

# Comparative Analysis of Water Purifiers

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## ABSTRACT

*The objective of the paper is to take into account various water purifiers that are deployed in the Indian market currently and determine the suitability of purifiers considering various sources of water supply. Various technologies employed by the water purifiers for purification of water and its applications are discussed in this paper. The criteria for selection of water purifiers are also mentioned in the paper. Quite often the necessity of water purifiers is overshadowed with the commercial popularity of the product, resulting in purchases without taking into account the water quality of the source of water supply. Thus, the most important parameter to check before investing in a water purifier is the water quality and the targeted removal of the pollutant. Other parameters that should be considered before purchasing a water purifier include capital cost, warranty periods, utilities required, rate of purification of water, recurring Operational and Maintenance costs, etc. There is a wide range of versatile water purifiers effectively accessible; however, it is important to settle on educated decisions about the suitability regarding a purifier for a specific circumstance, and henceforth this examination.*

**Keywords:-** Colloidal solids, Drinking Water, Pathogenic bacteria, Purification, Reverse Osmosis, Suspended solids, Water Purifiers, Ultrafiltration.

## I. INTRODUCTION

There are two major sources of drinking water supply in India- the Groundwater or Borewells and the other being water supplied by Municipal Corporation i.e. water from rivers, lakes, or other natural sources treated and then conveyed for domestic use to the public. With an increase in population, industrialization, and environmental degradation the need for pure water is increasing considerably. In order to meet this ever-increasing demand for pure water it is very important for humans to understand various water purification technologies and available water purifiers to ensure that everyone has access to safe drinking water.

The Water Treatment Plants are often centrally located in a municipal area and despite the treatment provided the water becomes contaminated until it reaches the consumer. In the case of water obtained from ground wells or borewells, the water does not receive primary treatment and is generally not recommended for drinking purposes without purification. Therefore, it is significant to understand the need for purification of water before its consumption. An ideal water purifier removes all the impurities such as suspended solids, colloidal solids, salts, and other pathogenic bacteria from water and retains essential salts and minerals. Thus, it is very important to understand the quality parameters of the drinking water supply in that area and choose the water purifiers accordingly.

The most important factor in choosing the water purifiers is identifying the targeted pollutant that needs to be eliminated or removed from the water, water quality, capital cost, warranty period, and maintenance cost. utilities that a particular water purifier uses should also be taken into consideration. Recently an order was passed by National Green Tribunal Board stating directives for use of RO (Reverse Osmosis) purifiers for the domestic water supply. RO technology generates high quantities of waste during the process of purification of water. It needs to be deployed in areas where the water is brackish (TDS>500mg/lit). Also, it is found that RO Systems remove essential minerals from the water thereby rendering the water-deficient of useful minerals such as Calcium and Magnesium. This in turn generates the need for remineralization of water. Hence, it becomes viable to explore alternate technologies that can help to maintain the essential minerals from the water, reduce the waste generated from the process of purification and also purify the water at optimal level achieving water quality standards. This paper highlights such alternative technologies that can be used at one's disposal and are easily available within the same price range.

## II. OBJECTIVES OF THE STUDY

The objectives of this study are as follows:

- Assessment of different water purifiers and establishing criteria for selection of water purifiers

- Comparison of water purifiers depending upon the treatment process
- To find suitable water purifiers addressing the removal of targeted contaminants from different sources of potable water.

### III. TYPES OF TREATMENT REQUIRED

Water is generally polluted and contaminated either due to natural sources such as the presence of salts, iron, nitrate, fluoride, etc. or due to anthropogenic causes. The main course of treatment provided during purification of the water includes (but not limited to): Removal of Physical impurities such as suspended solids, colloidal solids; removal of color and odor-causing agents; removal of Biological contaminants such as pathogenic bacteria, viruses, etc.; Removal of dissolved solids, etc. In potable water purifiers, the removal of physical impurities is carried out with the help of Sediment filter cartridge. A sediment filter cartridge is a device made up of either cotton, polypropylene, or glass fiber. The size of the pores of the cartridge is less than 5 microns. However, these filter cartridges are ineffective in the removal of dissolved solids from the water.

Removal of color and odor-causing agents is done with the employment of activated carbon filters. These filters work on the process of adsorption. The color and odor-causing compounds are adsorbed on the surface of the activated carbon. Carbon filters cannot remove inorganic chemicals, heavy metals, microorganisms, or hardness from water.

Biological contaminants present in the water are removed with the help of Ultra Violet disinfection. It is one of the highest forms of disinfection available in the country currently. It is very effective in the removal of various bacteria and viruses present in the water making the water suitable for drinking. Ultraviolet disinfection does not need the use of chemicals and it doesn't alter the taste or odor of the water. However, it is ineffective in the removal of dissolved impurities and the efficiency of the UV disinfection is affected in the presence of high turbidity. Removal of dissolved solids is one of the most significant treatment required for water purification. The most commonly used treatments include Ultra-Filtration or Reverse Osmosis (for TDS>500mg/lit). These treatments can effectively remove the dissolved solids along with certain bacteria and viruses.

In recent times, the turbidity of the water is controlled with the help of a TDS Controller. TDS Controller is a device that divides the stream of water into two parts. Part I of the stream enters the RO membrane. The water received as the output of has lower TDS than that of the input water. On the other hand, the Part II of the stream is passed through a UV disinfection chamber. This water received as output has the same TDS as that of the input water, however, it is free from bacteria and viruses. The output water then received at the end of this TDS Controller is a mixture of part I and part II, which has lower TDS as well as is free from bacterial contamination.

### IV. CRITERIA FOR SELECTION OF WATER PURIFIERS

The criteria for selection of water purifiers more or less remains the same. However, there can be difference of opinion considering the priority of each of the factors.

The following factors should be considered:

- The source of water: There can be different sources of water supply like groundwater, bore wells, river water, water supplied from municipal corporations, water tankers, etc. The water quality of the source of supply needs to be checked. The water quality parameters shall highlight the targeted pollutants from water that needs to be removed. This shall enable one to select the most appropriate purifier based on targeted pollutant removal.
- Treatment provided by the purifier: Once the targeted pollutant is identified from the water quality analysis of the source of water supply, the treatment can be chosen from a wide range of treatment options available in the market.
- Storage capacity of the purifier: This is a comparatively indicative factor while considering the best purifier in the market. It generally depends upon the size of the family and the need for the rate of purification.
- Capital Cost: Capital cost plays a significant role while selection of water purifier. Deciding a budget prior to the purchase shall assist in choosing a water purifier that can encompass all the needs of the targeted pollutant removal from the analysis of water quality.
- Annual Maintenance cost: This can be termed as recurring costs. It is important to understand that fundamentally water purifiers available in the market will require replacement of membranes and servicing of parts regularly to ensure smooth functioning.
- Dependency on utilities: Almost all of the purifiers that are currently available in the market utilize electricity for its functioning. Thus, the purchaser has to bear the additional costs of the utilities too. However, some purifiers do not require electricity and are based on the gravity-based purification principle.

**V. COMPARISON OF TREATMENTS**

Different available treatments are considered for this study and the comparison is done based on its advantages and disadvantages in terms of removal of contaminants or pollutants.

Table 1: Comparison of Treatments

Sr. No.	Water Purification Treatment	Advantages	Disadvantages
1	UV	Provides disinfection	Cannot work with turbid water
		Cost-effective	Ineffective in removal of dissolved solids
2	RO	Removes Dissolved solids	High quantities of rejects
		Suitable for hard water	Removal of essential minerals
3	UF	Provides disinfection	Ineffective in removal of dissolved solids
		Removal of Suspended solids	
4	Activated Carbon	Low cost	No disinfection
		Effective in the removal of color and odor	Ineffective in removal of dissolved solids
5	Gravity Based Filters	No electricity requirement	No disinfection
		Low cost	Not effective in removal of heavy metals

**VI. RESULTS AND DISCUSSIONS**

The treatment needs to be provided considering different water quality parameters that are present in the water. Below is the comparative study based on the same:

Table 2: Recommended water Treatment as per water sources

Sr. No.	Water Source	Contaminants	Required Treatment
1	Water from Bore Wells/ Groundwater	High bacteria	Sediment Filter Cartridge+ UF + UV
		Low Dissolved solids	
2	Water from Bore Wells/ Groundwater	Low bacteria	Sediment Filter Cartridge+ RO + UF (TDS> 500mg/lit)
		High Dissolved solids	
3	Water from Municipal Corporation	Low Bacteria & Viruses	Sediment Filter Cartridge+ Activated Carbon + RO/UF + UV
		High Dissolved solids	
		Low TSS	
4	Water Tankers	High Bacteria & Viruses	Sediment Filter Cartridge+ Activated Carbon + RO/UF + UV
		High TSS	
		Dissolved Solids	
5	Wells	High Bacteria & Viruses	Sediment Filter+ Cartridge UF + UV
		Low TSS	
		Dissolved Solids	
6	Rivers	High Bacteria & Viruses	Sediment Filter Cartridge+ Activated Carbon + UF + UV
		High TSS	
		Dissolved Solids	

The groundwater received from bore wells is generally free of suspended solids but it contains dissolved

solids. Also, this water can be either high or low in bacterial contamination and thus the most appropriate treatment that needs to be provided is Ultra-filtration + UV disinfection. Note that, if the quantity of dissolved solids is less than 500mg/lit there is no need to opt for Reverse Osmosis. Ultra-filtration can effectively remove bacteria and viruses from the water since the membrane sizes provided in Ultrafiltration is less than 0.02 micron.

On the other hand, water received from municipal corporation is already treated and then conveyed via pipes to the public. Despite necessary precautions, there are chances of contamination often results in deteriorating the water quality before it reached the public. Thus, this water can be effectively treated taking into consideration the water quality at individual levels. The water received generally has low suspended solid and bacterial contaminants however, it has considerable high quantities of dissolved solids. Thus, the most appropriate set of treatment shall include-Activated carbon to take care of the color and odor-causing compounds followed by RO (TDS>500mg/lit) or UF (TDS<500mg/lit) for removal of dissolved solids and then finally passing the water through UV Disinfection chamber to remove bacteria and viruses.

Quite often the source of water is unknown in cases of water supplied by water tankers and thus it is assumed that the water quality is considered poor. Therefore, the course of treatment should consist of passing the water through Activated Carbon Filters followed by removal of dissolved solids with the help of either RO (TDS>500mg/lit) or UV (TDS<500mg/lit) and at the end disinfection via UV chambers. The same course of treatment is followed for water received directly from rivers. River water contains various contaminants and pollutants due to various activities carried alongside the river and hence require definite activated carbon with UF and UV treatment.

## VII. CONCLUSIONS

It is necessary to check the quality of water before purchasing any water purifier. The need for RO is only required for the water that has TDS>500mg/lit. The water having TDS<500mg/lit can be treated with Ultrafiltration along with ultraviolet disinfection to have optimum removal of suspended solids and bacteria & viruses. Once the quality of water is checked one can clearly understand the target pollutant or contaminant that needs to be removed from the water. Thus, the treatment can be employed taking into consideration other factors such as cost and warranty.

It is a very conscious decision to make before purchasing a water purifier but one should know the source of water, assess the quality of water, and decide the budget and other relevant criteria.

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