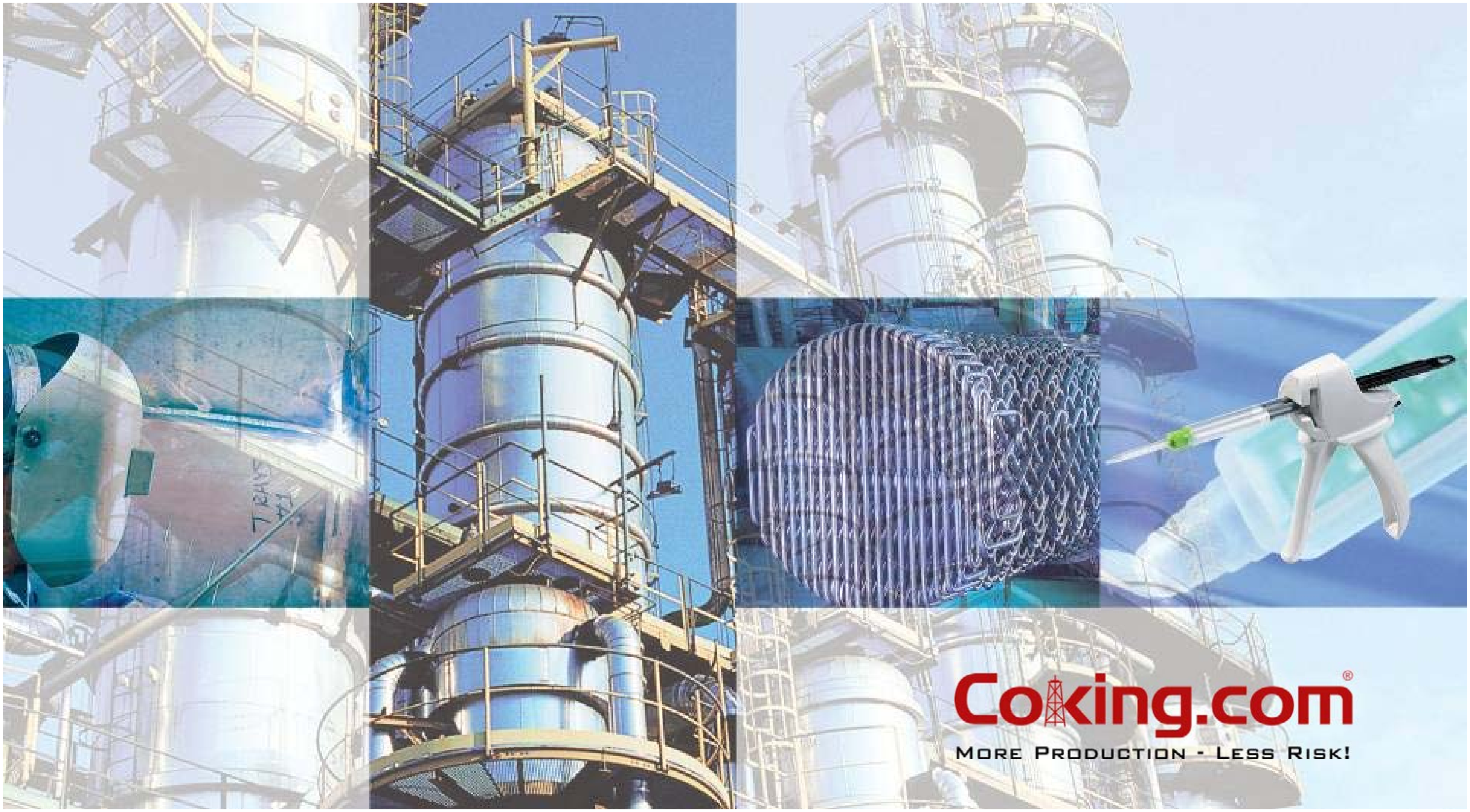
Sulzer Chemtech – Moving Ahead

Selection of Column Internals - Coker Unit

Sulzer Chemtech

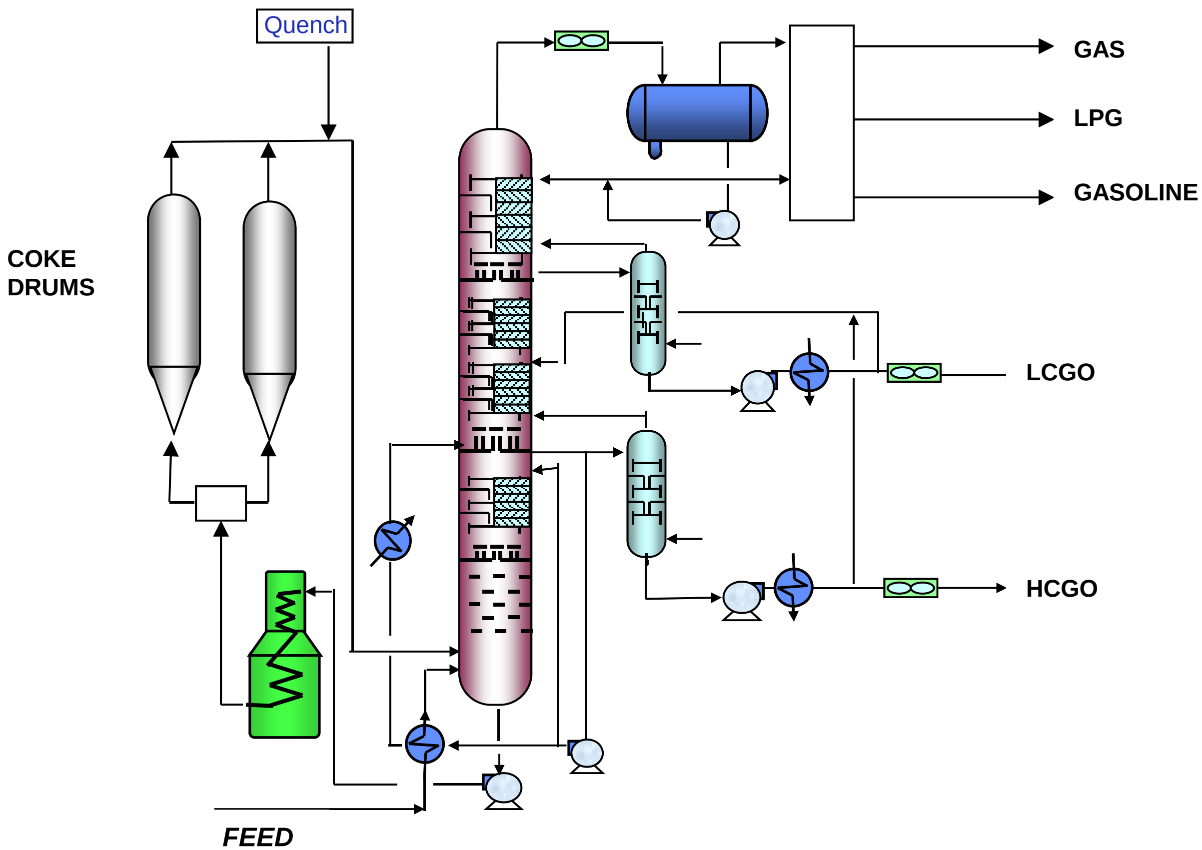
August 4, 2009

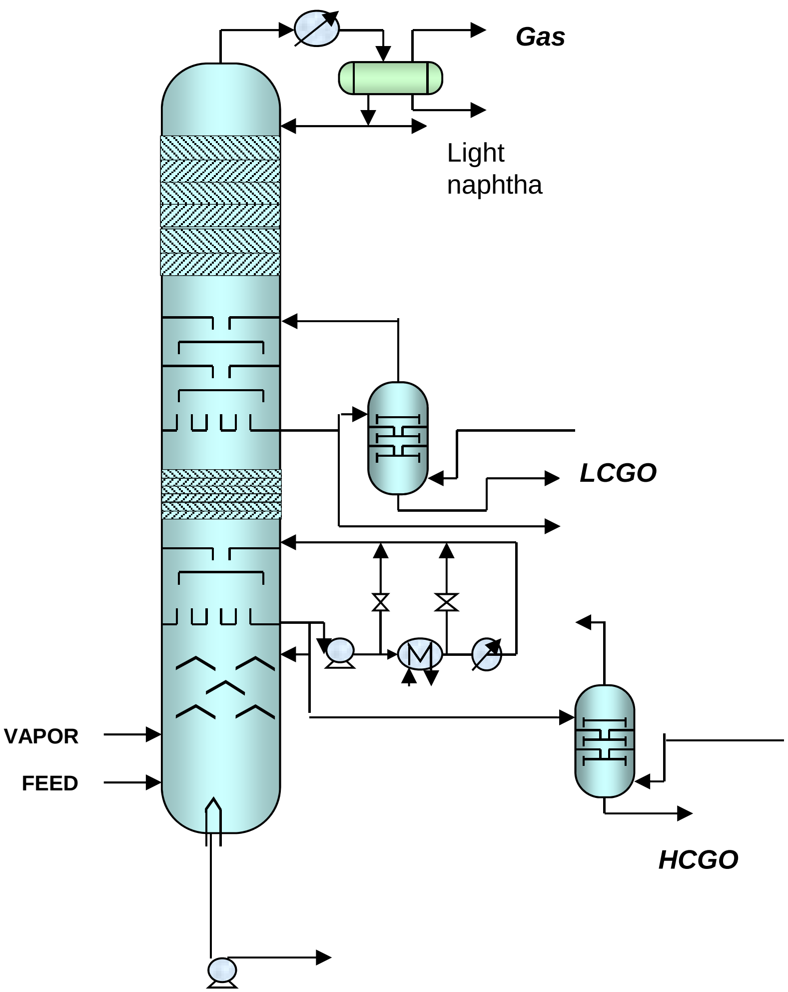
Presenter: Nina Prohorenko-Johnson



Coker Main Fractionator

Feed: Bottom of Barrel





Objectives

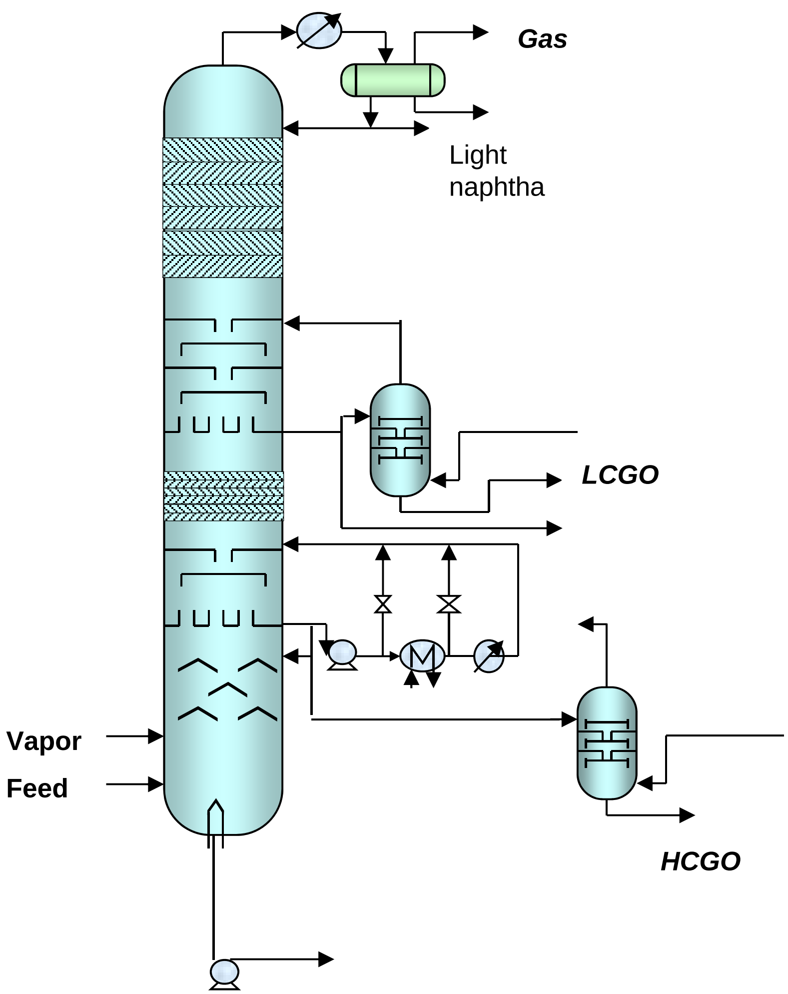
- **Safety.**
- **Reduce coke and coking problems.**
- **Increase conversion.**
- **Debottleneck equipment limitations:**

  - Cycle time.

  - Compressor.

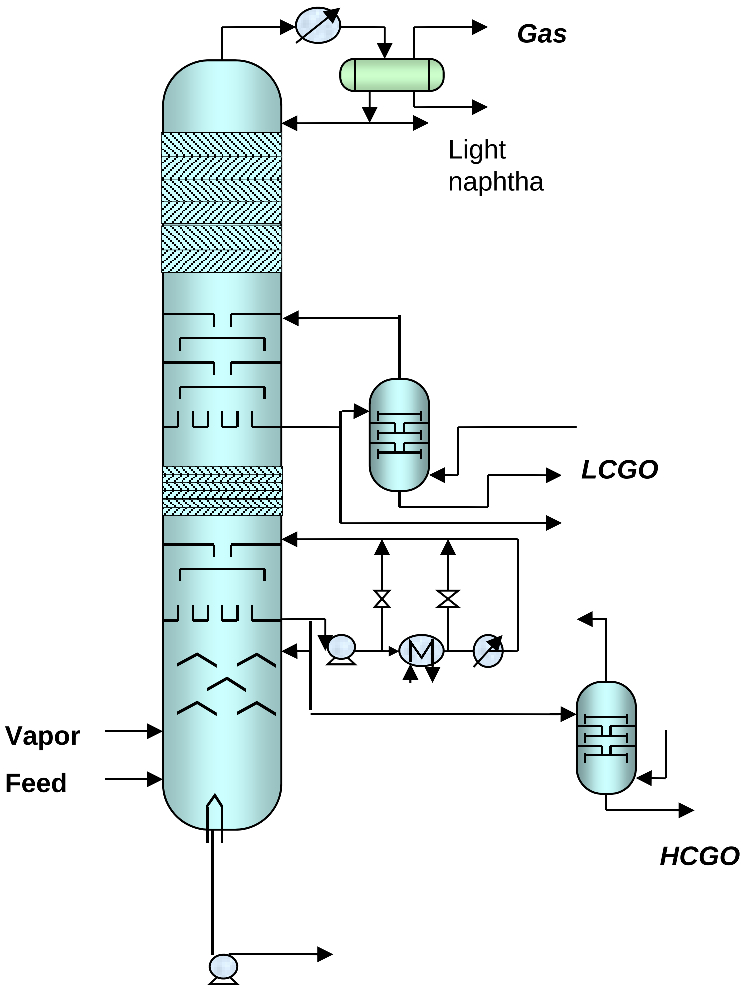
  - Furnace.

  - Fractionator.
- **Avoid salt deposits in fractionator overhead.**
- **Increase fractionation efficiency.**
- **Increase capacity.**



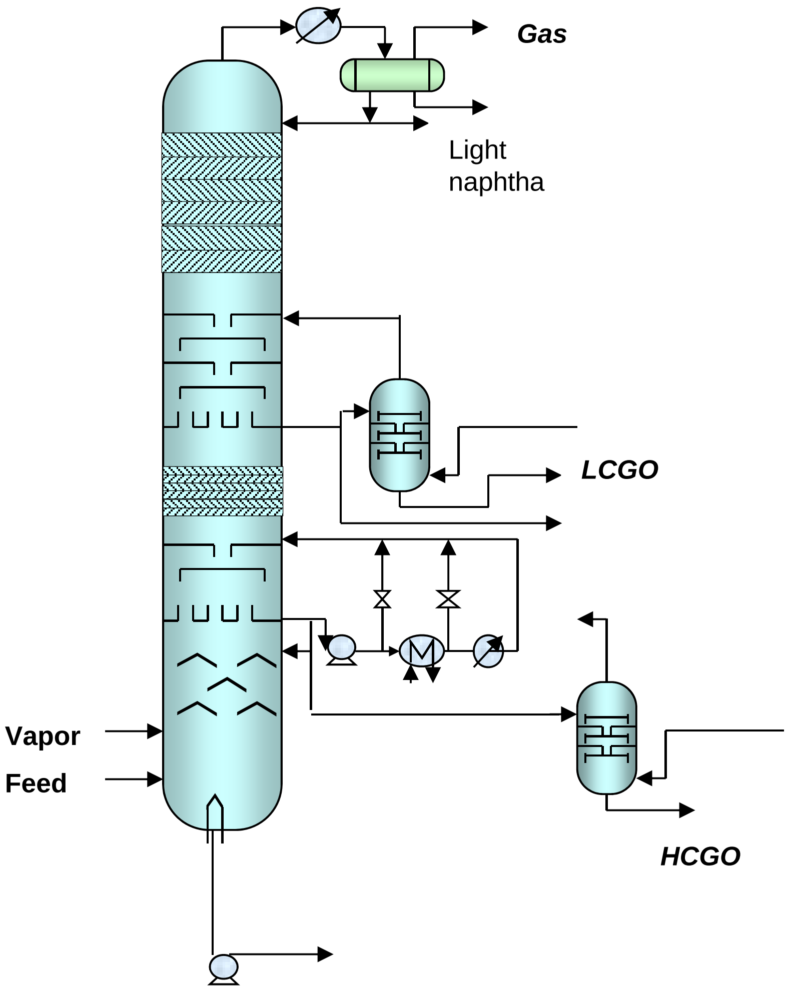
Coking Problems

- Unit processes all the heavy residues from the various refinery process units, mainly Vacuum Residue.
- Coke forms at undesirable locations in the equipment.
- Coke is generally formed in the wash zone and at times in the HCGO section.



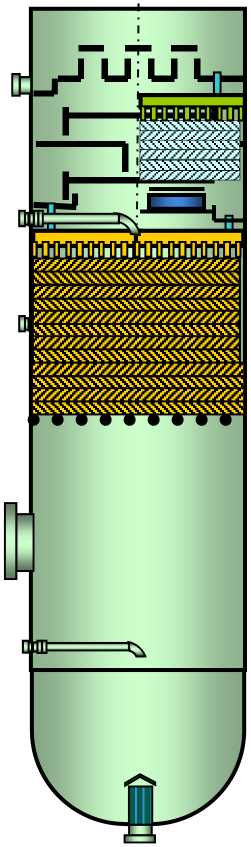
Wash Zone Objectives

- Quench the drum vapors
- De-entrain coke fines
- Improve HCGO quality and yield



Wash Zone Design

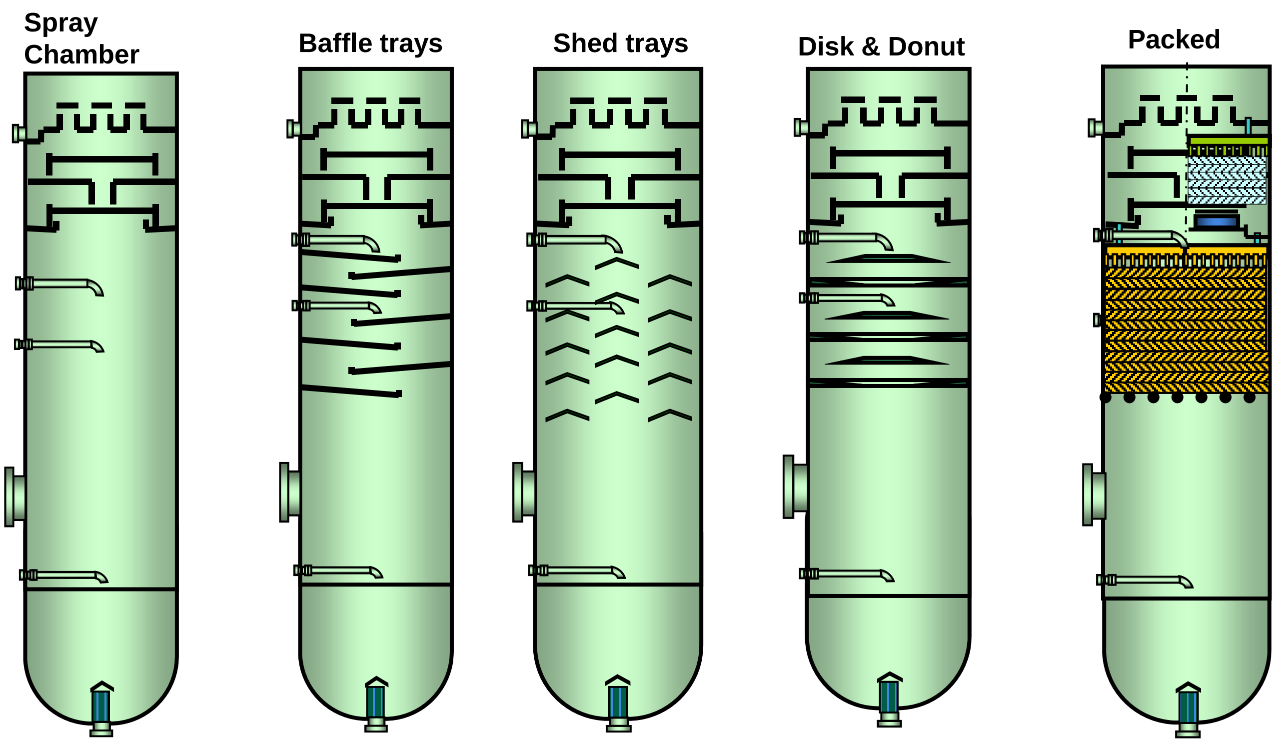
- HCGO quality
- Recycle ratio
- Feed quality
- Unit reliability
- Yields
- Capacity
- Fractionator internals



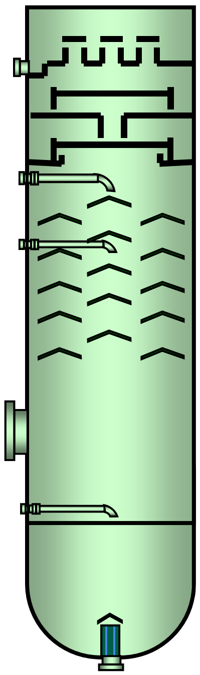
Wash Zone Design Requirements

- Test run for proper data collection and establish the design basis
- HTSD characterization curves for heavier products
- Antifouling internals
- Vapor and liquid distribution is very critical
- Uplift requirement to resist upset conditions

Conventional Coker MF Wash Zone Configurations



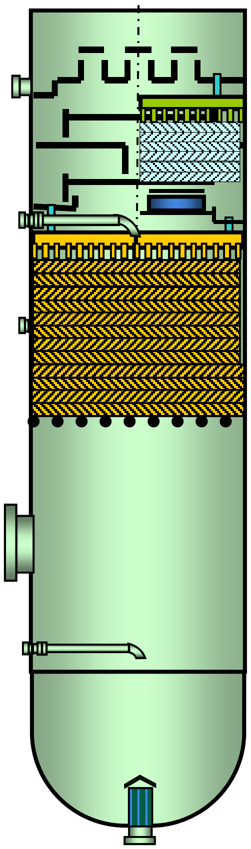
Shed trays



Use of Trays in Wash Section

Advantages	Disadvantages
High fouling resistance	Low mass transfer efficiency
Can operate with fouling or plugging for some time	Requires high wash rates for contact efficiency
Easy to inspect	

Packed



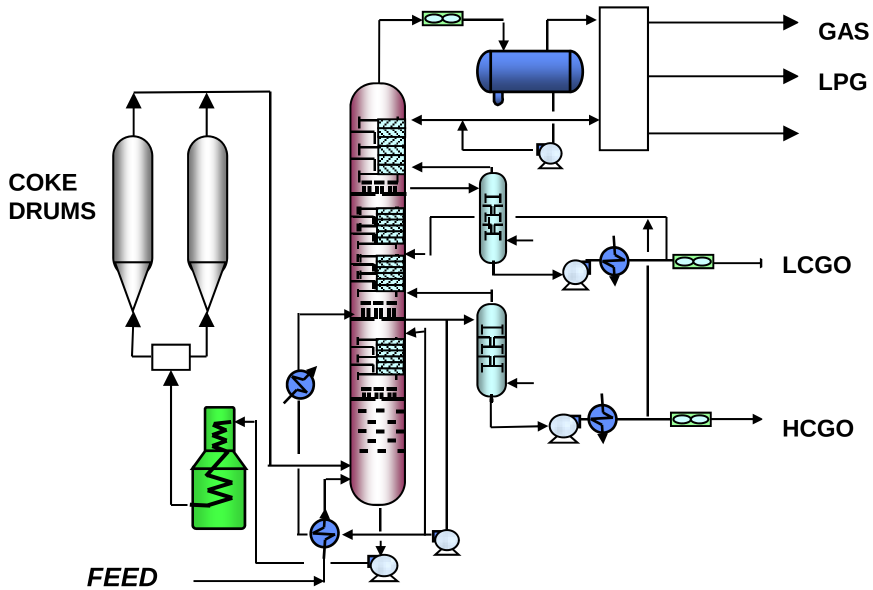
Use of Sulzer Grid Packing in Wash Section

Advantages

- Resistant to fouling or plugging due to open structure
- More efficient than spray chamber or sheds
- Can operate with less wash oil than trays
- Can be designed to resist upset conditions
- Higher capacity
- Better de-entrainment

Disadvantages

- More difficult to inspect
- Higher capital cost



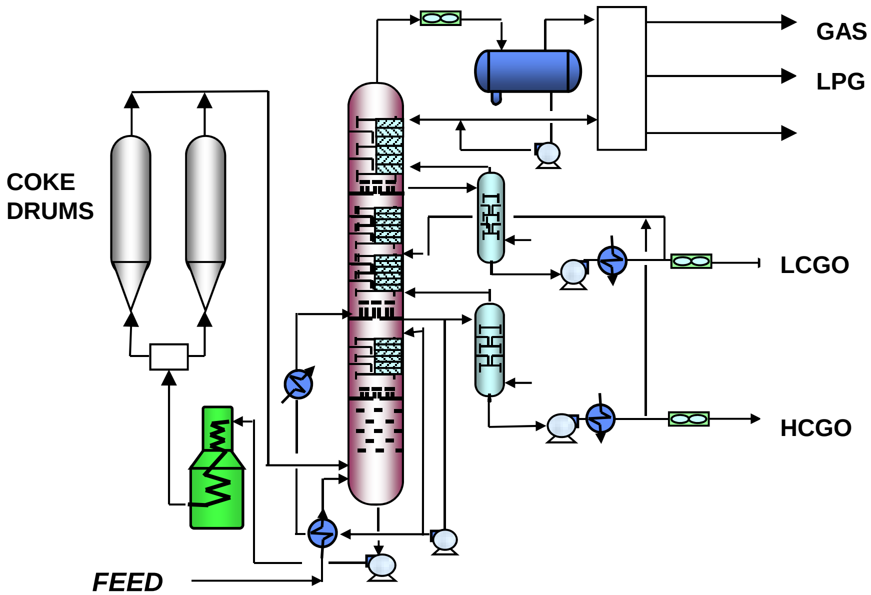
CFR: Combined Feed Ratio

$$= \frac{\text{Fresh Feed Rate + Recycle Rate}}{\text{Fresh Feed Rate}}$$

Recycle: Direct condensation of distillate tail in O/H vapors which is a result of:

- Injection of quench in O/H line
- Heat losses in O/H line
- Fractionator internal reflux or wash oil fed to reduce entrainment
- Typical value is 1.05 to 1.1

CFR: Combined Feed Ratio

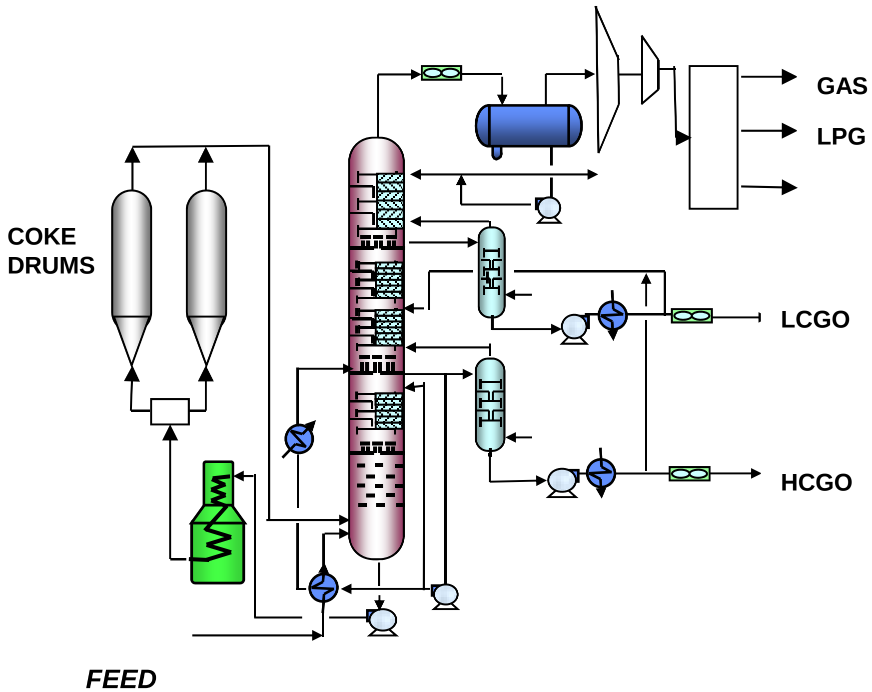


CFR affects:

- Type of coke produced: petroleum coke has lower CFR as compared to needle coke
- End point of HCGO
- Capacity
- Leads to more coke
- Furnace coking, fuel consumption
- Capital and operating costs

Use of any Internal:

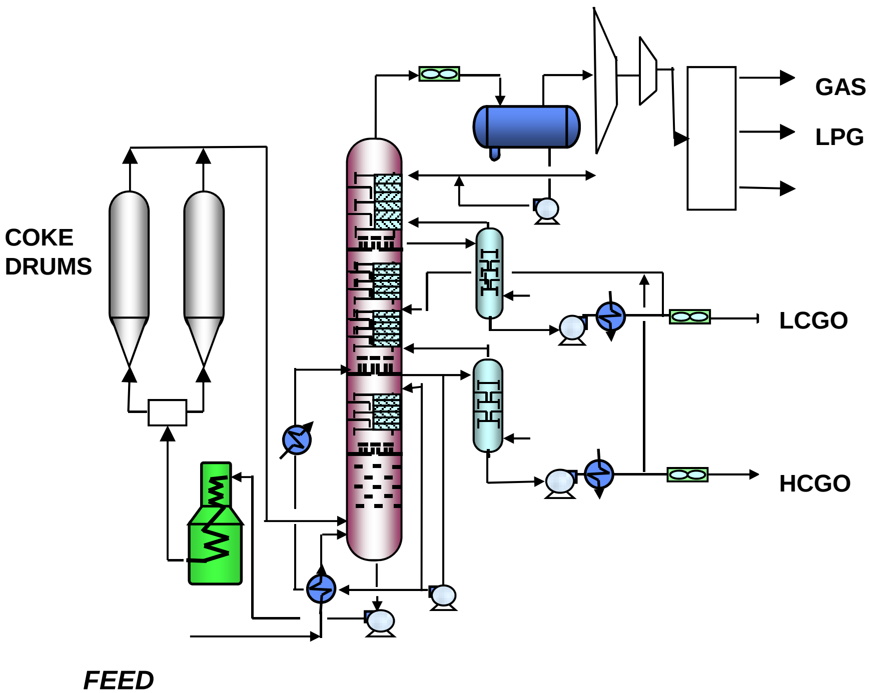
- Reduces the requirement of wash oil
- Reduces the CFR and increases the capacity
- Reduces capital and operating costs



Major Equipment Limitations

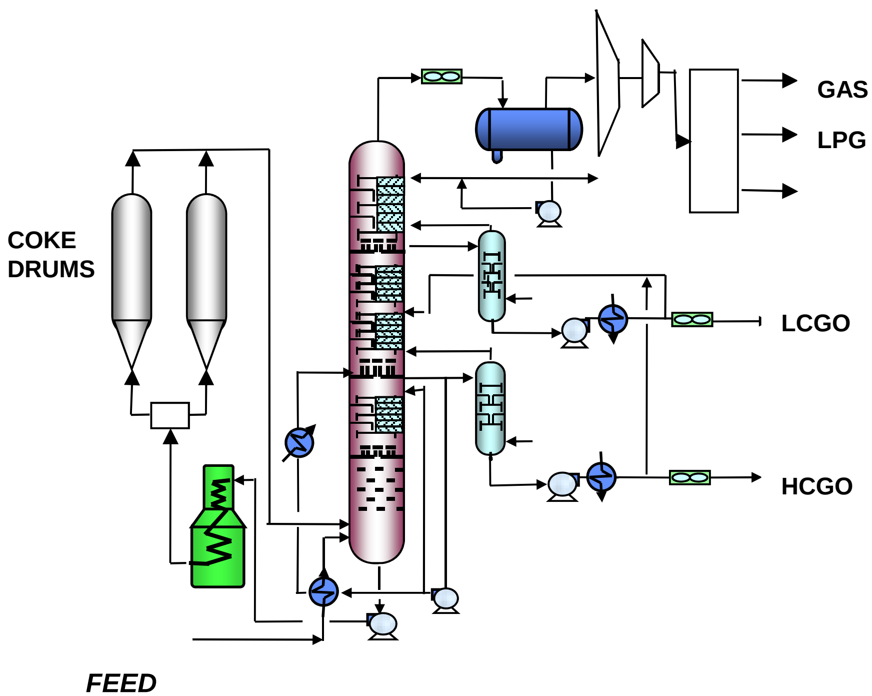
- Furnace
- Compressor
- Coke drums - Cycle time
- Fractionator

Main Fractionator

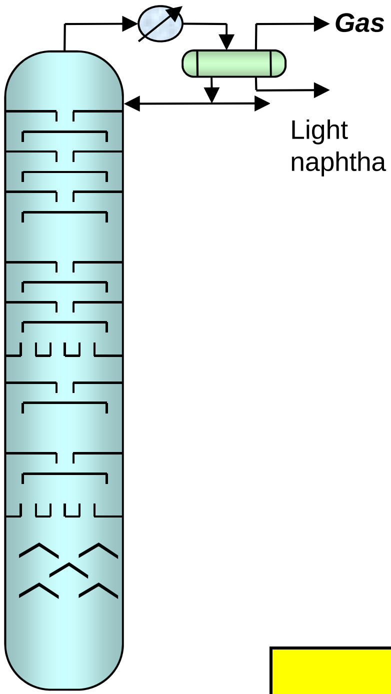


- Typically has about 24 trays
- 3 types of sections:
  - Wash
  - Pumparound
  - Fractionation
- Pressure drop through 24 trays ~ 5 to 7 psi
- Pressure drop with packing ~ 1 psi
- Reduced pressure drop can significantly increase the product and/or increase the capacity.
- 5 psi pressure drop reduction will significantly decrease the coke yield and increases the liquid yield.

Lower DP debottlenecks all the major equipment



- **Furnace:** Lower firing, lower fuel and less coking
- **Compressor:** Higher pressure at the suction reduces the gas volume
- **Cycle time:** Less coke reduces cleaning frequency
- **Fractionator:** Better separation and hydraulic capacity



Feed: Vacuum Residue
: TBP Cut point : 1050 F+
: API: 2.6
: Sulphur : 3.5% wt
: Ni+V : 943 ppm wt
: TAN: 0.5

Products: Gas : C1 & C2
: LPG: C3 & C4
: Gasoline : C5 to C14
: LCGO : C15 to C22
: HCGO : C23 to C40
: Coke : C70+

Feed: 20,000 BPSD

Coke Drum Pressure- Psig	Coke Make - t/d	Fuel Gas- MM BTU/HR	Liquid Yields (C5+) BPSD	% Increase	Incremental Product Value- US $/Year
15	1,037	259.6	14,465	Base	Base
13	1,029	255.8	14,538	0.5	326, 370
10	1,017	249.3	14,651	1.3	844,470
7	1,004	242.3	14,780	2.2	1,430,220

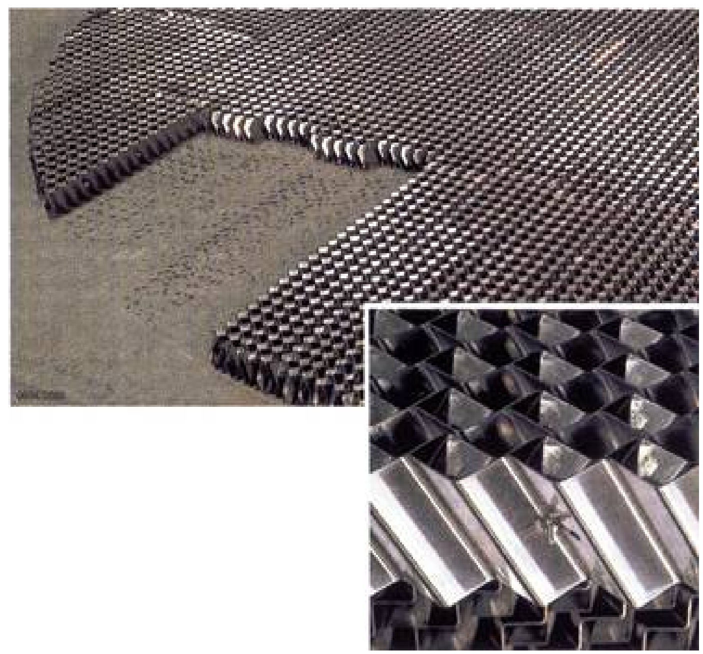
MELLAGRID

Special features:

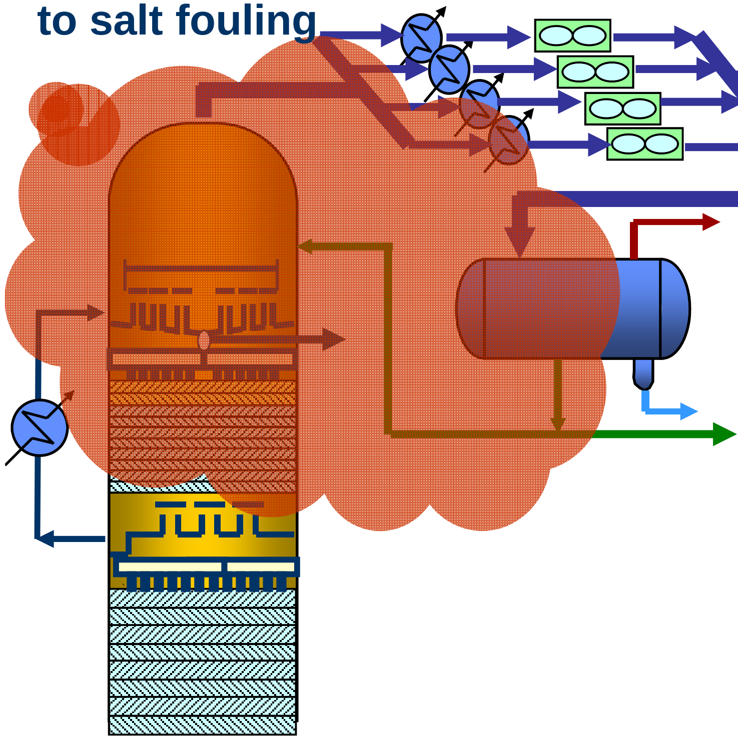
- Resists coking and fouling due to its smooth surface
- Geometric structure efficiently dissipates temperature and concentration gradients
- Much better de-entrainment and separation efficiency than conventional grids
- The low element height and its smooth surface structure allow for easy cleaning
- Mechanically robust structure

Application examples:

- Atmospheric or Vacuum Tower
  - Wash section
  - Pumparound section with high liquid and gas loadings
- FCC Main Fractionator
  - Slurry pumparound section
- Coker or Visbreaker Fractionator
  - Wash section



Areas prone to salt fouling



Salt Deposition and Corrosion in Main Fractionator Overhead

Circumstances:

- Low Sulfur Naphtha production requirement.
- Processing deep cut vacuum residue.
- Undercutting heavy high sulfur naphtha via side d/o.

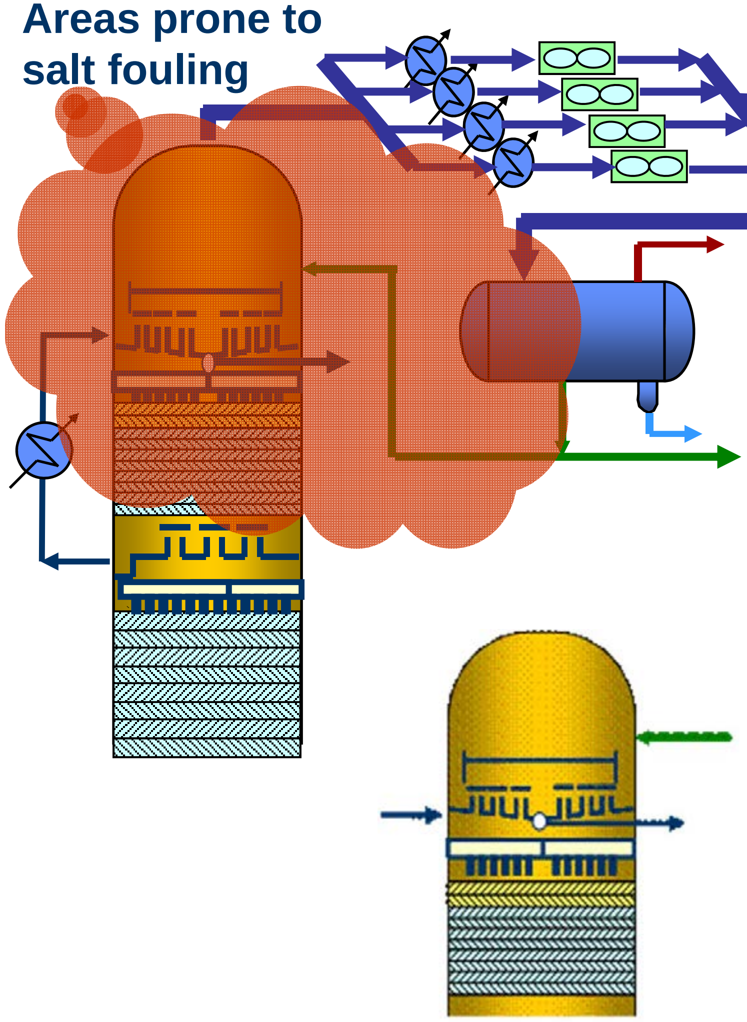
Constraints:

- Vacuum residue contains Chloride salts.
- Low operating temperature in top of main fractionator.

Problems:

- Deposition of Ammonia Chloride salts in upper sections of Coker MF and overhead condensation system
- Loss in capacity and efficiency in top of main fractionator

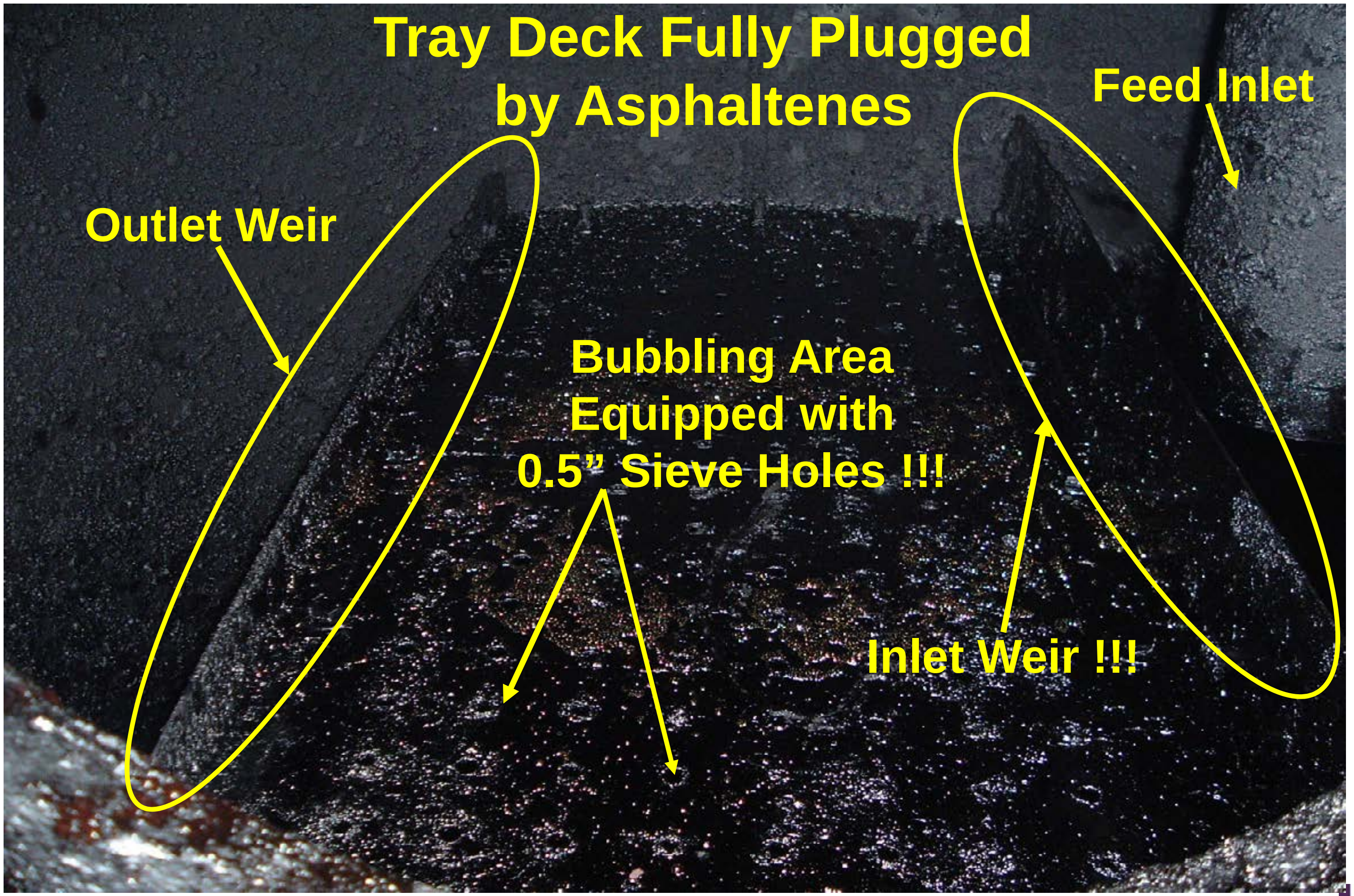
Areas prone to salt fouling



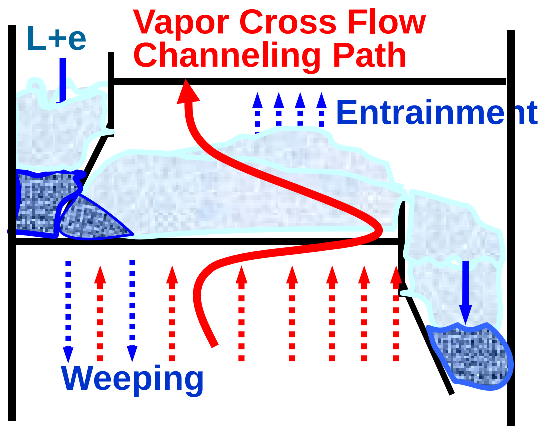
Salt Deposition and Corrosion in Main Fractionator Overhead

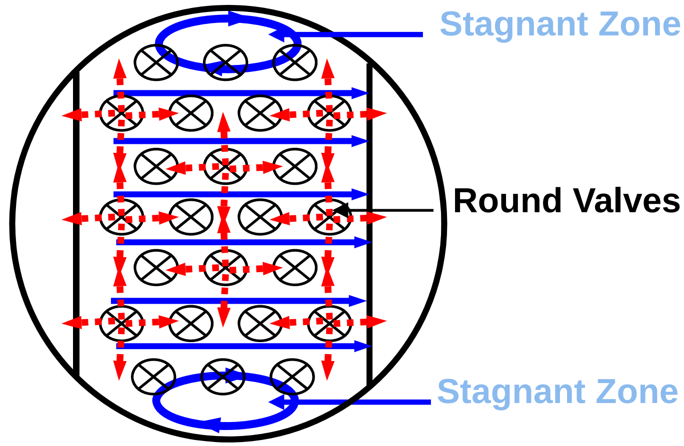
Methods employed to remove the salts :

- **Maintaining the fractionator top temperature high enough to ensure the sublimation of all the salts.**
- **Water washing of column.**
- **Minimizing chlorides contaminants in coker feed. (Desalting).**
- **Use of chemical additives (salt dispersants).**


Tray Deck Fully Plugged
by Asphaltenes
Feed Inlet
Outlet Weir
Bubbling Area
Equipped with
0.5” Sieve Holes !!!
Inlet Weir !!!

What Does Promote Fouling on Fractionation Trays?



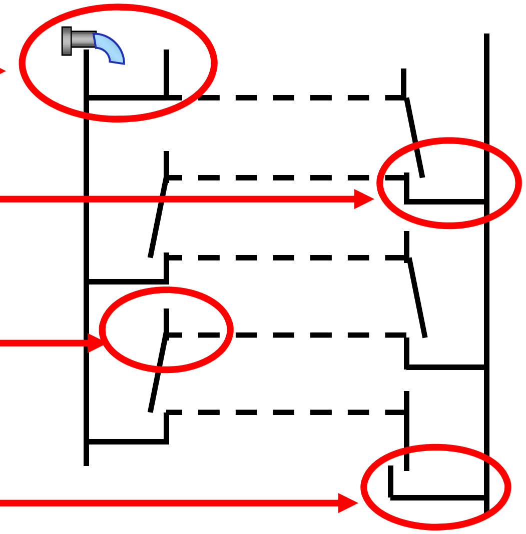


Outlet Weirs, Round Valves, Long Flow Path Cause:

- **Excessive liquid gradient along the tray deck;**
- **Vapor mal-distribution underneath the active area;**
- **Stagnant zones at the corners of the tray deck;**
- **Excessive residence time at the stagnant zones;**
- **Polymerization, fouling accumulation, reduced capacity.**

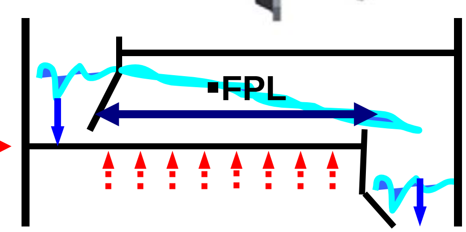
What Promotes Fouling on Fractionator Trays?

- Inlet Weirs
- Recessed Downcomer Inlet Areas
- Conventional Outlet Weirs
- Seal Pans at Bottom of Tower



- Moving Valves, in Particular the Round Ones

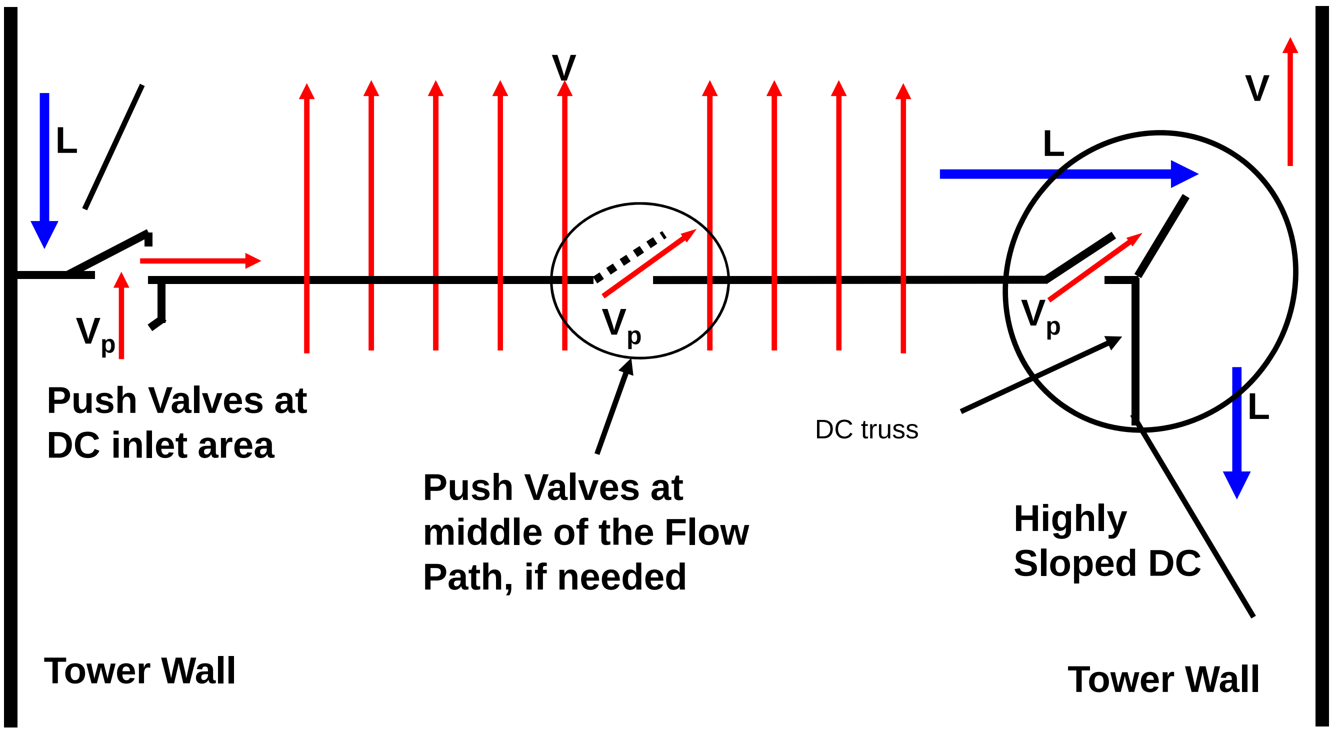
- Excessive Flow Path Length



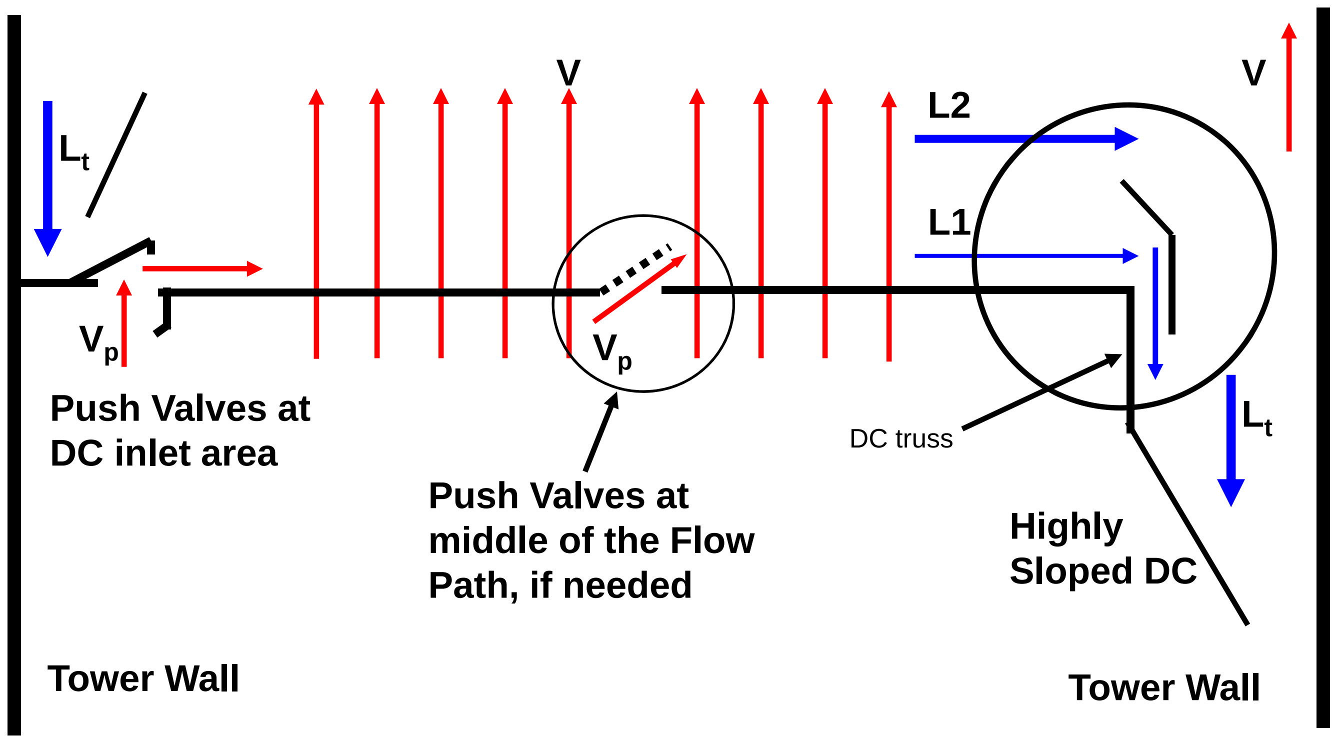
Sulzer VGAF^{TM} Tray Features

- Larger Size V-Grid Valves (MVG, SVG, LVG)
- Highly Sloped Downcomers
- Pushing Valves
- Modified Outlet Weir

VG AF trays equipped with Stepped Outlet Weir

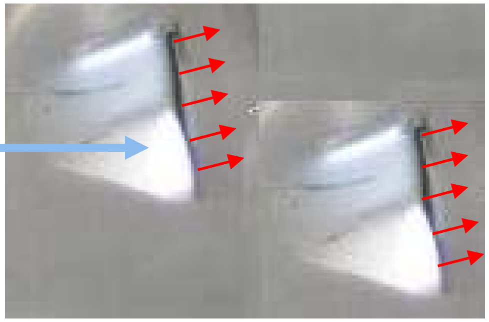


VG AF trays equipped with Stepped Outlet Weir

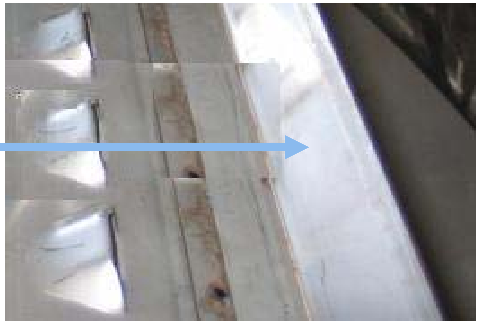


Features Inhibiting Fouling on Fractionator Trays

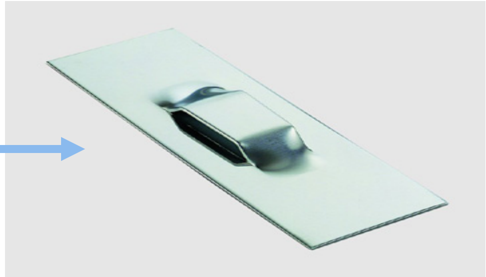
- **Push Valves: At the downcomer inlet area.**
  At the stagnant zone.
  At the middle of the flow path.



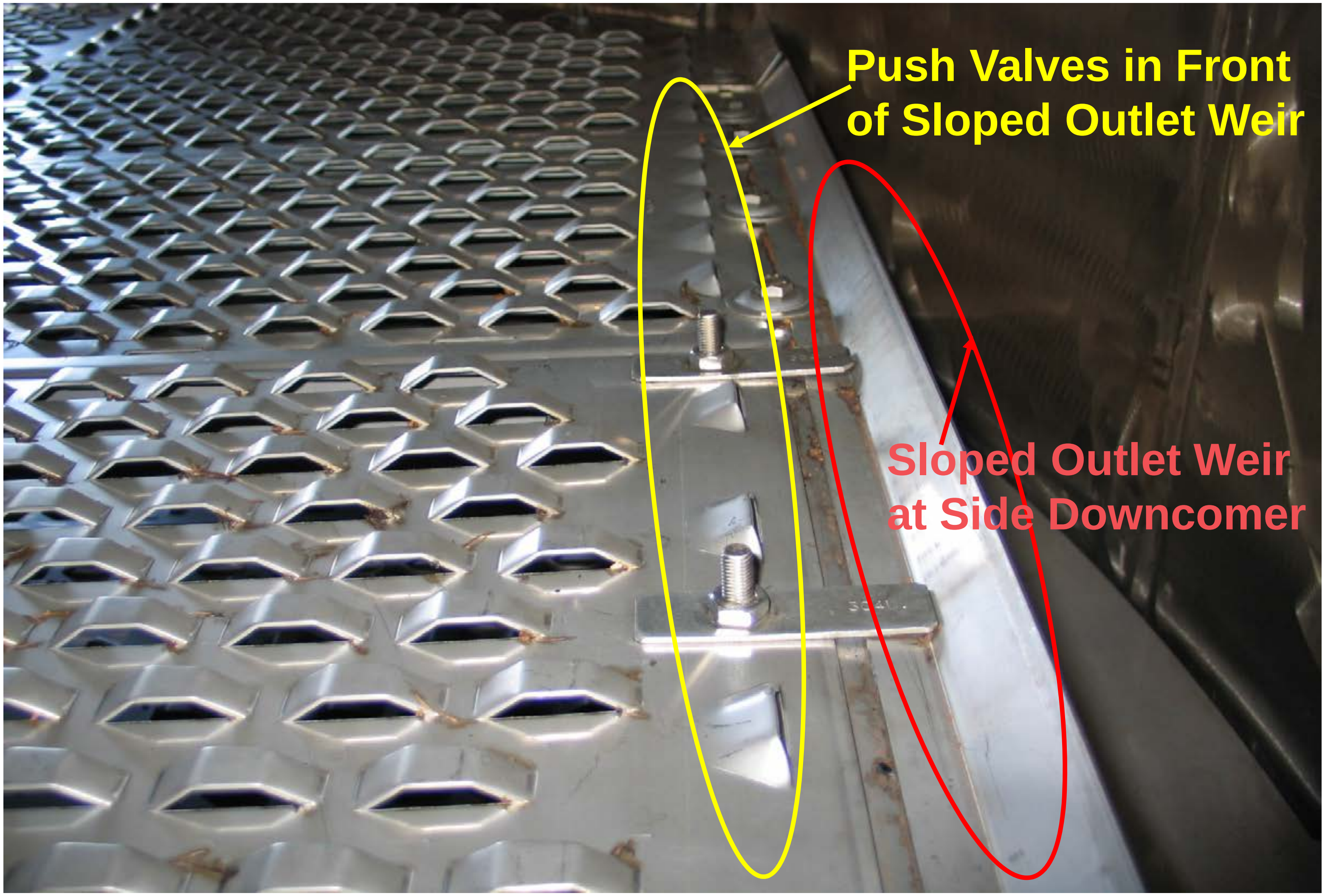
- **Enhanced Outlet Weir design.**



- **V-Grid fixed valves.**



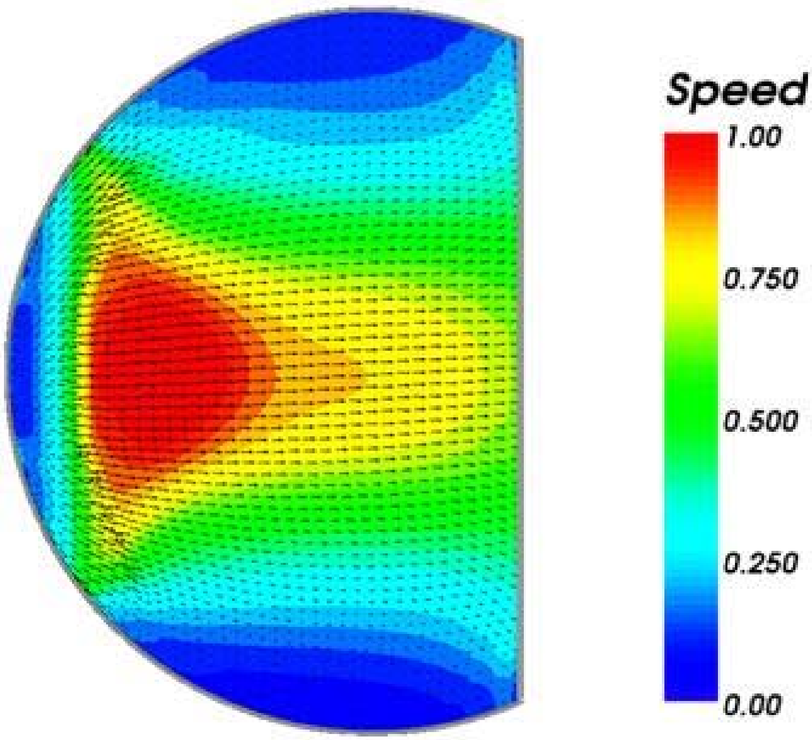
VGAF Trays Equipped with Sloped Outlet Weir



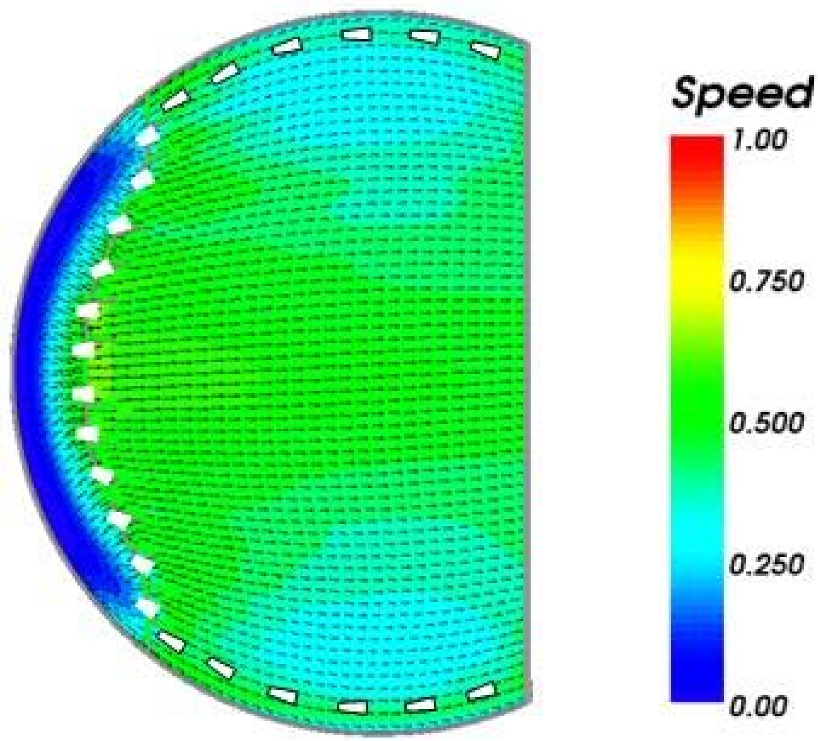
VGAF Trays Equipped with Sloped Outlet Weir

Froth Velocity Diagram Over the Active Area

Conventional Trays

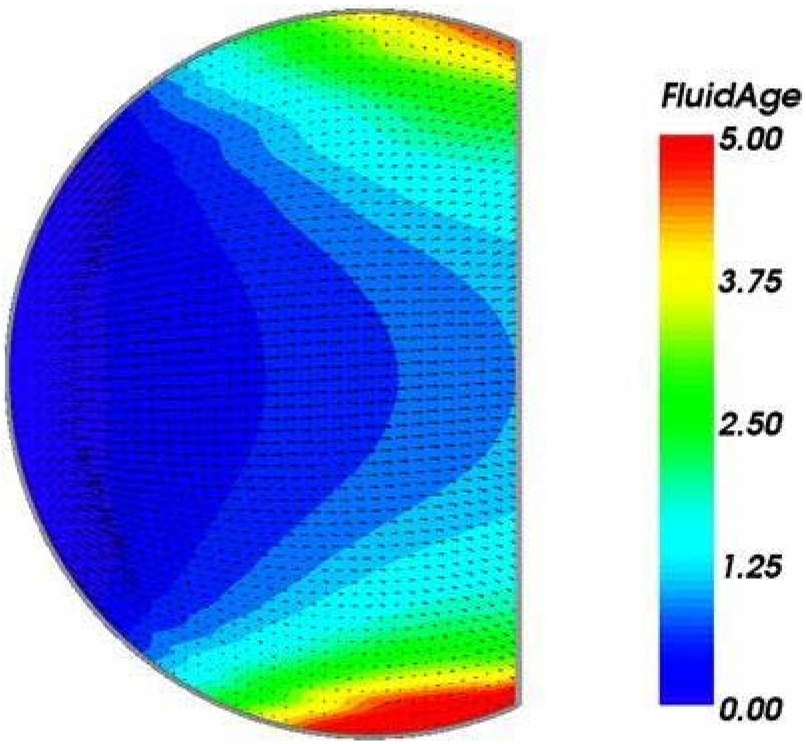


VGAF Trays

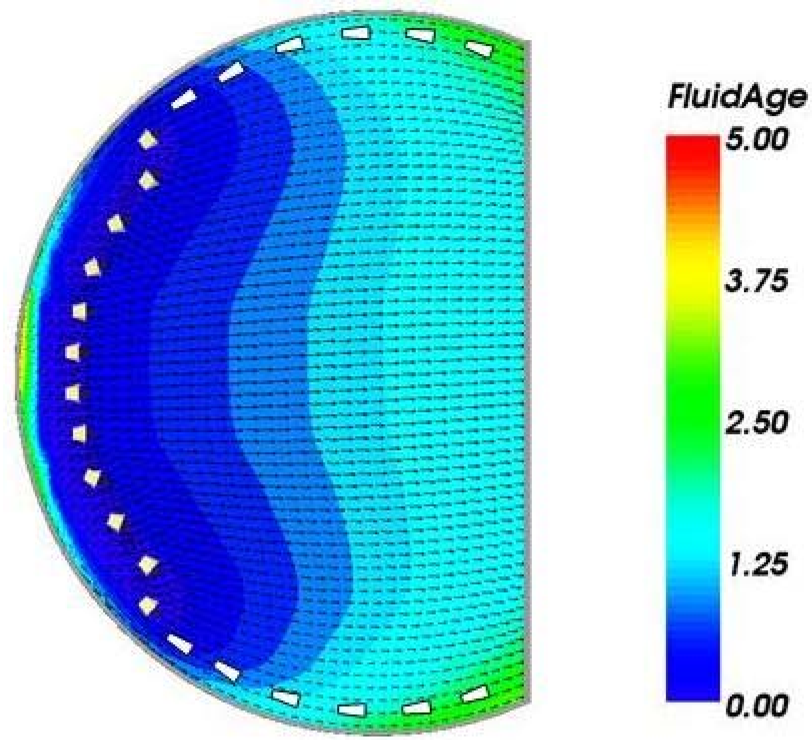


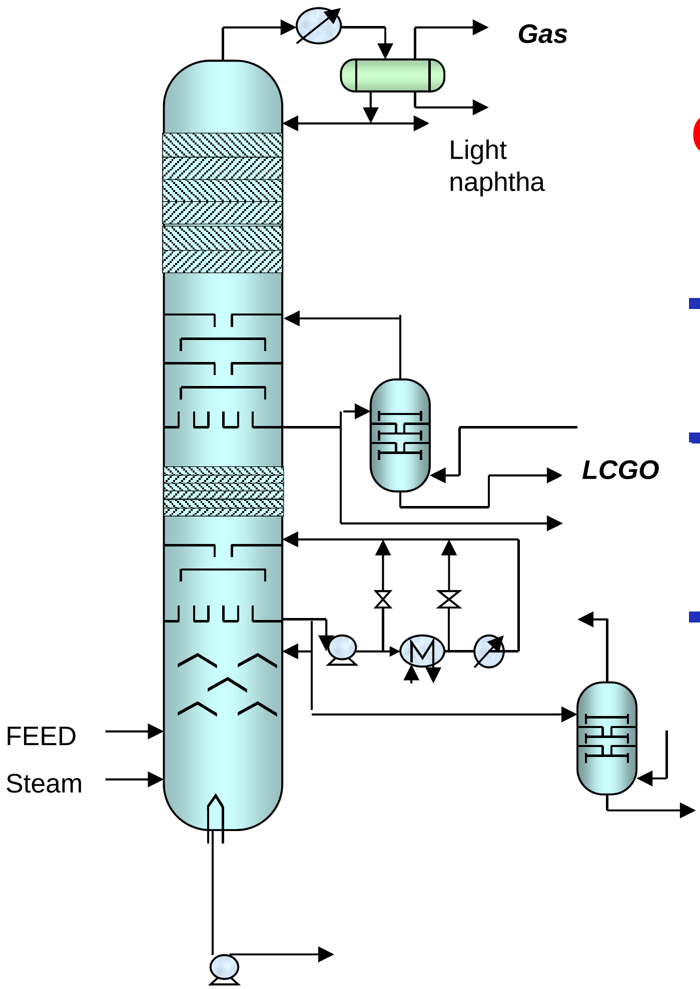
Residence Time Diagram Over the Active Area

Conventional Trays



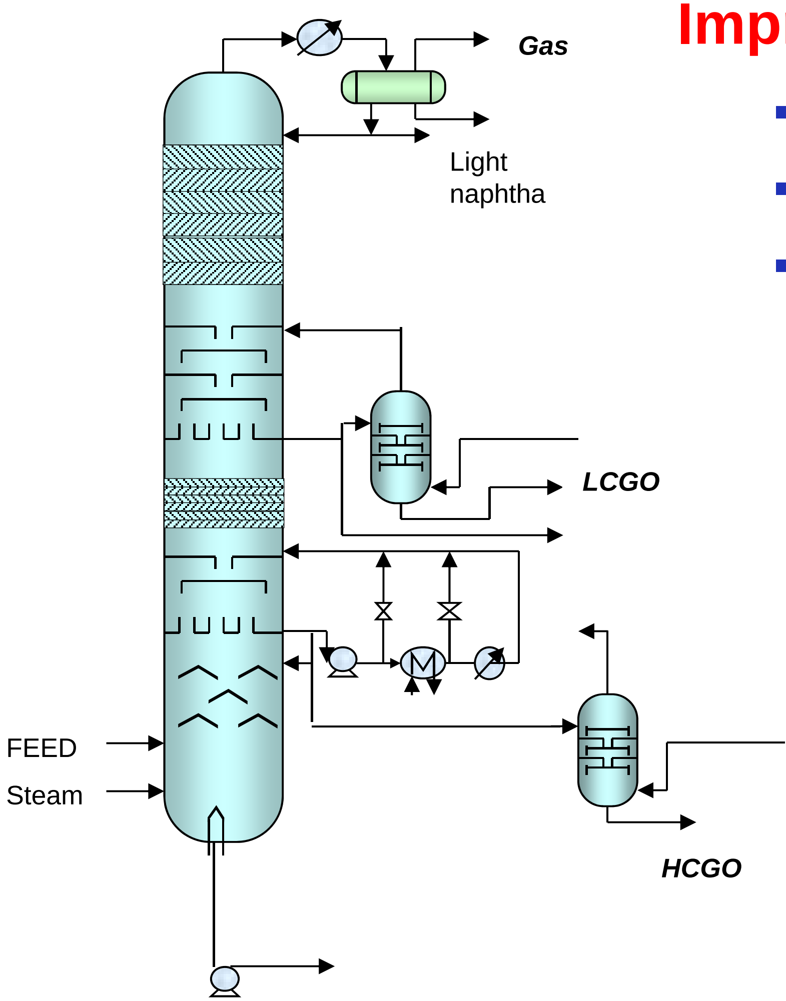
VG AF Trays





Options Available to Increase Capacity

- **Revamp HCGO Pumparound.**
- **Revamp with Sulzer High Capacity MVG™ and VGPlus™ Trays.**
- **Revamp with Sulzer Mellapak, Mellagrid and Nutter Grid Packing.**

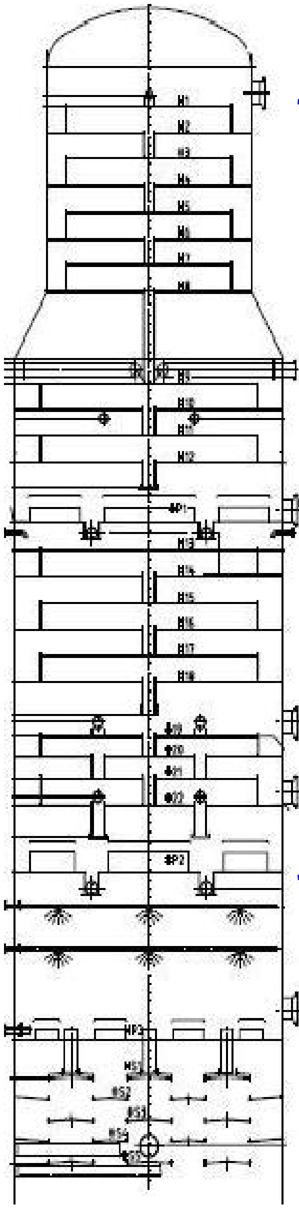


Improving the Gas Oil/Naphtha Quality

- Tray efficiency ~ 50 to 60%
- Packing efficiency can be about 500 mm/stage
- Improve the fractionation efficiency by changing to Sulzer Mellapak™ and MellapakPlus™.

Type	NTSM
M125.Y	1.2
M2.Y	2.0
M250.Y	2.5
M202.Y	2.0
M252.Y	2.5

The Largest Coker Main Fractionator Equipped with VG AF (V-Grid Anti-Fouling) Trays



ID 6710 mm

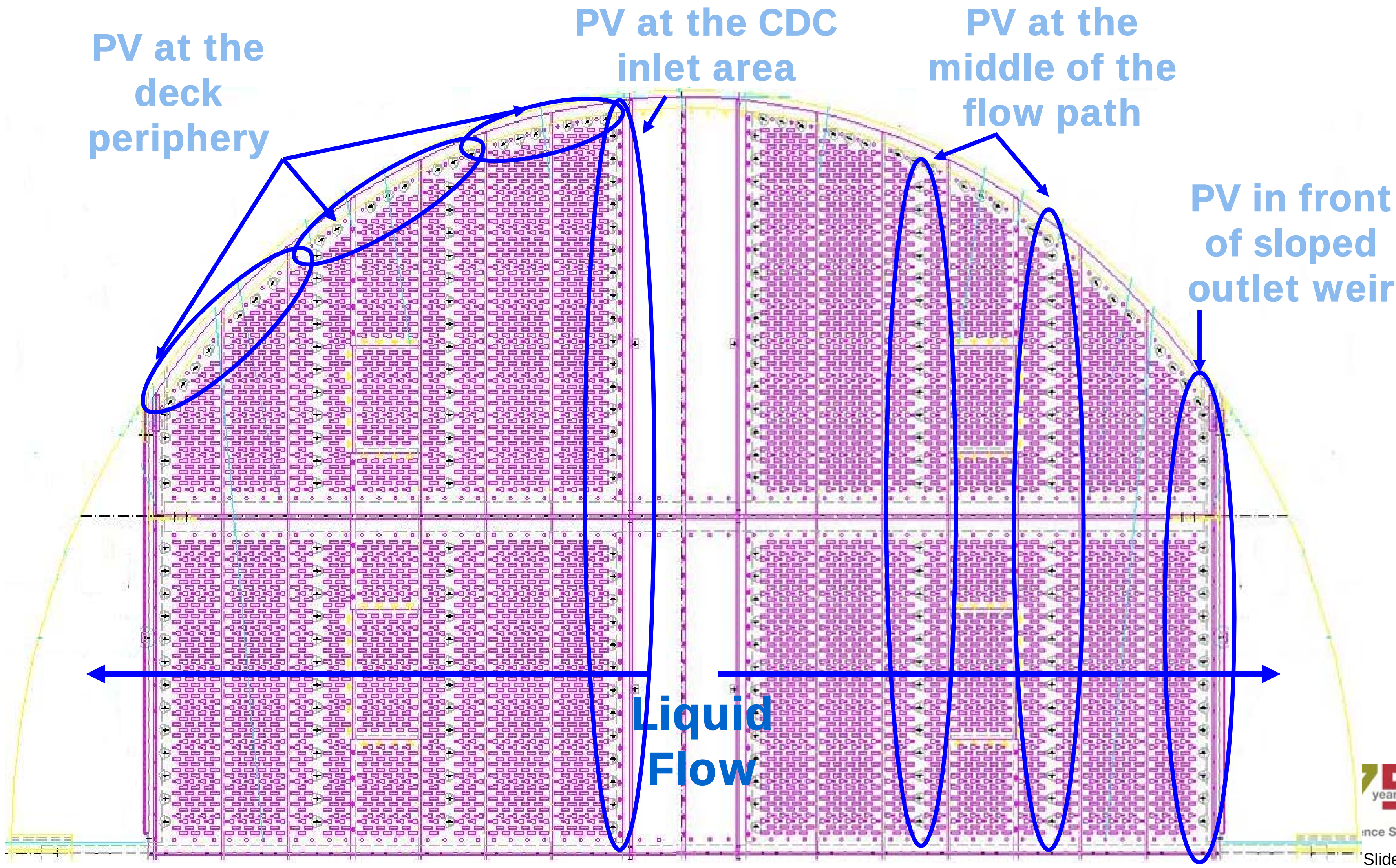
From Round Valve to VG AF trays

ID 8840 mm

New 6 Pass Baffle Trays

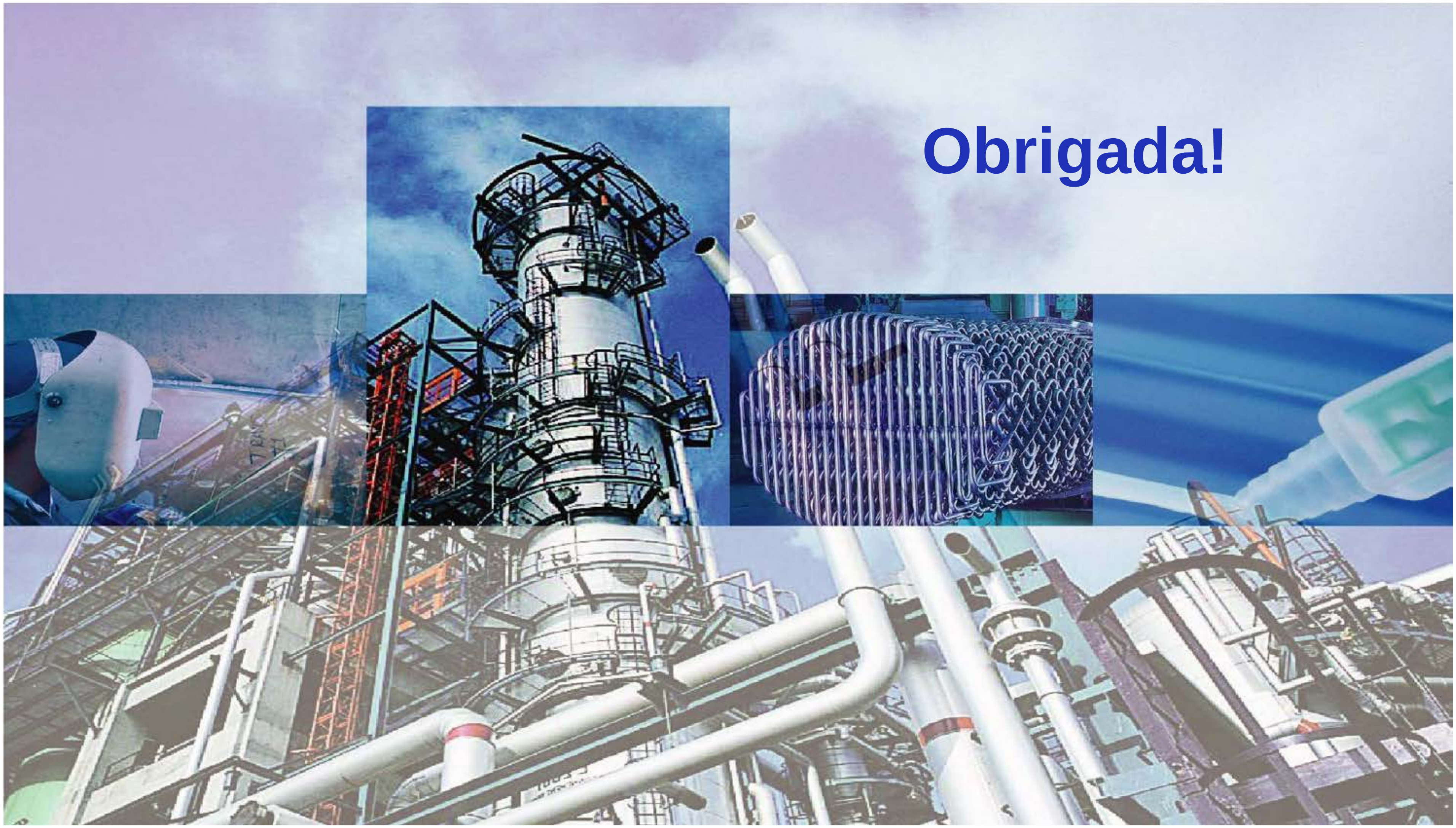
Nominal Capacity	122 kbpd
Maximum Capacity before Revamp	140 kbpd
Capacity after Revamp	160 kbpd

2 Pass VG AF Trays ID: 8840 mm



REFERENCES

Year	Customer	Diameter	Supplied Equipment
2000	Marathon, USA	168" / 4267 mm	BDH Trays
2000	Seadrift Coke, USA	126" / 3200 mm	Mellagrid
2000	Equilon Enterprises, USA	120" / 3048 mm	MVG Trays / Mellapak / Mellagrid
2002	Husky Oil, CAN	114" / 2896 mm	BDH / SVG Trays / Mellapak
2002	ConocoPhillips, USA	168" / 4267 mm	SVG Trays
2003	PETROBRAS-REGAP, BR	122" / 3100 mm	MVG Trays / Mellapak
2004	ESSO, AR	134" / 3400 mm	SIV Trays / Mellagrid
2004	Premcor, USA	216-264" / 5486-6706 mm	MVG Trays
2004	ConocoPhillips, USA	96" / 2438 mm	MVG Trays
2005	ConocoPhillips, USA	150" / 3810 mm	SVG Trays
2005	Valero, Aruba	156" / 3962 mm	MVG / SVG Trays
2005	PetroCanada, CAN	120"-144" / 3048-3658 mm	BDH / SVG Trays / Nutter Grid
2005	Husky Oil, CAN	114" / 2896 mm	BDH / SVG Trays / Mellapak
2006	Shell, USA	216" / 5486 mm	MVG Trays
2006	Coffeyville, USA	132" / 3353 mm	Mellagrid


Obrigada!