Variation in Effluent Quality of Household Water Treatment Systems Over Time: A Case Study in Ahvaz

Seyedeh Tooba Mirsalari[1] ,Hossein Sasani[*,1] ,Mohammad Azizipour[2] , Neematollah jaafarzadeh[3]

1. Department of Environmental Engineering, Faculty of Civil Engineering and Architecture, Shahid Chamran University of Ahvaz, Ahvaz, Iran.
2. Civil Engineering Department, Faculty of Engineering, Shahid Chamran University of Ahvaz, Ahvaz, Iran.
3. Environmental technologies research center, Ahvaz jundishapur university of medical sciences, Ahvaz, Iran.

***Corresponding Author:**
Hossein Sasani,

Email: h.sasani@scu.ac.ir
Received: 2025.05.02
Accepted: 2025.05.29
J. Hydraul. Struct., 2025; 12(1):69-83
DOI: 10.22055/jhs.2025.49748.1353

ABSTRACT

In certain regions, increased salinity in surface water and the aging of urban water distribution networks have led many citizens to rely on household water purification systems. However, if the filters in these systems are not replaced on time, the quality of the treated water can deteriorate. This study evaluated the performance of three household water purifiers over a one-year period in Ahvaz, Iran. Parameters such as Total Dissolved Solids (TDS), pH, turbidity, and total coliforms were measured monthly at both the inlet and outlet of the systems. In addition, weekly visual inspections were conducted to monitor changes in the appearance of the first-stage filters. The results confirmed the absence of coliforms in all effluent samples. However, in the first month following the installation of the first filter, the turbidity of its output exceeded the acceptable limit. Notably, significant color change in the first filter occurred by the second month. Furthermore, it was observed that two years after membrane installation, regular monitoring of output TDS is essential. If the TDS exceeds permissible levels, membrane replacement is necessary. Additionally, when the membrane is new, the TDS of the treated water may drop below 50 mg/L, increasing the risk of acidification. In such cases, adjusting the pH through a mixing valve or replacing the sixth-stage filter is recommended to ensure water quality and safety.

KEYWORDS

household water purifiers, TDS, Turbidity, pH, Coliforms.

1. Introduction

Providing access to safe drinking water is one of the core responsibilities of public authorities. To achieve this objective, a comprehensive infrastructure is developed, including water intake systems, treatment facilities, storage reservoirs, transmission pipelines, and distribution networks. The selection of a suitable treatment process, tailored to the characteristics of the raw water, along with careful attention to both design and operational standards, is essential for delivering water that meets safety and quality benchmarks. According to the latest revisions of national standards 1053 and 1011 by the Institute of Standards and Industrial Research of Iran (ISIRI), and consistent with the guidelines of the World Health Organization (WHO, 2011), water quality assessment is categorized into three main components: physical, chemical, and microbial. Each category includes defined permissible and maximum contaminant limits for various parameters. Nonetheless, challenges such as declining raw water quality due to prolonged drought and the influx of untreated wastewater into surface water sources have resulted in treated water from some conventional systems failing to meet safe drinking standards.

In addition, the aging and deteriorating condition of distribution network pipelines increases the likelihood of secondary contamination entering the water supply, thereby jeopardizing its safety at the point of use. This risk is further aggravated by external stressors such as extreme weather events, which can inflict significant damage on water treatment and distribution systems, adversely affecting both the availability and quality of drinking water[1]. Under such circumstances, consumers may become vulnerable to waterborne illnesses [2]. Simply having access to tap water does not ensure its safety, as contamination may arise at multiple stages—including the source, within the distribution network, or during the collection, transport, and storage of water. As a result, in many regions, the lack of reliable access to safe drinking water has driven populations to adopt alternatives like bottled water and Point-of-Use (POU) treatment methods [3]. The processes of purifying and safely storing water at the household level are collectively termed "household water treatment and safe storage" (HWTS), or more broadly, POU treatment (WHO, 2013). Until treated piped water becomes universally accessible, POU interventions represent a practical and cost-effective means of protecting public health in underserved communities [4]. Consequently, Point-of-Use (POU) drinking water treatment technologies are gaining widespread adoption due to their effectiveness in removing a wide range of contaminants and mitigating associated health risks. Numerous studies have demonstrated the considerable efficiency of household water treatment systems in reducing pollutant levels in drinking water. However, these systems are not without limitations [5]. A key concern is the unintentional removal of essential minerals during the treatment process, which may lead to nutritional deficiencies and an increased risk of bone-related disorders with prolonged consumption of demineralized water [6]. Additionally, the relatively high upfront costs of these systems, along with the recurring expenses for maintenance—particularly filter replacement—can be economically burdensome. In systems employing Reverse Osmosis (RO) technology, water is separated into purified and concentrated waste streams, the latter of which is discharged, often increasing overall water consumption. Consequently, the use of such systems is typically recommended only in regions where the drinking water is characterized by high salinity or elevated nitrate levels [7]. A reduction in fluoride concentration in treated water can adversely affect long-term dental and skeletal health. As such, it is crucial to educate both users and operators of Point-of-Use (POU) systems on water-related health issues and the potential consequences of improper usage. Regular and timely replacement of system filters is also essential to maintain the quality of treated water and to ensure continued protection against contaminants [5]. In a study by Angela D. Coulliette and colleagues examining the effectiveness of household water purification systems in developing nations, the findings indicated a substantial decrease in the risk of infectious diseases following water treatment [8]. Nevertheless, other research presents contrasting evidence, suggesting that water purified by such systems may still harbor various bacterial contaminants [9-12]. For instance, a study conducted in Sari, Iran, revealed a significant relationship between filter age and the presence of heterotrophic bacteria as well as residual chlorine levels in treated water, highlighting the importance of proper maintenance [10]. A study conducted in Turkey reported that coliform concentrations at the outlet of certain household water treatment devices were higher than at the inlet. This phenomenon was attributed to several factors, including aging municipal water distribution networks, diminished chlorine efficacy due to prolonged water retention times, poorly maintained building water storage tanks, and delays in filter replacement [9]. Another investigation

found that RO filters outperformed Ultrafiltration (UF) systems in removing organic contaminants and reducing turbidity. However, while household water purifiers are designed to lower microbial risks, under certain conditions they may inadvertently increase them. The most frequently detected bacteria within membrane pores were Escherichia coli and Pseudomonas aeruginosa. Therefore, to minimize microbial contamination, filters must be replaced or backwashed before reaching saturation, and integrating a UV-LED disinfection step at the final stage of treatment is recommended [12]. imilarly, a study on water purifiers in Ahvaz (Iran) revealed that the heterotrophic plate count (HPC) at the device outlet exceeded that at the inlet, underscoring the importance of timely filter maintenance [11]. A review of studies assessing the performance of household water treatment devices in Iran indicates that delayed filter replacement leads to a deterioration in the microbial quality of treated water. Specifically, the average concentrations of heterotrophic plate count (HPC) and total coliforms in the effluent have been reported at 436 and 36 colony-forming units per 100 mL, respectively [5]. These findings underscore the critical need for proper maintenance to ensure that the treated water remains within international drinking water quality standards. Timely replacement of filters is essential to consistently produce safe and potable water. Although numerous studies have evaluated the microbial quality of water produced by these devices, there remains a gap in the literature regarding how the effluent quality evolves over a defined period following filter installation. This highlights the need for longitudinal studies to better understand the temporal dynamics of water quality in household treatment systems. Accordingly, this study investigates the year-long performance of household water purification devices in the city of Ahvaz, with the aim of identifying trends in the quality of treated water over time. A key objective is to determine the point at which water quality parameters begin to exceed the acceptable thresholds defined by drinking water standards, thereby establishing the optimal interval for filter replacement. Given the findings of prior studies, maintaining these devices through proper and timely filter changes is critical to ensuring that the treated water remains safe for consumption. Despite extensive research on the output quality of household water purifiers, there remains a lack of longitudinal data assessing how their performance changes over time. This study seeks to address that gap by monitoring variations in water quality throughout a one-year period, ultimately aiming to recommend an evidence-based schedule for filter replacement to consistently achieve standard-compliant water quality.

2. Materials and methods

2.1 Study area

Ahvaz, is situated in the southwestern region of Iran. The city’s primary water supply is derived from surface water sources, which undergo conventional treatment processes prior to distribution through the municipal network. Despite these treatments, residents frequently experience issues such as elevated turbidity, as well as unpleasant taste and odor in tap water. As a result, many consumers turn to POU water purification systems to enhance the quality of their drinking water.



Figure 1. Location of studied systems in Ahvaz city

2.2. Selection of POU Systems

For this study, three POU water purification systems were selected from different residential areas within Ahvaz city (Fig. 1). All systems, produced by comparable manufacturers, shared similar specifications, with a daily treatment capacity of 10 to 12 liters. Each unit incorporated a six-stage filtration process designed to maximize purification efficiency. The first three stages functioned as pretreatment filters. The first stage included a microfilter, primarily responsible for removing total suspended solids (TSS) and reducing turbidity. The second and third stages featured granular activated carbon (GAC) and block activated carbon (BAC) filters, respectively, which were employed to remove free chlorine and residual organic compounds. Notably, the GAC filter contains larger particles, offering a higher flow rate but lower contaminant removal efficiency. Conversely, the BAC filter is composed of much finer particles—approximately 5 to 20 times smaller—which allow for more thorough contaminant removal at the expense of flow rate [13]. In the fourth stage of filtration, each system utilizes a horizontally mounted reverse osmosis (RO) membrane to effectively remove dissolved minerals and other impurities from the water. To support this process, a pump delivering pressure between 6 and 7 bar is employed, ensuring sufficient force for water to pass through the semipermeable membrane. A key distinction among the three selected POU systems is the age of their RO membranes. In Device (1), a new membrane was installed at the beginning of the sampling period. Device (2) was fitted with a membrane that had been in use for one year, while Device (3) featured a membrane with a two-year usage history. This variation in membrane lifespan provides valuable insight into the long-term performance and efficiency of the systems under real-world operating conditions. The fifth and sixth stages are dedicated to post-treatment processes. The fifth stage includes a taste-enhancing filter designed to improve the palatability of the RO-treated water, which often tastes flat due to the removal of both contaminants and beneficial ions. The sixth stage incorporates a remineralization filter that reintroduces essential minerals, thereby enhancing both the nutritional value and overall acceptability of the water. Table 1 presents a detailed summary of the characteristics and functions of each filtration stage, offering a clear understanding of their specific contributions to the overall purification process.

Table 1. Specifications of the filters installed in the household water purifier

Filter Location	Filter Name	Filter material	Performance	Reference
First stage	Microfiltration	Polypropylene	Turbidity removal	[14, 15]
Second stage	Granular activated carbon	Coal	Chlorine and organic matter removal	[15]
Third stage	Carbon block	Coal	Chlorine and organic matter removal	[16]
Fourth stage	Membrane	polyamide	demineralization	[1]
Fifth stage	Post carbon	Coal	Regulation of taste and odor	[15]
Sixth stage	Remineralization	Minerals	Returning minerals to water	[17]

2.3. Sampling method

This study was conducted over a one-year period, from July 2021 to June 2022. Three residential units located in different districts of Ahvaz—Golestan, Kian Pars, and Koye Mellat—were selected as sampling sites, as illustrated in Figure 1. All three POU devices were configured with identical filter arrangements, detailed in Figure 2, ensuring consistency in system design across sampling locations. Water samples were collected from three distinct points within each POU system: before filtration, after the RO membrane, and at the final output. As summarized in Table 2, a total of 102 samples were obtained throughout the study period. It is important to note that sampling from Device (3) commenced in the third month of the study, resulting in fewer total samples from that unit. Furthermore, the first-stage filter (microfilter) featured a transparent housing, allowing for regular visual inspection of its condition. To assess potential clogging, this filter was removed from its housing and examined on a weekly basis.

Table 2. Specifications of sampling points and sampling frequency

Row	Parameter	Input	First filter output	System output	Sampling frequency
1	pH	✓	–	✓	Monthly
2	TDS	✓	–	✓	Monthly
3	Turbidity	✓	✓	–	Monthly
4	Total Coliforms	✓	–	✓	Monthly
5	visual Inspection	✓	✓	✓	Weekly



Figure 2. The studied household water purifier

2.4. Test method

The parameters of pH, turbidity, and total TDS were analyzed using potentiometric, nephelometric, and gravimetric techniques, respectively, at the laboratory of Khuzestan Water and Wastewater Engineering Services Company. The equipment employed included an analytical balance (AND GF-3000, Japan) with a maximum capacity of 3100 grams and a precision of 0.01 grams, a pH meter (HACH Sension3, USA), and a turbidity meter (HACH 2100AN, USA). TDS measurements were conducted using filter paper with a pore size less than 0.2 micrometers. Total coliform bacteria were detected through the Presence/Absence (PA) test method applied to the water samples. Concurrently, the first-stage filter of each device was photographed weekly to monitor any visual changes. All sampling and analyses followed the relevant water and wastewater testing standards[18]. Finally, the obtained results were evaluated in comparison to the World Health Organization (WHO) guidelines and the drinking water quality standards established by Iran.

3. Results and discussion

3.1. Turbidity

To assess the efficacy of the first filter in turbidity removal, two methods (photographing the filter and a turbidity test) were employed. Typically, the first filter in each system is housed in a transparent container, allowing visual observation of its color change from white to brown, indicating the need for replacement. Over a two-month period, the clogging depth of this filter was monitored weekly, comparing the results of turbidity tests and filter clogging depth. Most membrane manufacturers recommend that water entering the membrane should have a turbidity of less than 1 NTU. Hence, surpassing this value in the output turbidity was established as the criterion for replacing the first filter. Fig. 3 illustrates changes in output turbidity for the first filter of System 1, while Fig. 6 depicts the weekly color change procedure over three months. Replacements were carried out in September, January, and June based on the appearance color of the filter. Fig. 6 highlights significant color changes on the filter surface after two months of installation. Fig. 4 showcases variations in the turbidity of the inlet and outlet water of the first filter of System 2, and Fig. 7 displays its color change procedure. Replacements occurred in October, January, and April based on appearance color, with the output turbidity exceeding 1 NTU about two months after the first filter replacement, as indicated in Fig. 4. Fig. 7 demonstrates color changes starting one month after filter installation, progressing to the inner layers by the end of the second month. Fig. 5 and Fig.8 depict changes in the color of the first filter in System 3 and variations in raw water turbidity and the first filter's output turbidity. Replacements took place in October, January, April, and July, guided by appearance color. An increase in output turbidity was observed approximately one month after filter installation, while raw water turbidity averaged 1.1 NTU during the sampling period, often exceeding 1 NTU. Fig.7 indicates that the color change on the filter surface began one week after installation. Thus, signs of first filter clogging manifested about one month after installation, reaching a potential maximum within second months.

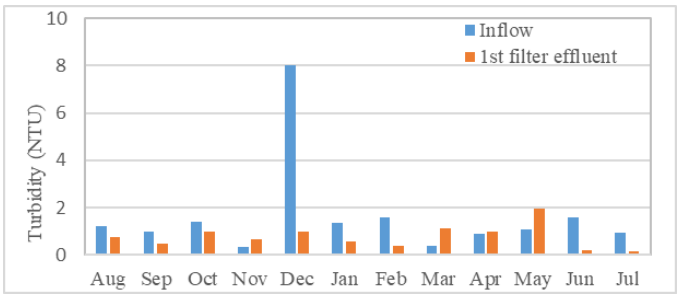


Figure 3. Changes in the input and output turbidity of system 1 during the sampling period

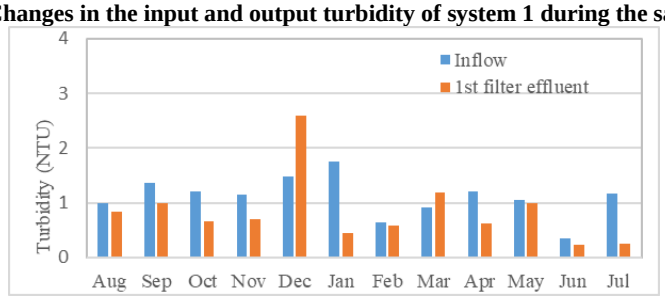


Figure 4. Changes in the input and output turbidity of system 2 during the sampling period

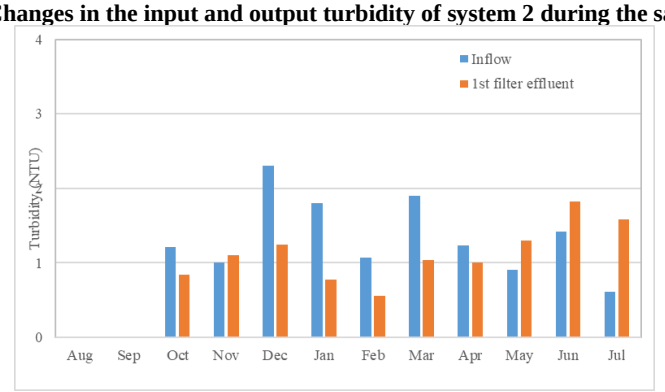


Figure 5. Changes in the input and output turbidity of system 3 during the sampling period

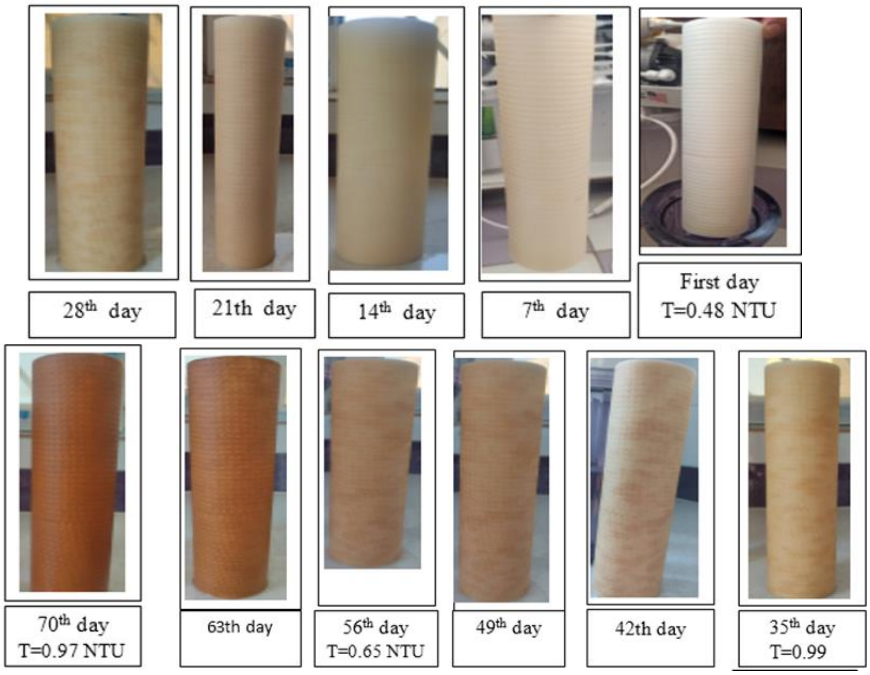


Figure 6. Appearance changes of the first filter of the system 1

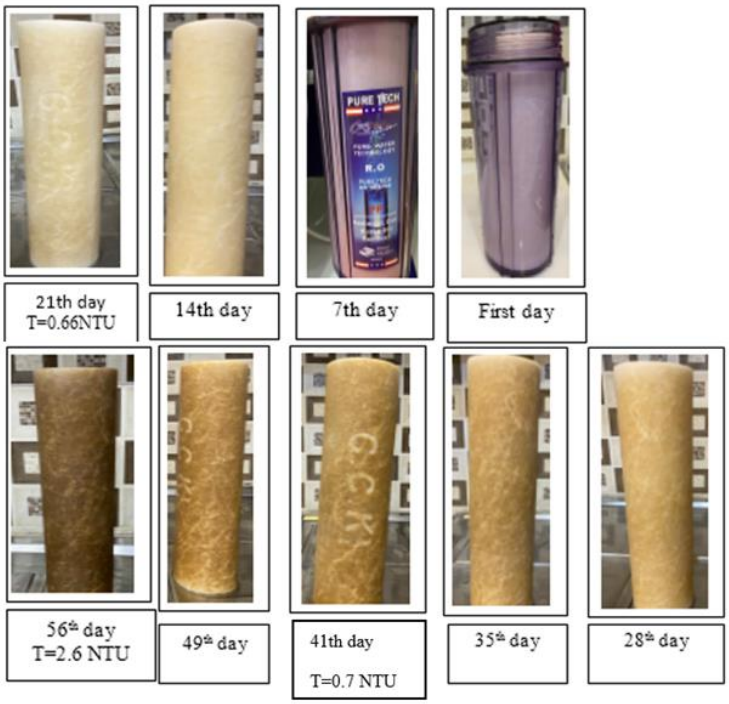


Figure 7. Appearance changes of the first filter of system2

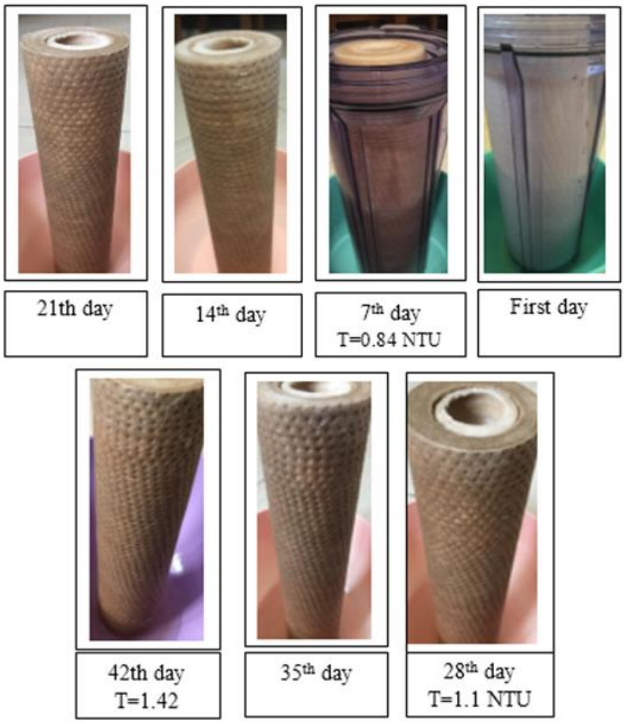
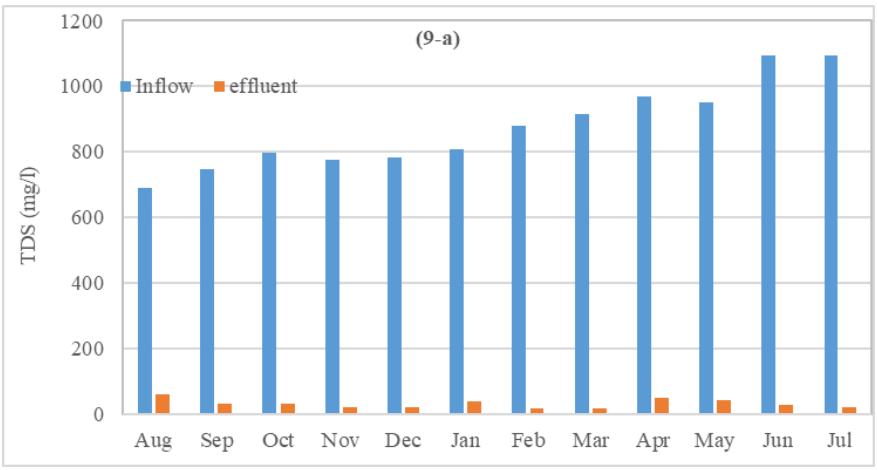


Figure 8. Appearance changes of the first filter of system3

3.2. TDS

Figure 9-a shows the fluctuations in input and output TDS for System 1 over the duration of one year. The input TDS values ranged from 700 to 1100 mg/L, while the output TDS consistently stayed below 100 mg/L. This level complies with the acceptable limits set by both ISIRI (1000 mg/L) and WHO (600 mg/L). However, an

output TDS below 100 mg/L may suggest the excessive removal of important dissolved minerals such as calcium, magnesium, and fluoride, which are beneficial for human health but tend to be largely removed by the membrane [19, 20]. Figure 9-b illustrates the TDS changes for System 2 during the year following membrane installation. The input TDS fluctuated between 700 and 1100 mg/L, and output TDS ranged from 100 to 200 mg/L. Similar to System 1, the output TDS was within recommended limits, although it was approximately 100 mg/L higher than System 1's output. This increase might be related to the longer membrane lifespan in System 2. Figure 9-c depicts the input and output TDS variations for System 3 across one year. The membrane in this device had been installed two years before sampling began. Input TDS ranged from 800 to 1300 mg/L, while output TDS was between 300 and 500 mg/L. In the final month of the sampling period, the membrane was replaced, causing output TDS to drop to 50 mg/L. Despite the TDS levels being within acceptable standards, consumers found the water's taste unsatisfactory, prompting filter replacement roughly three years after installation. Comparing the three systems indicates that during the first year of membrane use, output TDS consistently remained below 100 mg/L. In the second year, the output TDS levels increased to approximately 200 mg/L, and by the third year, they approached the upper permissible limits set by the WHO. It is important to be cautious about very low TDS concentrations, as water with insufficient mineral content may pose health risks, such as cardiovascular issues, impaired thyroid function, and a higher likelihood of diseases like osteoporosis and cancer. Consequently, in addition to following standards that specify maximum allowable levels, it is recommended to also consider minimum thresholds for essential minerals to protect human health during the use of these purification devices (see Table 3) [21, 22]). The study by Sediq et al. [23] reported output TDS values below 100 mg/L, which corresponds closely to the TDS levels observed in System 1 of the current research. Similarly, Bonnélye et al. [24] developed a seven-stage treatment process that included a Reverse Osmosis (RO) system to reduce TDS in Curacao's drinking water, achieving a final TDS concentration below 150 mg/L—comparable to the TDS output recorded for System 2 in this study. Dinarello et al. [25] reported an output TDS around 500 mg/L, aligning with the values seen for System 3 in the last month of sampling here. However, none of these studies specified the membrane lifespans used during their experiments.



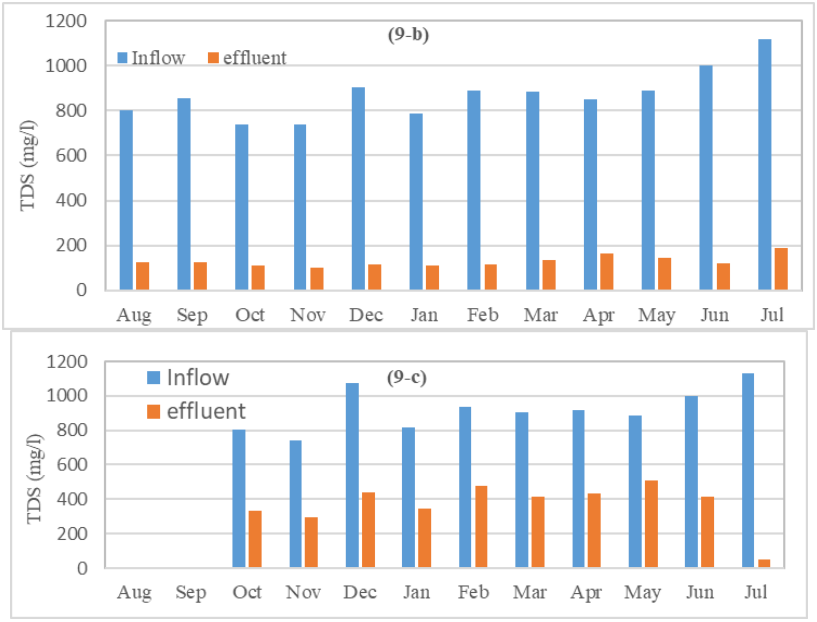


Figure 9. Changes in input and output TDS of systems 1(a), 2(b) and 3(c)

3.3. pH

As shown in Figure 10, the pH levels of all three systems decreased throughout the sampling period, reaching acidic values of 5.8, 6.7, and 6.5 for Systems 1, 2, and 3, respectively. This acidification is mainly due to the removal of alkalinity components, such as carbonate and bicarbonate ions, by the membranes. The extraction of these ions disturbs the balance between hydrogen (H^+) and hydroxide (OH^-) ions, causing the water to become more acidic, as noted by the WHO[26]. The WHO recommends a minimum pH of 6.5 for drinking water, and Figure 14 reveals that the pH of the effluent from all three systems occasionally reached this lower limit or even dropped below it, indicating acidity. Therefore, it is crucial to monitor and address this acidification because consuming acidic water over the long term may have adverse health impacts. Moreover, acidified water can cause unpleasant taste and heightened corrosiveness, which is particularly problematic near metal pipes [27]. Research by Rezaeinia et al. [27] and Saini [28] suggests that the intake of acidic water and beverages can disrupt the mineral balance in the human body. This is especially significant for cancer patients who often suffer from electrolyte imbalances such as hyponatremia, hypokalemia, hypocalcemia, and hypomagnesemia, emphasizing the importance of maintaining adequate mineral content in drinking water [21]. Although adjusting the pH of membrane-treated water by mixing it with other sources to increase TDS is possible, this method is not advisable for long-term use in Ahvaz due to the risk of sediment buildup and clogging in mixer taps. In System 3 (Figure 10-c), replacing the fourth filter in July led to a decrease in TDS from 400 to 50 mg/L and a corresponding pH drop from 7 to 6.5. Despite these fluctuations, continuous monitoring of pH in the treated water is recommended. Other studies, such as those by Yari et al. [29-31], have also confirmed the acidification of membrane-treated water, although their focus was more on the effects rather than the pH variation patterns. Conversely, some research has consistently found that output pH remained within acceptable standards, likely due to the effective functioning of the fourth and sixth filters during the sampling period [14, 25, 27, 32-35].

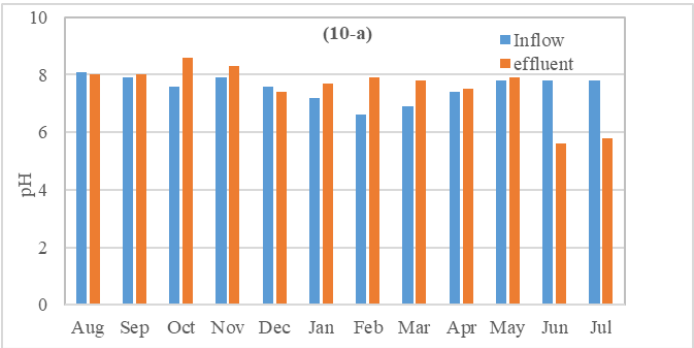
Table 3. Suggested suitable ranges for drinking water nutrients (Rosborg & Kozisek., 2019)

Parameter	Range	Unit
pH	7-8.5	-
Calcium	30-80	mg/l
Magnesium	10-50	mg/l
Bicarbonate	100-300	mg/l
Sulphate	25-100	mg/l
Fluoride	0.5-1	mg/l
Chloride	20-50	mg/l
TDS	100-500	mg/l

Figure 11 presents the relationship between pH and TDS for both the inlet and outlet water across all three systems. In these graphs, the TDS values are plotted in ascending order, with corresponding pH values shown for each data point. Figures 11-a, 11-c, and 11-e illustrate that the TDS levels of the input water consistently exceeded 690 mg/L, while the pH values remained within the acceptable range of 6.5 to 8.5, as per drinking water standards. In contrast, Figures 11-b, 11-d, and 11-f, which depict the treated water from each system, show several instances where the pH dropped below the minimum recommended limit of 6.5. Notably, these drops in pH coincided with very low TDS levels, often below 50 mg/L. This pattern points to a potential risk of water acidification as TDS decreases. Supporting this observation, Rosborg and Kozisek [21] have recommended a minimum TDS concentration of 100 mg/L in drinking water to ensure adequate mineral content and avoid associated health risks.

3.4. Microbial quality

During the sampling period, total coliforms were monitored in both the influent and effluent water. The findings showed that coliforms were detected in only three of the input water samples, while none were found in the treated water from any of the systems. This result is consistent with previous studies conducted by Dehghani et al. [36] and Twanger et al. and Twanger et al. [6]. In contrast, some studies, including those by Yari et al. [29] and Ebrahimi et al. [37] eported the presence of coliforms in the outlet water. These instances were often associated with delayed membrane replacement, during which microbial leakage could occur due to membrane fatigue or degradation [6]. Lin et al. [6]. Lin et al. [12] also observed coliform contamination in the treated water and suggested that to ensure microbial safety, either timely membrane replacement or the incorporation of a UV disinfection unit at the final treatment stage is necessary.



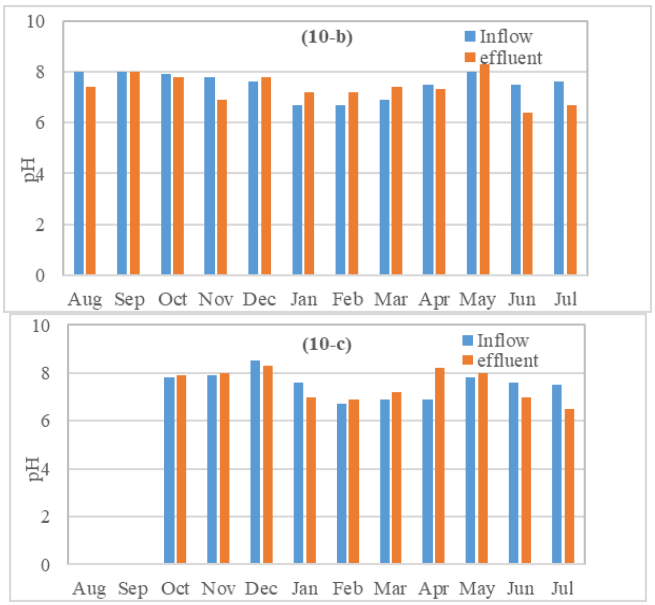


Figure 10. Changes in input and output pH of systems 1(a), 2(b) and 3(c)

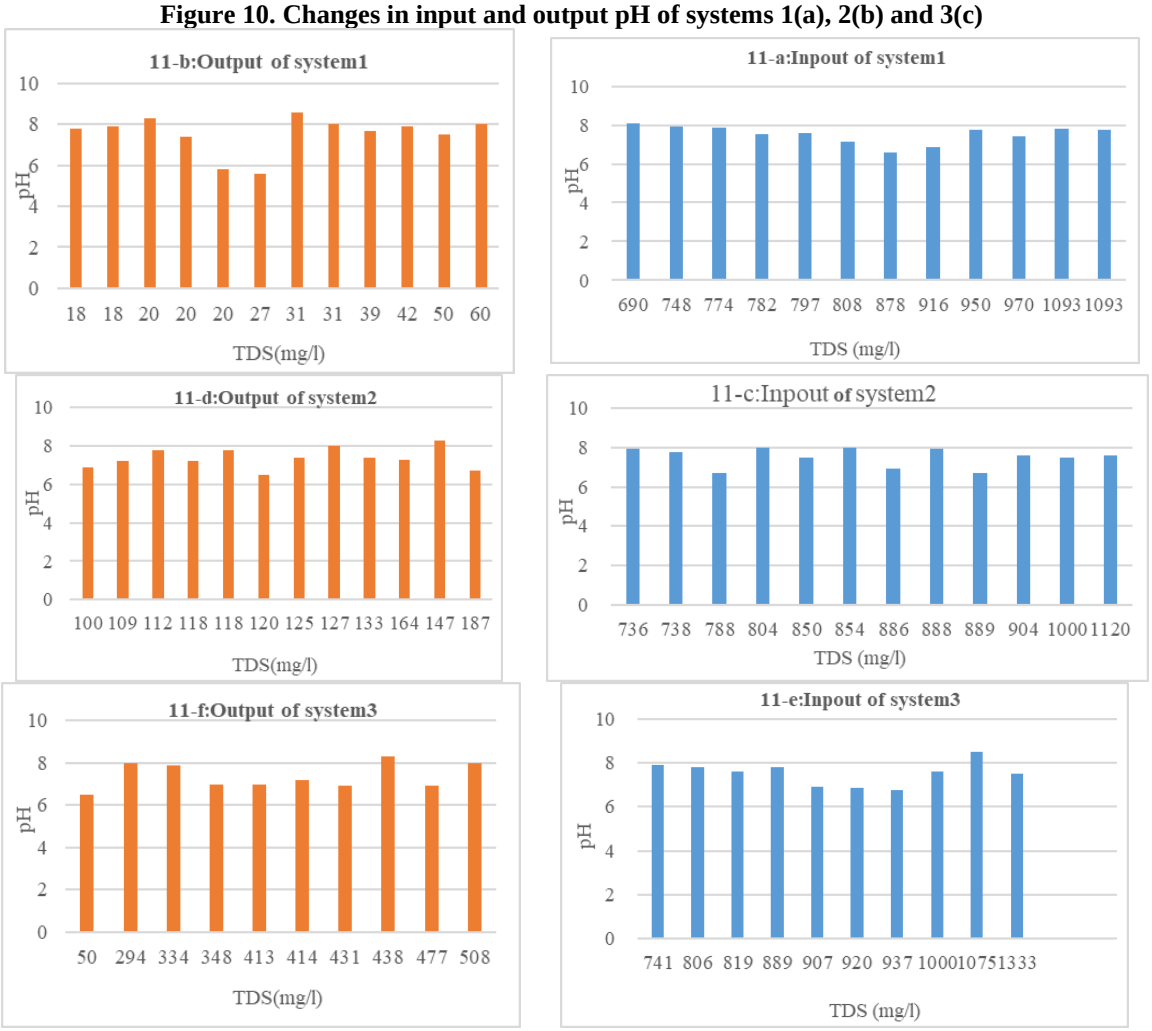


Figure 11. The impact of TDS on the pH levels of input water in the first (a), second (c), and third (e) systems, as well as the pH levels of output water in the first (b), second (d), and third (f) systems.

4. Conclusion

This study assessed the performance of three household water purifiers over a one-year period in Ahvaz, focusing on variations in effluent quality as a function of time and filter lifespan. The results revealed that the first-stage filters experienced significant clogging approximately one month after installation, with turbidity in the output water exceeding acceptable thresholds by the second month. These findings highlight the need for users to visually inspect and replace the first filter every 1–2 months to maintain water clarity and protect the downstream filters. Regarding the reverse osmosis membranes, the devices showed consistent removal of TDS within the first two years of operation. However, by the third year, TDS concentrations in the effluent increased notably, nearing the maximum acceptable limits. This gradual rise indicates a decline in membrane performance over time and underscores the importance of replacing the membrane after two years of continuous use to maintain water quality and system efficiency. Interestingly, after membrane replacement, output TDS dropped below 50 mg/L in one system, causing the pH to fall below the acceptable limit of 6.5. This observation demonstrates a potential for water acidification when the mineral content is excessively reduced. It suggests that maintaining a balance between adequate contaminant removal and essential mineral retention is critical. Monitoring and, if needed, adjusting the pH after membrane replacement—through mixing valves or remineralization filters—are important practices for ensuring the long-term safety of treated water. Also, Microbial analysis showed the consistent absence of total coliforms in all effluent samples throughout the year, indicating the effective performance of the RO membranes in removing microbial contaminants under regular maintenance conditions. While these findings provide valuable insights into the operational lifespan and quality outcomes of household water purifiers, further research is recommended to build upon and enhance these results:

-Future studies should include a larger number of devices across a broader demographic and geographic range to improve the statistical power of the findings and their generalizability.

-Testing a variety of brands and models will help assess the variability in system design and performance.

-Detailed evaluations of the second and third filters—typically granular and block activated carbon—are needed to better understand their efficiency in removing chlorine, organic matter, and undesirable taste or odor.

-In-depth investigations of the fifth (post-carbon) and sixth (mineral) filters will also be essential to assess their specific contributions to taste improvement, remineralization, and pH stabilization.

Such comprehensive research will contribute to more informed recommendations for users and manufacturers, ensuring that household water purification systems deliver safe, palatable, and mineral-balanced water over time.

Acknowledgements

This research was supported by the Water and Wastewater Company of Ahvaz and the Faculty of Civil Engineering and Architecture at Shahid Chamran University of Ahvaz. The authors gratefully acknowledge their valuable support and contributions throughout the course of this study.

Declarations

The authors declare that they have no competing interests.

References

1. Wang, Y.-N. and R. Wang, Reverse osmosis membrane separation technology, in Membrane separation principles and applications. 2019, Elsevier. p. 1-45.
2. Pooi, C.K. and H.Y. Ng, Review of low-cost point-of-use water treatment systems for developing communities. npj Clean Water, 2018. 1(1): p. 11.
3. Mulhern, R., et al., User experience of point-of-use water treatment for private wells in North Carolina: Implications for outreach and well stewardship. Science of the Total Environment, 2022. 806: p. 150448.
4. Fiebelkorn, A.P., et al., Systematic review of behavior change research on point-of-use water treatment interventions in countries categorized as low-to medium-development on the human development index. Social Science & Medicine, 2012. 75(4): p. 622-633.
5. Mirsalari, S.T., et al., Evaluation of effluent quality changes of household water purifiers: A case study of Ahvaz city. 2024.
6. Morris, R.W., et al., Hard drinking water does not protect against cardiovascular disease: new evidence from the British Regional Heart Study. European Journal of Preventive Cardiology, 2008. 15(2): p. 185-189.
7. Malakootian, M., et al., Performance evaluation of household water treatment systems used in Kerman for removal of cations and anions from drinking water. Applied Water Science, 2017. 7: p. 4437-4447.
8. Coulliette, A.D., et al., Risk reduction assessment of waterborne Salmonella and Vibrio by a chlorine contact disinfectant point-of-use device. International Journal of Hygiene and Environmental Health, 2013. 216(3): p. 355-361.
9. Aydin, R., Evaluation of household water treatment systems in terms of physicochemical and microbiological parameters, Adana Province (Turkey) example. Desalination and Water Treatment, 2019. 149: p. 209-227.
10. Gholami-Borujeni, F., et al., Heterotrophic Bacteria Count Index in Drinking Water and Possibility of Biofilm Formation in Household Drinking Water Treatment Devices in Sari, Iran. Journal of Mazandaran University of Medical Sciences (In Persian), 2021. 30(192): p. 118-125.
11. Talepour, N., et al., Isolation, identification and reviewing the health effect of HPC bacteria in household point-of-use (PoU) water treatment devices: a case study, Ahvaz, Iran. Journal of Environmental Health Science and Engineering, 2021. 19: p. 59-69.
12. Lin, W., et al., Analysis of microbial contamination of household water purifiers. Applied Microbiology and Biotechnology, 2020. 104: p. 4533-4545.
13. Labhasetwar, P.K. and A. Yadav, Membrane based point-of-use drinking water treatment systems. 2023: IWA Publishing.
14. Al-Jayyousi, O.R. and M.S. Mohsen, Evaluation of small home-use reverse osmosis units in Jordan. Desalination, 2001. 139(1-3): p. 237-247.
15. Hoslett, J., et al., Surface water filtration using granular media and membranes: A review. Science of the Total Environment, 2018. 639: p. 1268-1282.
16. Wu, J., et al., A critical review of point-of-use drinking water treatment in the United States. NPJ Clean Water, 2021. 4(1): p. 40.
17. Michel, M.M., et al., Mineral materials coated with and consisting of MnOx—characteristics and application of filter media for groundwater treatment: a review. Materials, 2020. 13(10): p. 2232.
18. Rice, E.W., et al., Standard methods for the examination of water and wastewater. 2012.
19. Warsinger, D.M., et al., A review of polymeric membranes and processes for potable water reuse. Progress in polymer science, 2018. 81: p. 209-237.
20. Bellona, C., et al., Factors affecting the rejection of organic solutes during NF/RO treatment—a literature review. Water research, 2004. 38(12): p. 2795-2809.
21. Rosborg, I. and F. Kozisek, Drinking water minerals and mineral balance. Springer International Pu, 2016. 1(1): p. 175.
22. Cotruvo, J.A., 2017 WHO guidelines for drinking water quality: first addendum to the fourth edition. Journal-American Water Works Association, 2017. 109(7): p. 44-51.

23. Sadigh, A., et al., Investigating the efficiency of home water treatment systems to reduce or eliminate water quality parameters in the city of Ardabil in 1392. J Health (In Persian), 2015. 6(4): p. 458-69.
24. Bonnélye, V., et al., Curacao, Netherlands Antilles: A successful example of boron removal on a seawater desalination plant. Desalination, 2007. 205(1-3): p. 200-205.
25. Dindarloo, K., et al., Drinking water quality: comparative study of tap water, drinking bottled water and point of use (PoU) treated water in Bandar-e-Abbas, Iran. Desalination and water treatment, 2016. 57(10): p. 4487-4493.
26. Team, W., Guidelines for Drinking water Quality, ed. t. edition. 2017.
27. Rezaeinia, S., et al., Qualitative and health-related evaluation of point-of-use water treatment equipment performance in three cities of Iran. Journal of Environmental Health Science and Engineering, 2018. 16: p. 265-275.
28. Saini, R.D., Health risks from long term consumption of reverse osmosis water. International journal of applied chemistry, 2017. 13(2): p. 293-301.
29. Yari A R, S.M., Hadadian L, Babakhani M H, Physical, Chemical and Microbial Quality of Treated Water in Qom s Desalination Plants. Qom University of Medical Sciences Journal (In Persian), 2016. 1(1): p. 45-54.
30. Miranzadeh, M.B. and D.K. Rabbani, Chemical quality evaluation for the inlet and outlet water taken from of the desalination plants utilized in Kashan during 2008. Feyz Medical Sciences Journal (In Persian), 2010. 14(2): p. 120-125.
31. Jafaripour, M., et al., Health, sanitary and economic evaluation of Home-like systems of water treatment (Reverse Osmosis, RO) in Qom city. Journal of Water and Wastewater; Ab va Fazilab (in persian), 2011. 22(2): p. 15-21.
32. babaei A, g.z.F., normoradi H, ahmadi angali K, moslemnia M, salimi J, Investigation on the Microbial Quality of Water Treatment centers in Abadan City. Journal of Ilam University of Medical Sciences (In Persian), 2014. 22(4): p. 132-140.
33. Tavangar A, N.N., Alizade H, Tavakoli Ghochani H, Ghorbanpour R, Evaluation of water treatment systems' performance available in Bojnurd ciry during 2013. North Khorasan University of Medical Sciences (In Persian), 2013. 5(5): p. 1107-1119.
34. Naghipour, D., et al., Data on microbial and physiochemical characteristics of inlet and outlet water from household water treatment devices in Rasht, Iran. Data in brief, 2017. 16: p. 1005.
35. Zhang, Z., et al., Evaluating the efficacy of point-of-use water treatment systems using the water quality index in rural southwest China. Water, 2020. 12(3): p. 867.
36. Deghani M, N.H., Hashemi , H, Azimi A A, Doleh M, Vafaee R, An evaluation of physical, chemical and biological quality of influent and effluent water obtained by reverse osmosis and multistage flash processes for drinking consumption. Research in Medicine, 2013. 36(5): p. 36-42.
37. Ebrahimi, S.M., et al., Bacteriological quality of water produced by household water treatment devices. Journal of Mazandaran University of Medical Sciences (In Persian), 2015. 25(130): p. 8-18.

© 2026 by the authors. Licensee SCU, Ahvaz, Iran. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution 4.0 International (CC BY 4.0 license) (http://creativecommons.org/licenses/by/4.0/).