FCC Main Fractionator

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

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REFCOMM GALVESTON
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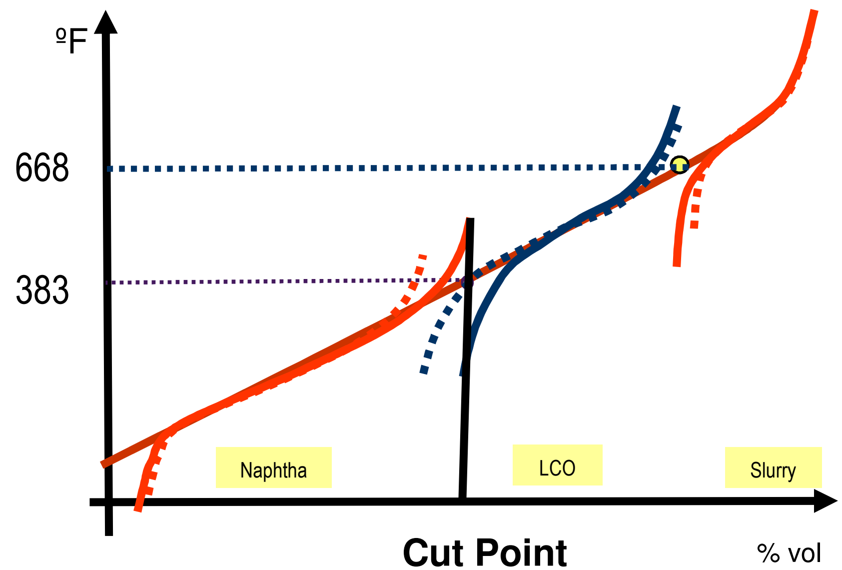
LCO Maximization

- 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

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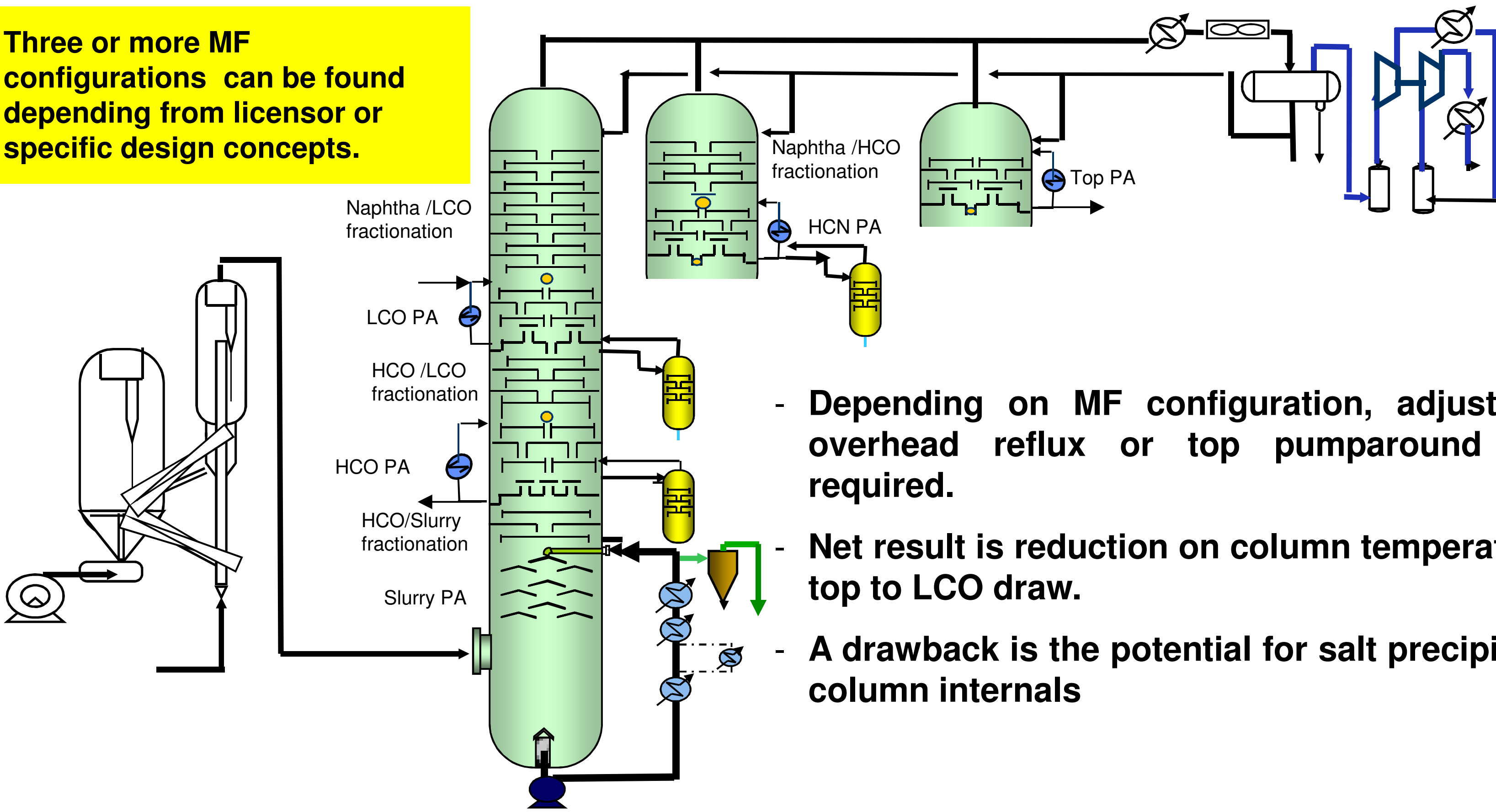
Three or more MF configurations can be found depending from licensor or specific design concepts.



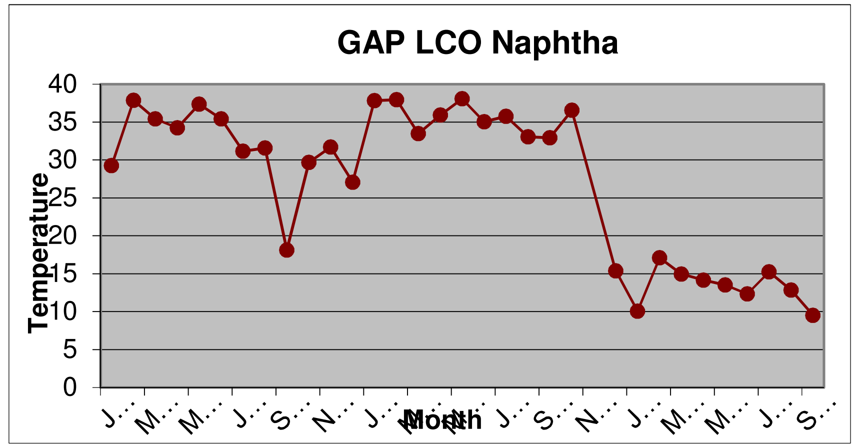
- **Depending on MF configuration, adjustment on overhead reflux or top pumparound will be required.**
- **Net result is reduction on column temperature from top to LCO draw.**
- **A drawback is the potential for salt precipitation on column internals**

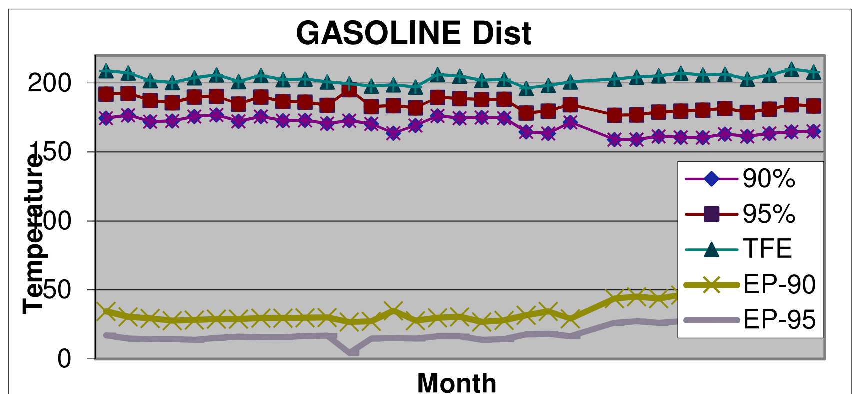
Salt Deposition and Corrosion in FCC MF

- 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

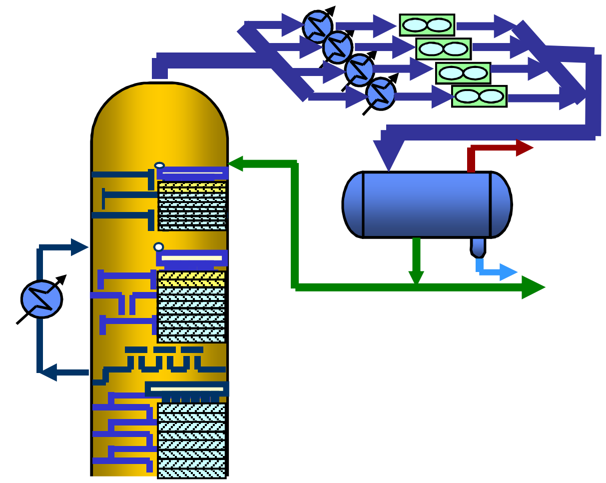
How to detect salt plugging

- 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.

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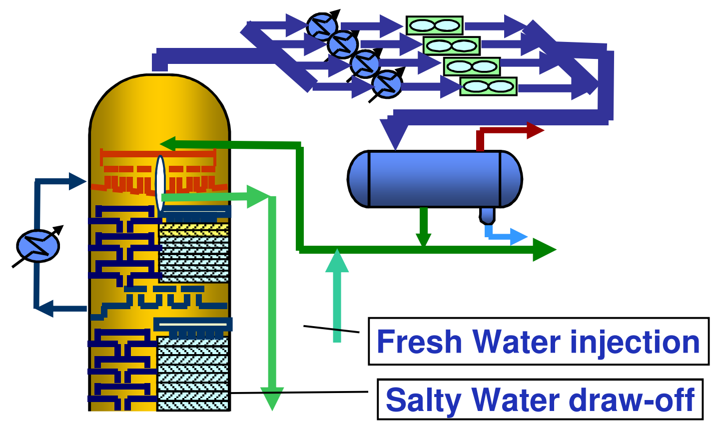
How to avoid salt plugging

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

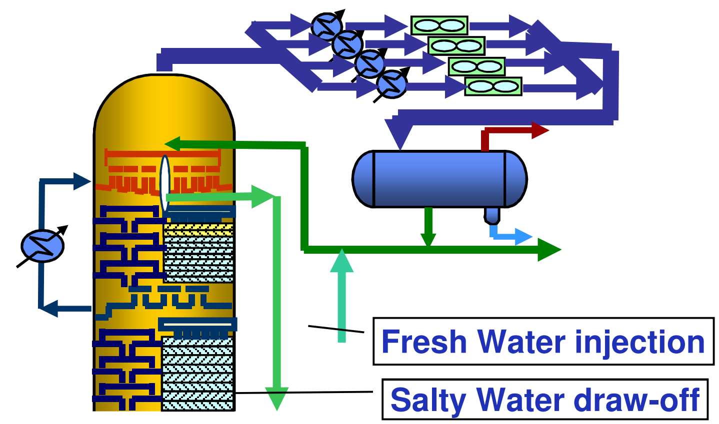
How to avoid salt plugging

- 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



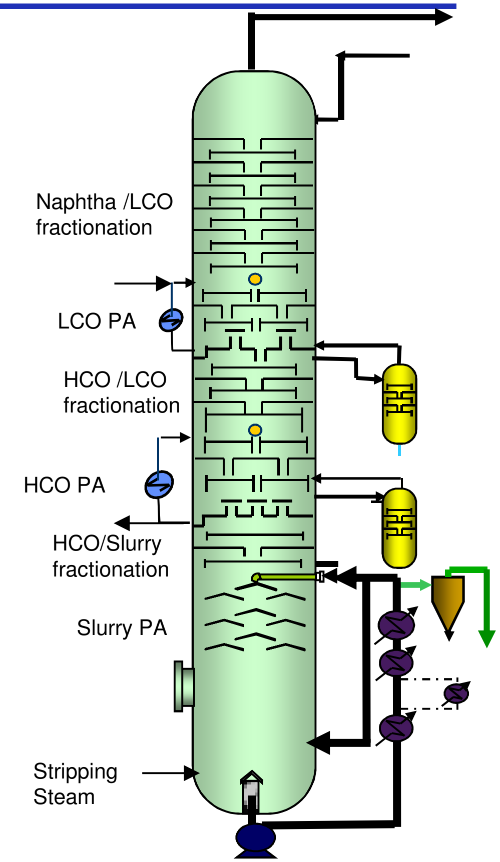
How to avoid salt plugging

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



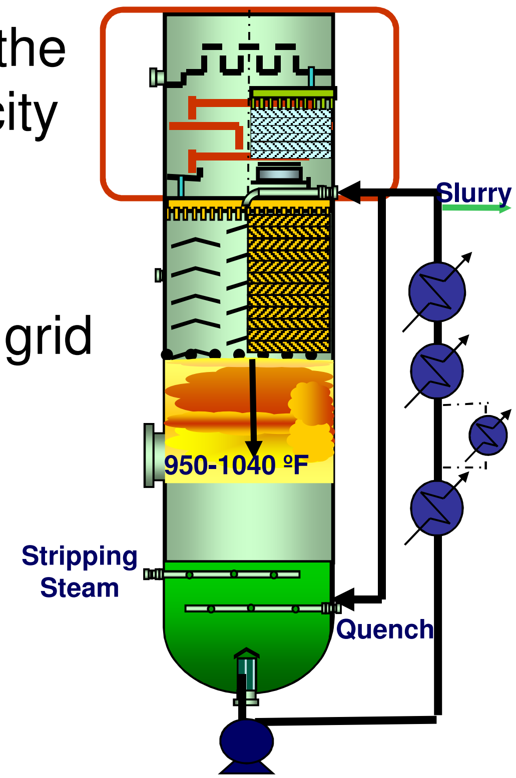
Reducing LCO losses with Slurry

- 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).



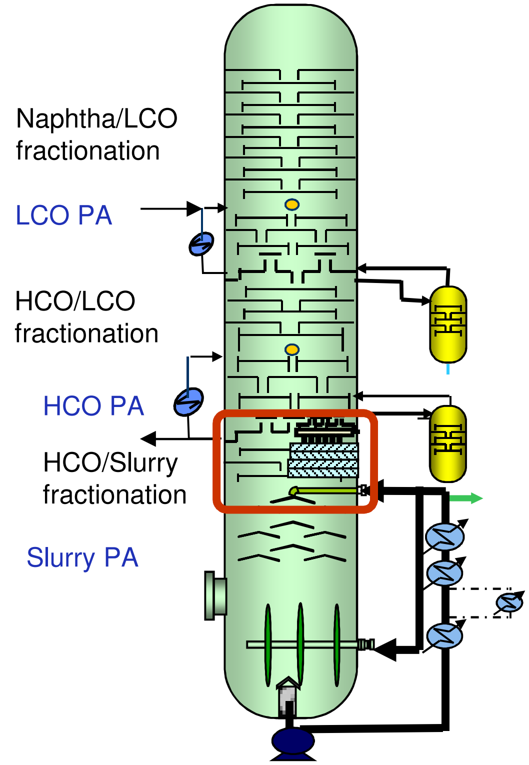
Adjust Heat Removal in Slurry Section

- 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/ft^2 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



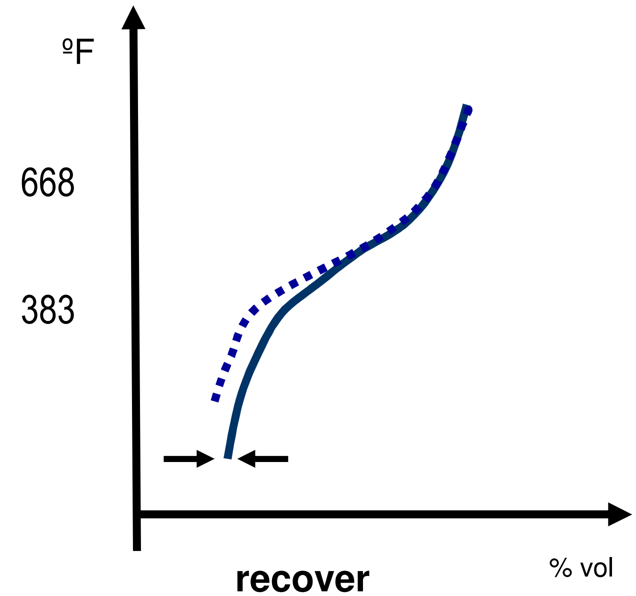
Adjust Heat Removal in Slurry Section

- 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



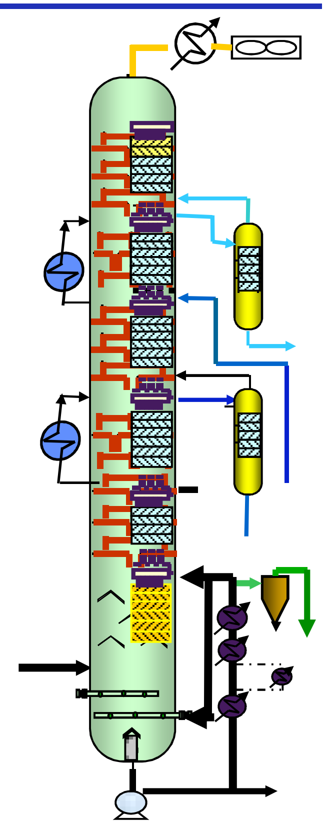
Additional Changes to maximize LCO

- 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.



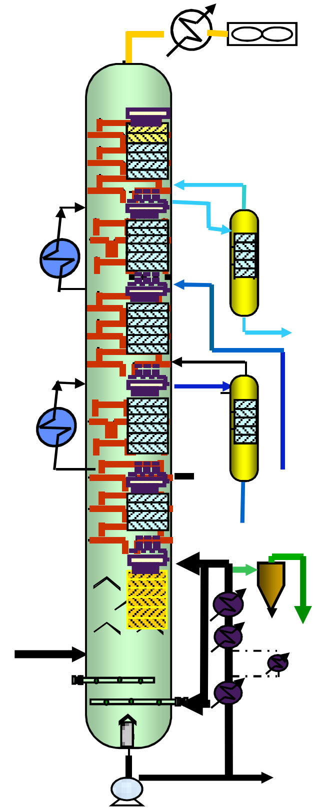
Improving Fractionator Efficiency

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



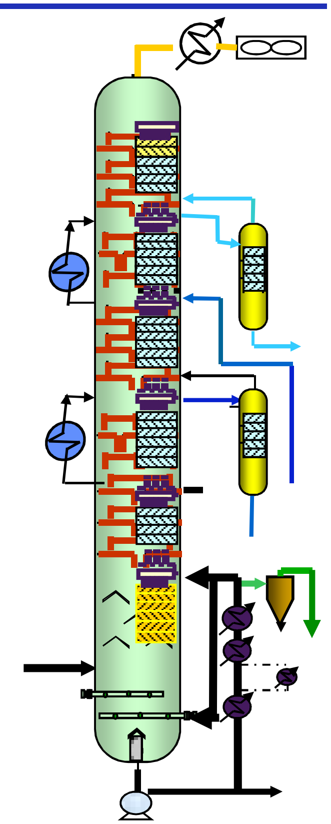
Main Fractionator Theoretical Stages

- 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^{TM} 202Y / 252Y / 452Y)
    - High Capacity Trays (VGPlus^{TM}) 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”)



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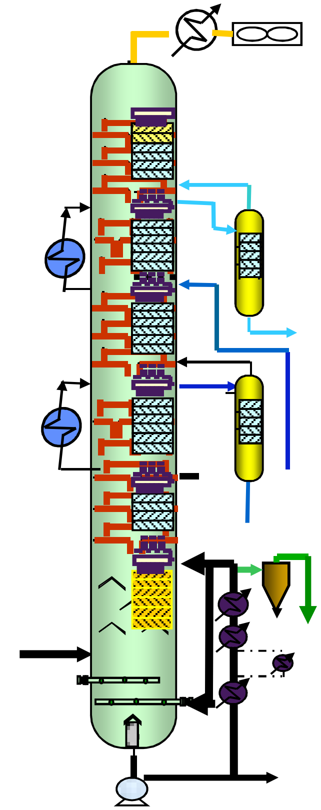
Liquid / Vapor Ratio

- 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 reduced 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