

REINHOLD ENVIRONMENTAL Ltd.



2019 NO_x-Combustion-CCR Round Table Presentation

February 11 & 12, 2019, in Salt Lake City, Utah / Hosted by PacifiCorp

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Coal – Hybrid Layer Catalyst Pitch Decisions to Balance Potential and Pluggage

Monday, February 11, 2019

Philip Elliott – Vice President Business Development

Agenda



- **Purpose of SCR and the Issues**
- **What is a Hybrid Layer**
- **Why a Hybrid Layer**
- **Benefits of a Hybrid Layer**
- **Conclusion**



Purpose of the SCR



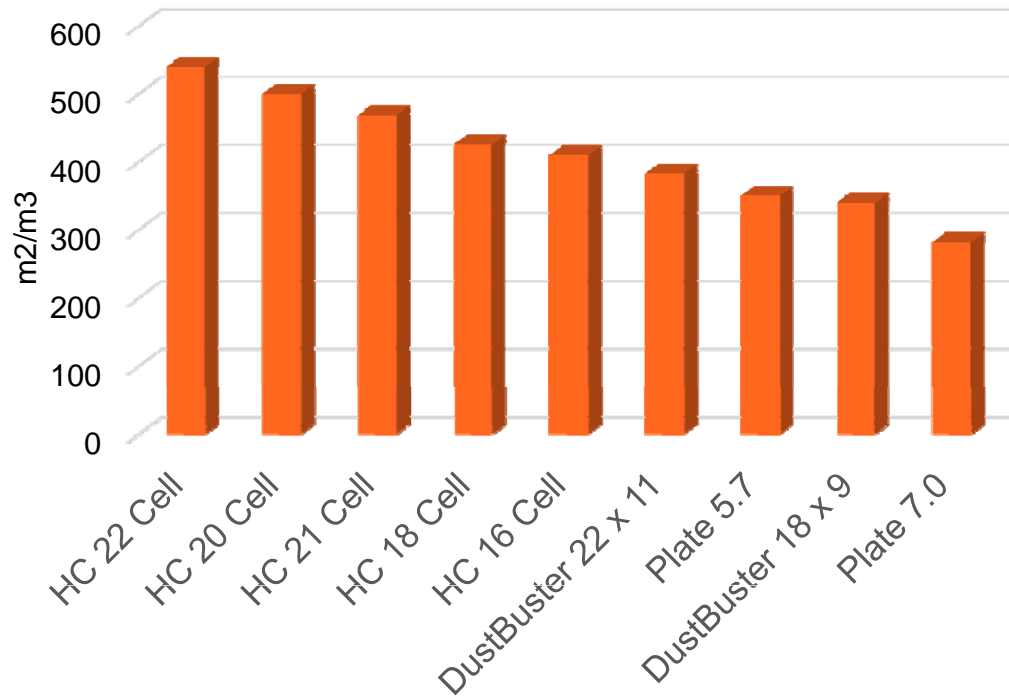
Analogy	Units	Ford F 150	Lexus RCF
0 to 60 mph DeNOx K (Speed)	Seconds	7.5	4.4
Fuel Economy	MPG	18	25
Fuel Tank Size	Gallons	36.0	17.4
Range DeNOx P (Life)	Miles	648	435

You are purchasing SCR Life (DeNOx Potential)

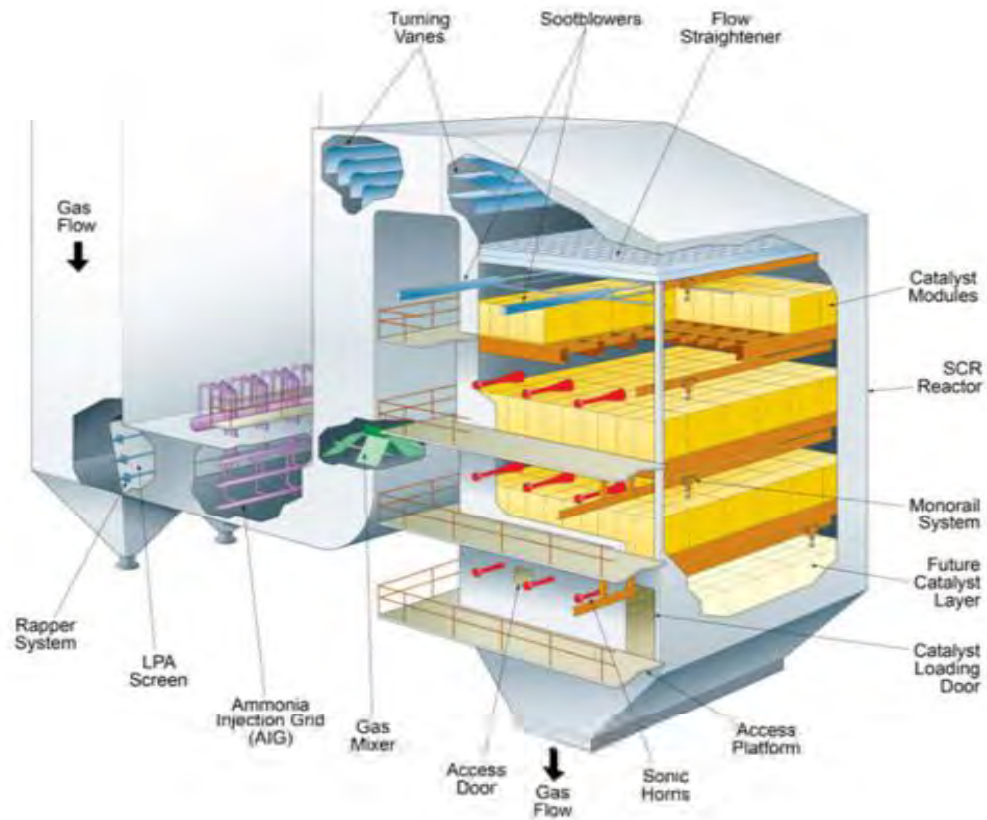
Surface Area Comparison



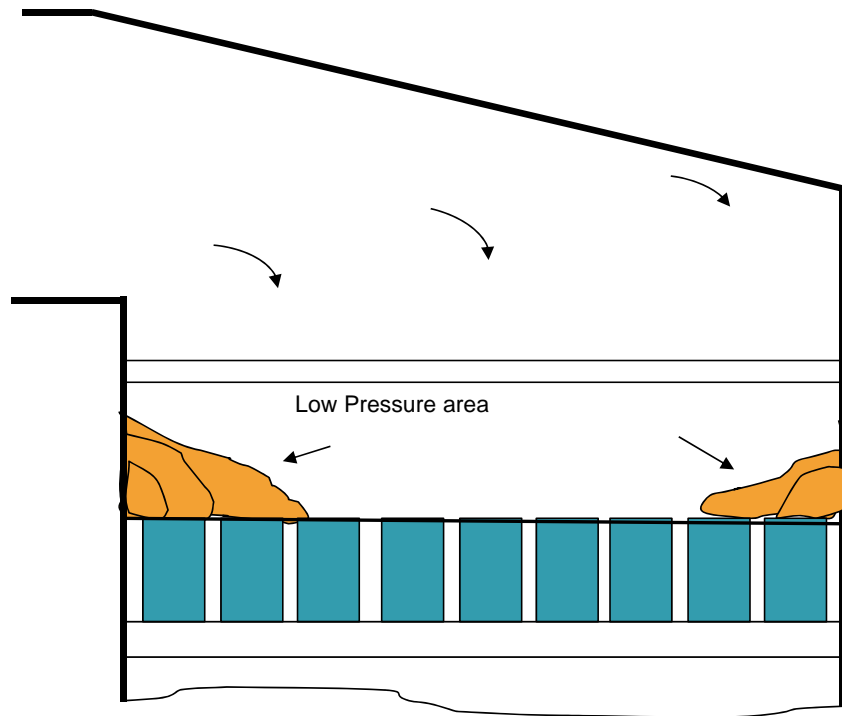
Specific Surface Area



Ideal SCR



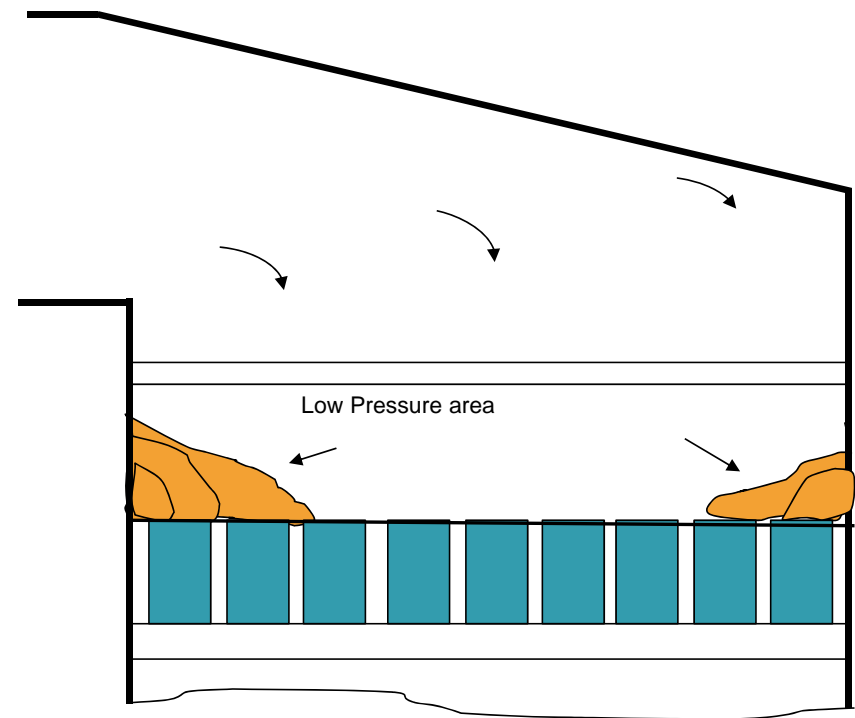
Reality of SCR



What Is the Effect



- Low pressure zone by the front wall or rear walls
- Normally the most severe on the top level
- Once the build-up starts, the progression of the build-up continues

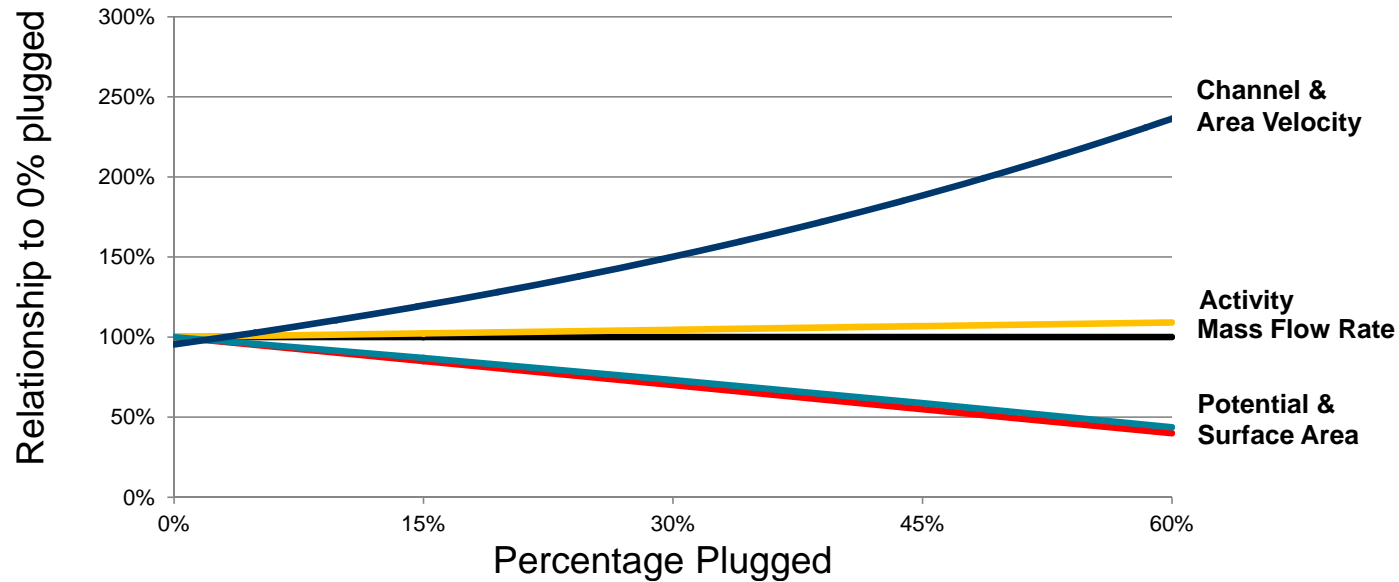


What Are The Impacts

- The velocity through the catalyst channels increases.
- The catalyst surface area is greatly reduced.
- The catalyst potential is greatly reduced.
- The pressure drop across the reactor is increased.



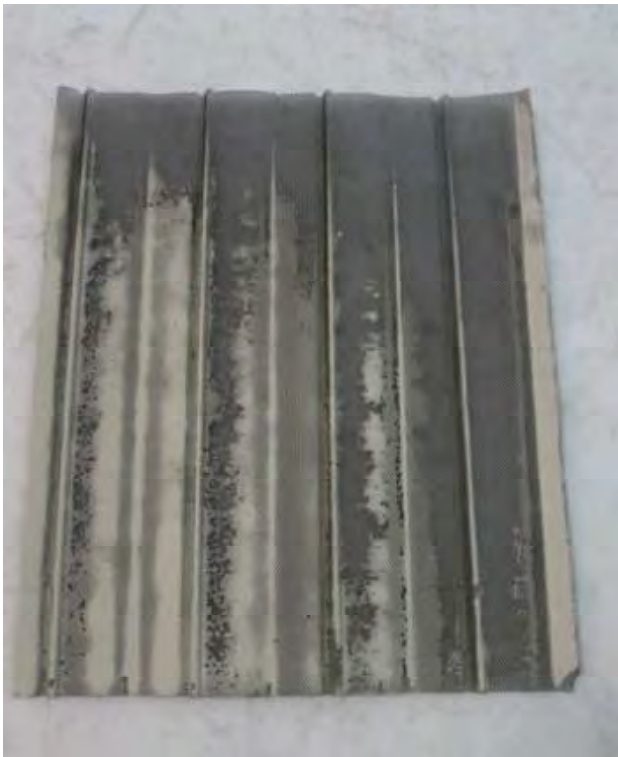
Example of Performance Degradation



As Pluggage Increases:

- Channel Velocity increases
- Potential and Surface Area decrease
- Pressure Drop increases exponentially on the square

Plate Erosion Examples



Honeycomb Erosion

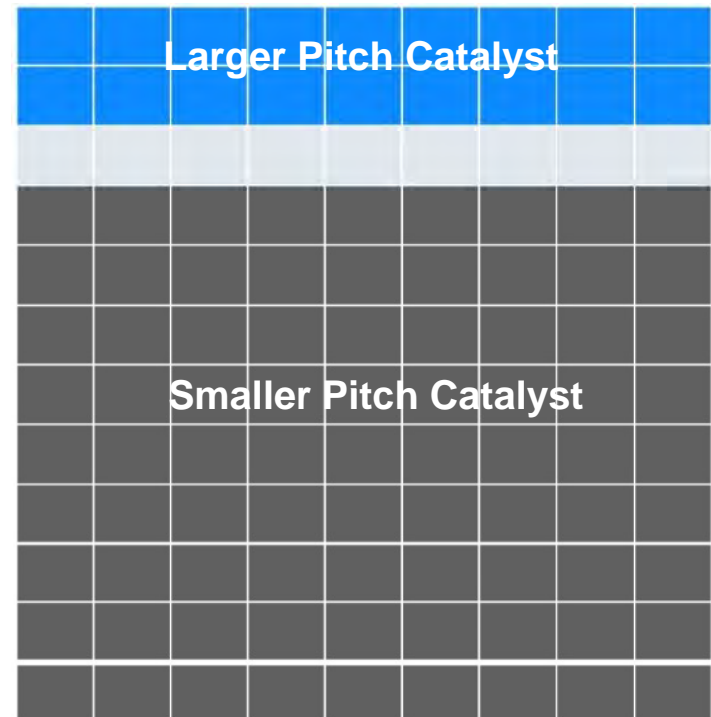


What is a Hybrid Layer



- **A Catalyst Layer with Two or More Different Pitch Catalyst Modules**
- **Typically the Same Style**
 - Honeycomb
 - Plate

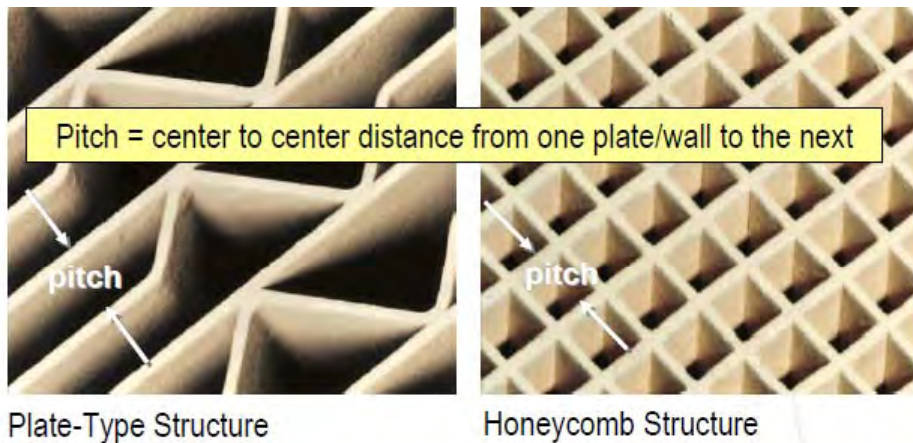
Reactor



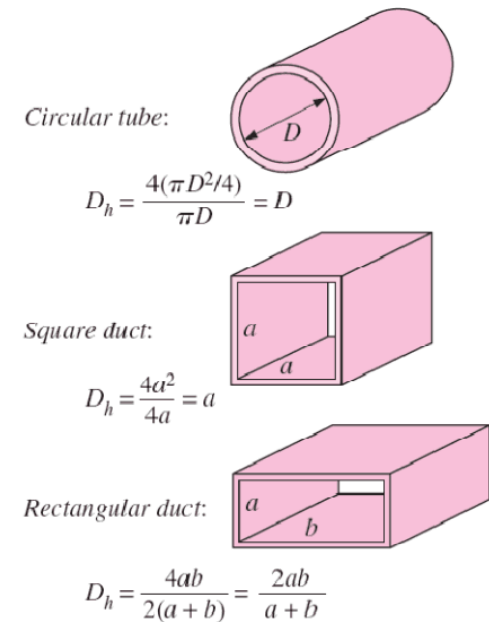
Pitch vs. Hydraulic Diameter



Catalyst Pitch



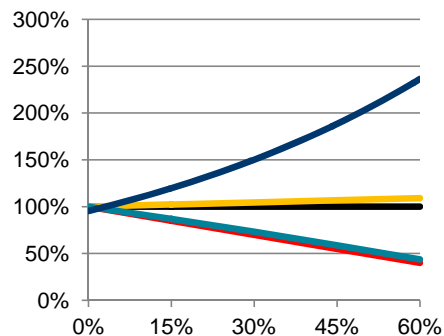
Catalyst Hydraulic Diameter



Larger Pitch = Less Potential



- Not Always True
- Catalyst Pluggage Prevents Reaction
- Loss of Surface Area
- Velocities are Higher

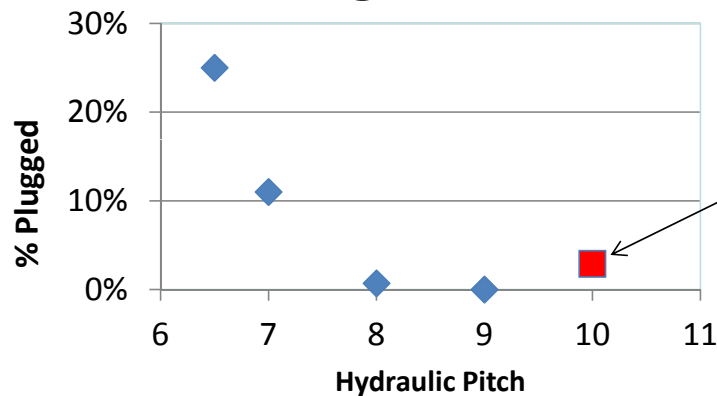


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Why Not Just Plate?



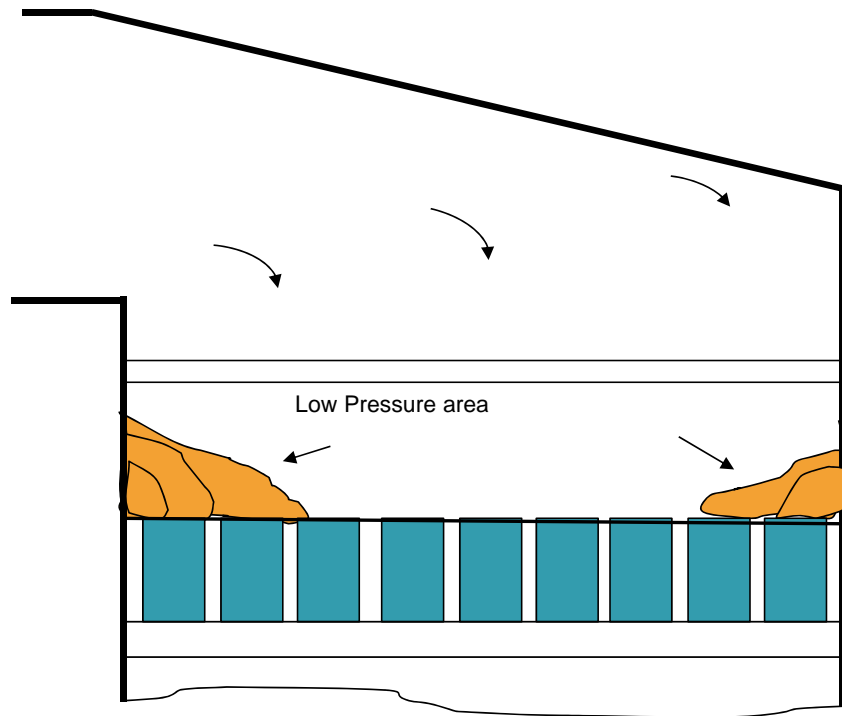
- **Common Perception: “Plate” simply plugs less than “Honeycomb”**
- **Fact: With sub-optimum / poor designs, larger pitch plugs less than smaller pitch**
- **Example: Ash drop testing to simulate sloughing or piling due to poor reactor design:**



**Rectangular plate hydraulic pitch. Aspect ratio: 8.5:1
(~49mm x 5.7mm pitch)
All other samples are Honeycomb**

Ash + flour 50:50 mixture to simulate sticky ash
1.25 Kg of mixture dropped per square foot of catalyst

Where Does Ash Piling Start



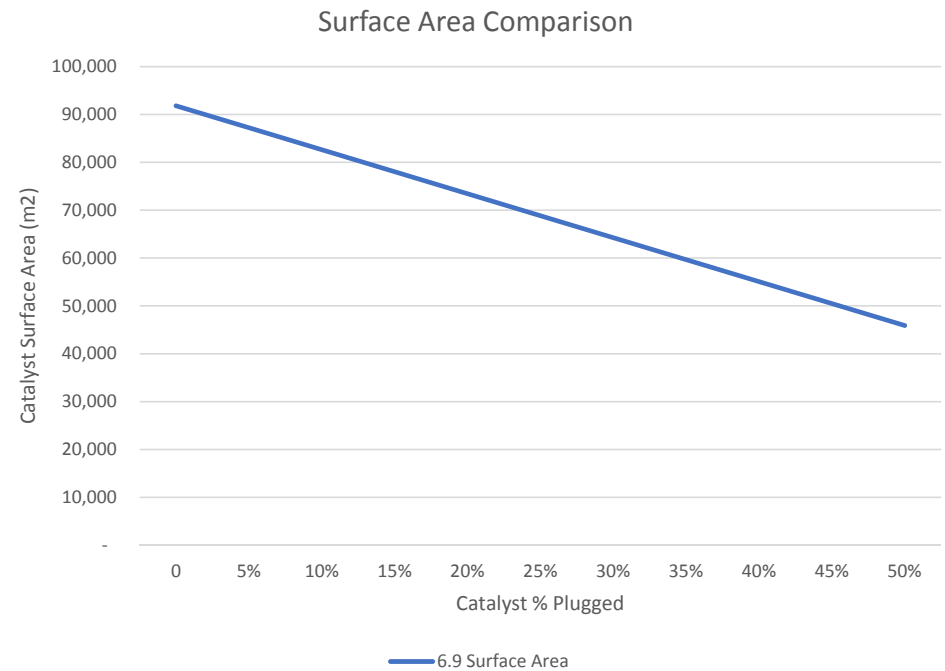
- Usually Along Boiler Walls
- Low Flow Lead to Ash Fallout
- Ash Buildup Progression Continues

Catalyst Surface Impact



Assumptions

1. Number of Modules → 100
2. Volume per Module → 1.7
3. 6.9 Pitch HC Catalyst
4. 8.2 Pitch HC Catalyst
5. Initial Layer Potential → 3
6. Pluggage Impact Only Impact on Potential

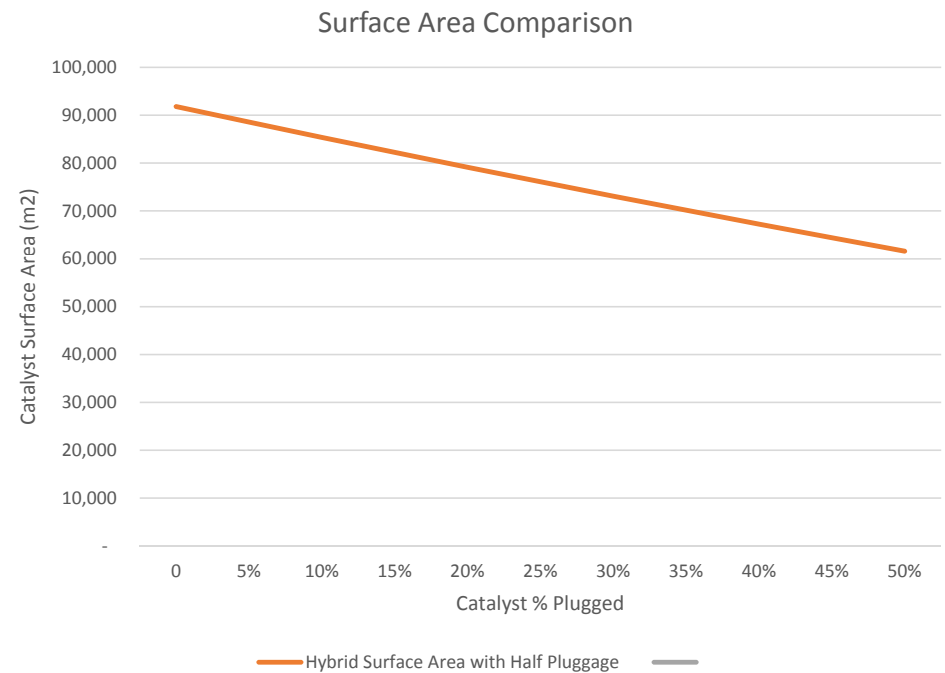


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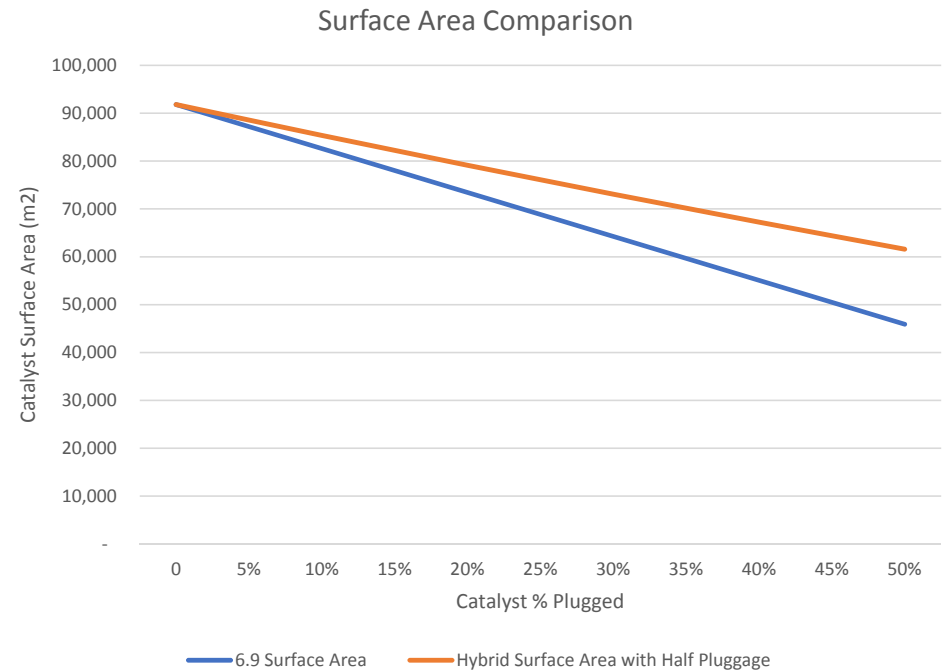


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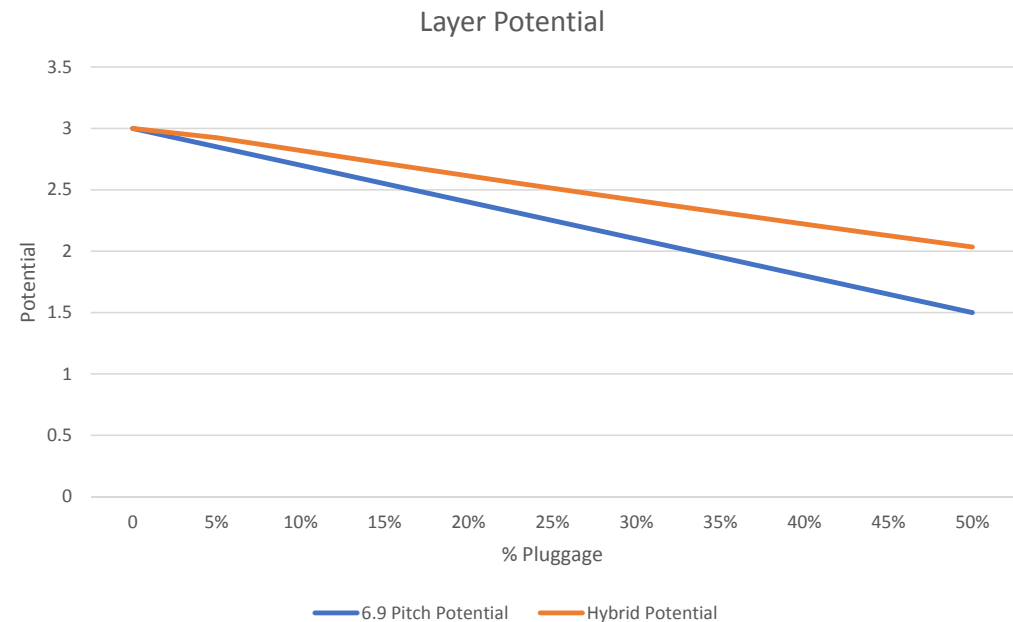


Catalyst Potential Impact

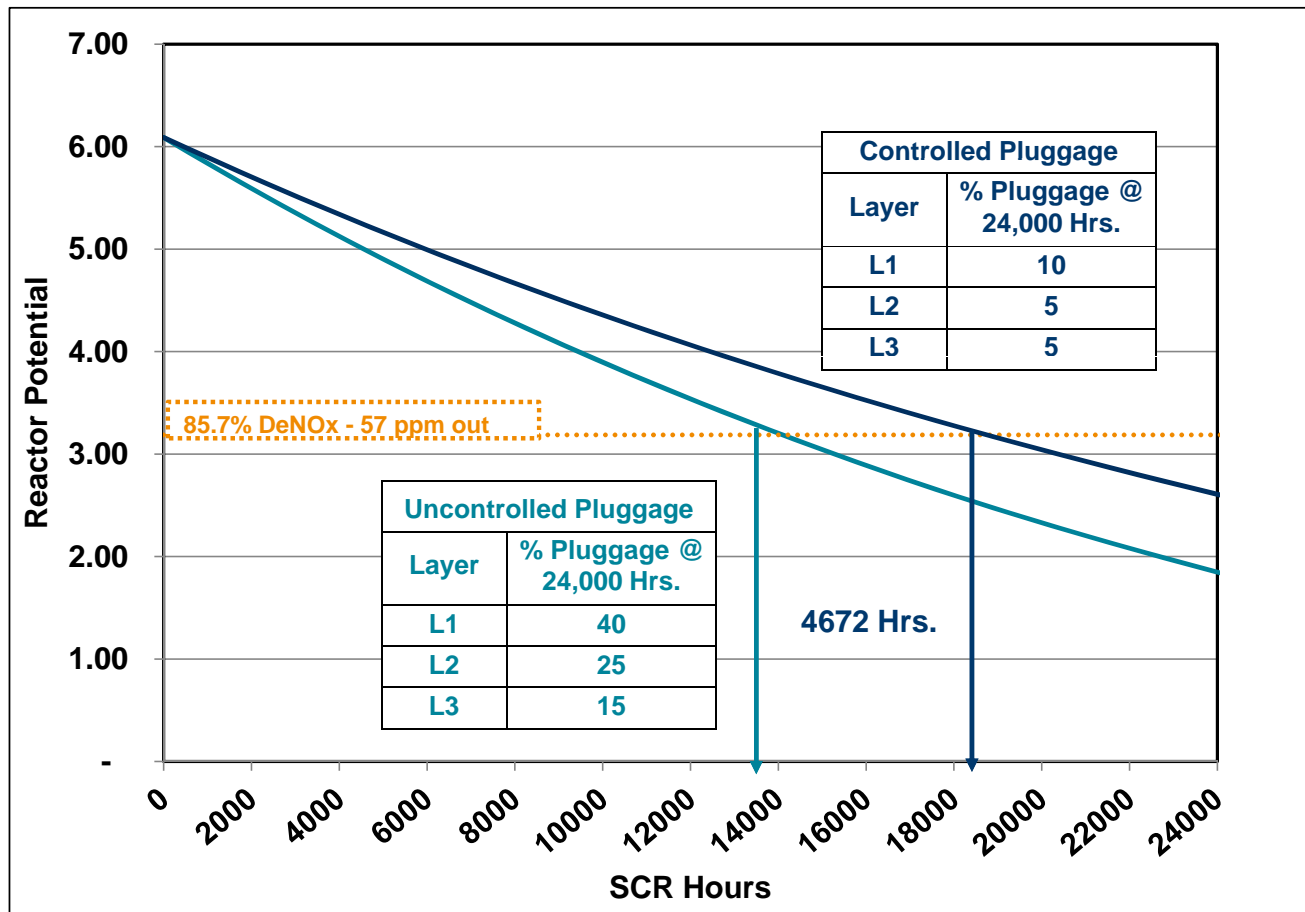


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Impact of Catalyst Pluggage



Case Study



- **Midwest Utility**
- **~ 600 MW**
- **Illinois Basin Coal**
- **Pluggage Along Front Wall**



Results



Parameter	Uniform Layer	Hybrid Layer
Catalyst Pluggage (%)	28	11.5
Specific Surface Area of Layer (m ² /m ³)	350	333
Total Layer Surface Area New (m ²)	71,232	67,772
Total Layer Surface Area Plugged (m ²)	51,198	59,978
Available Surface Area for Potential	1.8	2.2

History



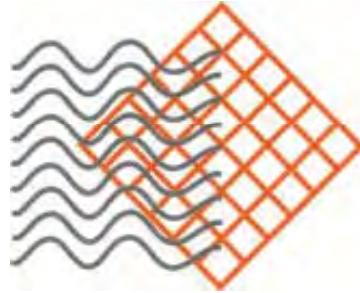
- **CORMETECH History Included 15 Units for Hybrid Layer**
- **All Effectively Mitigated Pluggage Issue**
- **Physical Damage to Catalyst has Slowed**
- **All Can Regenerate Catalyst**



Summary



- **Several Coal Units have Significant Plugging Issues**
- **Hybrid Layers of Different Pitches Helps Alleviate Plugging**
- **Operating Experience Shows that Loss of Potential is Made up by Less Pluggage**



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Questions?
