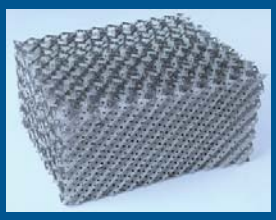
GTI SOLUTIONS

PACKED TOWER TECHNOLOGY



INNOVATIVE SOLUTIONS RELIABLE PERFORMANCE

ISO 9001 & ISO 14001 Certified

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Your Partner in Distillation Technology

GTI SOLUTIONS is a a process euipment and technology company committed to providing innovative mass transfer equipment and solutions to the refining, chemical and petrochemical industries.

Customer satisfaction is our top priority. We work to earn each client's trust and loyalty by providing customized solutions to all their process engineering needs with rapid response time and competitive pricing.

Our process design engineers have extensive experience in a wide range of mass transfer applications and work closely with each client to deliver measurable results that maximize production performance and unit profitability.

Our portfolio of products and services includes:

- Conventional trays
- High performance trays
- Random packing
- Structured packing
- Grid packing
- Column internals
- Mist eliminators
- Liquid-liquid coalescers
- Reactor internals
- Divided wall column technology
- Process validation
- Performance test runs
- CFD modeling
- Engineering services
- Feasibility and complex revamp studies
- Expedited replacement services
- Troubleshooting services
- Technical training
- Site supervision services

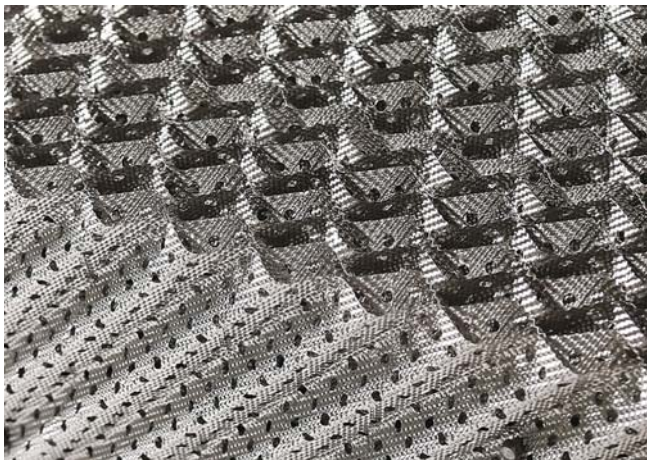
Our mass transfer equipment is designed to operate in a range of applications and can be fabricated in a variety of corrosion resistant materials such as zirconium, titanium, monel, duplex steels, stainless steel, and other exotic alloys.

Structured Packing

Over the last four decades, structured packing has become the preferred mass transfer equipment of choice for many applications. Structured packing's greatest advantage is that is provides lowest pressure drop and maximum stages per unit of packed bed height in low to moderate liquid load applications.

GTI SOLUTIONS offers a full range of structured packing products including:

- Conventional structured packing
- High capacity / efficiency structured packing
- Aqueous service structured packing
- Gauze structured packing
- Grid structured packing



Structured packing is made from a series of corrugated metal sheets, arranged in a predetermined pattern and crimp height to provide fluid flow channels. We can customize the size and type of our structured packing by varying the crimp height, angles and specific surface area. In addition, waffled, grooved, perforated or smooth texturing can be applied to our corrugated metal sheets to improve wettability and packing efficiency. The texturing applied to the corrugated metal sheets is dependent upon the application requirements and materials used to fabricate the sheets. For instance, smooth textured structured packing is typically applied in fouling applications such as refinery wash beds or ethylene quench columns.

When combined with our high performance internals, structured packing reduces liquid hold-up, lowers column height, reduces pressure drop, and improves heat transfer over the entire packed column. As a result, unit capacity increases and operational performance is improved. Our structured packing can be applied in a wide range of applications such as:

- Atmospheric fractionators
- Vacuum columns
- FCC main fractionators
- Styrene separation
- Acetic acid dehydration columns
- Fatty acid distillation
- Ethylene quench columns
- EO/EG wash columns
- CO2 absorbers for carbon capture

The type of packing selected for a unit is determined after assessing the operating pressure, liquid load, pressure drop, separation requirement and fouling potential of the application.

Our structured packing is typically supplied in brick formation with a standard layer height of 8"-11" for ease of installation. Successive layers are often rotated by 90 degrees in the column during installation to ensure lateral and radial cross mixing of the vapor and liquid over the entire cross section of the tower. In addition, the manufactured thickness of our structured packing is much lower compared to our random packing. This allows the packing to retain less liquid within a given packed volume, reducing the weight per unit volume of packing.

G-sPAC™ Conventional Structured Packing

G-sPAC is an industry standard conventional structured packing, best suited for fractionation heat transfer, scrubbing and de-entrainment applications. We offer two types of conventional structured packing, G-sPAC Y and G-sPAC X.

G-sPAC Y series of packing features a 45° crimp angle, while our G-sPAC X series of packing features a 60° crimp angle. The crimp angle can be further customized for both types of conventional structured packing to meet the needs of different application requirements.

Generally, G-sPAC Y provides the advantage of a higher number of theoretical stages compared to G-sPAC X for the same surface area. However, G-sPAC X can provide higher capacity and lower pressure drop compared to G-sPAC Y for the same surface area.

G-sPAC Y is typically used in fractionation services while G-sPAC X is typically used in heat transfer and absorption services. Both series of conventional structured packing products can be manufactured in various crimp sizes providing a specific surface area of 60 m2/m3 all the way up to 750 m2/m3.

Table 1. G-sPAC Structured Packing

CAPACITY ↓

Surface Area m2/m3	G-sPAC	
	45°	60°
60	60Y	60X
80	80Y	80X
125	125Y	125X
150	150Y	150X
170	170Y	170X
220	220Y	220X
250	250Y	250X
300	300Y	300X
350	350Y	350X
450	450Y	450X
500	500Y	500X
750	750Y	750X

↓ EFFICIENCY

As shown in Figure 1, when operating with low volatility systems the HETP of G-sPAC structured packing decreases as the surface area increases.

For applicable HETP in your operating system, please contact a GTI SOLUTIONS application specialist.

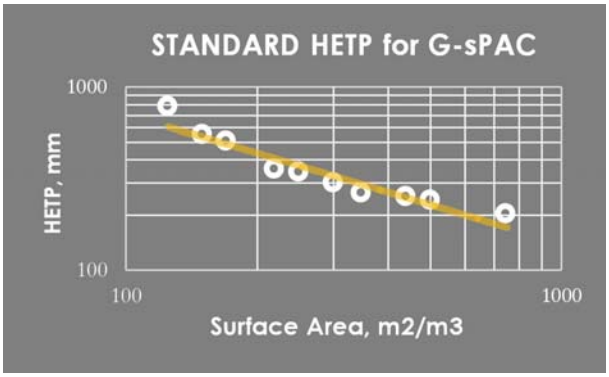


Figure 1. Standard HETP of G-sPAC structured packing

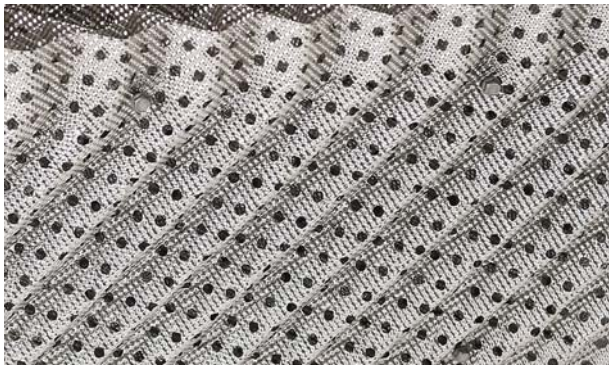
G-MxPAC™ High Capacity Structured Packing

G-MxPAC high capacity structured packing is similar in construction to our standard structured packing. However, G-MxPAC includes a smooth transition feature at the bottom and top of each packing layer to eliminate resistance to fluid flow in the interface zone.

The transition feature allows for a continuous directional change of vapor and faster liquid draining at the interface, eliminating premature flooding and higher pressure drop at each point. As a result, G-MxPAC can maximize capacity while achieving a significantly lower pressure drop compared to conventional structured packing with the same geometric surface area.

G-MxPAC can be used to reduce column diameter for a given capacity, lowering the capital cost for a new installation.

For revamp columns, G-MxPAC can provide 20%~30% higher capacity without any loss in efficiency. G-MxPAC can also be used to replace existing conventional packing in any column, improving unit performance and efficiency.



G-MxPAC Structured Packing

EFFICIENCY

Table 2. G-MxPAC Structured Packing

G-MxPAC™	220Y	250Y	300Y	350Y	450Y	500Y	750Y
Surface Area, m^2/m^3	220	250	300	350	450	500	750

CAPACITY

G-MxPAC-β™ High Efficiency Structured Packing

In addition to G-MxPAC high capacity structured packing, GTI Solutions also offers G-MxPAC-β high efficiency structured packing. G-MxPAC-β packing uses the same high capacity features as G-MxPAC to increase capacity above standard packing, with additional changes to increase the efficiency by 10~15%.

We also modify the inclination angle of G-MxPAC-β packing using our proprietary manufacturing techniques which improve the efficiency while maintaining a higher capacity than conventional packing.

G-AQPAC™ Structured Packing for Aqueous Service

G-AQPAC is a type of structured packing that has been developed exclusively for aqueous and high surface tension systems such as acetic acid, dehydration, and methanol-water systems.

G-AQPAC can be fabricated in a broad range of materials such as stainless steel or titanium and features innovative texturing on each packing surface layer. The texturing ensures that all layers are wetted completely while maximizing the contact between the vapor and liquid. As a result, better HETP values can be achieved.

G-BX™ Gauze Structured Packing

G-BX is gauze structured packing made from layers of corrugated woven wire gauze material. G-BX's advantage is that it provides the highest number of separation stages and lowest pressure drop per unit of packed bed height.

The closely woven material provides a capillary effect to ensure uniform wetting across the entire packing surface at exceptionally low liquid rates, maximizing the packing performance. G-BX is best suited for applications such as:

- Low liquid loads
- Heat sensitive distillations
- Fatty acid distillations
- Alcohol distillations
- MEG / DEG / TEG distillations
- Pharmaceutical applications
- Fine chemicals applications
- Isomer separations

G-BX Gauze Structured Packing

Grid Structured Packing

Grid structured packing features a high open area, robust structure and no horizontal surfaces making them excellent choice for applications, prone to fouling, coking, and process upsets.

For packed beds prone to frequent operational surges, the entire grid packing bed can be through-bolted together to act as an integrated structure providing significantly higher uplift resistance.

Use of GTI SOLUTIONS grid packing can extend the run length for fouling applications, reducing downtime and operational cost and can be used in the following applications:

- Wash sections of refinery vacuum columns , coker and visbreaker fractionators
- FCC Main Fractionator quench & slurry P/A sections
- Ethylene plant oil and water quench towers

GTI SOLUTIONS can also provide both conventional grid packing and grids made from corrugated sheet metal to suit individual application needs.

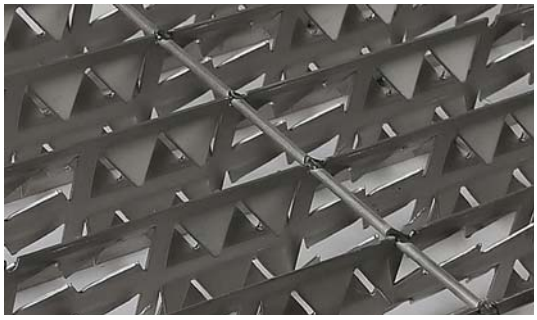
G-eGRID™ Grid Structured Packing

G-eGRID packing features a high open area and is free of horizontal surfaces. G-eGRID packing is constructed from metal saw-tooth or louver shaped blades. This allows the packing surface to be washed by downward flowing liquid, reducing liquid hold-up and minimizing the accumulation of solids on the packing surface. In addition, the high open area and robust structure allows the grid packing to handle severe operational surges without affecting mechanical integrity.

We offer two styles of grid structured packing, G-eGRID #2 and G-eGRID #3. Both styles of packing are typically 1.5 mm (16 ga) in thickness, which can be customized upon request.

G-eGRID #2 is designed with a saw-tooth blade structure to enhance the flow of liquid, resulting in improved fouling resistance and increased capacity. G-eGRID #3 is designed with a louver blade structure to provide better contact for vapor and liquid resulting in higher efficiency.

G-eGRID #3 Packing



G-eGRID #2 Packing

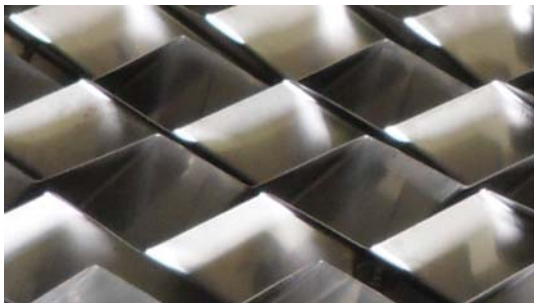
Table 3. G-eGRID Structured Packing

Packing Type	Surface Area, m^2/m^3	Feature
3	45	Louver blade
2	45	Saw-tooth blade

G-sGRID™ Sheet Metal Grid Structured Packing

G-sGRID grid packing combines de-entrainment capability and efficiency of sheet metal structured packing with higher mechanical strength.

The packing uses smooth texture surface to provide fouling protection and higher thickness and rigid structure to protect against mechanical upset.



G-sGRID Structured Packing

Table 4. G-sGRID Structured Packing

Packing Type	Surface Area, m^2/m^3	Feature
40 X / Y	40	Smooth texture surface
60 X / Y	60	
80 X / Y	80	

Random Packing

Although structured packing is becoming more common in packed tower applications, random packing can still offer advantages in applications such as:

- High pressure fractionators
- Fouling or corrosive services
- Light end fractionations (demethanizer, deethanizer, depropanzier and debutanizer)
- High liquid load services (acid gas absorbers and sour water strippers)

Random packing is especially well suited in low to moderate fouling services due to its ease of maintenance. Random packing can be used in corrosive services due to its high thickness compared to structured packing.

The capacity and efficiency of random packing can generally be related to its size and specific surface area. As the size of random packing increases, its capacity also increases. The capacity can be determined by calculating the packing factor (Fp). The lower the packing factor, the higher the packing capacity and lower the pressure drop.

The efficiency of different types of random packing can generally be compared based on their surface area. As the surface area of the random packing increases, its efficiency also increases. However, when comparing different types of random packing, the surface area is not the only factor that determines packing efficiency. For instance, modern random packing has a better geometrical shape and structure which ensures greater utilization of its surface area. Mordern random packing also improves liquid wetting, leading to higher efficiency per m2 of surface area.

GTI SOLUTIONS's high performance random packing such as G-IR™ and G-CR™ packing have an optimized geometrical shape and structure. The shape and structure of the random packing maximize the packing surface area utilization, while minimizing resistance to vapor and liquid flow across the column. As a result, higher efficiency, increased capacity and reduced pressure drop can be achieved.

G-IR™ High Performance Metal Random Packing

- Achieves the optimum combination of capacity and efficiency for any given size of packing
- Provides 10%-15% higher efficiency, 20%-25% more capacity and up to 40% lower pressure drop compared to conventional random packing of the same size and surface area
- Improves wetting characteristics due to the enhanced lateral spreading of liquid
- Has a lower liquid hold up leading to less residence time and a lower fouling tendency
- High mechanical strength that allows for deeper packed beds

G-IR Metal Random Packing

Table 5. G-IR Random Packing

Packing Type	Packing Factor	Surface Area, m^2/m^3	Void Fraction %
15	51	282	96
25	41	225	97
40	24	152	98
50	18	102	98
70	12	60	99

G-CR™ High Performance Metal Random Packing

- Applies a lower aspect ratio of 1:3 when compared to conventional G-PR that uses 1:1.
- 1:3 aspect ratio results in a preferential orientation position, providing lower resistance to vapor and liquid flow which increases capacity and lowers pressure drop
- Maintains a near horizontal orientation, which more effectively uses the packing surface area providing higher efficiency compared to conventional packing with the same surface area
- Reduces liquid hold up leading to lower residence time and a reduced fouling tendency
- High mechanical strength that allows for deeper packed beds.

G-CR Metal Random Packing

Table 6. G-CR Random Packing

Packing Type	Packing Factor	Surface Area, m^2/m^3	Void Fraction %
1	39	250	96
1.5	33	190	97
2	26	155	97
2.5	21	130	98
3	14	102	98
4	12	75	99
5	8	50	99

G-PR™ Metal Random Packing

- Conventional random packing with an aspect ratio of 1:1
- Includes multiple slots with inner fingers on a cylindrical wall to enhance vapor-liquid flow and wetting
- Provides higher capacity and efficiency compared to Raschig Rings
- Equivalent to pall ring random packing

G-PR Metal Random Packing

Table 7. G-PR Random Packing

Packing Type	Packing Factor	Surface Area, m^2/m^3	Void Fraction %
16	81	350	93
25	56	207	96
38	40	142	97
50	27	102	98
90	18	60	98

G-RR™ Metal Random Packing

- Conventional random packing with an aspect ratio of 1:1 and solid cylindrical wall
- First random packing to be introduced in the 19th century
- Equivalent to Raschig Ring random packing

G-RR Metal Random Packing

Table 8. G-RR Random Packing

Packing Type	Packing Factor	Surface Area, m^2/m^3	Void Fraction %
16	170	344	93
25	115	205	96
38	83	140	97
50	57	101	98
90	32	57	98

G-PR™ Plastic Random Packing

- The most common type of plastic random packing with aspect ratio of 1:1.
- Internal ribs across the cylindrical walls provide greater mechanical strength
- Equivalent to Pall Ring random packing

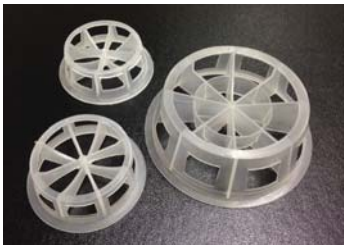
G-PR Plastic Random Packing

Table 9. G-PR Plastic Random Packing

Packing Type	Packing Factor	Surface Area, m^2/m^3	Void Fraction %
16	97	350	88
25	55	207	90
38	32	131	91
50	26	102	92
90	17	72	95

G-CR™ Plastic Random Packing

- Applies a lower aspect ratio of 1:3 and provides a higher capacity and efficiency compared to conventional packing
- Achieves a low pressure drop and reduces liquid hold-up due its preferential orientation within the column



G-CR Plastic Random Packing

Table 10. G-CR Plastic Random Packing

Packing Type	Packing Factor	Surface Area, m^2/m^3	Void Fraction %
0A	55	330	89
1A	30	230	92
2A	18	140	93
2	15	118	94
3A	12	80	95

Non-Metallic Random Packing Materials

GTI SOLUTIONS random packing products are available in a broad range of materials including:

- Polypropylene
- Polyethylene
- Plastic resins such as PVC, CPVC, PVDF (Kynar®)1, ECTFE (Halar®)2 and PFA (Teflon®)3
- Specialized plastic resins such as reinforced plastic
- Ceramic
- Carbon

Non-Metallic Random Packing

Please contact GTI SOLUTIONS engineering staff for more information about the type of fabrication materials we offer.

(Registered trademarks: 1 Arkema, 2 Ausimont, 3 DuPont)

Selecting the Right Packing

Structured packing has become the preferred solution in high vapor rate and low liquid rate applications due to its high capacity and low pressure drop compared to random packing. However, in certain applications such as high pressure distillations or moderate fouling applications, random packing remains the preferred option.

Table 11 highlights our general guidelines we use to help clients during the column internals selection process. We work closely with each client to identify the optimum product for their application and ensure the greatest return on their investment.

Table 11. General Characteristics of Packing

Parameter		Random Packing	Structured Packing
Capacity	Vacuum		√
	Atmospheric		√
	Pressure	√	
Pressure Drop			√
Liquid Hold-up			√
Fouling[1]		√	
Foaming			√
Corrosion		√	
Ease of Installation		√	

1. For moderate fouling application. For severe fouling applications, grid type packing is the optimum choice.

Column Internals

The most important aspect of column internal selection is deciding on liquid and vapor distribution. In addition, we recommend that our clients consider the following aspects:

- Liquid rates (for low to moderate liquid rates, trough type distributors are ideal, while for high liquid rates, deck type distributors are recommended)
- Distribution quality (trough type distributors typically provide the most optimum distribution quality)
- Fouling tendency (elevated holes are advised when using trough or deck distributors in fouling applications)
- Feed conditions (pressure distributors are not recommended for use with two phase feeds)

When the proper column internals are selected and designed for a column, premature flooding can be avoided and the packing performance can be maximized. For more guidance on packed tower internals, please contact us or refer to our Tower Internals Technology Brochure.

Global Locations

Korea: GTI Solutions Korea Co., Ltd.

Technical & Sales Office

Mapo-gu, Seoul
Phone: +82-2-6246-7400
Fax: +82-2-6246-7409
Email: gtis-korea@gtisoln.com

Manufacturing Facility

Wonju-si, Gangwon-do
Phone: +82-33-901-9241
Fax: +82-33-901-9295
Email: gtis-korea@gtisoln.com

USA: GTI Solutions International LLC.

Technical & Sales Office

Dallas, Texas
Phone: +1-707-400-0214
Fax: +1-707-202-1916
Email: usa@gtisoln.com

Houston, Texas
Phone: +1-346-219-3418
Fax: +1-707-202-1916
Email: usa@gtisoln.com

Japan: GTI Solutions Japan Co., Ltd.

Technical & Sales Office

Shinbashi, Minatoku, Tokyo
Phone: +81-3-6452-9555
Fax: +81-3-6452-9557
Email: japan@gtisoln.com

Singapore: GTI Solutions Pte Ltd.

Technical & Sales Office

Selegie Road, Singapore
Phone: +65-3138-1769
Email: singapore@gtisoln.com

Bulletin P-3008

GTI SOLUTIONS

www.gtisoln.com