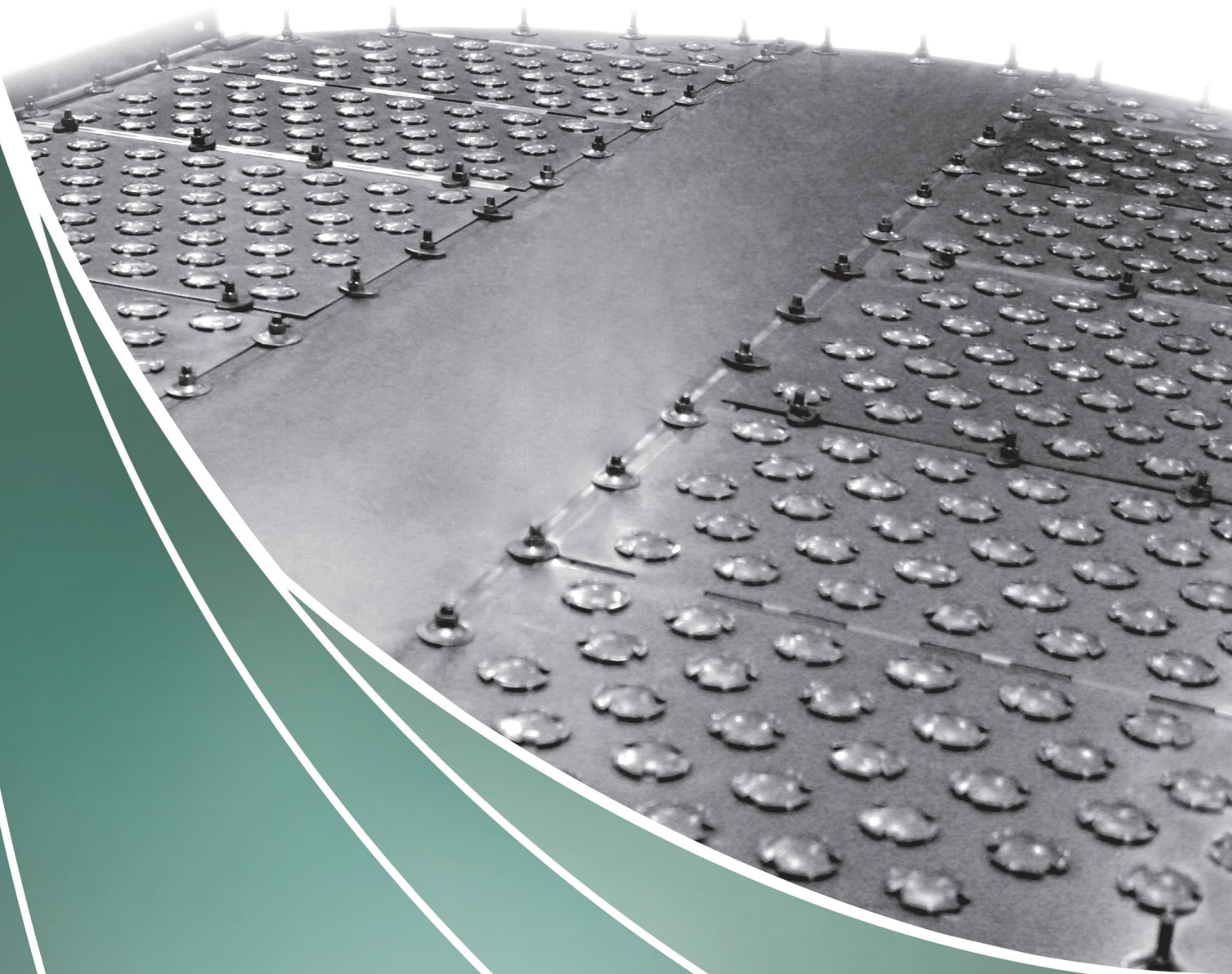


FLEXITRAY®

Valve Trays



Proven performance in all
liquid-vapor contacting applications.

 **KOCH-GLITSCH**

FLEXITRAY® Valve Trays

Proven performance in all liquid-vapor contacting applications.

FLEXITRAY® valve trays combine high capacity and excellent efficiency with a wide operating range. Utilizing proprietary design techniques and the wide range of valve types available for FLEXITRAY valve trays, design engineers at Koch-Glitsch have the knowledge and experience to assist you in optimizing performance for your application.

With Koch-Glitsch technical expertise in design, manufacturing, and installation, a well-designed FLEXITRAY valve tray generally provides the most economically attractive solution for grass-roots column construction projects.

Benefits of FLEXITRAY Valve Trays

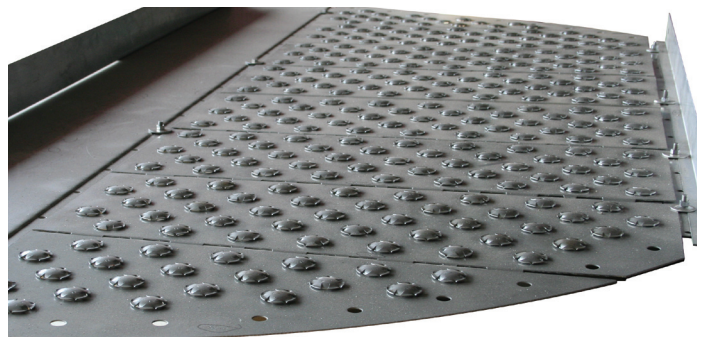
Uniform vapor distribution, wide operating range

- ▶ Excellent liquid-vapor contacting for high efficiency
- ▶ Reduction of the reflux ratio for a given tower diameter
- ▶ Smaller tower diameter for a given feed rate

The vapor exiting a valve is directed horizontally, rather than vertically as in a sieve tray, reducing entrainment. This also allows longer run times in fouling services because horizontal radial vapor flow at the tray floor reduces “dead spots” where solids can settle, polymer growth can start, or decomposition can occur.

Higher capacity and low pressure drop

FLEXITRAY valve trays can handle loadings up to 10% higher than sieve trays while providing higher efficiency. The contoured hole of the T0 type valve provides the lowest pressure drop per tray over a wide range of flow rates.



Conventional trays are equipped with standard downcomers. The typical inlet areas under the downcomer and a bubbling area can be customized using a variety of valve types depending on the application or service.

Cost effective

The initial purchase price, simple installation, and reduced maintenance of the FLEXITRAY valve tray contribute to cost effective projects.

Versatile

An existing tower equipped with FLEXITRAY valve trays can often be used in a different application with minimum modifications because of the wide operating range, high capacity, low pressure drop, and excellent efficiency.

With these product advantages plus Koch-Glitsch technical expertise, KOCH-GLITSCH® conventional trays have been installed in tens of thousands of plants worldwide. Year after year, they continue to be the trays preferred by plant operators.

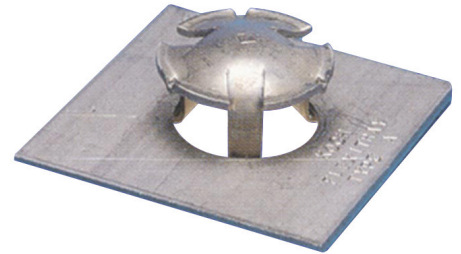
Valve Types

Koch-Glitsch has the valve type for your application/service.

Koch-Glitsch has developed a variety of valve styles to enhance the vapor-liquid contacting that takes place on a tray deck.

A - Full-size, one-piece valve

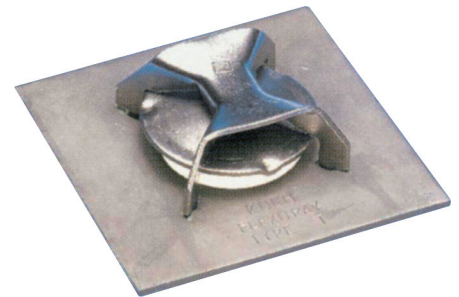
- Higher capacity than standard sieve trays
 - High efficiency
 - Wide operating range
 - Low pressure drop
 - Cost effective
- This is the standard, round, full-size, one-piece valve that has been used successfully in columns around the world for over 50 years.
- ▶ It is provided in several leg lengths to accommodate various tray deck thicknesses.
 - ▶ It is normally dimpled to help prevent sticking to the deck, but can be flush seated if needed.
 - ▶ The orifice can be made to prevent the valve from spinning.
 - ▶ Dual valve weights may be used in alternating rows to extend the already wide operating range.



Equivalent BALLAST® designation: V-1.

T - Full-size caged valve

- All the advantages of Type A valves
- Plus:
- More weepage resistance – even wider operating range
 - Increased fouling resistance – fewer costly shutdowns
 - Rugged construction – resistant to corrosion and erosion
 - FRI tested
- Type T is the caged equivalent to the Type A valve. The use of this FRI_(SM)-tested valve precedes the Type A valve.
- ▶ The Type T valve has a single moving cap with no moving legs protruding through the deck.
 - ▶ A cage assembly retains the cap.
 - ▶ It is more resistant to weeping and to becoming dislodged from the deck.
 - ▶ It is more fouling resistant than the Type A valve.
 - ▶ It normally comes dimpled, but can be flush seated as necessary.



Equivalent BALLAST® designation: A-2.

T0 - Full-size, low pressure drop valve

- Same as a Type T valve

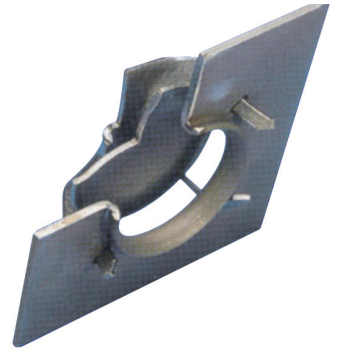
Except:

- Contoured hole in the deck for lowest possible pressure drop

This variation of the Type T valve uses an extruded, Venturi-like orifice.

- ▶ The dry tray pressure drop is thus lowered, providing an overall lower pressure drop.
- ▶ This comes with a price of higher weepage and reduced turndown.

Equivalent BALLAST® designation: A-5.

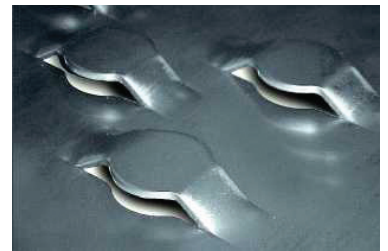


VG-10 - Full-size fixed valve

- Large opening size for improved fouling resistance
- Extended time between shutdowns
- Fixed opening means the valve cannot stick shut like moving valves
- Easy to clean – less downtime
- Rugged, durable construction for long tray life
- Can be made from materials up to 0.25" (6.35 mm) thick for maximum resistance to corrosion

This is a full-size fixed valve that is anything but conventional.

- ▶ The net rise typically ranges from 6 mm [0.236 in] to 14 mm [0.551 in], varying in 1 mm [0.039 in] increments. Other lifts may be available in some cases.
- ▶ This valve is also directional with the rear leg being visibly wider than the downstream front leg.
- ▶ As with any fixed valve, it can never become stuck to the deck nor can it spin.
- ▶ The large net rises available plus the directional liquid flow make this an outstanding anti-fouling valve. It is widely used on anti-fouling SUPERFLUX® trays.
 - Using a large net rise ensures that large particles can freely pass through the deck openings.
 - There are no protrusions below the deck for any material to hang up on and for deposits.
 - The liquid push is strong enough to help solid material to be flushed downstream and toward the downcomer where it can exit off the tray deck.



MINIVALVE® decks

The MINIVALVE® family of smaller-size valves provide reduced entrainment and better efficiency than conventional valve and sieve trays.

The improvement in capacity can exceed 13% in spray regime services with low-to-moderate weir loadings. MINIVALVE® valves exhibit a more uniform froth action on the tray deck compared to full-size valves. They are offered in both fixed (VG-0) and moveable (MV-1) styles.

MINIVALVE valves are directional with the rear leg being a little wider than the downstream front leg. This gives a slight pushing action to the liquid as vapor passes through the valves.

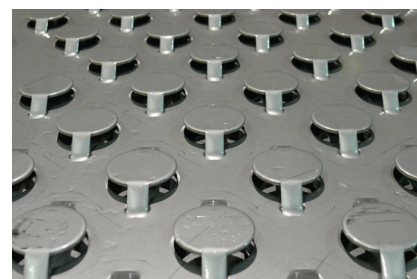
The liquid push assists in maintaining a more uniform flow pattern on crossflow trays with less retrograde action. It also helps offset vapor crossflow channeling effects to a small degree.

VG-0 - MINIVALVE® fixed valve

- Higher capacity than full-size valve trays – smaller tower or more throughput
- High efficiency – fewer trays or less reflux required
- Fixed opening – valve cannot stick shut
- Formerly used on SUPERFRAC® tray decks only
- FRI tested
- Cost effective
- U.S. Patent No. 5,147,584

This widely-used, fixed, high-performance valve has been tested at FRI on two different sets of high capacity trays.

- ▶ The net rise can range from as low as 4 mm [0.158 in] to as high as 11 mm [0.433 in]. Recommended rises vary with deck thickness and the nature of the service.
- ▶ A fixed valve can never become stuck to the deck nor can it spin.
- ▶ The VG-0 valve's fouling resistance is quite good. In fact, it has been used in a number of fouling applications on the decks of high performance, anti-fouling SUPERFLUX® trays.
- ▶ The operating range is quite good, exceeding that of a sieve tray and almost matching that of moving valves. This valve is replacing full-size, conventional moving valves in many installations.



MV-1 - MINIVALVE® moving valve

- Higher capacity than full-size valve trays – smaller tower or more throughput
- High efficiency – fewer trays or less reflux required
- Formerly restricted to SUPERFRAC® tray decks
- Wide operating range
- U.S. Patent No. 5,120,474

Originally used only on SUPERFRAC® high-performance trays, this moving valve is now available for use on conventional trays. This valve offers high capacity and efficiency AND a wide operating range.

Because of the way the legs are inserted into the deck, the valves cannot spin. The valves come in two leg lengths, although the longer length is rarely needed – the shorter leg accommodates most common deck thicknesses.

Valves are normally furnished dimpled with tabs to space the cap edges slightly off the deck. A flush-seated style is available upon request.



PROVALVE® fixed valve

- Higher capacity than full-size valve trays
- Maximum opening size for maximum fouling resistance and free passage
- Longest up time between shutdowns
- Fixed opening means the valve cannot stick shut like moving valves
- High weepage resistance for a wide operating range
- Easy to clean – less downtime
- Rugged, durable construction for long tray life
- Low pressure drop
- FRI tested
- U.S. Patent No. 5,762,834

The PROVALVE valve offers the wide operating range of conventional valve trays, but with no moving parts. The valve design prevents valve leg or deck wear and eliminates the potential for popped, fouled, or stuck valves.

- ▶ The tapered cover imparts a forward lateral push to the liquid across the tray, allows a large open area, and directs and deflects the vapor.
- ▶ The result is uniform liquid and vapor distribution across the entire tray with a low, even spray height across the deck. This increases the tray's efficiency, prevents liquid backflow, suppresses jet flooding, and permits operating at greater vapor rates.
- ▶ The cleansing action from the liquid push protects the tray deck from fouling.
- ▶ In addition, the sheltered valve design allows a large open area that promotes lower pressure drop and protects against vapor surges.

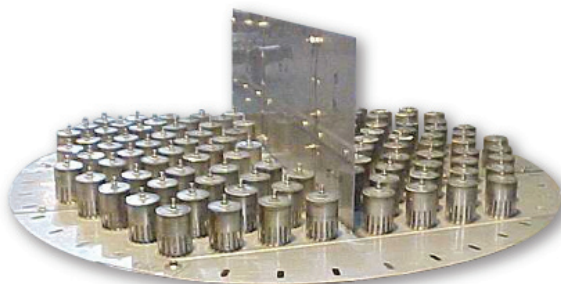


Other Conventional Trays from Koch-Glitsch

Koch-Glitsch has the broadest line of tray devices available in the industry.

From conventional trays to high performance trays, Koch-Glitsch has the right tray for your application:

- Sieve
- Bubble cap
- Tunnel
- Dualflow
- Baffle



High Performance Trays from Koch-Glitsch

For decades, Koch-Glitsch has been the driving force in tray design improvements.

Koch-Glitsch's design and manufacture of distillation trays have evolved from bubble cap to sieve to valve trays and now to specialty, high-capacity trays. The patented technologies used in SUPERFRAC® and ULTRA-FRAC® trays are the result of over twenty years of comprehensive tray development work.

- ▶ For new columns, Koch-Glitsch high-capacity trays can be employed to reduce diameters, heights, or both.
- ▶ For existing columns, they can replace existing trays to increase capacities, reduce utilities, or improve separations.
- ▶ In total, our high-capacity trays have been employed in over 1,000 columns.

SUPERFRAC® High Performance Trays

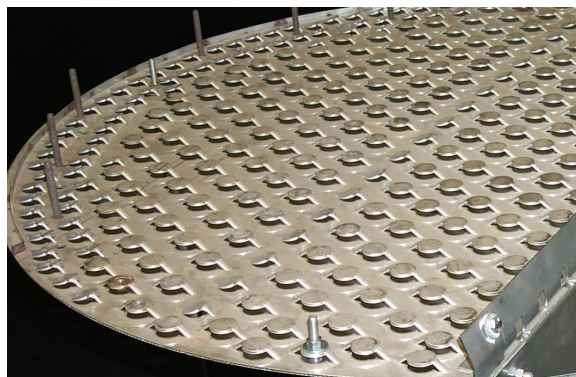
The SUPERFRAC® tray is a high performance crossflow tray that has the highest combined capacity and efficiency of all crossflow trays tested at FRI.

The unique combination of SUPERFRAC patented technologies and design strategies produces the high capacity and the maximum vapor/liquid contact efficiency achievable on a crossflow distillation tray.

These technologically advanced trays employ innovative downcomer designs and enhancements in the active and inlet areas to provide:

- ▶ Highest combined capacity and efficiency
- ▶ Minimal pressure drop
- ▶ Optimum mass transfer efficiency

As a result, the SUPERFRAC tray gives the highest economic benefit to operators of distillation columns seeking solutions for both new construction and revamp projects.



ULTRA-FRAC® High Performance Trays

Expand your capacity — not your vessel.

The ULTRA-FRAC® tray is the next logical step to increased capacity in existing vessels:

- ▶ Highest capacity commercial mass transfer device
- ▶ Multiple separators produce co-current flow

With these trays, existing columns can be retrofitted, resulting in significant capacity increases without the major capital expenditures and space requirements of building new columns. One-for-one change-outs of existing trays are possible for many services.

ULTRA-FRAC trays offer:

- ▶ Superior liquid handling
- ▶ Superior vapor handling
- ▶ Foam suppression



Construction Details

Metal

Trays are available in any formable, weldable sheet metal material. The most common materials for trays are:

- ▶ Carbon steel
- ▶ Stainless steel, Ferritic, Austenitic, Duplex, Martensitic
- ▶ Nickel alloys
- ▶ Copper alloys
- ▶ Titanium, Zirconium

Trays are not normally stress relieved or annealed and typically do not conform to pressure vessel standards.

Trays fabricated from sheet metal materials are typically supplied in “as-sheared” condition.

Bolting

Standard bolting conforms to AISI specifications. Bolting conforming to ASME® specifications is available upon request.

Certification

Material certification is available for all fabricated internals. Positive Material Identification (PMI) testing is available upon request.

Gasketing

For multi-piece trays requiring gasketed joints, many choices of gasket material are available. Where gasketing is required, braided fiberglass tape is supplied as the standard for linear joints. Depending on the service, KLINGERSIL® C-4401, expanded PTFE or spiral wound stainless steel with flexible graphite filler gaskets are supplied as the standard for flanged connections. Other gasket materials are available upon request.

Manway Access

All trays are designed in sections to pass through vessel manways. Tower internals are designed to pass through a vessel manway of 18 in [450 mm] minimum inside diameter, unless otherwise specified. Larger manways often provide the ability to optimize the design of components for faster, easier installation. Please provide manway locations and inside diameters at the time of inquiry.

Scope of Supply

For the trays in this brochure, Koch-Glitsch supplies all removable parts.

The trays do not include vessel attachments for connection or support, unless specifically stated in the item description. Vessel attachments may be quoted / supplied separately.

Examples of attachments that may be required are:

- ▶ Support rings
- ▶ Sump frames
- ▶ Internal flanges at feed inlet nozzles
- ▶ Wall clips for support
- ▶ Downcomer clamping bars
- ▶ Beam seats

Minimum Support Ring Widths

All dimensions are expressed as inches (millimeters)

TOWER ID	Trays Resting on or Clamped to Support Ring	Trays Through-Bolted or Using Leveling Screws
Up to 18 (Up to 457)	0.75 (20)	1.5 (40)
18.1 - 24.24 (458 - 615)	1.0 (25)	1.5 (40)
24.25 - 48.24 (616 - 1225)	1.5 (40)	2.0 (50)
48.25 - 72.24 (1226 - 1835)	2.0 (50)	2.0 (50)
72.25 - 96.5 (1836 - 2450)	2.5 (65)	2.5 (65)
96.6 - 144.5 (2451 - 3670)	3.0 (75)	3.0 (75)
144.6 - 168.7 (3671 - 4285)	3.5 (90)	3.5 (90)
168.8 - 216.3 (4286 - 5495)	4.0 (100)	4.0 (100)
216.4 - 240.5 (5496 - 6110)	4.5 (115)	4.5 (115)
If the support ring size is other than these listed above, special consideration must be given to the plate diameter and vessel tolerances.		

Feed Devices

Obtaining desired tower performance requires the proper handling of liquid and vapor entering the column. The types of feeds or inlets into a column can generally be classified into three major categories:

- ▶ Liquid only (contains less than 1% of vapor by volume)
- ▶ Mixed liquid and vapor, flashing or suppressed flash
- ▶ Vapor

The selection criteria for each category of feed device is unique.

Liquid-Only Feeds

Among the factors that Koch-Glitsch engineers consider when designing a liquid feed device are:

- ▶ Type of tray
- ▶ Expected tray performance
- ▶ Flow rate
- ▶ Operating range
- ▶ Degree of sub-cooled liquid
- ▶ Requirements for mixing

The feed arrangement for these conditions depends on the tray type. Please consult with a Koch-Glitsch technical representative for recommendations.

Liquid-Vapor and Flashing Feeds

For mixed liquid-vapor or flashing feed devices above a tray, the selection depends on:

- ▶ Tray type
- ▶ Liquid and vapor flow rates
- ▶ Turndown
- ▶ Column height needed for disengagement and vapor distribution
- ▶ Requirements for mixing

In all cases, separating the vapor and the liquid phases is a primary concern. In some cases, the requirements for additional pre-distribution may alter certain tray designs.

Vapor-Only Feeds

Two factors must be considered when choosing the proper device for a vapor-only feed.

- ▶ The kinetic energy of the inlet vapor in relation to the pressure drop across the trays, the feed nozzle arrangement, and the tower separation requirements.
- ▶ If there is a large difference in the composition and/or temperature between the inlet vapor stream and bulk vapor flow, mixing the two vapors optimizes the performance of the trays.

Specific equipment for vapor distribution may not be required if sufficient column height is available for equalization or if the pressure drop across the trays is sufficient to provide proper vapor distribution.

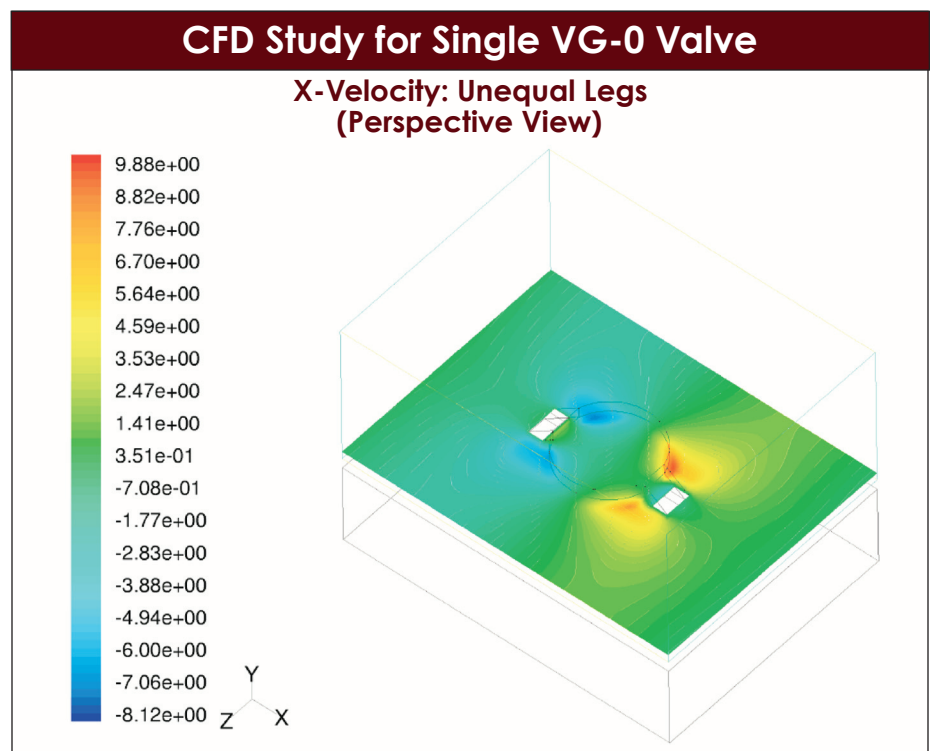
CFD Modeling

Good vapor distribution is essential to achieve superior separation efficiency. Poor vapor distribution is often a major source of problems.

Koch-Glitsch combines modern Computational Fluid Dynamics (CFD) modeling technology with its engineering expertise to analyze vapor and liquid distribution when evaluating the performance of existing equipment and developing new, improved designs. This involves computer modeling of the 3-dimensional configuration of the column internals to provide detailed predictions of fluid flow (velocity profiles and so forth) as shown in the figure below.

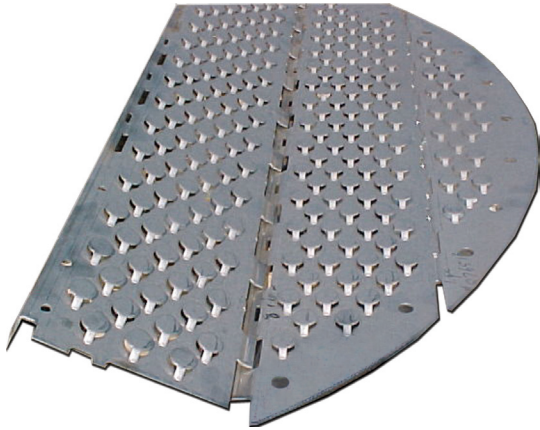
Koch-Glitsch offers CFD services for the following tasks:

- ▶ Development and optimization of new mass transfer equipment
- ▶ Troubleshooting or analysis of existing equipment
- ▶ Confirmation of equipment designs prior to fabrication and installation



Mechanical Features

FLEXILOCK® Tray Construction



The patented FLEXILOCK tray joint allows rapid installation of tray panels in vessel shops or in the field. FLEXILOCK tray construction eliminates the requirement for hardware between adjacent tray panels and provides for error-free deck installation. FLEXILOCK tray construction can be used to:

- ▶ Reduce hardware requirements
- ▶ Improve valve coverage
- ▶ Provide error-free deck installation
- ▶ Dramatically reduce installation time
- ▶ Strengthen joint and uplift tolerance
- ▶ Promote in-shop installations
- ▶ Cancel vibration-induced panel shifting

OMNI-FIT® Technology

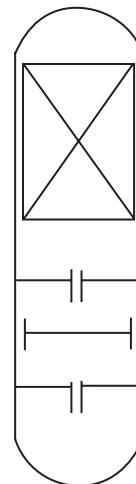
OMNI-FIT technology is a set of mechanical engineering designs used to reduce the cost and downtime of revamps. These technologies include expansion rings, pedestal supports, downcomer adapters, and innovative tray designs that can minimize or eliminate welding on an existing tower. Efficiency and capacity enhancements can be achieved by using OMNI-FIT technology for your next turnaround project.

OMNI-FIT technology can be used to:

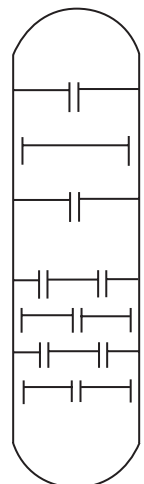
- ▶ Increase theoretical stages
- ▶ Change tray spacings
- ▶ Change the number of passes
- ▶ Modify downcomer sizes or configurations
- ▶ Install multi-pass SUPERFRAC trays
- ▶ Change tray orientation
- ▶ Eliminate welding
- ▶ Shorten turnarounds
- ▶ Replace packing
- ▶ And more...



Before



After



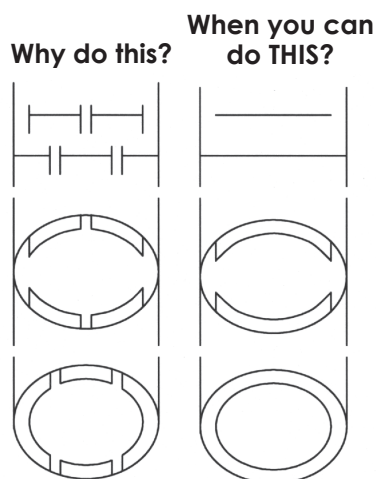
HORIZON® Technology



HORIZON technology is a set of mechanical construction techniques developed specifically for in-shop installation of trays with the vessel in the horizontal position. Using the patented FLEXILOCK tray construction as its primary building block, this special mechanical design prevents the problems that can occur when conventionally designed trays are installed with the vessel in the horizontal position. These problems include inefficient installation sequencing, part deforming / breaking, panel shifting, joint dislodging, extra field inspecting and field readjusting of tray parts. If you plan to shop-install trays, then you need the assurance provided by HORIZON technology.

Mechanical Features

SATURN® Technology



The patented SATURN technology can reduce the total installed cost of new distillation columns with its combination of innovative tray designs and simple tower attachments.

When crossflow trays are used, conventional designs use horizontal ring segments to support tray decks and vertical bolting bars to support tray downcomers. With the SATURN technology, all of the crossflow tray parts are supported from the horizontal ring.

SATURN technology brings together:

- ▶ The high efficiency, high capacity, low cost, and reliability of crossflow trays
- ▶ The simple rings of dual-flow trays

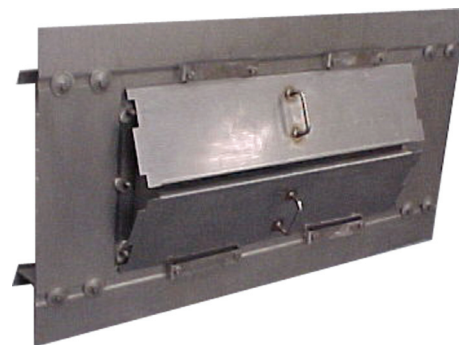
SPEED-WAY® Manways

At last, a design that allows you to easily add quick-opening manways to your existing trays. Just remove the existing manway or active panels and replace them with SPEED-WAY panels.

These quick-opening manways are especially beneficial when:

- ▶ Turnaround manpower is limited
- ▶ Short downtime is critical
- ▶ Routine inspections are required

If you have a need to tunnel through your column on a routine basis, SPEED-WAY manways are a must.



Tray Maintenance Services

Comprehensive services for turnarounds and shutdowns.

Koch-Glitsch provides comprehensive services to help you reduce costs and shorten scheduled turnarounds and emergency shutdowns for maintenance.

Our Response Teams are strategically located around the world and are ready to serve you at any time.

Services include:

- ▶ Inspection
- ▶ Hardware trailers and lockers
- ▶ Automated Hardware Ordering Program (AHOP)
- ▶ Equipment Support Services (ESS) technicians

Emergency Delivery

Emergencies happen . . .

Koch-Glitsch has a wide variety of tray products to provide optimum performance whatever your application. Many common materials are in stock and trays can be quickly manufactured to get you back on line.

For emergencies, call the Hotline of your nearest Koch-Glitsch office:

- ▶ In the US, call the Hotline at 1-888-KOCH-911.
- ▶ In Europe, call +44-1782-744561, +39-06-928-911, or your local Koch-Glitsch office.

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