

3M Purification

Product Brochure - Filter Cartridges and Capsules
for the Food & Beverage Industry



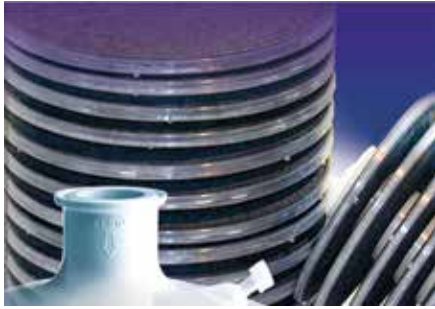
Zeta Plus™ Activated Carbon

The smart way to use carbon

Featuring:

- Activated carbon immobilized within a filter matrix
- Scale-up from discs and capsules to sheets and cartridges
- Wide range of different carbons available





Zeta Plus™ Activated Carbon Products: The efficient way to decolorize your process liquids

Zeta Plus™ Activated Carbon products incorporate our latest technology to decolorize and remove contaminants from process streams. In today's manufacturing processes, efficiency, yield, quality and consistency are critical, as well as operating in a safe environment for operators. Zeta Plus Activated Carbon products eliminate most of the handling concerns of using powdered carbon. Bulk carbon operations may also negatively impact yields, and thereby increase the required number of production batches. Zeta Plus Activated Carbon products may help address many of these operational and performance concerns.

Activated carbon

Activated carbon is a highly porous carbonaceous material that is characterized by a large internal surface area, providing exceptional adsorptive properties. Pores within the structure can be classified into different categories depending on their size: micropores (< 10 nm range), mesopores (10-25 nm range) and macropores (larger than > 25 nm).

Activated carbon can be produced from different sources such as peat, lignite, pine wood, coconut shell, etc. The raw material influences the pore structure of the activated carbon; as an example, activated carbon made from pinewood has a wide distribution of micro, meso and macro pores, whereas activated carbon obtained from coconut shell is typically microporous.

Two ways of activation used to create the porosity and internal structure of carbon are steam and chemical activation. In practice, steam activation leads to a greater degree of microporosity, while chemical activation makes a more macroporous/mesoporous structure.

The porous structure gives the activated carbon a very large internal surface area (larger than 500 m²/g) which allows the activated carbon to be efficient in adsorbing a wide range of molecules. Adsorption is caused by Van der Waals' forces. These short-range interactions are influenced by the nature of the molecule being adsorbed, such as its molecular weight and the presence of functional groups (double bonds, halogen).

Figure 1 and figure 2 show activated carbon and Zeta Plus Activated Carbon media.

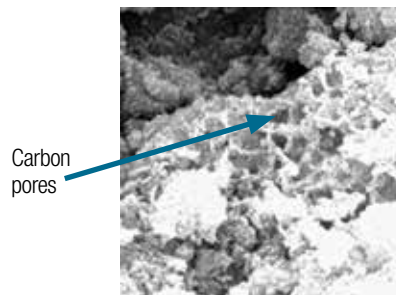


Figure 1:
Activated carbon

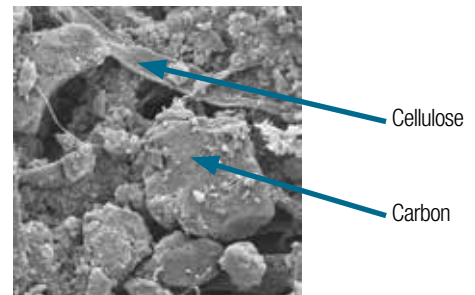


Figure 2:
Zeta Plus™ Activated
Carbon media

The Zeta Plus™ Activated Carbon principle

Zeta Plus™ Activated Carbon filter media is made by formulating bulk activated carbon with cellulose fibers and a positively charged binder resin. This combination is wet formed into a robust porous filter matrix or media. The activated carbon particles are immobilized in the filter matrix ensuring minimal particle shedding during use.

3M Purification offers five standard product grades, each based on a different type of activated carbon. These carbon types have been specifically selected for their properties to cover a broad range of applications while meeting various industry requirements. Zeta Plus Activated Carbon filter media is available in three different porosities so that solutions with different viscosities can be processed.

Regulatory Information

When used according to 3M's product use requirements, including a minimum required pre-conditioning flush with a 50% ethanol/water solution at 54 L/m² of filter media*, and a minimum use volume of 12,000 kg/m² of filter media, Zeta Plus™ AC series filter products may be used in food processing applications as described below in full compliance with the Federal Food, Drug, and Cosmetic Act and the applicable regulations administered by the United States Food and Drug Administration (FDA) in 21 C.F.R. parts 170-190.

For additional information, please refer to 3M Purification Technical Brief: 70020340314

Advantages of using Zeta Plus Activated Carbon vs. bulk activated carbon

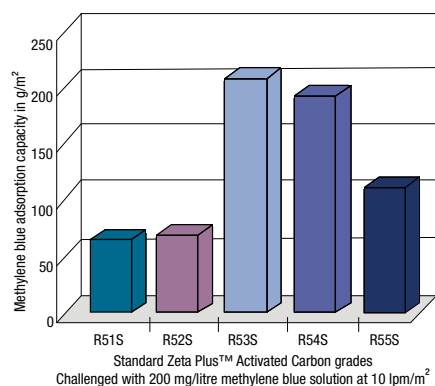
Immobilizing activated carbon in a filter matrix has many distinct advantages over bulk carbon. Some of the advantages of using Zeta Plus Activated Carbon are summarized in Table 1 below:

Table 1: Advantages of Zeta Plus™ Activated Carbon compared to bulk activated carbon		
	Bulk activated carbon	Zeta Plus™ Activated Carbon advantage
Carbon dust	<ul style="list-style-type: none"> Potential health issues Safety 	<ul style="list-style-type: none"> Reduced fire risk and reduced carbon dust.
Cleanliness	<ul style="list-style-type: none"> Production process: <ul style="list-style-type: none"> Time consuming Hard to clean Potential batch to batch cross-contamination Potential for downstream carry over 	<ul style="list-style-type: none"> Clean product After initial flush of the cartridge, there is minimal release of carbon fines in the filtered solution
Process times	<ul style="list-style-type: none"> Long due to contact time, preparation time and removal time 	<ul style="list-style-type: none"> Decreased process time because of constant flow rate filtration and efficiency No product rework because of consistent performance
Carbon powder	<ul style="list-style-type: none"> Relies on diffusion of contaminants to reach active site Additions of filter aid required to remove carbon 	<ul style="list-style-type: none"> Activated carbon is fixed and the flow is forced through the matrix that increases mass transfer efficiency
Process steps	<ul style="list-style-type: none"> A filtration step is required to remove the carbon fines Potential for carry over to solvent recovery plants 	<ul style="list-style-type: none"> A single step used as decolorization is combined with the filtration step Potential for reduced costs in solvent recovery

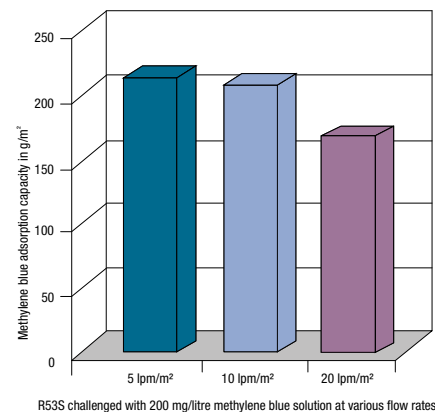
*The flush solution must be removed from the processing system prior to exposing the filter to the customer product.



Graph 1: Adsorption capacity of Zeta Plus™ Activated Carbon



Graph 2: Adsorption capacity of Zeta Plus Activated Carbon R53S



Decolorization efficiency of Zeta Plus™ Activated Carbon

One metric to characterize Zeta Plus™ Activated Carbon media is methylene blue (an organic dye) dynamic binding capacity. The methylene blue dynamic binding capacity is widely used by activated carbon manufacturers as a reference for decolorization efficiency. This molecule has a 8 nm diameter, which means that it has the ability to enter pores with a diameter larger than 8 nm. In the glucose syrup industry (where activated carbon is used to remove a color precursor called methyl-hydroxy-furfural), and in pharmaceutical and chemical synthesis (where many contaminants and by-products are formed), activated carbon with high methylene blue capacity can be beneficial.

Methylene blue test

Graph 1 shows the methylene blue adsorption capacity of several 3M Purification standard Zeta Plus Activated Carbon grades.

Due to the chemical variations in contaminants targeted to be removed, methylene blue dynamic binding capacity can not be used to universally compare the performance Zeta Plus Activated Carbon in all applications. It is, therefore, recommended to perform a bench-scale test to identify the most efficient Zeta Plus Activated Carbon grade.

Flow rate influence

As discussed earlier, adsorption of molecules by activated carbon relies on Van der Waals' forces. As those interactions are of short range, residence time between the solution and the filter media is critical.

Graph 2 shows the influence of flux (flow rate per unit area) on the adsorption capacity of the filter media. It shows that when the flux increases the adsorption capacity of Zeta Plus Activated Carbon filter media decreases.

High decolorization efficiency

Zeta Plus Activated Carbon contains a very high loading level of the adsorbent. The five standard product grades offered are based on a range of targeted, high performing carbon types.

Evaluation and scaling-up

3M Purification offers a range of Zeta Plus Activated Carbon product configurations for laboratory-scale filtration, for process development studies and for small to large production scale operations. BC25 single-use capsules have effective filter areas of 25 cm² enabling process development and scale-up. In addition, Zeta Plus Activated Carbon discs (47 mm and 90 mm diameter) are available. These are ideal for carbon selection and scale-up evaluation. Numerous companies worldwide have scaled-up reliably and predictably to 12" and 16" diameter cartridge systems using small surface area Zeta Plus Activated Carbon discs and BC25 capsules, with the assistance of scientists from 3M Purification Scientific Application Support Services (SASS).

Zeta Plus™ Activated Carbon filtration is scaled-up using a fixed filter flux (fluid flow rate per effective filtration area). Zeta Plus Activated Carbon should be evaluated initially at a recommended flux of 1-3 lpm/m². However, there are some successful applications where flux can be much higher than this recommended value, while maintaining high adsorption efficiency.

Applications

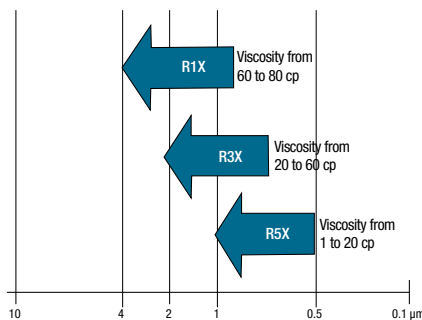
Zeta Plus™ Activated Carbon can be used in any application where bulk activated carbon is involved. It is widely used in the following applications:

Food and beverage

- Removal of trace organic contaminants from gelatin, pectin, juices, oils
- Decolorization of wine and cider
- Decolorization of sugar
- Decolorization and flavor adjustment of distilled spirits
- Haze removal



Graph 3: Types of media for different fluid viscosities



Grades of Zeta Plus™ Activated Carbon

Zeta Plus™ Activated Carbon is available in different porosities or filtration ratings to optimize performance with fluids having different viscosities. Graph 3 can be used as a guide for optimum filter selection.

Cartridge construction

Cartridge construction provides integrity in severe environments including *in situ* steam sterilization and hot water sanitation.

The edge seal design for durable cell construction maintains integrity under many demanding process conditions.

Filter housings

3M Purification offers a wide range of sanitary filter housings (standard and custom designs) for Zeta Plus Activated Carbon cartridges.

Operating parameters

Max. operating temperature	Cartridges: 176 °F (80 °C) BC25 capsules: 104 °F (40 °C)
Max. differential pressure	2.4 bar (35 psid)
Required pre-conditioned flush with a 50% ethanol/water solution*	54 l/m ² (1.25 gal./ft ²) of media
Recommended test flow rate	3 liters/min/m ² of media
Steam sterilization	Cartridges: 1 cycle at 250 °F (121 °C) for 30 min. BC capsules: autoclave only
*The flush solution must be removed from the processing system prior to exposing the filter to the customer product.	
** Contact 3M Purification for additional information.	



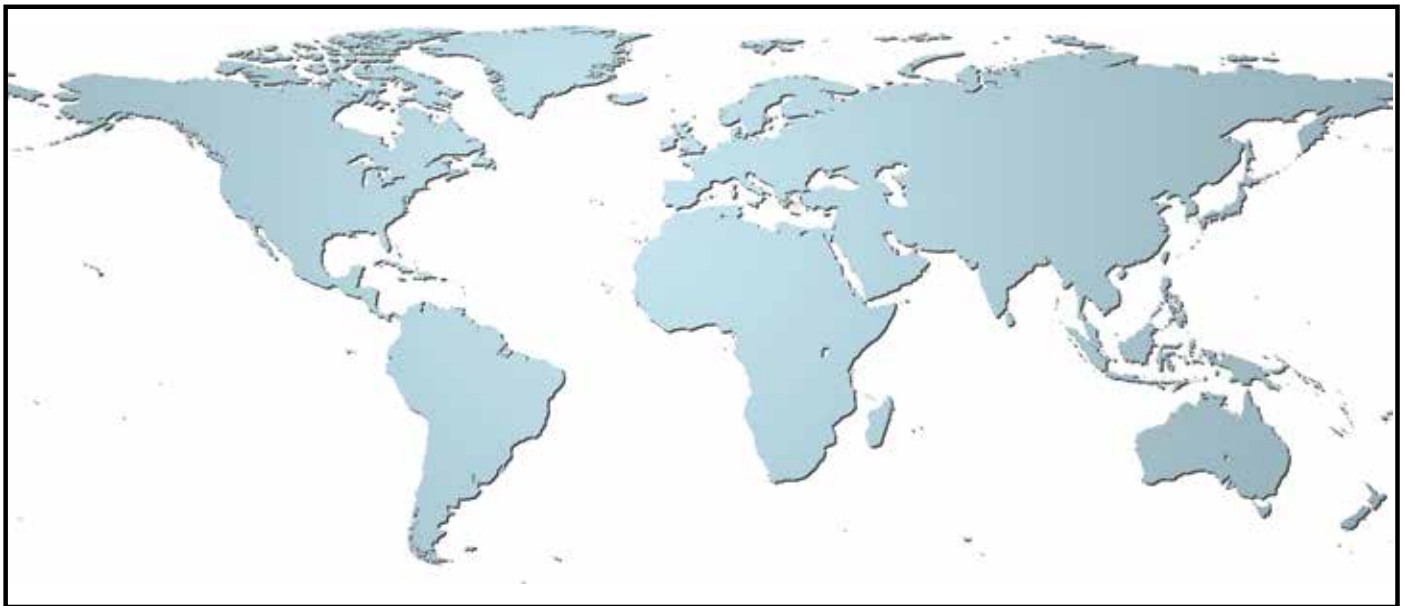
Scientific Applications Support Services (SASS)

3M Purification's 100 years of experience are synonymous with quality, performance and high level technical support. The cornerstone of 3M Purification's philosophy is service to customers, not only in product quality and prompt delivery, but also in validation assistance, applications support and in the sharing of scientific information.

3M Purification's Scientific Application Support Services group works closely with customers to solve difficult separations problems and to recommend the most economical and efficient filter system. SASS specialists are skilled in performing on-site testing and relating test results to full-scale manufacturing operations.

A world leader in fluid purification

3M Purification's manufacturing sites producing Zeta Plus Activated Carbon have ISO registered quality systems. Global manufacturing together with trained stocking distributors and state-of-the-art laboratory support bring quality solutions to existing and challenging new filtration applications.



Zeta Plus™ Activated Carbon Series filters - Ordering guide

Zeta Plus™ BC Capsules

Catalog number	Basic cartridge design/Effective filter area	Connection/Packaging	Grade	Quality grade
BC	0025 (Capsule, 25 cm²)*	L = Luer lock S = Sanitary flange	R11, R12, R13, R14, R15, R31, R32, R33, R34, R35, R51, R52, R53, R54, R55	S

Examples of entire product description: BC0025LR11SP, BC2000AR55S
* Minimum order quantity 4 pieces

8" Diameter Cartridges

Catalog number	Basic cartridge design/Effective filter area	Gasket material	Grade	Quality grade
C08	D = 8", 7 cells, 0.23 m², DOE (double open end)	Standard: A = Silicone Other: B = Fluorocarbon C = Ethylene propylene D = Nitrile E = PTFE	R11, R12, R13, R14, R15, R31, R32, R33, R34, R35, R51, R52, R53, R54, R55	S

12" Diameter Cartridges**

Catalog number	Basic cartridge design/Effective filter area	Gasket material	Grade	Quality grade
C12	C = 12", 9 cells, 0.9 m², DOE D = 12", 13 cells, 1.2 m², DOE	Standard: A = Silicone Other: B = Fluorocarbon C = Ethylene propylene D = Nitrile E = PTFE	R11, R12, R13, R14, R15, R31, R32, R33, R34, R35, R51, R52, R53, R54, R55	S

** 12" diameter cartridges, in double open end (DOE) configuration, can be obtained with Hastelloy® bands.

16" Diameter Cartridges

Catalog number	Basic cartridge design/Effective filter area	Gasket material	Grade	Quality grade
C16	M = 16", 13 cells, 3.0 m², Stainless steel bands, DOE	Standard: A = Silicone Other: B = Fluorocarbon C = Ethylene propylene D = Nitrile E = PTFE	R11, R12, R13, R14, R15, R31, R32, R33, R34, R35, R51, R52, R53, R54, R55	S

Zeta Plus™ Activated Carbon Filters



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