Maximize LCO in FCC main fractionation without corroding, plugging, or coking the internals
LCO Maximization

LCO maximization in the FCC unit is achieved by:

- Changing Reactor conditions (cracking severity) by reducing:
  - Reactor temperature
  - Catalyst activity
  - Catalyst/oil ratio

- Modifying main fractionator conditions to minimize LCO losses with Naphtha and Slurry
LCO Fractionation

- Modifying main fractionator operating conditions by:
  - Cooling column top to reduce the FCC naphtha end point.
  - Adjusting the heat removal in the slurry section to minimize LCO losses with the slurry.
  - Increasing stripping steam to LCO Stripper

- Hardware change to increase fractionator efficiency
  - Column internals improvement
Reducing FCC Naphtha End Point

Three or more MF configurations can be found depending from licensor or specific design concepts.

- Depending on MF configuration, adjustment on overhead reflux or top pumparound will be required.
- Net result is reduction on column temperature from top to LCO draw.
- A drawback is the potential for salt precipitation on column internals
Salt Deposition and Corrosion in FCC MF

- Low temperature and presence of chlorides and ammonia allow formation of ammonia chloride salts.

- Salts will partially plug openings leading to:
  - Increase of pressure drop and entrainment/flooding of trays/packing
  - Fouling of PA exchangers

- Ammonia salts are hygroscopic making them extremely corrosive
  - Corrosion will damage column internals
  - Corrosion by-products will create additional plugging
How to detect salt plugging

Salt plugging symptoms

- Increase in column section pressure drop
- Decrease in fractionation efficiency between naphtha and LCO
  - Decrease in GAP (difference between LCO 5% distillation minus Naphtha 95% distillation)
  - Increase in Naphtha heavy tail (difference between the End Point minus the 90%)
How to avoid salt plugging

- Removing chloride source.
  - Catalyst
  - Desalter for imported FCC Feed
- Calculate salt dew point.
  - Measure chlorides/ammonia in sour water and estimate flowrate doing mass balance.
- Keep column temperature 10 °F above salt dew point
  - Keep in mind reflux is subcooled and top tray temperature is lower than simulation.
How to avoid salt plugging

If a lower Naphtha End Point is required, then:

- Perform a column simulation to get temperature profile for require naphtha end point
- Determine which place on the column salt deposition will start.
- Install fouling resistant column internals
  - Trays: avoid floating valves, pay attention to seal pans and transitions
  - Packing: use of liquid spray distributor or gravity distributor with anti-fouling features. Use of ammonium chloride resistant alloys
How to avoid salt plugging

- Install water wash facilities
  - Continuous
    - Allows continuous operation of the unit at maximum capacity
    - It may not allow you to achieve the desired Naphtha end point
  - Intermittent
    - It requires reduced feed to the unit (24 hours)
    - Loss in product yield, LCO out of spec
    - Risk of column internal damage
How to avoid salt plugging

- Combined measures
  - Use salt dispersants and perform water wash when necessary
  - Perform routine Column warm-up

- Fresh Water injection
- Salty Water draw-off
Reducing LCO losses with Slurry

- Some LCO material is condensed in the column bottom section and leaves with the slurry product.
- Reduction in slurry pumparound minimize LCO but increases bottom temperature which requires more quench.
  - Mixing quench with hot liquid (>740 °F) is a challenge
  - Local hot spots can lead to coke formation
- Bottom stripping steam can recover some LCO (0.5% of slurry).
Adjust Heat Removal in Slurry Section

- Slurry Pumparound removes >30% of the total heat, the upper pumparounds/condenser will need extra capacity to pick any reduction on slurry P/A.

- A minimum wetting rate (8-10 gpm/ft² top) has been recommended to avoid coking on the baffle/sheds or grid bed.

- Good quench dispersion on the bottom minimize the probability of hot spots.

- Bottom stripping steam helps:
  - Reduce liquid temperature / creates liquid turbulence
Adjust Heat Removal in Slurry Section

- Some FCC columns are equipped with a wash section.
- As slurry reflux is reduced, vapors leaving the section are hotter (>710 °F).
- It is important to measure the amount of liquid leaving the HCO collector tray and estimate and control the wetting rate to avoid coking conditions.
- LCO draw should be adjusted based on distillation and wetting rate to wash zone. Some units can adjust the HCO pumparound duty.
Additional Changes to maximize LCO

- Increasing stripping steam to LCO Stripper
  - Side stripper allows controlling the LCO light tail. This avoid sending naphtha material with LCO.
  - An increase in stripper efficiency will allow a further LCO recovery by further reducing naphtha end point:
    - Increasing stripping steam.
    - Increasing number of trays.
Improving Fractionator Efficiency

- Improving fractionation efficiency reduces overlap between products.
- Fractionation efficiency depends on:
  - Theoretical stages (Function of column height and internal type)
  - Liquid/vapor ratio
Main Fractionator Theoretical Stages

- Typical number of theoretical stages:
  - Naphtha / Heavy Naphtha: 2-3
  - Heavy Naphtha / LCO: 3-4
  - Full range Naphtha / LCO: 3 - 7
  - LCO/HCO: 3 – 5
  - HCO / Slurry: 0 - 2
Main Fractionator Theoretical Stages

- How to increase theoretical stages:
  - Overhead Section (Naphtha / LCO)
    - High Capacity Structured Packing (Mellapak™ 202Y / 252Y / 452Y)
    - High Capacity Trays (VGPlus™) allow lower tray spacing which add more trays (TS: 18”)
  - Middle section (LCO/HCO)
    - High Capacity Structure Packing (Mellapak 202Y / 252Y / 452Y)
    - High Capacity Trays (VGPlus) allow lower tray spacing which add more trays (TS: 18”)

Maximize LCO in FCC Main Fractionator
Liquid / Vapor Ratio

- Liquid / Vapor ratio (internal reflux) depends on heat removal distribution.

- Main fractionator heat removal is a function of heat integration
  - Slurry: 20 – 40%
  - HCO: 8 – 30%
  - LCO: 5 – 25%
  - Heavy Naphtha: 0 – 10%
  - Top pumparound / Condenser: 15 – 40% (Balanced)
Liquid / Vapor Ratio

- Excess bottom heat removal will significantly reduce reflux on the top section impacting Naphtha / LCO fractionation.

- “Excessive” heat integration with Gas Plant and other units can impair the ability to adjust Naphtha / LCO or LCO / HCO fractionation.
Q & A