

How to remove pollutants of urban water ?



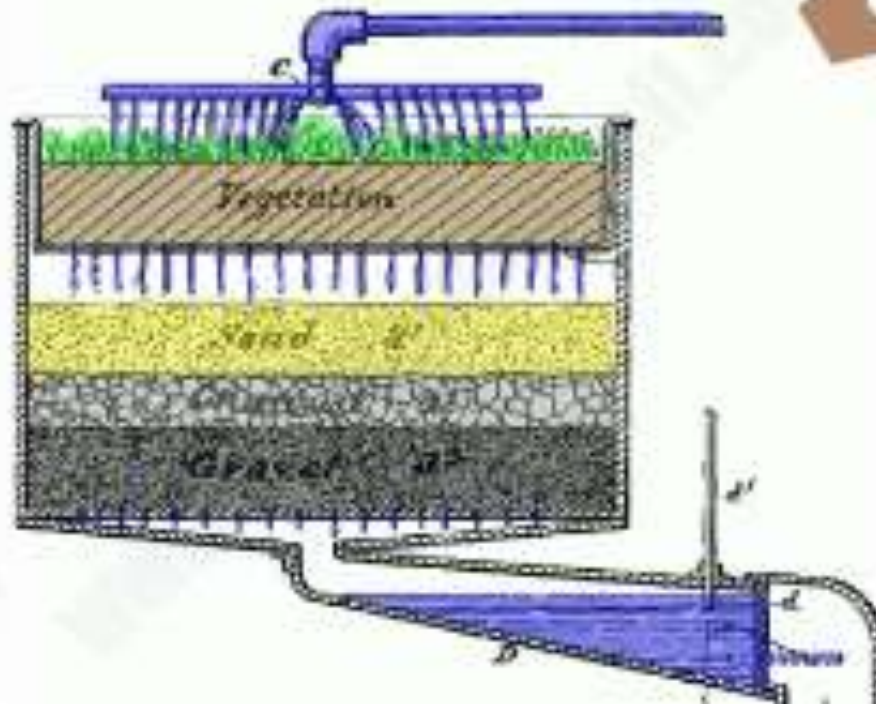
- PREPARED BY : DR.MRINMOY MAJUMDER,FOUNDING EDITOR(HONR), INNOVATE FOR SUSTAINABILITY,[HTTP://WWW.BAIPATRA.WS](http://www.baipatra.ws).
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Different Types of Filters

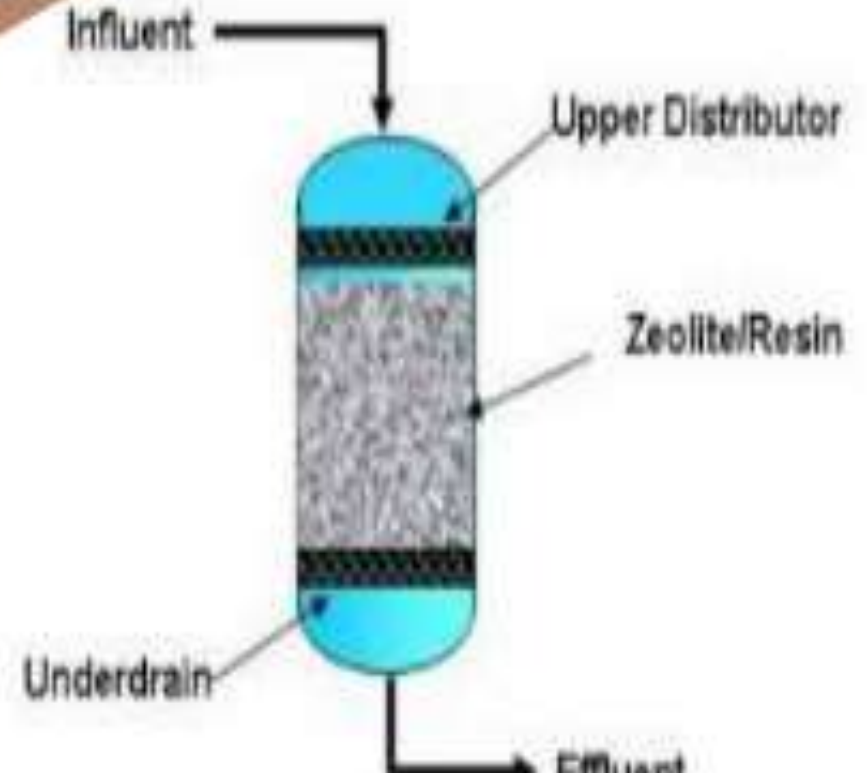
- Broadly filters can be classified into six types :
 - Physical Filters : “filtering by gravity”
 - Ion Exchange : “filtering by exchanging bad ions with good ions”
 - Activated Carbon : “filtering by trapping impurities within pores of carbon material”
 - Reverse Osmosis : “filtering by reversing the process of osmosis thus separating the impurities and water by semipermeable membrane”
 - Distillation : “filtering by boiling”
 - UV Light : “filtering by lights of ultra-violet frequency”
- *A brief description, strength and weakness of the filters are explained in the next slides.*

PHYSICAL
FILTER

Patented Sept. 3, 1901.
C. MONJEAU.
PURIFYING WATER.
(Application filed Dec. 19, 1899.)



ION
EXCHANGER



Different Types of Filters

LOW COST
MEDIUM MAINTENANCE

PHYSICAL FILTERS

USE SEDIMENTS OF DIFFERENT
DIAMETERS ARRANGED IN
VERTICAL OR HORIZONTAL
LAYERS

REMOVES IMPURITIES WITH LARGER
DIAMETER COMPARED TO THE
DIAMETERS OF THE SEDIMENTS

USELESS WHEN IMPURITIES ARE OF
SMALLER DIAMETER THAN THE DIAMETER
OF SEDIMENTS
REQUIRES FLUSHING OFF OF IMPURITIES
FROM THE LAYERS OF SEDIMENTS

ION EXCHANGE

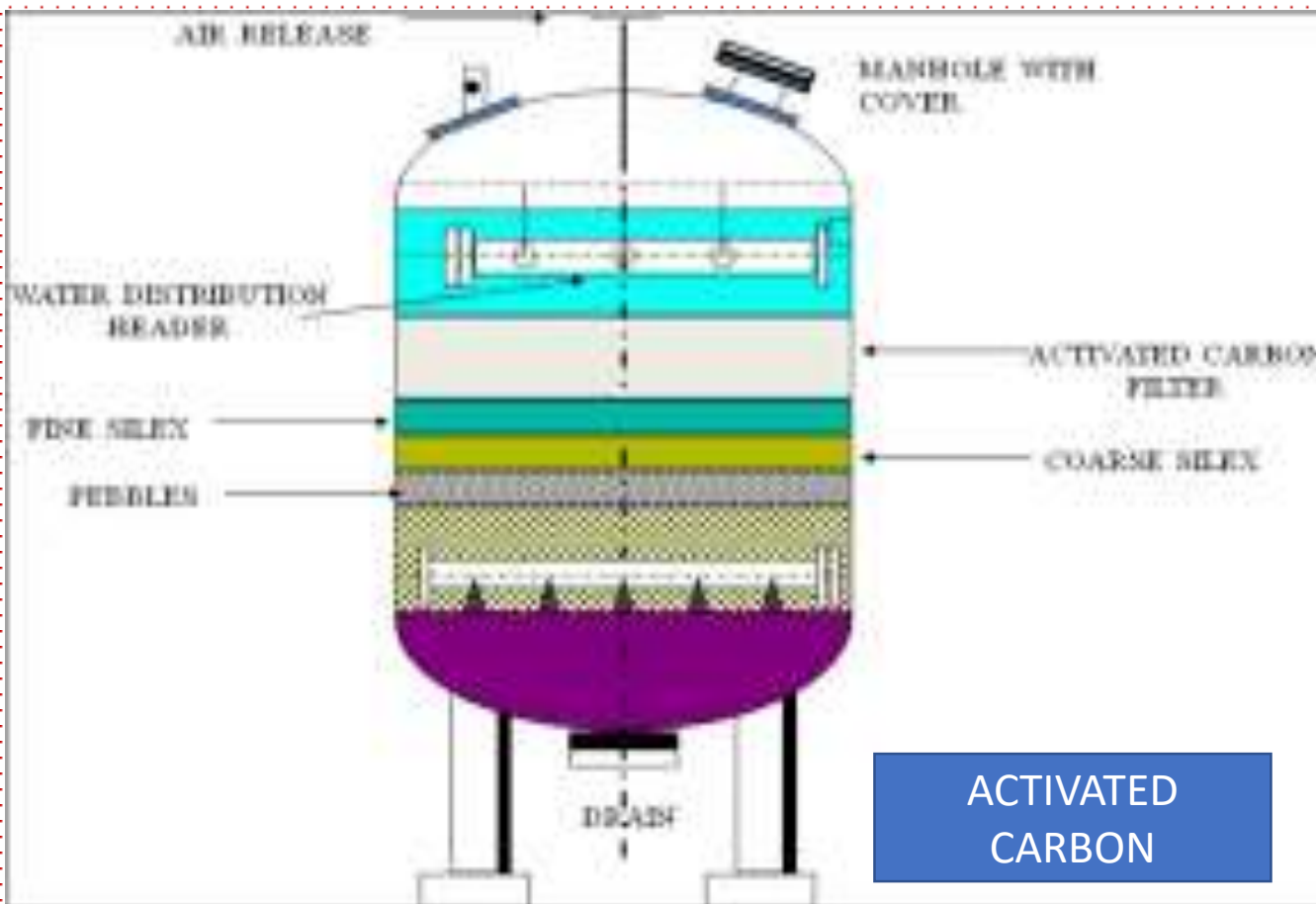
ZEOLITE BEADS CONTAINING SODIUM
IONS ARE USED WHEN HARDNESS
CAUSING IONS LIKE Ca OR Mg
REPLACES THE SODIUM IONS AND GET
TRAPPED WITHIN THE BEADS
THEREBY SOFTENING THE WATER

USEFUL FOR REMOVING HARDNESS
DUE TO CALCIUM AND MAGNESIUM IONS

RELEASES SODIUM IONS IN THE TREATED
WATER AND THEREBY INCREASING SALT
CONTENT IN THE WATER WHICH MAY NOT BE
SUITABLE FOR CONSUMERS WITH SALT
RESTRICTED DIETS

HIGH COST
MEDIUM MAINTENANCE

PHYSICAL
FILTERS AND ION
EXCHANGE
FILTERS



ACTIVATED
CARBON



REVERSE
OSMOSIS

ACTIVATED CARBON AND REVERSE OSMOSIS FILTERS

ACTIVATED CARBON

USES ACTIVATED CARBON GRANULES LIKE CHARCOAL WHICH ARE GENERATED FROM BURNED WOODS OR COCONUT SHELLS. CHARCOALS ARE HIGHLY POROUS AND ADSORBS COMMON IMPURITIES OF WATER

CAN REMOVE MOST OF THE COMMON IMPURITIES INCLUDING CHLORINE, PESTICIDES AND INDUSTRIAL SOLVENTS

CANT REMOVE HARDNESS, HEAVY METALS, MICROBES, SODIUM, NITRATES, FLUORINES

LOW COST
LOW MAINTENANCE

REVERSE OSMOSIS

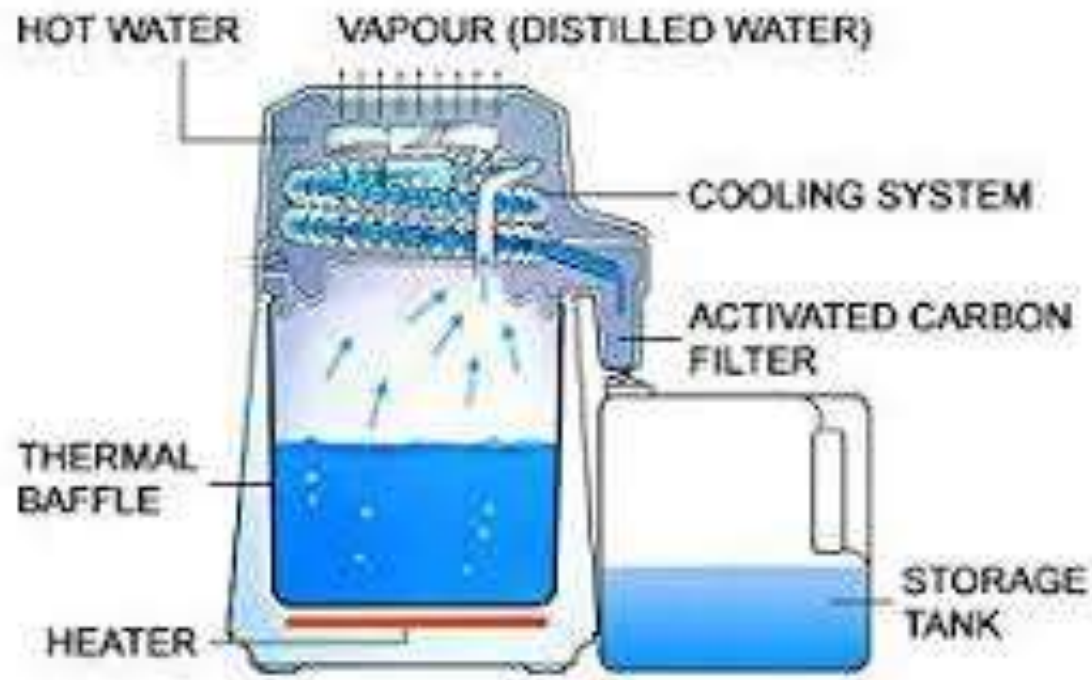
FOLLOWS THE OSMOSIS THEORY OF BIOLOGY. IN OSMOSIS IF TWO LIQUIDS OF DIFFERENT CONCENTRATIONS ARE SEPERATED BY A SEMI PER MEABLE MEMBRANE THEN LIQUID FROM LOW CONCENTRATION WILL MOVE TOWARDS HIGH CONCENTRATION. IN THE REVERSE OSMOSIS OPPOSITE OF OSMOSIS OCCURS DUE TO AN ARTIFICIAL PRESSURE CREATED OVER THE MEMBRANE

AT THE TIME OF REVERSE OSMOSIS THE CONTAMINANTS MIXED IN WATER CAN NOT PASS THE SEMI PER MEABLE MEMBRANE AND IN TURN PURE WATER CAN BE RECEIVED AT THE OTHER END OF THE MEMBRANE

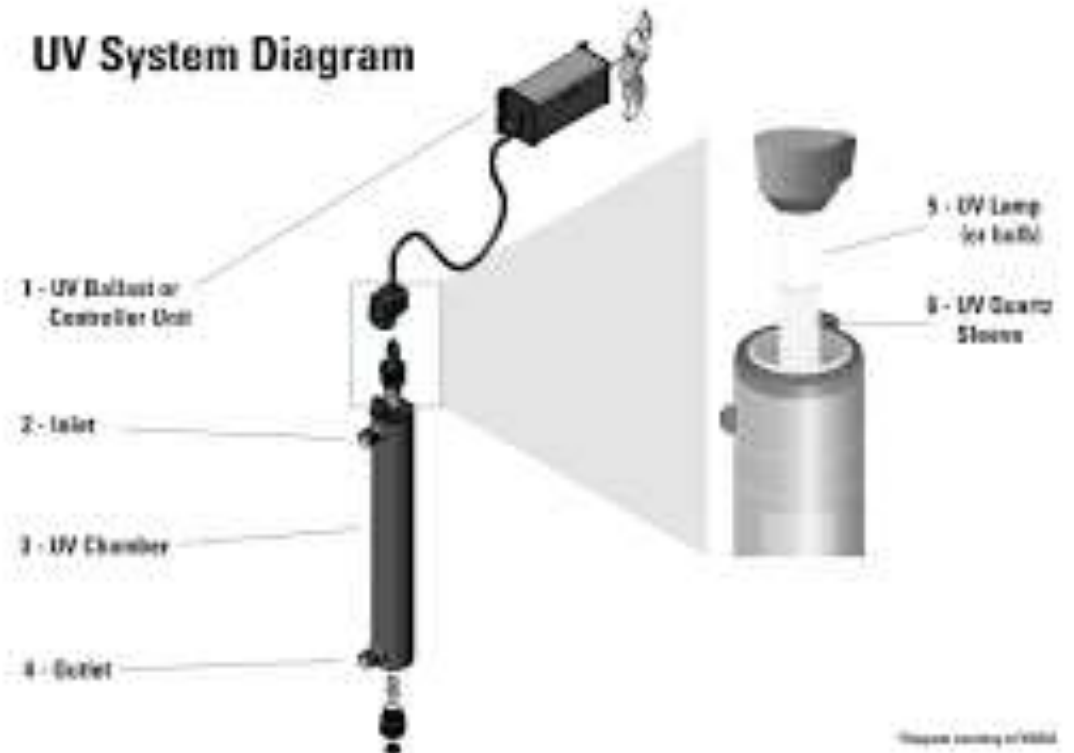
REVERSE OSMOSIS PRODUCE A LOT OF WASTE WATER RELEASE OF WHICH BECOME A PROBLEM FOR THE USER

HIGH COST
HIGH MAINTENANCE

Distillation vs UV Filters



UV System Diagram



DISTILLATION AND UV FILTERS

DISTILLATION

IMPURE WATER IS BOILED AND VAPOURIZED. THE WATER VAPOUR IS THEN CONDENSED BY PASSING IT THROUGH A COOLANT AND THE CONDENSED WATER IS USED AS TREATED WATER

CAN REMOVE MOST OF THE COMMON IMPURITIES AS BOILING POINT OF MOST OF THE CONTAMINANTS ARE HIGHER THAN WATER

BUT SOME VOLATILE ORGANIC COMPOUNDS HAVE LOWER BOILING POINT AND THUS REMAINS IN THE VAPOURIZED WATER. ALSO EXTERNAL ENERGY IS USED TO VAPOURISE WATER WHICH INCREASES THE COST OF TREATMENT.

**HIGH COST
MEDIUM MAINTENANCE**

UV FILTER

USES ULTRA VIOLET LAMPS ON IMPURE WATER. UV LIGHTS CAN EXTERMINATE MOST OF THE WATER BORNE BACTERIAS

CAN REMOVE OR KILL MICROORGANISMS

AS EXTERNAL ENERGY IS REQUIRED COST OF TREATMENT GET INCREASED, LAMP IS REQUIRED TO BE CHANGED AT REGULAR INTERVALS SO THERE WILL BE A PERIODIC MAINTENANCE COST.

**HIGH COST
HIGH MAINTENANCE**

**FACTORS TO BE CONSIDERED BEFORE
PROCURING A FILTER**

**IN ORDER OF IMPORTANCE
(MAY BE ADJUSTED BASED ON PERSONAL REQUIREMENTS)**

CRM

CONTAMINANT REMOVAL EFFICIENCY

MAINTENANCE

**COST AND FREQUENCY OF MAINTENANCE
REQUIRED**

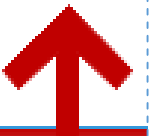
COST OF PURCHASE

COST OF PROCUREMENT REQUIRED

TYPE OF FILTERS

**HOW MANY TYPE OF FILTERS INCLUDED
AND HOW MANY TIMES THE SAME FILTER
IS USED**

How to select the best water filter ?



Water Pollutants in Urban Areas

- Sediment, nutrients, oxygen-demanding substances, road salts, heavy metals, petroleum hydrocarbons, pathogenic bacteria, and viruses.
- *Suspended sediments constitute the largest mass of pollutant loadings to receiving waters from urban areas*
- Emerging Organic Compounds : Hormones, antibiotics, surfactants, endocrine disruptors, human and veterinary pharmaceuticals, X-ray contrast media, pesticides and metabolites, disinfection-by-products, algal toxins and taste-and-odour compounds(Pal et.al.,2014)

Some tips and tricks while buying water filters

- **In urban areas** generally water is supplied from surface or waste water treatment plants. At the treatment plant the suspended sediments are already reduced by different high end filtration procedures. The toxic chemicals and other harmful infectious compounds were removed at the treatment plant by chlorination process and then after disinfection the water is supplied to the consumers.
- Thus first of all the supplied water will have high concentration of Chlorine due to the conduction of chlorination at the treatment plant for disinfecting the treated water before supplying.
- Water may also get contaminated with organic compounds like micro-bacterium (thus increasing the Biological Oxygen Demand(BOD)) or by the presence of inorganic pollutants like microplastics (that will aggravate the Chemical Oxygen Demand(COD)) in the pipelines through which water is supplied to your household. There is also a high chance of heavy metal presence.
- There is also a probability of high concentration of Calcium and Magnesium ions (which is responsible for hardness) in the treated water if required treatment for reducing hardness is not available in the treatment plants.

Some tips and tricks while buying water filters

- For such cases a four stage filter will be required having one activated carbon to remove the chlorine and other organic pollutants followed by ion exchange to remove the hardness.
- At the third stage a reverse osmosis filter can be used to reduce the concentration of inorganic pollutants including heavy metals.
- In the last stage a UV light can be utilized to remove the remaining concentration of organic pollutants which will mainly consist of micro-organisms.
- However such configuration will attract high amount of operation as well as maintenance cost. That means such filter configurations will not be economically viable for middle income group of consumers.

Some tips and tricks while buying water filters

- A cheaper alternative can be a three stage filter having a physical filter in the first part to remove the suspended solids which will include most of the inorganic pollutants.
- The second stage can include activated carbon which can adsorb most of the organic pollutants including chlorine and lastly an ion exchange filter which will remove the hardness of water.
- Such arrangement will be cheaper but the quality of the treated water will not be as good as from the earlier configuration of filters.
- But you can avoid the additional requirement of electricity consumption and waste water removal produced at the end of RO process

Some tips and tricks while buying water filters

- If you stay in a location where the **water is heavy** (i.e. presence of Calcium or Magnesium ions) then go for a filter configuration with activated carbon filter in the first stage, ion exchange in the second and physical filter in the last stage.
- This configuration will remove most of the hardness of water during the medium stage and the salt which will be produced by the medium stage as a by-product of ion exchange filter, can be removed by the physical filter at the last stage.
- Off course if you have high budget then you can go for ion exchange at first stage followed by reverse osmosis(RO) filter in the second stage and Ultraviolet(UV) light in the last stage. In this type of configurations, the ion exchange will remove hardness of the water and then the reverse osmosis filter will remove the sodium as well as other inorganic contaminants like sodium, chloride, copper, chromium, and lead; may reduce arsenic, fluoride, radium, sulphate, calcium, magnesium, potassium, nitrate, and phosphorous etc. also (Centers for Disease Control and Prevention, 2015).
- Lastly, the UV light will kill the micro-bacteriums which can seep through the semi-permeable membrane of the RO filter.

Thank you

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- Join the group :
Water, Energy and Informatics
(<http://groupspaces.com/WaterResourceManagers/>)

References

- Abdulrazak, Sani, K. Hussaini, and H. M. Sani. "Evaluation of removal efficiency of heavy metals by low-cost activated carbon prepared from African palm fruit." *Applied Water Science* 7, no. 6 (2017): 3151-3155.
- Centers for Disease Control and Prevention. "A Guide to Drinking Water Treatment Technologies for Household Use." (2015).
- Department of the Environment, Community and Local Government, 2020, Urban and Rural Water Pollution, Retrieved from <http://www.askaboutireland.ie/enfo/irelands-environment/water/water-pollution/urban-and-rural-water-pol/>
- Pal, Amrita, Yiliang He, Martin Jekel, Martin Reinhard, and Karina Yew-Hoong Gin. "Emerging contaminants of public health significance as water quality indicator compounds in the urban water cycle." *Environment international* 71 (2014): 46-62.

Bookmarks

HOW TO?

- 1)PURCHASE WATER FILTERS
- 2) REPLACE WATER FILTERS
- 3)FIND NEW IDEAS FOR LOW COST WATER FILTERS

BOOKS

- 1) DIY Filtration
- 2) Quality and Treatment of Drinking Water II: 2
- 3)Water Quality and Treatment A Handbook on Drinking Water

JOURNALS

- 1) Water research, Elsevier
- 2)Environmental Science: Water Research & Technology
- 3)Water Science and Technology

NEW PATENTS

- Roof Top Water Collection System
M J Stokes - US Patent App. 15/959,236, 2019
- UV Water Treatment in portable water tank
US Pat. No. 9,260,323
- Drinking Water purification Device
US Pat. No. US16/350,772

MORE INFORMATION ABOUT WATER FILTERS