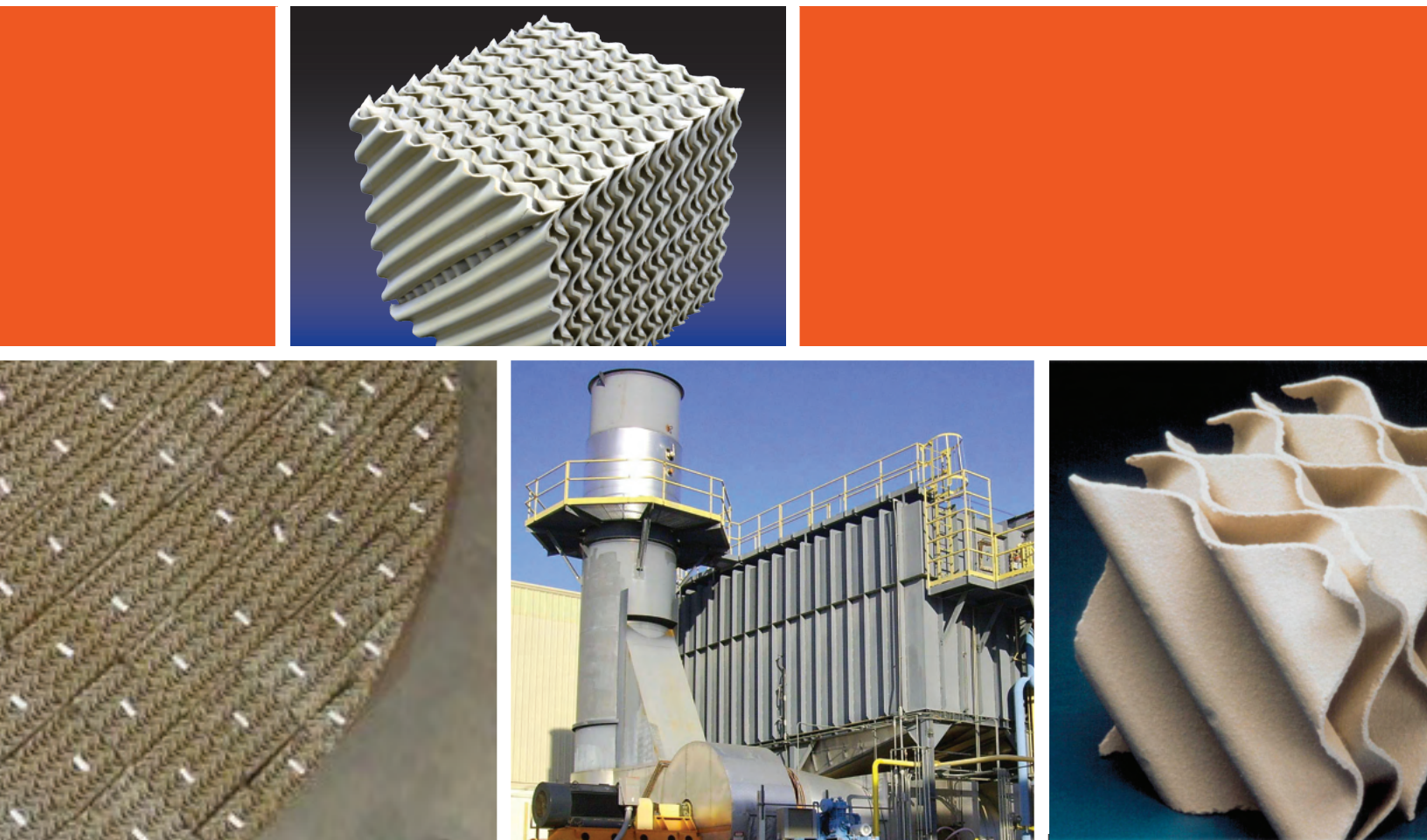


FLEXERAMIC®

Ceramic Structured Packing Systems



A leader in acid proof and corrosion solutions.

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 Knight Material Technologies 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 Knight Material Technologies over their decades of involvement in heat and mass transfer operations. For more information on our high performance distributors and other internals, contact Knight Material Technologies 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, Knight Material Technologies 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

Properties of FLEXERAMIC® Structured Packing

TYPICAL PHYSICAL PROPERTIES

FLEXERAMIC® STRUCTURED TOWER PACKING	DENSITY		SPECIFIC SURFACE AREA		COMPRESSIVE STRENGTH		% VOID SPACE
	LB/FT ³	KG/M ³	FT ² /FT ³	M ² /M ³	LB/IN ²	KG/CM ²	
TYPE 28	35	560	98	320	150	10.5	77
TYPE 48	30	478	63	208	67	4.7	79
TYPE 88	20	318	38	125	30	2	85

TEMPERATURE

°F	°C	% EXPANSION
0	-18	0.00
400	204	0.07
800	427	0.21
1200	649	0.36
1600	871	0.48

SPECIFIC GRAVITY	2.6
WATER ABSORPTION, %	<1
ACID SOLUBILITY, %	1-2
THERMAL CONDUCTIVITY	8 BTU-IN/HR-FT ² -°F 1.2 W/M-°C

Features & Benefits

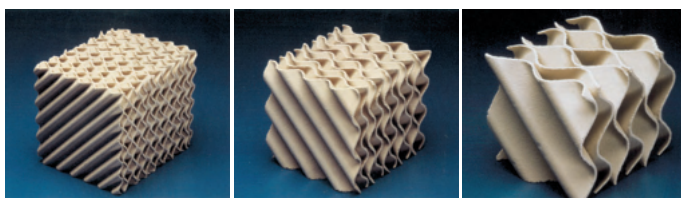
The unique features of a FLEXERAMIC® structured packing system provide significant benefits over traditional random packing:

- **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.

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

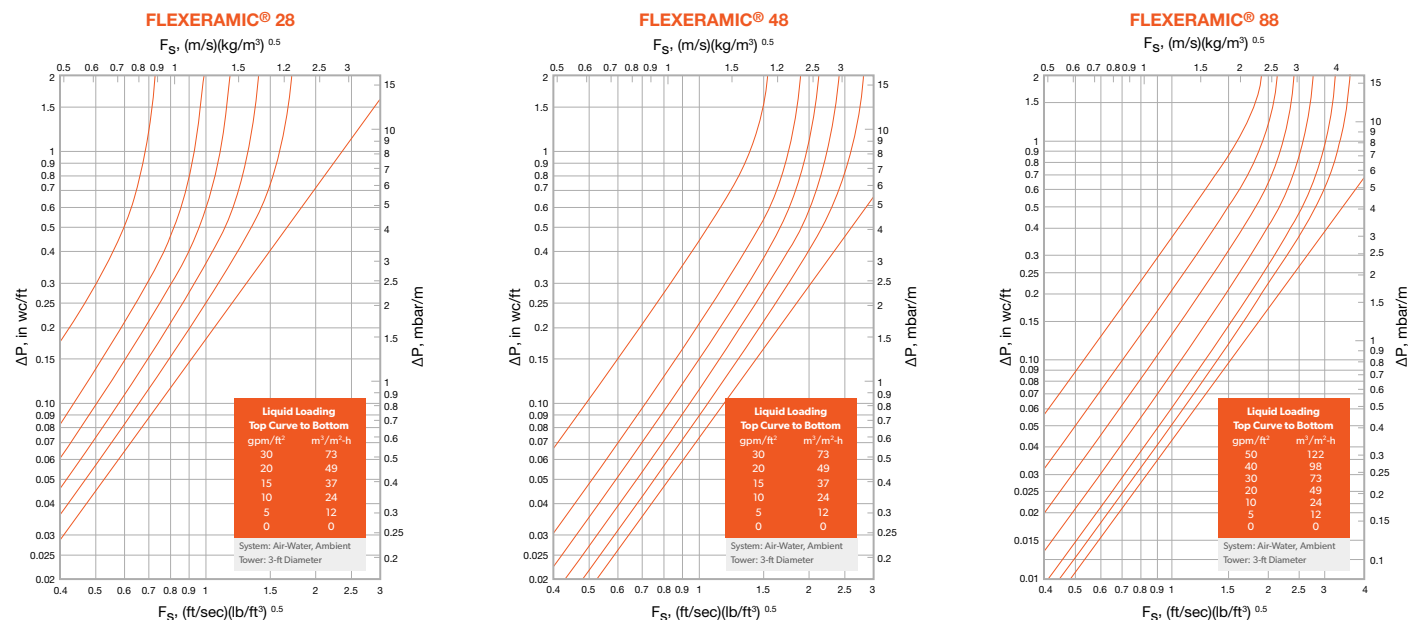
Better efficiency than 1.5-inch saddles, with more capacity than 2-inch saddles.

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 | ρ_v = Vapor density, lb/ft³ or Kg/m³



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

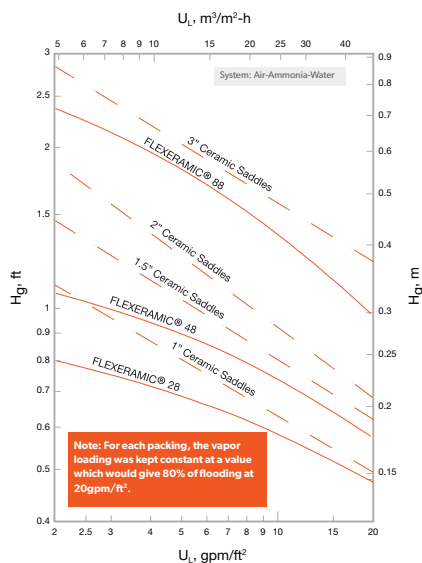
FLEXERAMIC® Structured Tower Packing's geometric design effectively minimize channeling and radially distributes the gas and liquid. Wall wipers around each element prevent by-passing of fluid at the vessel wall. Virtually even distribution is quickly established in the packed bed and homogeneous gas/liquid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

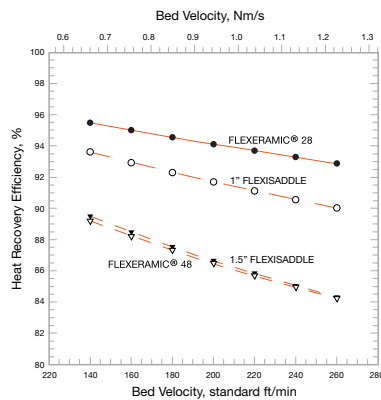
The natural wettability of ceramic in aqueous systems further improves the separation or absorption efficiency of FLEXERAMIC® Structured Tower Packing over metal and plastic packings where high surface tension hinders thin film formation.

Technical Engineering Curves

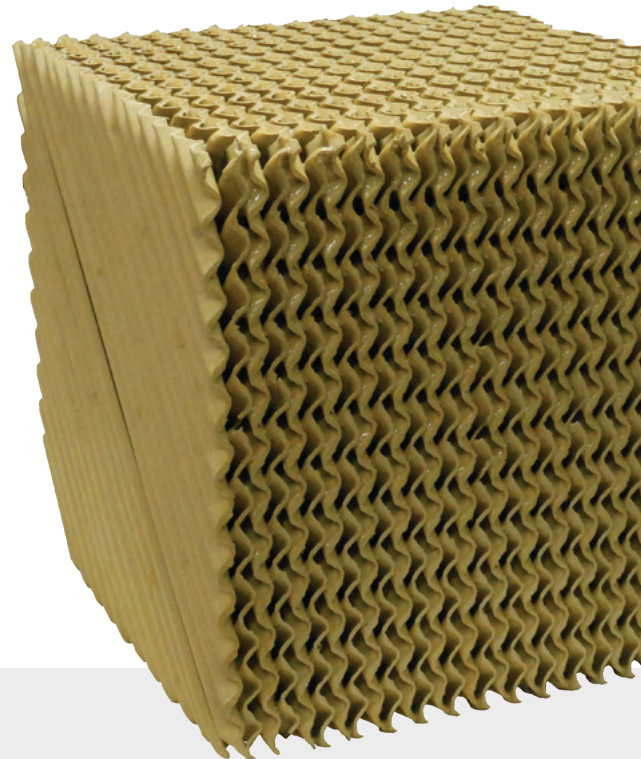
**Mass Transfer HTU:
FLEXERAMIC® vs. Ceramic Saddles**



**Heat Transfer Performance Characteristics for
FLEXISADDLE™ and FLEXERAMIC™ Heat Transfer Media**



Basis:
70°F (21°C) Inlet Temperature
1800°F (980°C) Combustion Temperature
8 ft (2.4 m) Bed Depth
3 minute Valve Switch

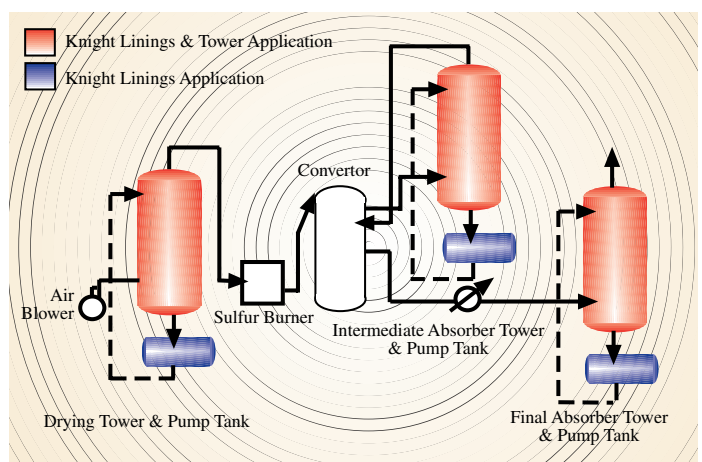


Application File - Sulfuric Acid Production

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.

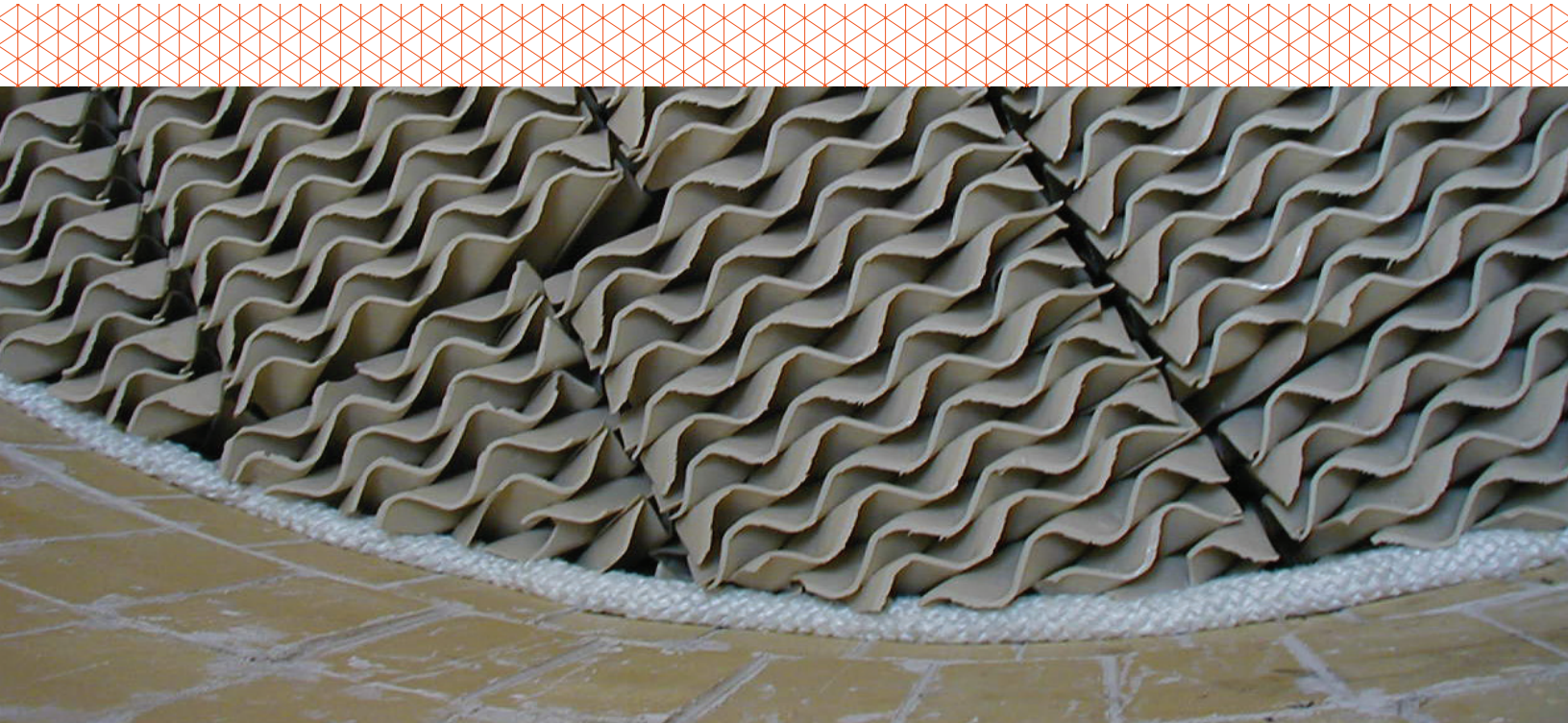


PARAMETER	BASE CASE	62% ΔP REDUCTION	INCREASED EFFICIENCY AND 50% ΔP REDUCTION	30% INCREASE IN CAPACITY	30% INCREASE CAPACITY AND INCREASE EFFICIENCY	25% SMALLER TOWER CROSS SECTIONAL AREA 25% SHORTER BED
PACKING	3" CERAMIC FLEXISADDLE® RANDOM PACKING	FLEXERAMIC® STRUCTURED PACKING 88	FLEXERAMIC® STRUCTURED 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 ₃ ABSORPTION	99.98%	99.98%	99.99+%	99.98%	99.99+%	99.98%

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.

Data Common to All Cases

INLET GAS TEMP. (°F)	450
INLET GAS GAUGE PRESS. ("w.c.)	40
INLET GAS COMP. (wt%)	
SO ₂	3
SO ₃	8
N ₂	83
O ₂	6
INLET ACID TEMP. (°F)	180
INLET ACID STRENGTH	98.0%



FLEXERAMIC® Structured Packing Installations



GLOBAL OFFICES



Knight Material Technologies Headquarters

PO Box 30070
5385 Orchard View Drive SE
East Canton, Ohio 44730
USA
Phone: +1 (330) 488-1651
Fax: +1 (330) 488-1656
Email: info@knightmaterials.com

Chile Office

Av. Kennedy 5770
Office 704 Vitacura
Santiago, Chile
Phone: +56 (2) 2873-7200
Email: chile@knightmaterials.com

Australia Office

Collins Square, Tower Four
Level 18, 727 Collins Street
Melbourne, VIC, 3008
Australia
Phone: +61 (02) 6658-4949
Email: australia@knightmaterials.com

CAPABILITIES

Knight Material Technologies works closely with our customers in taking a comprehensive look at their applications. We offer complete solutions for the corrosion and processing application using innovative custom designs or standard configurations and materials.

Our design and application expertise encompasses decades of engineering knowledge, experienced field crew installation, and maintenance and market leadership within the industry.

Knight Material Technologies offers value-added service with engineering support, custom design capabilities, and personable customer service. We are your single-source supplier of custom design packages. Our focus is to provide customers with superior products and materials, world-class engineering support, high-quality installation and responsive maintenance.

24-Hour Service: Call (330) 313-6372



Visit us on the web: knightmaterials.com

NOTE: THE INFORMATION CONTAINED IN THIS BULLETIN IS BELIEVED TO BE ACCURATE AND RELIABLE BUT IS NOT TO BE CONSTRUED AS IMPLYING ANY WARRANTY OR GUARANTEE OF PERFORMANCE. YOUR SINGLE SOURCE FOR TOWER OPTIMIZATION.

PRINTED IN U.S.A.
© COPYRIGHT REV. 2022
KNIGHT MATERIAL TECHNOLOGIES