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PhD students, teachers, scientists, research workers of higher educational institutions, research institutes and industrial enterprises are invited to participate in the conference. The conference provides an interdisciplinary forum for researchers, practitioners and scholars to present and discuss the most recent innovations and developments in modern science. The aim of conference is to enable academics, researchers, practitioners and college students to publish their research findings, ideas, developments, and innovations.

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NATURE MANAGEMENT, RESOURCE SAVING AND ECOLOGY

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COMPARATIVE ANALYSIS OF THE EFFECTIVENESS OF VARIOUS METHODS OF WATER PURIFICATION IN INDIA

Abstract. *Water contamination and pollution pose health hazards to humanity and hence the need for their treatment. This paper comparatively assessed the effectiveness of potable water purification methods, commonly used in different districts of India.*
Keywords: *potable water, methods, effectiveness.*

Introduction. The World Bank estimates that 21 percent of communicable diseases in India are linked to unsafe water and the lack of hygiene practices. Further, more than 500 children under the age of five die each day from diarrhea in India alone [1]. India continues to lag in proper drinking water, sanitation and hygiene facilities. Parliament constituencies in Bihar, Odisha, Jharkhand and Madhya Pradesh shared the highest burden of unsafe child stool disposal. Three constituencies in Odisha — Bargarh (95.85 per cent), Jajapur (95.65 per cent) and Kandhamal (95.28 per cent) — had the highest prevalence of unsafe child stool disposal in the country, showed the study.

The findings are based on the performance of India's 543 parliamentary constituencies on three important indicators of Water Sanitation and Hygiene (WASH) index: Unsafe disposal of child stool, unimproved drinking water supply and sanitary facilities.

The data was collected by generating precision-weighted estimates of each indicator at the constituencies-level, based on the recently developed methodologies of linking cluster GPS data from the National Family Health Survey (NFHS-4) to potential constituencies. The survey was designed to provide estimates of key indicators related to population health and nutrition at the national, state and district levels. Sanitary facilities were very poor in parliamentary constituencies in northern and eastern India. Budaun (90.69 per cent) and Ambedkar nagar (89.80 per cent) in Uttar Pradesh and Bhagalpur (87.14 per cent) in Bihar were the constituencies with the highest prevalence of poor sanitation facilities. On the other hand, constituencies in Lakshadweep (0.19 per cent), Sikkim (0.91 per cent) and Idukki (0.96 per cent) and Alappuzha (0.97 per cent) in Kerala had the lowest prevalence of poor sanitary facilities. Interestingly, Maharashtra, which seems to perform far better on WASH indicators than Uttar Pradesh, had far more constituencies with high burden of poor sanitary facilities than the latter, the study showed. The paper also found a strong correlation between unsafe child stool disposal and poor sanitary facilities.

The constituencies with the highest prevalence of poor drinking water were Inner Manipur (64.17 per cent) and Outer Manipur (59. 86 per cent) in Manipur; and Kadapa (46.62 per cent) and Kakinada (42.73 per cent) in Andhra Pradesh.

Constituencies in the northern and eastern parts of India had the lowest prevalence of unimproved drinking water sources. Fatehgarh Sahib (0.75 per cent), Ludhiana (0.58 per cent), and Jalandhar (0.35 per cent) in Punjab shared the lowest prevalence of poor drinking water. [2]

Aim and objectives. The aim of this study was to evaluate types of techniques used in the process of water purification in India and also to see whether it eliminates the essential materials such as fluorine beside filtering the heavy ions and other unwanted particle out of water. This can provide help in improvising the public health and concern for water contamination nowadays

There are many water purification techniques used in India. Those are as follows: sediment filtration, ion exchange, activated carbon towers, ultraviolet light, one micron pre-filter, two passes of reverse osmosis, ozonation, RO (reverse osmosis) water зurification [3].

Sediment filtration. A sediment filter captures and removes particulate matter like dirt and debris from your water. Sediment is a generic term for all the particulate matter in your water that is not liquid. Flakes of rust can enter your water supply from corroded galvanized plumbing. Rainwater can carry silt, clay, soil, and grains of sand into your well groundwater supply. Flow changes in your water main can also transport sediment to your home. The sediment filter is the first line of defense against this dirt and debris. It prohibits all this solid particulate from entering your water supply and impeding the performance of your water filtration systems. Sediment filters exist in a multitude of applications. Restaurants and coffee shops use sediment profilers to ensure the quality of their food and beverages. Whole house filtration systems employ sediment filtration to eliminate particulate matter from entering your faucets and showers and to protect the lifespan of other filters. Your pool filter cartridges are a form of sediment filter, blocking dirt and clay from muddying your pristine swimming water. Any instance in which clean water is imperative, you will likely find some form of sediment filter [4].

Ion exchange. Ion exchange is a water treatment process commonly used for water softening or demineralization, but it also is used to remove other substances from the water in processes such as de-alkalization, deionization, and disinfection.

But what exactly is it? Ion exchange describes a specific chemical process in which unwanted dissolved ions are exchanged for other ions with a similar charge.

Ions are atoms or molecules containing a total number of electrons that are not equal to the total number of protons. There are two different groups of ions, cations, which are positively charged, and anions, which are negatively charged. We have

Michael Faraday to thank for these names, which he devised based on the cation's attraction to the cathode and the anion's attraction to the anode in a galvanic device.

Removing Ionic Contaminants

This attraction is used to remove dissolved ionic contaminants from water. The exchange process occurs between a solid (resin or a zeolite) and a liquid (water). In the process, the less desired compounds are swapped for those that are considered more desirable. These desirable ions are loaded onto the resin material.

In the exchange of cations during water treatment, positively charged ions that come into contact with the ion exchange resin are exchanged with positively charged ions available on the resin surface, usually sodium. In the anion exchange process, negatively charged ions are exchanged with negatively charged ions on the resin surface, usually chloride. Various contaminants — including nitrate, fluoride, sulfate, and arsenic — can all be removed by anion exchange.These resins can be used alone or in concert to remove ionic contaminants from the water. If a substance is not ionic, such as benzene, it cannot be removed via ion exchange

Ion Exchange in Drinking Water Treatment. Recently ion exchange resins have been increasingly used to create drinking water. Specialized resins have been designed to treat various contaminants of concern, including perchlorate and uranium.There are many resins designed for these purposes, such as strong base/strong anion resin, which is used to remove nitrates and perchlorate. There are also resin beads that can be used for water softening [5].

Ion Exchange water purifier advantages and disadvantages. Ion exchange is widely used for water treatment in both industrial and municipal water treatment systems. The process provides many advantages over other treatment methods. It is environment friendly, can provide high flow rate of treated water and has low maintenance cost. Along with these benefits, there are certain disadvantages associated with ion exchange, such as calcium sulfate fouling, iron fouling, adsorption of organic matter, organic contamination from the resin, bacterial contamination and chlorine contamination.

Calcium Sulfate Fouling. The most common regenerate (chemical used to recharge the resin) used for cation resin is sulfuric acid. Some extremely hard water contains high amounts of calcium, and when this calcium reacts with the regenerating sulfuric acid, it forms calcium sulfate as a precipitate during the regeneration process. This precipitate can foul the resin beads and can block the pipes in the vessel.

Iron Fouling. Feed water from the underground water bores has soluble iron in the form of ferrous ion. Small amounts of this iron is removed by the ion exchange softeners, but if this feed water comes in contact with air before treatment, the ferrous ions are converted ferric ions. These ferric ions precipitate as ferric hydroxide after reacting with water. This compound can clog the resin beads and affect the resin efficiency. This can even result in failure of the softener column.

Adsorption of Organic Matter. Feed water from lakes and rivers usually contain high amounts of dissolved organic matter. The yellow or brown color of this feed water is due to the decayed vegetation and other organic matter present in it. These organic substances may be permanently adsorbed within the resin beads, resulting in reduced resin efficiency. The treated water quality is thus degraded. These organic contaminants can be removed prior to treatment with resin by treating the feed water with alum to precipitate the organic matter.

Organic Contamination from the Resin. The ion exchange resin itself can sometimes become the source of organic contamination. The new ion exchange resin often has organic elements remaining in the resin beads after manufacturing. Such contamination of the resin may be treated by passing the treated water through an ultrafiltration treatment plant.

Bacterial Contamination. Ion exchange resins do not remove microorganisms like bacteria from the feed water but sometimes aid in the bacterial growth. The resin beds may accumulate organic matter which serves as a source of nutrient for continued growth of bacteria. When sterile water is required after the treatment, the demineralized water produced by the ion exchange treatment plant should be treated by heat, ultraviolet irradiation or very fine filtration. Ion exchange resins beds can also be treated with disinfectants such as formaldehyde but, not with heat or chlorine, as they will damage the resin.[6]

Activated Carbon Towers. Granular activated carbon (GAC) is commonly used for removing organic constituents and residual disinfectants in water supplies. This not only improves taste and minimizes health hazards; it protects other water treatment units such as reverse osmosis membranes and ion exchange resins from possible damage due to oxidation or organic fouling. Activated carbon is a favored water treatment technique because of its multifunctional nature and the fact that it adds nothing detrimental to the treated water. Most activated carbons are made from raw materials such as nutshells, wood, coal and petroleum.

Typical surface area for activated carbon is approximately 1,000 square meters per gram (m^2/gm). However, different raw materials produce different types of activated carbon varying in hardness, density, pore and particle sizes, surface areas, extractable, ash and pH. These differences in properties make certain carbons preferable over others in different applications.

The two principal mechanisms by which activated carbon removes contaminants from water are adsorption and catalytic reduction. Organics are removed by adsorption and residual disinfectants are removed by catalytic reduction [7].

Ultraviolet Light Ultraviolet water purification is the most effective method for disinfecting bacteria from the water. Ultraviolet (UV) rays penetrate harmful pathogens in your home's water and destroy illness-causing microorganisms by attacking their genetic core (DNA). This is extremely efficient in eliminating their ability to reproduce. Disinfecting your water with Ultraviolet light is exceptionably simple, effective and environmentally safe. UV systems destroy 99.99% of harmful microorganisms without adding chemicals or changing your water's taste or odor. UV water purification is usually used with other forms of filtration such as reverse osmosis systems or carbon block filters.

UV Purification > Chemical Disinfectant. UV systems are an effective means of water disinfection for residential point of entry use to help disinfect the entire home. UV systems are highly recommended to homeowners who may suspect any E.coli, cryptosporidium, giardia or any other types of bacteria and viruses in the water. It is not advised to use chlorine or other chemicals to disinfect water like private well owners, because of the toxic byproducts they create. It is important to avoid drinking any water that is potentially contaminated from bacteria to protect yourself from any water-borne bacterial diseases.

Ultraviolet Purification Advantages

- Chemical Free: UV purification does not use any chemicals like chlorine or leave any harmful by products.
- Taste & Odor Free: UV does not add any chemical taste or odor to the water.
- Extremely Effective: One of the most effective ways to kill disease-causing microbes by destroying 99.99%.
- Requires very little energy: Uses about the same energy as it would to run a 60 watt light bulb.
- Low Maintenance: Set and forget type of system, just change UV bulb annually.

Limitations in UV Water Systems. Ultraviolet purification itself is not enough to purify water down to drinking water purposes. This is because the UV radiation is only effective for treating bacteria and viruses. UV light does not work to eliminate contaminants such as chlorine, heavy metals and VOC's (Volatile Organic Compounds). UV systems are often paired with Reverse Osmosis Systems to provide a complete purification process for the safest drinking water.

Choosing the Right UV Unit Size. If you draw water from a private water supply it is recommended to treat your entire home. To assure the highest satisfaction, choose the right size (gpm) of UV system that matches your household peak demand flow rate. This is simply a measure of how much water can flow through your main water line if all the water outlets were opened at once.[8]

Reverse osmosis. It removes contaminants from unfiltered water, or feed water, when pressure forces it through a semipermeable membrane. Water flows from the more concentrated side (more contaminants) of the RO membrane to the less concentrated side (fewer contaminants) to provide clean drinking water. The fresh water produced is called the permeate. The concentrated water left over is called the waste or brine [9].

RO water purifier advantages and disadvantages. RO water purifier uses semi-permeable membrane through which salty water forces to move. During this process it filter contaminants such as arsenic, nitrates, sodium, copper and lead, some organic chemicals. RO water purifier helps to convert hard water to sweet, soft water using RO membrane.

Advantages of RO water purifier

- Reverse osmosis (RO) water purifier is the best solution for treating hard water.
- RO water purifier removes toxin such as lead, mercury, Fluoride, Arsenic, Chlorine which case human body to be ill. Lead metal can cause brain damage and anemia.
- RO water filter is great for removing commonly found Cryptosporidium in lake, river and public supply water.

For example Pureit marvella slim RO is one of the best RO water purifier.

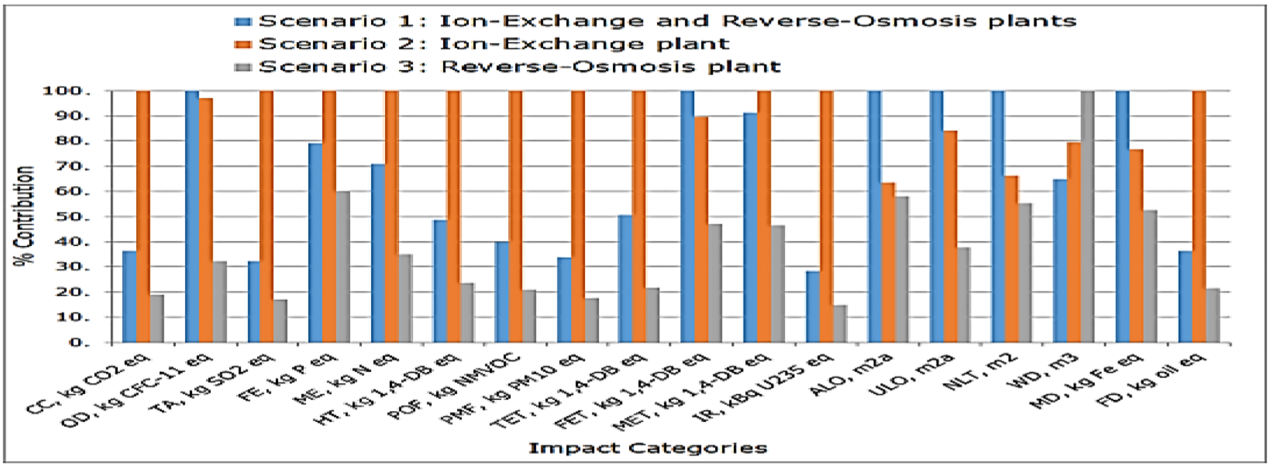
Disadvantages of RO water purifier

- Removes essential minerals: While RO water purifier removes dissolved impurities it removes natural mineral such as iron, magnesium, calcium and sodium which are essential to the human body and cause a mineral deficiency in the body.
- Not kills bacteria, viruses: RO water purifier does not kill waterborne disease-causing bacteria and viruses. There high probability that microorganisms can pass through RO membrane(It is advisable to pass RO water through the UV water purifier to treat microorganisms).
- Water taste altered: As natural minerals are removed water gets de-mineralized as a result water taste affected, it becomes tasteless.
- More time to purify: RO water purifier takes too long to the purification of water.

- Water wastage: Approximately much more water compared to filtered out water flushed down as waste water.
- Expensive: RO water purifier costlier compared to counterpart water purifiers UV and RO water purifier consumes much more electricity.
- RO membrane breakage: No mechanism is there, to know when to replace RO membrane. Chlorine can damage RO membrane. Chlorine makes small pores of RO membrane clogged and makes drastic reduction in performance. On breakage of membrane dissolved salts, bacteria, viruses can easily pass through RO membrane. It is advisable to replace RO membrane once in a year [10].

Conclusion.

Water treatment is often necessary if surface water supplies and sometimes groundwater supplies are to be available for human use. Because the vast majorities of city use water distribution system for household, industries, fire control, large quantities of water often made available to satisfy the hygienic use which is usually



drinking water. According to our study the most often used water purification process is ionization exchange because it is ecofriendly and low maintenance cost which helps in improvising the economic and hygienic norms and standard at the same time [11].

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