Intalox
PACKED TOWER SYSTEMS
Severe Services

KOCH-GLITSCH
Many refining separation processes as well as several petrochemical and chemical processes are subject to severe operating conditions such as fouling, coking, erosion, corrosion and frequent upsets. Designing tower internals capable of providing reliable unit operation in such severe conditions requires extensive experience.

**Fouling Mechanisms**

In order to properly design internals for severe services, it is important to first identify the potential for the severe conditions and then, develop a clear understanding of the nature or cause of the problem. It is sometimes possible to modify operating conditions or the process scheme to minimize the potential hazard. However, in many cases the severe conditions cannot be eliminated and the equipment has to be designed accordingly.

*Dual Strainer designed to avoid fouling of the liquid distributor*

There are a large number of known fouling mechanisms. Solid particles (such as pipe scale) often enter the column with the feed or reflux stream and can be easily removed with correct treatment of the liquid stream by installing strainers or filters.

In other instances, the solids are actually formed through exposure to the operating conditions inside the column. Fouling of this nature can be created by a number of mechanisms including coking, salt deposition, polymerization, decomposition and other chemical or physical interactions. To minimize the formation of this type of fouling, the column operating conditions (temperature, pressure, etc.) should be carefully optimized. In addition, it is often important to ensure that the mass transfer equipment is properly wetted to keep the equipment flushed clean. Proper equipment design will help to ensure that fouling accumulation is minimized.

*Structured packing plugged with coke*

There are also a few known processes where the solids enter the column with the vapor or gas stream. In addition to fouling problems, these solid particles may also result in an erosion problem for the equipment directly exposed to the vapor stream.

Not all solids behave in the same manner inside the column. Solids in crystalline form are often easily removed with sufficient liquid flow. Other solids, like coke and polymers, once formed will stick to the mass transfer device and will grow like a cancer. Performance (capacity, pressure drop and efficiency) of the equipment deteriorates over time as the amount of solids accumulate. Eventually, a column shutdown is required to clean or replace the fouled equipment.

**Corrosion**

Corrosion problems can often be properly corrected with careful equipment material selection.

Packed bed systems subject to corrosion must also allow for heavier gauge material designs than conventional packings which offer no allowance for corrosion.
**Column Upsets**

The operating conditions of some columns contain a high risk for upsets or surges. A crude oil distillation column with stripping steam is a good example of an application that is subject to frequent upsets. The presence of any water (liquid phase) in the stripping steam will result in a massive expansion of the volumetric flow upon vaporization. This can create an upset force capable of damaging the tower internals, which will reduce or completely eliminate equipment performance.

Proper startup, shutdown and operating procedures are the best defense in eliminating equipment damage caused by upsets. However, complete elimination of upsets is not practical in many cases. The use of packings and grids is often a good choice in these applications as the extremely high open area of these devices (compared to trays) allows the packing to better handle a sudden increase in vapor rate. A full range of heavy-duty tower internal designs is available from Koch-Glitsch to increase the mechanical integrity of the equipment and allow for improved unit reliability.

**History of Packing for Severe Service**

Koch-Glitsch pioneered the use of grid packing for severe service with the introduction of GLITSCH GRID® Structured Packing in 1962. Koch-Glitsch developed a number of different designs of grid packing that has evolved over time based on years of commercial experience. Every detail of the grid design (including the grid hardware), has been optimized to provide superior fouling resistance. As a result of these efforts, Koch-Glitsch’s line of proven grid packings is the most fouling resistant.

Koch-Glitsch has installed hundreds of grid packing columns during the past forty years. This extensive experience list has also led to the steady and continuous development of packed tower internals (liquid distributors, vapor distributors, collectors, etc.) for severe services. Reliable operation of the packed bed is not possible without proper design of the internals. The packing operates in conjunction with the internals as complete INTALOX® Packed Tower Systems.

For more information regarding Koch-Glitsch column internals, please ask for KGMTIG-1.

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**GLITSCH GRID® EF25A Structured Packing**

This booklet provides information on quick sizing of packed columns for severe services. The following charts provide information on hydraulic ratings. In addition, predictions of FLEXIGRID® and FLEXIPAC® Structured Packing capacity and pressure drop can be obtained utilizing the KG-TOWER™ Software, which may be downloaded from the Koch-Glitsch website. [www.koch-glitsch.com](http://www.koch-glitsch.com)

**Severe Service Applications**

- Crude Atmospheric and Vacuum Tower Wash and Stripping Zones
- Lube Vacuum Tower Wash Zones
- Delayed Coker / Fluid Coker Scrubber Wash and HCGO Pumparound Zones
- FCCU Main Fractionator Slurry Pumparound Zones
- Top Section of Refinery Fractionators
- Visbreaker Fractionators
- Pollution Control Scrubbers (SO2 and NOx Scrubbers)
- Reactor Off-Gas Scrubbers
- Ethylene Oil and Water Quench Columns
- Acrylonitrile Quench and Absorption Columns
- Edible Oil Deodorizers
FLEXIGRID® and GLITSCH GRID® Structured Packing

FLEXIGRID and GLITSCH GRID structured packings are specifically designed to provide reliable operation in severe services that are susceptible to fouling, erosion, coking and high solids content.

There are three distinct styles of FLEXIGRID structured packing - FLEXIGRID packing styles 2, 3 and 4. Style 2 is optimized for maximum capacity, low liquid holdup and minimum pressure drop and provides the greatest fouling resistance. Style 3 provides improves efficiency because it has a larger projected area perpendicular to the gas flow (causing higher localized vapor velocities). Style 4 provides a greater specific surface area and higher heat transfer performance. GLITSCH GRID EF25A structured packing was one of the first grid packings ever applied and is still widely used in refineries around the world.

Fouling and Coking Resistance

Blades of FLEXIGRID packing are bent out at an angle from the vertical to induce turbulent contact between the rising vapors and descending liquid. There are no horizontal surfaces on the packing so that the packing can drain freely and liquid and solids do not collect. This minimizes liquid residence time (or liquid holdup) which reduces the potential for coking.

Coking in the wash zone of refinery fractionators (as well as polymerization in many other refinery and petrochemical applications) is often caused by dry-out due to vaporization from under-irrigated packing. Adequate wetting of the packing is required to ensure that the packing is continually flushed clean. This allows for the removal of particles that can otherwise collect and begin the formation of coke in this high temperature environment. The low surface areas of FLEXIGRID and GLITSCH GRID packings allow for excellent wettability at low liquid rates -- meaning that the packing can remain adequately wetted at lower liquid rates.

The large blade spacing provides large flow channels through the grid so solid particles can be more easily passed.

Corrosion and Erosion Resistance

FLEXIGRID and GLITSCH GRID packings are typically manufactured from 16 gauge [1.5 mm] material, but upon request are also available in 14 gauge [2 mm]. The standard 16 gauge [1.5 mm] packing thickness is 7 - 15 times thicker than conventional sheet metal structured packings and 3 - 5 times thicker than a typical random packing. This increased packing thickness gives the packing a significantly greater life in corrosive and/or erosive systems.

Materials of Construction

Koch-Glitsch grid packings are available in a wide variety of materials including:

- Carbon Steel
- Stainless Steels, including Austenitic, Ferritic, Martensitic; types 410/430, 304, 316 and 317 are readily available
- Duplex Stainless Steel
- Nickel Alloys
Resistance to Upsets

Both the increased packing thickness and welded construction provide a rigid framework that makes the packing very strong and resistant to damage during upsets. The top three layers of the grid are normally "J"-bolted together for increased mechanical strength. No other retaining device is usually required because of the high open area and low pressure drop of FLEXIGRID and GLITSCH GRID packing.

When additional uplift protection is required, the entire FLEXIGRID or GLITSCH GRID packing bed can be held together with tie rods to form a continuous structure which is highly resistant to mechanical damage and upset.

High Capacity and Low Pressure Drop

FLEXIGRID and GLITSCH GRID packings have an extremely high open area and thus provide higher capacity and lower pressure drop than other packings (or trays). As a result, FLEXIGRID and GLITSCH GRID packings are used in pumparounds of refinery fractionator vacuum columns to increase throughput and minimize column pressure drop.

<table>
<thead>
<tr>
<th>FLEXIGRID® &amp; GLITSCH GRID®</th>
<th>FG 2</th>
<th>FG 3</th>
<th>FG 4</th>
<th>EF25A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific Surface Area¹)</td>
<td>ft²/ft³</td>
<td>m²/m³</td>
<td>ft²/ft³</td>
<td>m²/m³</td>
</tr>
<tr>
<td></td>
<td>13.7</td>
<td>13.7</td>
<td>20.4</td>
<td>11.3</td>
</tr>
<tr>
<td>Packing Weight²)</td>
<td>lb/ft³</td>
<td>kg/m³</td>
<td>lb/ft³</td>
<td>kg/m³</td>
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<tr>
<td></td>
<td>16.4</td>
<td>263</td>
<td>16.4</td>
<td>263</td>
</tr>
<tr>
<td>Layer Height</td>
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<td>mm</td>
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<tr>
<td></td>
<td>2.75</td>
<td>70</td>
<td>2.75</td>
<td>70</td>
</tr>
</tbody>
</table>

¹) Relative mass transfer efficiencies are highly dependent on packing geometry (blade design and angles) and can not be accurately predicted using relative differences in the specific surface areas.
²) Packing weight is dependent on packing thickness and material type.

Droplet Removal Efficiency at $V = 10.3$ ft/sec [3.1 m/s] ($C_s = 0.36$ ft/s [0.11 m/s])

Droplet Diameter, μm

Removal Efficiency, %
FLEXIPAC® S Structured Packing

FLEXIPAC® S Structured Packing is a minor adaptation of conventional FLEXIPAC sheet metal structured packing. It utilizes a smooth metal packing surface (as opposed to conventional FLEXIPAC packing which contains surface texturing) and is similar to the GEMPAK® AS Structured Packing. The removal of the surface texturing eliminates the small sites on the packing surface where fouling can begin. FLEXIPAC S packing is suitable for moderately fouling applications but does not provide the same reliability and fouling protection as the FLEXIGRID and GLITSCH GRID packing product lines.

FLEXIPAC S structured packing is also available in significantly heavier gauge material than conventional FLEXIPAC packing to provide improved corrosion and/or erosion resistance.

<table>
<thead>
<tr>
<th>FLEXIPAC® S</th>
<th>4Y/4X</th>
<th>3.5Y/3.5X</th>
<th>3Y/3X</th>
<th>2.5Y/2.5X</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal Crimp Height</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>inch</td>
<td>2</td>
<td>1.5</td>
<td>1</td>
<td>3/4</td>
</tr>
<tr>
<td>mm</td>
<td>50</td>
<td>38</td>
<td>25</td>
<td>19</td>
</tr>
<tr>
<td>Specific Surface Area</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ft²/ft³</td>
<td>17</td>
<td>25</td>
<td>34</td>
<td>47</td>
</tr>
<tr>
<td>m²/m³</td>
<td>55</td>
<td>80</td>
<td>110</td>
<td>155</td>
</tr>
<tr>
<td>Available Thickness</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>inch</td>
<td>0.008-0.080</td>
<td>0.008-0.080</td>
<td>0.008-0.016</td>
<td>0.008-0.016</td>
</tr>
<tr>
<td>mm</td>
<td>0.2-2.0</td>
<td>0.2-2.0</td>
<td>0.2-0.4</td>
<td>0.2-0.4</td>
</tr>
</tbody>
</table>

![Graphs for FLEXIPAC S 3.5Y and 4Y](image)
Spray nozzle distributors are primarily used for heat transfer and refinery applications where good liquid coverage and complete wetting of the bed is necessary. They are commonly used in scrubbers and in the wash and pumparound zones of refinery fractionators. In heat transfer applications, the liquid spray cone produced by the distributor enhances heat transfer by providing contact with the rising vapor before the liquid reaches the packing.

Special design features are utilized by Koch-Glitsch when designing spray distributors in fouling services such as the wash zones of refinery fractionators. These design features provide the following benefits:

- Ensure high liquid velocities throughout the distributor piping
- Eliminate dead areas in the distributor piping where liquid can stagnate
- Provide free drainage of pipes and nozzles
- Allow for maximum plugging resistance of the spray distributor by utilizing nozzles with maximum free passage
- Optimize liquid coverage to the packing to prevent dry spots (caused by low coverage), and excessive flow to the tower wall (caused by high coverage)
- Minimize entrainment by avoiding the formation of mist and small droplets through careful nozzle selection and design

The Model 943 spray nozzle distributor can be designed for very low liquid rates because each spray nozzle covers a large area of the tower. It can utilize relatively large nozzle opening sizes so each nozzle provides a reasonable flow, even at low irrigation rates. This reduces the likelihood of plugging compared to gravity style distributors that utilize a greater drip point density and smaller openings. The orifice size, in conjunction with the significantly higher spray distributor liquid velocities, makes the spray distributor a more reliable distributor in severe services operating at low liquid rates.

The normal turndown ratio is 2 : 1. A typical design pressure drop across the spray nozzles is 10 - 15 psi [0.7 - 1.0 bar].
The Model 985 distributor is fabricated in sections for installation through a vessel manway and can be designed with various support methods, depending on specific mechanical and process requirements.

For redistribution between packed beds, a separate liquid collector is required.

- Diameters greater than 36 in. [900 mm]
- Liquid rates between 2 - 40 gpm/ft² [5 - 100 m³/m² h]
- Weirs in troughs
- Used for fouling services, preferably in combination with FLEXIGRID® Structured Packing

The weir trough distributor is specifically designed for applications with severe fouling conditions and high liquid flow rates. It is well suited for applications where the liquid feed stream contains solid particles. This distributor is the preferred choice for the slurry pumparound zone of an FCC Main Fractionator.

Liquid is metered to the closed-end troughs by large orifices or slots in the parting box(es). The number of parting boxes required is dependent on the tower diameter and the liquid flow rate. Liquid discharges to the packing from large slots in the troughs which are arranged in a uniform pattern across the tower cross sectional area at a typical pour point density of 2 - 4 points/ft² [20 - 40 points/m²]. The vertical slots provide improved flow distribution compared with V-notches. In the event that the vertical slot becomes plugged, the top portion of the slot is equipped with a triangular-shaped emergency overflow opening.

Liquid is proportionately metered to the closed-end troughs by one or more parting boxes. The normal turndown ratio is 2.5 : 1. Higher turndown ratios can be achieved with a special parting box design.

**Construction Details**

The Model 985 distributor is fabricated in sections for installation through a vessel manway and can be designed with various support methods, depending on specific mechanical and process requirements.

For redistribution between packed beds, a separate liquid collector is required.

**Design Options**

- Clamped to support ring or suspended from beams
- Uplift resistant
- Distribution notch shape
- Guide channels
Diameters greater than 5 ft [1.5 m]
Used for heavy fouling services, preferably in combination with FLEXIGRID® Structured Packing

The slurry vapor distributor is a Koch-Glitsch proprietary vapor distribution device that was specifically designed for distribution of the FCC Main Fractionator feed gas below the slurry pumparound bed. The design was developed from experience and lessons learned from several attempts to apply more conventional vapor distributor designs which were unable to withstand the severe conditions of erosion and coking.

Unlike other vapor distribution devices, this distributor is free of horizontal surfaces that will allow liquid to collect and begin the formation of coke. In addition, the sturdy design allows the device to withstand the presence of catalyst fines that will inevitably enter with the reactor vapor. As a result, this is the only vapor distribution device available that has been proven to withstand these severe conditions over a long period of time.

The vapor distributor for FCC Main Fractionators is typically utilized when there is a concern about severe vapor maldistribution of the feed gas to the slurry pumparound bed. The cause of this maldistribution is due to excessive inlet nozzle velocities or a close spacing between the nozzle inlet and the bottom of the packed bed. Improper vapor distribution will result in areas with unbalanced vapor-to-liquid ratios across the tower. Locally high vapor rates will displace the liquid and will increase the potential for coking in the slurry pumparound bed.

The vapor distribution quality improvement created by this device has been validated by commercial experience as well as detailed Computational Fluid Dynamic (CFD) modeling performed by Koch-Glitsch.

**Construction Details**

The Model 798 vapor distributor is fabricated in sections for installation through a vessel manway and is supported by tower wall clips.

**Design Options**

- Corrosion and Erosion allowance
- High temperature resistant design

**CFD Modeling of FCC Feed Inlet Systems**

Vapor distribution without a Model 798 vapor distributor

Vapor distribution with a Model 798 vapor distributor
Model 758 Enhanced Vapor Horn

- Diameters greater than 6 ft [1.8 m]
- Suitable for vapor-only, mixed liquid-vapor or flashing feeds

Vapor horns have been utilized primarily for two phase inlets of refinery fractionators. These devices are designed to provide both bulk phase separation of the vapor and liquid as well as initial distribution of the feed vapor. Performance of these feed inlet devices is critical to ensure adequate gas oil quality and yield, maximum column capacity and proper wash bed performance. Koch-Glitsch's proprietary enhanced vapor horn, an extension of conventional vapor horn technology, provides improved vapor distribution and de-entrainment of the feed.

For vapor/liquid phase separation, the open bottom construction and the centrifugal action induced to the feed stream will direct entrained liquid particles to the column wall, where they will flow down into the column sump or collector tray below.

The patented enhanced vapor horn employs baffles, in a proprietary arrangement, to avoid excessive impingement and feed splashing which can result in the formation of small liquid particles that are more likely to be re-entrained. The baffles help break the high feed inlet velocity for both improved vapor distribution and de-entrainment. Uniform velocity (in both the vertical and horizontal direction) is desired to minimize re-entrainment of liquid.

Once the bulk phase separation is complete and the swirling motion is no longer desirable, patented anti-swirl baffles eliminate the cyclonic motion of the vapor.

Koch-Glitsch has applied both large scale laboratory testing and CFD analysis to evaluate, optimize and validate the de-entrainment and vapor distribution performance. Koch-Glitsch has hundreds of commercial installations of this technology in columns with diameters up to 50 ft [15 m].
Model 768 EVENFLOW™ Vane Type Vapor Distributor

- **Diameters greater than 6 ft [1.8 m]**
- **Preferred for vapor-only feed**

The Model 768 EVENFLOW™ vane type vapor distributor is used for high energy vapor inlet streams entering through a radial inlet. Although the device has been utilized in applications with high velocity mixed phase feeds, the performance of the device is best when limited to vapor-only feeds.

Baffles used in conjunction with a tapered configuration provide vapor distribution with minimal pressure drop. The curved baffle plates partition the inlet vapor stream into multiple small segments, reducing the velocity and directing the segmented streams horizontally across the column area.

Performance of the EVENFLOW vapor distributor has been validated using CFD analysis as well as numerous successful commercial installations.

Model 622 Trough Style Liquid Collector for Fouling Services

- **Diameters greater than 3 ft [900 mm]**
- **Used for fouling services, preferably in combination with FLEXIGRID® Structured Packing**

The Model 622 trough collector is specially designed for liquid collection below a packed bed in applications where liquid hold-up must be minimized to avoid coking or fouling. It is the preferred design for the overflash collector tray in Deepcut Crude Vacuum Towers.

The decks, hats and/or sumps are sloped to minimize the liquid residence time. A uniform riser pattern is utilized to provide good vapor distribution to the packing. The open area of the riser is carefully optimized to provide the lowest possible pressure drop while still maintaining proper vapor distribution.

This collector is often equipped with an emergency overflow pipe to avoid excessive liquid residence time and/or spill-over down the vapor chimneys in the event that the side draw is temporarily lost.
Good vapor distribution is essential to achieve superior separation efficiency. Poor vapor distribution can be a major source of coke formation resulting in frequent unit shutdowns. Koch-Glitsch uses modern Computational Fluid Dynamics (CFD) modeling technology to analyze the performance of existing equipment and to develop 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, etc.). A commercially available CFD software package is used in conjunction with expertise developed by Koch-Glitsch to analyze vapor and liquid distributors as well as packing performance.

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

**CFD Feed Inlet Optimization**

A CFD study was used to help determine the optimum feed inlet design of a 29.5 ft [9.0 m] diameter Crude Vacuum Tower. Three different designs were modeled for the study:
- Model 758 Enhanced Vapor Horn with radial inlet
- Model 768 EVENFLOW Vapor Distributor
- Model 758 Enhanced Vapor Horn with tangential inlet

The entire flash zone design was modeled as a complete system and included the design of the overflash collector tray to predict the vapor distribution to the bottom of the wash bed.

No single device offered a pressure drop advantage. The calculated pressure drop across all three devices was essentially the same (within 0.5 mm Hg of each other).

The feed particle paths and velocity profiles in a number of different planes were carefully studied to determine the design having the best vapor distribution and estimated de-entrainment removal efficiency.

In this particular case, the enhanced vapor horn with the radial inlet nozzle produced the most uniform velocity profile to the wash bed and was selected as the optimum configuration. The improved vapor distribution from this device eliminated the need to design the overflash collector tray with an increased pressure drop to further improve vapor distribution to the packed bed.

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**Model 768 EVENFLOW™ Vapor Distributor**

**Model 758 Enhanced Vapor Horn with radial inlet**

**Model 758 Enhanced Vapor Horn with tangential inlet**

*Note: White areas in the CFD study indicate negative-downward-vapor flow*
The industry standard practice for the mechanical design of tower internals is limited to a normal operating load and a maintenance load. This standard design criteria does not consider upset or uplift design conditions. For towers prone to upsets, it is recommended that the design of the tower internals be upgraded for a heavy-duty uplift resistance. The additional expense for the upgraded design often pays for itself by reducing the risk of equipment damage that can lead to significant losses in production, poor product quality and/or an unplanned unit shutdown.

Since upsets are generally unsteady conditions, it is extremely difficult to predict the force generated by a specific column upset. Two levels of uplift protection are generally offered depending on the amount of protection desired -- 1 psi and 2 psi [52 and 104 mmHg] net uplift. Koch-Glitsch utilizes a "net" uplift force in the design calculations -- meaning that the 1 or 2 psi upset force is the total upward force used in the calculation -- the 1 or 2 psi force is not reduced by the downward force created by the weight of the internals.

A variety of different hardware configurations is available to provide a given level of uplift protection. For packed systems, a high-strength hold-down grid is typically used when uplift protection is needed. A common design used for short beds of grid and structured packed beds utilizes rods through the packed bed so the packed bed becomes a single structural element. This design often eliminates the need for larger support structures that can interfere with the vapor and liquid flow and increase the possibility of fouling or coking.

### Typical Applications

- Steam strippers or steam stripping sections of refinery fractionators
- Wash sections of Crude Atmospheric, Crude Vacuum, Lube Vacuum and Coker Main Fractionator Towers
- Slurry pumparound section of FCC Main Fractionators

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KFBE™ Structured Packing was specifically developed by Koch-Glitsch to meet the demanding needs of gas-solid fluidized bed systems. Robust and efficient, KFBE distributes gas and solid flows evenly, breaks up large gas bubbles and enhances gas-solid contact without restricting flow or creating areas of solids stagnation. The result is higher capacity, increased efficiency and a stable fluidization profile maintained over a wide range of operating conditions.

KFBE packing has been successfully applied in numerous FCC Spent Catalyst Stripper applications. Although disc and donut or shed-deck type trays have been traditionally used, these designs can easily block 50% of the available cross-sectional area, thereby restricting catalyst circulation and overall unit performance. With more refiners facing catalyst circulation and stripping efficiency limitations, there is an increasing need for higher capacity and more efficient stripper internals. KFBE packing has met this challenge by allowing full use of the vessel cross-sectional area, eliminating catalyst stagnation and fully activating the available stripper volume. Capacity, residence time and stripping efficiency are simultaneously increased with a corresponding improvement in overall unit performance and operating flexibility. Stripping steam is also reduced resulting in less steam traffic to the FCC Main Fractionator and a reduction in sour water discharge. Additional benefits are:

- Increased hydrocarbon recovery
- Increased hydraulic stability
- Increased residence time
- Reduced regenerator oxygen demand
- Reduced regenerator operating temperature

KFBE packing provides operating flexibility and allows system optimization to meet plant production requirements for both retrofit and new installations. The KFBE packing is free flowing and constructed to meet life cycle requirements.
Fouling, corrosion and equipment damage due to upsets are common obstacles to reliable operation in a Crude Distillation Unit. Crude Vacuum Towers are almost exclusively packed to allow minimum pressure drop as well as high capacity and product yields. Packing in the Crude Atmospheric Tower is often employed in the capacity-limited pumparound zones and in the wash section. FLEXIPAC structured packing in the Crude Atmospheric Tower wash zone offers improved de-entrainment and fractionation, greater capacity and effective operation at a significantly lower overflash rate compared to trays.

**Atmospheric Crude Tower**

Corrosion and fouling due to salt deposition in the top section of the crude tower and other refinery fractionators is common due to the low overhead operating temperatures. The severity is dependent on the specific operating conditions (temperature and pressure), crude type and crude desalter performance. Careful material selection for the uppermost tower internals is critical for corrosion protection. For most crude units, trays with fouling-resistant fixed valve units are recommended for the greatest protection from fouling and corrosion products. Packing can also be used when necessary by utilizing proper equipment designs. A heavier, more corrosion-resistant packing (such as FLEXIGRID, GLITSCH GRID or FLEXIPAC S structured packing) is generally recommended for these cases.

**Wash Section**

The wash zones in both the Atmospheric and Vacuum Crude Distillation Towers are subject to all types of severe conditions--fouling/coking, frequent upsets and corrosion. FLEXIGRID style 3 or GLITSCH GRID EF25A packing is the preferred packing of choice in crude unit wash zones due to its resistance to fouling, heavy-duty construction and good de-entrainment capabilities. FLEXIGRID packing is frequently used in conjunction with FLEXIPAC S structured packing in the wash section to provide further improvements in de-entrainment and fractionation for units operating with heavy crudes or deep cut points.

Through rods and/or heavy-duty hold-down grids are often recommended to increase the protection from damage due to an upset.

Model 943 spray nozzle distributors, with the special anti-fouling design features, are typically recommended for distribution of the wash oil to the top of the bed. The larger spray nozzle orifices, in conjunction with the significantly higher distributor velocities, make the spray distributor a more reliable distributor than other distributor types at the low wash oil rates.

For very light crudes, Vacuum Columns with a low flash zone temperature and/or Lube Vacuum Columns -- with moderate risk for fouling and coke formation -- a Model 156 or 986 trough type liquid distributor may also be considered.
**Flash Zone**

The Model 758 Enhanced Vapor Horn is the preferred flash zone equipment for optimum vapor distribution and feed de-entrainment.

**Stripping Section**

The stripping sections are prone to fouling and have a high potential for upsets due to the presence of steam. High performance fixed valve trays with heavy duty uplift designs are generally recommended for the stripping sections. Koch-Glitsch offers a full line of fouling resistant fixed valve trays.

**FCC Reactor/Regenerator**

KFBE packing maximizes stripper efficiency, residence time and catalyst circulation in FCC Spent Catalyst Strippers. Regenerator temperature and after-burn are reduced. Overall unit performance and operating flexibility are improved.

**FCC Main Fractionator**

Structured packing in the Fluid Catalytic Cracking Main Fractionator Unit offers increased capacity, lower pressure drop and improved efficiency compared to trays. The lower pressure drop can offer a number of valuable benefits:

- Increased gasoline yields
- Reduced load on wet gas compressor, regenerator and/or air blower
- Reduced coke formation on catalyst
- Improved octane number of gasoline

Severe conditions in the lower sections -- particularly the slurry pumparound zone -- require special equipment design considerations. In addition, refiners that run unhydrotreated feeds, purchased feeds from a barge or tanker, or resid may also experience corrosion and fouling problems in the upper most tower internals similar to problems seen in the top section of other refinery fractionators.

**Slurry Pumparound**

The high temperature environment in the slurry pumparound is prone to coke formation. In addition, catalyst fines from the reactor are introduced into the Main Fractionator with the vapor feed. The catalyst fines are often found as high up as the HCO pumparound and can cause erosion problems and plugging of liquid distributor orifices.

Koch-Glitsch pioneered the use of grid packing in the slurry pumparound zone in FCC units and has the most installations of grid packing in this application. The superior fouling resistance and high capacity of the FLEXIGRID style 2 packing make it the preferred packing selection for the slurry pumparound zone.

Koch-Glitsch offers special liquid and vapor distributor designs (Model 985 and 798) which have been developed and enhanced specifically for this application.
The Coker Main Fractionator is one of the most severe distillation services in a refinery. The heavy material processed in the high temperature environment is very prone to coking. In addition, the drum switches, resulting in drastic load changes to the fractionator, increase the likelihood of damage to the tower internals. The top section of the Fractionator is also prone to the corrosion and salt deposition problems that are seen in other refinery fractionators.

Most Coker Main Fractionators are initially designed with conventional valve or sieve trays. However, there are many cases where an expansion in capacity requires the use of either high capacity trays or structured/grid packings. Pressure drop savings obtained with these higher capacity devices can also provide an increase in gas oil yield by allowing a lower coke drum pressure.

**Cleanup/Wash Section**

FLEXIGRID packing is more frequently used in the wash section for towers that require a higher quality heavy coker gas oil (HCGO) and operate at very high vapor velocities. FLEXIGRID packing provides better efficiency than spray chambers, thus allowing better de-entrainment of coke fines and improved fractionation of the tail of the HCGO product. FLEXIGRID packing style 2 is recommended due to its superior fouling resistance and higher capacity.

**HCGO Pumparound**

The HCGO pumparound is usually the capacity bottleneck of the Coker Fractionator. The potential for fouling in this section remains very high. When high capacity trays can no longer provide the desired capacity, FLEXIGRID packing style 2 can be installed in the HCGO pumparound section.
In Ethylene (Olefins) Plants, the potential for significant fouling exists in the Quench Columns that are used to cool the hot process gas from the cracking furnaces. Coke fines from the cracking furnaces are entrained with the vapor to the first column in the Quench Unit. This first column will be an Oil Quench (Primary Fractionator) or a Water Quench Column, depending upon whether the plant has been designed to crack naphtha liquids or ethane and propane gases.

In older Ethylene Units, the column section above the cracked gas inlet will often contain open-type trays such as angle trays, baffle trays or splash decks. While these devices are resistant to fouling, they also have poor efficiency which can be improved by the use of FLEXIGRID and FLEXIPAC S packings. At the bottom of the column (nearest to the cracked gas inlet), FLEXIGRID packing style 2 is often used to maximize the column capacity and minimize the fouling from the entrained coke solids. As the vapor cools and the worst fouling is eliminated, the packing type can be changed to FLEXIGRID packing style 3 or 4, GLITSCH GRID EF25A or FLEXIPAC S packings for high efficiency while retaining effective fouling resistance. As a result of the additional packing efficiency, the liquid outlet temperature from the column can be increased, resulting in greater heat recovery from the Ethylene Quench Unit.

In the upper section of these columns, where fouling is less of a concern, high performance IMTP® Random Packing is used to provide greater efficiency for additional fractionation or increased cooling of the process gas.

With the coke fines being washed from the process vapor, the liquid at the bottom of the quench column is usually dirty. Recirculating the liquid in the bottom pumparound calls for a fouling resistant liquid distributor design such as the Koch-Glitsch Model 943 spray nozzle distributor or 985 trough distributor with weirs.
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