Revamping Existing Units to Increase Rates, Handle Lighter Feedstocks, and other Issues (Problems)

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Need for Revamps?

To Make Your FCC Facility*
More Reliable - More Flexible

• Operational & Maintenance Reliabilities

• Feedstock & Product Flexibilities

• Maximize Profits!!!
Purpose (Objective)

To Present and Briefly discuss:
• What to Look for in Your FCC Unit/Facility?
• What Can We* Do?

* We Refiner…
Need for Revamps? When & Why?

• When --- Maintenance / Repairs – (Reliability)
  • Shutdowns & Turnarounds
  • Scheduled & Unscheduled

• Why? (Flexibility)

• Meet New Specifications - Products, Environmental, Others?

• Different Feedstocks - Different Products

• Different Operating Mode
  • Distillate Mode + Propylene
  • Gasoline Mode + Petrochemical Feedstocks
Need for Revamps? Why

- Different Feedstocks
  - More Severe HDT
  - Less Heavy Crudes
    - Less Resid or (More Resid Heavy Crudes??)
- Lighter Feeds –
  - Tight Oil
  - Condensates
    - Naphtha (paraffinic)
- Others??
Need for Revamps?

• Change Current Operating Modes & Feedstocks

To:

• Gasoline + Alkylate (G&A) - More C3=

• More Petrochemicals – Olefins & Aromatics

  Alkylate- Olefins & Aromatics

  ( 30 ppm S Gasoline - May 1st Refcom Gal 19 Pres.)

• Different Mode – More Distillate + C3=
Existing Unit Limits? Pg. 1

Do you know… (Take a GOOD LOOK)

Feedstocks & Products Flexibilities

• Longer Term Supply

• What Crude / Feedstocks Available?

• What Potential FS from other process units? Cokers, Visbreakers, Hydrotreaters /Hydrocrackers, Lube Plant, etc.

• Potential Feedstocks from the surrounding area? Chemical Plants, Lube Plants, Power Plants (Coal), etc.
Existing Unit Limits? Pg. 2

Do you know… (Take a GOOD LOOK)

Converter Section Reactor / Regenerator

• Max. / Min Fresh/ Recycle Feedrates
• What Feedstock Qualities & Variability

• What Product Slate / Slates?
Existing Unit Limits? Pg. 3

Do you know… (Take a GOOD LOOK)

• Air Blower Rates / Coke Burning Rates
  • Min / Max -

To Increase:

• Reducing Delta P
• O2 Enrichment
• Remove/Replace Orifice Chamber With Valves(?)
Existing Unit Limits?  Pg. 4

Do you know… (Take a GOOD LOOK)

• Catalyst Circulation Rates – Limitations / Increase?
  • Standpipe Delta P’s
    • Increase Bed Levels
    • Increase/Improve Fluidization
  • Aeration Taps

• Coke Burning Rates (Regen Locations / 2 Stages)

• Stripping / Dispersion Steam Rates

• Lift Gas Rates - Riser/ Transfer Lines Standpipe (Even if Possible?)
Existing Unit Limits?  Pg 5

Do you know… (Take a GOOD LOOK)

• Coke Burning .....  
• Reactor Cat Stripper  
  • How Effective…..  
    • Steam Quantity Entrained to Regen  
  • Light Feedstocks …… ?  
    • Cool Regenerator  
      • Cut Stripping Steam  
    • or
Stripper

Dispersed “Lean Oil” to Rx Stripper for carry over into the regenerator

• Example
Stripper Packing Internals

- KFBE™ packing is actually a mixing element
- Full cross-sectional area used (minus blade width is 97% open)
- Much lower flux is achieved, allowing small bubbles to rise
- Small bubbles promote good contacting

Lean Oil Location
Existing Unit Limits?

Do you know… (Take a GOOD LOOK)

Main Column … (Heat Removal)

• Reduce Delta P - (packing)
• Improve Fractionation
  • Install Product Draws LCG / HCG
  • LCO /HCO Product Draws
• Install a Second Fractionation Column
  • Parallel Column
  • Preflash Column
• New Top Section – in Series
Existing Unit Limits?

Do you know… (Take a GOOD LOOK)

Main Column … (Heat Removal)

• Bottoms / Slurry
  • Recycle for Heat Balance / Increase Coke Make
  • PREVENT TOWER BOTTOMS COKING
  • Slurry Product for Cokers!
Existing Unit Limits?
Do you know… (Take a GOOD LOOK)

Gas Concentration
• Wet Gas Compressor –
• Absorbers / Strippers
• Treating (Various)

Product Recovery
• Splitters –
  ▪ Naphtha/Gasoline
  ▪ Propylene / Propane
Existing Unit Limits?

Do you know… (Take a GOOD LOOK)

Downstream Units

Alkylate Feedstocks --- Butylenes

/Pentenes?

FCC Gasoline Hydrotreaters – (Invista – Refcom Gal 2019)

• Solvent Extraction Technology – Sweetening, & Aromatics

ANYTHING ELSE  ????
Need for Revamps?

More Reliable - More Flexible

• Operational & Maintenance Reliabilities
• Feedstocks & Products Flexibilities

Maximum Unit Flexibility

• Install / Utilize 2nd Cracking Reaction Zone
Need for Revamps?

Maximum Unit Flexibility

• Install / Utilize 2\textsuperscript{nd} Cracking Reaction Zone

• Separate (2\textsuperscript{nd}) Reactor Vessel 
  & Fractionation Sections
KBR MAXOFIN Process

- Primary Feed Riser
- Second Riser For Light Feed or Naphtha Recycle
- Fresh Feed
- Feed or Recycle Injection
R2P Technology with PetroRiser™

Potential 2nd Rx Vessel

Vapor Line Quench Injection

Rough Cut cyclones for short contact time

Withdrawal Well
dedicated to PetroRiser

590° C
C/O 12+

PetroRiser

Main Feed Riser

LCN injectors

590 Deg C = 1100 Deg F
UOP PetroFCC Process
RxCat Technology Process Design

- Increases Regenerator Temperature
- Mixes Spent & Regen in Mixing Chamber at base of Riser
Need for Revamps?

Maximum Unit Flexibility

• Install / Utilize 2nd Cracking Reaction Zone
HS-FCC Key Components

- Feed injection
- Downflow reactor
- Regenerator
- Catalyst / product separator
- Stripper using structured packing

Courtesy Axens/TechnipS&W
Retrofit To Axens/Shaw’s R2R FCC Unit

Existing RFCC

Retrofit

Stripper Vessel

Downer Reactor

Reactor Riser

Regenerator
HS-FCC RETROFIT EXAMPLE
Block Flow Diagram

Polymer Grade Ethylene & Ethane to Steam Cracker

Refinery Off Gas Purification (ROG)

Quench Tower & Gas Recovery

C\textsubscript{3} C\textsubscript{4} Purification & Separation

Polymer Grade Propylene & Propane to Steam Cracker

Main Column & Unsaturate Gas Plant; Treating to produce Fuel Grade Products

Fract. Plant & Gas Recovery

Fuel Grade Products to Sales
Need for Revamps?

Maximum Unit Flexibility

• Install / Utilize 2\textsuperscript{nd} Cracking Reaction Zone

• Separate (2\textsuperscript{nd}) Reactor Vessel & Fractionation Sections

• 2 Rx Zone in a Single Riser
MTC NOZZLE ELEVATION LOCATIONS

REACTION SECTION
MIX TEMPERATURE CONTROL (MTC)

- Zone 1
- Zone 2
- Feed Injection Nozzles
- Recycle Quench Injection
- MTC Nozzles
- Mix Zone Temperature
- Regenerated Catalyst
- OIL
- STEAM
- STEAM
Need for Revamps?

Maximum Unit Flexibility

• Install / Utilize 2\textsuperscript{nd} Cracking Reaction Zone

• Separate (2\textsuperscript{nd}) Reactor Vessel & Fractionation Sections

• PRODUCE PETROCHEMICALS from LIGHT FEEDSTOCKS - Naphtha / Paraffinic
  (LSR/ Condensates, Others)
Petrochemicals Opportunities

Main Building Blocks

- **Olefins - Two Main Blocks**
  - Ethylene
  - Propylene

- Butylenes

- **Aromatics**
  - Benzene
  - Paraxylene (other xylenes too)

*High Olefins - FCC (HOFCC) produces C3= and byproducts of other light olefins and aromatics*
Advanced Catalytic Olefins (ACO) Process

ACO Process Key Features - Reactor

- Proprietary KBR FCC reactor features
- Propylene/ethylene (P/E) Product Ratio ~1/1
- Proprietary catalyst from SK Corporation
- All proven hardware and processes
- Robust and flexible, compared to other processes
HS-FCC Naphtha Process

- Retrofit Type to existing FCCU
- Standalone Unit
Naphtha Cracking Fluid Processes

ACO Commercial Demonstration Unit
Ulsan, South Korea

* HS-FCC Semi-Commercial Unit Mizushima, Japan
Downer Technology

** Downer Rx. Potential Use
THANK YOU

The End

Questions - Comments ???

Follow-up Discussions?

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