



Graver Technologies

ZTEC-E Series

**Microelectronics Grade
Polyethersulfone Membrane
Filter Cartridges**

**Performance
Guide**

ISO 9001:2015

Preface

The Graver Technologies ZTEC-E (0.03 µm, 0.1 µm, 0.2 µm, and 0.45 µm) pleated filter cartridges are designed as an exceptionally clean, non-leaching, non-shedding barrier for membrane filtration. These filters offer reliable performance in removing minute contaminants larger than their rated pore sizes. All ZTEC-E filter cartridges incorporate polyethersulfone membrane and all other ZTEC-E cartridge components (cage, core, end caps and support layers) are entirely polypropylene. ZTEC-E filters are manufactured in an ISO Class 7 cleanroom environment. Each filter is rinsed with 18 megohm-cm resistivity de-ionized water to single digit TOC readings and integrity tested before release from manufacture. All the ZTEC-E filter products are fabricated in an ISO 9001, Rev. 2015 Registered manufacturing facility.

Each section of this Performance Guide represents only the summary portion of the actual test. If your company has a need for expanded detail on any specific test method or the actual data, please contact Graver Technologies Filtration & Separation Group for assistance at 1-888-353-0303.

Table of Contents

Preface	2
Table of Contents	3
Nomenclature & Construction	4
Filter Configurations	5
Product Traceability	6
Cartridge Integrity Test	7
TOC Rinse-Up	8
Resistivity Rinse Up	9
Particle Shedding	10
Leachables	11
Flow Rate Testing	12
Core Collapse (Differential Pressure Stress) Test	13
Notes	14
Appendix	15

Nomenclature & Construction


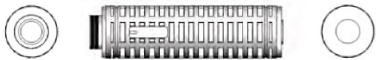




Nomenclature Information						
ZTEC E Filter Type	0.2 Retention Rating (microns)	-10 Nominal length (inches)	P End Configuration		E Gasket or O- Ring	
ZTEC E	0.03	5	P	DOE		
	0.1	9.75	P2	226/flat Single Open End	S	Silicone
	0.2	10	P3	222/flat Single Open End	B	Buna-N
	0.45	20	P7	226/fin Single Open End	E	EPDM
		30	P8	222/fin Single Open End	V	Viton
		40	AM	Single Open End, Internal O-Ring	T	TEV
			NPC	Double Open End, Internal O-Ring		



Materials of Construction

Membrane: Single layer expanded polyethersulfone (PES) – 7.6 ft² (0.7 m²)
 Drainage Layer: Polypropylene
 Core: Polypropylene
 Cage/Outer Sleeve: Polypropylene
 End Caps: Polypropylene
 O-Rings: Viton (standard)
 Silicone
 EPDM
 Buna-N
 Teflon Encapsulated Viton

Filter End Configurations

Graver offers a wide variety of end configurations on our filter cartridges to meet customer requirements and for fit in installed housings. The following guide will familiarize you with the options available.

Style	DOE or SOE	Visual
P	DOE	Thermally bonded-plastic caps with flat gasket seal on both open ends 
P3	SOE	222 double o-ring on open end Flat on closed end 
P8	SOE	222 double o-ring on open end Spear on closed end 
P2	SOE	226 double o-ring on open end Flat on closed end 
P7	SOE	226 double o-ring on open end Spear on closed end 
AM	SOE	Internal o-ring on open end Recessed cup on closed end 

Style	DOE or SOE	Visual
NPC	DOE	Internal o-rings on both open ends 
P28	SOE	222 double o-ring with tabs on open end Spear on closed end 

*DOE = Double Open End / SOE = Single Open End

Note: not all configurations are available on every product. Please consult specific product data sheets for more detail.

The following trademarks are used throughout:

Viton® — Registered trademark of DuPont Performance Elastomers

Teflon® — registered trademark of Dupont

Chemraz® — Registered trademark of Greene Tweed

Kalrez® — Registered trademark of DuPont Performance Elastomers

Santoprene® — Registered trademark of Advanced Elastomer Systems

Product Traceability

ZTEC E Filter Elements are manufactured in conformance with established current Good Manufacturing Practice (cGMP) standards. The filter elements are produced and distributed according to a Quality Management System that is registered for compliance to EN ISO 9001:2015. All ZTEC E filters are non-destructively integrity tested and flushed with Purified Water with a maximum conductivity of 1.1 $\mu\text{S}/\text{cm}$ @ 20°C (68°F) and a maximum TOC (Total Organic Carbon) content of 0.5 mg (500ppb) of carbon per liter. They are then dried using HEPA filtered air and sealed in a protective polyethylene bag within the cleanroom. To enable full traceability of all ZTEC E filter products, each filter module is marked with an individual serial number, a lot number, product code and general description which is also shown on both the bag label and on the outer product box, therefore all data concerning materials used and production data are documented, accessible and fully traceable.



Cartridge Integrity Test

Graver Technologies, as part of its quality process, integrity tests all ZTEC-E filter cartridges before release from manufacturing. The specific test used is a Diffusion Test. A discussion of this testing procedure is included in the package insert accompanying the ZTEC-E product. For an integral cartridge, the air diffusion rate which is a measure of the rate at which air diffuses through the water-filled pores of the membrane, must be below a specified value at the Integrity Test pressure. A cartridge with even a minor defect will exhibit much higher airflow rates when measured by this test.

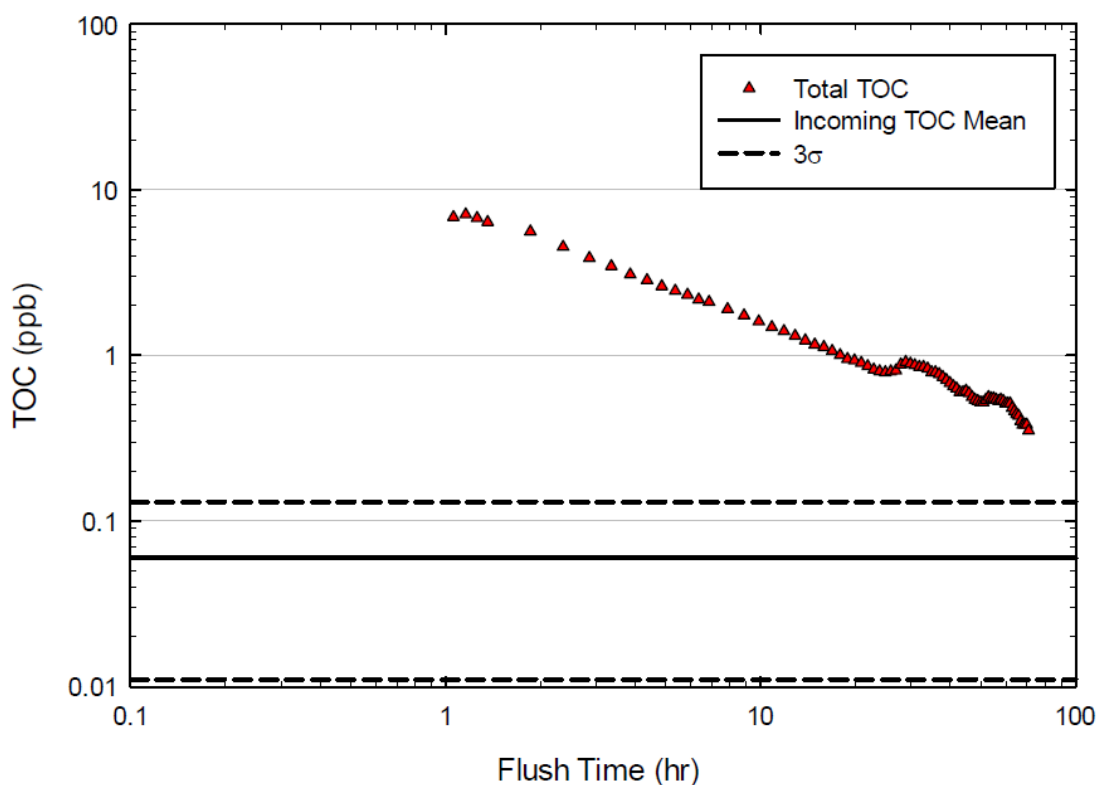
Test Procedure

- 1) A filter cartridge is installed into the test system and wetted with de-ionized water by flowing water through the cartridge.
- 2) The water flow is shut off and a pressure of 5 psid (0.34 bard) of compressed air is applied upstream of the filter. Any excess water in the housing passes through the filter and is drained from the downstream side of the housing.
- 3) The air pressure is increased to the value shown in Table below, “Diffusion Pressure” and the system is allowed to stabilize for 2 minutes
- 4) The diffusive air flow through the filter system is measured and the filter passes the integrity test only if the diffusion flow value is less than the “Maximum Diffusion” shown in the table below.

Pore Size	Test Pressure psig (bar)	Maximum Diffusion (cc/min) per 10-Inch Cartridge Length
0.03 µm	45 (3.1)	≤ 60
0.1 µm	40 (2.8)	≤ 50
0.2 µm	30 (2.1)	≤ 35
0.45 µm	20 (1.4)	≤ 35

TOC Rinse-up

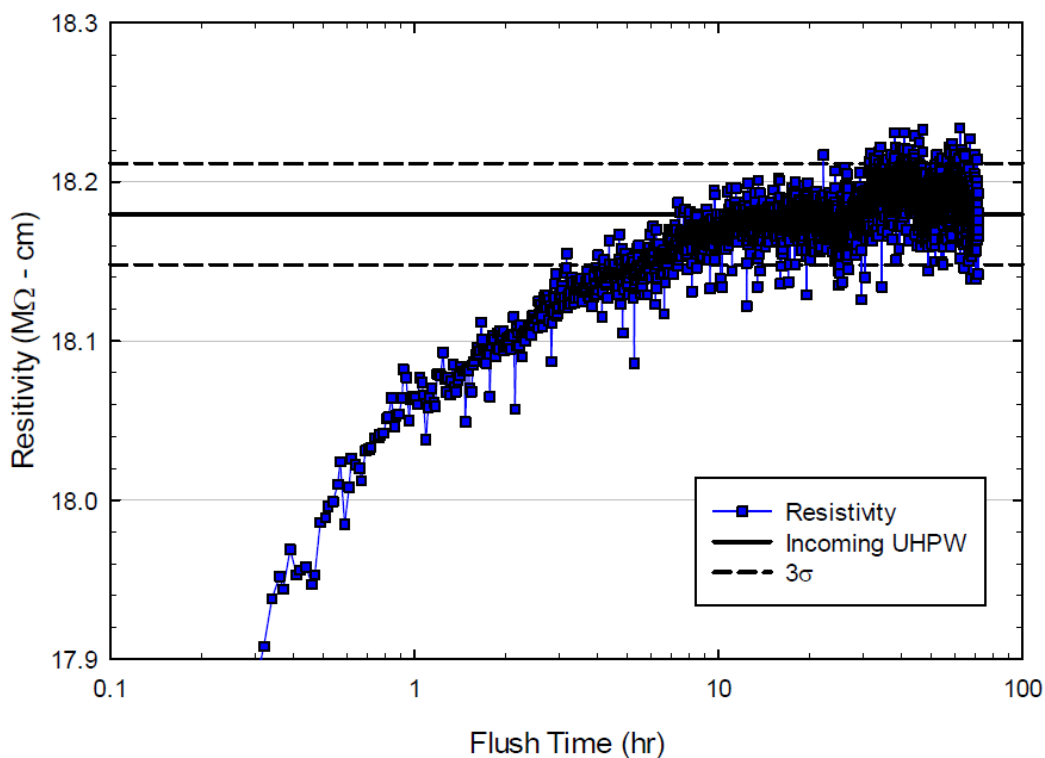
Testing was conducted on ZTEC-E cartridges by flushing with 18 megohm-cm DI water. TOC levels were measured throughout the duration of the test using an Anatel A-1000 Organic Analyzer. Single digit TOC levels are reached within one hour of rinsing and fall below 1 PPB within 18 hours.



During manufacture, each ZTEC-E filter is flushed with semiconductor grade ultrapure water for 50 minutes at a flow rate of 10 GPM, assuring the high purity of each filter shipped. For on-site purposes, customers are advised that a rinse-up of no more than 60 minutes at a flow of 3 GPM will achieve single digit TOC level.

Resistivity Rinse-up

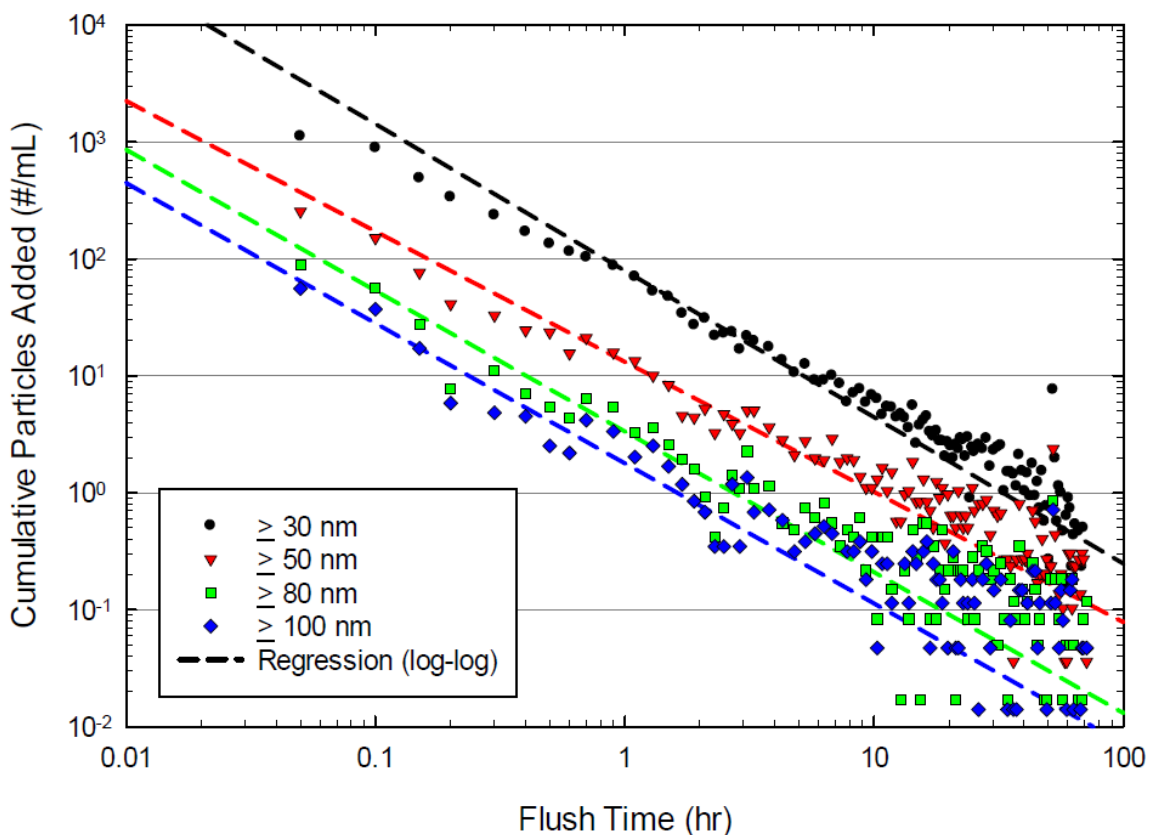
A ZTEC-E sample filter was flushed with ultrapure DI water at a flow rate of 8.5 LPM. Incoming Ultra High Purity Water was showing 18.2 megohm-cm resistivity. The resistivity exceeds 18.0 megohm-cm within 30 minutes of flushing and is equal to the incoming water within 10 hours of flushing.



In production, each ZTEC-E filter is flushed with semiconductor grade UPW for 50 minutes at a flow rate of 10 GPM, assuring the high purity of each filter shipped. For on-site purposes, customers are advised that a rinse-up of no more than 35 minutes at a flow of 3GPM will achieve 18 megohm-cm resistivity.

Particle Shedding

A ZTEC-E sample filter was flushed with ultrapure DI water at a flow rate of 8.5 LPM. Particle shedding from the cartridge was measured over time using Lighthouse NC30+ optical particle counter which is capable of measuring particles as small as 30 nm (0.03 microns). Single digit particle counts above 80 nm are reached within 1 hour and single digit counts for particles as small as 30 nm can be reached with 6 hours.



In production, each ZTEC-E filter is flushed with semiconductor grade UPW for 50 minutes at a flow rate of 10 GPM, assuring the high purity of each filter shipped. For on-site purposes, customers are advised that a rinse-up of no more than 120 minutes at a flow of 3 GPM will achieve single digit particle counts.

Leachables

A factory flushed Graver ZTEC-E 0.03 µm filter was sent to Balazs Analytical Services to determine leachable Anions and Metals in UPW. The cartridge was soaked for 24 hours in 1.5 liters of UPW at ambient temperature and the fluid then analyzed by ion chromatography (IC-ICP-MS)

ANION_PPb					
Analysis / Rep	Result Value	Units			
Bromide	<3	ppb			
Chloride	<5	ppb			
Fluoride	<5	ppb			
Nitrate	<4	ppb			
Nitrite	<5	ppb			
Phosphate	<6	ppb			
Sulfate	<4	ppb			
Metals					
Analysis / Rep	Result Value	Units	Analysis / Rep	Result Value	Units
Aluminum	<0.005	ppb	Lithium	<0.004	ppb
Antimony	<0.004	ppb	Magnesium	0.015	ppb
Arsenic	<0.007	ppb	Manganese	<0.004	ppb
Barium	<0.002	ppb	Molybdenum	<0.003	ppb
Bismuth	<0.005	ppb	Nickel	<0.003	ppb
Boron	<0.006	ppb	Niobium	<0.005	ppb
Cadmium	<0.004	ppb	Potassium	0.056	ppb
Calcium	0.889	ppb	Silver	<0.006	ppb
Chromium	<0.005	ppb	Sodium	0.089	ppb
Cobalt	<0.003	ppb	Strontium	0.003	ppb
Copper	0.174	ppb	Tin	<0.004	ppb
Gallium	<0.004	ppb	Titanium	0.007	ppb
Germanium	<0.004	ppb	Tungsten	0.006	ppb
Iron	<0.005	ppb	Vanadium	<0.005	ppb
Lead	<0.003	ppb	Zinc	0.077	ppb

Flow Rate Testing

To contribute to the overall operating economics of an existing filter system, it is important that process filter cartridges offer high flow rates at low-pressure drops. For new systems, this can also allow a smaller filter housing to be used with a resultant savings in capital cost.

Test Procedure

- 1) A filter cartridge is installed into the test system and wetted with clean water. An integrity test is performed, and the results are recorded. (See Page 7 for Integrity Test Procedure.)
- 2) The filter system is connected to a source of clean water. The pressure of water can be regulated and was adjusted to 18 psi (1.2 bar).
- 3) The flow through the filter is adjusted to establish a test differential pressure across the filter of 1 psid (.07 bard).
- 4) The flow rate through the filter housing is recorded.
- 5) The test is repeated with several cartridges for each pore size.

Results

The filter cartridges at each pore size tested showed flow rates as summarized below, meeting the minimum specifications for that pore size.

Cart. ID #	US GPM Flow at 1 PSID
0.03 µm	1.3
0.1 µm	2.3
0.2 µm	2.8
0.45 µm	5.1

Specification

Based on this testing, the typical flow rate/pressure drop characteristics of ZTEC-E cartridges per 10-inch cartridge length are:

0.03 µm: 1.3 gpm/psid
0.1 µm: 2.3 gpm/psid
0.2 µm: 2.8 gpm/psid
0.45 µm: 5.1 gpm/psid

Core Collapse (Differential Pressure Stress) Testing

In normal use a filter cartridge will be exposed to an increasing differential pressure as the filter accumulates contaminants. In addition, due to normal stops and starts in a production line, the filter will be subjected to numerous differential pressure surges. The limiting factor in a filter cartridge's resistance to differential pressure is the strength of the cartridge core.

The testing regimen below was designed to stress the ZTEC-E filter core under more rigorous conditions than the filter would normally be exposed to in "real world" operation. To pass this test, the filter cartridge must remain integral throughout the pressure testing.

Test Procedure

- 1) A filter core, bonded to an adapter suitable for a test housing (e.g., -226 or -222 adapter), is encased in a non-porous film to prevent permeability of a test liquid.
- 2) The core is installed into the filter housing, which is attached to a hydraulic test system.
- 3) At ambient temperature, hydraulic pressure is slowly increased until the core collapses.
- 4) The temperature of the hydraulic fluid, and hence the housing/filter core, is increased to 176°F (80°C).
- 5) The hydraulic pressure is slowly increased until the core collapses.

Results

The filter cores consistently avoided collapse until well over 100 psid (6.9 bard) at ambient temperature (70°F/21°C). The filter cores consistently avoided collapse until well over 60 psid (4.1 bard) at an elevated temperature of 176°F (80°C).

Collapse Strength	Temperature
100 psid (6.9 bard)	70°F (21°C)
60 psid (4.1 bard)	176°F (80°C)

Conclusion

Based on this testing and Graver Technologies ZTEC-E cartridge fabrication methodology, ZTEC-E cartridge filters can withstand differential pressures up to 80 psid @ 70°F (5.5 bard @ 21°C), and 40 psid @ 176°F (2.8 bard @ 80°C) and remain integral.

Recommended Max Operating Conditions	Temperature
80 psid (5.5 bard)	70°F (21°C)
40 psid (2.8 bard)	176°F (80°C)

NOTES

Appendix