High Performance Packed Tower Solutions
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Engineered to Innovate

GTC Technology is a global licensor of process technologies and mass transfer solutions with the core mission of creating value for our clients. Refining, petrochemical and chemical companies around the world rely on our advanced technology to optimize production capacity and efficiency. We combine unparalleled technical expertise and innovative thinking to solve complex processing problems. GTC has earned a reputation of excellence by designing and delivering high quality, strategic solutions for clients worldwide.

Providing Mass Transfer Solutions that Optimize Efficiency

GTC Technology’s Process Equipment Technology (PET) team designs and provides specialized process equipment technology solutions that cover a broad spectrum of conventional and proprietary trays, packing and other tower internals. Beyond providing innovative process equipment, we offer practical solutions backed by process optimization and energy saving studies.

At GTC, we recognize that no two situations or clients are alike. We pride ourselves on working with each client to understand their business objectives and concerns, combining the right mix of PET solutions to sustain their competitive position in the marketplace.

GTC’s diverse portfolio offers the greatest potential to serve clients. We customize our engineering and design equipment and services based on each client’s needs, application and market. Our products and services include:

- Feasibility studies for column revamps
- Basic engineering package
- CFD modeling capabilities
- Equipment engineering, design, fabrication and delivery
- Project management and execution
- Equipment installation by GTC; at plant-site or vessel shop
- Installation site services supervision
- Start-up assistance
- Packed column internals
- Urgent replacement service

GTC provides complete vessel fabrication including tower internals, field erection and installation of entire distillation columns.
- **Why GTC Technology?**
  Our engineers at GTC Technology know that high quality equipment, advanced technology and on-time delivery are critical to the success of your operation. We are committed to our clients and hold ourselves accountable by delivering products that optimize efficiency and lower costs through energy saving equipment, innovative engineering, in-depth analysis and reliable service. Drawing on our many years of experience installing licensed technology around the world, we have unparalleled technical expertise to design and implement custom solutions for clients. As an ISO-9001 certified full-service provider of mass transfer solutions, clients depend on GTC for fast on-time delivery for urgent replacement needs.

- **Uniquely Positioned to Meet the Global Demands of the Industry**
  GTC Technology’s expansive capabilities allow us to mobilize resources to serve a global clientele. With tight linkages between manufacturing and design, we can respond quickly to regional demands with manufacturing and engineering facilities located in the U.S., Korea, China, Singapore, Russia, Czech Republic and Mexico, as well as sales agents stationed around the globe.

  Our recent PET projects include providing engineering services, troubleshooting, column revamp solutions for capacity and efficiency improvements, fast track replacement services and turnkey installation packages for high-profile clients worldwide.
Structured Packing

GTC Technology's structured packing is designed to help clients achieve higher capacity, higher efficiency and lower pressure drop. When selecting structured packing, we advise our clients to consider several parameters that influence the performance of the equipment including crimp height, crimp inclination angle, element height, surface treatment, fouling tendency, system properties and service. Our corrugated sheet structured packing, the industry standard clients have come to expect, can be modified through the packing geometry, surface treatment and manipulation of variables in order to increase efficiency and capacity. GTC Technology's extensive line of structured packing currently includes:

- GT-PAK™ - Industry Standard Corrugated Sheet Packing
- GT-OPTIM™ PAK High Capacity Structured Packing
- GT-OPTIM-e™ PAK High Performance Packing
- GT-AQUA™ PAK Aqueous Service Structured Packing
- GT-GRID™ - Industry Standard Latice-Grating Packing
- GT-MixGRID™ - Industry Standard Corrugated Sheet Packing

GTC Technology completed one of the largest structured packing installations in the world with a tower diameter in excess of 15 meters.
In this graph, the overall performance comparison shows an inherent capacity advantage for structured packing over random packing at any chosen efficiency basis.

Comparing Efficiency and Capacity of Structured and Improved Random Packing

GTC often recommends structured packing over improved random packing. When comparing relative capacity and efficiency for structured and improved random packing, several conclusions can be drawn. First, notice that in the graph above, capacity is an inverse relationship to efficiency. As capacity increases, efficiency decreases. In addition, it is evident that as the specific surface area (SSA) increases, structured packing displays greater efficiency.

The inherent advantage to structured packing is in utilizing the corrugated sheet surface area while allowing higher vapor-liquid handling capacity in low pressure or vacuum systems. The graph above confirms that structured packing can help achieve much greater capacity compared to random packing at similar efficiencies in low pressure systems.

Notes:
1. Random packing may achieve the same height equivalent to a theoretical stage (HETP) as structured packing in some cases, but random packing would have lower capacity at these same operating conditions.
2. Random packing has shown superior performance over structured packing in some systems, such as high pressure (above 6 bar or 90 psia) services.
3. Refer to the additional graphs in this brochure for more complete comparison views.
This graph compares Specific Surface Area (SSA) to Height Equivalent to a Theoretical Stage (HETP), for GT-PAK. As indicated, when surface area increases, efficiency rises.

Comparing Surface Area and Efficiency of Structured Packing

Clients can estimate bed height by calculating the number of theoretical stages required for the desired separation. The calculation can be carried out by multiplying the expected HETP result for the selected structured packing. For instance, GT-PAK 250Y has an HETP value of approximately 380 mm, the bed height required per theoretical stage of separation for a typical low-alpha relative volatility test system. For design applications, a minimum of 10 percent safety margin would be applied to allow for changes in actual feed composition and operating control variations. Therefore, an applied HETP of 420 mm is assumed. For 20 stages, the design bed height would be 8.4 meters. For 60 stages, three beds 8.4 meters each in height would be required, keeping in mind that feed locations may affect the actual bed arrangements.

Note:
Several factors that may reduce the efficiency of the structured packing, can impact the separation and require more than the recommended 10 percent safety factor including:

- Aqueous or water-organic separations
- Two liquid phases
- “High-alpha” relative volatilities
- High pressure systems, above 6 bar (90 psia)
- Low liquid-to-vapor ratio
- Deep beds (over 20 theoretical stages)
- Foaming systems
- Scale-up from small diameter pilot columns
- Liquid or vapor mal-distribution
- Drip point density
Clients can minimize energy use while improving product yield by revamping process towers with GTC structured packing.

Comparing Pressure Drop and Capacity of Structured and Random Packing

The relationship between pressure drop and capacity of structured and random packing can be observed in the graph above. When conventional 250 m²/m³ corrugated sheet structured packing is compared to #50 third-generation random packing, structured packing has a greater capacity while maintaining a lower pressure drop. When clients are looking to reduce energy costs and improve column efficiency, GTC recommends revamping existing packed and trayed columns with structured packing.

As displayed in the graph above, the random packing pressure drop is 15-20 percent higher than structured packing at the same column diameter and throughput. Clients can benefit from structured packing by revamping existing towers, reducing new column cross sectional area by 15-20 percent, improving product purities and minimizing operating costs.
- **Comparing Efficiency and Capacity of Structured and Random Packing**

When comparing the efficiency and capacity of structured packing to random packing, structured packing has significantly better performance.

There is a significant difference between the performance of GT-PAK 250Y corrugated sheet structured packing and #50 third-generation random packing. GT-PAK 250Y requires 50 percent less bed height for the same separation in sizing new columns and can maintain greater capacity compared to random rings. For revamped columns bed heights can be maintained, while a larger crimp size structured packing can gain up to 50 percent greater capacity and yield the same product purities as the #50 third-generation random packing. In addition, clients can gain 10 percent more throughput, with better product purities at the same column diameter or smaller by using GT-PAK 250Y as opposed to third-generation random packing.

**Notes:**
1. The data represents a typical refinery application at atmospheric pressure.
2. A 10 percent minimum safety factor of added bed height is recommended to allow for feed composition and operating control variations.
3. It is typical for new column sizing to be conservatively estimated at about 75 percent flood to allow for future increases at efficient operation.
4. An 85 percent flood is considered a maximum safe design for revamp projects.
5. The maximum efficient column operation is around 90 percent flood for most modern packing.
GT-PAK™: Structured Packing

For direct replacement of industry standard conventional structured packing, GTC offers GT-PAK. Our high efficiency structured packing is designed to achieve maximum efficiency in column revamps or grassroots units and is available in perforated, textured or corrugated sheet metal and can be customized for all major surface area requirements. To simplify installation, the corrugated sheets that make up our structured packing modules are assembled with screws, and periphery column wall wiper banding is attached prior to shipment. These enhancements ensure a stronger, more robust structured packing module that is easier to handle in the field during installation. Additional GT-PAK features include:

- Excellent wetability with continually renewed mass transfer surface area
- Complete mixing of vapor and liquid with optimum radial distribution
- Waffled, grooved, lanced and dimpled texturing
- Standard 45° (Y) and 60° (X) crimp inclination
- Individual corrugated sheets forming intersecting channels
- Stronger module sections designed to resist damage during installation

<table>
<thead>
<tr>
<th>Packing Type</th>
<th>Nominal Inclination Angle°</th>
<th>Nominal Specific Surface Area (m²/m³)</th>
<th>Bulk Density (kg/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GT-PAK™ 750 Y/X</td>
<td>45/60</td>
<td>750</td>
<td>260</td>
</tr>
<tr>
<td>GT-PAK™ 500 Y/X</td>
<td>45/60</td>
<td>500</td>
<td>177</td>
</tr>
<tr>
<td>GT-PAK™ 440 Y/X</td>
<td>45/60</td>
<td>440</td>
<td>168</td>
</tr>
<tr>
<td>GT-PAK™ 350 Y/X</td>
<td>45/60</td>
<td>350</td>
<td>129</td>
</tr>
<tr>
<td>GT-PAK™ 300 Y/X</td>
<td>45/60</td>
<td>300</td>
<td>161</td>
</tr>
<tr>
<td>GT-PAK™ 250 Y/X</td>
<td>45/60</td>
<td>250</td>
<td>93</td>
</tr>
<tr>
<td>GT-PAK™ 220 Y/X</td>
<td>45/60</td>
<td>220</td>
<td>80</td>
</tr>
<tr>
<td>GT-PAK™ 170 Y/X</td>
<td>45/60</td>
<td>170</td>
<td>82</td>
</tr>
<tr>
<td>GT-PAK™ 150 Y/X</td>
<td>45/60</td>
<td>150</td>
<td>79</td>
</tr>
<tr>
<td>GT-PAK™ 125 Y/X</td>
<td>45/60</td>
<td>125</td>
<td>76</td>
</tr>
<tr>
<td>GT-PAK™ 80 Y/X</td>
<td>45/60</td>
<td>80</td>
<td>58</td>
</tr>
<tr>
<td>GT-PAK™ 60 Y/X</td>
<td>45/60</td>
<td>60</td>
<td>43</td>
</tr>
</tbody>
</table>
GT-OPTIM™ PAK: High Capacity Structured Packing

GTC Technology has developed GT-OPTIM PAK, a product line of high performance structured packing that delivers greater column throughput at the same efficiency as traditional structured packing. GT-OPTIM PAK can be used in a wide range of application settings and is designed to optimize film flow vapor-liquid mixing, reduce pressure drop, increase capacity and provide excellent separation efficiency. Our GT-OPTIM PAK product line includes:

<table>
<thead>
<tr>
<th>GT-OPTIM™ PAK 750Y</th>
<th>Highest Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>GT-OPTIM™ PAK 500Y</td>
<td></td>
</tr>
<tr>
<td>GT-OPTIM™ PAK 440Y</td>
<td></td>
</tr>
<tr>
<td>GT-OPTIM™ PAK 350Y</td>
<td></td>
</tr>
<tr>
<td>GT-OPTIM™ PAK 300Y</td>
<td></td>
</tr>
<tr>
<td>GT-OPTIM™ PAK 250Y</td>
<td></td>
</tr>
<tr>
<td>GT-OPTIM™ PAK 220Y</td>
<td>Highest Capacity</td>
</tr>
</tbody>
</table>

Prior to selecting high capacity structured packing, GTC recommends clients with vacuum separations systems such as styrene, o-p Xylenes, iC₈₆-Toluene, cis-tran Decalin, ChloroBenzene-EB and Cyclohexanone-Cyclohexanol to carefully evaluate pressure drop and efficiency parameters.

Systems with close boiling components, such as styrene purification, require low pressure drop distillation to avoid operational problems due to polymer formation. Reduction in column pressure drop to the lowest drag possible is significant in reducing bottoms reboiler temperatures, which naturally reduces polymerization within the structured packing. The effect on relative volatility of low pressure drop devices can also result in energy savings, specifically close boilers at vacuum pressures.

GT-OPTIM PAK has a streamlined vapor profile at each layer interface, along with a surface texture that optimizes the film-flow efficiency. This profile reduces liquid holdup, which allows for greater capacity. Many other vacuum distillations show significant energy savings and higher product purities with the lower pressure drop of high performance structured packing.
GT-OPTIM-e™ PAK: High Performance Large Crimp Structured Packing

With the rising need from plant operators to increase product yield, improve product purity specifications and reduce energy costs, GTC has developed GT-OPTIM-e PAK to boost performance of refinery distillation units.

We work with each client to evaluate their separation system capacity, pressure drop and efficiency parameters to determine what type of structured packing offers the best solution for refining upgrades. In Fluidized Catalytic Cracking (FCC) main fractionator revamps, our large crimp/low surface area structured packing can increase the FCC converter effluent charge rates, enhance cracked naphtha recovery from the light cycle oil and increase unit capacity by allowing a higher suction pressure of the existing wet gas compressor.

For vacuum tower revamps, GT-OPTIM-e PAK is proven to increase vacuum gas oil (VGO) lift from the vacuum residue (VR) and in distillation unit revamps, our structured packing has been shown to improve cut-point sharpness along with capacity increase.

GT-AQUA™ PAK: Aqueous Service Structured Packing

Aqueous-organic systems that utilize structured packing often result in lower efficiency compared to typical hydrocarbon systems. The reduced performance in aqueous systems can be attributed to surface tension effects and the resistance of droplet beads spreading into the liquid film phase. In such conditions, proper mixing with the vapor transport phase, product purification and separation cannot be achieved.

GTC has designed GT-AQUA PAK, a product line of structured packing that optimizes the spreading turbulence required for high efficiency within an aqueous system. GTC recommends textured packing surfaces rather than smooth packing surfaces because textured packing surfaces can achieve higher efficiency in high surface tension systems. We work closely with clients to evaluate design separation efficiencies prior to making a selection of packing for acetic acid-water, acrylonitrile-water, acetone-water, alcohols-water, ethylene glycol and water-DMF systems.
GT-GRID™ and GT-MixGRID™: Anti-Fouling Packing

GTC Technology has developed a product line of grid anti-fouling packing designed to remove heavy metals, Con-carbons and residue entrainment in crude atmospheric and vacuum distillation column wash sections.

Our GT-GRID and GT-MixGRID are suited for heat transfer sections such as a slurry pumparound section of a FCC main fractionator. The anti-fouling packing is designed to address high-temperature severe conditions that have coking or polymerizing sediment. When clients require high throughput and fouling resistance, GTC’s grids combined with the appropriate distributor are the best solution for delivering industry leading performance.

GT-GRID and GT-MixGRID allow clients to achieve the highest capacity at the lowest pressure drop, with minimum liquid holdup. Our anti-fouling packing has been developed to withstand extreme operating conditions ranging from high temperatures to high fluid velocities, without causing disruption due to pressure surges. Benefits of our GT-GRID Classic Grating, Style A packing include:

- High-open area and low liquid hold up
- Resistance to plugging, coking and fouling
- Excellent heat transfer efficiency
- Highest capacity
- Excellent turndown ratio
- Wide operational flexibility
- Grid-bar packing, installed as sectional modules
- Structurally robust equipment designed to resist operational surges
- CS, 410, 304, 316L, Titanium, Monel, Duplex and other exotic alloys are available upon request

We manufacture a variety of grids ranging from traditional bar-grating lattice-type grids (GT-GRID) to corrugated sheet structured packing style grids (GT-MixGRID).
GT-GRID™ and GT-MixGRID™: Anti-Fouling Packing

<table>
<thead>
<tr>
<th>Packing Type</th>
<th>Description</th>
<th>Specific Surface Area (m²/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GT-GRID™ 20</td>
<td>Saw-tooth</td>
<td>45</td>
</tr>
<tr>
<td>GT-GRID™ 30</td>
<td>Louvers</td>
<td>45</td>
</tr>
</tbody>
</table>

Benefits of our GT-MixGRID Corrugated Sheet, Style B packing include:

- Higher efficiency and de-entrainment than classic grid due to structured packing configuration
- An “anti-fouling” smooth surface
- An alternating arrangement of individual corrugated sheets forming intersecting channels for best in-bed mixing
- Corrugated sheets that are bolted for easy disassembly and cleaning, which reduces replacement costs

<table>
<thead>
<tr>
<th>Packing Type</th>
<th>Specific Surface Area (m²/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GT-MixGRID™ 80 X/Y</td>
<td>80</td>
</tr>
<tr>
<td>GT-MixGRID™ 60 X/Y</td>
<td>60</td>
</tr>
<tr>
<td>GT-MixGRID™ 40 X/Y</td>
<td>40</td>
</tr>
</tbody>
</table>

Column Internals

The importance of column internal design is often overlooked in packed columns. GTC’s products are designed to improve the column operating performance while maximizing the value of the plant investment. We offer a wide range of GT-SMART™ column internals, including liquid/vapor distributors, collector trays, packing supports, and retaining devices to help clients achieve high volume throughput in new or existing towers.
High Performance Liquid Distributors

Vapor and liquid distribution are of critical importance in ensuring optimum performance is achieved in packed columns. GTC’s Liquid Distributor product line is designed to reach high-quality initial liquid dispersion in packed columns. Our engineers work with clients to help them evaluate and select the best option of system distributors for their process. We offer trough, pan, pipe or spray type liquid distributors that can be constructed from standard or exotic materials with optimum distribution configuration to maximize column coverage and turndown.

Trough Type Distributors - High Performance

<table>
<thead>
<tr>
<th>Model</th>
<th>Type</th>
<th>Description</th>
<th>Features</th>
<th>Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>TT-767</td>
<td>Drip Trough</td>
<td>Parting box and contoured trough with side orifice liquid distribution system: using triangular tubes</td>
<td>Drip tubes Contoured trough bottom profile Field leveling system</td>
<td>Delivers discrete drip point liquid Anti-fouling capability Maximum operating range Minimizes pressure drop across troughs Best coefficient of variation for liquid distribution</td>
</tr>
</tbody>
</table>
**Tray/Deck/Pan Type Distributors - High Performance**

GTC's high performance deck-orifice type liquid distributors use narrow risers to achieve the optimum orifice pattern for best distribution quality.

<table>
<thead>
<tr>
<th>Model</th>
<th>Type</th>
<th>Description</th>
<th>Features</th>
<th>Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>HD-447</td>
<td>Deck Type</td>
<td>Deck distributor with vapor risers and liquid distribution orifices</td>
<td>Deck orifices</td>
<td>Good turndown</td>
</tr>
<tr>
<td></td>
<td>Liquid</td>
<td></td>
<td>Ring supported</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Distributor</td>
<td></td>
<td>Narrow rectangular risers</td>
<td>Optimized vapor/liquid distribution</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>With or without hats</td>
<td>configuration</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Re-distributor configuration</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>available</td>
</tr>
<tr>
<td>HD-437</td>
<td>Deck Type</td>
<td>Deck distributor with vapor risers and liquid distribution tubes</td>
<td>Orifices are elevated in drip tubes</td>
<td>Maximum turndown</td>
</tr>
<tr>
<td></td>
<td>Liquid</td>
<td></td>
<td>Ring supported</td>
<td>Fouling resistance</td>
</tr>
<tr>
<td></td>
<td>Distributor</td>
<td></td>
<td>Narrow rectangular risers</td>
<td>Optimized vapor/liquid distribution</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>With or without hats</td>
<td>configuration</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Re-distributor configuration</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>available</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>SD-346RM</td>
<td>Pan Type</td>
<td>Pan distributor with vapor risers and liquid distribution orifices</td>
<td>Used in columns &lt; 30&quot; diameter</td>
<td>Optimized vapor/liquid distribution</td>
</tr>
<tr>
<td></td>
<td>Liquid</td>
<td></td>
<td>Clip supported or between body flanges</td>
<td>configuration</td>
</tr>
<tr>
<td></td>
<td>Distributor</td>
<td></td>
<td>Designed as a single piece or two halves</td>
<td>Re-distributor configuration</td>
</tr>
<tr>
<td></td>
<td>(bucket)</td>
<td></td>
<td>Orifices in pan or drip tubes</td>
<td>available</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Good turndown</td>
</tr>
</tbody>
</table>

Pictured above is GTC's deck type liquid distributor; model HD-447.
**Feed Distributor Devices**

Feed distribution is a critical component to achieving desired column performance. Flashing feed distribution is especially important for controlling phase separation, momentum and direction of the fluids. GTC offers a range of liquid/vapor hooded pipes, perforated pipes, vee-baffles and vapor horns built from carbon and alloy steel, designed to optimize tower performance. Our liquid feed piping features precisely sized openings and orifices for proper distribution, various configurations to deliver liquid to the optimum device zone and flanged spool designs for ease of assembly and disassembly. Our flashing feed distributors offer segmented plate designs and heavy duty designs that can withstand high inlet forces.

<table>
<thead>
<tr>
<th>Model</th>
<th>Type</th>
<th>Description</th>
<th>Features</th>
<th>Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>GT-OPTIMFLOW™</td>
<td>Radial Type Distributor</td>
<td>A custom designed annular 2-phase feed horn</td>
<td>Tangential or radial nozzles</td>
<td>Excellent phase separation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>De-entrainment vanes</td>
<td>Low pressure drop</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Good phase distribution</td>
</tr>
<tr>
<td>VEB-661</td>
<td>Vee-Baffle Distributor</td>
<td>Heavy duty 2-phase feed impingement baffle with wear plate</td>
<td>V-shape impingement plate design</td>
<td>Absorbs 2-phase feed kinetic energy</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Tee-box exit configuration</td>
<td>Directs flow patterns and initiates vapor liquid separation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Reduces entrance velocities</td>
</tr>
<tr>
<td>FPS</td>
<td>Feed Pipe</td>
<td>Straight feed pipe with orifices or tubes</td>
<td>Straight pipe configuration</td>
<td>Provides quality distribution of liquid and vapor</td>
</tr>
<tr>
<td>FPT</td>
<td>Feed Pipe</td>
<td>“T” shaped feed pipe with orifices or tubes</td>
<td>T-pipe configuration</td>
<td>Provides quality distribution of liquid and vapor</td>
</tr>
<tr>
<td>FPH</td>
<td>Feed Pipe</td>
<td>“H” shaped feed pipe with orifices or tubes</td>
<td>H-pipe configuration</td>
<td>Provides quality distribution of liquid and vapor</td>
</tr>
<tr>
<td>FPL</td>
<td>Feed Pipe</td>
<td>Feed pipe with multiple laterals with orifices or tubes</td>
<td>Multi-lateral pipe configuration</td>
<td>Provides quality distribution of liquid and vapor</td>
</tr>
</tbody>
</table>

**Pipe Type Liquid Distributors**

<table>
<thead>
<tr>
<th>Model</th>
<th>Type</th>
<th>Description</th>
<th>Features</th>
<th>Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>SND-900</td>
<td>Spray Nozzle Distributor</td>
<td>Pipe with laterals and spray nozzle distributor (standard)</td>
<td>Various spray nozzle patterns</td>
<td>Uniform distribution</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Header/lateral pipe configuration</td>
<td>Pressurized flow stream</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Minimum residence time</td>
</tr>
</tbody>
</table>

*SND-950 available for anti-fouling capability*
### Packing Supports

<table>
<thead>
<tr>
<th>Model</th>
<th>Type</th>
<th>Description</th>
<th>Features</th>
<th>Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>PSG-101</td>
<td>Packing Support Grid</td>
<td>Standard structured packing support grid</td>
<td>Custom designed for application Support beams included as required</td>
<td>Minimal pressure drop Designed for mechanical integrity</td>
</tr>
<tr>
<td>ISB-201</td>
<td>Injection Support Beam</td>
<td>Random packing support</td>
<td>Gas injection design with sinusoidal wave structure Support beams included as required</td>
<td>Minimal pressure drop Designed for mechanical integrity</td>
</tr>
</tbody>
</table>

GTC’s packing supports and hold-downs are designed to optimize the performance of packed bed systems. We offer a full product line of packed beds, designed with superior strength, mechanical integrity and the maximum open area achievable for specified vapor and liquid passage.

### Packing Hold-Downs

<table>
<thead>
<tr>
<th>Model</th>
<th>Type</th>
<th>Description</th>
<th>Features</th>
<th>Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>HDB-110</td>
<td>Hold-Down Bar</td>
<td>Hold-down bar for structured packing</td>
<td>Simple design for small towers 95% open area</td>
<td>Functional design minimal space requirements Minimal pressure drop Quick installation</td>
</tr>
<tr>
<td>HDG-111</td>
<td>Hold-Down Grid</td>
<td>Structured packing hold-down grid</td>
<td>Uplift resistant design</td>
<td>Functional design with minimal space requirements Minimal pressure drop Quick installation</td>
</tr>
<tr>
<td>HDG-112</td>
<td>Hold-Down Grid</td>
<td>Random packing hold-down grid sized for specific packing diameter</td>
<td>Uplift resistant design</td>
<td>Functional design with minimal space requirements Minimal pressure drop Quick installation</td>
</tr>
</tbody>
</table>
**Liquid Collection Trays**

Poor liquid collection tray design can significantly downgrade column performance. GTC recommends that clients carefully evaluate liquid collection trays to ensure proper product draw and liquid vapor distribution. GTC offers an extensive line of collector/re-distributor products built from standard or exotic materials featuring a variety of shapes and configurations. Fully seal-welded or bolted designs are available for applications of total draw-off to various downcomer and overflow designs.

<table>
<thead>
<tr>
<th>Model</th>
<th>Type</th>
<th>Description</th>
<th>Features</th>
<th>Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLT-601</td>
<td>Collector Tray</td>
<td>Collection/redistribution tray with optional downcomers and liquid draw-off arrangements</td>
<td>Custom designed for application vapor risers</td>
<td>Beams provided as required for mechanical integrity Optimum riser configuration</td>
</tr>
<tr>
<td>CVT-621</td>
<td>Vane type collector/ redistribution tray</td>
<td>Liquid vane collector tray with radial ring channel and optional downcomers and liquid draw-off arrangements</td>
<td>Integral hat/vane collector Channel collector troughs</td>
<td>Low pressure drop</td>
</tr>
</tbody>
</table>

**Random Packing**

Packed towers were first introduced in the 1900s with Raschig Rings and Ceramic Saddles utilized in distillation columns. By the end of the 1950s, random packing became the most widely used packing in the petrochemical, chemical and refining industries. Over time, random packing designs evolved and a second-generation of a Pall-type slotted ring was commercialized. The second-generation of rings permitted liquid flow through the element walls and were equal in height and diameter with a 1:1 aspect ratio.

In the 1980s, a third-generation of rings introduced further improvements to slotted rings and could achieve even higher efficiency and capacity. This hybrid of improved geometrical shapes is focused on an optimum orientation by redesigning as a lower height aspect ratio in a range of 1:2 to 1:3.
Random Packing

GTC offers all commercial sizes and shapes of each generation of rings in metallic, non-metallic, carbon and alloy steel materials. Although today it is more common to use structured packing in packed columns, there are circumstances in which random packing can provide better performance and throughput capacity. For instance, in certain high pressure and foaming service systems, our random packing can achieve superior performance compared to structured packing.

We recommend our random packing for high pressure gas absorption systems, cryogenic Demethanizers, and other high pressure and/or high liquid rate systems where trays or structured packing are not the preferred choice. Our GT-CR and GT-IR rings are well-suited to handle very high liquid applications, in particular where foaming is a concern. The geometric packing shapes have been developed to minimize foam while allowing greater liquid and vapor loads than older generations of packing.

Basic Design Criteria

The performance of GTC’s random packing depends on the geometric shape and size. The dimensional parameters define both the “Packing Factor” (Fp) and “Specific Surface Area” (SSA). For our packing, a lower packing factor is synonymous with a lower pressure drop, resulting in higher capacity. The total effective surface area inside our random packing shapes define the efficiency, with higher surface areas producing higher efficiencies.

The capacity of our random packing is a function of its packing factor (Fp). A good approximation of the difference in capacity between two types of our packing materials can be calculated by the square root of their packing factor ratio.

Our small size packings (with bigger Fp & SSA) generate greater efficiency resulting in shorter bed height. Our large size packings (with lesser Fp & SSA) have a larger open area and allow for greater column throughput (vapor–liquid handling capacity). The capacity criteria for our standard design is flooding < 70-85 percent and pressure drop < 4 mbar/m-bed (0.5 inch H₂O/ft-bed).
Random Packing: GT-CR™ Rings

GT-CR™ Third Generation Metal Rings:

<table>
<thead>
<tr>
<th>Model</th>
<th>Void Fraction</th>
<th>Specific Surface Area (m²/m³)</th>
<th>Packing Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>GT-CR™1.0</td>
<td>96.9</td>
<td>250</td>
<td>40</td>
</tr>
<tr>
<td>GT-CR™1.5</td>
<td>97.2</td>
<td>188</td>
<td>33</td>
</tr>
<tr>
<td>GT-CR™2.0</td>
<td>97.8</td>
<td>144</td>
<td>26</td>
</tr>
<tr>
<td>GT-CR™2.5</td>
<td>97.8</td>
<td>123</td>
<td>23</td>
</tr>
<tr>
<td>GT-CR™3.0</td>
<td>98.0</td>
<td>103</td>
<td>18</td>
</tr>
<tr>
<td>GT-CR™4.0</td>
<td>98.5</td>
<td>74</td>
<td>14</td>
</tr>
<tr>
<td>GT-CR™5.0</td>
<td>98.8</td>
<td>49</td>
<td>11</td>
</tr>
</tbody>
</table>

GT-CR™ Third Generation Plastic Rings:

<table>
<thead>
<tr>
<th>Model</th>
<th>Void Fraction</th>
<th>Specific Surface Area (m²/m³)</th>
<th>Packing Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>GT-CR™0A</td>
<td>89</td>
<td>320</td>
<td>55</td>
</tr>
<tr>
<td>GT-CR™1A</td>
<td>92</td>
<td>230</td>
<td>30</td>
</tr>
<tr>
<td>GT-CR™2A</td>
<td>93</td>
<td>140</td>
<td>18</td>
</tr>
<tr>
<td>GT-CR™2</td>
<td>94</td>
<td>118</td>
<td>15</td>
</tr>
<tr>
<td>GT-CR™3A</td>
<td>95</td>
<td>79</td>
<td>12</td>
</tr>
</tbody>
</table>
Pressure Drop Data for GT-CR™ Third Generation Rings

- **GT-CR™ 1.0 Pressure Drop**
  - C-Factor: \( C_s \) (m/sec)
  - C-Factor: \( C_s \) (ft/sec)

- **GT-CR™ 1.5 Pressure Drop**
  - C-Factor: \( C_s \) (m/sec)
  - C-Factor: \( C_s \) (ft/sec)

- **GT-CR™ 2.0 Pressure Drop**
  - C-Factor: \( C_s \) (m/sec)
  - C-Factor: \( C_s \) (ft/sec)

- **GT-CR™ 2.5 Pressure Drop**
  - C-Factor: \( C_s \) (m/sec)
  - C-Factor: \( C_s \) (ft/sec)

*Note: C-Factor, \( C_s \) = Vapor Superficial Velocity = \( \frac{\rho_v}{\rho_l - \rho_v} \)

- **SI Units**
  - \( P, \text{mm liquid/m} \)
  - \( \Delta P, \text{mm liquid/m} \)

- **US Units**
  - \( P, \text{Inches liquid/ft} \)
  - \( \Delta P, \text{Inches liquid/ft} \)

- **Dry Liquid**
  - 5 m³/hr/m² (2 gpm/ft²)
  - 12 m³/hr/m² (5 gpm/ft²)
  - 25 m³/hr/m² (10 gpm/ft²)
  - 50 m³/hr/m² (20 gpm/ft²)
  - 75 m³/hr/m² (30 gpm/ft²)
  - 100 m³/hr/m² (40 gpm/ft²)
  - 125 m³/hr/m² (50 gpm/ft²)
  - 250 m³/hr/m² (100 gpm/ft²)

- **Note:**
  - \( \rho_v \): Vapor Density
  - \( \rho_l \): Liquid Density
  - \( V \): Volumetric Flow Rate
  - \( P \): Pressure Drop
Pressure Drop Data for GT-CR™ Third Generation Rings

**GT-CR™ 3.0 Pressure Drop**

*C-Factor: C (ft/sec)*

**GT-CR™ 4.0 Pressure Drop**

*C-Factor: C (ft/sec)*

**GT-CR™ 5.0 Pressure Drop**

*C-Factor: C (ft/sec)*

*Note: C-Factor, \( C \), = Vapor Superficial Velocity \( \sqrt{\frac{\Delta P}{\rho_L - \rho_v x}} \)

US Units

- \( P \), Inches liquid/ft
- \( \rho \), lbs/ft\(^3\)
- \( v \), ft/sec

SI Units

- \( P \), mm liquid/m
- \( \rho \), kg/m\(^3\)
- \( v \), m/sec

Dry

- \( 75 \text{ m}^3/\text{hr/m}^2 \) (30 gpm/ft\(^2\))
- \( 100 \text{ m}^3/\text{hr/m}^2 \) (40 gpm/ft\(^2\))
- \( 125 \text{ m}^3/\text{hr/m}^2 \) (50 gpm/ft\(^2\))
- \( 50 \text{ m}^3/\text{hr/m}^2 \) (20 gpm/ft\(^2\))
**Random Packing: GT-PR™ and GT-IR™ Rings**

**GT-PR™ Second Generation Metal Rings:**

<table>
<thead>
<tr>
<th>Model</th>
<th>Void Fraction</th>
<th>Specific Surface Area (m²/m³)</th>
<th>Packing Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>GT-PR16</td>
<td>93.3</td>
<td>344</td>
<td>81</td>
</tr>
<tr>
<td>GT-PR25</td>
<td>95.9</td>
<td>202</td>
<td>56</td>
</tr>
<tr>
<td>GT-PR38</td>
<td>97.4</td>
<td>142</td>
<td>40</td>
</tr>
<tr>
<td>GT-PR50</td>
<td>97.5</td>
<td>98</td>
<td>27</td>
</tr>
<tr>
<td>GT-PR90</td>
<td>98.3</td>
<td>57</td>
<td>18</td>
</tr>
</tbody>
</table>

**GT-PR™ Second Generation Plastic Rings:**

<table>
<thead>
<tr>
<th>Model</th>
<th>Void Fraction</th>
<th>Specific Surface Area (m²/m³)</th>
<th>Packing Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>GT-PR16</td>
<td>86</td>
<td>354</td>
<td>97</td>
</tr>
<tr>
<td>GT-PR25</td>
<td>90</td>
<td>207</td>
<td>52</td>
</tr>
<tr>
<td>GT-PR38</td>
<td>91</td>
<td>128</td>
<td>32</td>
</tr>
<tr>
<td>GT-PR50</td>
<td>92</td>
<td>102</td>
<td>25</td>
</tr>
<tr>
<td>GT-PR90</td>
<td>93</td>
<td>72</td>
<td>16</td>
</tr>
</tbody>
</table>

**GT-IR™ Third Generation Metal Rings:**

<table>
<thead>
<tr>
<th>Model</th>
<th>Void Fraction</th>
<th>Specific Surface Area (m²/m³)</th>
<th>Packing Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>GT-IR15</td>
<td>96.4</td>
<td>282</td>
<td>51</td>
</tr>
<tr>
<td>GT-IR25</td>
<td>97.2</td>
<td>225</td>
<td>41</td>
</tr>
<tr>
<td>GT-IR40</td>
<td>98.1</td>
<td>152</td>
<td>24</td>
</tr>
<tr>
<td>GT-IR50</td>
<td>98.1</td>
<td>102</td>
<td>18</td>
</tr>
<tr>
<td>GT-IR70</td>
<td>98.3</td>
<td>60</td>
<td>12</td>
</tr>
</tbody>
</table>
Pressure Drop Data for GT-PR™ Second Generation Rings

**GT-PR™25 Pressure Drop**

- C-Factor: \( C_S \) (ft/sec)
- \( \Delta P \), inches liquid/ft

**GT-PR™38 Pressure Drop**

- C-Factor: \( C_S \) (ft/sec)
- \( \Delta P \), inches liquid/ft

**GT-PR™50 Pressure Drop**

- C-Factor: \( C_S \) (ft/sec)
- \( \Delta P \), inches liquid/ft

**GT-PR™90 Pressure Drop**

- C-Factor: \( C_S \) (ft/sec)
- \( \Delta P \), inches liquid/ft

*Note: C-Factor, \( C_S \) = Vapor Superficial Velocity \( \frac{P}{\rho V - \rho v} \)

**SI Units**
- \( P \), millimeters liquid/m
- 5 m/hr/m² (2 gpm/ft²)
- 12.5 m/hr/m² (5 gpm/ft²)
- 50 m/hr/m² (20 gpm/ft²)
- 100 m/hr/m² (40 gpm/ft²)

**Dry P**
- 2.5 m/hr/m² (1 gpm/ft²)
- 12.5 m/hr/m² (5 gpm/ft²)

**US Units**
- \( P \), inches liquid/ft
- 0.03 0.04 0.06 0.08 0.10 0.20
- 0.12
- 0.165 0.33 0.66
Worldwide Locations

**USA**

*Corporate Headquarters*

**GTC Technology**
900 Threadneedle St., Suite 800
Houston, Texas 77079
USA
+1-877-693-4222 Toll Free
+1-281-597-4800 Main
+1-281-597-8438 Fax

**Euless, Texas**

**GTC Process Equipment Technology**
1400 Westpark Way, Building 100
Euless, Texas 77040
USA
+1-817-685-9125 Main
+1-406-685-0236 Fax

**Bozeman, Montana**

**GTC Research and Development**
910 Technology Boulevard, Suite F
Bozeman, Montana 59718
USA
+1-406-582-7417 Main
+1-406-922-6440 Fax

**India**

**GTC Process Technology (India) Pvt. Ltd.**
108, 1st Floor, Vipul Agora, M.G. Road
Gurgaon 122 002
India
+91-124-4694100 Main
+91-124-4694129 Fax

**China**

**GTC (Beijing) Technology Inc.**
Room 1601, Building C of Triumph Center
No. 170, Beiyuan Road, Chaoyang District
Beijing, China 100101
+86-10-5823-5297 Main
+86-10-5823-6143 Fax

**Korea**

**GTC Technology Korea Co. Ltd.**
14F, Imgwang BD, 81, Tongil-ro
Seodaemun-gu
Seoul, Korea 120-705
+82-2-6009-9104 Main
+82-2-786-7111 Fax

**Singapore**

**GTC Process Technology (Singapore) Pte. Ltd.**
3 Science Park Drive, #01-08/09
The Franklin Building
Singapore, 118223
+65-6872-9380 Main
+65-6776-7282 Fax

**Czech Republic**

**GTC Technology Europe s.r.o.**
Lidická 965/31
60200 Brno
Czech Republic
+420-511-118-000 Main
+420-511-118-099 Fax
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