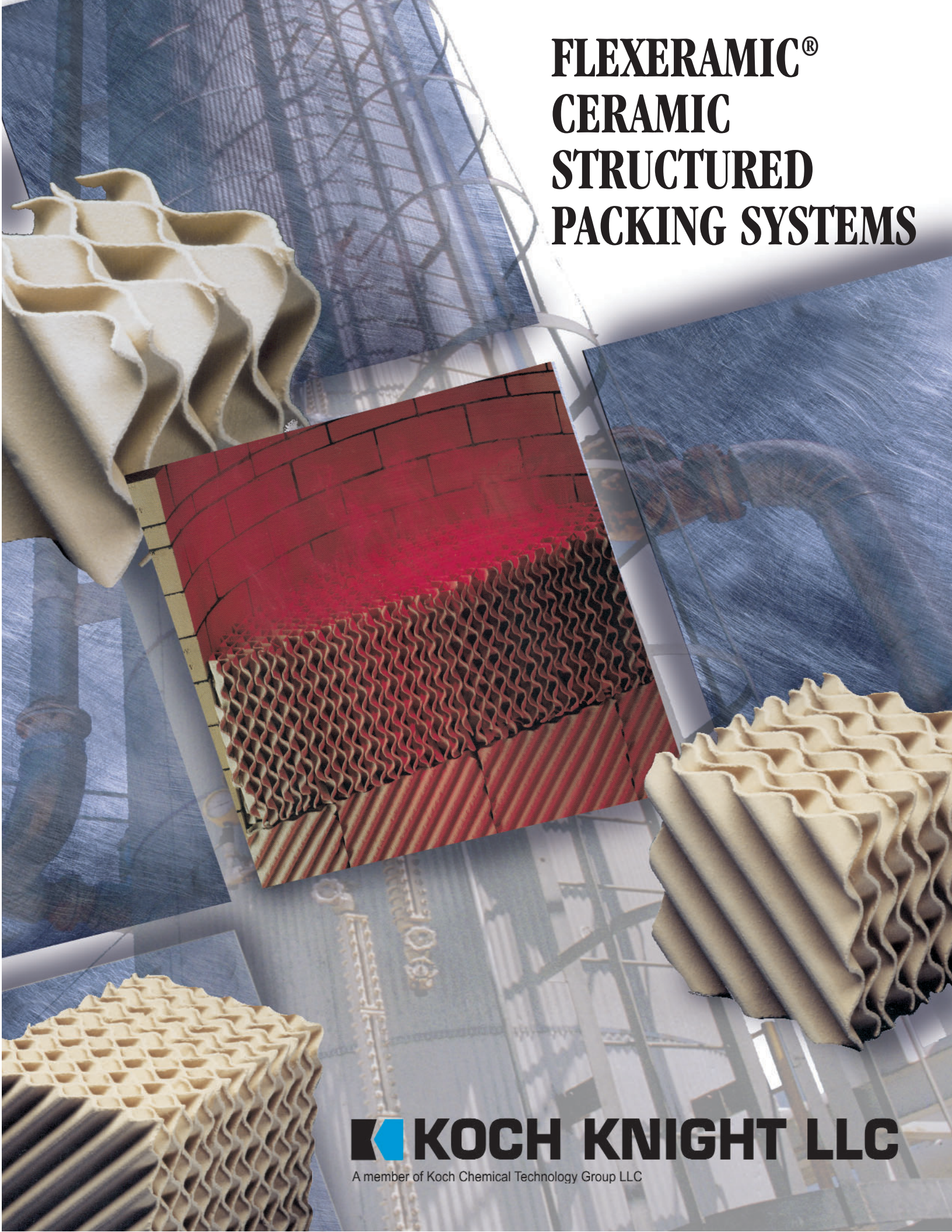




# **FLEXERAMIC® CERAMIC STRUCTURED PACKING SYSTEMS**

 **KOCH KNIGHT LLC**

A member of Koch Chemical Technology Group LLC



# FLEXERAMIC® Structured Packing Systems

## For Heat and Mass Transfer Applications - Distillation, Absorption, Stripping, Heat Exchange, Gas Mixing, Extraction

The high performance FLEXERAMIC structured packing system, is a carefully engineered design comprising the proper size selection of FLEXERAMIC structured packing and critical column internals. Our Koch Knight LLC engineers, working with customers unique requirements, optimize the system design by selecting or designing key components, to provide a total solution.

The key to system performance is the FLEXERAMIC structured packing. The geometrical arrangement provides for maximum liquid-vapor mixing and improved hydraulics.

FLEXERAMIC proprietary structured packing is constructed of corrugated sheets of ceramic. The angle of inclination of the corrugations of adjacent sheets is reversed with respect to the vertical column axis, forming mixing cells at every point where the corrugation intersect. This promotes intimate mixing and radial distribution of the liquid and gas streams. Each subsequent element is rotated about the column axis so that the sheets of one element are opposed to the sheets of the elements above and below. In passing through each element, gas and liquid are thoroughly mixed in the direction parallel to the plane of the sheets. By rotating subsequent elements, excellent mixing and spreading, both side to side and front to back are obtained over the entire cross section of the tower. The flow characteristics developed by the structured geometrical arrangement creates high effective surface area resulting in good efficiency as compared to other mass transfer devices.

Improved hydraulic performance of the FLEXERAMIC structured packing result from the corrugated sheets being vertically oriented, eliminating any horizontal surfaces which create resistance to fluid flow. As a result, towers packed with FLEXERAMIC structured packing have a very low pressure drop and a corresponding higher capacity.

A critical component to any packed tower system is the liquid distributor. Working with our customers, our application engineers select the optimal distributor design for the specific application to maximize tower performance. The high performance distributors used in the FLEXERAMIC structured packing systems utilize the knowledge developed by Koch Knight LLC over their decades of involvement in heat and mass transfer operations. For more information on our high performance distributors and other internals, contact Koch Knight LLC representative.

FLEXERAMIC structured packing system stands up to the toughest operating environments. Manufactured in corrosion resistant ceramics, FLEXERAMIC is an economical alternative to exotic metals and engineered plastics, and provides excellent service life in most corrosive applications.

Whether applying FLEXERAMIC technology to retrofits, upgrades or new construction, Koch Knight LLC professionals draw on an accumulated body of knowledge that nobody else can offer: more installations...more years of experience...more technical expertise...than any other supplier.

### FLEXERAMIC® systems can be installed in:

- Carbon Steel Vessels
- Glass Lined Columns
- Acid Brick Columns
- FRP Columns
- Regenerative Thermal Oxidizers
- Alloy and Alloy Clad Columns
- Refractory Lined Chambers

## Features & Benefits

The unique features of a FLEXERAMIC® structured packing system provide significant benefits over traditional random packing:

- **Geometric Design** - Effectively minimizes channeling and radially distributes gas and liquid uniformly over the tower cross section.
- **Rigid Construction** - Significantly less breakage and fouling of down stream equipment normally associated with random ceramic packing.
- **Greater Surface Area per Unit Volume** - More efficient per unit height than random packing of equal capacity.
- **Natural Wettability** - Improve film formation for high surface tension aqueous liquids enhances efficiency.
- **Higher Capacity** - Increase flow to existing towers or reduce diameters of new tower designs.
- **Lower Pressure Drop** - Lower energy costs without sacrificing capacity.
- **Better Efficiency** - Increase product recovery and improve product quality.
- **Economical** - Cost effective alternative to exotic alloy and engineered plastic tower packings.
- **Corrosion Resistance** - Corrosion resistance benefits found in ceramics applied to a high performance mass transfer device.

# Properties of FLEXERAMIC® Structured Packing

## Typical Physical Properties

| FLEXERAMIC<br>Structured Tower Packing | Density<br>lb/ft <sup>3</sup> | Density<br>kg/m <sup>3</sup> | Specific Surface<br>Area ft <sup>2</sup> /ft <sup>3</sup> | Specific Surface<br>Area M <sup>2</sup> /M <sup>3</sup> | Compressive Strength<br>lb/in <sup>2</sup> | Compressive Strength<br>kg/cm <sup>2</sup> | % Void Space |
|----------------------------------------|-------------------------------|------------------------------|-----------------------------------------------------------|---------------------------------------------------------|--------------------------------------------|--------------------------------------------|--------------|
| Type 28                                | 48                            | 769                          | 86                                                        | 282                                                     | 270                                        | 19                                         | 72           |
| Type 48                                | 32                            | 513                          | 48                                                        | 157                                                     | 140                                        | 10                                         | 77           |
| Type 88                                | 21                            | 336                          | 31                                                        | 102                                                     | 95                                         | 7                                          | 85           |

|                                             |     |             |                      |                                               |
|---------------------------------------------|-----|-------------|----------------------|-----------------------------------------------|
| Linear Thermal Expansion<br>Temperature ° F | ° C | % Expansion | Specific Gravity     | 2.6                                           |
| 0                                           | 0   | 0           | Water Absorption, %  | <1                                            |
| 400                                         | 204 | 0.07        | Acid Solubility, %   | 5-6                                           |
| 800                                         | 427 | 0.21        | Thermal Conductivity | 8 BTU-in/hr-ft <sup>2</sup> -°F<br>1.2 W/M-C° |
| 1200                                        | 649 | 0.38        |                      |                                               |
| 1600                                        | 871 | 0.48        |                      |                                               |

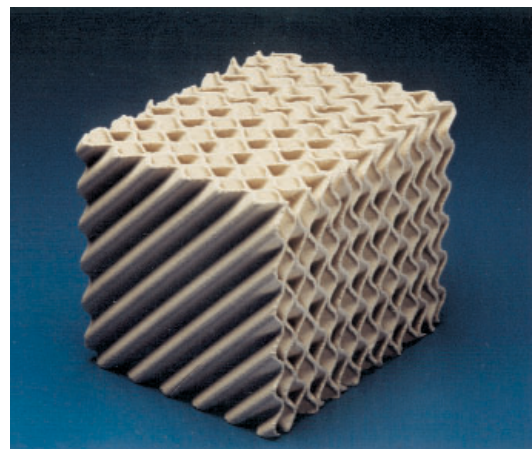
## High Performance Ceramic Structured Packings

Before the availability of FLEXERAMIC Structured Tower Packing, if more capacity was desired, the choices were limited and costly – construct a new, larger diameter column, or retrofit with expensive exotic metal or engineered plastic packing and internals.

FLEXERAMIC Structured Tower Packing offers a more economical alternative. An advanced development in ceramic materials, FLEXERAMIC Tower Packing provides plant operators increased separation efficiency, increased capacity, lower pressure drop and often significantly lower energy costs of operation. This means retrofitting existing packed units with FLEXERAMIC tower packing will improve profitability.

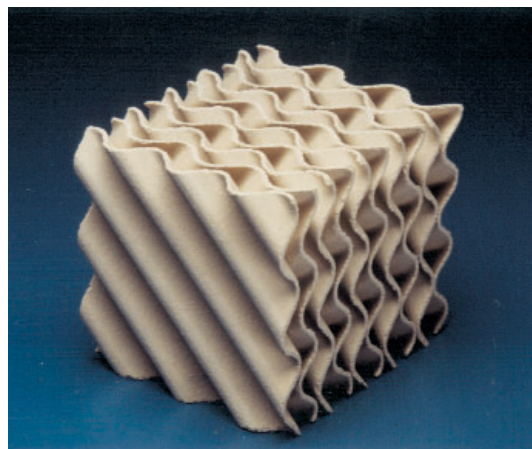
### FLEXERAMIC® TYPE 28

Higher efficiency (lower HTU) than 1-inch saddles, with capacity equivalent to 1.5-inch saddles. Excellent in Regenerative Thermal Oxidizers.



### FLEXERAMIC® TYPE 48

Better efficiency than 1.5-inch saddles, with more capacity than 2-inch saddles.



### FLEXERAMIC® TYPE 88

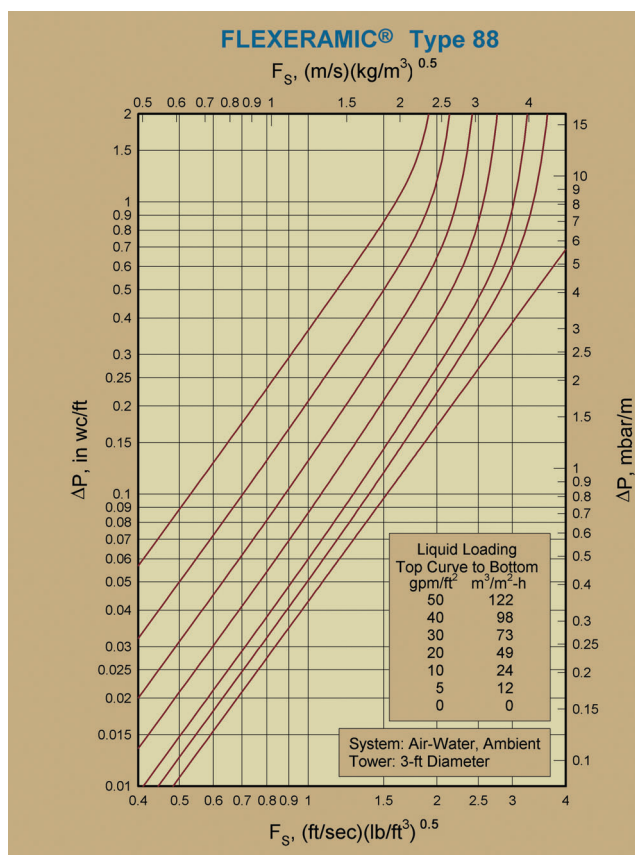
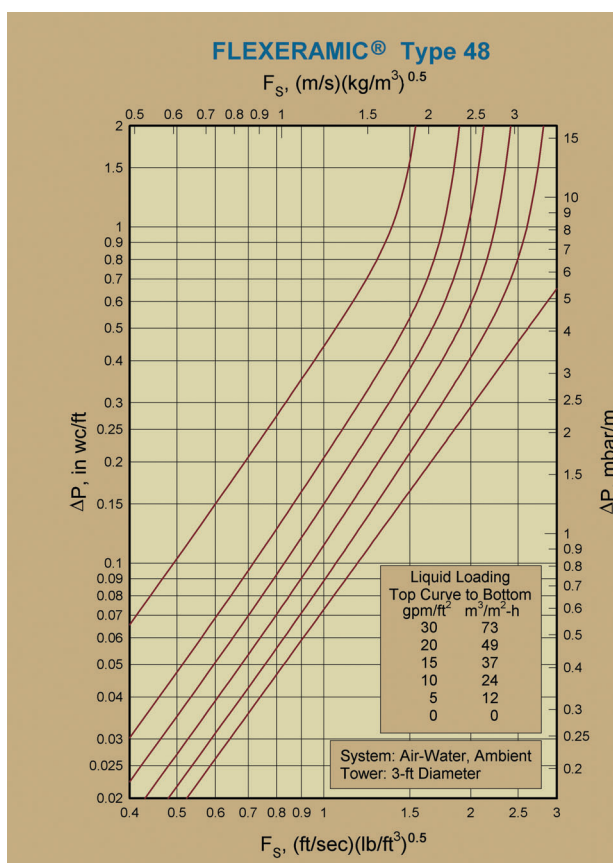
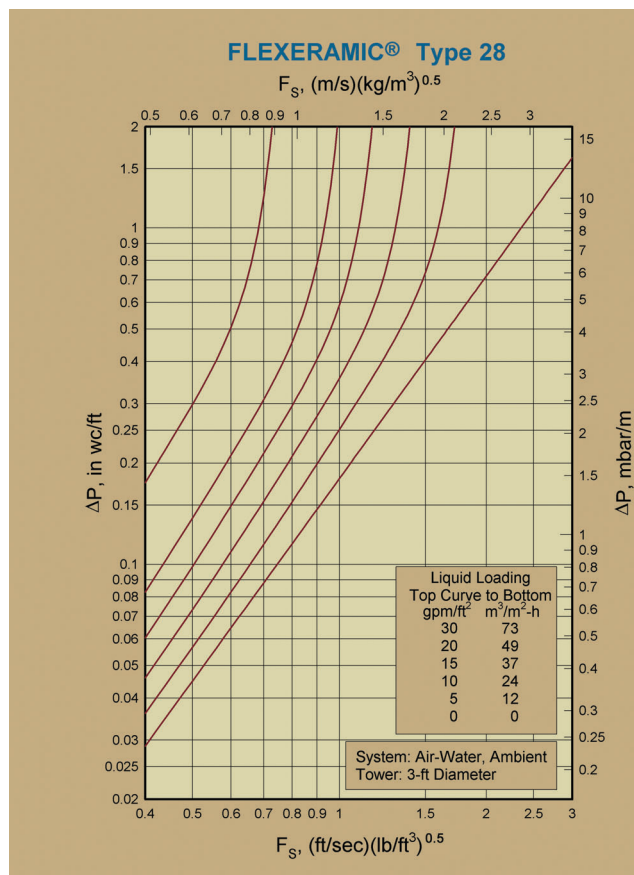
Efficiency equivalent, or better than 3-inch saddle, with much greater capacity.





# Pressure Drop-Capacity Curves

## FLEXERAMIC® Structured Packing... More Efficient Than Random Packings



### Definition of Terms

$$F_S = V_v \sqrt{\rho_v}$$

Where  $V_v$  = Superficial vapor velocity, ft/sec or m/s

$\rho_v$  = Vapor density, lb/ft³ or Kg/m³



FLEXERAMIC Structured Tower Packing's geometric design effectively minimize channeling and radially distributes the gas and liquid. Wall wipers around each element prevent by-passing of fluid at the vessel wall. Virtually even distribution is quickly established in the packed bed and homogeneous gas/liquid concentrations are maintained at any given tower elevation.

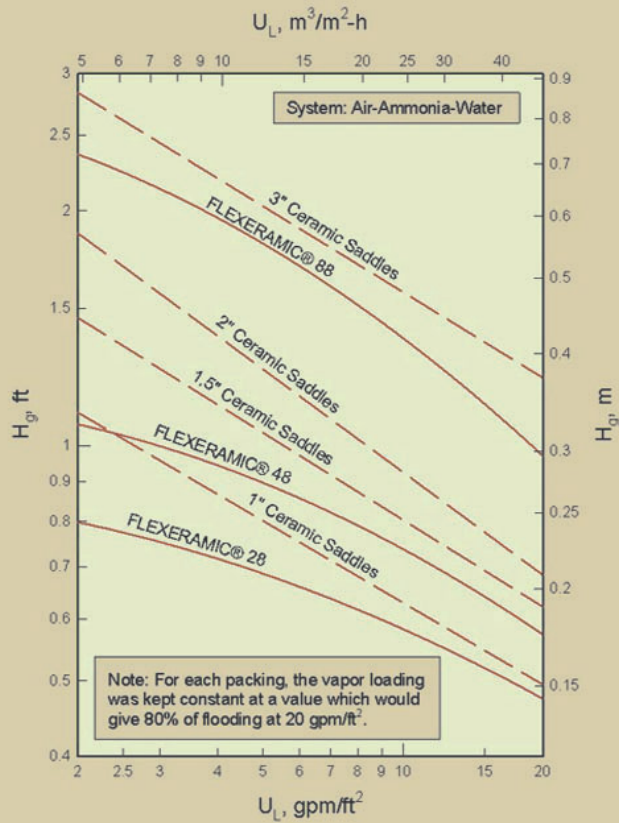
The geometric design allows for FLEXERAMIC Structured Packing to have a much higher effective surface area per unit volume than any ceramic random packing of equal capacity.

The natural wettability of ceramic in aqueous systems further improves the separation or absorption efficiency of FLEXERAMIC Structured Tower Packing over metal and plastic packings where high surface tension hinders thin film formation.

## Typical Applications

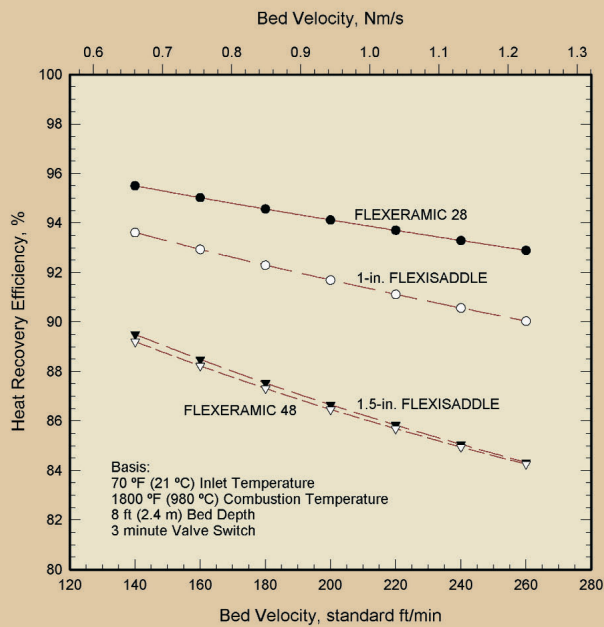
- Sulfuric Acid Plants
- Regenerative Thermal Oxidizers
- Chlorine Cooling and Drying Towers
- Bromine and Hydrochloric Acid Plants
- Liquid Organic Waste Disposal Coolers and Scrubbers
- Natural Gas Treating and Dehydration Units
- Purification of Aqueous Organic Acids

## Mass Transfer HTU: FLEXERAMIC® vs. Ceramic Saddles



# Technical Engineering Curves

## Heat Transfer Performance Characteristics for FLEXISADDLE™ and FLEXERAMIC® Heat Transfer Media

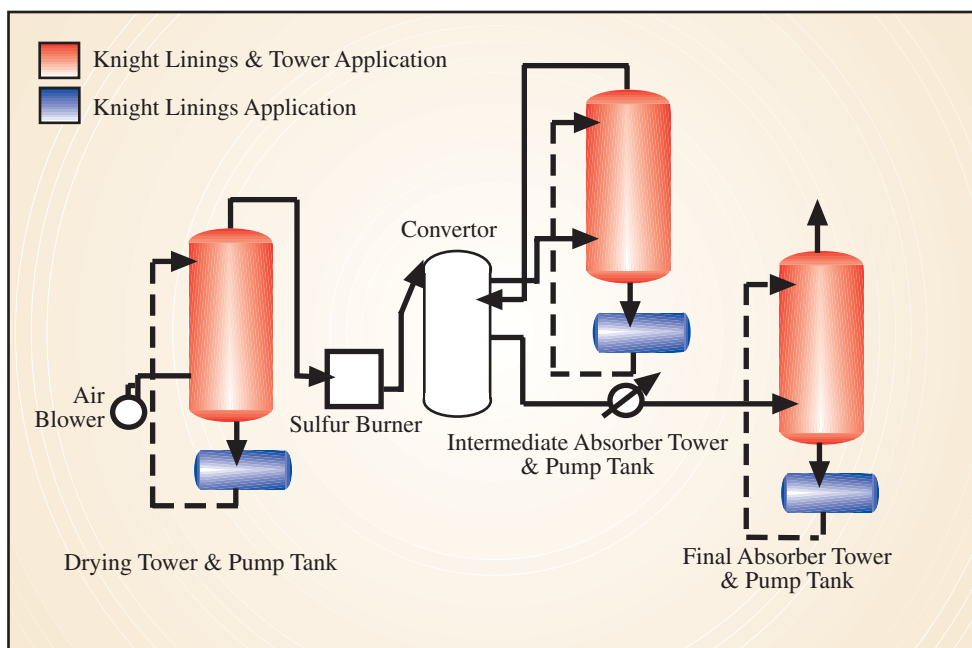


# Application File - Sulfuric Acid Production

Sulfuric acid is the world's most widely produced chemical. Efficient operation is dependent on good tower performance. The tower mass transfer efficiency and pressure drop have major impact on the plant's process economics.

With its excellent, radial distribution and wettability, FLEXERAMIC Structured Tower Packing provides plant operators operational benefits; with higher capacity, lower pressure drop and better efficiency.

What do applying these benefits mean to the acid plant operation? The following table summarizes the operational improvements available by applying FLEXERAMIC Tower Packing Technology to a typical sulfuric acid intermediate absorber in a 1000 ton/day plant. The base unit is a 20 ft ID final absorber packed with a 12 ft bed of 3" FLEXISADDLE Tower Packing.



| PARAMETER                | BASE CASE                              | 62% $\Delta P$ REDUCTION         | INCREASED EFFICIENCY AND 50% $\Delta P$ REDUCTION | 30% INCREASE IN CAPACITY         | 30% INCREASE CAPACITY AND INCREASE EFFICIENCY | 25% SMALLER TOWER CROSS SECTIONAL AREA 25% SHORTER BED |
|--------------------------|----------------------------------------|----------------------------------|---------------------------------------------------|----------------------------------|-----------------------------------------------|--------------------------------------------------------|
| Packing                  | 3" Ceramic FLEXISADDLE™ Random Packing | FLEXERAMIC Structured Packing 88 | FLEXERAMIC Structured Packing 88                  | FLEXERAMIC Structured Packing 88 | FLEXERAMIC Structured Packing 88              | FLEXERAMIC Structured Packing 88                       |
| Diameter                 | 20'0"                                  | 20'0"                            | 20'0"                                             | 20'0"                            | 20'0"                                         | 17'3"                                                  |
| Packed Height            | 12'                                    | 9'                               | 12'                                               | 9'                               | 12'                                           | 9'                                                     |
| Gas Flow (lb/hour)       | 500,000                                | 500,000                          | 500,000                                           | 650,000                          | 650,000                                       | 500,000                                                |
| Acid (gpm)               | 4,700                                  | 4,700                            | 4,700                                             | 6,100                            | 6,100                                         | 4,700                                                  |
| Pressure Drop ("w.c.)    | 8                                      | 3                                | 4                                                 | 7                                | 7                                             | 8                                                      |
| % Flood at Bottom (Max.) | 73%                                    | 54%                              | 54%                                               | 77%                              | 77%                                           | 80%                                                    |
| SO <sub>3</sub> Removal  | 99.98%                                 | 99.98%                           | 99.99+%                                           | 99.98%                           | 99.99+%                                       | 99.98%                                                 |

## DATA COMMON TO ALL CASES

|                                |       |
|--------------------------------|-------|
| Inlet Gas Temp. (°F)           | 450   |
| Inlet gas Gauge Press. ("w.c.) | 40    |
| Inlet Gas Comp. (wt%)          |       |
| SO <sub>2</sub>                | 3     |
| SO <sub>3</sub>                | 8     |
| N <sub>2</sub>                 | 83    |
| O <sub>2</sub>                 | 6     |
| Inlet Acid Temp. (°F)          | 180   |
| Inlet Acid Strength            | 98.0% |

This proven tower packing technology is successfully being applied in drying towers, intermediate and final absorbers, cross flow strippers, oleum towers, and other process towers with diameters over 20 ft.



# Your Single Source for Tower Optimization



Koch Knight LLC can put it all together for you from process design and mechanical layout to field construction and installation.

Our design capability does not stop at the process application. We can design and build the vessel with state of the art lining systems using custom engineered plastics, PYROFLEX® membrane, KNIGHT-WARE® acid proof brick and our proprietary corrosion resistant mortars.

Our world class field crews and top flight project management teams insure Knight quality is maintained throughout the installation.

Let our over 90 years of field experience and over \$100 hundred million in recent successful construction projects go to work for you.

## KOCH KNIGHT LLC

A member of Koch Chemical Technology Group LLC

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[www.kochknight.com](http://www.kochknight.com)

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