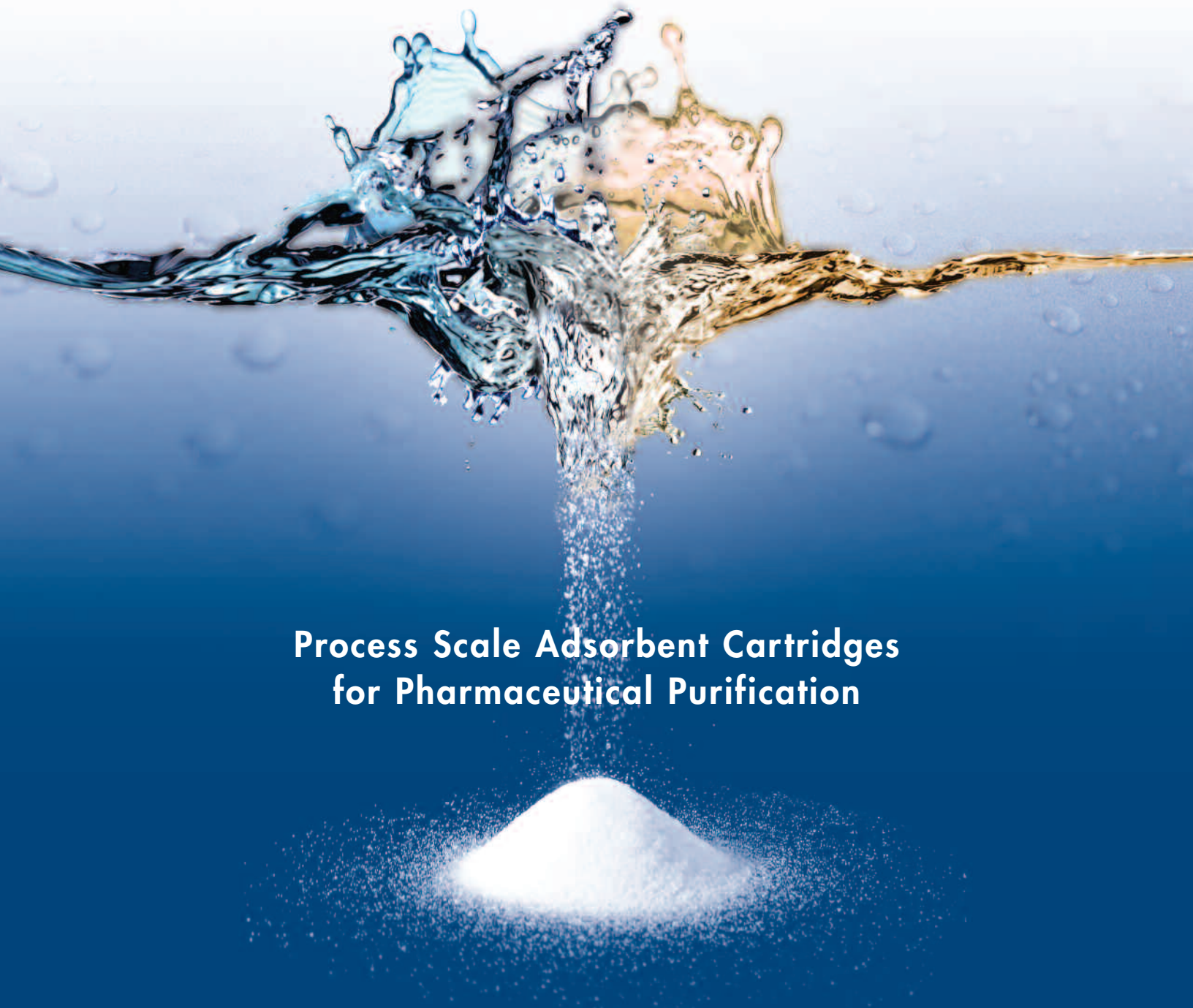




Graver Technologies

***E-PAK***<sup>®</sup>

**RAPID, RELIABLE ADSORPTION PROCESSING**



**Process Scale Adsorbent Cartridges  
for Pharmaceutical Purification**



## Features and Benefits

- Proven cartridge design assures simple, reliable adsorption processing
- Fixed porous media eliminates handling and safety issues associated with loose carbon
- Large adsorbent capacity in small area foot print increases product recovery and reduces solvent requirements
- Extended flow path provides more contact time and better adsorption performance

# E-PAK<sup>®</sup>

## Ecosorb<sup>®</sup> Process-Scale Adsorbent Cartridges

Until recently the use of activated carbon was largely avoided in API manufacturing due to handling and safety issues. Filtration and chromatography products converted to incorporate activated carbon have provided handling and safety improvements for pilot scale use but done little to address the practical requirements of large scale

processing. Graver Technologies, producer of Ecosorb<sup>®</sup> Products, recognized the need for a better way to use activated carbon at the bench, in pilot, kilo labs and commercial operations. The result is a new family of cartridge adsorbent products we believe will improve and expand the use of adsorption processing.

### Product Description

E-PAK products are radial flow adsorption cartridges developed specifically for pharmaceutical processing. (Figure 1) Created with proprietary technology E-PAK cartridge products provide rapid adsorption kinetics at flow rates and processing capacities suitable for laboratory, pilot and commercial operations. E-PAK cartridges are designed for use with organic and aqueous solvents and incorporate design features useful for the production of active pharmaceutical ingredients (API) manufactured in explosion proof environments. E-PAK cartridges are available in a range of sizes and formulas (Ecosorb C- Series-carbon formulas and custom) to accommodate the broad range of processing requirements encountered over the API development cycle.

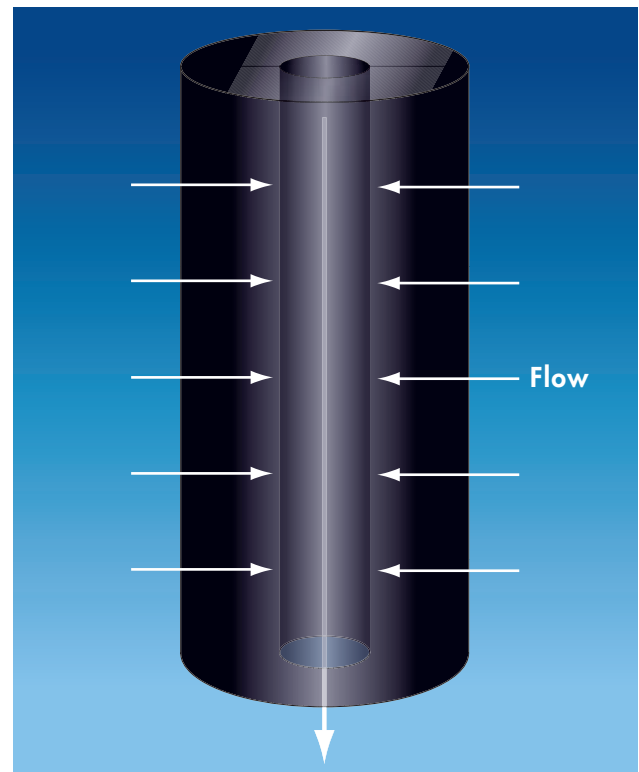


Figure 1 – Out to in radial flow through fixed porous adsorbent media.



Grounding connector (optional) provides true earth electrical ground for XP operation.

## Applications

Uses for E-PAK cartridges include the removal and recovery of precious metal catalyst, reaction-by-products and color from synthetic reaction mixtures and natural products. Compared to loose media, pre-packed columns and stacked disc filters E-PAK products provide *High Adsorption Capacity and Flow Rate; Increased Product Recovery and Safe User-Friendly Handling, Clean Up and Disposal.*

### LAB EVALUATION

To facilitate the evaluations of small samples Graver provides loose media and lab scale cartridges. Testing with loose media can be done with samples as small as a few milliliters and are normally done in advance of cartridge testing to identify the formula with the highest capacity to remove contaminants with the least loss of product.

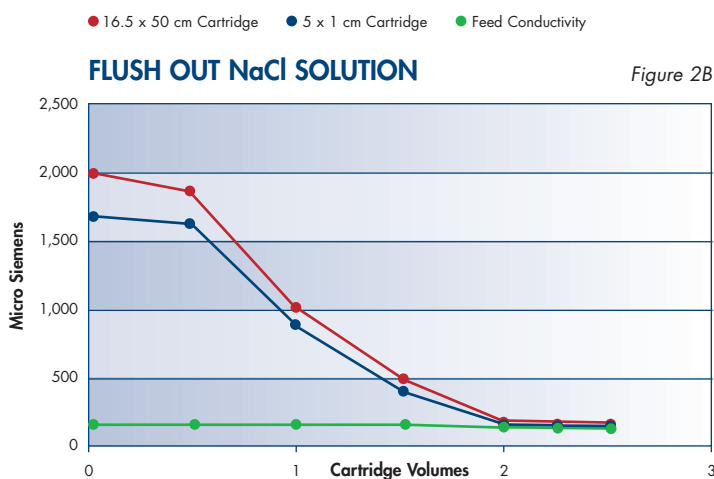
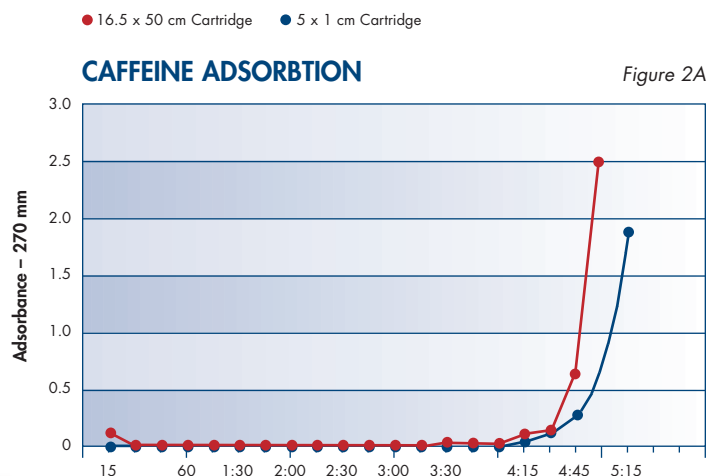


Pre-screening with Ecosorb loose media.



Lab cartridge test can be operated with pump (shown) or small pressure vessel.

E-PAK lab cartridges are generally used for processing samples of 50 ml or more. Testing in Graver's laboratory has shown good correlation between the performance of lab, pilot and commercial size cartridges (Figures 2A and 2B). A typical setup for testing E-PAK lab cartridges is shown in the photo bottom left. For additional information on adsorbent selection see Organic Process Research and Development 2005, 9, 198-205. For information on the operation of E-PAK lab cartridges please request a copy of Graver publication GTX 324.



Graphs show the break through curves of Graver lab and commercial cartridge with a highly adsorbed compound (caffeine) and non adsorbed compound (NaCl). Test demonstrate very similar performance between the lab and commercial scale cartridges for processing and recovery operations when operated at a flow rate providing the same contact time through the cartridge (contact time in example shown 2.5 minutes).

## ECOSORB, E-PAK MEDIA AND LAB CARTRIDGES

ECOSORB C-SERIES EQUIVALENT	ACTIVE ADSORBENT	AVAILABLE PRODUCTS/SIZES	MEDIA WEIGHT
C-941	Carbon-Wood Acid Activated	Loose Media 5 cm Diameter • 1 cm High • 10 cm High	100 g Plastic Container
C-944	Carbon-Coal Steam Activated		
C-947	Carbon-Wood Acid Activated		5 g
C-948	Carbon-Wood Acid Activated		50 g

Custom formations available.

E-PAK lab cartridges are used in Graver lab filter housing or filter housing using single 222 o-ring seal.



## PILOT EVALUATION

Pilot scale cartridges provide rapid processing for volumes from 10 to hundreds of liters. Pilot and Commercial cartridges are provided with a Code 8 (closed top & open bottom end caps-bottom with double 2-222 Teflon® encapsulated VITON o-ring) cartridge sealing configuration.

## E-PAK PILOT SCALE CARTRIDGES

ECOSORB C-SERIES EQUIVALENT	ACTIVE ADSORBENT	AVAILABLE PRODUCTS/SIZES	MEDIA WEIGHT
C-941	Carbon-Wood Acid Activated	16.5 cm Diameter • 12.5 cm High • 25 cm High Code 8	0.85 Kg 1.7 Kg
C-944	Carbon-Coal Steam Activated		
C-947	Carbon-Wood Acid Activated		
C-948	Carbon-Wood Acid Activated		

Custom formations available.



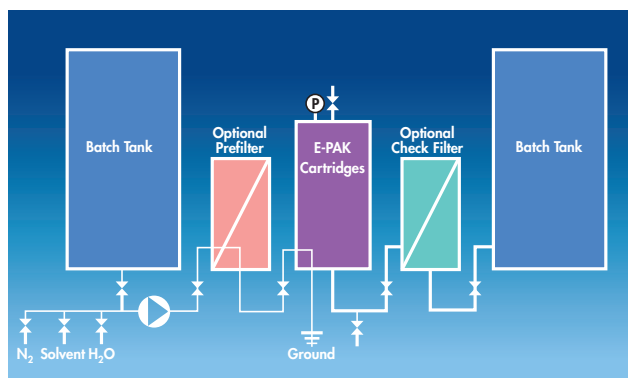
Pilot scale cartridges provide a convenient means for confirming scale-up considerations and for producing kilo quantities of API's and intermediates.

## COMMERCIAL SCALE PROCESSING

To meet commercial processing requirements E-PAK cartridges can be operated in parallel for increased capacity. E-PAK cartridges provide rapid processing for manufacturing operations needing to process batch sizes of  $\geq 10,000$  liters or can be adapted for continuous operation using a duplex design. For applications where precious metal catalyst recovery is an important consideration E-PAK cartridges can be thoroughly flushed with a low volume of solvent followed by water and a final blow down with nitrogen. All the materials E-PAK are combustible producing a low ash residue suitable for processing to recover precious metals.

## E-PAK COMMERCIAL SCALE CARTRIDGES

ECOSORB C-SERIES EQUIVALENT	ACTIVE ADSORBENT	AVAILABLE PRODUCTS/SIZES	MEDIA WEIGHT
C-941	Carbon-Wood Acid Activated	16.5 cm Diameter • 50 cm High • 100 cm High Code 8	3.4 kg 6.8 kg
C-944	Carbon-Coal Steam Activated		
C-947	Carbon-Wood Acid Activated		
C-948	Carbon-Wood Acid Activated		



Typical flow schematic for E-PAK Pilot or Commercial Scale operation.

## FLOW, HYDRAULIC PRESSURE DROP & CONTACT TIME

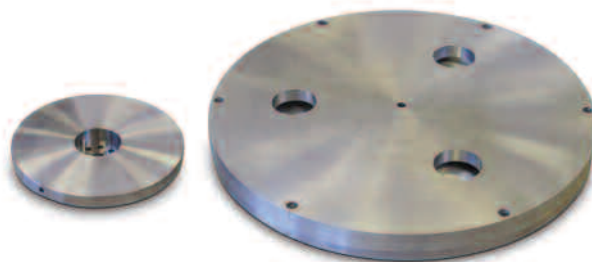
Cartridges provide rapid kinetics at flow rates and contact times suitable for single pass operation. The chart above shows typical contact time and pressure drop performance for Ecosorb C-941 formula Lab, Pilot and Commercial Scale Cartridges.

## E-PAK FLOW RATE

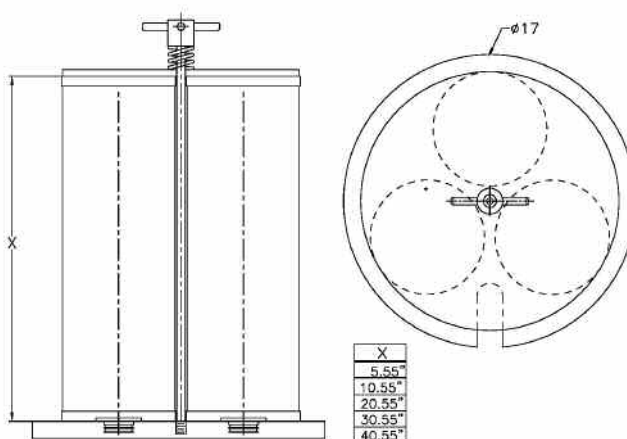
CARTRIDGE SIZE DIAMETER X HEIGHT (CM)	FLOW RATE	PRESSURE DROP $\Delta P$ (PSIG) WITH w/1 CPS FLUID	CONTACT TIME (MINUTES)
5x1 (Lab)	5 ml/min	$\approx 7.5$ psig	2.5
5x10 (Lab)	50 ml/min	$\approx 5$ psig	2.5
16.5x12.5 (Pilot)	0.95 lpm	$\approx 10$ psig	2.5
16.5x25 (Pilot)	1.9 lpm	$\approx 10$ psig	2.5
16.5x50 (Commercial)	3.8 lpm	$\approx 10$ psig	2.5
16.5x100 (Commercial)	7.6 lpm	$\approx 10$ psig	2.5

## Adapter Kits for Lenticular Cartridge Filter Housings

Graver offers conversion kits that allow E-Pak cartridges to be operated in existing lenticular cartridge housings. Adapter kits are available to convert 8", 12" and 16" housings for use with E-PAK Pilot and Commercial cartridges; in some case this can provide a substantial increase in adsorption capacity up to 2.5X.



Installation is as simple as removing the old tie rod and bolting down the new adapter base plate. Adapter kits are available in 316LSS and HASTELLOY 276 with a 20 Ra surface finish.



Elevation drawing shows complete adapter kit for a 16" lenticular filter housing. This allows for the use of up to three cartridges in this size housing and increases working capacity by more than 2.5X.

## Cartridge Housing Selection

Graver Technologies offers a series of semi custom fabricated cartridge housings for operation of 1 to 12 cartridges. The table below shows guidelines and details for standard housing configurations. For additional information on filter housings and industrial scale housing retrofit kits please request a copy of Graver bulletin GTX 325 and or contact Graver Technologies.

### E-PAK SEMI CUSTOM CARTRIDGE HOUSINGS

NUMBER OF CARTRIDGES	DESCRIPTION
1	Single Cartridge, T-Style-Code 8 (50 or 100 cm Dome)
3	Three Cartridge, T-Style-Code 8 (50 or 100 cm Dome)
7	Seven Cartridge, T-Style-Code 8 (50 or 100 cm Dome)
12	Twelve Cartridge, T-Style-Code 8 (50 or 100 cm Dome)

*Filter housing options: ASME or PED pressure rated/stamped, conductive casters, KALREZ® gaskets, type and size of inlet & outlet, connections – wetted and non wetted surface finish.*



E-PAK single cartridge housing (for use with cartridges to 100 cm).

**For the most current listing of available E-PAK cartridge sizes and formulas please request copy of GTX 327 or go to [gravertech.com/adsorbents/E-PAK](http://gravertech.com/adsorbents/E-PAK)**

## Chemical Compatibility

E-PAK cartridges are formed using a proprietary technology and chemically stable materials in common organic solvents. E-PAK cartridges have been tested and found satisfactory for use with the following commonly used solvents: methanol, dichloromethane, ethyl acetate, tetrahydrofuran, toluene and N-ethyl-2-pyrrolidone. E-PAK cartridges are suitable for operation at pH of 1 to 14.

## Quality and Regulatory

E-PAK cartridges are manufactured in Gravers' ISO 9001:2000, GMP manufacturing operations in Glasgow, DE. Drug Master File registration(s) are in progress.

## Handling and Safety

- Initial solvent wetting of E-PAK cartridges will produce heat; a risk assessment with the use with low vapor pressure solvents is recommended.
- The adsorbent matrix in E-PAK cartridges is electrically conductive. E-PAK cartridges filter housings and retrofit kits provide a connection between the adsorbent matrix and the filter cartridge housing. A risk assessment of electrical discharge in explosion proof environments is recommended.



## Superior Products & Global Reach

Whether your business is around the corner or around the world, Graver Technologies can support you with superior products and services. Our ion exchange, adsorbent, filtration, and membrane products deliver exceptional performance in some of the harshest process environments in North America, Europe, Asia, the Pacific Rim, South America, and Africa.

Graver Technologies is a member of The Marmon Group (a Berkshire Hathaway Company), an international group with more than \$7 billion in annual sales. Around the corner or around the world, Graver Technologies is a fast growing company with the technical resources and financial strength that make us the perfect partner for your business.

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Graver Technologies



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