REINHOLD ENVIRONMENTAL Ltd.

2013 NOx-Combustion Round Table & Expo Presentations

February 18 & 19, 2013, in Salt Lake City, UT / Hosted by PacifiCorp

Multi Pollution Control using Mitagent™ Combustion Additive

2013 Reinhold NO_x Combustion Round Table

Salt Lake City, Utah , February 18-19, 2013

Disclaimer

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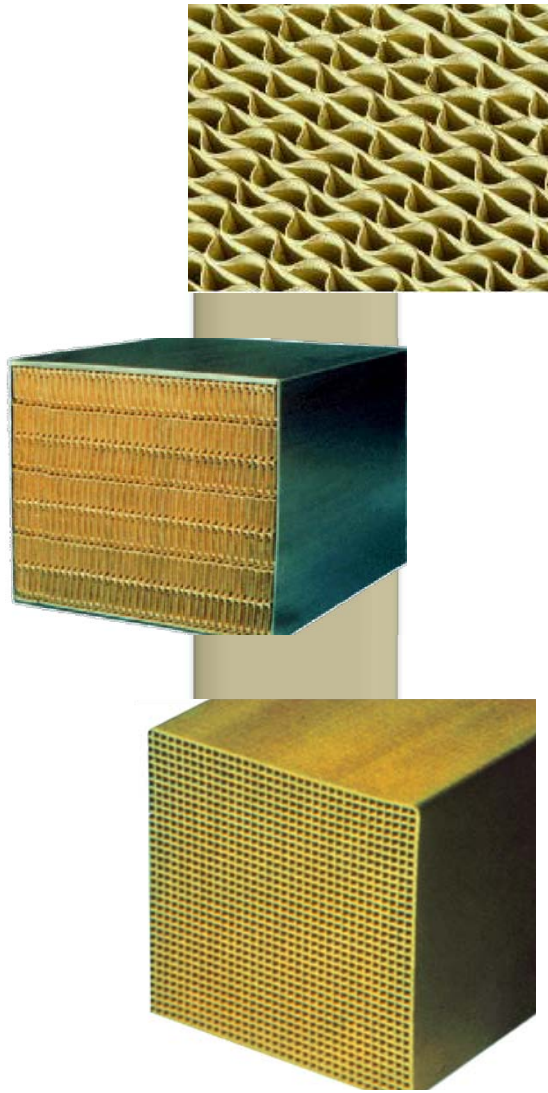
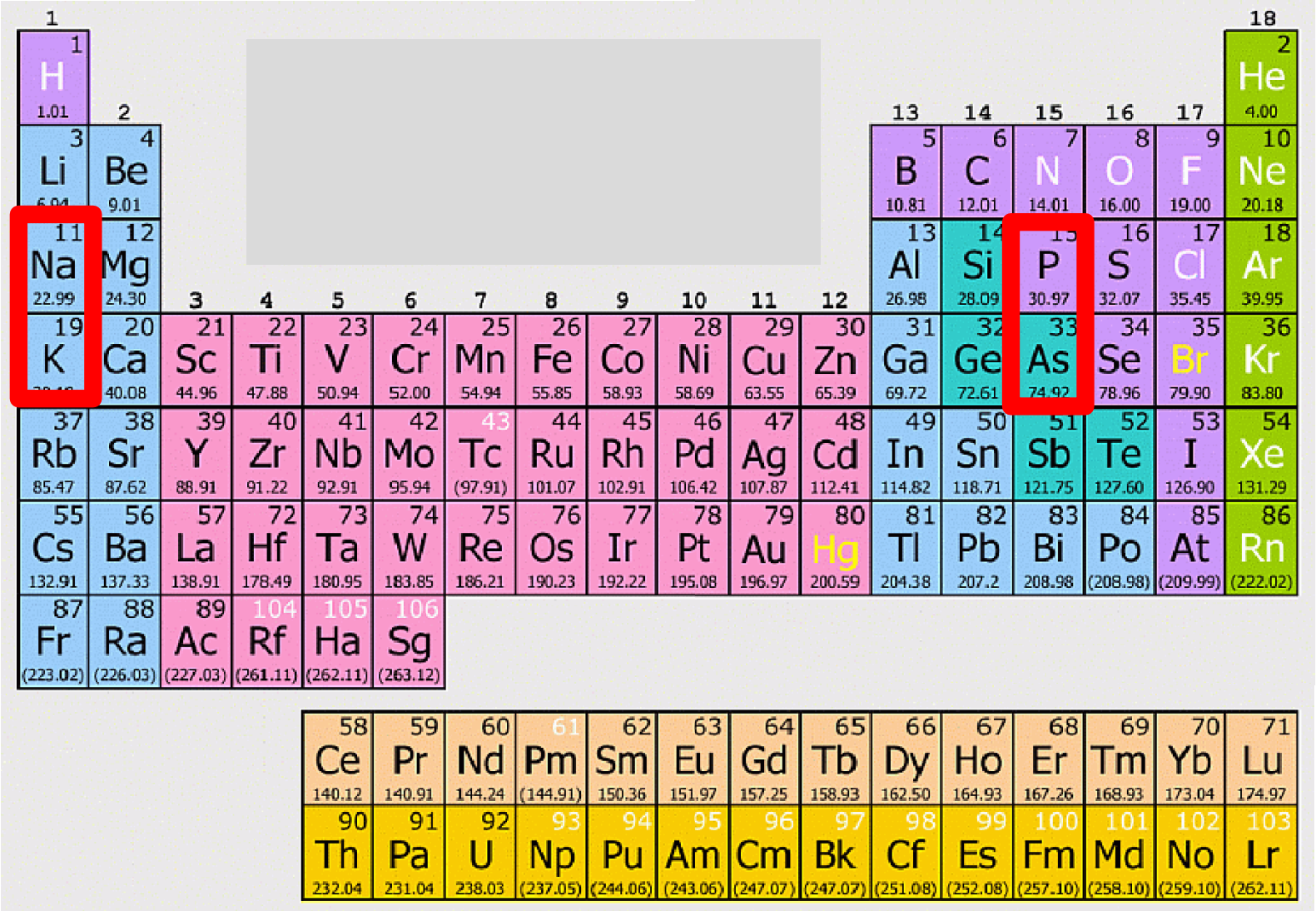
Presentation Agenda

- **Mitagent™ combustion additive development**
- **Field test results**
- **Economic analysis of combustion additive injection**
- **Selenium mitigation**

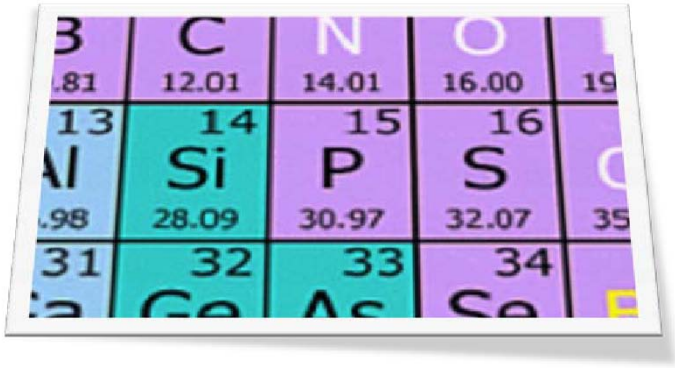


Periodic Table of the Elements



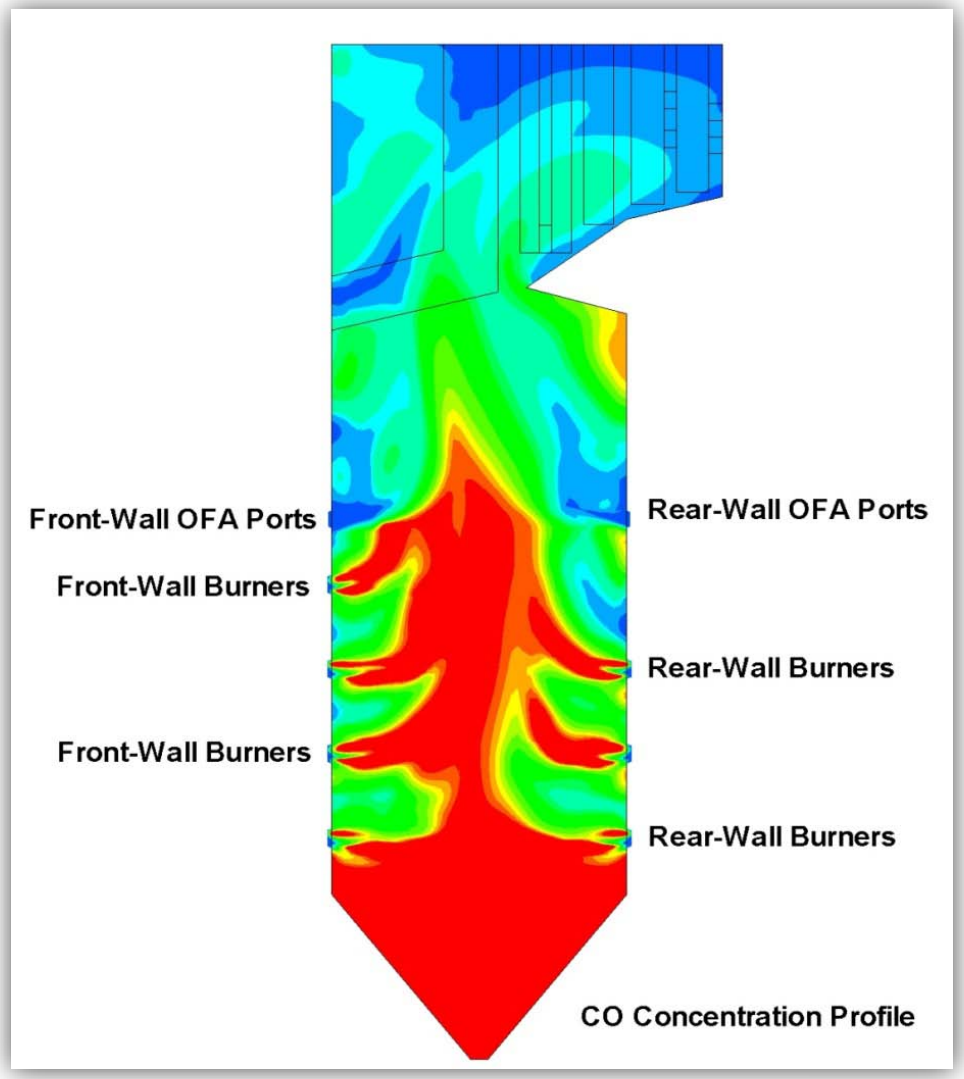
Deactivation of SCR Catalyst by Phosphorus

- **Deactivation by phosphorus many times experienced with PRB coal**
- **Combustion conditions play major role in deactivation process**
- **Deactivation observed more often under staged combustion conditions as compared to unstaged combustion**
- **Staged or poor combustion can lead to deactivation of catalyst by phosphorus**
- **Gas phase phosphorus at SCR inlet is important contributor to deactivation**



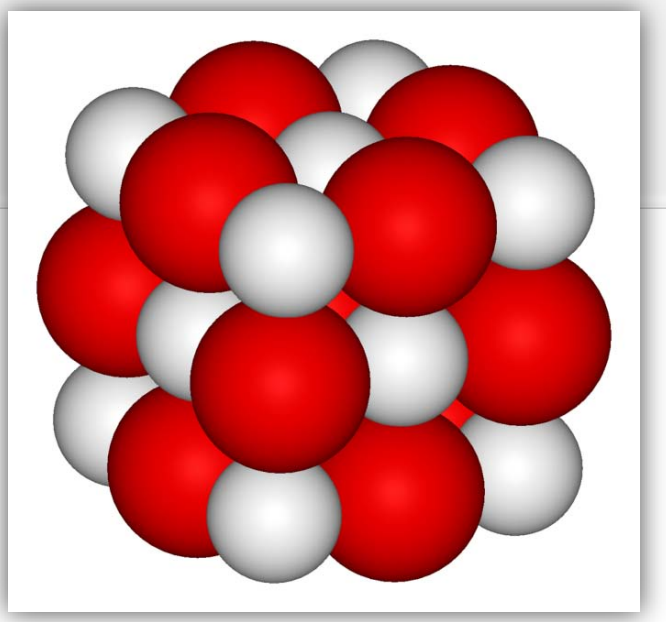
Staged/Poor Combustion Effects

- **Carbothermic reduction of phosphorus-bearing minerals due to staging in lower furnace**
- **Even unstaged, if poor combustion exists in furnace the same effect of carbothermic reduction of phosphorus bearing minerals can be observed**

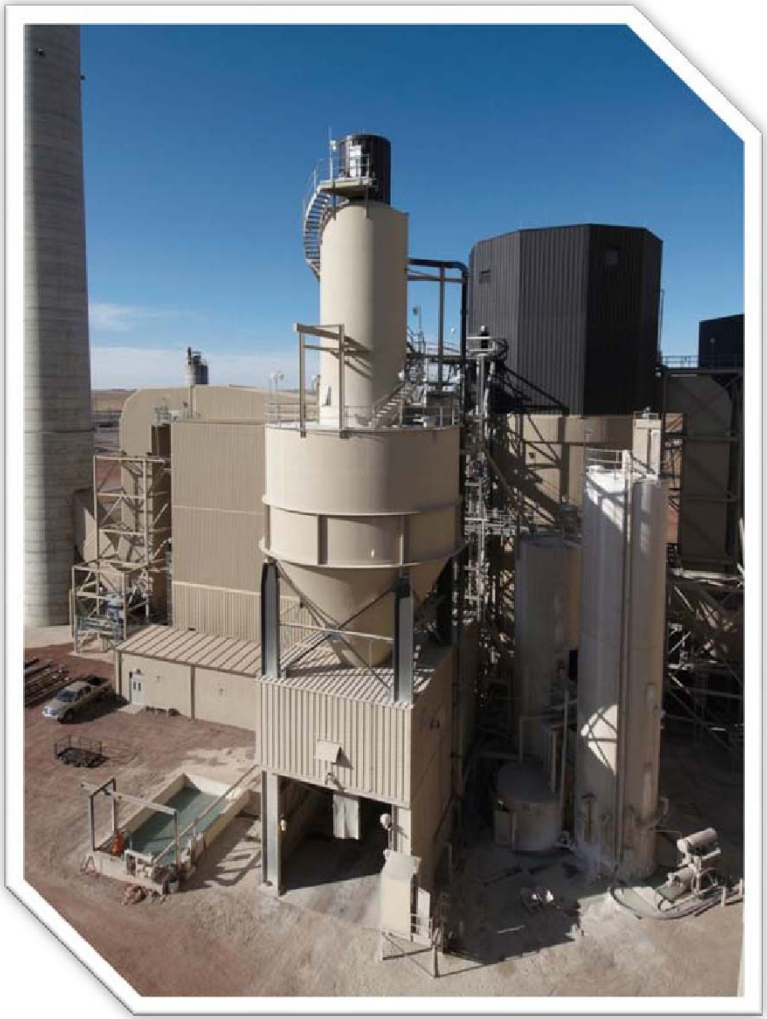


Combustion Additive Development

- **B&W investigations for binding gas phase phosphorus**
- **Impact on boiler performance**
- **Technical feasibility of injection**
- **Short term testing**
- **Long term testing**



Long Term Injection

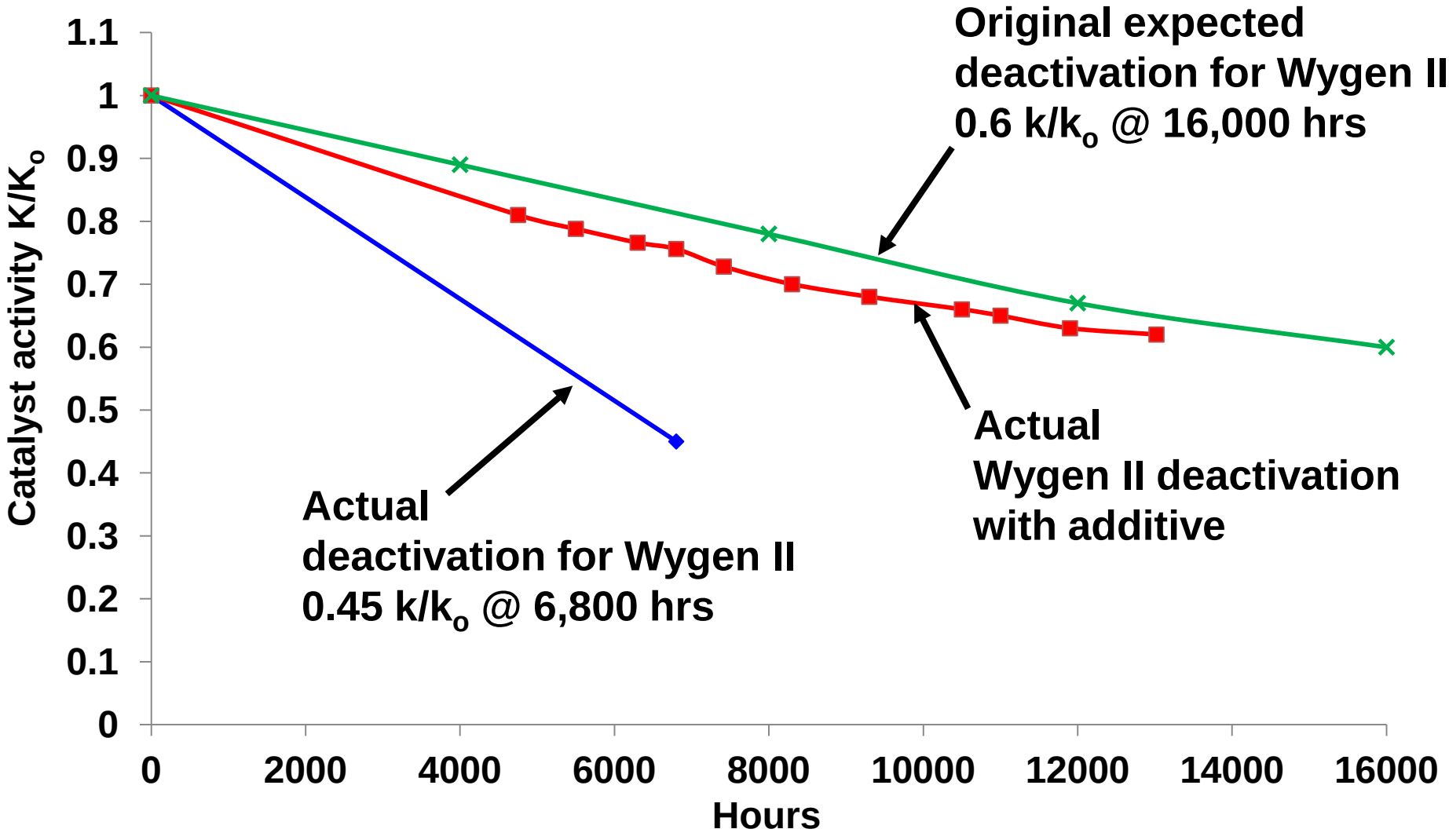


- **To demonstrate reduction in rate of catalyst deactivation**
- **Wygen II – 100 MW unit with SCR, SDA and fabric filter**
- **Wyodak mine PRB coal**
- **Staged combustion**
- **Experienced rapid catalyst deactivation due to phosphorus previously with new catalyst**
- **At time of testing, catalyst was 6.9 mm pitch, single layer, regenerated**

Using Combustion Additive for SCR Catalyst Deactivation Mitigation

Results

Wygen II – Catalyst Performance



Projections of Catalyst Life

- **Based on deactivation rate at Wygen II with additive injection, the theoretical catalyst life for different scenarios:**

Unit	*No. of Layers*	*End of Life Activity K/Ko*	*Theoretical Life Hours*
Wygen III – no additive	**2**	**0.43**	**16,000**
Wygen II – with additive	**1**	**0.6**	**16,000**
Wygen II – with additive	**2**	**0.6**	**24,000**
Wygen II – with additive	**3**	**0.6**	**32,000**

- **An improvement in life of catalyst can be achieved due to slower rate of deactivation**

How Does a Slower Rate of Deactivation Benefit New or Existing SCRs?

- **Having less volume for the same DeNO$_x$ requirement**

Parameter	*With Additive*	*Without Additive*
Unit size	**> 650 MW**	**> 650 MW**
Inlet NO$_x$	**0.26**	**0.26**
Outlet NO$_x$	**0.05**	**0.05**
Slip	**2 ppm**	**2 ppm**
Initial volume	**480 m^3**	**680 m^3**
Number of change events in 20 years	**12**	**12**
Replacement volume each event	**160 m^3 each subsequent replacement layer**	**230 m^3 each subsequent replacement layer**

How Does a Slower Rate of Deactivation Benefit New or Existing SCRs?

- **Extending life further with the same volume**

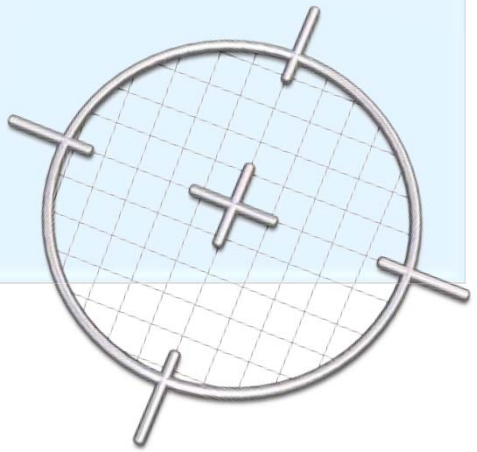
Parameter	With Additive	Without Additive
Unit size	> 650 MW	> 650 MW
Inlet NO_x	0.26	0.26
Outlet NO_x	0.05	0.05
Slip	2 ppm	2 ppm
Initial volume	680 m^3	680 m^3
Theoretical life	26,000	16,000
Number of change events in 20 years	6	12

Blended Additive Development

- **Demonstrate reduction in gas phase phosphorus entering SCR and simultaneous increase in Hg oxidation due, in part, to additive to control gas phase phosphorus**
- **Demonstrate Hg emissions compliance with oxidation and removal using FGD only**
- **Developed a patent pending blended additive to achieve simultaneous phosphorus reduction and Hg oxidation**
- **Tested at 300 MW PRB unit with SCR, CDS and fabric filter air quality control system**

Observations from Blended Additive Testing

- **Able to achieve stack Hg below 1.2 lb/Tbtu compliance limit set by MATS along with 45% reduction in gas phase phosphorus at SCR inlet**
- **Confirms capability to achieve Hg compliance using SCR, CDS and fabric filter without ACI injection**
- **No increase in undesirable hydrogen halide stack emissions observed with injection**



Economic Benefits of Blended Additive

- **Significant savings in compliance cost due to elimination/reduction in use of activated carbon injection**
- **As poisoning of catalyst is mitigated, Hg oxidation with halogen or halogen composition should achieve reduced Hg emissions without carbon for long-term**
- **Additional revenue from sale of ash due to elimination of carbon**
- **In particular for units with circulating dry scrubber (CDS) reduction in carbon use will reduce the concern with bag house and air slide fire**

Effect of Bromine Injection on Selenium

- **Bromine or bromine compound injection is very effective method for Hg oxidation on low halogen coals**
- **It was observed that as a result of bromine or bromine compound injection, selenium speciation was changed resulting in more selenium in gas phase**
- **On units with wet scrubbers this resulted in high selenium in scrubbers**
- **Selenium in Se(VI) oxidation state cannot be removed effectively from scrubber waste water discharge**

Selenium Mitigation

- **Long-term Mitagent™ testing at Wygen II, observed an increase in particulate bound selenium as a result of injection**
- **At Springfield test even with Mitagent™ 95 injection, particulate bound selenium increased as compared to baseline at air heater outlet**
- **As a result, it is possible to use bromine or bromine compound injection for Hg oxidation without negative impact on selenium speciation**

power generation group

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THANK YOU. QUESTIONS?

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