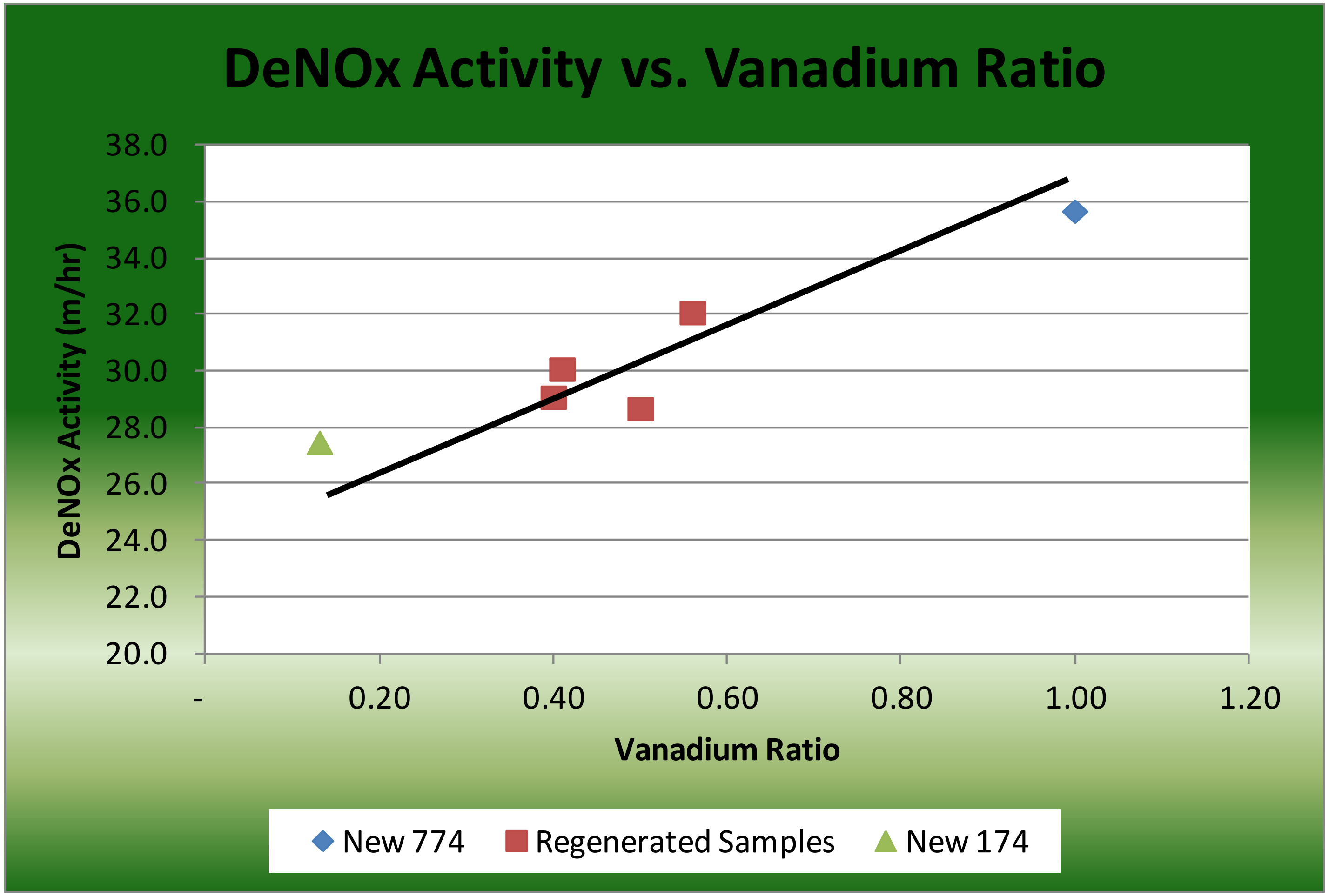

DeNOx Activity vs. % SO_2 Conversion

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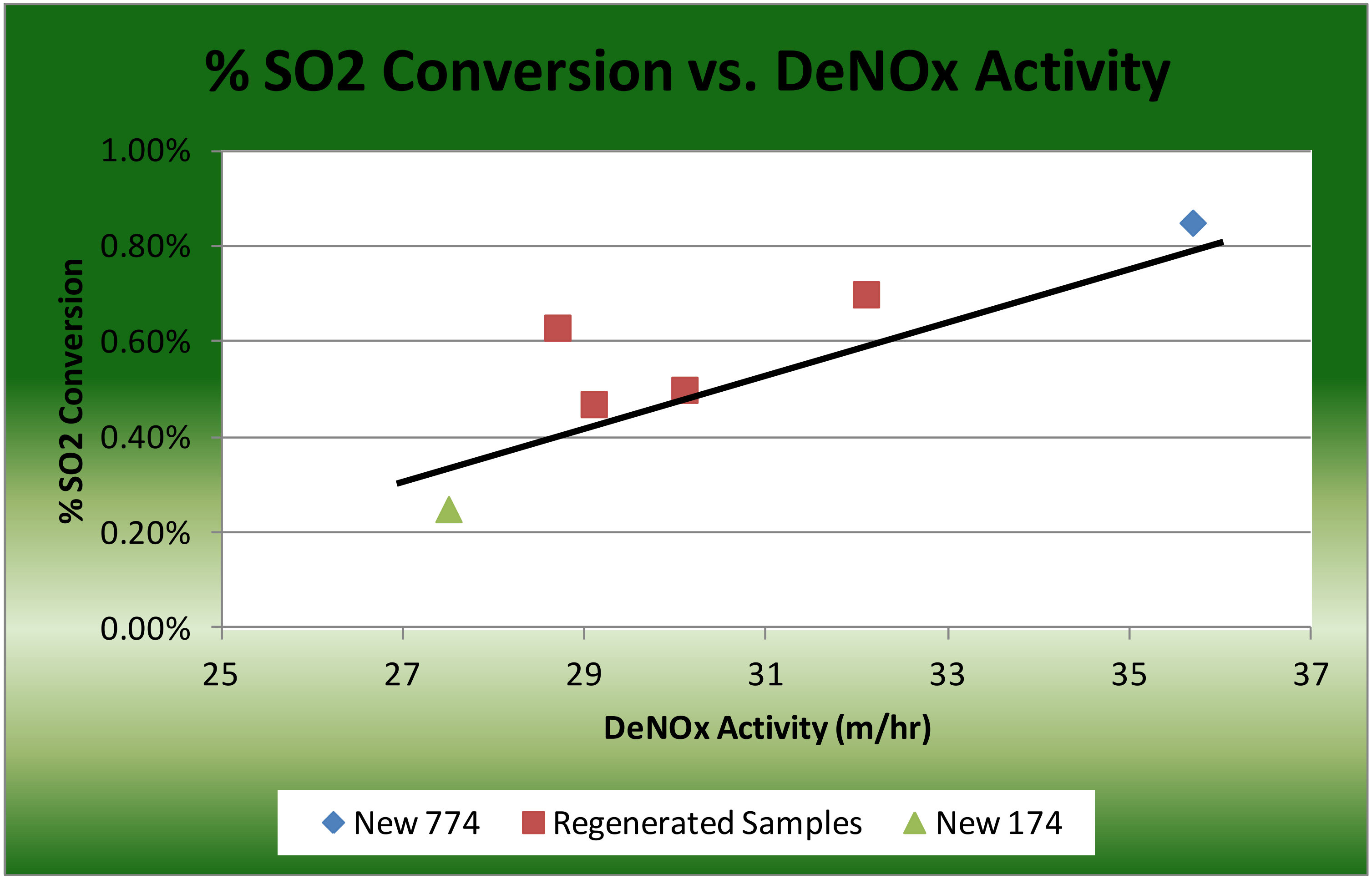

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Conclusions

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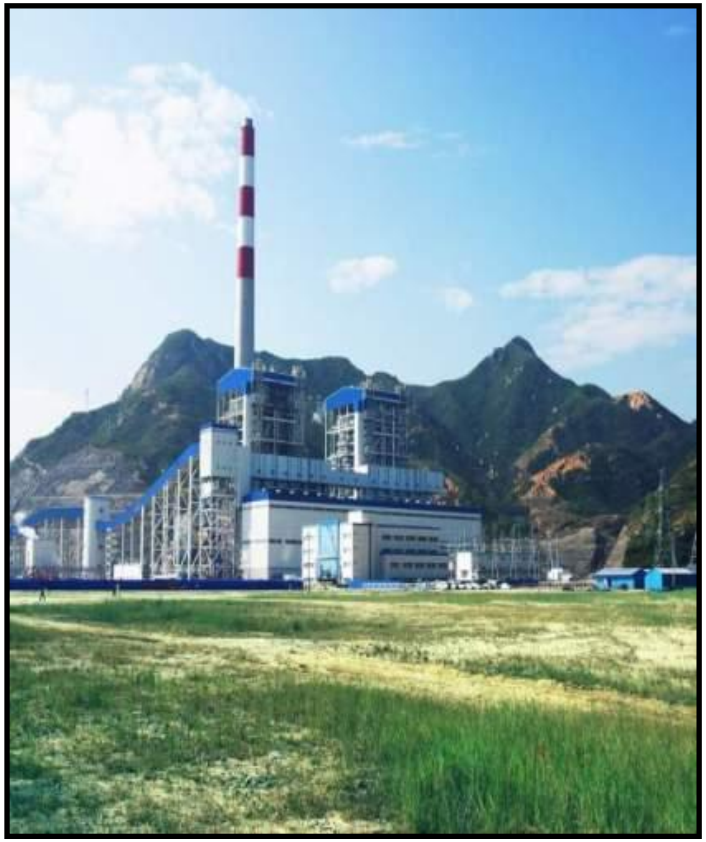
- Performance significantly closer to 174
- More studies required

	DeNOx Activity (m/h)	SO_2 to SO_3 conversion per layer
New 774	> 35	0.85%
Best Regeneration Fit	29.1	0.47%
New 174	> 27	0.25%
Alpha (α)for activity testing was 1		
Alpha (α) for conversion testing was 0		
No SO_3 was used in the flue gas simulation		



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Thank-you

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