Leading Tray Technology
Reliability and Performance
Sulzer Chemtech- Mass Transfer Technology
Your Partner in Separation and Mixing Technology

A Broad Range of Innovative and High-performing Products
Our more than 200 products cover a wide range of needs in the field of separation and mixing technology. They have proven their performance in more than 100,000 columns, 40,000 gas/liquid separators and 100,000 mixers in operation worldwide.

The Highest Level of Application Know-how
Our team provides state-of-the-art expert know-how for more than 500 applications in 100 processes, this enables us to optimize the performance and your installation.

Fast and Reliable Turnaround Services
You can rely on Sulzer professionals, expertise and procedures to get you back and running in the shortest possible time.

Comprehensive Engineering and Technology Services
We provide a full scope of associated engineering and technology services to optimize or trouble-shoot your installation.
Leading Tray Technology

We understand the ever increasing requirement for both reliability and performance of your process equipment. To meet these challenges, you can rely on our innovative, industry-leading products and expertise. Our extensive tray portfolio ranges from single pass to multi-downcomer as well as conventional to high-performance, including the latest technology in ultra-system limit trays. All designs are tailored to meet the exact requirements of your specific application.

For your most demanding applications, our High Performance Trays include VGPlus™ trays with MVG™ decks and enhanced downcomer technology as well as the newest trays, UFMPlus™ with UFM™ valves. The UFM valve is an industrially proven, advanced movable mini-valve providing the highest efficiency and capacity. For fouling applications that require high performance, our VG AFTM Anti-Fouling trays provide a proven and robust solution. This portfolio has been greatly enriched since 2000 by our technology alliance with Shell Global Solutions, and also includes Shell high performance trays such as the Shell HiFiTM trays, ideal for high liquid load applications, and Shell ConSep™ trays with proven ultra-system capabilities.

This Leading Tray Technology Brochure provides an overview of Sulzer tray products. For more detailed information on high performance tray products together with their case studies, please refer to our High Performance Trays brochure.
Conventional Trays for Special Applications

For Simple Solutions

Sieve Trays
Sieve trays are widely accepted as a low cost mass transfer device where high turndown is not required. Sulzer offers all common sieve tray designs including smaller holes for higher vapor capacity and venturi holes for lower pressure drop.

For Fouling Conditions

Dual Flow Trays
Dual Flow trays are perforated trays with no downcomer. They are typically equipped with large holes which make them particularly suitable for fouling applications.

For High Turndown

Bubble Cap Trays
Bubble Cap trays are generally used for low liquid loads and have a very high turn down ratio. Sulzer offers a standard cap for 3” and 4” and a slotted type for 6”.

Applications include amine absorbers, regenerators and caustic towers.

For Severe Fouling Conditions

Baffle, Shower Deck, Disc & Donut Trays
These trays are typically applied in severely fouling services. They are configured so that the liquid flows downward through the column, splashing from one baffle to the next lower one. Ascending vapor contacts the liquid by passing through the liquid curtains. These trays are used in washing sections where fouling resistance has priority over high efficiency.
For Small Columns

Cartridge Trays
Cartridge trays are typically used for small flanged columns where physically installing the trays inside the column is not feasible. Column diameters range between 300 to 800 mm (12” to 30”). Cartridge trays are assembled in bundles for easy and fast installation. They can be equipped with all types of tray decks and downcomers.

For Liquid-Liquid Extraction

LLE
Conventional extraction trays are designed with holes punched in the tray deck. Sulzer extraction trays are equipped with enhanced downcomers and extruded holes which allow:
- Higher fouling resistance
- More uniform droplets, thus higher efficiency
- Wider operating range

For High Efficiency

Slit Trays™
Slit Trays are high efficiency, radial liquid flow devices featuring rows of concentric slits for vapor passage. They are mainly used for the distillation of aqueous systems and specialty chemicals.

Features of Slit Trays:
- Low tray spacing: 150 - 250 mm (6” – 10”)
- High fractionation stages per given column height
- Self supporting structure
- High turndown ratio, up to 4:1
- Suitable for 2 liquid phase systems
Floating Valves

For Wider Operation Flexibility

BDH™

The unique rectangular shape sets the BDH apart from the conventional round valves. The BDH is oriented parallel to the liquid flow direction, providing lateral vapor release and a closed upstream edge to minimize weeping. This contributes to an improved efficiency/capacity profile compared to conventional round valves.

Further advantages of the rectangular valves:
- Improved liquid flow along the flow path of the tray deck
- Wider operating range than round valves
- Robust mechanical design due to wide legs
- Anti-rotating which reduces wear and tear

Round Valve

Sulzer offers conventional round valve trays for replacement or whenever requested by the customer.

There are two types of round valves available, conventional and caged valves.

The conventional valve types available are:
- RV1 for flat decks
- RV4 for decks equipped with venturi holes for lower pressure drop

The caged types available are:
- RC1 for flat decks
- RC4 for decks equipped with venturi holes for lower pressure drop
**UFM™**

UFM valves are an advanced type of movable mini-valves which maximize the hydraulic capacity, the separation efficiency, and the operating range of fractionation trays.

The distinctive “Umbrella” shape:

- Reduces jetting momentum of the vapor, minimizing entrainment and providing higher capacity
- Maximizes contact area between vapor and liquid on tray deck for higher efficiency

UFM valves are oriented parallel to the liquid flow to minimize hydraulic gradient along the flow path of the tray. Distinctive features are:

- Two wide legs to maximize robustness, minimizing wear and tear.
- Four spacers which prevent valves sticking to the tray deck, maximizing fouling resistance

UFM valves should be used when both high performance and wide operating range are needed for any distillation column, absorber and regenerator.

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**Industrial Scale Validation**

UFM valves have been tested at a well known independent test facility, in a 1.22m diameter tower, 1 pass, with C6/C7 system at 1.6 bara.

In this test system, the UFM valves showed a 30% gain in useful capacity and significantly higher efficiency compared to a conventional moving valve tray.

**Key Areas of Application**

- Main fractionators of refineries
- Gas concentration columns of refineries
- Light ends columns of petrochemical plants
- LNG / NGL fractionation columns
- Absorbers & regenerators of gas sweetening plants
High Performance Fixed Valves

For Lower Pressure Drop

V-Grid Trays
V-Grid tray technology utilizes fixed valves and combines the attributes of sieve holes and float valves. V-Grids offer low pressure drop while delivering high tray performance in terms of capacity and efficiency.

The tapered, rectangular valves are extruded from the tray deck and oriented parallel to the liquid flow providing unique advantages compared to sieve holes:

- Lower froth height, less entrainment due to lateral vapor release
- Increased capacity and improved turndown
- High efficiency over a wide operating range
- Superior mechanical strength
- Excellent fouling resistance

Smaller valves provide more capacity than larger ones due to reduced pressure drop and entrainment rate. To meet your requirements we offer following standard sizes: MMVG™, MVG™, SVG™ and XVG™.

MVG™
MVG valves provide higher capacity compared to standard sieve holes or conventional valves while providing higher efficiency and lower pressure drop. The MVG valves offer better turndown capability than a sieve tray, i.e. up to 3:1.

MVG valves are well proven in various industrial applications ranging from low to high pressure distillation, i.e. atmospheric towers to C3 Splitters.

FRI Validation
Sulzer MVG Trays have been successfully tested in the C6/C7 system at 0.34 and 1.64 bara pressure. Measurements showed up to a 20% advantage in capacity and efficiency compared to sieve trays.

MMVG™
MMVG valves are used where extremely high vapor capacity is required. The smaller size opening compared to MVG results in up to 7% additional capacity with equivalent tray efficiency.

MMVG™ Valve Tray
**SVG™**

SVG valves are high lift fixed valves. These large lateral openings produce a vapor cleaning effect on the tray deck which results in excellent operational performance in fouling services, guaranteeing a long run time.

Sulzer also offers the SVG-H™ fixed valve, which is fitted to the deck rather than extruded. This method is used to avoid cracking in materials such as titanium, zirconium and inconel.

**XVG™**

XVG (Extra Large V-Grid) valves are intended for severe fouling services.

The valves can be combined with other VG AF (Anti-Fouling) features, such as modified outlet weirs and push valves to minimize the accumulation of solids on trays.

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**Key Areas of Application**

- Atmospheric and Vacuum Towers, Coker, HF Alkylation, Waste Water Towers
- Primary Fractionators, Depropanizers, Debutanizers, Caustic Towers, Butadiene Towers, Amine Contractors
- Beer Columns, PVC Slurry Strippers
Sulzer High Performance Trays

For Higher Capacity

Sulzer "Plus" Technology

VGPlus and UFMPlus Trays, are Sulzer’s high performance “Plus” Technology chordal downcomer trays. They offer industry proven and validated advanced tray technology.

Sulzer "Plus" Technology Trays make use of enhanced downcomers such as highly sloped, Truncated, StepArc™ and ModArc™ downcomers, as well as enhanced tray decks equipped with high capacity MVG fixed valves or UFM float valves.

Comparing against Conventional Trays

- Higher capacity: up to 30%
- Lower pressure drop: up to 20%
- Equal or higher efficiency
- Elimination of hydraulic gradient
- Uniform liquid flow and vapor distribution

Please refer to Sulzer High Performance Trays brochure for more information on Sulzer VGPlus and UFMPlus, as well as their areas of applications and case studies.

See pages 6-8
For Higher Fouling Resistance

VG AF™ Trays

VG AF (Anti-Fouling) trays are part of the Sulzer High Performance Tray family and are especially designed for fouling services.

The combination of large fixed valves with modified outlet weirs (sloped or stepped weirs) and tailored design features make these trays less susceptible to plugging and increase the run time of fouling applications.

Please refer to Sulzer High Performance Trays brochure for more information on Sulzer VG AF Trays, as well as their areas of applications and case studies.

See page 9

e-VGPlus and e-UFMPlus

Sulzer also offers e-VGPlus and e-UFMPlus, our new e-series enhanced high performance trays. These trays are equipped with capacity enhancement features, which further optimize the utilization of the tray decks, for maximum potential capacity of chordal downcomer trays. Depending on process conditions and tray designs, these enhancement features can offer up to 12% higher capacity than our Sulzer “Plus” Technology trays - VGPlus and UFMPlus. Kindly contact Sulzer Chemtech for a technical evaluation.
Shell High Performance Trays

Shell HiFi™ Plus Trays

Shell HiFi trays are high capacity fractionation trays equipped with multiple envelope downcomers.

The HiFi Plus trays are an enhanced version featuring advanced valves (i.e. MVG, MMVG, UFM) to further boost the tray deck performance, and may include the Crown Inlet Device CID™ to maximize the downcomer capacity as well.

Self Balancing Operating

• The unique orientation of the HiFi downcomers creates a more uniform liquid distribution on the tray deck (blue arrows).
• The vapor is uniformly distributed underneath the tray deck and released laterally through the MVG valves perpendicular to the liquid flow (red arrows).
• Both liquid and vapor are naturally self-balanced across the entire tray for the most uniform mixing, contacting, and separating efficiency.
• The liquid flow path lengths are uniform across all over the entire tray.

Please refer to Sulzer High Performance Trays brochure for more information on Shell HiFi (Plus) trays, as well as their areas of applications and case studies.
Shell HiFi™ Extraction Trays

Shell HiFi extraction trays are particularly well suited for liquid-liquid extraction systems with interfacial tensions below 25 dyne/cm and large phase ratios. They can be used to increase the capacity of existing towers in aromatics extraction, caustic treating and lube oil applications.

Shell HiFi extraction trays vs. conventional sieve trays:
- up to 15% additional capacity with same efficiency
- less tray spacing without capacity loss

Shell HiFi extraction trays vs. Rotating Disc Contactor in Sulfolane extraction:
- up to 25% additional capacity and 20% more separation stages

Key Areas of Application
- Benzene Extraction, Butadiene Wash, Isoprene Purification, DCH and ECH Recovery from Heavy Ends
- LP Sweetening, Lube Oil Extraction
Shell High Performance Trays

Shell CS Grid™ Trays

Shell CS Grid trays are high capacity dual flow trays constructed with adjacent round or flat bars. Open area is defined by the size and pitch of the bars.

These trays are equipped with 4 vertical baffles oriented radially to achieve the most uniform froth distribution over the tray deck. Each tray is rotated 45° respective to the tray above for most uniform vapor and liquid contacting. They are supported on a 360° support ring and major beams.

Shell CS Grid trays are mainly used for heat transfer services in fouling and/or corrosive environments.

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Key Areas of Application

- Slurry pumparound of FCC Main Fractionators
- Oil and water quench towers of Ethylene plants
- Top pumparound of CDU and Coker Main Fractionators
- Bottom pumparound of Visbreaker and Thermal Cracker Main Fractionators
Shell ConSep™ Trays

Shell ConSep trays are one of the highest capacity fractionation trays available on the market, offering up to 80% additional capacity over conventional trays without any major impact on separation efficiency.

They utilize the principle of de-entrainment by centrifugal force to overcome the gravitational limitation of jet flooding and the system limit of the vessel.

Operating Mechanism

Shell ConSep trays start to work when the conventional trays reach incipient flooding. The vapor carrying entrained liquid, before reaching the next tray, passes through the swirl tubes where the entrained liquid is separated by means of centrifugal acceleration and is collected on the swirl tube deck which is then refluxed back to the downcomer below by means of a secondary downcomer. Thus only clear vapor will rise up to the tray above.

Please refer to Sulzer High Performance Trays brochure for more information on ConSep trays, as well as their areas of applications and case studies.

See pages 12-13
Internals for Trayed Columns

Internals inside trayed columns such as feed inlet distributors are pivotal to the performance of the column. Proper design of these essential internals is the key in ensuring steady operation and optimal tray performance.

1. Mist Eliminator
Mist Eliminator above top tray, to minimize liquid carryover in the overhead vapor.

2. Reflux Feed Inlet
Sulzer will design the optimal feed inlet considering the feed loadings, nozzle size, nozzle orientation and tray type.

3. Trays for Your Application
Sulzer’s extensive tray portfolio allow us to offer the optimum trays specifically designed for your application.

4. Transition
Custom designed transitions are critical for optimal column operation.

5. Intermediate Feed Inlet
The design for intermediate feed inlet requires special care. The design has to achieve good distribution to the tray designs above and below the feed inlet.

6. Vapor Feed (Reboiler) Inlet
Sulzer offers customized solutions for the optimal vapor distribution.

Chlordal Downcomer Tray

Shell Tray
For Liquid Feed Distribution and Draws-off

**Liquid Feed Distribution**

Every Sulzer liquid distribution system is customized based on tray geometry, nozzle orientation and feed condition to ensure good distribution to the trays.

A good liquid distribution system is especially important for multi-pass trays, such as 4-pass and 6-pass because any mal-distribution to the different tray sections could lead to poor column performance.

**Liquid Draw-off**

Liquid can be drawn from the column as a side-product or pumparound.

A well designed draw-off system ensures:

- Adequate draw-off nozzle sizing for the liquid amount to be drawn
- Sufficient residence time for deaeration of the liquid
- Adequate liquid hold-up volume for smooth column operation with the draw-off system

Depending on the process conditions, the draw-off system can be as simple as the draw-off from the double sealpan under downcomer (shown below).

For draw-off systems which require longer residence time, or total liquid draw-off, a chimney tray liquid collector can be used.
Internals

For Vapor and Mixed Feed Distribution

Vapor and Mixed Feed Distribution

Vapor maldistribution can lead to localized flooding and/or weeping which can reduce column performance.

For an optimum vapor inlet system, Sulzer customizes the solution according to the tray geometry, nozzle orientation and feed condition.

For flashing intermediate feeds onto a tray, an inlet V-baffle at the feed nozzle can minimize liquid entrainment and provide a better vapor distribution by directing the vapor to the sides of the column wall.

Shell Schoepentoeter™
Shell Schoepentoeter Plus

Shell Schoepentoeter is a well known vane-type radial feed inlet device.

Shell Schoepentoeter Plus is an enhanced version of the Schoepentoeter, with the same vapor distribution performance but with a higher gas-liquid separation capability. Testing shows that liquid entrainment can be reduced by 33% compared to a conventional Schoepentoeter.
For Transition

Tray-to-Tray transitions

Vapor and liquid loadings inside the column can vary drastically for different tray sections due to process conditions. Often, the most economic design is to equip columns with sections of trays with different number of passes or with different diameters.

A proper transition between the different layouts is critical to avoid mal-distribution of liquid and vapor which could lead to reduced column performance.

Sulzer provides customized solutions based on the tray geometry (2-pass, 4-pass and 8-pass etc), orientation and the internal loading to ensure optimal transition.

Tray-to-Packing transitions

It is common for modern refineries to use both tray and packing sections within a single column.

With excellent engineering know-how in both tray and packed bed technology, Sulzer can provide optimized solutions to overcome the challenges by ensuring proper vapor and liquid distribution throughout the entire column.

Transition from a 1-pass tray to a 2-pass tray over a conical section.

Transition from a 4-pass tray to a packed section with a trapout for partial draw-off.
Mechanical Features

Non-Welded Tray Support System

In several revamp projects aimed to increase the separation stages of an existing column, the number of actual trays had to increase (e.g. 3-for-2, 4-for-3, or 5-for-4).

To accomplish this, a mechanical design is required to avoid impact on the schedule of the plant's turn-around, and minimize cost as well.

Sulzer has developed a mechanical solution enabling installation of the trays by reusing the existing tower attachments, without any direct welding to the tower wall, thus avoiding any post-welding heat treatment and/or hydraulic testing of the vessel. This technique consistently reduce the turnaround time by using this technique.

The following devices shown in the illustration below are used:

• Expansion rings
• Expansion joints
• Vertical struts
• Downcomer adaptors
• Solid or lattice beams

The system can be also used for other purposes: modify the geometry of existing downcomers, modify the number of passes; change the tray orientation; replace packing beds with trays.

Trays for Heavy Duty Services

In some applications, particularly those subjected to operating upsets leading to panel dislodgment, the trays must withstand higher than normal mechanical loadings, i.e. 7000 N / m² (1 psi) or even 14000 N / m² (2 psi).

In such cases, special features may be employed in the mechanical design:

• Through-bolting panel connection
• Shear clips
• Downcomer spreaders
• Explosion doors
**Horizontally installed trays**

Some projects require the trays to be installed at the vessel fabricator workshop. In such cases, the installation will be done with the vessel in the horizontal position.

Sulzer has developed a specific procedure for horizontal installation and transportation of trays which:

- Avoids partial deformation and breakage
- Avoids panel shifting
- Avoids joint dislodgment
- Reduces additional inspection at site
- Avoids parts readjustment at site
- Minimizes installation time
- Minimizes cost

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**Lip-Slot™ Panel Connection**

The Lip-Slot is an enhanced type of tray panel connection which allows for:

- safe and easy installation
- up to 30% less installation time
- less maintenance costs as it does not use any bolted connection
- same mechanical reliability as conventional connections

The Lip-Slot is combined with universal clamps for the fixation around the tray periphery.
**Services**

**Computer-Aided Engineering (CAE): 3D Models**

Upfront engineering and design play a crucial role in cost optimization. Sulzer has integrated all major mass transfer products into an in-house design tool, creating a global standard.

Customers profit directly from the use of our internal CAE tool. Layout drawings supplied in the course of the engineering phase will show a 3D sketch of the equipment being designed, for an easy and fast checking by the customer.

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**Natural Frequency Analysis for Tray Vibration Phenomena**

In some critical applications and under specific operating conditions, vibration phenomena may be induced to the trays. Based on plant feedback data and in-house know-how, Sulzer has developed a design tool to check for the following two main parameters:

- Natural frequency of the tray panels, as a function of the geometry, the supports, and the material of construction.
- Vibration factor, as a function of the flow rates and physical properties of the streams being processed.

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**Finite Elements Method (FEM) and Computational Fluid Dynamics (CFD)**

Sulzer also employs other advanced design tools, for example verification of mechanical integrity and functionality using finite element and CFD analysis.
Turn Around and Tower Field Services

Sulzer’s global manufacturing capabilities ensure fast delivery of any tray hardware and replacement tray parts, regardless of original supplier. These can be manufactured from existing drawings or damaged parts and supplied on site quickly to meet your turnaround schedules. Replacement hardware can be supplied on consignment in lockers or trailers for convenience.

Customer Hydraulic Design Software SULCOL

SULCOL is the latest, state-of-the-art design tool for mass transfer columns. It is available to customers via the Sulzer website.

Tray hydraulic design and rating
- Fixed and movable valves
- One pass and multipass tray design
- Conventional downcomer design
- Description of Sulzer tray portfolio including Shell tray technology

You may download SULCOL from www.sulzer.com
Sulzer Chemtech Ltd, a member of the Sulzer Corporation, with headquarters in Winterthur, Switzerland, is active in the field of process engineering and employs some 4000 persons worldwide.

Sulzer Chemtech is represented in all important industrial countries and sets standards in the field of mass transfer and static mixing with its advanced and economical solutions.

The activity program comprises:

• Process components such as fractionation trays, structured and random packings, liquid and gas distributors, gas-liquid separators, and internals for separation columns
• Engineering services for separation and reaction technology such as conceptual process design, feasibilities studies, plant optimizations including process validation in the test center
• Recovery of virtually any solvents used by the pharmaceutical and chemical industry, or difficult separations requiring the combination of special technologies, such as thin film/short-path evaporation, distillation under high vacuum, liquid-liquid extraction, membrane technology or crystallization.
• Complete separation process plants, in particular modular plants (skids)
• Advanced polymerization technology for the production of PLA and EPS
• Tower field services performing tray and packing installation, tower maintenance, welding, and plant turnaround projects
• Mixing and reaction technology with static mixers
• Cartridge-based metering, mixing and dispensing systems, and disposable mixers for reactive multi-component material

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