TRAINING WORKSHOP ON WATER MONITORING NETWORK AND EARLY WARNING SYSTEM

16-19 AUGUST 2021

VIRTUAL-SESRIC, ANKARA - TURKEY

Most Trouble Shouting & Mistakes Could be Happened in the Drinking & Industrial water plant:

Biofilms Forming ,Contamination of *Pseudomonas aeruginosa*

Problems and solutions.

مختبرات غرفة التجارة والصناعة والزراعة في طرابلس ولبنان الشمالي
LABORATORIES OF CHAMBER OF COMMERCE INDUSTRY & AGRICULTURE of Tripoli and North Lebanon

الجامعة اللبنانية
UNIVERSITE LIBANAISE

LEARNING OBJECTIVES:

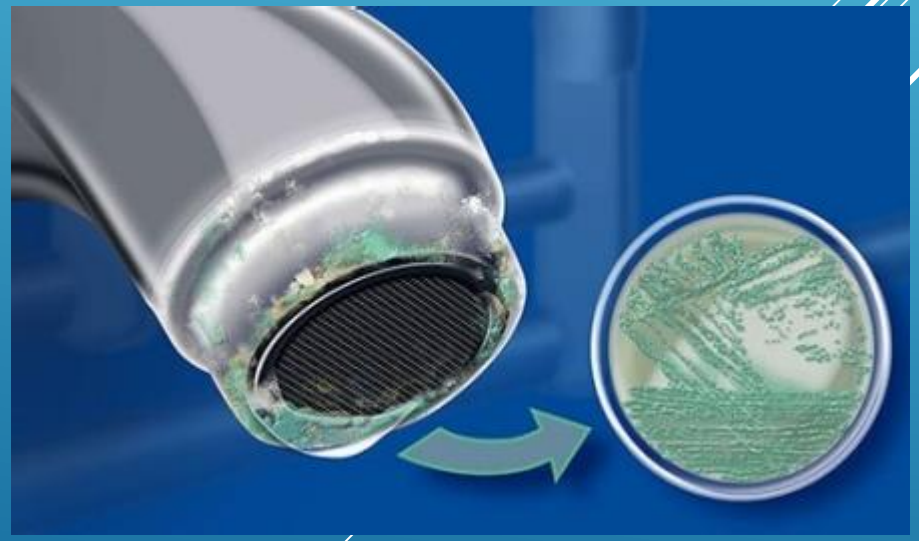
- Introduction of *Pseudomonas aeruginosa* and Biofilm Production
- Water Treatment Methods Techniques
- Case Studies

Introduction

- *Pseudomonas aeruginosa* is a rod-shaped Gram-negative opportunistic pathogen that may cause human infections, and *P. aeruginosa* is also considered to be the most important pseudomonad in drinking water.

- Previous studies have reported that

P. aeruginosa could develop resistance to low levels of chlorine used in water treatment. Furthermore, *P. aeruginosa* is able to grow under a wide variety of environmental conditions, especially in low-nutrient water.



Meet the pathogens

Salmonella

Lives in the gut of many farm animals. Symptoms include diarrhoea, fever and cramps. Found on raw meats and unwashed vegetables.

Escherichia coli

Lives in the intestines of livestock and can be passed into meat and milk. It causes serious food poisoning with symptoms of diarrhoea, vomiting and urinary tract infections.

Pseudomonas aeruginosa

An opportunistic pathogen found in soil, water and plants. Can cause disease in plants, animals and humans. Symptoms include redness of the skin, abscesses and wounds.

Clostridium perfringens

Found in the intestinal tract of humans, decaying vegetation and raw meat and poultry. Spores can survive in most conditions, including high temperatures. Symptoms include cramping, vomiting and diarrhoea.

Staphylococcus aureus

Found on the human skin, in the nose, armpit and groin area. Does not always cause harm but can be dangerous in some circumstances. Symptoms include food poisoning, skin and respiratory infections.

Faecal streptococci

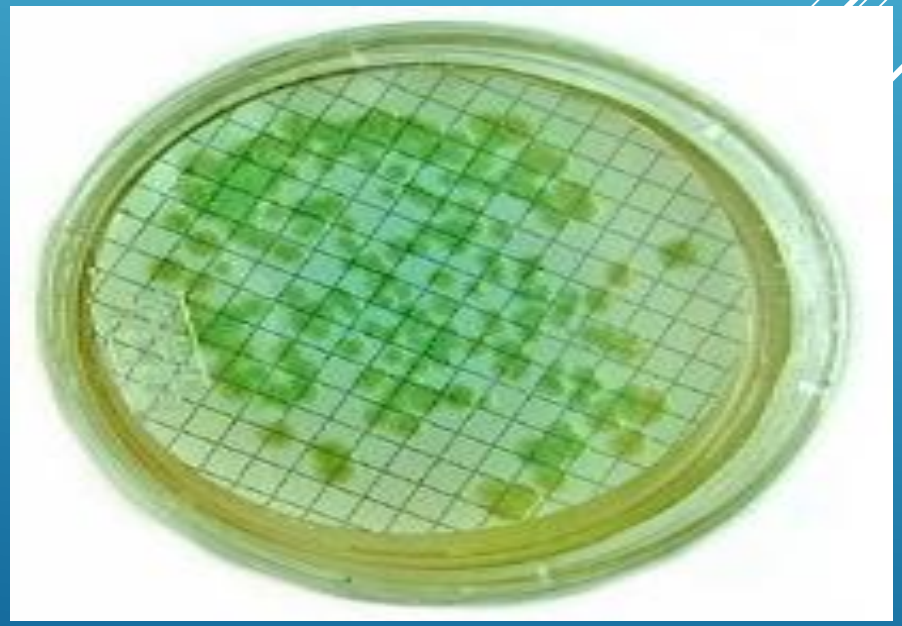
Found in the intestines of humans and animals. Both are strong indicators of faecal matter contamination. Symptoms can cause vomiting, diarrhoea and nausea.

Bacillus cereus

Found in soil and vegetation. Causes food poisoning when food is improperly cooked. Can cause severe nausea, vomiting and diarrhoea.

P. aeruginosa growing in nutrient-poor water exhibited considerably diverse properties compared to bacteria grown in rich media under laboratory conditions.

Additionally, several opportunistic pathogens have been shown to reactivate during long-term storage of added chlorine Therefore, it is essential to investigate the dynamics of *P. aeruginosa* subjected to long-term chlorine disinfection in drinking water distribution systems.

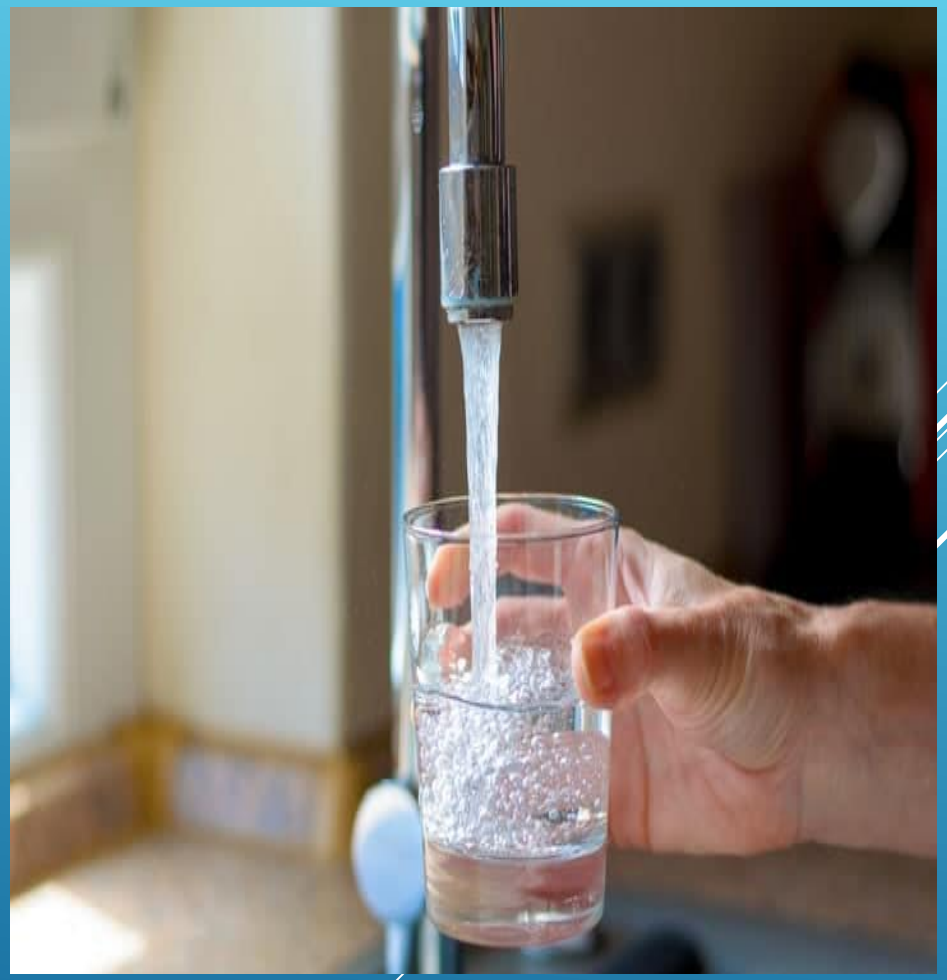


WHAT IS *PSEUDOMONAS AERUGINOSA*?

- *Pseudomonas aeruginosa* can be found in soil, water and on plants. It is an opportunistic pathogen which needs very little nutrients to survive.
- The bacterium almost never infects healthy tissues, yet there is hardly any tissue that it cannot infect if the body's defenses are compromised in some manner.

HOW DOES CONTAMINATION OCCUR?

- *Pseudomonas aeruginosa* is a bacterial species which is particularly good at forming biofilms.
- Its growth in drinking water can cause problems with colour, taste, odour and turbidity if found in high numbers.
- Once established, biofilms can be difficult to eradicate from manmade water systems, because they need a biodispersant (a chemical to breakdown the biofilm) and/or physical removal prior to disinfection. *Pseudomonas aeruginosa* is very difficult to get rid of once established in a vending machine, because of the inaccessibility of many of the components.



HOW DOES CONTAMINATION OCCUR?

- Contamination of vending machines and water coolers by *Pseudomonas aeruginosa* results from the bacteria either being introduced via the mains supply or through poor cleaning or installation practices.

- Due to the often sporadic or low flow rates in these types of units, the bacteria can attach to the internal pipework surfaces and form a biofilm to protect themselves and then start to multiply

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WHAT IS THE LEGISLATION?

- There is no legislation relating directly to the presence of *Pseudomonas aeruginosa*, however it's presence can encourage the growth of other bacteria which contravenes the Water Supply (Water Quality) Regulations.
- The Water Supply Regulations and the Public Water Supplies (Scotland) Regulations set strict guidelines to the physical properties of drinking water.
- They also state that drinking water should not contain certain chemicals or microorganisms.
- This legislation is further enforced by the Workplace (Health, Safety and Welfare) Regulations, which state that every employer has a duty to supply "wholesome" drinking water.

WHAT ARE THE HEALTH EFFECTS ?

- *Pseudomonas aeruginosa* has not been shown to cause any health effects following ingestion.

- It is more likely to cause problems with the taste and odour of drinking water. However, the biofilms that *Pseudomonas aeruginosa* form could harbor more dangerous bacteria, such as coliform organisms and *E.coli*.

WHAT SHOULD BE DONE IF *PSEUDOMONAS AERUGINOSA* IS DETECTED IN A VENDING MACHINE OR WATER TREATMENT SYSTEM?

- As *Pseudomonas aeruginosa* can prove difficult to remove, care needs to be taken when dealing with the management of *Pseudomonas aeruginosa* contamination.

Actions to take should include:

- Discussions with your vending contractor regarding their procedures to minimise/remove the contamination.
- A review of the location and usage of the machines.
- A regular review of the water quality from your machines, ideally independent of your suppliers.

TO AVOID PROBLEMS WITH CROSS-CONTAMINATION OF MACHINES

- It is extremely important to ensure that the staff responsible for the cleaning and sanitizing of vending machines or water coolers are correctly trained and are aware of the potential for contamination during the cleaning process.

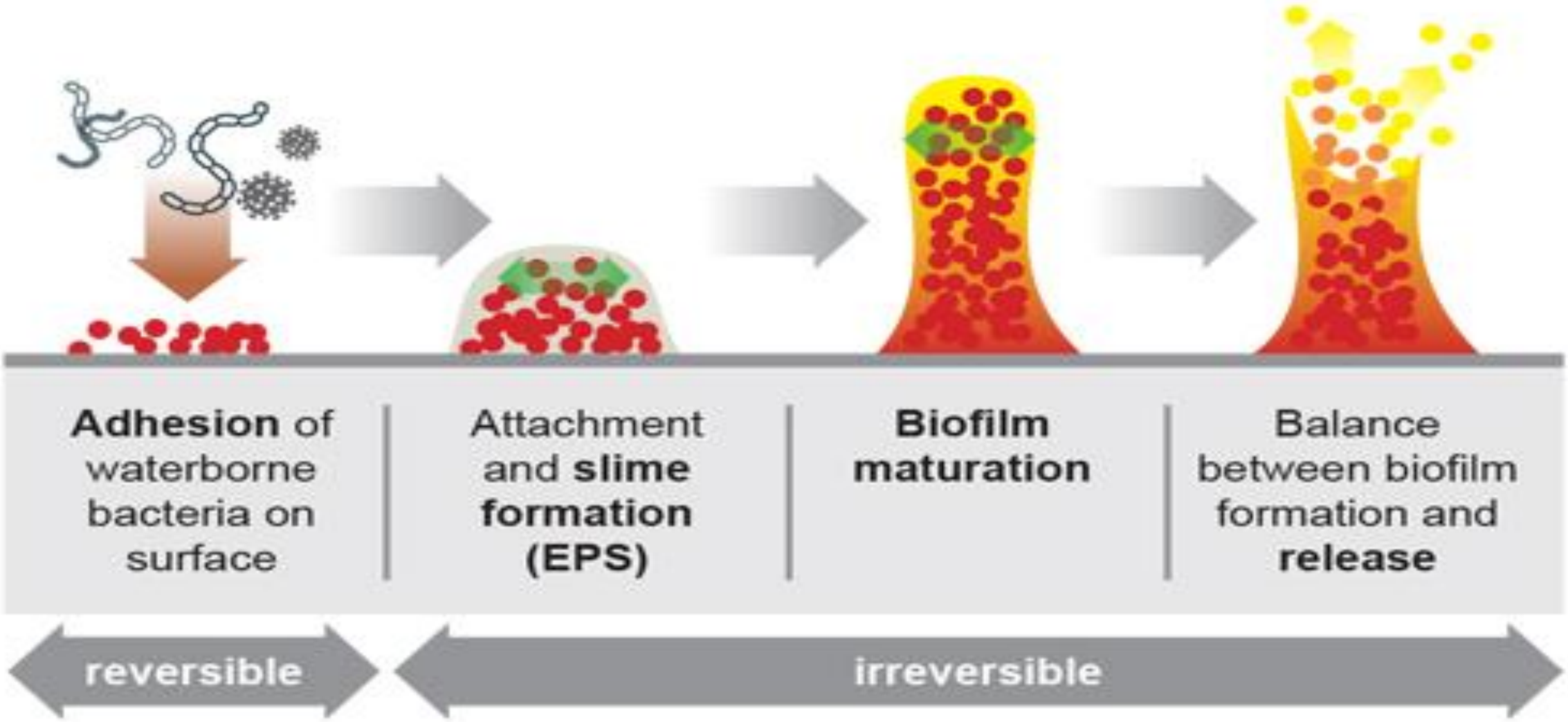
BIOFILM FORMATION

- In aquatic environments, microorganisms have the ability to adhere to solid surfaces and form biofilms.
- Biofilms are bacterial communities embedded in a polysaccharide matrix, which gives them the opportunity to resist destruction by antibiotics, environmental stress, biocides and detergents.
- Bacterial regrowth in the distribution system may result from the detachment of biofilm bacteria, which increases the risk of infection in humans when the water is consumed.
- Generally, most water distribution systems are characterized by the presence of biofilms, regardless of purity, the type of pipe material used for distribution or the presence of a disinfectant.

BIOFILM FORMATION

- Bacteria in drinking water systems can therefore grow in bulk water and as biofilms attached to the walls of pipes.
- Moreover, the development of biofilms inside water distribution pipes facilitates the propagation of mixed microbial populations and is considered the main source of planktonic bacteria in water supply systems.
- This problem is further aggravated by the presence of opportunistic pathogens such as *Pseudomonas, Aeromonas, Klebsiella, Mycobacter, Escherichia coli, Helicobacter, Salmonella* and *Legionella* spp. that may increase the health risks associated with the consumption of water from these sources.

BIOFILM FORMATION



- Different materials - such as cast iron galvanised steel, stainless steel, copper and polyethylene - have been used to manufacture water distribution pipes and these materials favour biofilm formation in the water distribution systems.
- Differences in the pipe materials greatly favour the survival of different bacterial species.
- The presence of biofilms in drinking water distribution pipes usually leads to a number of undesirable effects on the quality of water that is supplied to consumers
- The development of biofilms in copper pipes facilitates cuprosolvency which increases the release of copper into the distribution system. Furthermore, increased carbon influences the growth of heterotrophic plate count bacteria which are also involved in the corrosion of copper.
- The corrosion of lead-containing plumbing materials increases the chances of lead contamination in tap water, which can cause adverse health effects in humans, especially children.

- Detachment of bacteria from the biofilms may affect the quality of the water.[17] Therefore, the deterioration of the quality of drinking water as a result of biofilm formation is a major concern for most municipal supply agencies and communities.
- Biofilms are present in spite of different treatment processes; the occurrence of biofilms in drinking water is attributed to bacterial resistance to disinfectants, ability of the bacterial species to resist chemical compounds released from pipe materials and species association which increases the proportion of viable cells.
- Moreover, the use of different disinfectant methods may have long-term effects on the biofilm community.
- Biofilms consisting of *Pseudomonas aeruginosa* and different faecal bacterial species have been detected in water distribution systems, even in countries that have more advanced water-treatment facilities.

WATER TREATMENT METHODS TECHNIQUES

1- Chlorine Pump System

2-Automatic Backwash Sand filter

3-Automatic Backwash Activated Carbon filter

4-Automatic Backwash Softener filter

5-Reversr Osmosis Filter Unit

6-Ozone Generator System

Water Filters

3-stage water filtration

Ceramic Filtration

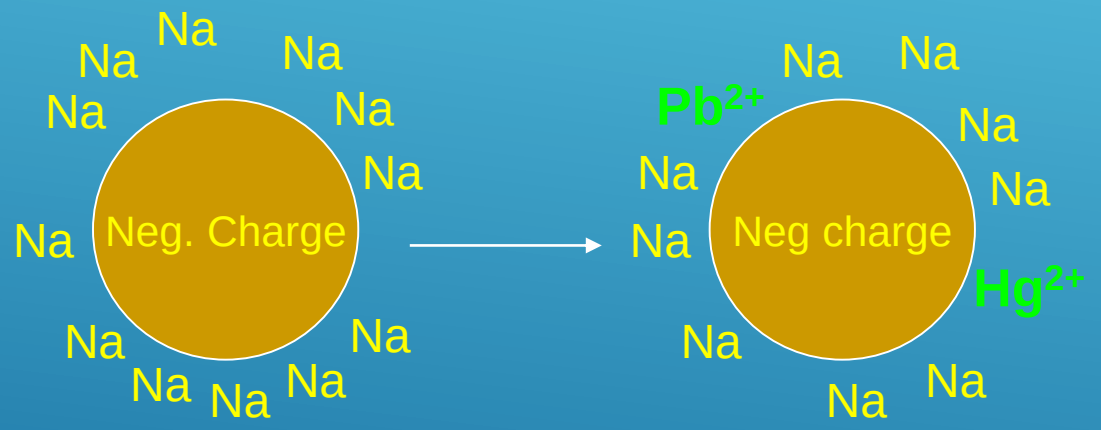
Ion Exchange

Carbon

Ion Exchange Filters

Metals

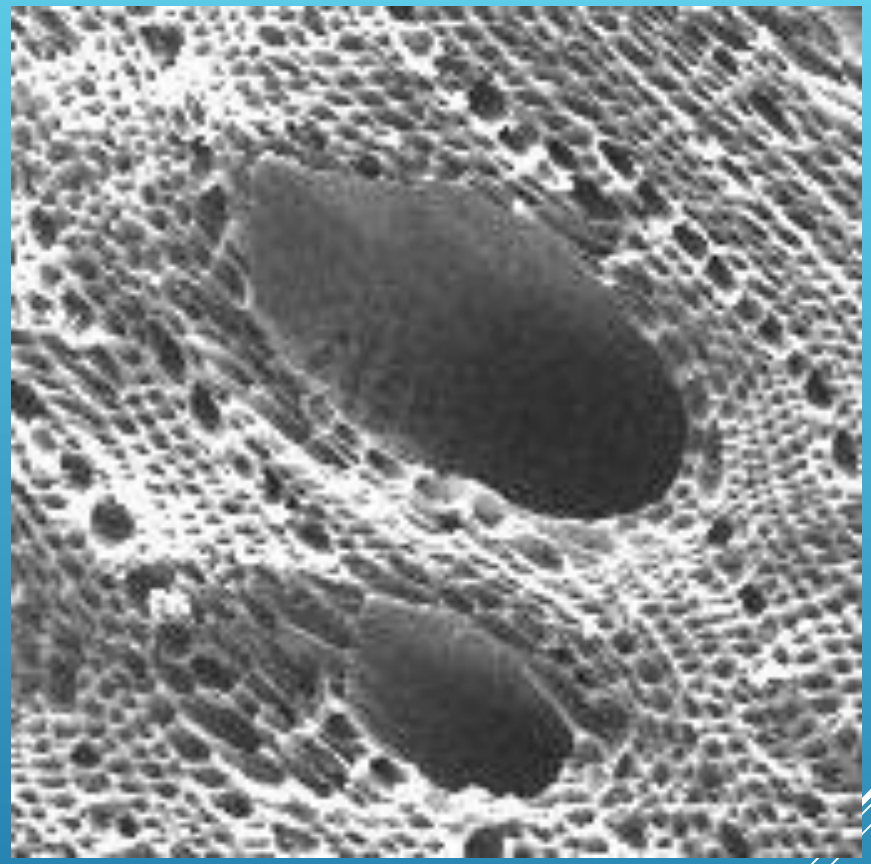
Pb^{2+}, Hg^{2+}



Finite Capacity

4 Na^{+}

ACTIVATED CARBON

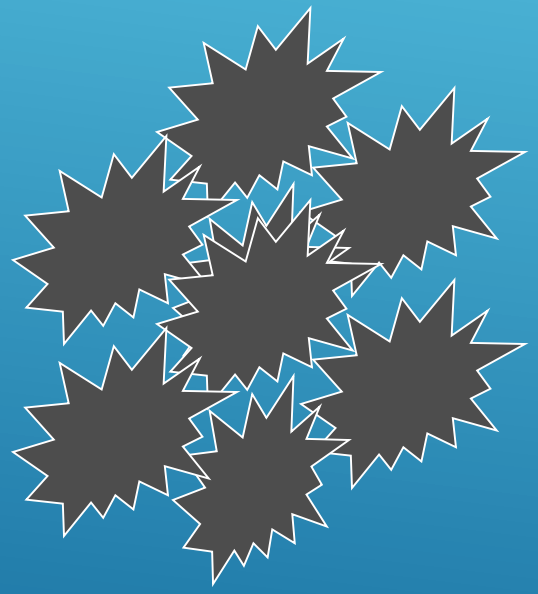


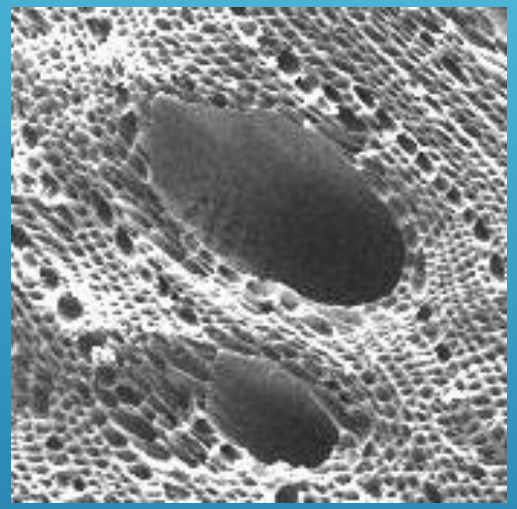
Activation by heating

Extremely porous with high surface area: 500 m^2/g

ACTIVATED CARBON

Filtration

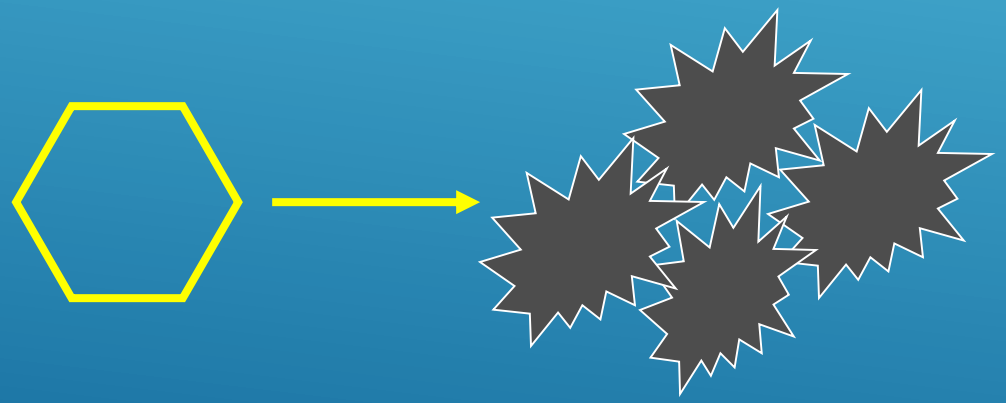




Particle size removal > 0.5 microns (bacteria, fungi)

ACTIVATED CARBON

Absorption: spontaneous movement of primarily organic contaminants from water to carbon matrix.



Pesticides, volatile organics

Carbon Filter Removal

2,4-D
2.4.5-TP (Silvex)
Alachlor
Atrazine
Carbofuran
Chlordane
Endrin
Heptachlor Epoxide
Lindane
Methoxychlor
Simazine
Toxaphene
Benzene
Carbon Tetrachloride
Chlorobenzene

Ethylbenzene
Monochlorobenzene
MTBE
O-Dichlorobenzene
P-Dichlorobenzene
Styrene
Tetrachloroethene
Toluene
Trichloroethene
VOCs

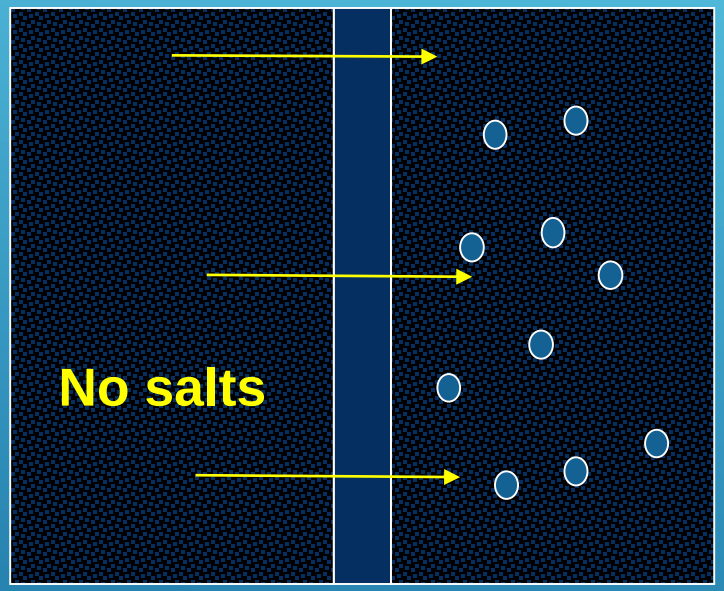
Antidepressants
Steroids/Hormones
Prednisone,
Prednisolone,
Progesterone,
Testosterone,
Cortisol/Hydrocortisone
Antibiotics

Reverse Osmosis

OSMOSIS

Net movement of water →

Spontaneous movement of water



Salt molecule

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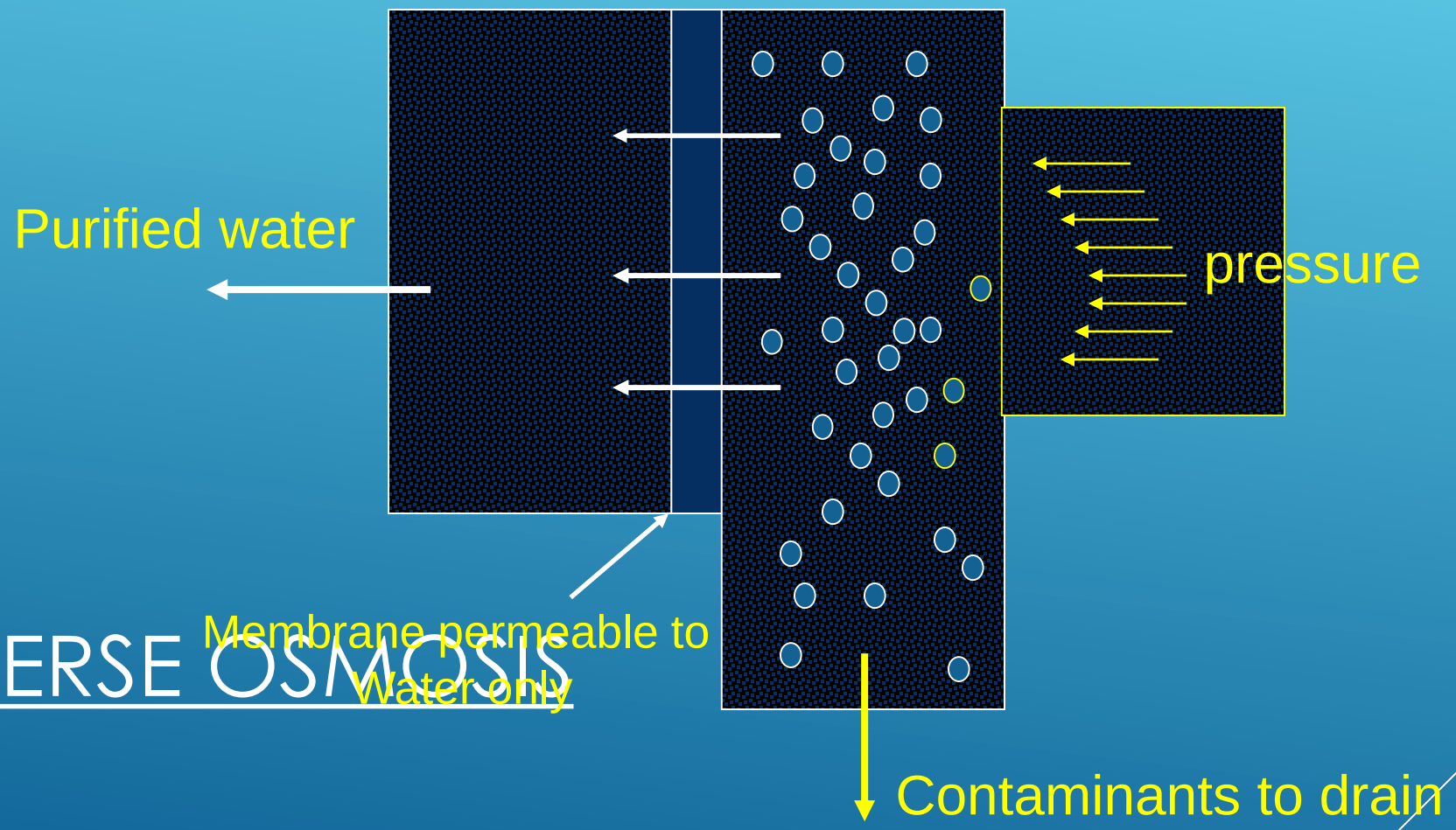
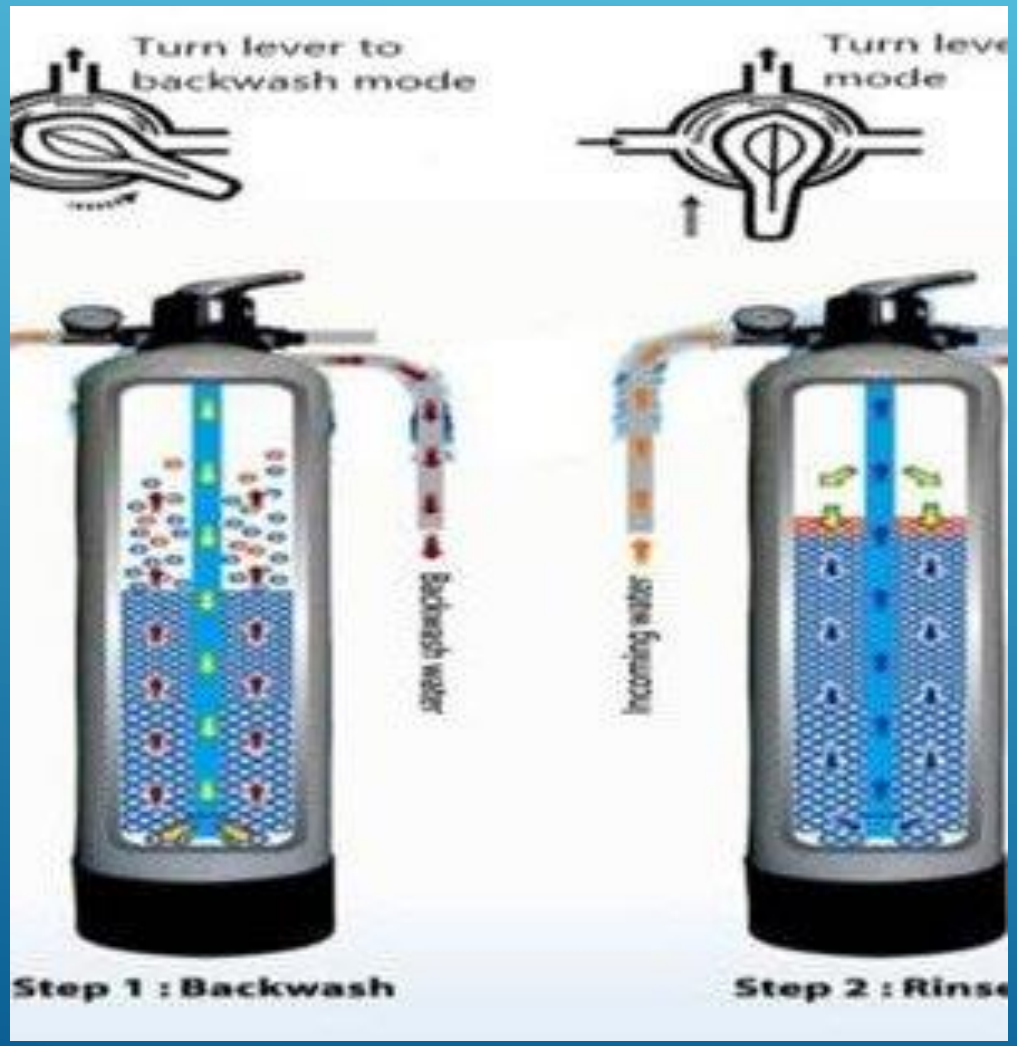
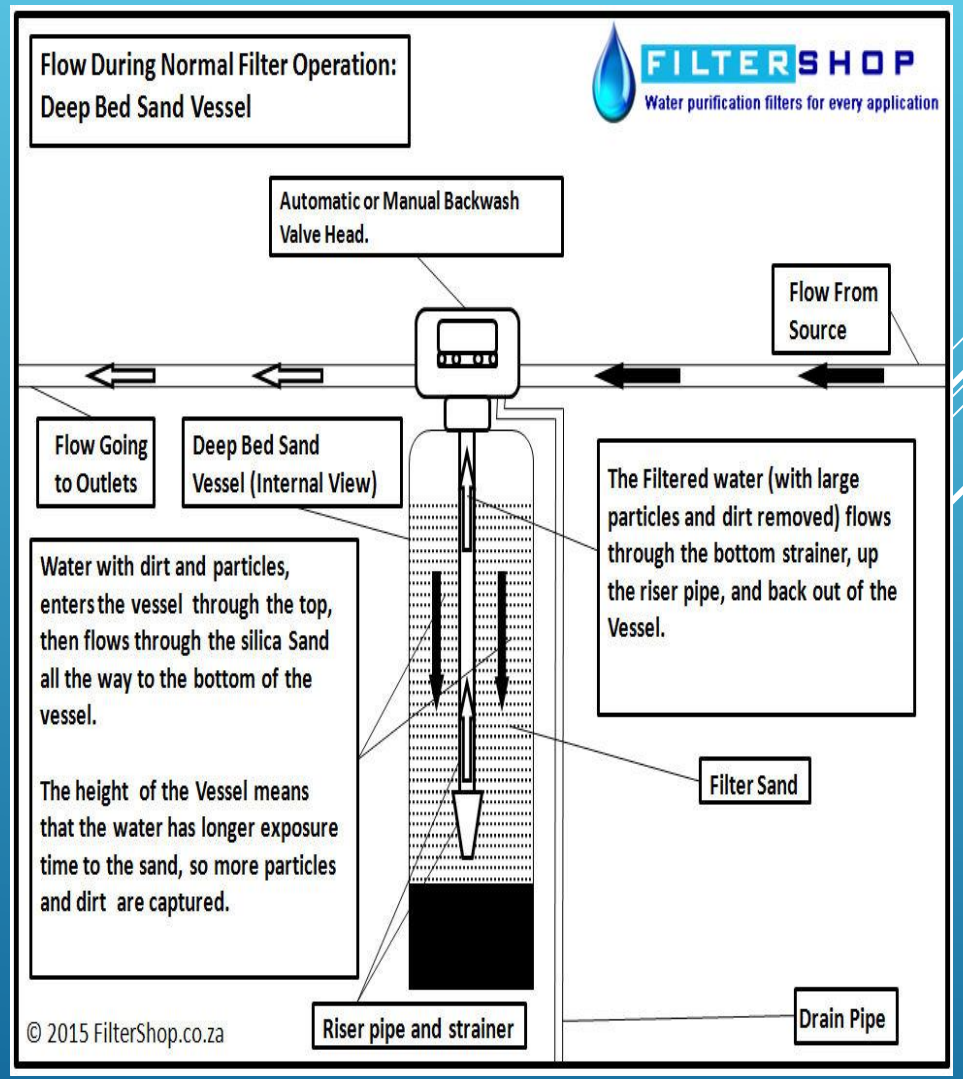
Membrane permeable to Water only

REVERSE OSMOSIS



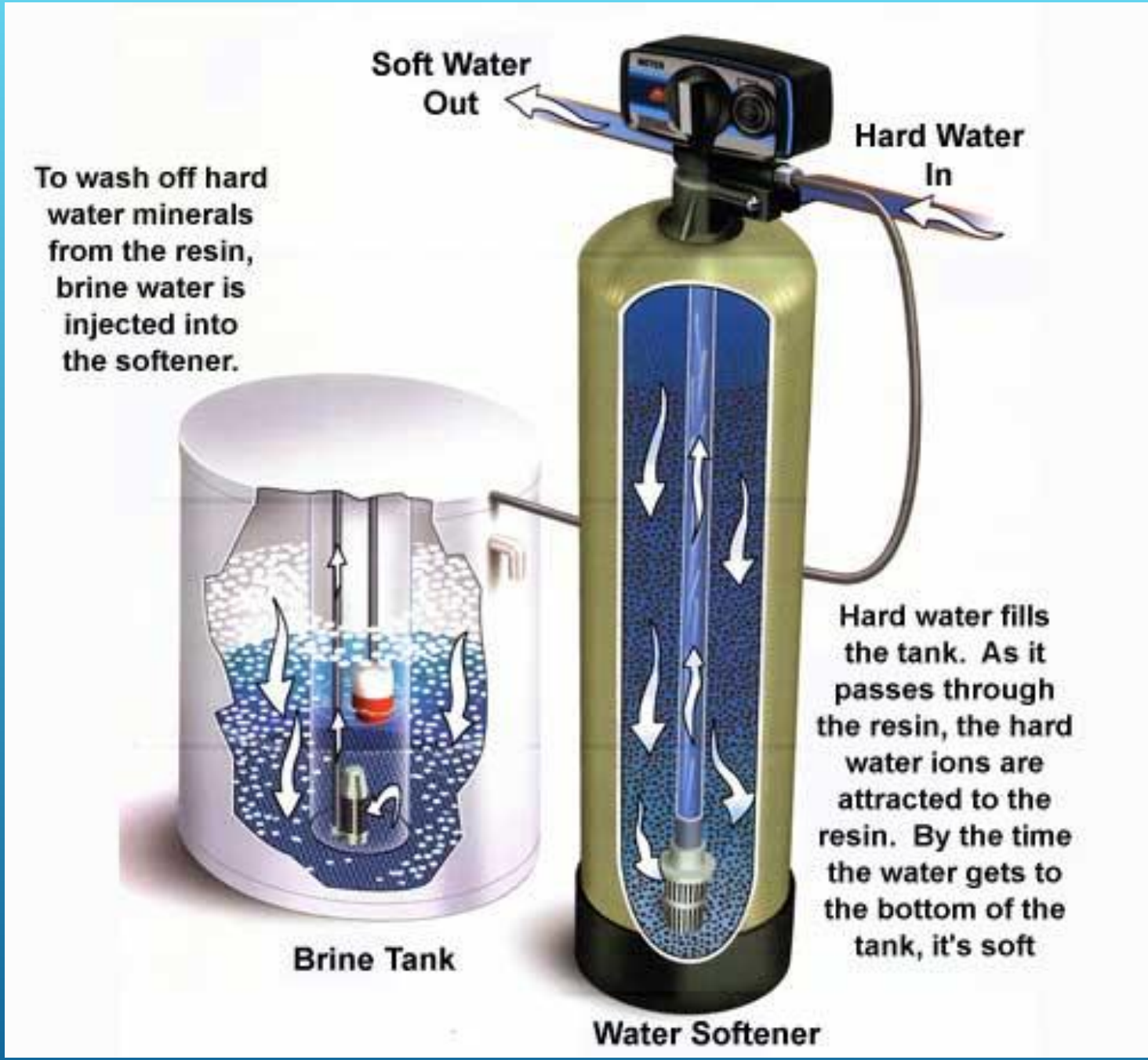
SAND FILTER


Turn lever to backwash mode
Turn leve mode
Backwash water
Incoming water
Step 1 : Backwash
Step 2 : Rinse


Flow During Normal Filter Operation: Deep Bed Sand Vessel
FILTERSHOP
Water purification filters for every application
Automatic or Manual Backwash Valve Head.
Flow From Source
Flow Going to Outlets
Deep Bed Sand Vessel (Internal View)
The Filtered water (with large particles and dirt removed) flows through the bottom strainer, up the riser pipe, and back out of the Vessel.
Water with dirt and particles, enters the vessel through the top, then flows through the silica Sand all the way to the bottom of the vessel.
The height of the Vessel means that the water has longer exposure time to the sand, so more particles and dirt are captured.
Filter Sand
Drain Pipe
Riser pipe and strainer
© 2015 FilterShop.co.za

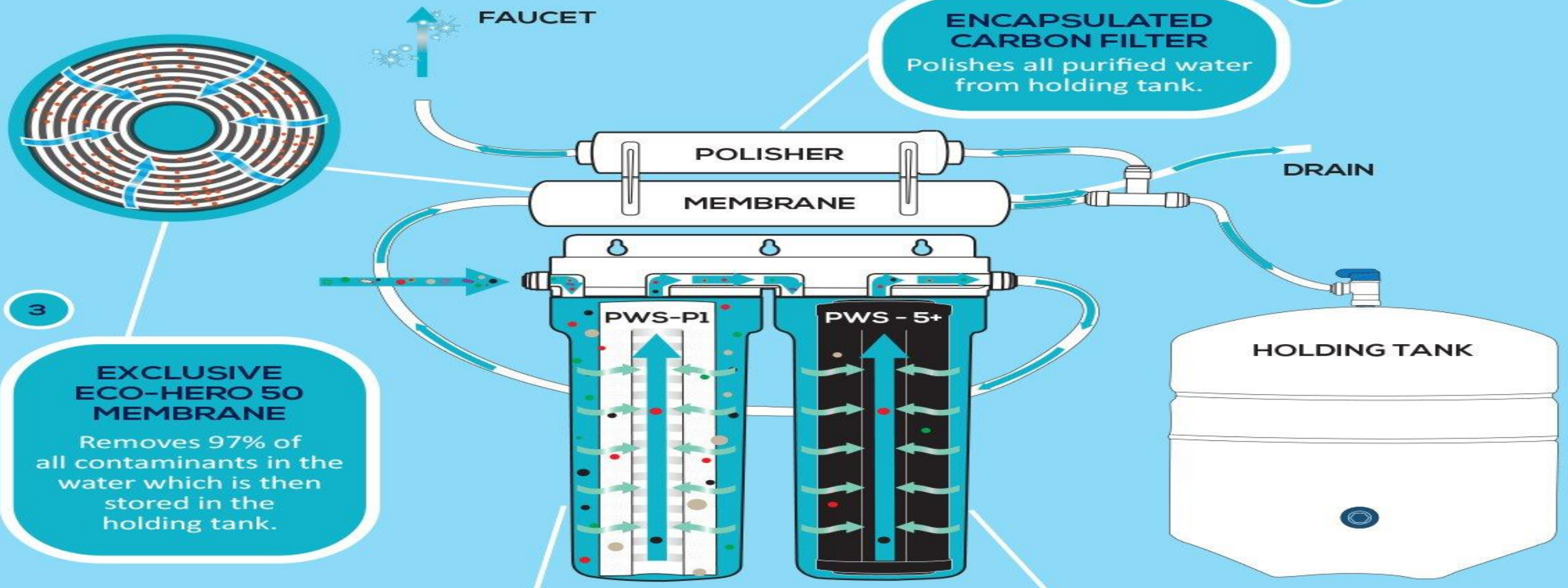
ACTIVATED CARBON FILTER

SOFTENER FILTER



PURE
WATER SYSTEMS

UNDER SINK REVERSE OSMOSIS



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ENCAPSULATED CARBON FILTER
Polishes all purified water from holding tank.

3

EXCLUSIVE ECO-HERO 50 MEMBRANE
Removes 97% of all contaminants in the water which is then stored in the holding tank.

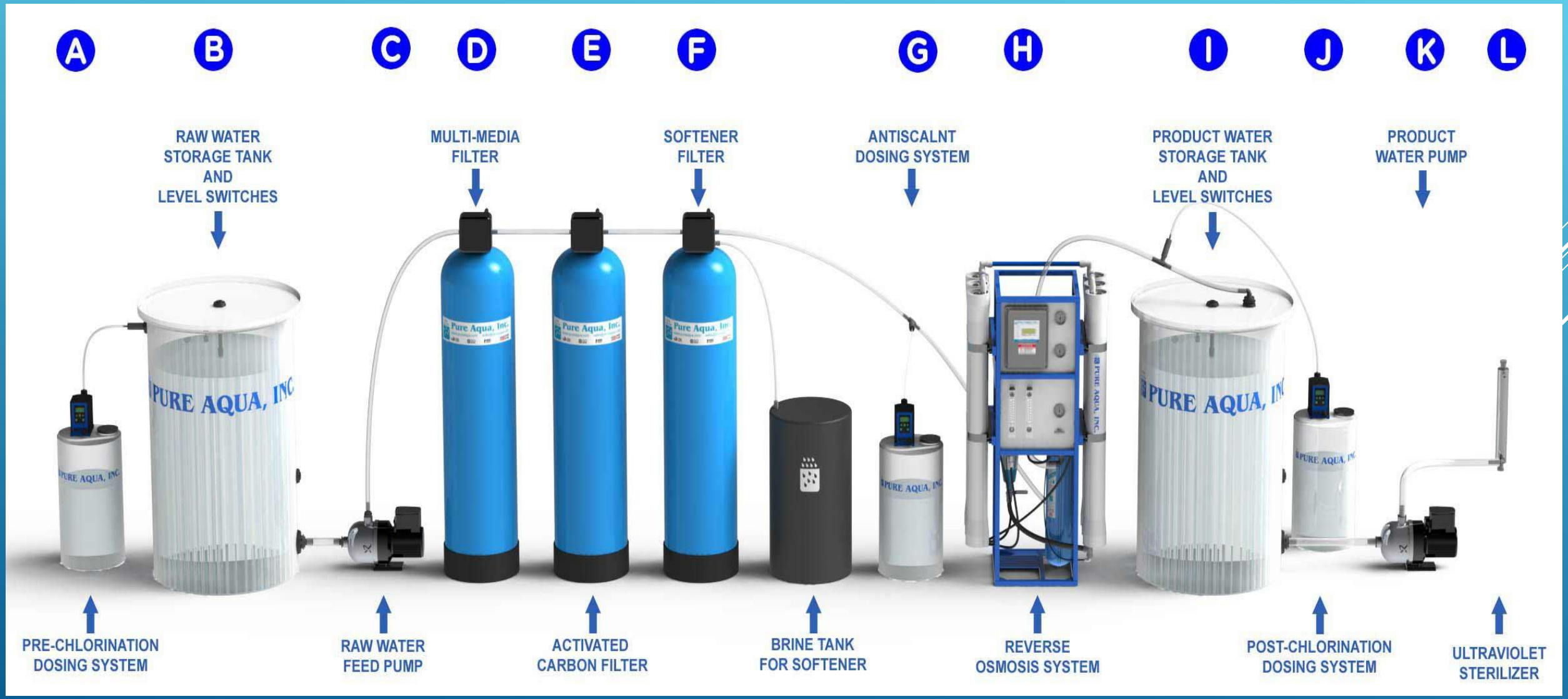
1

PRE FILTER
Water enters the pre filter where sediment, dirt, rust & algae is reduced.

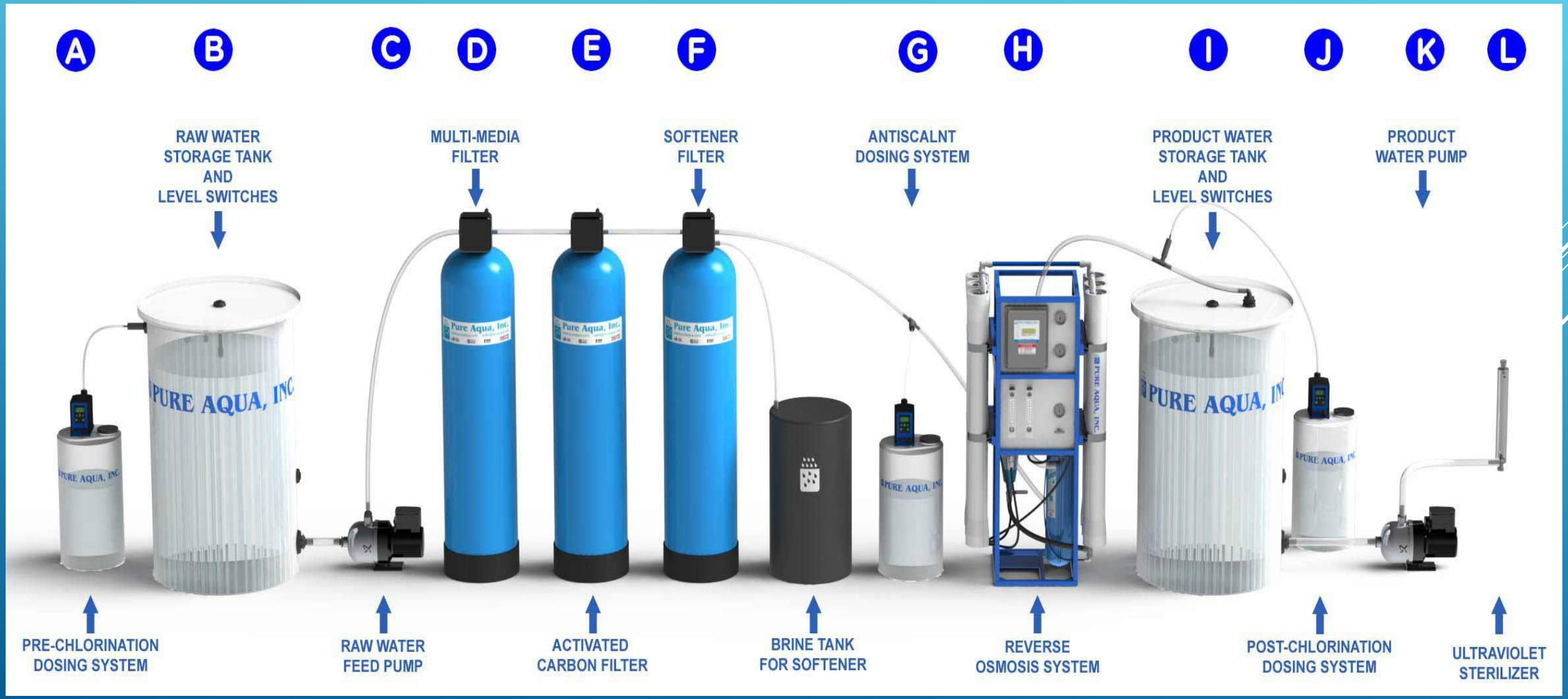
2

CARBON FILTER
Reduces chlorine & chemicals.

DRINKING WATER TREATMENT SYSTEM FOR BOTTLED WATER AND BEVERAGES



CASE STUDY:


A
B
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RAW WATER STORAGE TANK AND LEVEL SWITCHES
MULTI-MEDIA FILTER
SOFTENER FILTER
ANTISCALNT DOSING SYSTEM
PRODUCT WATER STORAGE TANK AND LEVEL SWITCHES
PRODUCT WATER PUMP
PURE AQUA, INC.
Pure Aqua, Inc.
PRE-CHLORINATION DOSING SYSTEM
RAW WATER FEED PUMP
ACTIVATED CARBON FILTER
BRINE TANK FOR SOFTENER
REVERSE OSMOSIS SYSTEM
POST-CHLORINATION DOSING SYSTEM
ULTRAVIOLET STERILIZER

INTEGRATED DRINKING WATER TREATMENT SOLUTIONS

AUTO SOFTNER FILTER
AUTO CARBON FILTER
AUTO SAND FILTER

FLOW CHART
OF WATER TREATMENT

The main equipment are silica sand filter, active carbon filter, sodium ion exchanger, hollow fiber, RO(reverse osmosis), UV sterilizer, precision filter, ozone generator, water tank etc.

1.Water pump
2.Silica sand filter
3.Active carbon filter
4.Sodium ion exchanger
5.Precision filter
6.Reverse osmosis
7.RO buffer tank
8.UV
9.Ozone mixing tower
10.Ozone generator
11.Water tank

THANK YOU