# Delayed coking Seminar

SULZER

**The First Name in Mass Transfer**
**The Only Name in Service**

Presented by

Vilas Lonakadi

**19th April, 2005 Houston, Texas**

# The Refinery Applications

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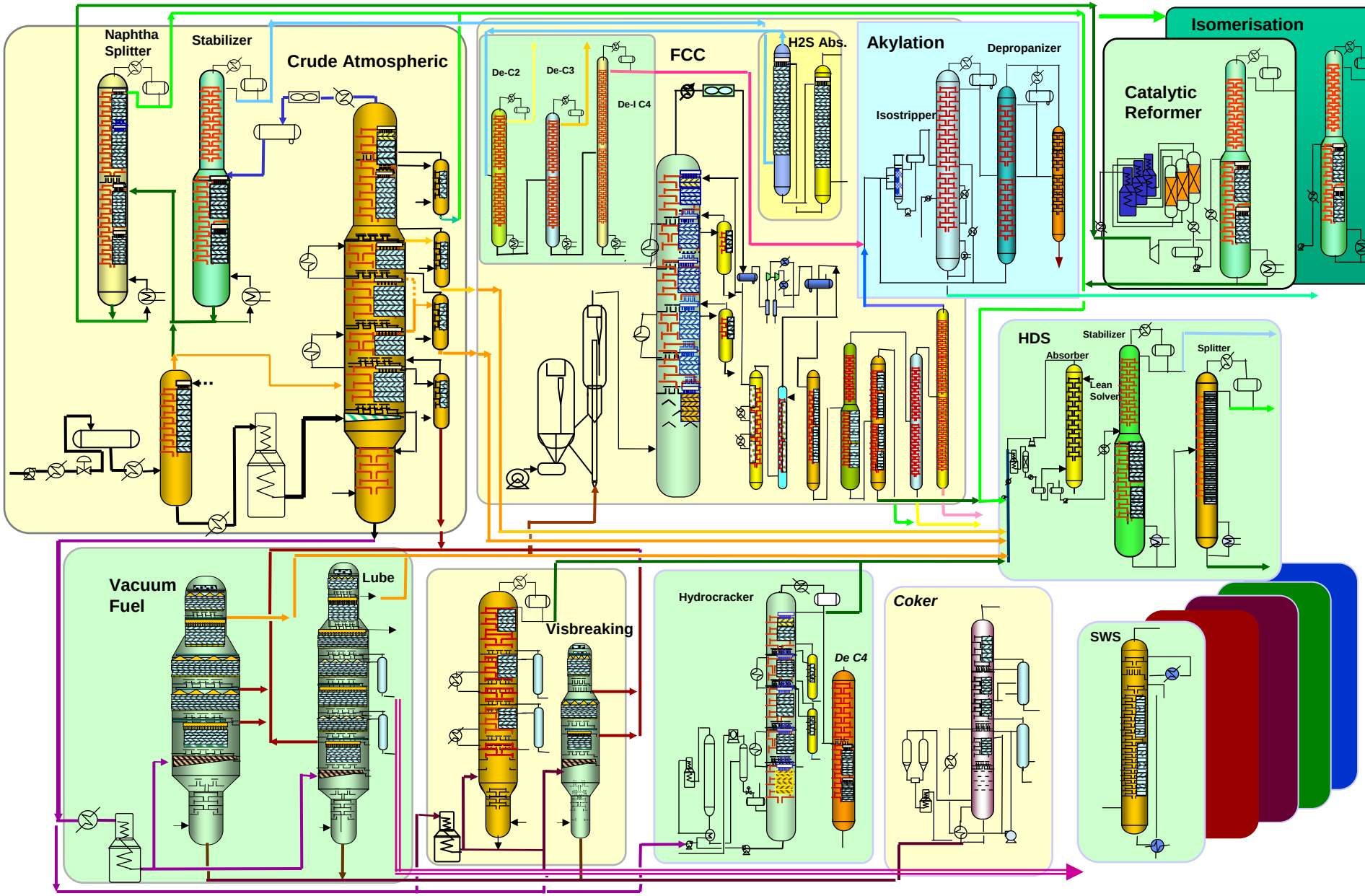

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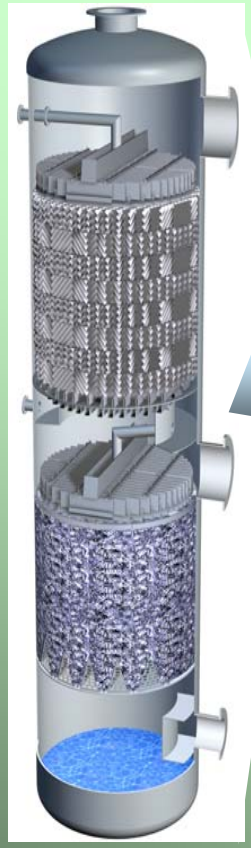
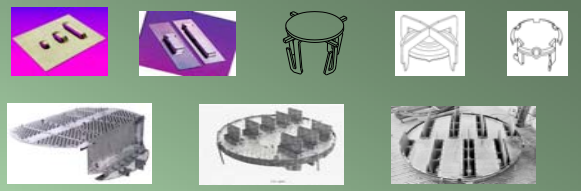
# Mass Transfer Technologies: Products



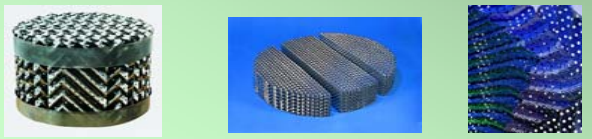
**Trays**
- Conventional
  - Bubble Cap
  - Sieve
  - Valve
- High performance
  - Nutter
  - Shell



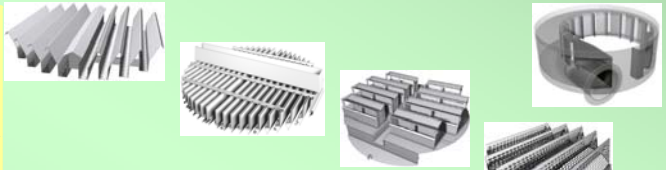
**Grids**
- Mellagrid
- NutterGrid

**Random packing**
- Nutterring

**Structured packing**
- Gauze BX, CY
- Mellapak
- MellapakPlus



**Column internals**
- Vapor distributors
- Liquid distributors
- Collect /Accumulator
- Supports



**Static mixing units**

**Membranes**

**The full spectrum of Mass transfer Components for the most efficient and economical solution**

# Sulzer global TRAY portfolio

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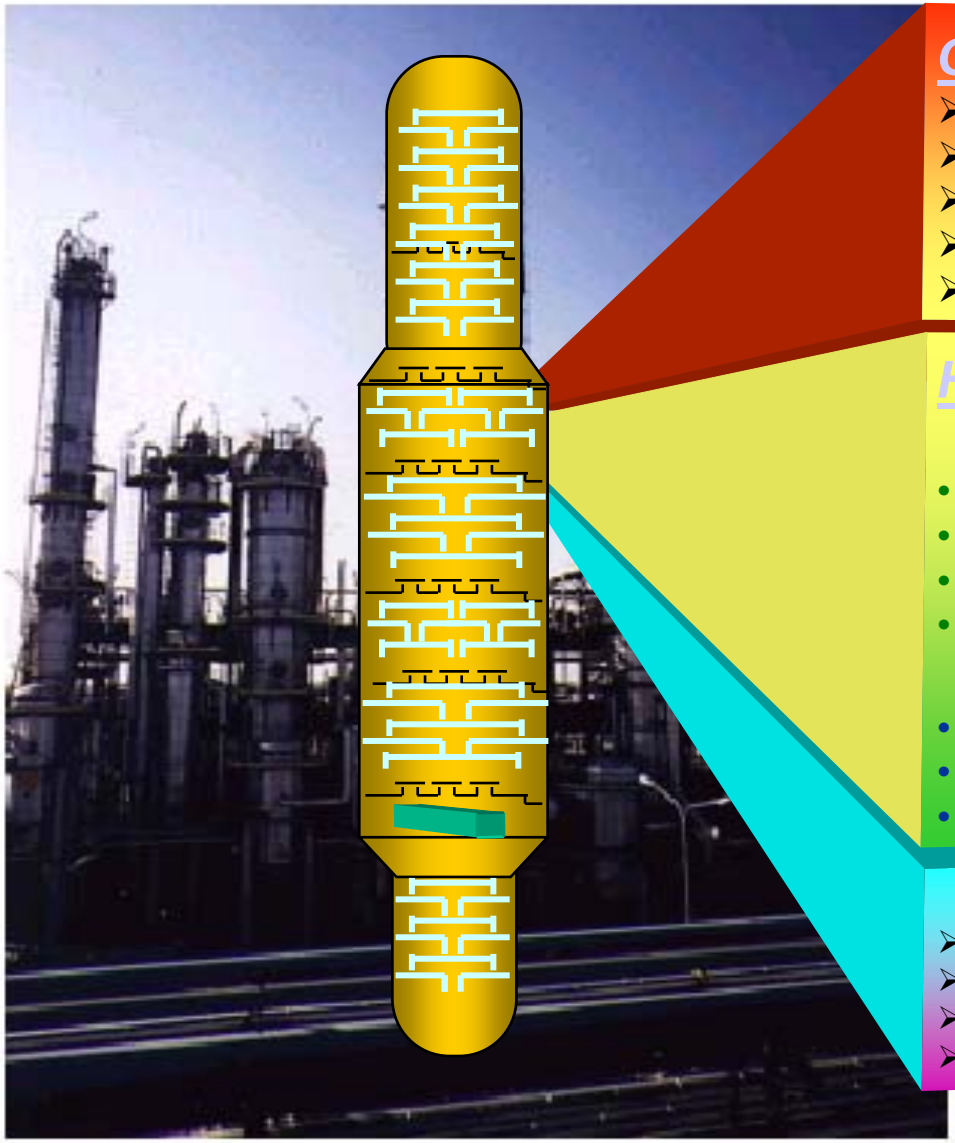

## Conventional

- Sieve Trays
- Nutter V Grid
- Floating Valve Trays
- Cage Valve Trays
- Bubble Cap Trays

## High Performance

### Nutter Technology

- Mini V-Grid MVG™
- Enhanced Mini V-Grid - MVGE
- Mini V-Grid -Truncated DC- MVGT
- Mini V-Grid -Multiple DC- VGMD™

### Shell Technology

- HiFi
- Calming Section
- ConSep

## Other

- Dual Flow Trays
- Disc & Donut Trays
- Cartridge Trays
- Shower Decks / Baffle

# V-GRID™ Trays (fixed-valve)

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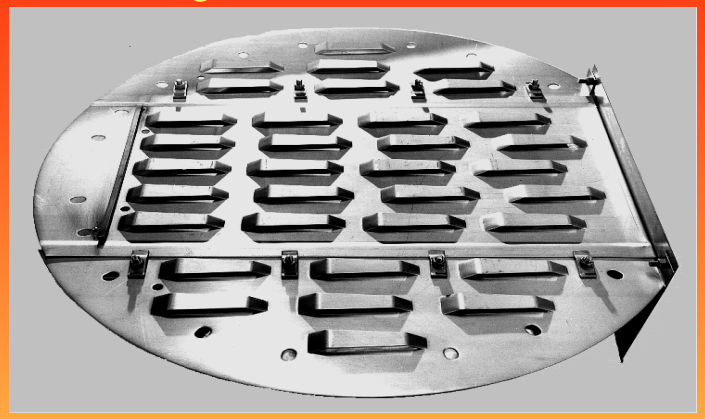
## LVG Trays



## SVG Trays

## MVG Trays

## Advantages

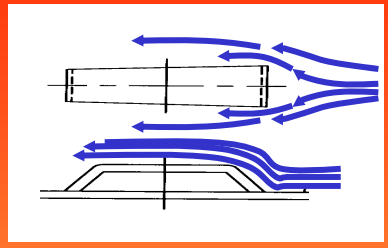
- Simple Design
- High Capacity* at Low Cost
- Fouling resistant
- Short Installation Time
- Smaller Grassroots Towers*
- High Turndown*
- MVG - Highest capacity-efficiency

* Compared with Sieve trays

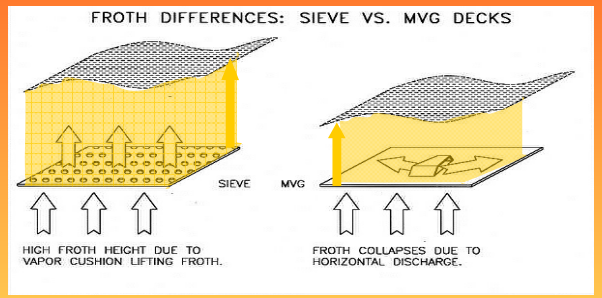
# Valve trays **(fixed-valve)**

## V-GRID™ Trays - ADVANTAGES

- Tapered slot of V-Grid reduces **Weeping**



- Lateral release of vapor decrease **Entrainment**

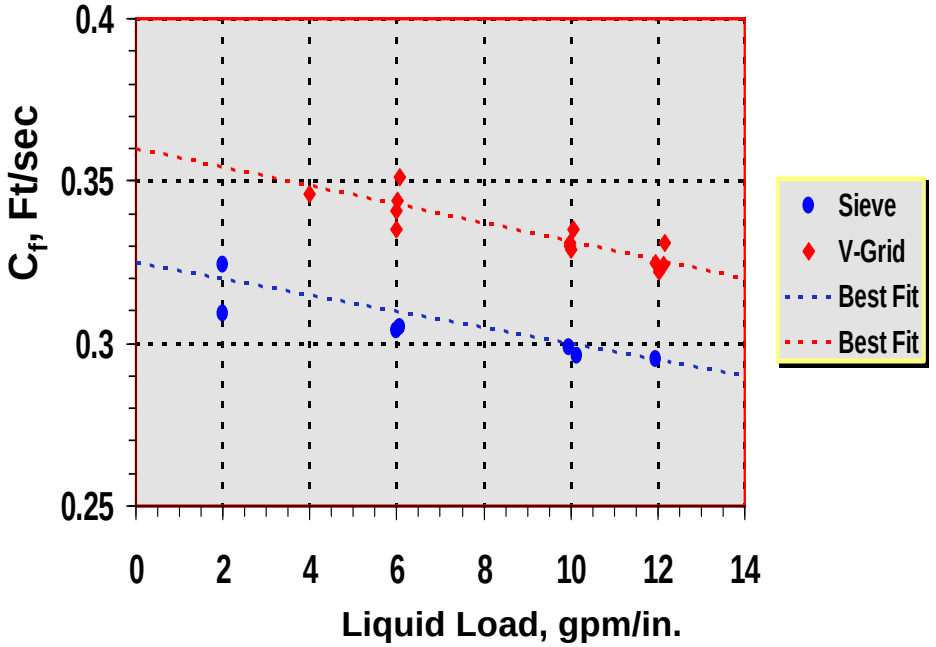



- Lateral release of vapor at tray deck
  **Reduce Fouling** by effectively wiping deck clear.

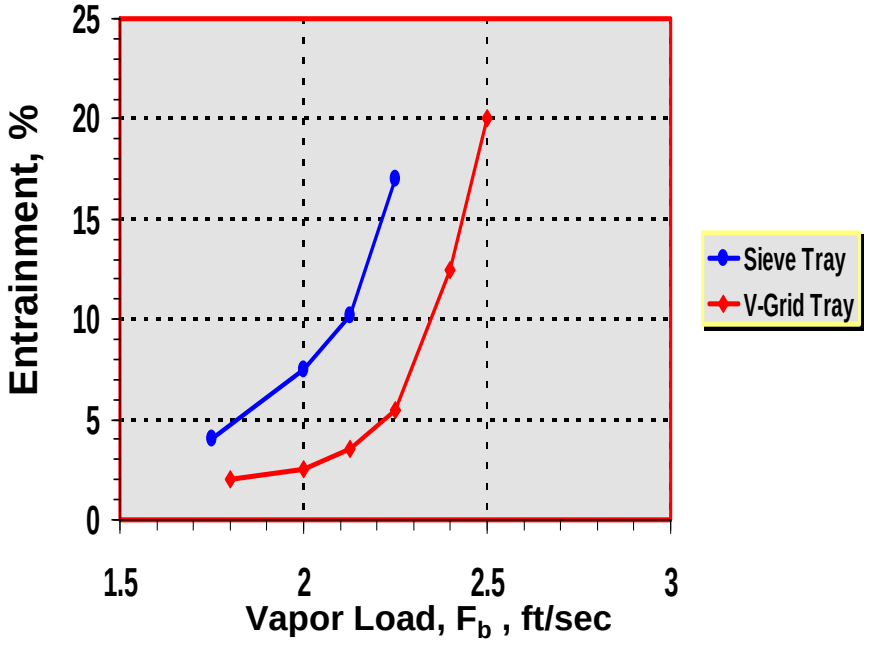
- **Superior strength**
  **Forming of V-grid from tray deck; cross sectional 3 times stronger than sieve tray**

# V-GRID™ Trays (fixed-valve)

**Sieve Tray & V-Grid Capacity**
10% Observed Entrainment
4' Test Column, 24" Tray Spacing - Air/Isopar M




**Sieve Tray & V-Grid Capacity**
2 GPM/in. Weir Loading
4' Test Column, 18" Tray Spacing - Air/Isopar M



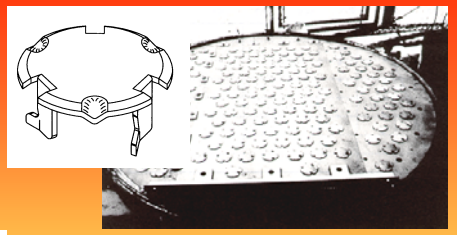
# Float Valve Trays

## *Conventional Trays*

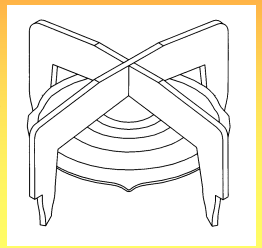
- **Floating Valve Trays**

**V type**

**Metawa Snap in**



**Cage Valve Trays**



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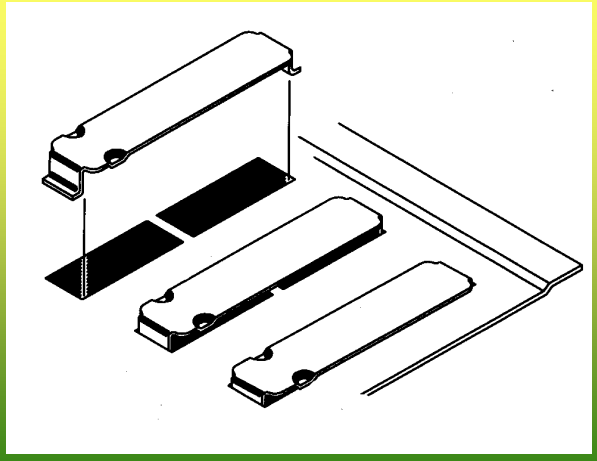
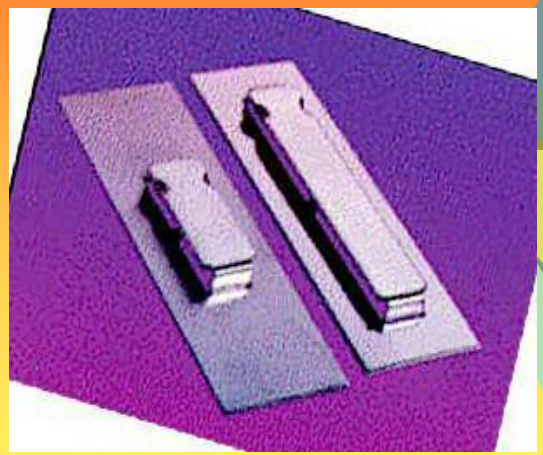
**BDH** and **BDP**
Float Valve Trays



# BDH / BDP Float Valve Trays

***Conventional***

**BDH** and **BDP**
Float Valve Trays



**FRI tested**

## Lateral (axial) Vapor Release

- Assures Uniform contacting in ALL Active Area
- Turndown: 3 to 7 : 1
- Capacity high to very high.
- High efficiency .
- Pressure Drop moderate.

## Wide Valve legs

- Prevents Weeping
- Reduces chances of damage during installation
- Easily crimped shut for reduced vapor flow

## Longer Life:

- NO wear due to valve spinning
- Top side replacement

# Sulzer Global Tray Portfolio

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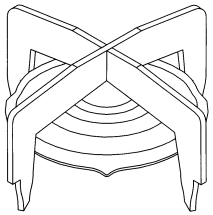
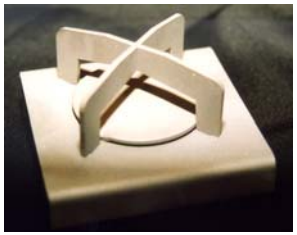
## Cage valve tray

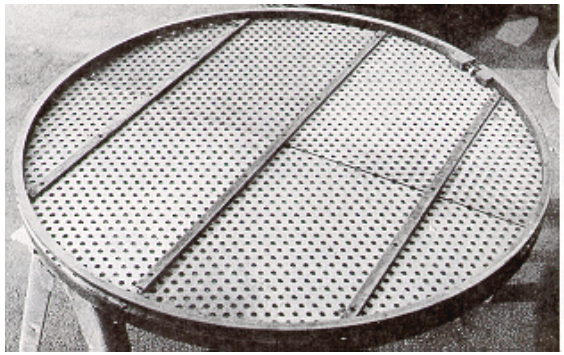
- Capacity relatively high.
- Efficiency lower than other tray types.
- Pressure Drop low to moderate.
- Narrow optimum performance range
- Suitable for high fouling services.





## Dualflow Tray

- Perforated deck with no downcomers.
- Tray action is simultaneous eruption & drainage of liquid when vapor forced clusters of holes.
- Capacity relatively high.
- Efficiency lower than other tray types.
- Pressure Drop low to moderate.
- Narrow optimum performance range
- Suitable for high fouling services.

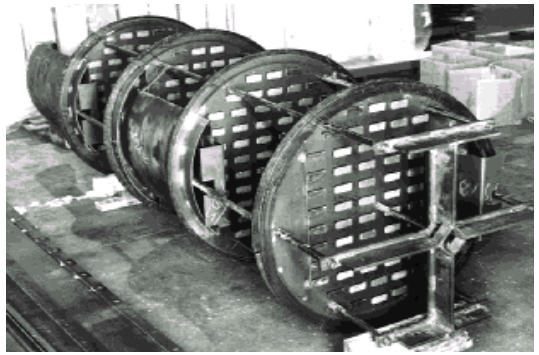


## Cartridge Trays

- For small column diameter (< 800mm)
- equipped with Valve, V-Grid, Sieve, Bubble cap

and

- EXXON Jet - Tab Trays
- Transition & Chimney Trays



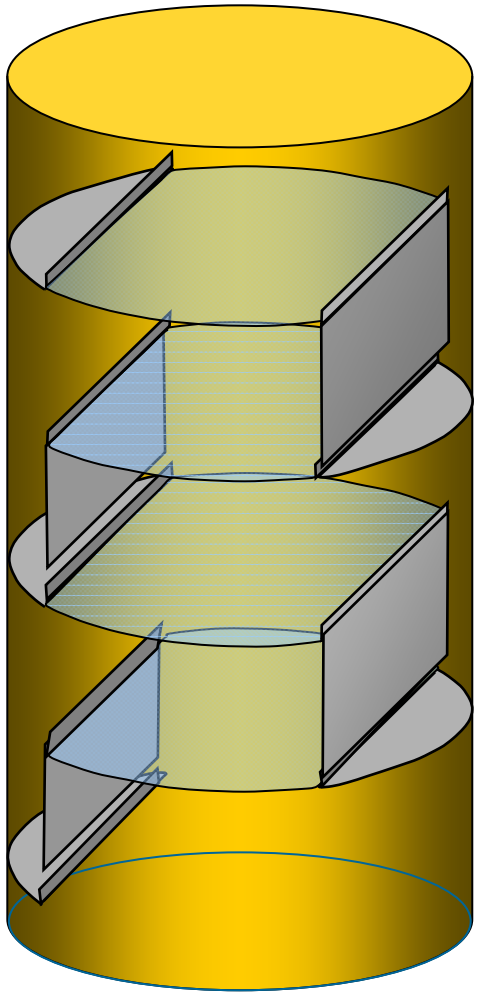
Sieve Tray, Round valve tray and bubble cap trays also available

# Conventional Tray



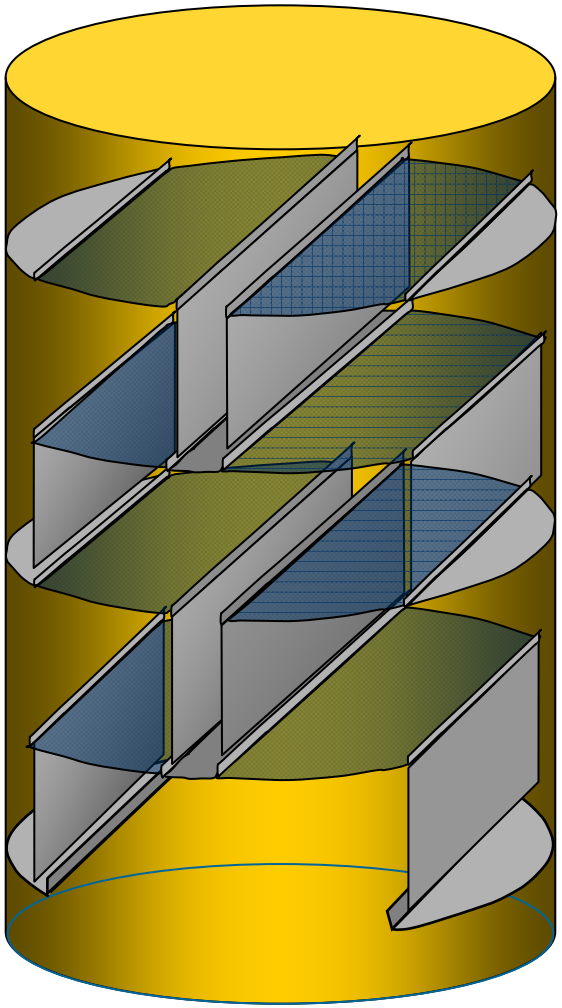
## One Pass Tray

Straight Down comer

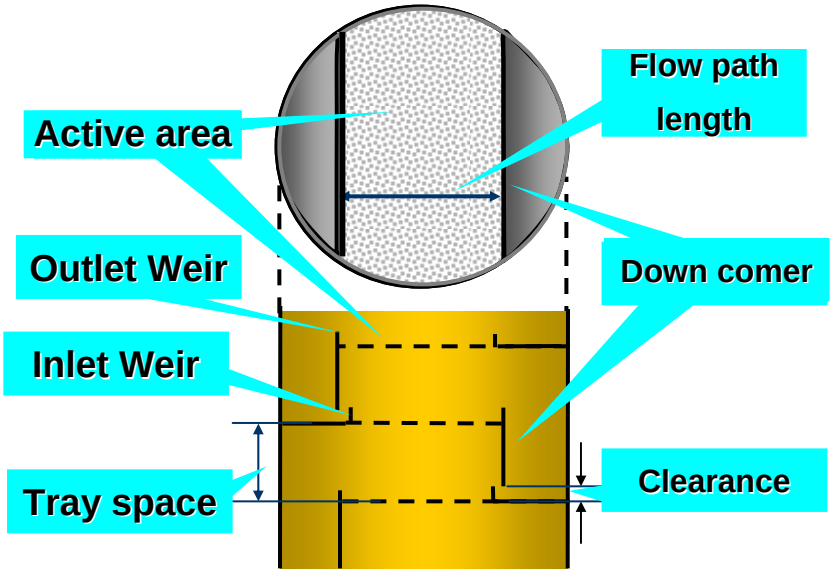


## Two Pass Tray

Straight Down comer



## Tray features




## Advantages

- Simple design

## Disadvantages

- Limited Capacity

# Conventional Tray

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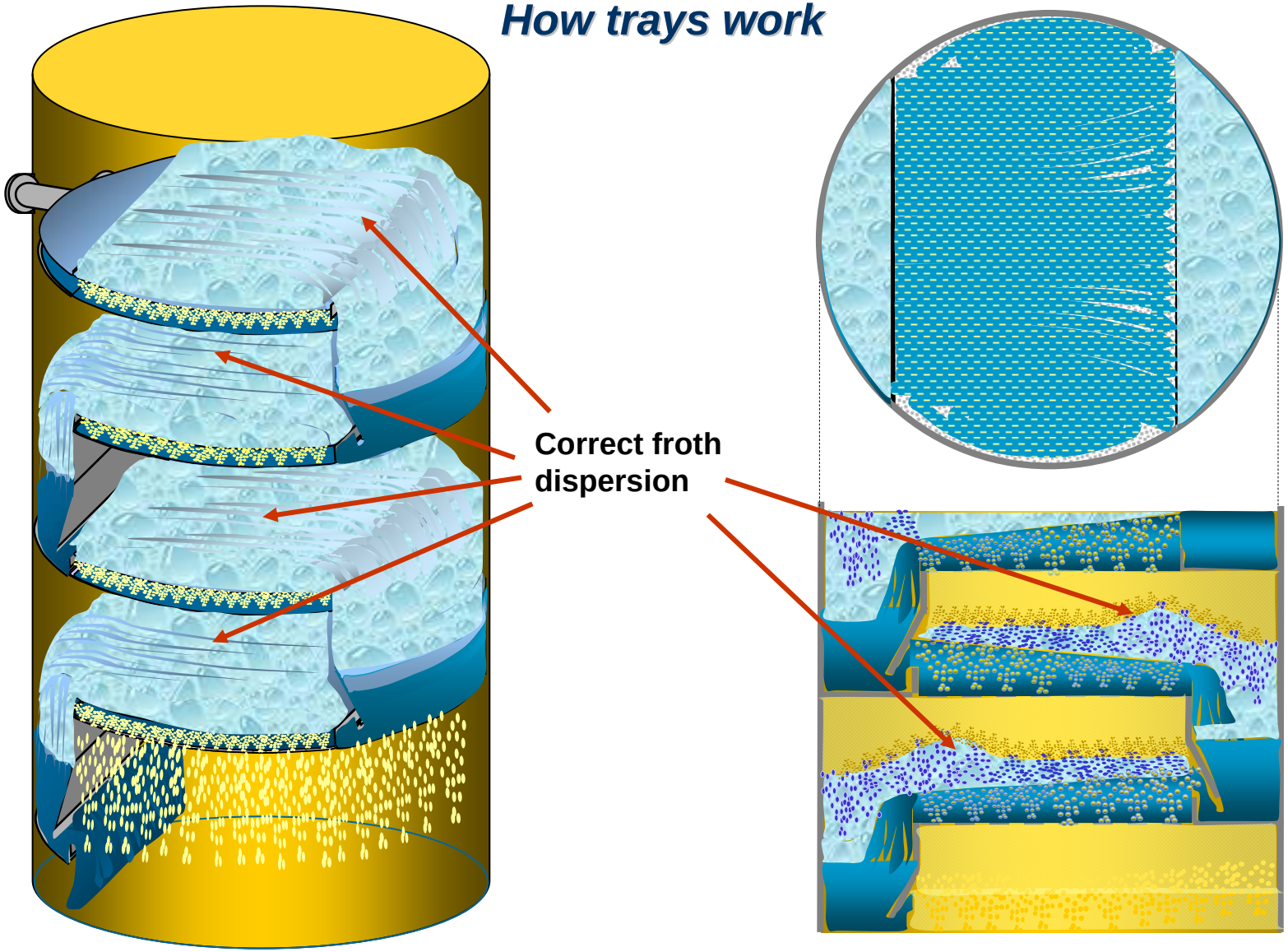
## *How trays work*



# Conventional Tray

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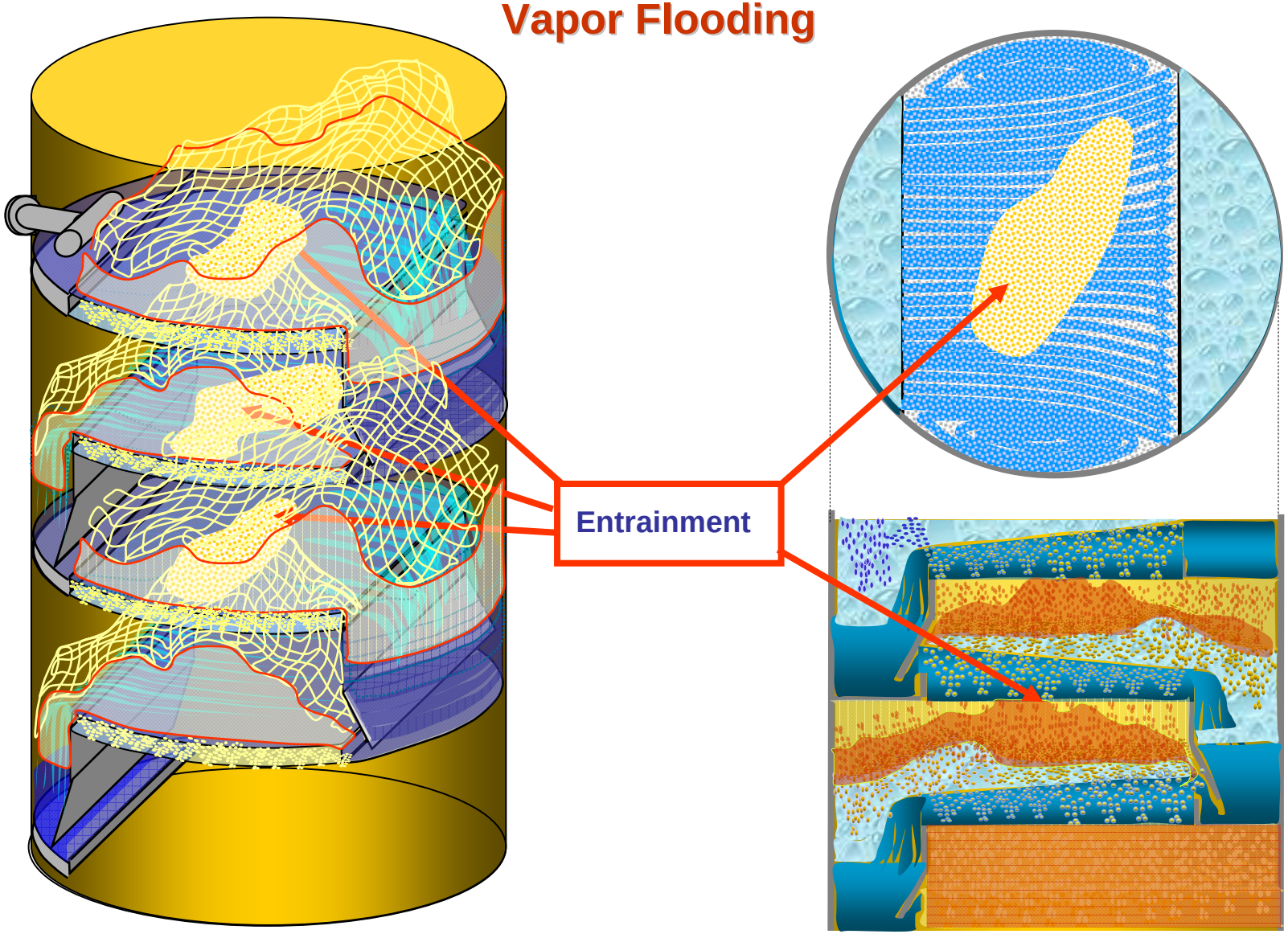
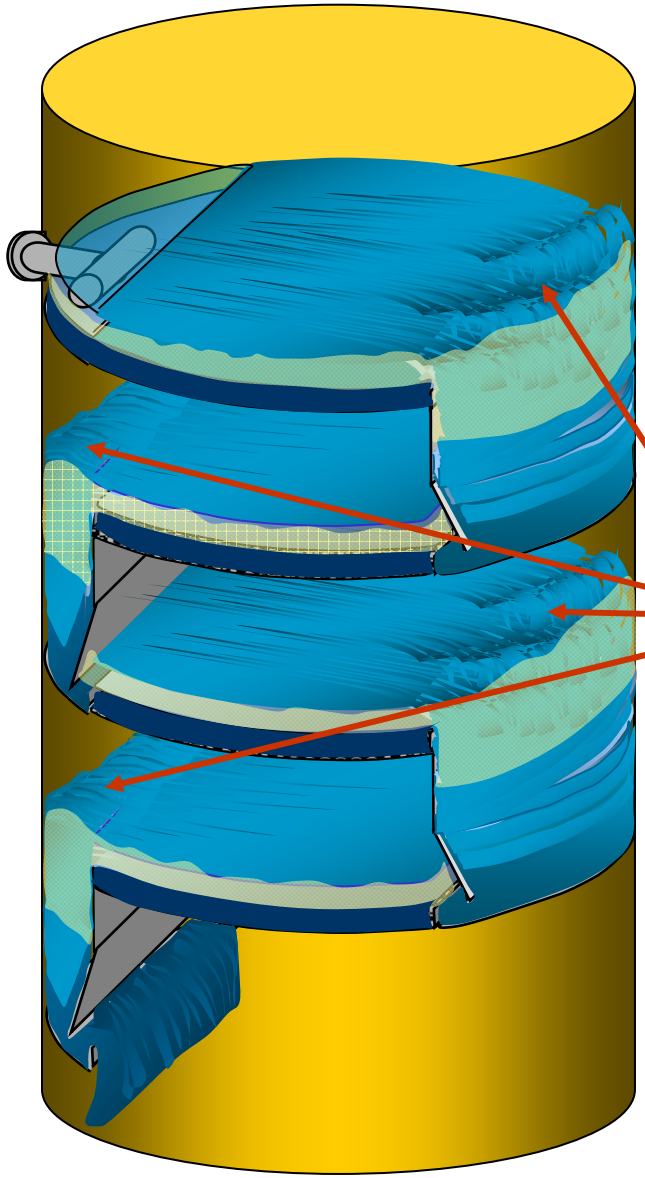
## Vapor Flooding

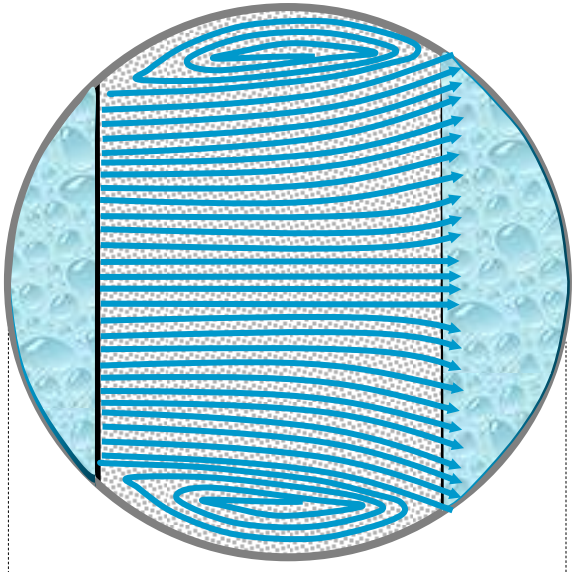


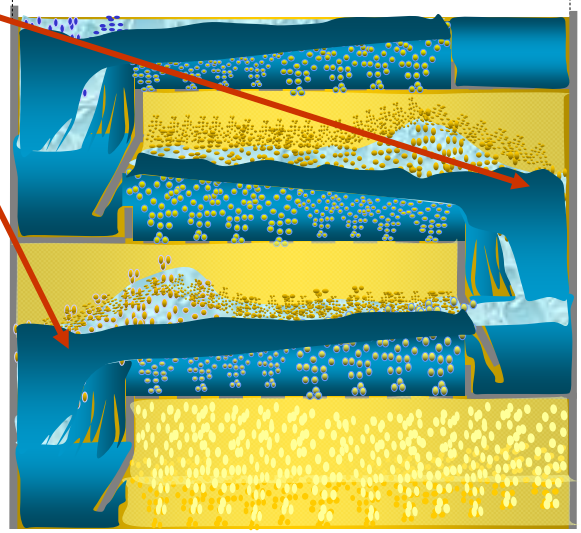
# Conventional Tray



**Downcomer Flooding**

**High liquid**





# Conventional Tray

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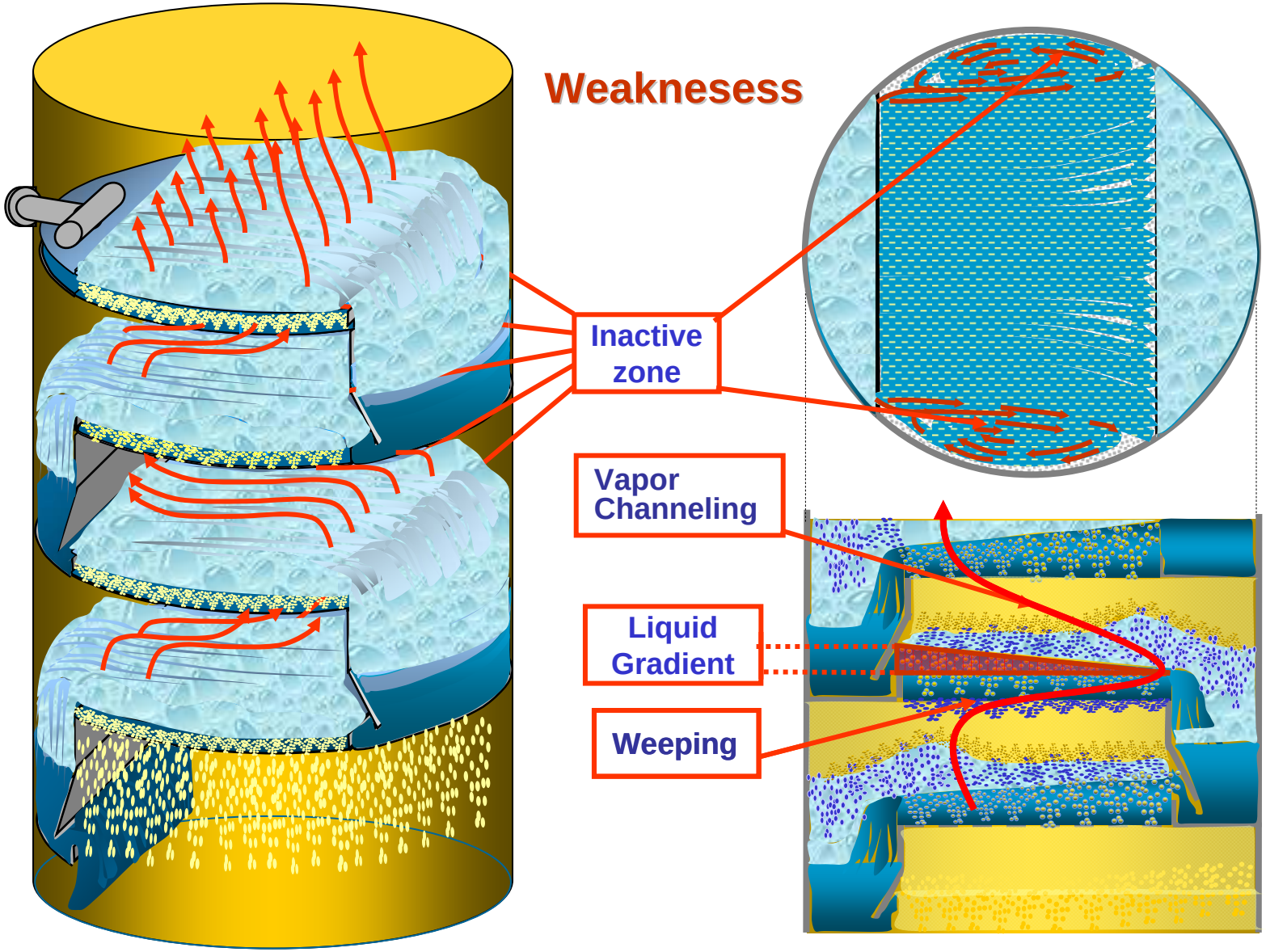
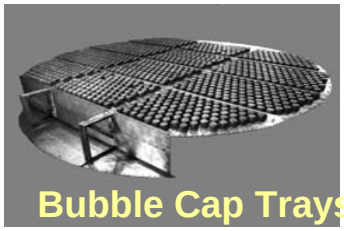
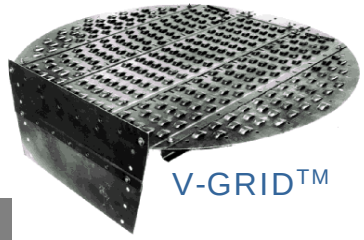


# Conventional Tray

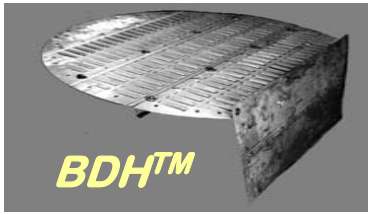
## Increase tray capacity by:

*... type of perforation*


Bubble Cap Trays


+ 5 ÷15 %

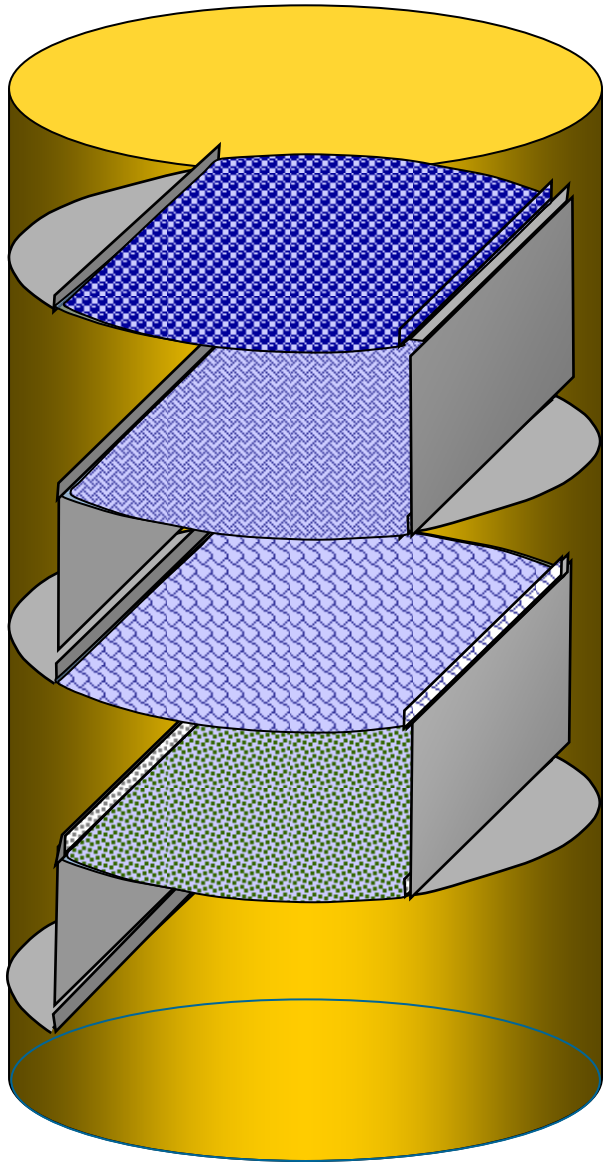
V-GRID™


BDH™

+ 5 ÷15 %


+ 5 ÷20 %

MV-GRID™



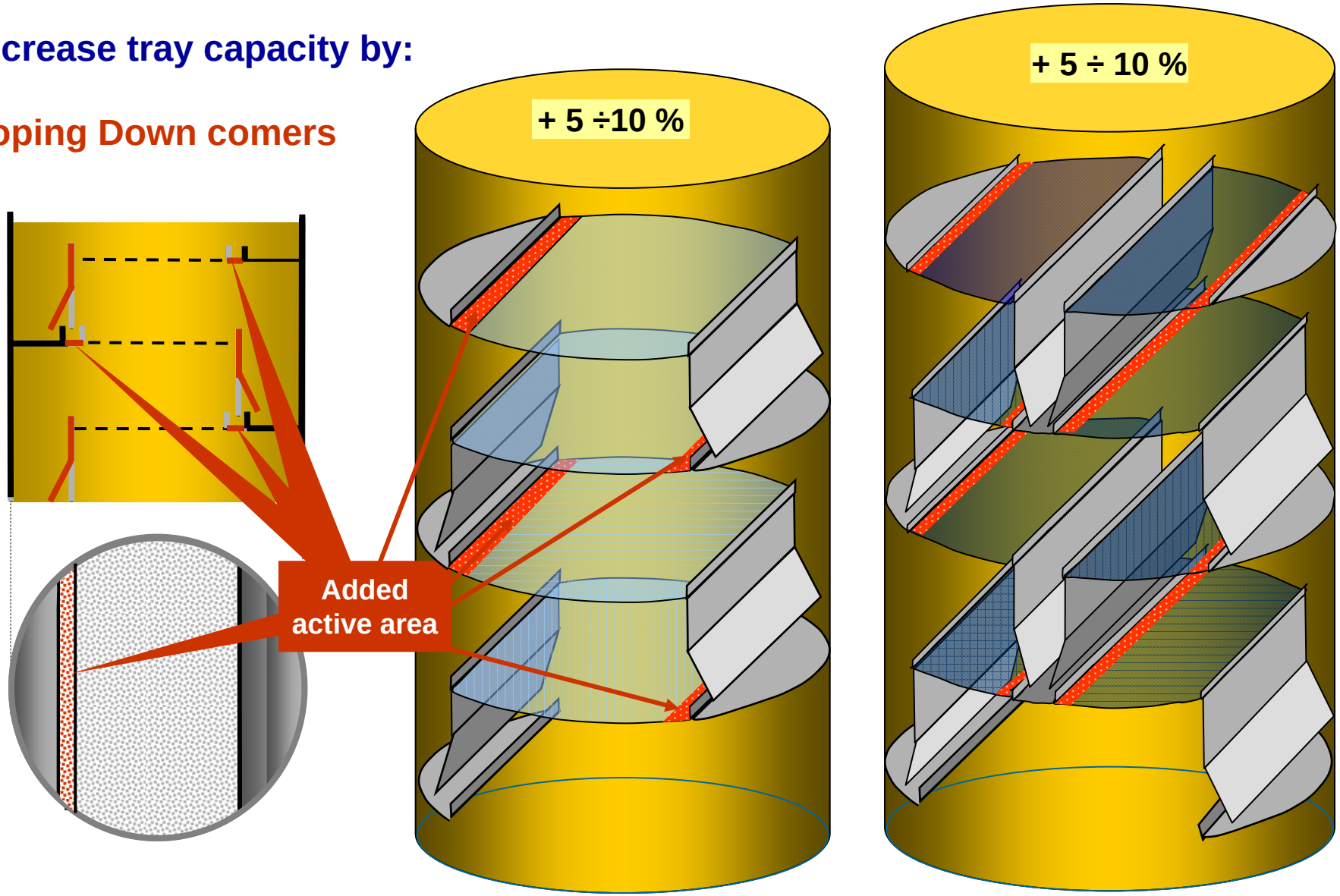
# How To Boost Tray Performances Up ?

- **Maximize Bubbling Area**
  - Reduce Jet Flooding
  - Reduce Entrainment
- **Optimize Down Comer Design**
  - Reduce Choke Flooding
  - Reduce Liquid Back up
  - Reduce DC Aerated Flooding
- **Maximize Outlet Weir Length**
  - Reduce Crest height
- **Optimize Down Comer Inlet Area**
  - Reduce Hydraulic liquid Gradient
  - Eliminate Inactive Zones

# Conventional Tray

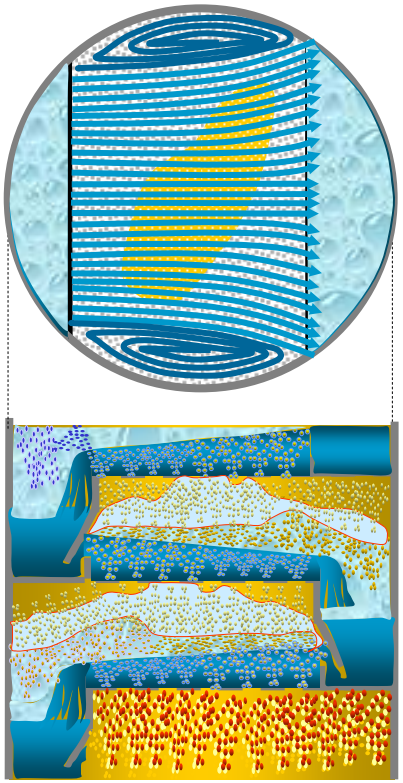
## Increase tray capacity by:

**sloping Down comers**

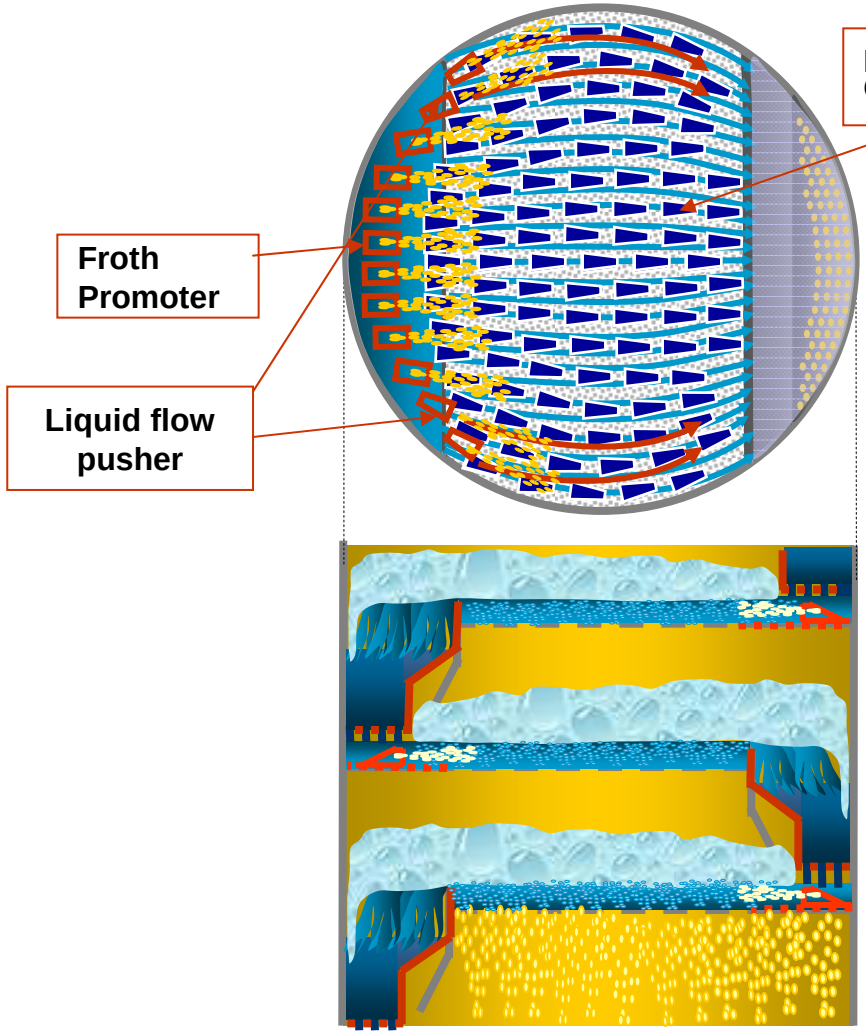


# How To Boost Tray Performances Up ?

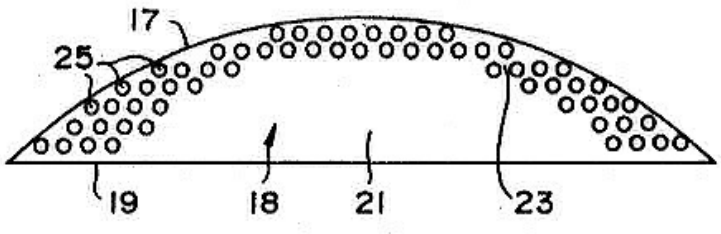
## Increase tray capacity by:

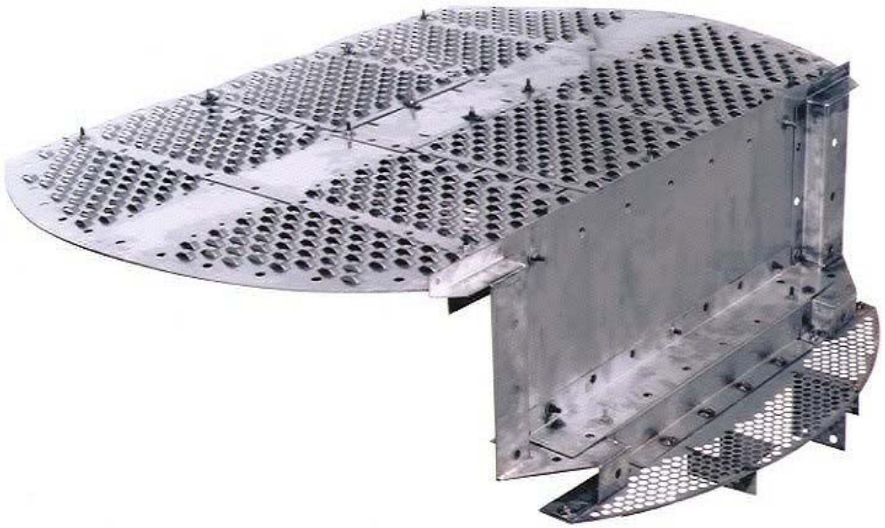


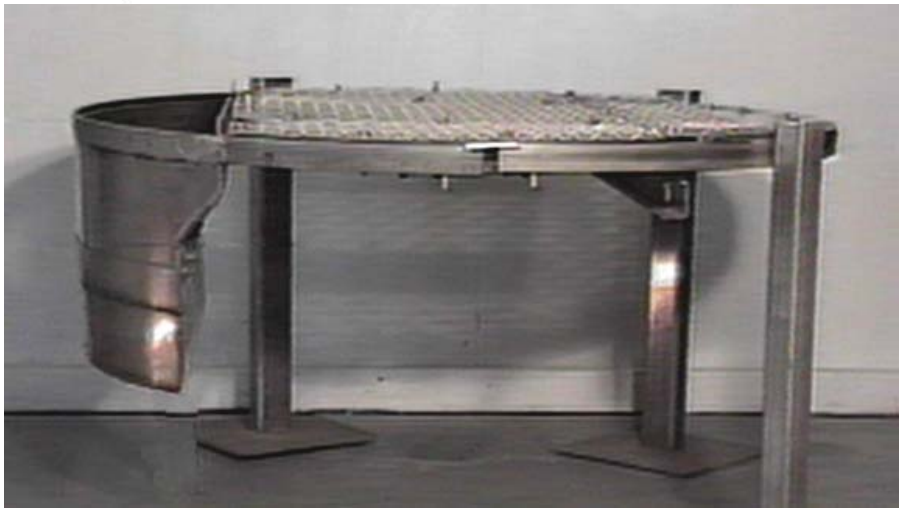
## Truncated downcomer and liquid distribution



# VG Plus™ Trays





# High Performance Trays

## MVG tray deck advantage *over Conventional Trays*

- ⇨ *15% to 40% Greater capacity;*
- ⇨ *Uniform Liquid flow;*
- ⇨ *Minimum Hydraulic gradient;*
- ⇨ *Uniform Vapor Distribution;*
- ⇨ *Uniform L/V on the Tray Deck;*
- ⇨ *Equal or Greater efficiency.*
- ⇨ *Lower Pressure Drop;*
- ⇨ *Lower & Equalized Froth Height;*
- ⇨ *Lower Foaming Tendency;*
- ⇨ *Lower Entrainment;*
- ⇨ *Fouling Resistance*
- ⇨ *High turn down*
- ⇨ *Mechanical strength*

## *The Functional Features of Mini V-Grid Trays*

### *(VG Plus Trays)*

- ⇨ ***Enhanced tray deck design:*** ***Shape & Size of the openings (MVG)***
- ⇨ ***Enhanced Down Comer design:*** ***Multi-Chordal, Truncated, Radius Tip***
- ⇨ ***Enhanced Inlet Area design:*** ***Froth Promoter, Liquid Flow Pusher, Jet Tab;***
- ⇨ ***Enhanced Outlet Weir design:*** ***Swept back, Stepped***

# The Shell and Sulzer Alliance

## Brand Names

### Licensed Products

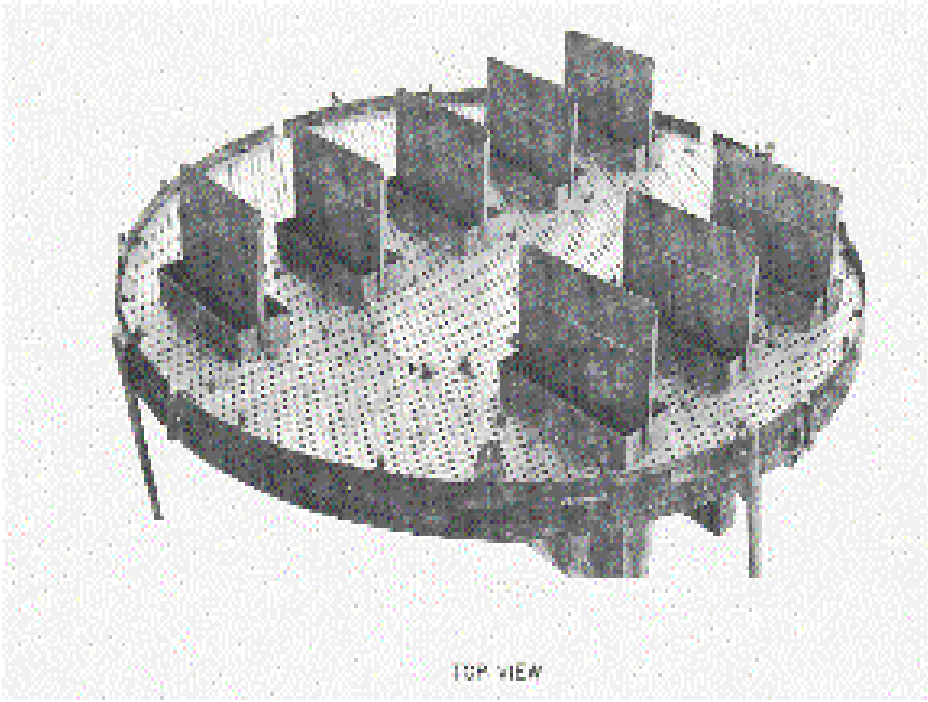
- Shell Calming Section™ tray
- Shell HiFi™ tray
- Shell Schoepentoeter™ inlet device
- Shell Calming Section Grid™ trays
- Shell SMS™ separators

### SSP Equipment

- Shell Calming Section Plus™ tray
- Shell HiFi Plus™ tray
- Shell ConSep™ tray
- Shell Swirl Tube™ tray
- Shell SMSM separator
- Shell Extraction HiFi™ tray

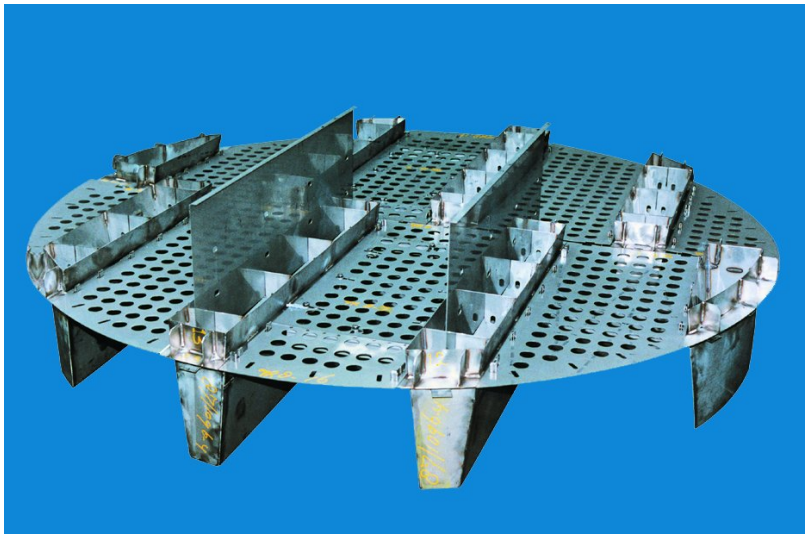
# Shell Calming Section™ Trays

- Maximizes bubbling area
- Highest jet flood and vapor handling capacity
- Long flow path length.  High efficiency
- Available in boltless construction. Minimum installation time
- Can use many types of bubblers (sieves, valves, fixed valves, etc.)
- Small tray spacing to provide maximum stages
- Several hundred columns in operation
- Typical applications
  - Main Fractionators
  - Deisobutanizers, C6/C7/C8 fractionations
  - Atmospheric and mild vacuum chemical columns
  - Any place where entrainment is a concern



# The Shell and Sulzer Alliance

## Shell HiFi™ Tray



- **Best in high liquid load services. Longest weir length with longest flow path. Minimum dead zones**
- **Highest liquid handling capacity**
- **Best tray efficiency at large liquid loads**
- **No requirement for trusses.**
- **Available in boltless construction. Minimum installation time**
- **Can use many types of bubblers (sieves, valves, fixed valves, etc.)**
- **Tray spacing as low as 300 mm are achievable**
- **Several hundred columns in operation**

Typical applications

Pump-around sections in fractionators
Any place where liquid capacity is a concern
High pressure absorbers and splitters

# The Shell and Sulzer Alliance

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## Shell Calming Section™ Grid Trays

- Shell CS Grid trays offer the best efficiency of any grid tray or packing with equivalent capacity
- The tray is a dual flow tray with calming baffles to enhance distribution and prevent sloshing
- Grid trays are generally more resistant to fouling in services where chemical instability can cause coking
  - Round bar Grid Trays offer the most fouling resistance
  - Slotted Grid Trays offer the least
- Typical Applications
  - For FCCU Main fractionator slurry sections
  - Bottom section of Crude distillers
  - Bottom section of Pygas fractionators
  - Sour water and Waste water strippers

## Shell Calming Section™ Plus and HiFi™ Plus Trays

- Newer versions of the previous CS and HiFi trays
- Incorporate more efficient downcomer designs to increase liquid handling capacity by 10-20% over normal CS and HiFi trays
- Incorporate low entrainment bubblers (MVG fixed valves)
- Improved liquid distribution features that give higher efficiency at higher flow parameters
- Developing experience data base
- Typical applications
  - Superfractionators ( C2 and C3 splitters)
  - Gas plants ( De-C2, De-C3, De-C4, DIB)
  - Workup sections of Catcrackers and Hydrocrackers

# The Shell and Sulzer Alliance

## ConSep™ Tray Background

## Factors limiting tray capacity

**Jet flood** — **“ Excessive vapour flow causing liquid to be entrained in the vapour up to tray above and backing up the liquid in the downcomers”.**

**DC flood** — **“ High liquid traffic requires larger DC volume and longer weir length.**

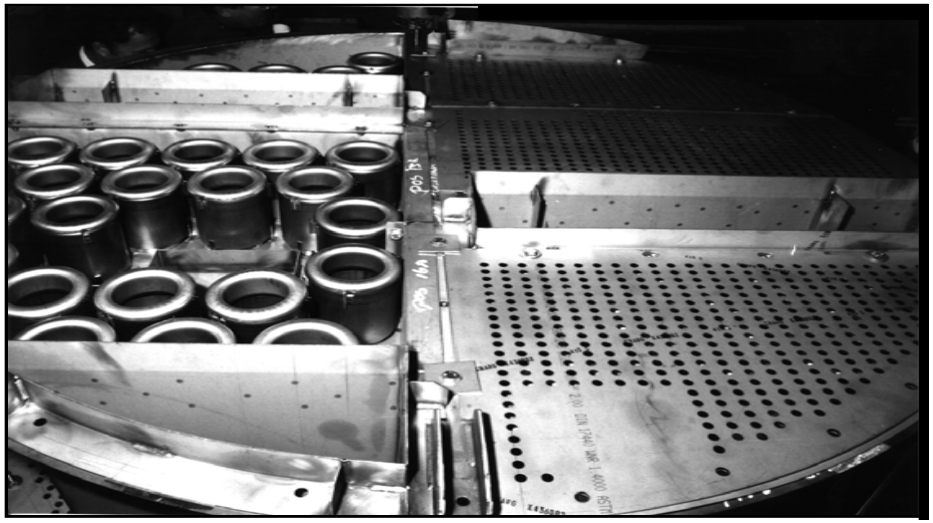
**Option to overcome the limit**

**Conventional high capacity trays shift the jet flood limit maximizing the bubbling area; this limits the DC capacity therefore ultimate capacity achievable**

# The Shell and Sulzer Alliance

## Shell ConSep™ Tray

- Highest capacity device in the family and in the market
- Can increase capacity of conventional trays by 50-80% and 30-50% over CS or HiFi trays
- Maximizes jet flood capacity
- Maximizes liquid handling capability
- Can be retrofitted to existing towers
- Provides equivalent efficiency to other trays
- Requires some additional pressure drop



# Packing

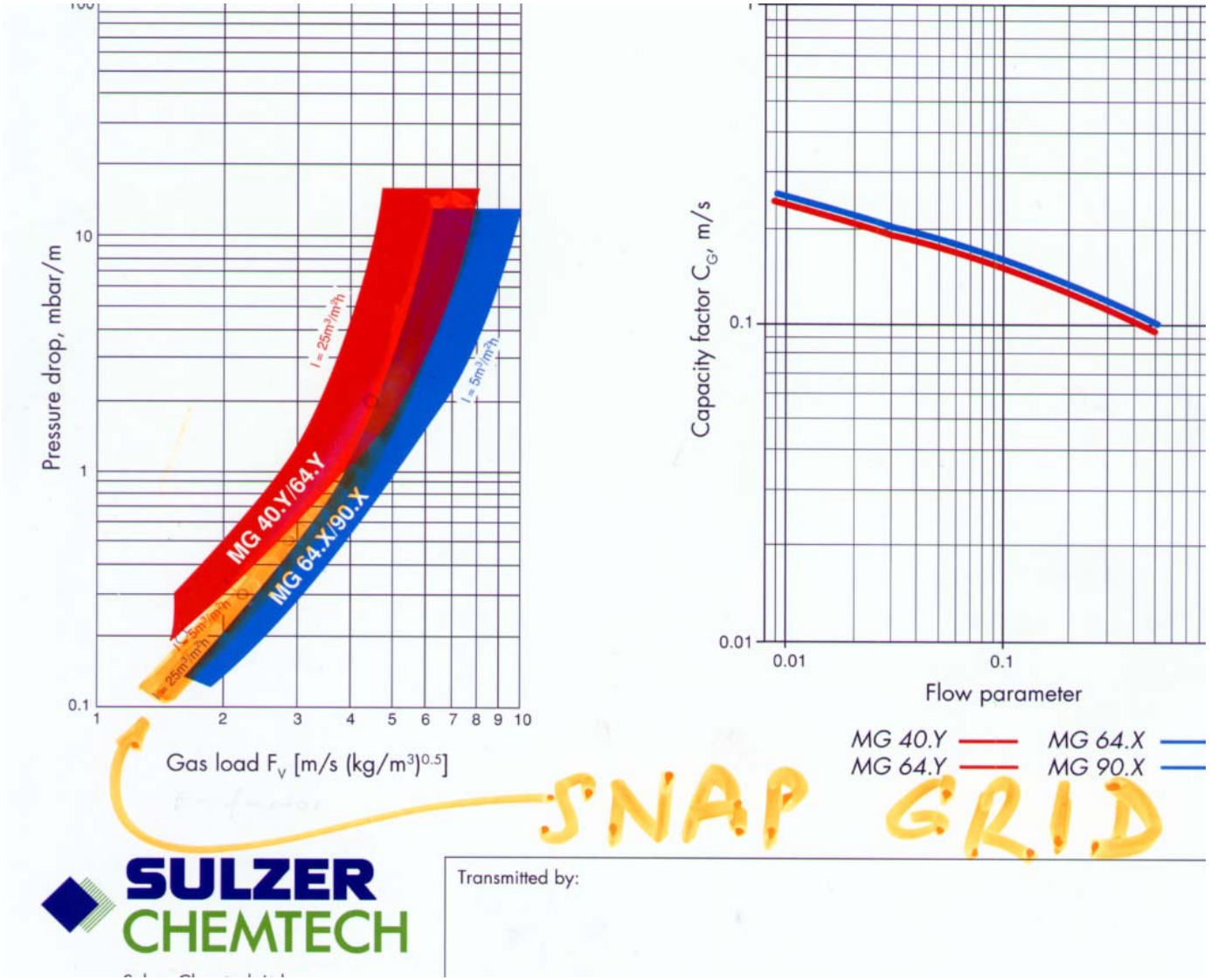
**Grids**
- Mellagrid
- NutterGrid

**Structured packing**
- Gauze BX, CY
- Mellapak
- MellapakPlus

**Random packing**
- Nutterring

**The full spectrum of Mass transfer Components**

# Grid


Pressure drop, mbar/m
100
10
1
0.1
1
2
3
4
5
6
7
8
9
10
Gas load $F_V$ [m/s (kg/m³)$^{0.5}$]
MG 40.Y/64.Y
MG 64.X/90.X
l = 25m³/m²h
l = 5m³/m²h
Capacity factor $C_G$, m/s
0.1
0.01
0.01
0.1
Flow parameter
MG 40.Y
MG 64.Y
MG 64.X
MG 90.X
SNAP GRID
SULZER
CHEMTECH
Transmitted by:

# Grids

## Grid in Refinery Towers

| Application | Section | No. |
|---|---|---|
| Atm. Crude Tower | TPA | 1 |
| Main Fractionator | Slurry PA | 6 |
| FCC Vacuum Tower | Wash | 11 |
| Lube Vacuum Tower | Wash | 1 |
| Coker Fractionator | Wash | 1 |
| Visbreaker Vac. Tower | Wash | 4 |
| Water Quench | | 1 |

# *Packing*

SULZER

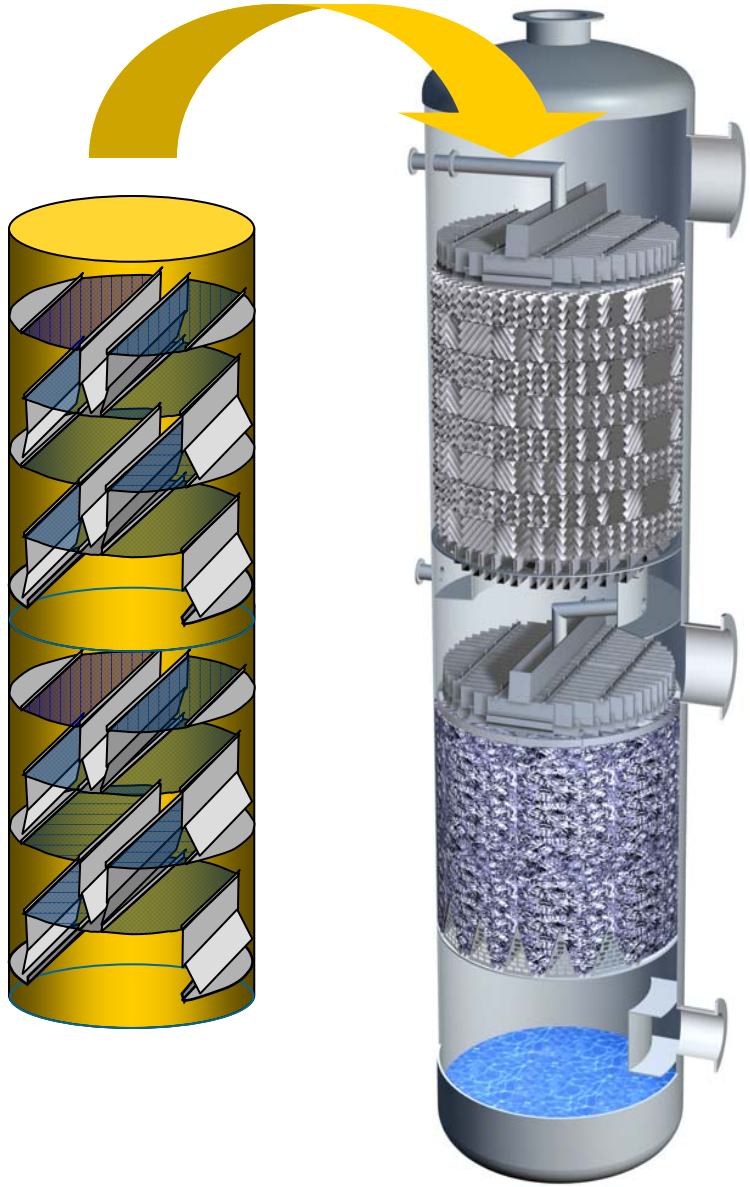
Sulzer Chemtech

**Alternatively to Trays, Packing may allow advantages related to:**

- **High Hydraulic Capacity**
- **High Mass Transfer Efficiency**
- **High Heat Transfer Capability**
- **Low Pressure drop**

**Benefits are:**

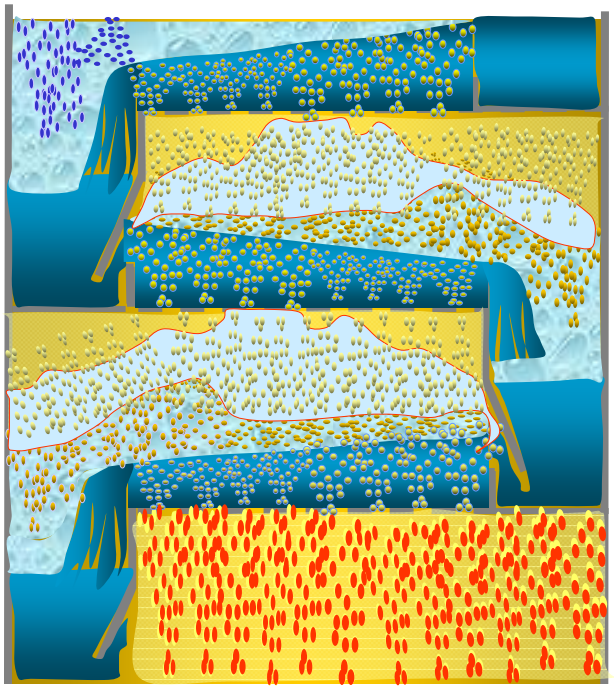
- **Increased Vap/Liq internal loads for:**
  - **higher Feed rate ( capacity)**
  - **higher Reflux (efficiency)**
- **Increase Number of separation stages per meter of column (NTSM) for:**
  - **higher efficiency**



# Packing

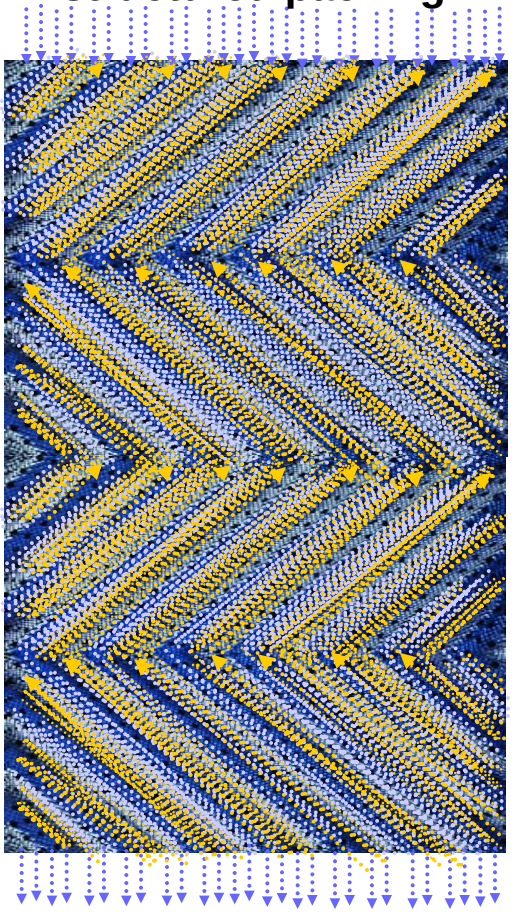
## *the mass transfer mechanism*

**in trays**



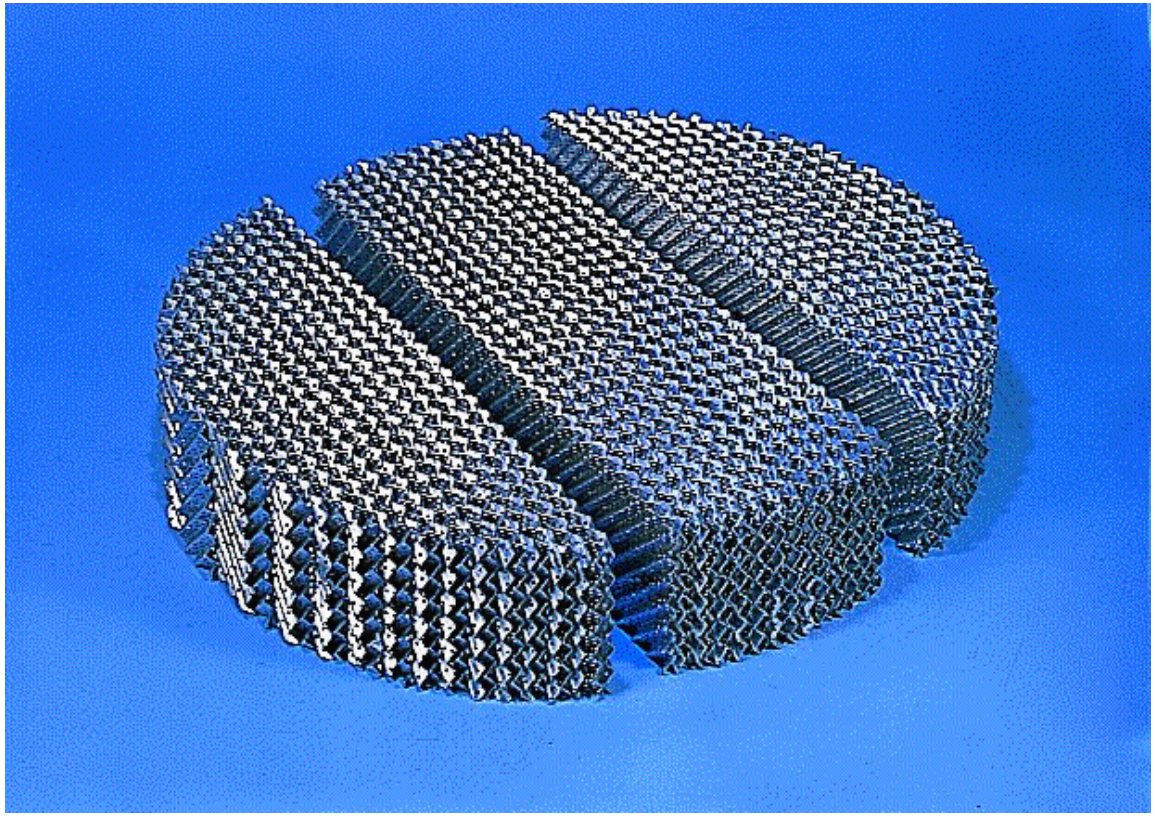
- ***Vapor is dispersed in liquid***
- ***Vapor to move through 8-15 % open sectional area***

**In structured packing**



- ***Liquid is dispersed in vapor***
- ***Vapor moves through 92 -95 % open sectional area***

# Mellapak™

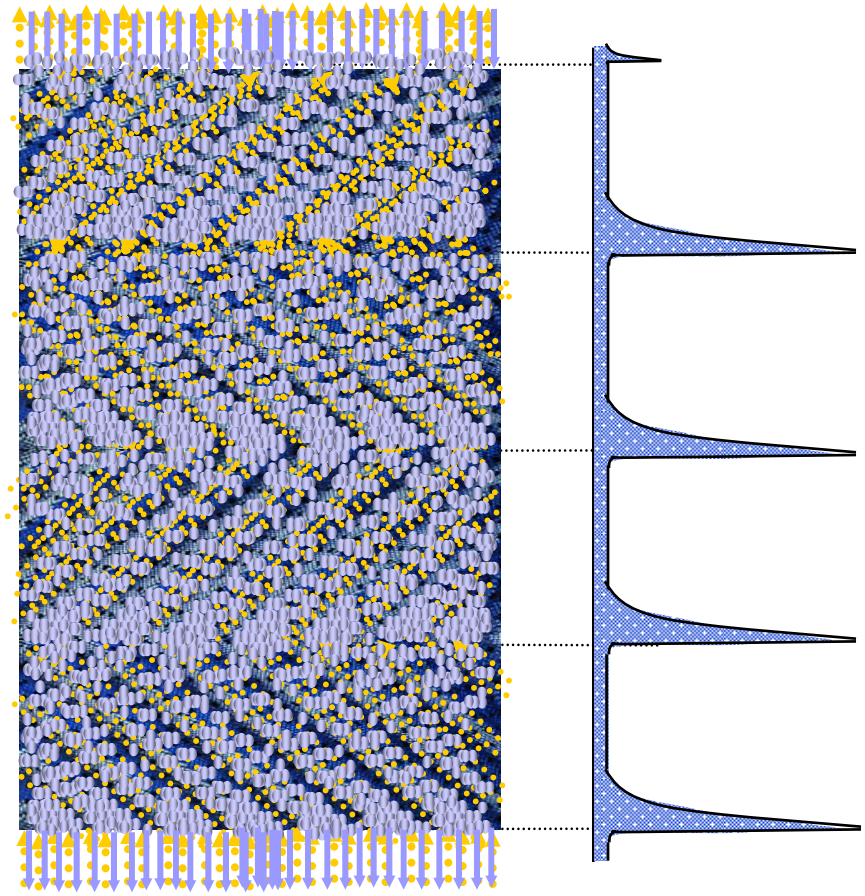


| Type | NTSM | Limit Capacity F Factor |
|---|---|---|
| 2.Y | 2.0 | 3.5 |
| 250.Y | 2.5 | 2.6 |
| 350.Y | 3.5 | 2.2 |
| 500.Y | 4.0 | 1.6 |
| 750.Y | 5.9 | 1.5 |

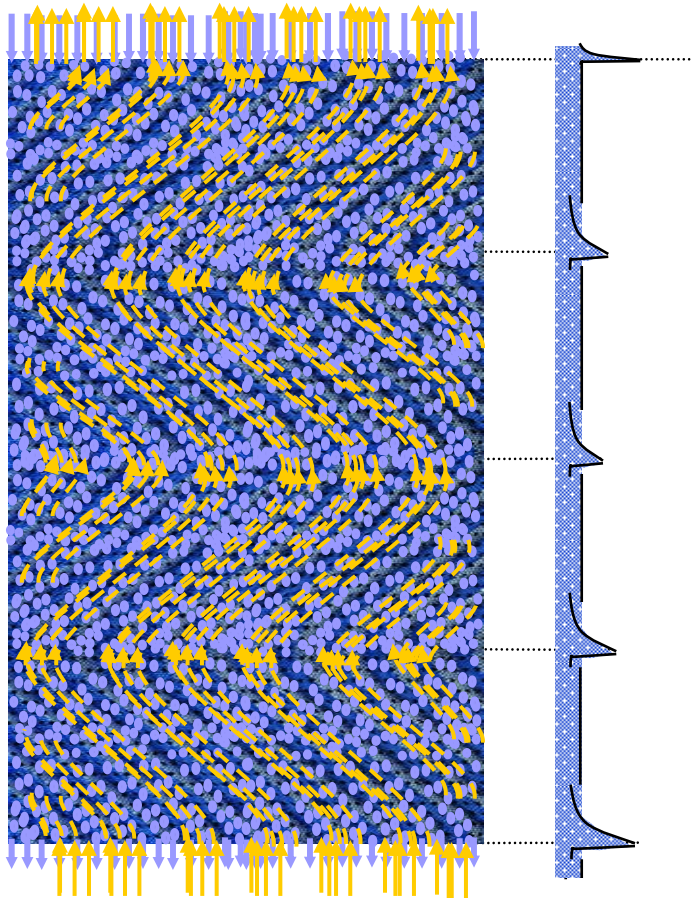
# MellapakPlus®:

## Gamma ray scanning at operating condition

### Mellapak

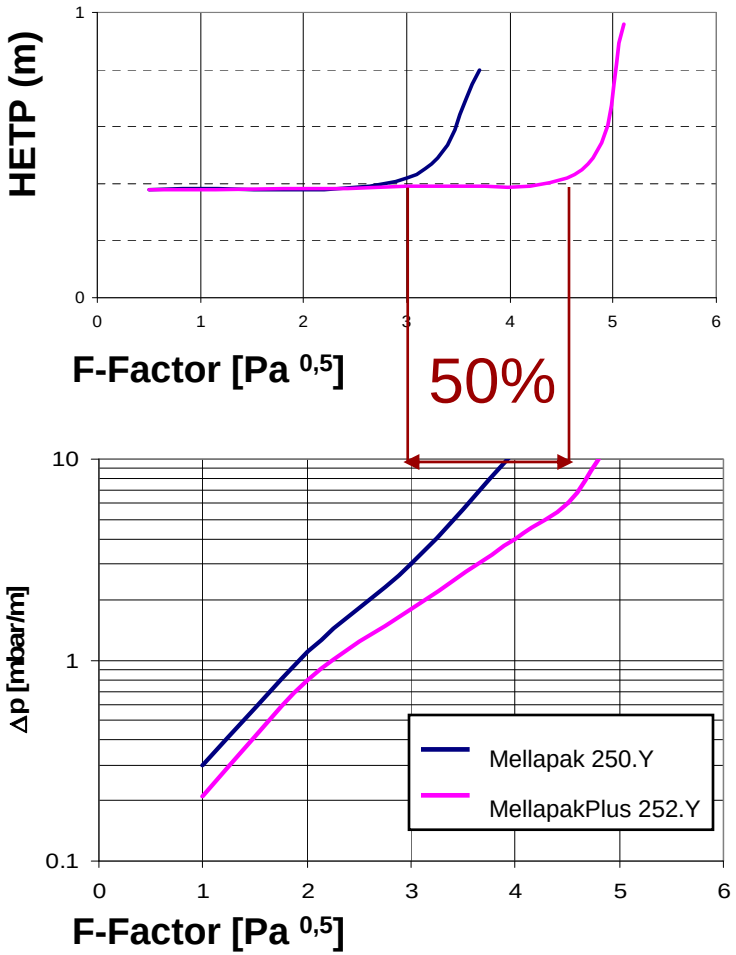


### MellapakPlus



# MellapakPlus






Main features:

- Up to 50 % more capacity at same efficiency with the new packing generation
  → smaller columns for new plants
  → use existing vessels for plant upgrades
- Stable efficiency up to 5mbar/m pressure drop
- Calculation tool SULPAK available at **www.sulzerchemtech.com**
- Everything you already know about Mellapak remains valid for MellapakPlus
- More MellapakPlus types to come

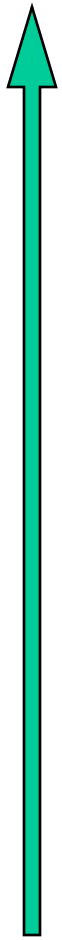
# Nutter Ring™

- FRI and other commercial test data proves stated performance
- Pressure drop per theoretical stage is 40% to 55% lower than comparable size pall rings.
- Useable capacity is 13 to 23% greater than comparable Pall ring. :
- Cost per theoretical stage is 12 to 55% less than other metal packings.
- Unique shape enhancing lateral liquid film renewal.
- Strength-to-weight ration sufficient to 15m. bed height.

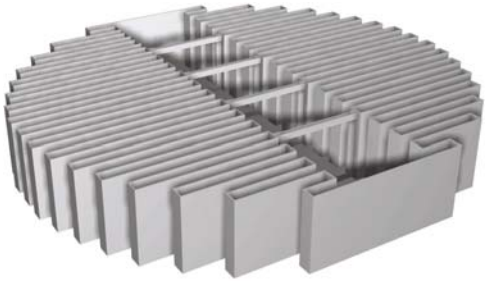
# Distributor Systems



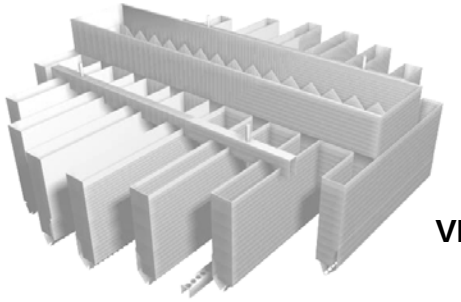
L > 100 $m^3/m^2h$



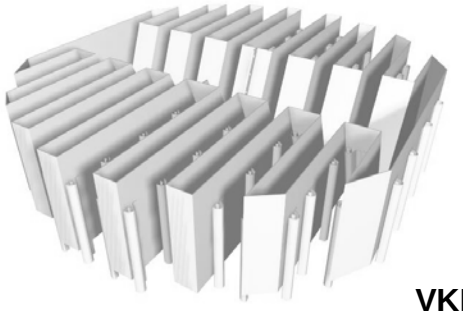
L < 0.1 $m^3/m^2h$



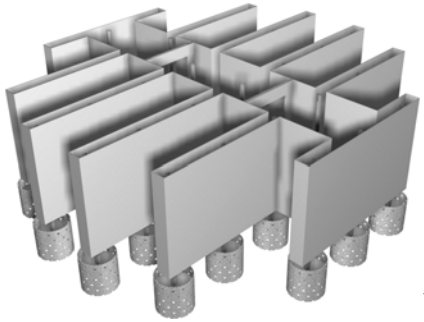
VKG



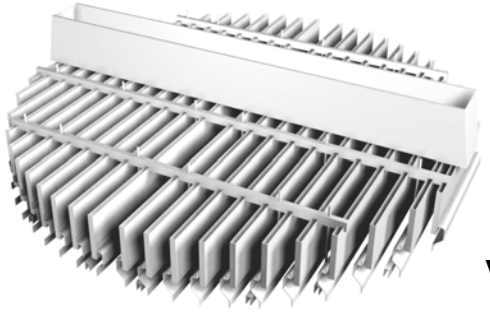
VKH



VKR



VKRP



VEP

# VEP™ Liquid Distributor
# The Best Liquid Distributor

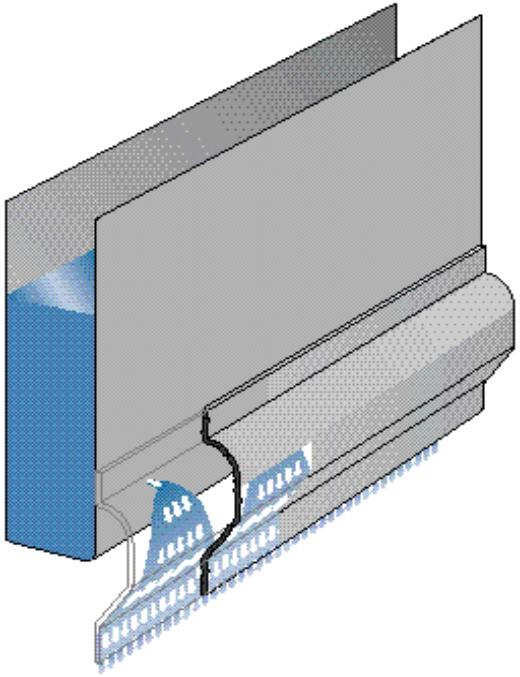
SULZER
Sulzer Chemtech

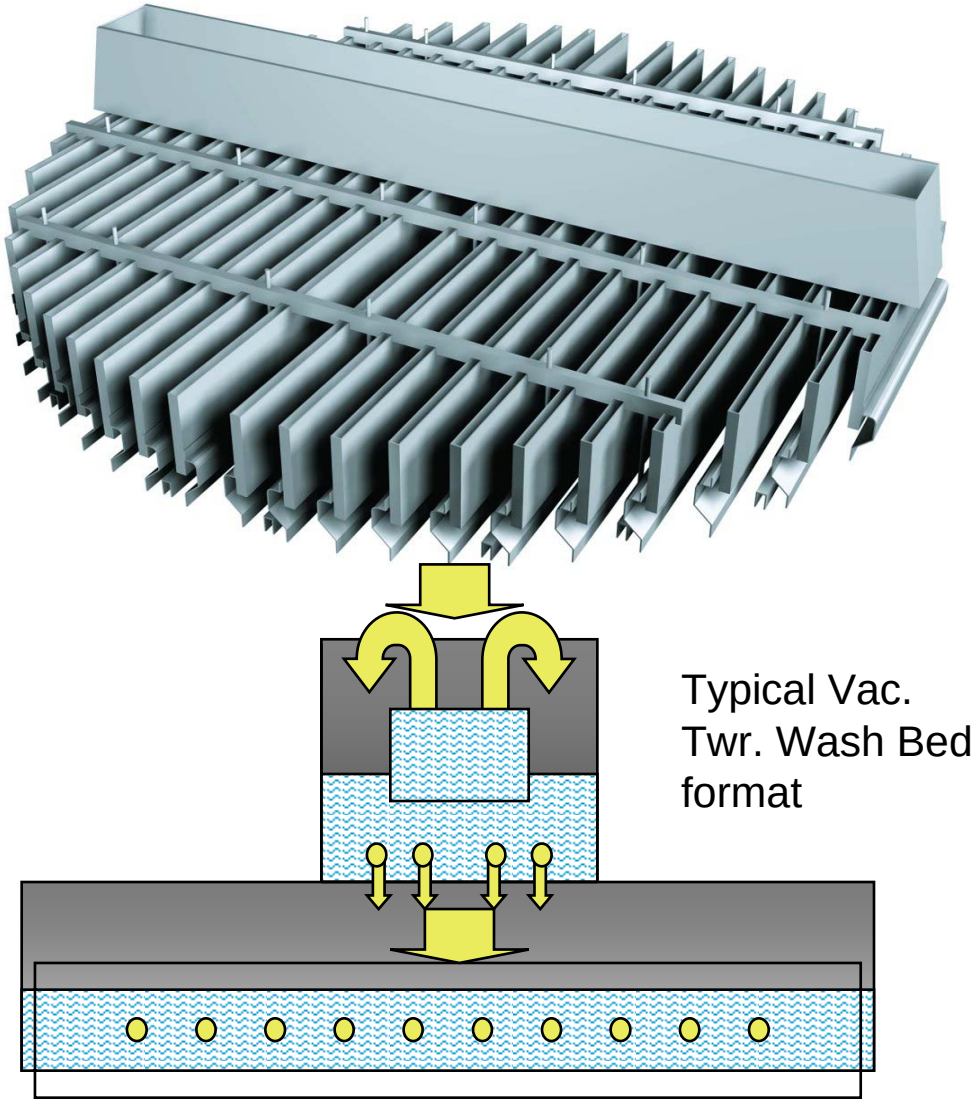
- Sulzer's VEP™ Liquid Distributor
- High efficiency (low Cv, typically less than 5%)
- Highest Capacity (low pressure drop and minimized entrainment developed for MellapakPlus)
- Excellent Anti-Fouling design (5 points for wash beds)
- Cost is comparable to regular distributors and spray headers
- Good liquid distribution implemented in structured packing in one layer less than drip-tube distributors

# VEP™ Liquid Distributor

SULZER

Sulzer Chemtech





Typical Vac. Twr. Wash Bed format