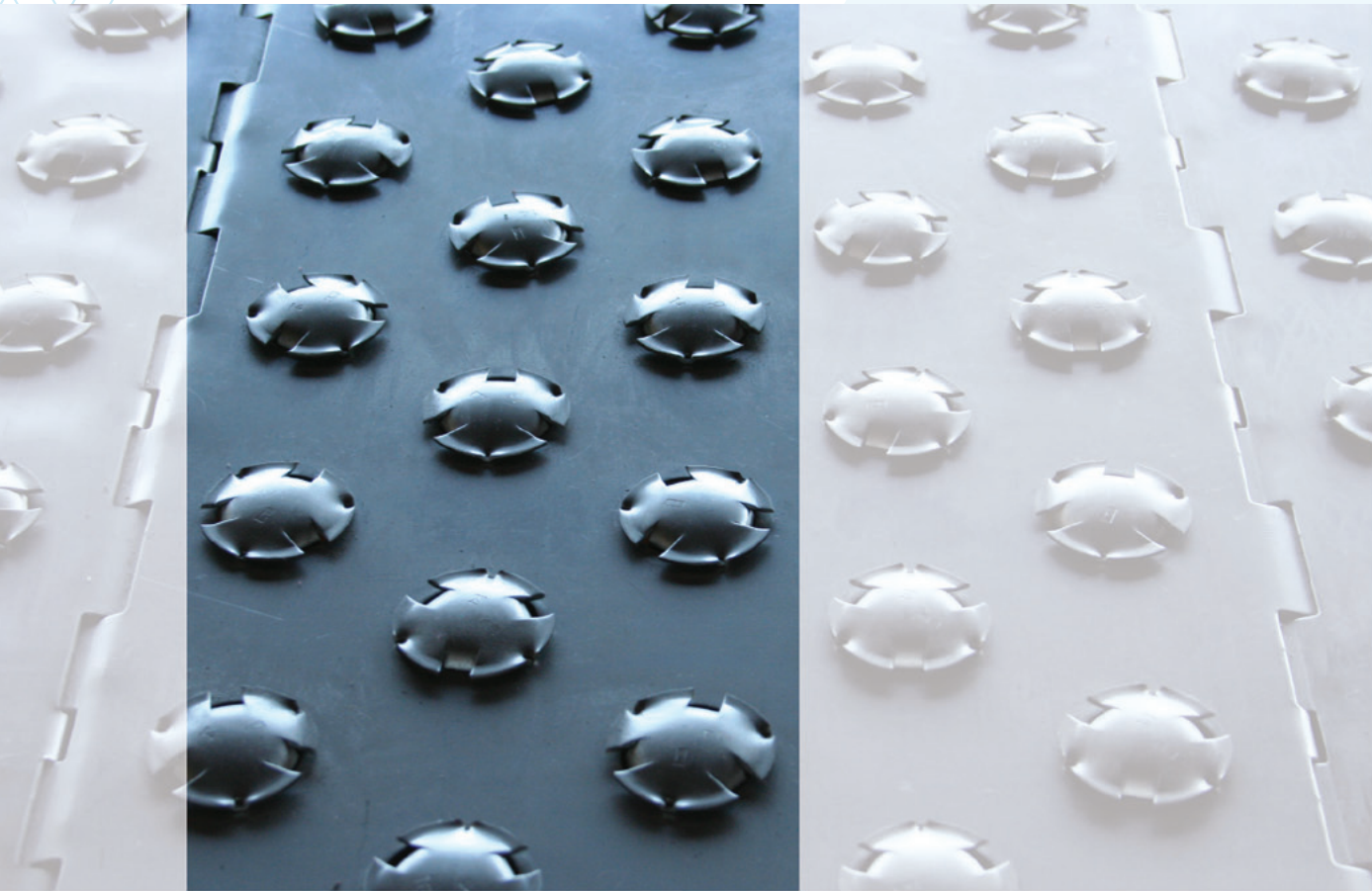

FLEXITRAY[®]

VALVE TRAYS



YOU CAN RELY ON US.

 **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. Using 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 quantity of trays
- ▼ 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.

Cost effective

The initial investment cost, 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.

Experience

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

Fractionation Research Inc. (FRI) Testing

FRI is a non-profit, member-supported organization that conducts independent research in commercial scale distillation facilities operating with hydrocarbon systems. Its research programs include basic research into the design and operation of distillation columns as well as testing of proprietary distillation devices. FRI members vote on the projects to be conducted at FRI's facilities, including which proprietary devices will be tested. Over the years, Koch-Glitsch has had numerous devices tested at FRI, including the T, T0, and VG-0 valves, the PROVALVE® tray, and the SUPERFRAC® and ULTRA-FRAC® high performance trays.

VALVE TYPES

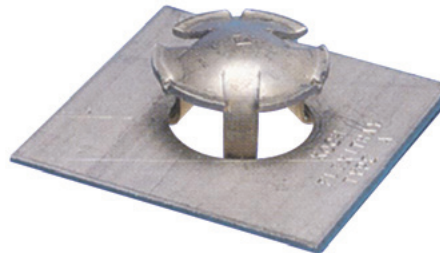
Koch-Glitsch has the valve type for your application/service.

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

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.



CHARACTERISTICS

- ▼ Higher capacity than standard sieve trays
- ▼ High efficiency
- ▼ Wide operating range
- ▼ Low pressure drop
- ▼ Cost effective

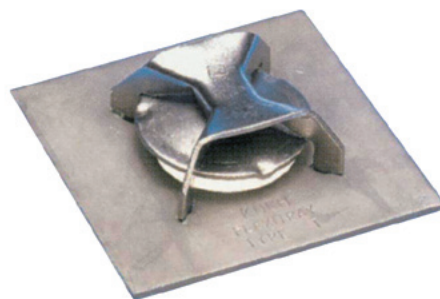
EQUIVALENT DESIGNATIONS

- ▼ BALLAST® tray: V-1
- ▼ FRI tested

T - FULL-SIZE CAGED VALVE

Type T is the caged equivalent to the Type A valve. The use of this FRI-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 is normally supplied dimpled, but can be flush seated as necessary.



CHARACTERISTICS

- ▼ All the benefits of Type A valves
- ▼ More weepage resistance – even wider operating range
- ▼ Increased fouling resistance – fewer costly shutdowns
- ▼ Rugged construction – resistant to corrosion and erosion
- ▼ FRI tested

EQUIVALENT DESIGNATIONS

- ▼ BALLAST® tray: A-2

T₀ - FULL-SIZE, ONE-PIECE VALVE

This variation of the Type T valve uses an extruded orifice.

- ▼ The dry tray pressure drop is thus lowered, providing an overall lower pressure drop.
- ▼ This comes at a cost of higher weepage and reduced



CHARACTERISTICS

- ▼ All the benefits of Type A valves
- ▼ More weepage resistance – even wider operating range
- ▼ Increased fouling resistance – fewer costly shutdowns
- ▼ Rugged construction – resistant to corrosion and erosion
- ▼ Contoured hole in deck for lowest possible pressure drop
- ▼ FRI tested

EQUIVALENT DESIGNATIONS

- ▼ BALLAST® tray: A-5
- ▼ European: T₉

PROVALVE® FIXED VALVE

The patented 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.



CHARACTERISTICS

- ▼ 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
- ▼ Patented

MINIVALVE® DECKS

The MINIVALVE® family of smaller-size valves provides 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 cross-flow trays with less retrograde action. It also helps offset vapor cross-flow channeling effects to a small degree.

VG-0 - MINIVALVE® FIXED VALVE

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 0.158 in [4 mm] to as high as 0.433 in [11 mm]. Recommended rises vary with deck thickness and the nature of the service.
- ▼ A fixed valve can never stick to the deck nor can it spin.

Because of the VG-0 valve's fouling resistance, it has been used in a number of fouling applications on the decks of high performance, anti-fouling SUPERFLUX® trays.



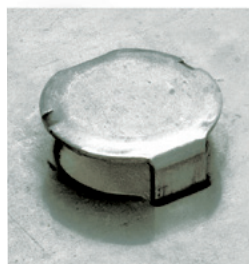
The operating range exceeds that of a sieve tray and almost matches that of moving valves. This valve is replacing full-size, conventional moving valves in many installations.

CHARACTERISTICS

- ▼ 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 nor can it spin
- ▼ Cost effective
- ▼ FRI tested

MV-1 - MINIVALVE® MOVING VALVE

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 combined with 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.

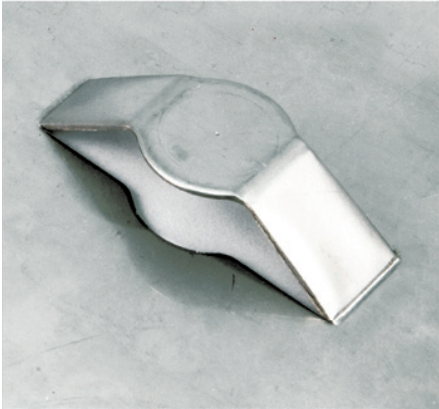
CHARACTERISTICS

- ▼ Higher capacity than full-size valve trays – smaller tower or more throughput
- ▼ High efficiency – fewer trays or less reflux required
- ▼ Wide operating range

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

VG-10 - FULL-SIZE FIXED VALVE

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

- ▼ The net rise typically ranges from 0.236 in [6 mm] to 0.551 in [14 mm], varying in 0.039 in [1 mm] 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 stick 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 or for deposits to accumulate.
 - The liquid push is strong enough to help flush solid material downstream and toward the downcomer where it can exit off the tray deck.
- 
- ### CHARACTERISTICS

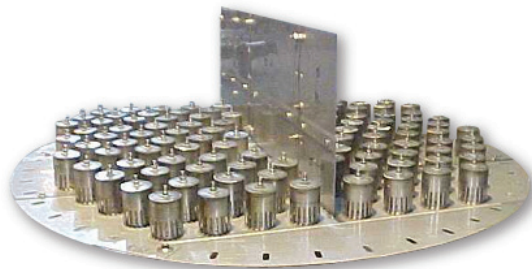
 - ▼ Large opening size for improved fouling resistance
 - ▼ Extended time between shutdowns
 - ▼ Fixed opening means the valve cannot stick shut like moving valves
 - ▼ Easy to clean – less downtime
 - ▼ Rugged, durable construction for long tray life
 - ▼ Can be made from materials up to 0.25 in [6.35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

OTHER CONVENTIONAL TRAYS FROM KOCH-GLITSCH

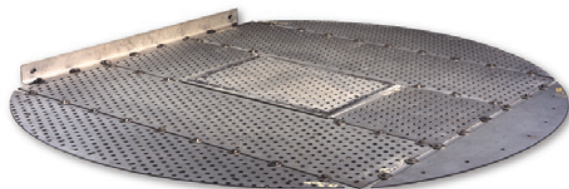
Koch-Glitsch has the broadest line of tray devices available in the industry.

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

- ▼ Bubble cap
- ▼ Sieve
- ▼ Tunnel
- ▼ Dualflow
- ▼ Baffle



Bubble cap tray



Sieve tray

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 approximately 2,000 columns.

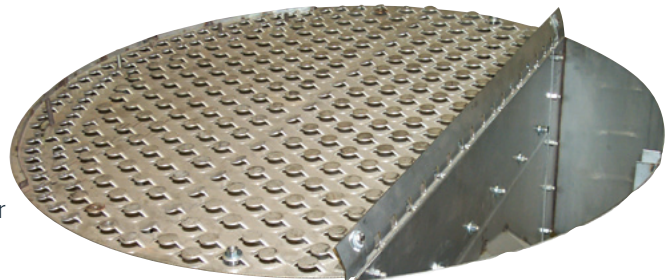
SUPERFRAC® HIGH PERFORMANCE TRAYS

The SUPERFRAC® tray is a high performance cross-flow tray that has the highest combined capacity and efficiency of all single-pass cross-flow 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 cross-flow 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

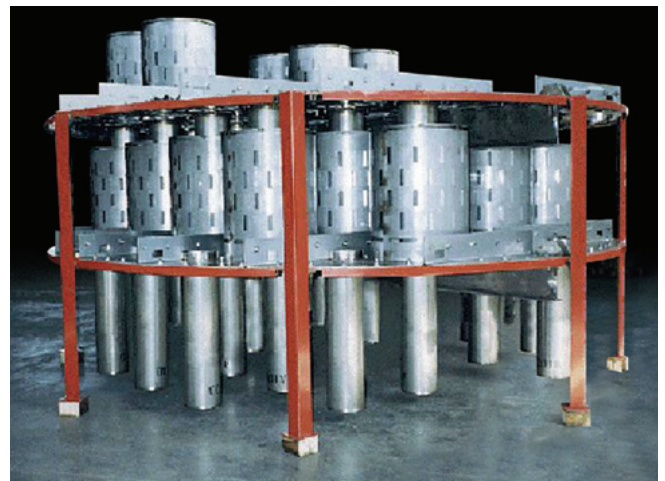
Expand your capacity — not your vessel.

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.

The FRI-tested ULTRA-FRAC trays offer superior liquid and vapor handling while suppressing the creation of foam.



CONSTRUCTION DETAILS

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

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 Clamped to a Support Ring
Below 27.5 [Below 700]	Typically supplied as cartridge tray construction; trays require a vessel body flange for installation.
27.5 - 59.0 [700 - 1500]	1.5 [40]
59.1 - 98.4 [1501 - 2500]	2.0 [50]
98.5 - 137.8 [2501 - 3500]	2.5 [60]
137.9 - 177.2 [3501 - 4500]	3.0 [70]
177.3 - 236.2 [4501 - 6000]	3.5 [90]
236.3 - 295.3 [6001 - 7500]	4.0 [100]
295.4 - 354.3 [7501 - 9000]	5.0 [120]

If support ring size is other than those 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)
- ▼ Vapor
- ▼ Mixed liquid and vapor, flashing or suppressed flash

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

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.

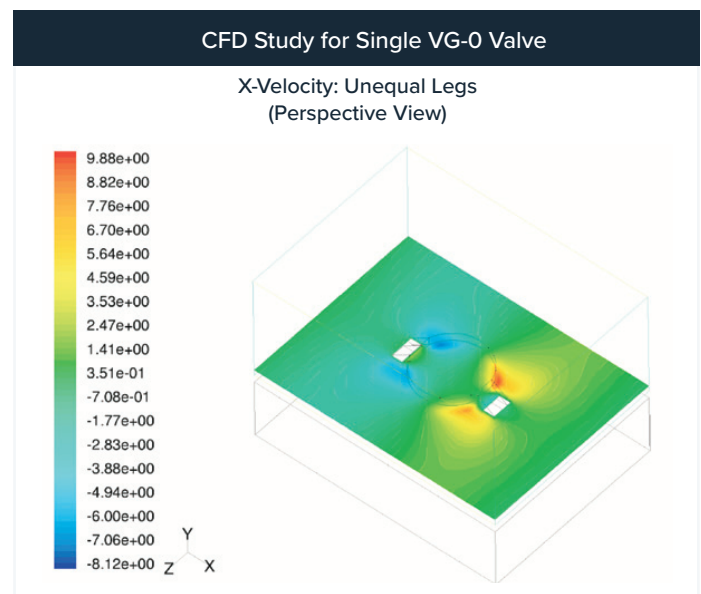
Selection Criteria

The selection criteria for each category of feed device is unique. Please consult with a Koch-Glitsch technical representative for recommendations.

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.



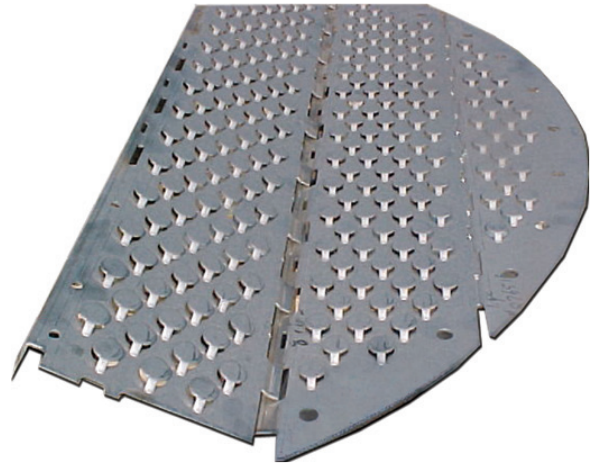
MECHANICAL FEATURES

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 the patented OMNI-FIT technology for your next turnaround project.

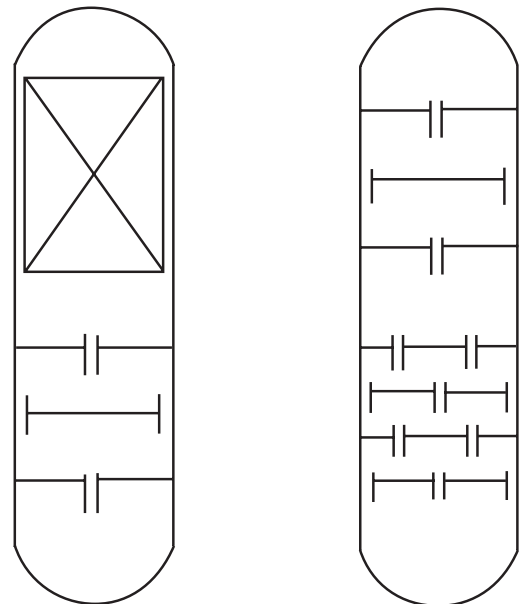
OMNI-FIT technology can be used to:

- ▼ 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. The patented FLEXILOCK® tray construction from Koch-Glitsch is the primary building block of the HORIZON technology. If you plan to shop-install trays, then you need the capabilities provided by HORIZON technology.



- ▼ Special mechanical design helps prevent inefficient installation sequencing, part deforming/breaking, panel shifting, joint dislodging, extra field inspecting, and field readjusting of tray parts.
- ▼ Installation in the shop versus in the field helps reduce installation costs, accommodates short turnaround schedules, and reduces space constraints involved with manhole access and off-shore platform installations.

TRAY MAINTENANCE SERVICES

Comprehensive services for turnarounds and shutdowns. Downtime is critical for both planned and unplanned turnarounds. Koch-Glitsch is available 24/7 to offer equipment and comprehensive support and services to get your tower up and running as quickly as possible. Our response teams are strategically located around the world and are ready to serve you at any time.

Services include:

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

Combined with Koch Specialty Plant Services, Koch-Glitsch goes a step further with its ability to deliver unique, value-driven turnkey equipment and installation solutions to provide faster, safer revamps, which often result in shorter duration turnarounds.

EMERGENCY DELIVERY

Koch-Glitsch has a wide variety of products to provide optimum performance whatever the application. Many common materials are in stock, and equipment can be quickly manufactured to meet your requirements regardless of original equipment manufacturer.

With manufacturing facilities and warehouses strategically located worldwide, Koch-Glitsch leads the industry with its on-time performance for delivery of emergency trays and hardware, packing and internals, and mist elimination equipment.

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

- ▼ **In the US and Latin America**, call 1-888-KOCH-911 (mass transfer), 1-316-207-7935 (mist elimination), or your local Koch-Glitsch office.
- ▼ **In Canada**, call 1-905-852-3381 (Uxbridge, Ontario).
- ▼ **In Europe**, call +39-06-928-911 (Italy), +44 1782 744561 (UK), or your local Koch-Glitsch office.
- ▼ **In Asia**, call +65 6831-6500 (Singapore) or your local Koch-Glitsch office.



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For a complete list of our offices and facilities, visit koch-glitsch.com.

Trademarks

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For related trademark information, visit <http://www.koch-glitsch.com/trademarks>.

Patents

The following technologies are protected by one or more patents in the USA; other foreign patents may be relevant: FLEXILOCK® tray construction (US6592106), OMNI-FIT® technology (US6736378, US7055810, US7125005), PROVALVE® tray (US5762834), SUPERFLUX® tray (US5895608), SUPERFRAC® tray (US5762668, US5895608, US5632935), and ULTRA-FRAC® tray (US8500105, US8191870).

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