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Evaluating the Efficacy of Implosion Water Treatment Versus Traditional Methods

Basudev Singh[1], Jayanta Kumar Mahat[2], Jyoti Sharma[1,*]

Abstract

The first worry of all people is the quality of the water. The majority of the water that is accessible is unfit for immediate usage. Certain methods are frequently employed to purify water for optimal use. These methods include UV treatment, chemical treatments, reverse osmosis, filtration, and ultrafiltration, among others. Each of these water treatment methods is applied separately or in combination. There are benefits and drawbacks to each of these methods. The present research work is aimed to make the water potable through various different water treatment processes. Reverse Osmosis is the major technique used for water treatment along with filtration and UV treatment. One more technique which in not used in general practice but can be very useful is Implosion technology. Filtration is the technique which only removes suspended particles; it does not work on dissolved solids. For bacterial contamination UV treatment is effective. Reverse osmosis efficiently eliminates minerals and dissolved solids, but regular use may have negative effects on the human body. Reverse osmosis has been shown to reduce dissolved solids from 60% to 95%. It also causes a significant drop in water pH, which is not good for the human body on a regular basis. The implosion technique is the only one that is durable and has no adverse effects on the human body. It improves the water's chemistry by preserving its mineral content, raising the dissolved oxygen content (10–20%), decreasing turbidity (20–80%) and hardness (10–30%), improving the water's appearance and flavor, and, in certain situations, assisting in the removal of bacterial contamination. Implosion technique. Such increase of dissolved oxygen and remove of turbidity as well as hardness of water is highly beneficial for human health. Hence, implosion technique is the best solution among conventional water treatment techniques for the drinking water having acceptable dissolved solids (150mg/l to 600 mg/l); however, Reverse Osmosis is best solution when dissolved solids in water exceeds 600mg/l.

Keywords: Implosion, UV technique, Filteration, Reverse Osmosis, dissolved Solids, water quality

***Author for Correspondence**
Jyoti Sharma
E-mail: jyoti2@shobhituniversity.ac.in

[1]Student, School of Humanities, Physical & Mathematical Sciences, Shobhit Institute of Engineering and Technology (Deemed to be University), Meerut, Uttar Pradesh, India
[2]Faculty of Engineering Applied Science & Technology, Shobhit Institute of Engineering and Technology (Deemed to be University), Meerut, Uttar Pradesh, India

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INTRODUCTION

For the entire industrial world, water pollution from industrial wastes such dangerous chemicals is a major problem and a major issue that is of utmost importance to the ecology and society worldwide [1–7]. Water is used by humans for many everyday activities, such as drinking, cooking, cleaning, bathing, swimming, and irrigation. Water pollution is a significant issue in the current environment of fast industrialization and widespread urbanization [1–7]. A clean and pure water supply is necessary for a variety of home and agricultural tasks. The reverse osmosis (RO) technology is widely used for water purification, but it is quite expensive and wastes a lot of water during the entire treatment

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process [8–11]. Depending on local geology and mineral solubility, drinking water's chemical characteristics can differ. Total dissolved solids (TDS) are the primary cause of this fluctuation in drinking water [12]. TDS in drinking water can come from sewage, urban runoff, industrial effluent, and natural sources [13]. In addition to TDS, a number of other factors, including pH, total hardness, and odor, significantly affect the quality of drinkable water [14–16].

Both inorganic and organic pollutants have maximum allowable amounts, according to the rules, and certain bacteria can contribute to water quality contamination. Drinking water should have a TDS level of no more than 500 parts per million; any higher than this is considered undesirable. Many of the various mineral salts that comprise TDS present a range of health risks when they exceed the allowable limit. These include kidney stones, gallstones, artery hardening, joint stiffness, and more. Even more than half of the water that is wasted by reverse osmosis is unusable. Other methods, such as UV sterilization, ion exchange, and microfiltration, are also employed singly or in combination. These methods can't provide desirable product water and aren't cost-effective either. Artificially produced de-mineralized waters, initially distilled water and later deionized or reverse osmosis-treated water, were used mostly for industrial and other commercial reasons due to the lack of adequate water. Due to the restricted supply of drinking water in certain inland and coastal dry regions that were unable to satisfy the growing demand for water, these techniques were applied more widely in the 1960s to treat drinking water. The fast population growth, industrialization, and infrastructure development were the causes of these circumstances. Where highly mineralized brackish or seawater was the main or only plentiful water supply, demineralization of the water was required. Ocean-going ships and spaceships were similarly concerned about their drinking water supply. Since these water treatment techniques were expensive and technically demanding, they were first not utilized elsewhere. Its sustainability is threatened by its ongoing depletion and quality degradation in the northern region of India as a result of growing demand and careless use.

Our body requires water and minerals to perform proper functioning. Water is an important source of administrating minerals to our body. Therefore, minerals and no harmful chemicals should be present in drinking water. Generally, people think that water without minerals will not harm our body. However, a number of authors [17–20] have looked at the fact that minerals are necessary for our bodies to function properly, and that water is the primary source of minerals because an average person drinks two to five liters of water every day. If we drink water with low dissolved solids i.e osmosis, which is the transport of solute particles to the substantially less concentrated solution, allows water to regularly excrete minerals from our bodies through urination when the concentration is below 50 mg/l. In this situation, ongoing and consistent efforts are needed to conserve and regenerate water supplies.

Implosion water treatment technique is a new and innovative process used to purify water by utilizing the principles of hydrodynamic cavitation, which involves the formation and implosion of cavities in water [21-28]. In this technique, water is forced into a vortex, creating a spiraling motion that mimics natural water flow. This implosive action revitalizes the water by breaking down contaminants, re-oxygenating it, and restructuring the water molecules, which is believed to make the water healthier and more hydrating [24, 26, 28]. Applications of implosion water treatment can be found in sustainable for drinking water purification, agriculture, and wastewater management, where it enhances water quality without relying on chemical additives [21-23, 25]. Advantages of this technique include its eco-friendliness, as it requires less energy and avoids harmful chemicals, as well as the potential to improve water's natural properties, mainly increase the dissolved oxygen level. However, limitations include its relatively low scalability for large-scale industrial use, high initial setup costs and limited scientific validation, which has led to more investigation about its effectiveness. In this regard, the present research work is aimed toward comparatively investigate the effectiveness of implosion water treatment technique on chemical properties of three different sources water as compared to the conventional water treatment techniques.

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EXPERIMENTAL

Material and Method

Sample Collection: Three distinct locations—ground water, surface water, and municipal water—with varying levels of total dissolved solids were used to gather raw water.

Water Treatment Techniques

In the current study, various water treatment procedures were used, including standard filtration, reverse osmosis (RO), ultraviolet (UV) treatment, and implosion techniques. Normal filtration, reverse osmosis (RO), ultraviolet (UV) treatment, and implosion procedures were all performed on water treatment setups manufactured by ISI-standard businesses. Figure 1 shows the set-up for water treatment under implosion technique. The flow diagram of process of implosion technique is shown in Figure 2. The idea of vortex generation serves as the foundation for the implosion technique. The vortex formation process begins with creating a vortex or spiral motion in the water. This spiral motion mimics natural water flows, such as those found in rivers, where water moves in a curving, dynamic path. This movement is intended to activate and energize the water molecules. As the water flows through a vortex and has pressure approximately 1 to 2 bar, the water molecules are undergoing an implosion with each other. This implosion action breaks down the contaminants, re-oxygenate and restructure the water molecules. This improvement of water quality is very beneficial for human health as more oxygenated water may enhance hydration and nutrient delivery.

Figure 1. Outdoor and Indoor Setup for water treatment by Implosion Technique.

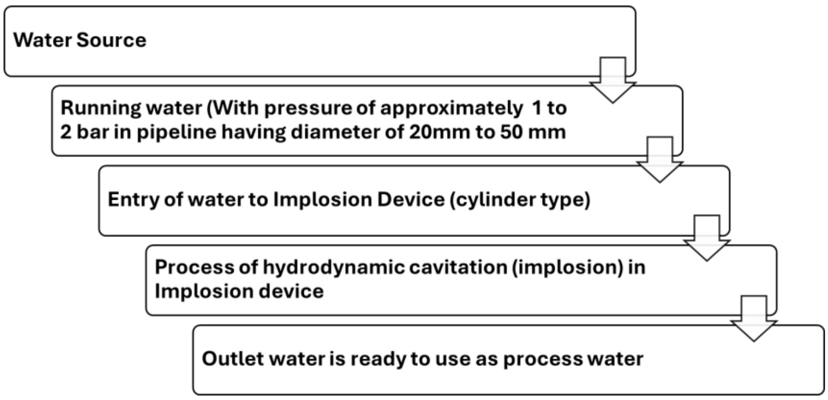

Figure 2. Flowchart of Implosion water treatment technique.

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Sampling Parameters and Reference

Sampling: The selection of sampling locations included both surface and ground water from various areas close to major cities, as well as the Yamuna River. A variety of parameters were examined, including appearance, color, taste, turbidity, pH, and total dissolved solids (TDS) as physical and organoleptic parameters; dissolved oxygen as a microbiological parameter; chlorides (mg/l); magnesium (mg/l); calcium (ca); sulphate (SO4; mg/l); alkalinity (caCO3; mg/l); hardness (caCO3; mg/l); and coliform bacteria as microbiological parameters. Parameters are selected on the basis of the majority of constituents in water which can show significant difference between different treatment techniques. Table 1 lists the IS 3025 standards and procedures that were used to analyze the water quality. As advised by the standard technique of examination and wastewater, the laboratory examined the water samples that were gathered from various sources (APHA, 2012). All the samples were analyzed in the ITL Lab Pvt. Ltd., Delhi and in Environmental Engineering Laboratory in the University of Engineering and Technology Roorkee, UETR.

RESULTS AND DISCUSSIONS

In the present study three types of samples were taken e.g. Tap water, potable water from the municipal supply, ground water from a hand pump, and ground water from other sources, such as a tube well, with three distinct amounts of total dissolved solids.

Sample 1

Sample description: A groundwater sample was taken 2.5 kilometers from the Yamuna River in the Mathura, Uttar Pradesh, village of Musmuna in the Naujheel Block. The collected water had fewer than 500 mg of total dissolved solids per liter. Four distinct water treatment methods were applied to the collected water: implosion, UV treatment, reverse osmosis, and filtration. Table 2 lists sample 1's physio-chemical characteristics following the use of various water treatment methods.

The comparison of physio-chemical properties of sample-1 after water treatment conditions by four different techniques viz. Filteration, RO, UV and Implosion is shown in Figure 3. After the treatment of raw water coliform bacteria was found active in case of filtration and reverse osmosis water treatment techniques; however, in case of UV and implosion water treatment technique the bacteria only get disinfected when these techniques merged with ultra filtration and nano technology. The pH value of good drinking water should be between 6.8 and 7.8, but RO treatment significantly alters pH values, making them unfit for human consumption but after RO water treatment it reduced to 6.2. It is also observed that TDS, total hardens and total alkalinity in water can be reduced to the sufficient amount in case of RO water treatment technique It is also interestingly observed that the dissolved oxygen level increases upto 15% in case of implosion water techniques, but it remains almost constant in case of other water treatment techniques.

Table 1. Methods used for analysis of chemical parameters of water.

Sr. No.	Name of Parameter	Method Used
1	Color	IS 3025 (Part-4)
2	Taste	IS 3025 (Part-8)
3	Turbidity	IS 3025 (Part-10)
4	pH Value	IS 3025 (Part-11)
5	Total dissolved solids	IS 3025 (Part-16)
6	Total Hardness	IS 3025 (Part-21)
7	Total Alkalinity	IS 3025 (Part-23)
8	Calcium	IS 3025 (Part-40)
9	Chloride	IS 3025 (Part-32)
10	Sulphate	IS 3025 (Part-24)
11	Dissolved Oxygen	IS 3025 (Part-38)
12	Coliform Bacteria	IS 5401 (Part-1)

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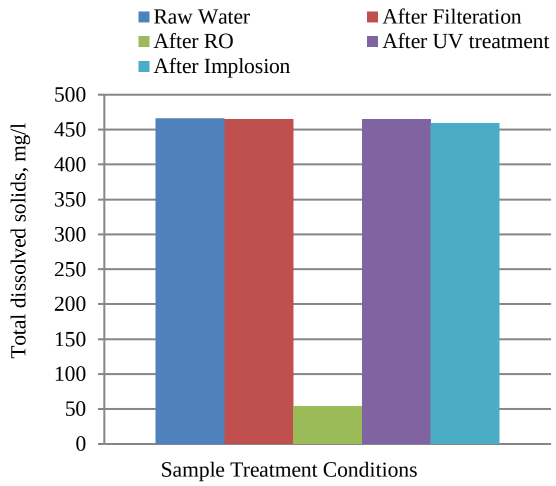
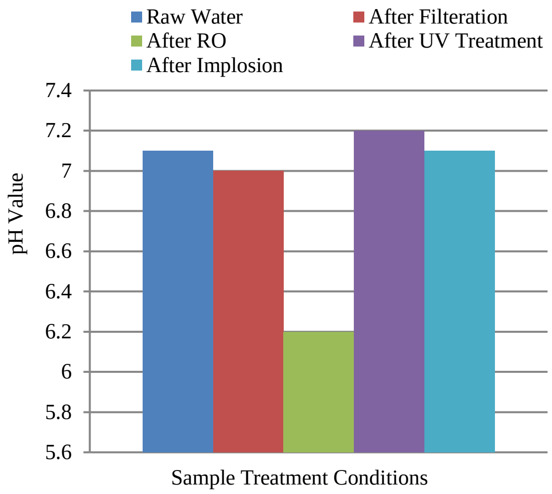
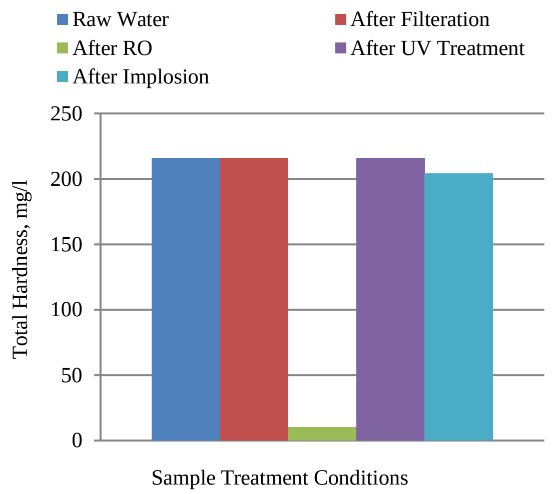
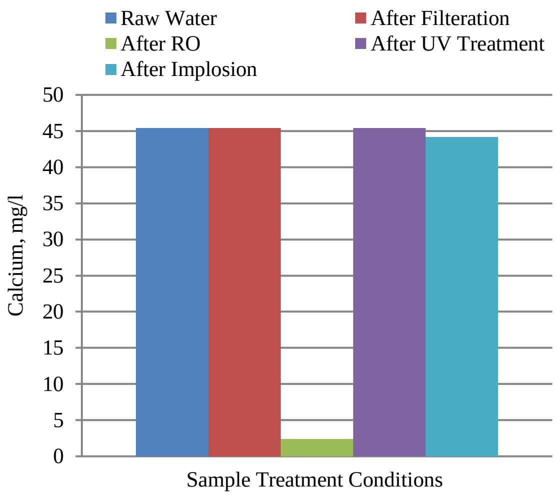
Table 2. List of different chemical properties of sample-1 under raw condition and after various water treatment techniques.

Sr. No.	Parameter, unit	Raw Water	After Filtration	After Reverse Osmosis	After UV Treatment	After Implosion
1	Appearance	Very slightly yellowish appearance	Almost Clear	Clear	Very slightly yellowish appearance	Clear
2	Color, Hazen	Less than 1	Less than 1	Less than 1	Less than 1	Less than 1
3	Taste Rating	Agreeable (c)	Agreeable (c)	Agreeable (a)	Agreeable (c)	Agreeable (a)
4	Turbidity, NTU	1	Less than 1	Less than 1	1	Less than 1
5	pH Value	7.1 ± 0.06	7.0 ± 0.06	6.2 ± 0.06	7.2 ± 0.06	7.1 ± 0.06
6	Total dissolved solids, mg/l	466 ± 10.6	465 ± 12.9	54 ± 6.0	465 ± 12.2	459 ± 13.3
7	Total Hardness, mg/l	216 ± 7.2	216 ± 5.3	10 ± 1.5	216 ± 6.9	204 ± 7.2
8	Total Alkalinity, mg/l	350 ± 11.1	344 ± 7.2	12 ± 2.0	348 ± 10.0	348 ± 7.2
9	Calcium, mg/l	45.4 ± 1.11	45.4 ± 0.91	2.4 ± 0.26	45.4 ± 1.04	44.2 ± 2.00
10	Chloride, mg/l	22 ± 2.0	21 ± 1.2	8 ± 1.0	22 ± 2.0	22 ± 1.5
11	Sulphate, mg/l	28.6 ± 2.17	28.4 ± 1.78	2.2 ± 0.21	28.6 ± 1.46	24.7 ± 1.65
12	Dissolved Oxygen, mg/l	5.6 ± 0.46	5.5 ± 0.58	5.7 ± 0.46	5.6 ± 0.38	6.4 ± 0.67
13	Coliform Bacteria	Present	Present	Present	Absent	Absent









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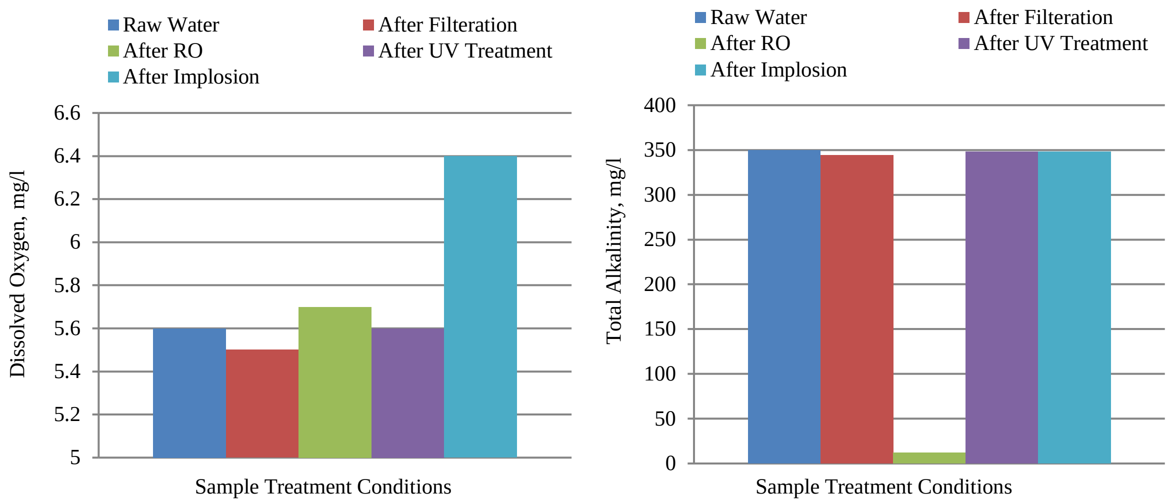

Figure 3. Variation of TDS, pH value, total hardness, Calcium, dissolved oxygen and total alkalinity respectively w.r.t. different after sample treatment conditions for Sample-1.

Such observation may be attributed to working principles of implosion technique as water flows through a vortex and having pressure approximately 1 to 2 bar in case of implosion technique, the water molecules are undergoing an implosion with each other, results in breaking down the contaminants and regenerate oxygen [24, 26, 28]. This improvement of dissolved oxygen level in water is very much beneficial for human health as more oxygenated water may enhance hydration and nutrient delivery. However, limitations of this process include the relatively low scalability for large-scale industrial use and high initial setup costs. In addition, TDS, total hardens and total alkalinity in water can't be reduced to sufficient amount by implosion water treatment techniques.

Sample-2

Sample description: Water was collected for investigation from the Tilak Nagar area of west Delhi. Less than 150 mg of total dissolved solids were present in the sampled water. This water is supplied by Delhi Jal Board in that area. Table 3 lists sample 2's physio-chemical characteristics following the use of various water treatment methods.

Table 3. List of different chemical properties of sample-2 under raw condition and after various water treatment techniques.

Sr. No.	Parameter, unit	Raw Water	After Filtration	After Reverse Osmosis	After UV Treatment	After Implosion
1	Appearance	Very slightly yellowish appearance	Almost Clear	Clear	Very slightly yellowish appearance	Clear
2	Color, Hazen	Less than 1	Less than 1	Less than 1	Less than 1	Less than 1
3	Taste Rating	Agreeable (b)	Agreeable (b)	Agreeable (a)	Agreeable (b)	Agreeable (a)
4	Turbidity, NTU	1	1	Less than 1	1	Less than 1
5	pH Value	6.8 ± 0.10	6.8 ± 0.17	6.0 ± 0.21	6.8 ± 0.21	6.9 ± 0.12
6	Total dissolved solids, mg/l	118 ± 3.2	116 ± 4.0	22 ± 1.7	116 ± 4.0	116 ± 3.5
7	Total Hardness, mg/l	44 ± 3.5	42 ± 3.5	4 ± 0.6	44 ± 5.3	36 ± 4.0
8	Total Alkalinity, mg/l	52 ± 5.3	52 ± 4.0	6 ± 0.6	50 ± 3.5	52 ± 3.5
9	Calcium, mg/l	8.4 ± 0.50	8.4 ± 0.35	0.8 ± 0.06	8.4 ± 0.40	8.4 ± 0.35
10	Chloride, mg/l	12 ± 2.0	12 ± 2.0	5 ± 0.6	12 ± 2.0	12 ± 2.0
11	Sulphate, mg/l	6.4 ± 0.26	6.3 ± 0.20	0.4 ± 0.06	6.4 ± 0.20	6.4 ± 0.31
12	Dissolved Oxygen, mg/l	5.7 ± 0.17	5.7 ± 0.21	5.7 ± 0.21	5.6 ± 0.21	6.5 ± 0.25
13	Coliform Bacteria	Present	Present	Present	Absent	Absent

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It is observed from Figure 4 that the effect of four different water treatment techniques on physio-chemical properties of sample-2 after water treatment conditions is same as in case of sample-1.

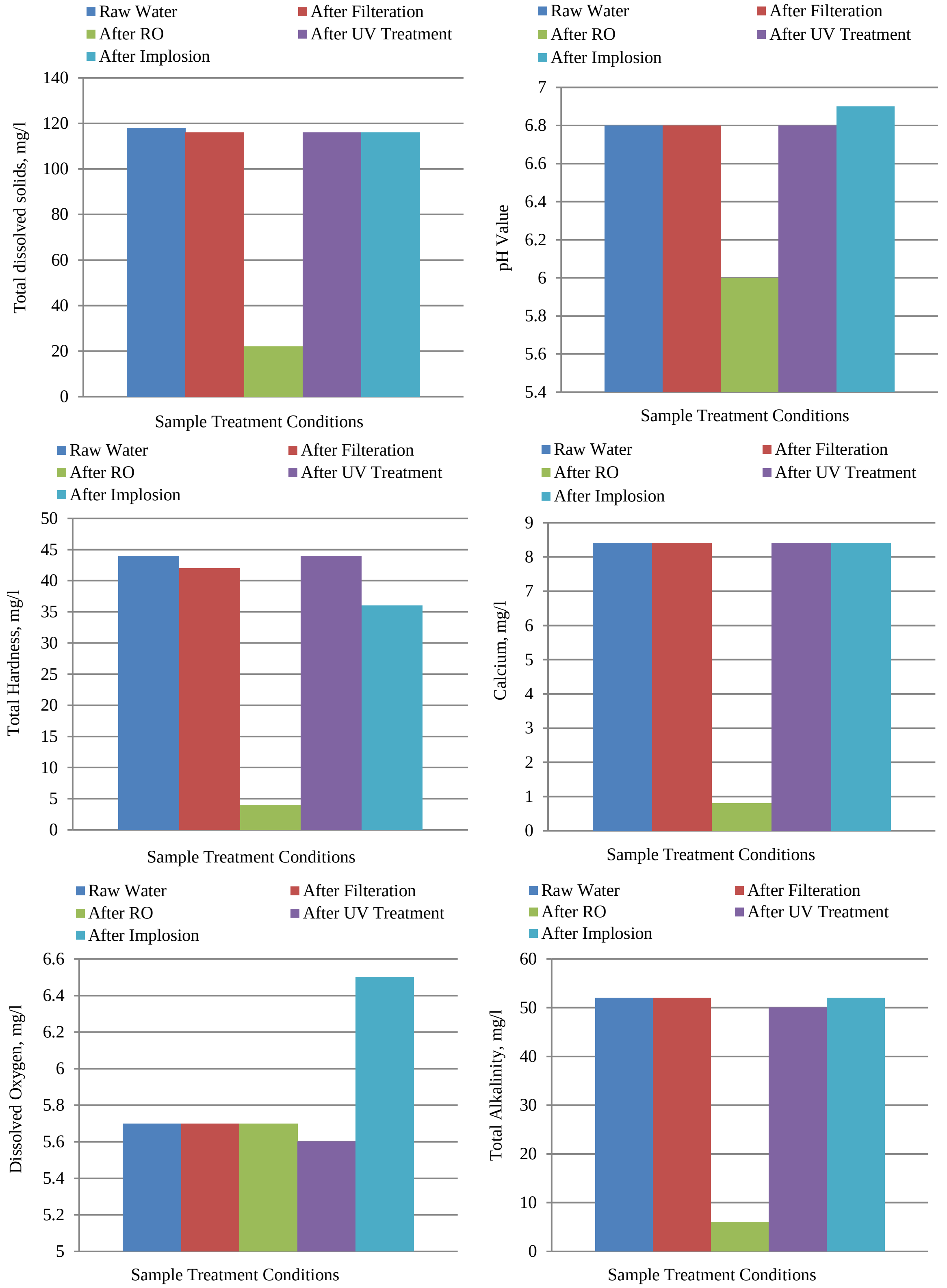

Figure 4. Variation of TDS, pH value, total hardness, Calcium, dissolved oxygen and total alkalinity respectively w.r.t. different after sample treatment conditions for Sample-2.

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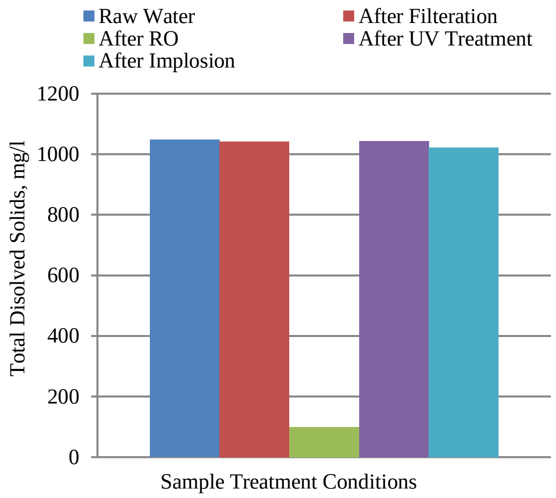
Sample-3

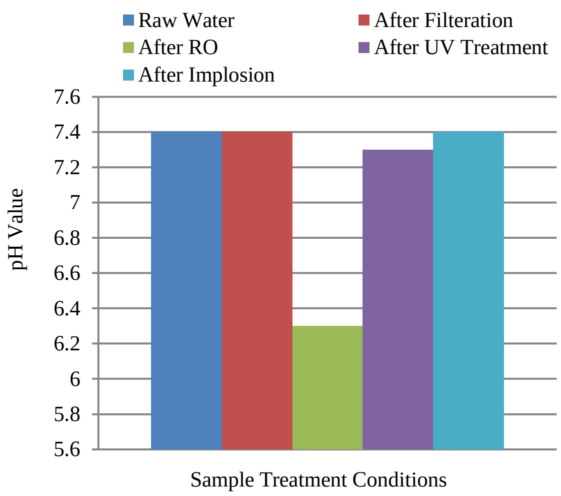
Description of Sample: Underground water of a hand pump was collected from Naujheel village, Mathura for analysis having total dissolved solids more than 1000 mg per liter; The source of this sample was 600 meters far away from Yamuna River and this sample is treated under 4 different techniques. The physio-chemical properties of sample-3 after application of different water treatment techniques are listed in Table 4.

It is observed from Figure 5 that TDS level decreases from 1048 mg/l to 100 mg/l in case of only RO water treatment. It is also observed that total hardness, total alkalinity, calcium, chloride and sulphate in heavy raw water can be reduced to sufficient amount in case of only RO water treatment technique. The other three water treatment techniques are not effective to reduce such physio-chemical properties of heavy water having TDS level around 1000 mg/l. It is also observed that dissolved oxygen level can be increased upto 15% by using implosion water treatment technique. However, only RO water treatment technique can be used to convert the raw water having around 1000 mg/l TDS into drinkable water.

Table 4. List of different chemical properties of sample-3 under raw condition and after various water treatment techniques.

Sr. No.	Parameter, unit	Raw Water	After Filtration	After Reverse Osmosis	After UV Treatment	After Implosion
1	Appearance	Very slightly yellowish appearance	Almost Clear	Clear	Very slightly yellowish appearance	Clear
2	Color, Hazen	Less than 1	Less than 1	Less than 1	Less than 1	Less than 1
3	Taste Rating	Agreeable (b)	Agreeable (b)	Agreeable (a)	Agreeable (b)	Agreeable (a)
4	Turbidity, NTU	1	1	Less than 1	1	Less than 1
5	pH Value	7.4 ± 0.10	7.4 ± 0.10	6.3 ± 0.12	7.3 ± 0.12	7.4 ± 0.10
6	Total dissolved solids, mg/l	1048 ± 11.1	1042 ± 10.6	100 ± 2.0	1044 ± 10.6	1022 ± 7.2
7	Total Hardness, mg/l	584 ± 11.1	584 ± 10.6	42 ± 2.0	584 ± 10.6	504 ± 7.2
8	Total Alkalinity, mg/l	566 ± 16.4	558 ± 12.5	112 ± 6.0	562 ± 18.0	558 ± 11.1
9	Calcium, mg/l	102 ± 5.29	102 ± 5.29	10.4 ± 0.53	102 ± 5.29	102 ± 7.21
10	Chloride, mg/l	178 ± 11.1	176 ± 10.6	32 ± 4.0	178 ± 10.4	176 ± 8.0
11	Sulphate, mg/l	56.2 ± 1.73	55.8 ± 2.75	6.8 ± 0.35	56.1 ± 1.86	55.8 ± 2.75
12	Dissolved Oxygen, mg/l	5.4 ± 0.32	5.4 ± 0.31	5.5 ± 0.30	5.4 ± 0.20	6.3 ± 0.21
13	Coliform Bacteria	Present	Present	Present	Absent	Present





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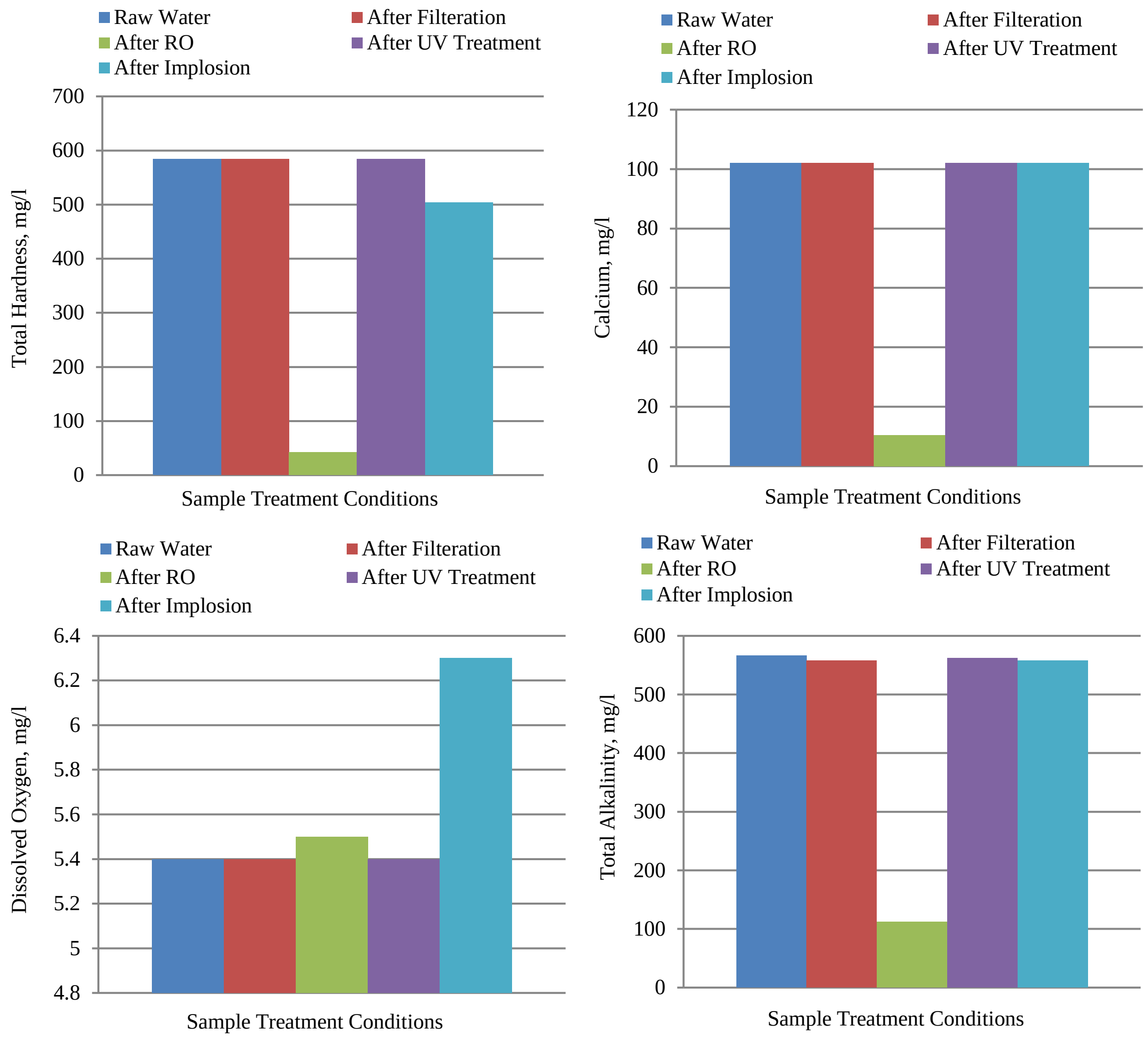

Figure 5. Variation of TDS, pH value, total hardness, Calcium, dissolved oxygen and total alkalinity respectively w.r.t. different after sample treatment conditions for Sample-1.

Numerous factors, such as mining operations, domestic sewage, industrial processes, and inadequate infiltration, can contaminate water, but widespread industrial water usage is one of the most serious causes [29, 30]. Three distinct samples are collected in order to assess the efficacy of the various water treatment methods. These samples, sample-1, sample-2 and sample-3 were collected from different sources having different amounts of total dissolved solids e.g. 450, 120 and 1048 mg/l respectively i.e. normal to medium and very high. Four distinct methods were used to measure the physio-chemical characteristics of these samples, including total dissolved solids, pH, colour, taste, turbidity, total hardness, carbonate hardness, non-carbonate hardness, total alkalinity, calcium, chloride, sulphate, dissolved oxygen, and coliform bacteria. We can determine that various treatments are needed for different types of samples based on a comparison of these samples for these criteria. Given that Sample 1 contains roughly 500 mg/l of total dissolved solids, it could need to be treated using an implosion approach or UV treatment. Sample 2 requires little treatment because its total dissolved solids are about 100 mg/l. However, Sample 3 contains over 1000 mg/l of total dissolved solids, necessitating extensive treatment such as reverse osmosis. This study makes it clear that RO water treatment is not always necessary because it removes minerals from water that the human body needs. According to reports, the RO-system reduces the alkalinity and pH to 6.2 by eliminating too much calcium and magnesium salt, which is bad for human health. Because RO water treatment removes minerals from the water while it is being treated, drinking it causes mineral deficiencies in the body. RO was more effective to remove surfactants for firefighting waters containing fluorinated surfactants [31]. He has proposed RO water treatment method for purifying firefighting water to remove all the surfactants.

Although the implosion technique in sample 3 was not successful in eliminating the coliform bacteria, it did somewhat raise the level of dissolved oxygen by up to 15%. Additionally, it raises the amount of organic carbon in the ground, which can affect the microbial activity in the soil and is dependent on the rate of penetration and the time it takes for polluted water to return. In the case of sample-2 (potable water) all the water treatment techniques are effective for maintaining the mineral contents in sufficient amount; however, implosion technique is very effective for sample-2 as it increases the dissolved oxygen level. According to Meckes et al. [32]. Reverse osmosis (RO) systems have been used for many years to efficiently remove all organics from all sorts of water sources, while there are other methods to remove low concentrations of absorbed organic carbon in water systems.

It is found that water can be treated without losing minerals by using implosion water treatment technique. This technique is highly effective in increasing the dissolved oxygen level in water which is very beneficial for human beings. It also increases appearance, improves color, taste and turbidity which is the visual indicator of quality of water like more turbidity means more contamination). This technique also helps in removing coliform bacteria which is an indicator of biological contamination. In addition, this technique does not waste water from any outlet pipe as water waste in case of RO water treatment technique. However, the working of Implosion technique is limited to a particular range of TDS. This technique is not suitable for water having higher TDS.

CONCLUSION

After applying four different water treatment techniques on three different sources of water e.g. raw water, underground water and supply water having different physio-chemical properties, it is concluded that all four water treatment techniques are effective for treating water of different resources for different purposes; however, all these four water treatment techniques are not suitable for water having different total dissolved solids. RO water treatment technique is the most efficient water treatment technique if water having TDS level very high, more than 600 mg/l. But in case of lower TDS water (~ 100 mg/l), the RO water treatment technique is not appropriate as it reduces TDS further and reaches upto 25 gm/l. In this case, Implosion water treatment technique is highly efficient technique as it increases the total dissolved oxygen in water without removal of minerals including TDS. The UV water treatment technique is highly efficient for removing coliform bacteria irrespective of TDS level of water; but this technique does not decrease the TDS and other contaminants to a greater extent. The implosion water treatment technique is highly efficient among all four different water treatment techniques for the supply water having normal TDS level (~ 100 mg/l); however, this technique also works efficiently in combination with RO technique in case of higher TDS level water. The future prospect of the implosion technique is that this technique may be used widely in combination with RO technique as a most efficient water treatment technique for providing healthy drinking water to human beings. However, further research work in this direction is required.

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