

INFRASTRUCTURE MINING & METALS NUCLEAR, SECURITY & ENVIRONMENTA OIL, GAS & CHEMICALS



Bechtel Hydrocarbon Technology Solutions (BHTS)

# DCU Furnace On-Line Spalling

Safe Clean Reliable Profitable



2016 RefComm Mumbai Presentation Presentation by: J. Adams, G. Hughes & S. Alexander Presentation given by: R. Heniford & T. Hudson

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# Presentation Agenda

- Background Information
- What is OLS?
- Some Extra Benefits of OLS
- Applicability to DCU Furnaces
- OLS Operation Overview
- OLS Procedure
- Double Fired Furnaces with OLS
- Summary



ThruPlus® Designed DCU Furnaces

## **Background Information**

- The DCU operation is for thermally cracking other refinery unit residues to increase refined product yields
- The residues fed to the DCU are cracked at 875 940°F (470-505°C)
- The goal is to heat the residue in the DCU furnace(s) and to crack the residue in the coke drums and <u>not in the furnace</u>
- Steam, velocity, tube metallurgy, advanced furnace designs and sometimes specialty tube coatings are used to minimize carbon lay down in furnace tubes

However carbon (coke) lay down does still occur in furnaces, so periodic decoking is necessary to recover DCU furnace capacity and efficiency



# Online Spalling:

- A procedure using steam and temperature to remove coke deposits from the inside of the DCU furnace tubes
- Eliminates need to shut down the DCU to decoke furnace tubes, thereby improving stream factor & refinery profitability
- If used instead of Steam Air decoking or Pigging, it reduces DCU operation shutdown days by 2 to 4 days per episode, and up to possibly 10 to 20 days per year

# Industry Experience with Online Spalling

- It is proven and is already in use in many DCUs, but not all OLS systems are equally capable
- To utilize it successfully a carefully developed DCU furnace design and OLS procedure (with strong DCU area Process Engineer and DCU Operator training) are essential
- Some words of caution:
  - Inorganic compounds present in some DCU feeds are sometimes not removed by spalling, and OLS will sometimes not return the furnace to SOR temperatures
  - In such cases, pigging may be required after every 3 to 4 OLS's
- But many sites have been known to go for 6 to 7 years between pigging when utilizing OLS



# Some Extra Benefits of Online Spalling

- It improves the <u>safety</u> of the DCU operation by reducing the number of unit shutdowns and startups required
- OLS is a more <u>clean and environmentally friendly</u> method to decoke the inside of furnace tubes, since coke spalled out of furnace tubes is deposited in the DCU's coke drums



# **OLS Applicability to DCU Furnaces**

- It is applicable for use in DCU furnaces with:
  - Two or more furnaces or cells
  - Multiple tube passes
  - Adequate temperature and pressure design



Courtesy: PetroChem Development, 2016



# **OLS Applicability to DCU Furnaces**

- OLS is not applicable for use in all DCU furnace applications
  - In DCU furnaces with tube passes that cannot be separated, such that one or two passes can be spalled while the other passes continue in operation
  - Where feed to the DCU has significantly high levels of certain inorganic compounds
  - Where soft coke type furnace tube plugging can occur
- Or under certain operating conditions
  - When the furnace tube maximum design temperature and pressure will be exceeded by the targeted / required OLS procedure conditions





# **Furnace Design Considerations for OLS**

- For 9Chr-1Mo tubes, the end-of-run (EOR) skin temperatures might be 1200-1275°F (649-690°C)
- During OLS, skin temperatures should reach 50°F (28°C) <u>higher than</u> the EOR skin temperature to achieve an effective spall
- Mechanical design temperatures and pressures will limit EOR, to allow for this temperature rise during spall





# Furnace Design Considerations for OLS (cont.)

 Steam air decoking and pigging will allow DCU to run to higher EOR temperatures but then require additional downtime for decoking

Steam-Air decoking, Pigging, and OLS are all accepted ways to decoke a DCU furnace, however new DCU furnace designs often consider being able to do only OLS and Pigging



# **OLS Operation Overview**

- Maintain furnace tube velocity with steam
- Cool one cell; tubes contract
- Block oil to one cell
- Increase steam rate
- Manage tube velocity
- Increase temperature; tubes expand
- Manage antifoam



## OLS Spalling Procedure (general / typical steps to complete OLS)

- Review OLS procedure and prior procedures conducted
- OLS usually begins soon after a coke drum switch is completed
- Reduce residue feed rate and cool the furnace cell to be spalled
- Double block the flow of residue feed to the furnace cell to be spalled
- Increase high pressure steam to maintain roughly constant velocity through the furnace tubes
- High pressure steam rate is increased within specific velocity limits
- Furnace tubes being spalled temperatures are increased and monitored closely



## OLS Spalling Procedure (general / typical steps to complete OLS) (Cont.)

- Maximum furnace tube temperature during OLS is set based upon mechanical limitations of the tubes
- For optimum OLS results steam temperature is typically set at about 50 degrees F above the maximum end of run skin temperature for the furnace tubes
- One of the goals is to slough coke off gradually inside of the tubes
- Steam velocity should typically be around 325 feet per second
- Thermal shocking of the furnace tubes may be considered at the end of OLS based upon previous experience of and direction of the DCU Area Process Engineer and DCU Operator



# OLS Spalling Procedure (general / typical steps to complete OLS) (Cont.)

- During OLS the higher volume of steam (and/or boiler feed water) going into the coke drum may cause a higher foaming tendency in the coke drum
- Antifoam injection can be utilized to prevent excessive foaming
- If necessary, coke drums may be switched during the hottest period of the spall



## OLS Spalling Procedure (additional comments)

- The initial switch from residue to steam through the furnace tubes occurs rapidly and in large increments. This should be done at low temperatures – 750F or below
- During OLS expect the fuel gas rate to the furnace cell being spalled to be 10-20% of the normal fuel gas rate
- As necessary, take burners off-line to control furnace temperature during OLS
- It is still very important to fire as many furnace burners as possible at low rates to provide uniform heat distribution throughout the furnace firebox

# DCU Double Fired Furnaces with OLS

- Designed for increased run lengths between OLS events
- Have lower peak to average flux profile
- Have lower residence time of hydrocarbons at high temperatures (30 percent less furnace tubes)
- Lower costs: fewer tubes, box size & plot space; ease of modular construction





## <u>Summary</u>

- Successful utilization of OLS requires applicable DCU furnace design, proper OLS Procedures, and DCU refinery area Process Engineer and Operator training & experience!
- OLS benefits refiners mainly because of:
  - Improved DCU safety with fewer unit shutdowns & startups
  - Improved environmental impacts with coke from the furnace tubes being sent to / contained in the DCU coke drums
  - Proven results at many refineries
  - And very importantly increased DCU stream factor and refinery profitability



For additional information or support with DCU furnace OLS contact:



or BHTS's DCU furnace alliance partner in India:

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