

# Reinhold Environmental Ltd.



## 2010 NO<sub>x</sub>-Combustion Round Table & Expo Presentation

***February 8 & 9, 2010***

***Chattanooga, TN***

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# Catalyst Change-out Optimization



Johnson Matthey  
Catalysts



REINHOLD ENVIRONMENTAL LTD.

2010 NO<sub>x</sub>-Combustion Round Table  
Chattanooga, TN  
February 8, 2010

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# Goals for Optimizing Catalyst Change-out



- Well-planned, well-executed project
- Minimize outage time
- Minimize project costs
- Prevent injury
- Avoid equipment damage



# Questions to Answer



- What can be done to reduce outage time?
- What are the best practices?
- Wish list . . .
- How can we better monitor performance between change-outs?



# Reasons for Catalyst Change-out



- Per CMP - replace catalytic potential lost to expected deactivation
- Fix a problem
  - Severe plugging – need larger pitch/openings, different catalyst type
  - Faster-than-expected deactivation
  - Need lower SO<sub>x</sub> conversion
  - Replace damaged catalyst
- Changing emission targets requires different catalyst design
- Extend time between outages for catalyst management



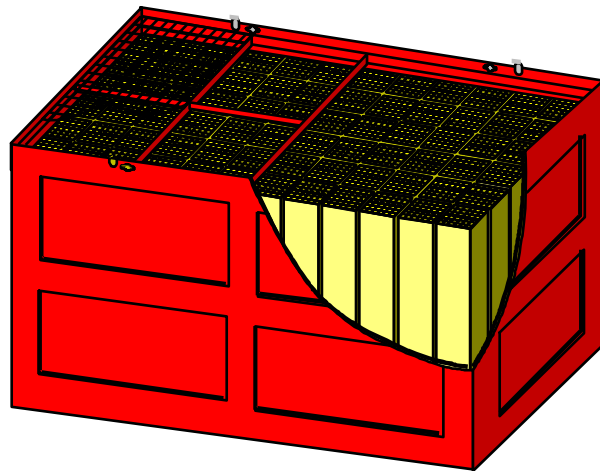
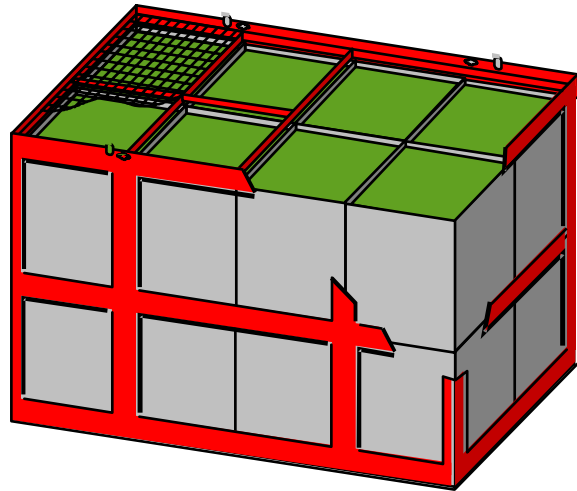
# Challenges



- Outage timing uncertainty may not allow just-in-time delivery
- Limited space for storage and staging
- Limited access for reactor entry
- Reactor layers designed for non-standard modules (not typical)
- Spacing between reactor layers limits module height
- Make the best of what there is



# Catalyst Modules



- Standardized cross-section ~ 1 m x 2 m
- Possible to interchange catalyst types within reactor
- Module height varies with catalyst height
- Catalyst elements arranged in steel frames
  - Plate – 2 sub-layers of 8 element boxes
  - Honeycomb – 72 blocks per module
  - Corrugated – similar to plate, sub-layers with 8 “cassettes”
- Top-screens
- Weight – 2500 to 3200 lbs



# Module Delivery – Scale and Logistics



- Reactor Size
  - Small: 1 reactor, 24 modules per layer
  - Large: 3 reactors, 112 modules/layer/reactor (336 total per layer)
- Delivery (Sea Containers)
  - 11 modules per container
  - 2 hours unloading time per container
  - 4 – 5 containers delivered/unloaded per day
  - 3 – 4 days of delivery for average unit (400 – 600 MW)



# “Over-Simplified” Change-out Procedure



- Procurement – Spec development, RFQ, bid evaluation, award contract, receive delivery
- Facilities preparation – Labor, module handling/lifting tools, space
- Unit shut-down → cool-down → reactor entry
  - Safety/hazard prep
  - Vacuum fly ash
  - remove old catalyst, install new catalyst
- Unit restart
- AIG tuning (if necessary)
- Monitor performance

Document Everything!



# Module Installation Crew



- Crew of 7 to 8 per reactor
  - 1 forklift operator
  - 2 at ground level for module prep and staging
  - 2 at reactor level for module lift
  - 2 – 3 inside reactor to position modules



# Facilities Preparation – Space Considerations



- Consider the weather – keep modules dry before installation
- Space, temporary storage
  - Onsite warehouse
  - Large pavilion tents
  - Sea Containers
  - Smaller storage footprint if modules can be stacked (2-high)
- Ground staging
  - Close to pick point for lift up to reactor level
  - Use roller conveyors to move modules into position



# Module Handling and Lifting Tools



- Forklift with pneumatic tires and telescoping boom
  - Delivery unloading
  - Moving modules in/out of temporary storage
  - Good for rough terrain
- Turning table for honeycomb modules(?)
- Module lifting yoke – attaches to module for lifting
- Hoist at SCR, crane for lifting modules to reactor layer deck
- Roller conveyors at reactor layer deck
- Temporary grating inside reactor
- Hydraulic cart/trolley for moving modules into position in reactor



# Module Turning Table



# Module Lifting Tool (a k a lifting beam, lifting frame, yoke, etc.)



# Hydraulic Cart



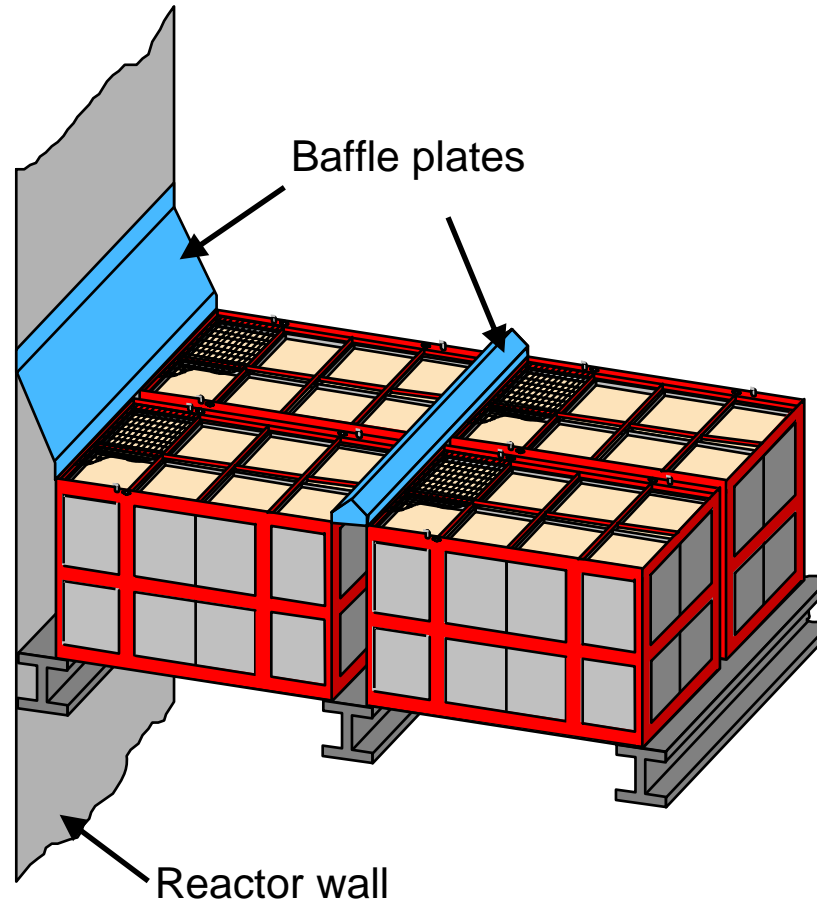
# Work inside the Reactor



- Prepare safety harnessing (“rat-lines”)
- Vacuum fly ash
- Remove fly ash baffles
  - Between modules
  - Between inner wall and module perimeter
- Remove old modules
- Install temporary grating
- Position hydraulic cart
- Clean support beams and install sealing gasket (bottom sealing modules)



# Fly-Ash Baffles



# Hydraulic Cart Placed Between Support Beams



# Ground Staging



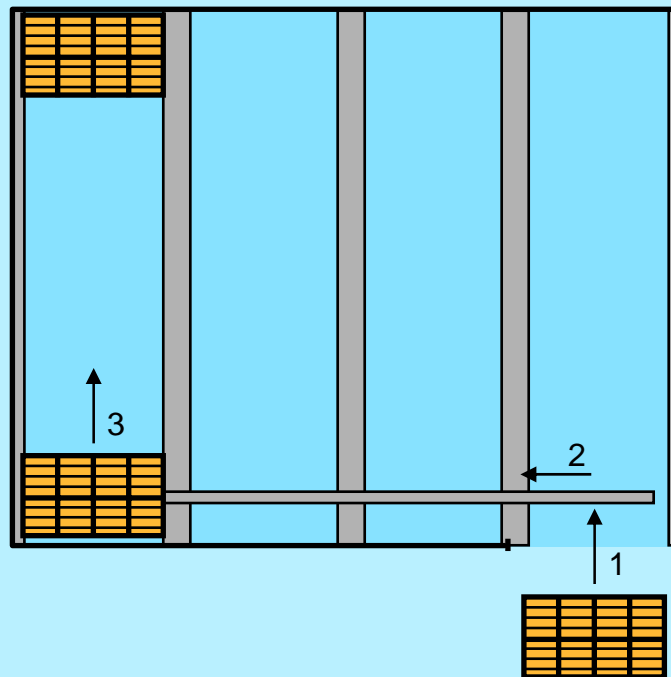
# Lifting



# Module Installation – Single Door Access



Reactor catalyst level top view



Step 1 : Transport from outside to reactor inside via a trolley. Inside the reactor the module is attached to a hoist on a temporary beam.

Step 2 : Transport inside the reactor to the final row and lowering the module on the hydraulic trolley.

Step 3 : Transport to the final module position and placement.



# Monorail and Cart System



Lowering the catalyst module from the temporary hoist on the hydraulic trolley.

- Sealing strips are placed on the beams.
- Gratings are temporary and will be removed.



# Module on Cart being Rolled into Position



# Improvements



- Just-in-time delivery
- Modify ductwork to reduce/prevent fly ash piling
- Multiple access points into reactor
- Monorail extensions outside reactor for easier loading
- Non-welded fly ash baffles
  - Snap in place
  - Bolted/pinned
- Install modules with maximum available height
  - Extending time between outages
  - Standardized for Fleet deployment



# Module Installation



# Module Installation



# Performance Monitoring



- Traditional catalyst sampling
  - Routine (annual) relative activity testing
  - Element analysis – XRF, EDX
  - Requires unit outage to pull samples
- *In Situ* Potential Monitoring
  - Good for comparison with laboratory results
  - Unit outage/shutdown not required
- NH<sub>3</sub> slip monitoring
  - Ash sampling
  - Optical (TDL) online flue gas NH<sub>3</sub> slip monitoring



# Summary



- Adequate space for staging and temporary storage
- Tooling for module moving and handling
- Create as much access into the reactor as possible
- Avoid welded baffles if possible
- Fleet-wide standardization approach
- Keep thorough documentation



# Thank You!



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