

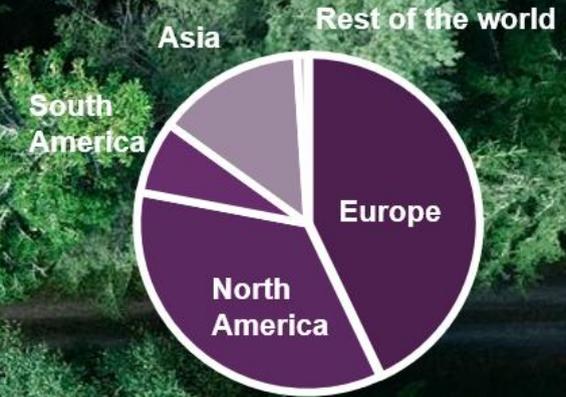
Introduction to Disruptor®

Ahlstrom – Munksjö in a nutshell

Global leader in sustainable and innovative fiber-based solutions

What we do

- Fibers are at the core of what we do and the common denominator for our products and solutions
- Natural fibers represent 95% of our total fiber use
- We offer custom made specialized fiber-based materials
- Our value proposition is based on innovation, quality and service
- Our offering contributes to a more sustainable everyday life

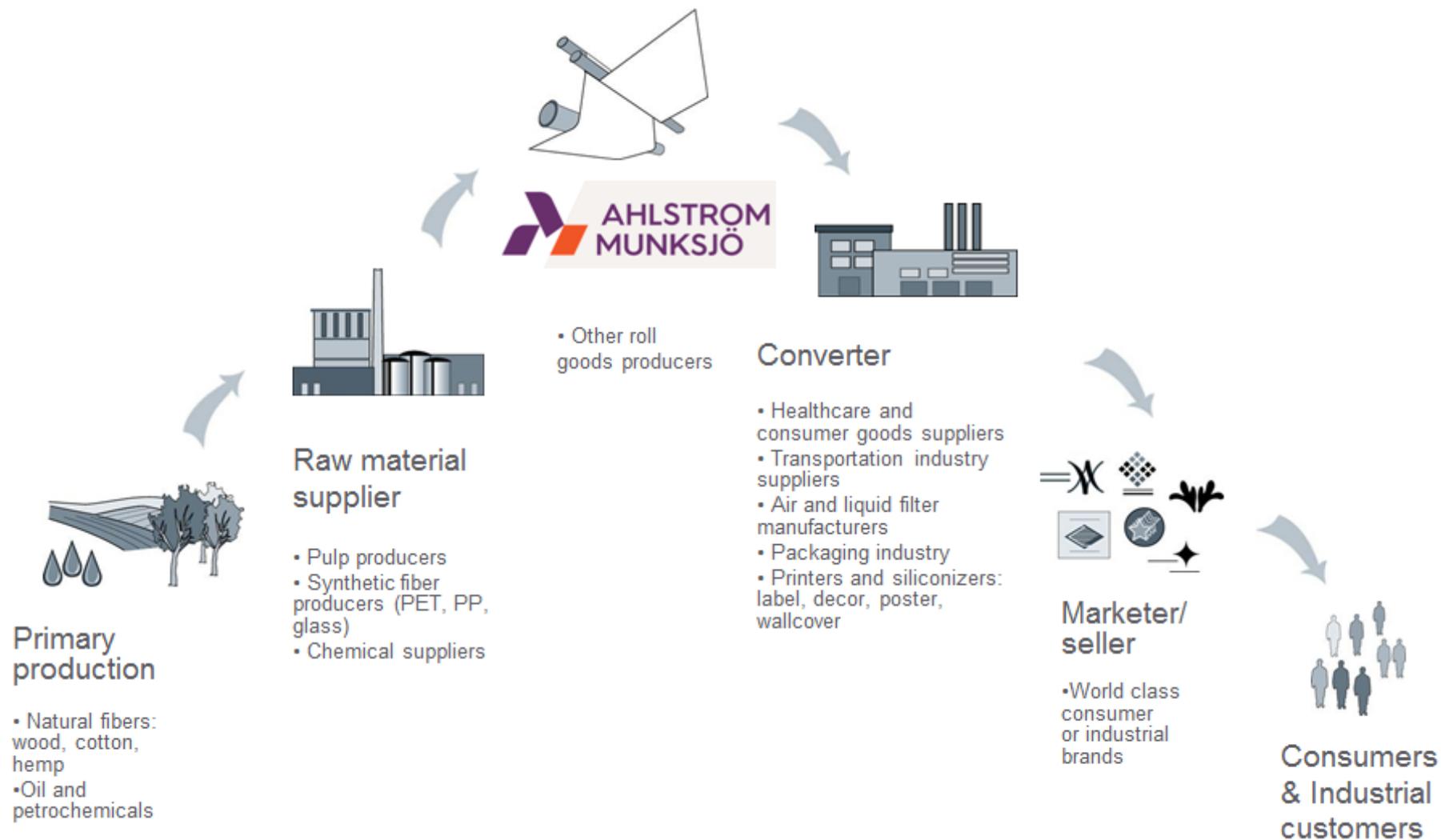


Global presence with 45 plants in 14 countries

- Global network of sales offices and 45 plants in 14 countries
- Approximately 7,800 employees
- More than 6,000 customers in over 100 countries
- Net sales of approximately EUR 2.7 billion
- Head office in Helsinki, Finland

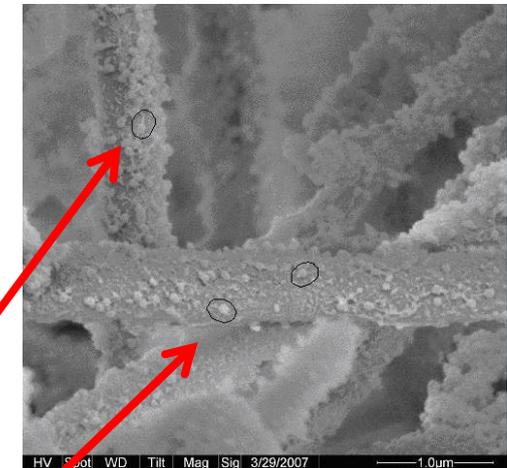
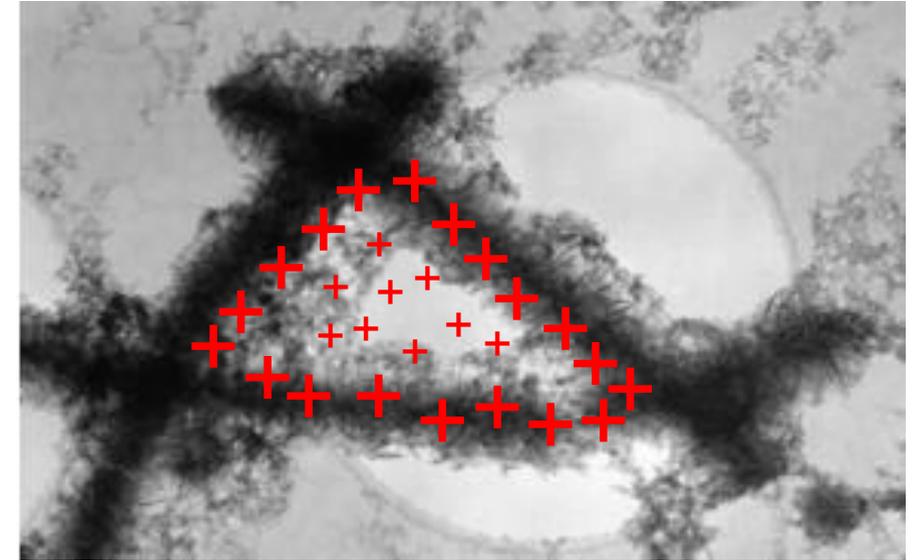


Ahlstrom-Munksjö in the value chain



What is Disruptor®?

- Disruptor® is a breakthrough technology for the **more demanding** water purification needs.
- Not directly comparable to any other water purification media currently in the market, Disruptor® is an **electro-adsorptive technology**: due to its crystal structure, the mineral creates a natural, strong positive charge which attracts the negative charge present on most submicron contaminants.
- When exposed to water having a **pH between 5 – 9,5** a charge potential is generated by the natural crystal structure of the fibers overlapping further into the fiber pore structure.
- Since Disruptor® is an electro-positive wet-laid nonwoven with a pore size around 1.2-1.5 microns it captures very small diameter substances and pathogens, but in addition also removes larger particles **mechanically**.



Bacterial cells: typically 1-10 micron in length & 0,2-1 ,0 micron in width

Viruses: typically 0,004 – 0,1 micron in size

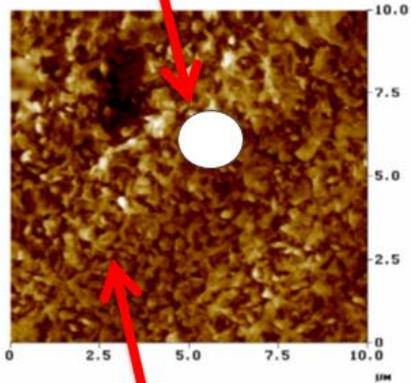
Cysts: typically 2 – 50 micron in diameter



Biological testing vs. pathogen and contamination types

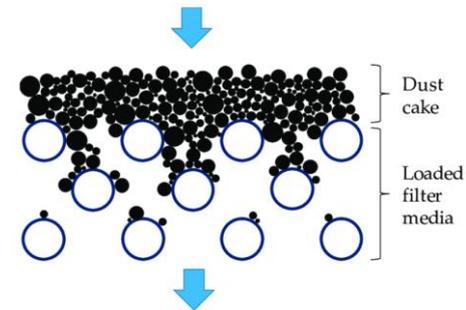
- Reduction of virus typically requires the use of ultrafiltration or reverse osmosis membranes
- Disruptor® technology reduces virus, bacteria and endotoxin with high flow and low pressure drop as compared to polymeric membranes
- Thanks to the wet-laid production technique Disruptor removes contaminants both by the electro-positive charging mechanism but also mechanically due to the porosity gradient and depth filtration mechanism.

Disruptor® pore size on same scale!

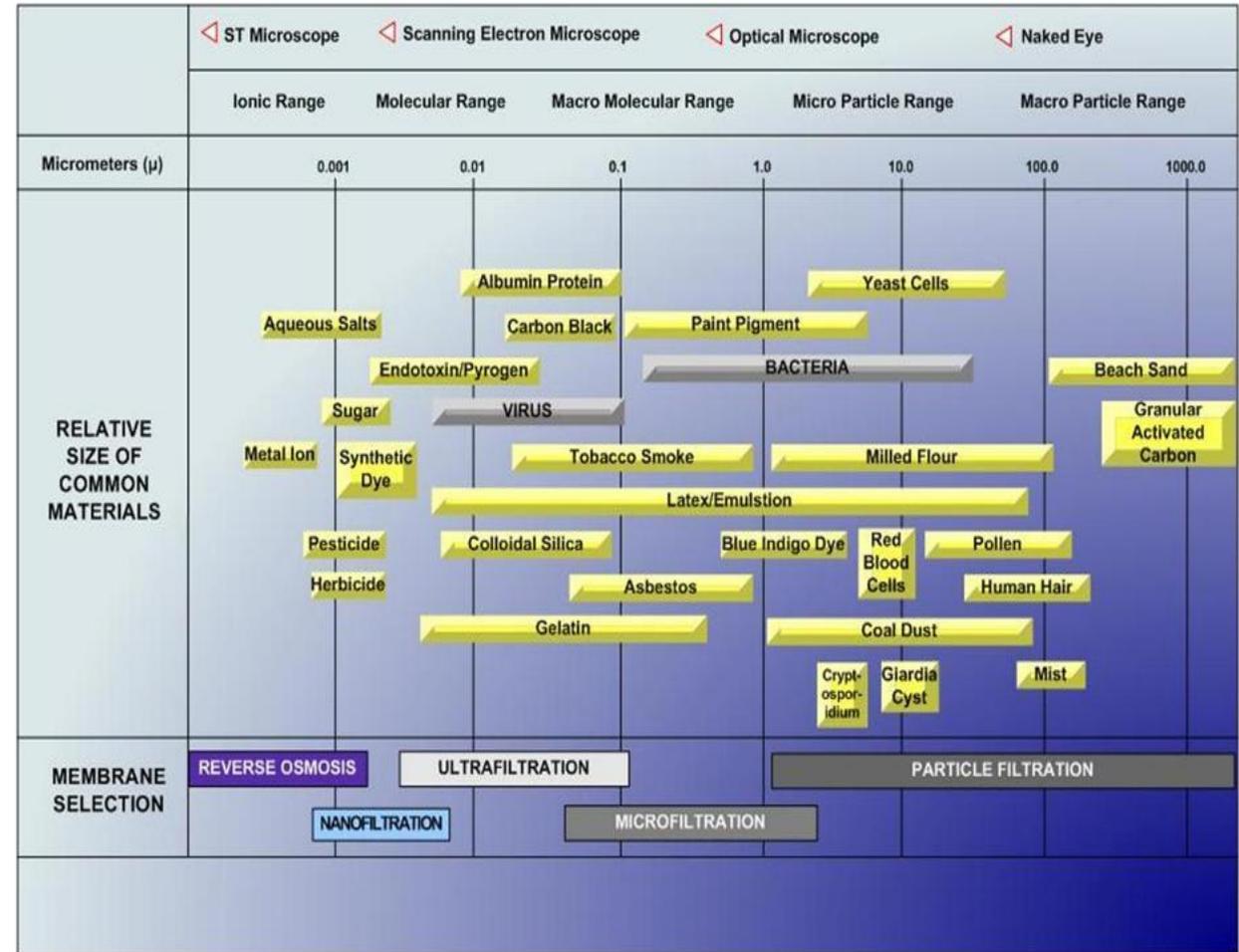
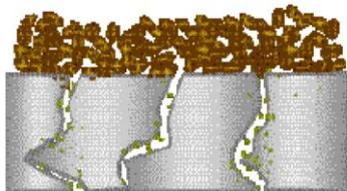


RO Membrane surface

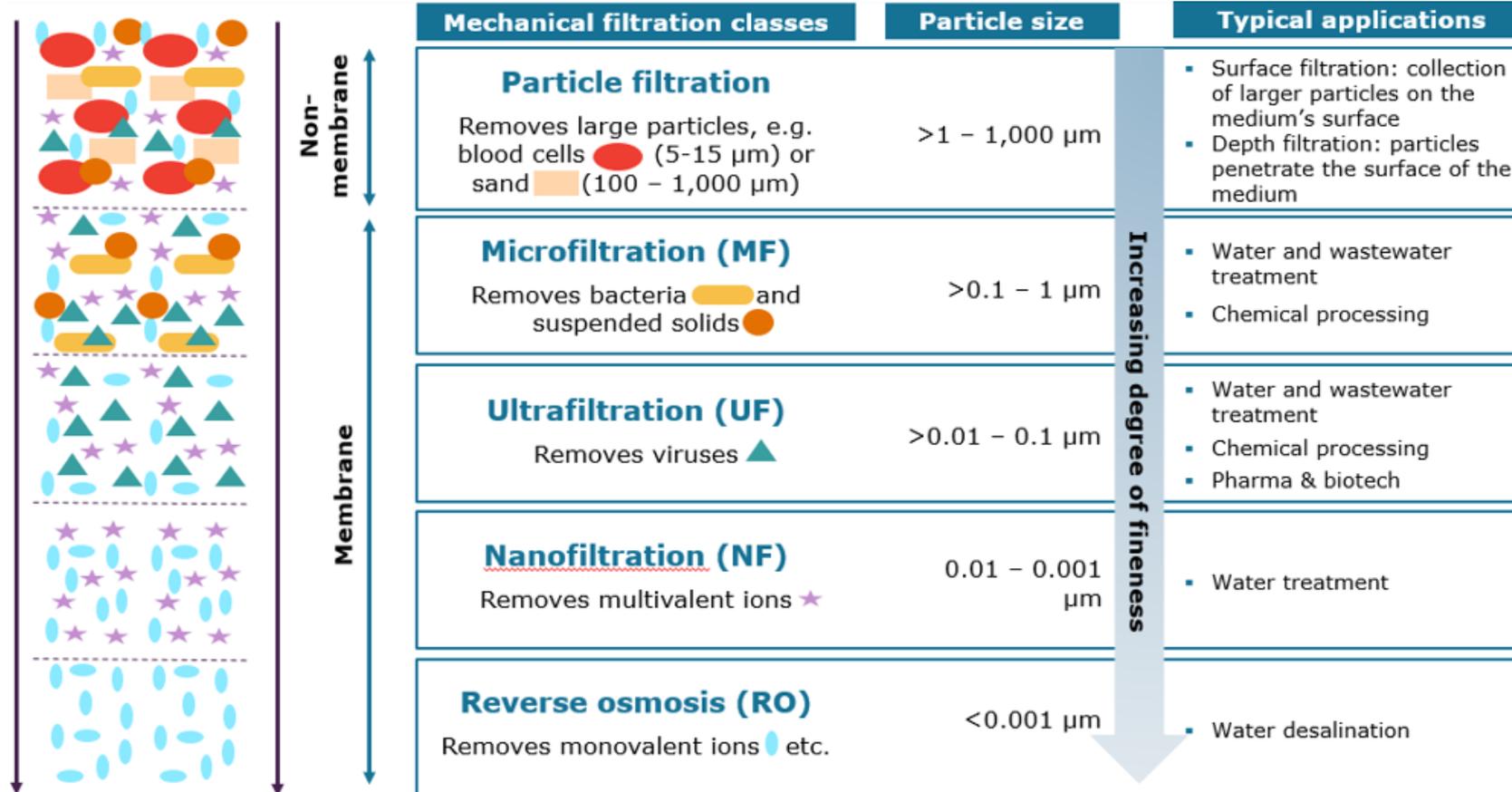
Disruptor – Depth filtration



MF/UF/NF membranes – Surface filtration

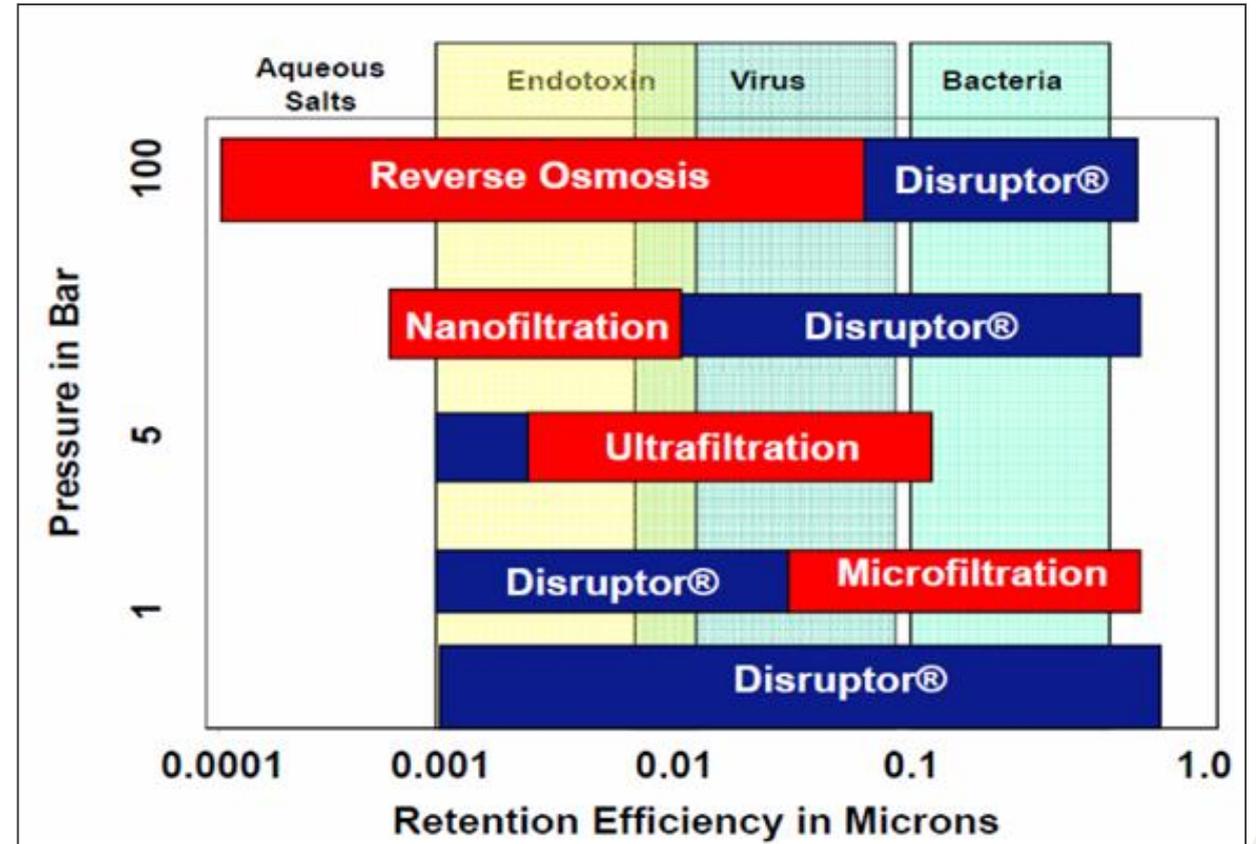


Disruptor® performance coverage compared to std. membrane product offerings



How can Disruptor® be used?

- Due to the open media structure Disruptor® can be used in a very wide range of end uses covering both **pressurized** water purification systems as well as **gravity flow** applications.
- Disruptor® can compete as a **stand alone** alternative to polymeric membranes or used **in combination** with other water purification technologies.
- In addition to outstanding pathogen performance products available also with special functionalities such as **chlorine** removal, **heat-sealing**, and **antimicrobial treatment** for preventing bacteria build-up.
- The removal of selected **trace metals** in given pH ranges.
- Disruptor® media is **easy to convert** and can be made into virtually any size filter cartridge.



Why buy Disruptor®? Key value propositions

Performance

- Disruptor® removes a **wider range** of contaminants than membranes, carbon blocks, particulate cartridges and ultraviolet technologies such as bacteria/legionella, viruses, cyst, endotoxin, polysaccharides, colloids, trace pharmaceuticals, particulates, PFOA/PFOS, chlorine, etc.
- **Hundreds of billions** of bacteria, viruses, Cysts, and other pathogens can be removed per m² of Disruptor® filter media at a very high % removal rate.
- The contamination removal functionality is based on **electro-positive charge** but also **mechanical filtration** since the media MFP (Mean Flow Pore) is in the 1-2 micron size range. Thanks to the porosity gradient for enhanced depth filtration Disruptor® offers extended filter life opposed to membranes relying only on surface filtration for contaminant removal.

Energy Savings - Sustainability

- Disruptor® offers very **high flux rates** at lower pressure drops compared to competing technologies with similar biological removal performance and media pore sizes.
- Disruptor® can therefore be designed for **both gravity flow** as well as **pressurized** water purification systems.
- Due to the **high surface area** less material is needed compared to competing technologies such as e.g. hollow fibers or flat membranes

Product Safety - Taste

- Disruptor® removes effectively the pathogens and other contaminants, but in parallel **maintaining the minerals** for taste in the water **without issues of handling “brine” waste-water** using RO systems.
- Compared to UF/hollow fibers Disruptor® **does not block easily** and filter remains odorless even if not used for several days.
- All Disruptor® grades are complying under **NSF/ANSI 42** applicable drinking water requirements.

Flexibility & Multi-functionality

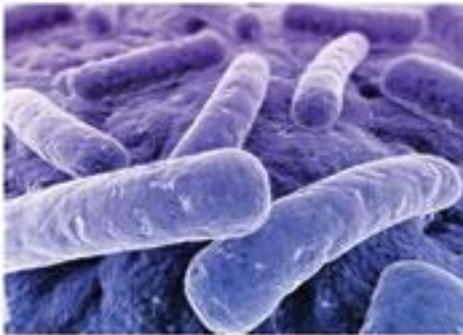
- Disruptor® can be used as a **stand-alone** solution or **in combination** with other technologies depending on the level of water purification needs. It can be used in pleated configurations to fit any filter housing size, or in the format of die cut flat samples.
- Since Disruptor® is also a unique **“one of it’s kind” technology** in the market-place it offers excellent opportunities for **product differentiation** in both pressurized and gravity flow applications.



Ahlstrom-Munksjö quality testing of initial bacteria (RT), virus (MS2), and cyst (test method: TM-120)

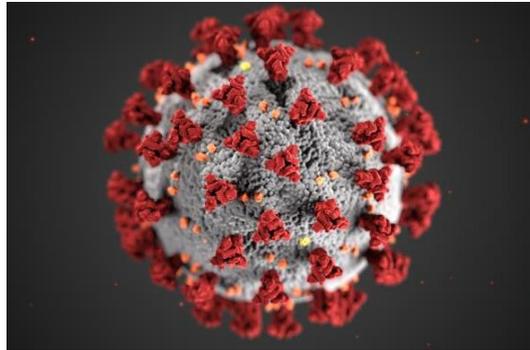
Bacteria

- *Raoultella terrigena*
- Influent concentration of 10^5 or 10^6 per ml
- Required reduction 99.9999% or **6 log**



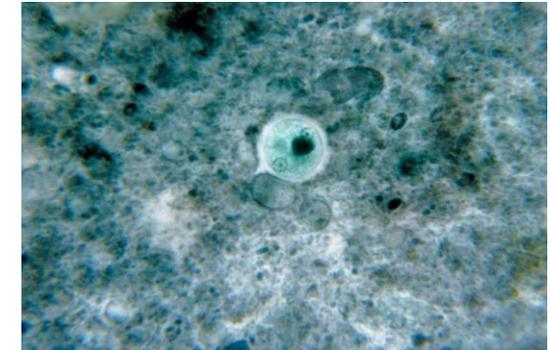
Virus

- MS2 Bacteriophage
- Influent concentration of 10^5 or 10^6 per ml
- Required reduction 99.99% or **4 log**



Cyst

- 3 microns bead surrogate
- Influent concentration of 10^5 or 10^6 ml
- Required reduction 99.95% or **3.5 log**



In comparison: Ganges River in India carries a total coliform concentration in the 1×10^6 /ml range

Virus (MS2) capacity testing for 5283 at 3rd party BCS labs.



Single Layer 90 mm	MS-2 PLAQUE FORMING UNITS COUNTS PER MILLILITER												
	Influent	1 Liter Effluent	5 Liter Effluent	10 Liters Effluent	15 Liters Effluent	20 Liters Effluent	25 Liters Effluent	30 Liters Effluent	35 Liters Effluent	40 Liters Effluent	45 Liters Effluent	50 Liters Effluent	55 Liters Effluent
Filter A	3.0 x 10 ⁵	<0.45	<0.45	1,4	1,4	0,91	4,5	6,3	12,2	24,1	27,2	28,6	N/A
Filter B		<0.45	<0.45	1,4	1,4	2,7	3,6	6,3	16,8	28,1	31,8	32,7	N/A

Single Layer 90 mm	MS2 PERCENT REDUCTION (%)												
	Influent	1 Liter Effluent	5 Liter Effluent	10 Liters Effluent	15 Liters Effluent	20 Liters Effluent	25 Liters Effluent	30 Liters Effluent	35 Liters Effluent	40 Liters Effluent	45 Liters Effluent	50 Liters Effluent	55 Liters Effluent
Filter A	3.0 x 10 ⁵	>99.9999%	>99.9999%	99,9995%	99,9995%	99,99997%	99,9999%	99,998%	99,996%	99,991%	99,991%	99,99 %	N/A
Filter B		>99.9999%	>99.9999%	99,9995%	99,9995%	99,9991%	99,999%	99,998%	99,994%	99,99 %	99,99 %	99,99 %	N/A

Corresponding to ca. 8000 liters/m² capacity or in total 2,36 x 10¹² (2,36 trillion) MS2 virus removed per m2 media at LRV 4.



Bacteria (E-Coli) capacity testing for 5283 at 3rd party BCS labs.



Single Layer 90 mm	Day 1 Date: __02/14/2017__													
	Influent	1 Liter Effluent	15 Liter Effluent	30 Liters Effluent	45 Liters Effluent	60 Liters Effluent	75 Liters Effluent	90 Liters Effluent	105 Liters Effluent	120 Liters Effluent	135 Liters Effluent	150 Liters Effluent	165 Liters Effluent	180 Liters Effluent
5283 Filter A__	6.0 x 10 ⁵	>99.99993%	>99.99993%	>99.99993%	>99.99993%	>99.99993%	99,9991%	99,998%	99,996%	99,998%	99,992%	99,99 %	99,98 %	99,91 %
5283 Filter B__		>99.99993%	>99.99993%	>99.99993%	>99.99993%	99,9998%	99,999%	99,998%	99,996%	99,996%	99,995%	99,99 %	99,96 %	99,9%

Corresponding to ca. 7100 liters/m² capacity or in total 4,25 x 10¹² (4,25 trillion) E-Coli bacteria removed per m² media at LRV 6.

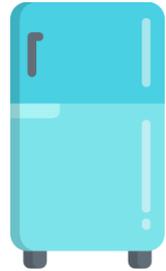


Where can Disruptor® be used?



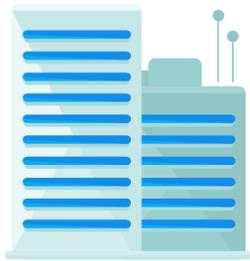
Personal Use

- Water bottle
- Backpack



Residential

- Top
- Countertop
- Under sink
- Pitcher
- Shower
- Dispenser
- Cooler
- Refrigerator
- Roof-top tank
- Whole house



Commercial

- Soft drink
- Coffee
- Tea
- Water
- Ice machines
- Buildings
- Hospitals



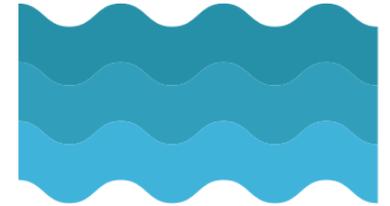
Industrial

- Cooling tower
- Manufacturing
- Water reuse
- Nuclear
- Aquaculture



Municipal

- Drinking water
- Waste water



Desalination

- Sea water
- Brackish water
- River water

Opportunities to tailor-make Disruptor® solutions covering the complete range of water purification applications!



Where can Disruptor® be used? (cont.)

Filtration Technology Positioning

Water Remediation Technologies - Residential, Commercial, Industrial, Municipal, Desalination								
	Disruptor® PAC Technology	RO	NF	UF	MF	Particulate Catridges	Carbon Block	Ultra Violet
Contaminants								
Dissolved Minerals		x						
Endotoxin	x	x	x	x	x	x		
Virus	x	x	x					x
Bacteria	x	x	x	x	x	x	x	x
Cysts	x	x	x	x	x	x	x	x
Polysaccharides (TEP)	x	x	x	x	x			
Colloids	x	x	x	x				
Particulates	x	x	x	x	x	x	x	
Chemical Reduction	x	x					x	x
Trace Pharmaceuticals	x	x					x	x

Membrane definition: Reverse Osmosis=RO; Nanofiltration=NF; Ultrafiltratio=UF; Microfiltration=MF.



Thank you!

