Ministry of Higher Education
And Scientific Research
University of Babylon
College of Engineering
Department of Environmental Engineering

The role of roughening filter in the amount of alum consumed in drinking water treatment.

A research project submitted to the council of University of Babylon / College of Engineering / Department of Environmental Engineering in partial fulfilment of the requirements for a bachelor's degree in Environmental Engineering

By

Ali Ahmed Musa

Supervised by

Dr. Alaa Hussein Wadi Al-Fatlawi

2022-2023

بسم الله الرحمن الرحيم

(وَقُلْ رَبِّ زِدْنِي عِلْماً)

صدق الله العلي العظيم

سورة طه: من الآية114

SUPERVISOR CERTIFICATION

We certify that this project entitled "**The role of roughening filter in the amount of alum consumed in drinking water treatment.** Presented by " ***Ali Ahmed Musa***"was prepared under our supervision as partial fulfillment for the degree of Bachelor of Science in Environmental Engineering at the Department of Environmental Engineering, College of Engineering, University of Babylon.
signature

Name :Prof**. Dr. Alaa Hussein Wadi Al-Fatlawi**
Data: / /2023

Examining Committee's Certification

We certify that we have read this project entitled " **The role of roughening filter in the amount of alum consumed in drinking water treatment** " and as an examining committee, examined the student " ***Ali Ahmed Musa*** " in its content and in what is connected with it, and that in our opinion it meets the standard of a graduated project for the degree of Bachelor of Science in Environmental Engineering.

Signature:
Asst. Prof. Dr. Rawa H. Kadhim

Signature :
Asst. Prof. Dr. Ali J. Chabuk

Signature:
Prof. Dr. Israa S. Samaka

Signature :
Prof. Rasha S. Alqizwini

Signature
Prof. Dr. Nisren. J. AL-Mansori

Approval of Environmental Engineering Department

Signature

Asst. Prof. Dr. Hussien A. M. Al-Zubaidi
Head of Environmental Engineering Department

الإهداء

إلى من أُفضِّلها على نفسي، ولِمَ لا؛ فلقد ضحَّت من أجلي
ولم تدَّخر جُهدًا في سبيل إسعادي على الدَّوام
(أُمِّي الحبيبة).

نسير في دروب الحياة، ويبقى من يُسيطر على أذهاننا في كل مسلك نسلكه
صاحب الوجه الطيب، والأفعال الحسنة.
فلم يبخل عليَّ طيلة حياته
(والدي العزيز).

إلى أصدقائي، وجميع من وقفوا بجواري وساعدوني بكل ما يملكون، وفي أصعدة كثيرة

أُقدِّم لكم هذا البحث، وأتمنَّى أن يحوز على رضاكم.

Acknowledgements

I would like to express my sincere gratitude to Dr. Alaa Hussein Wadi Al-Fatlawi, my esteemed supervisor, for his invaluable guidance, unwavering support, and constant encouragement throughout the course of this research. Dr. Al-Fatlawi's expertise in the field of environmental engineering and his dedication to the pursuit of knowledge have been instrumental in shaping the direction and quality of this study.

I am immensely grateful to the University of Babylon, specifically the College of Engineering, for providing me with the necessary resources and facilities to conduct this research. The conducive academic environment, state-of-the-art laboratories, and access to extensive literature have greatly contributed to the successful completion of this study.

I would also like to extend my heartfelt appreciation to the Department of Environmental Engineering for their assistance and cooperation. The department's faculty members and staff have been a constant source of inspiration, offering valuable insights and engaging in constructive discussions that have significantly enriched the research process.

My sincere thanks go to all the participants and experts who willingly shared their knowledge and experiences, making this study possible. Their willingness to contribute to this research has been instrumental in shaping its outcomes and enhancing its credibility.

I am indebted to my family and friends for their unwavering support, understanding, and encouragement throughout this endeavor. Their words of motivation and belief in my abilities have been a constant source of strength, enabling me to overcome challenges and persevere.

Finally, I would like to acknowledge the contributions of all those who have directly or indirectly assisted me in this research. Their support and encouragement have been crucial, and I am deeply grateful for their involvement.

Table of Contents

List of Tables

List of Figures

List of Abbreviations

- NTU: Nephelometric Turbidity Units
- ANOVA: Analysis of Variance
- HSD: Honest Significant Difference
- p: probability value
- t-test: t-test for dependent samples
- SD: Standard Deviation.

Abstract

The role of roughening filters in reducing the amount of alum consumed in drinking water treatment was investigated in this study using water samples from Shatt Al-Furat in Diwaniya, Iraq. A pretest-posttest research design was employed, involving the assessment of turbidity levels in water samples before and after treatment with a roughening filter. Three glass water tanks were used, each subjected to different alum dosages, to identify the optimal alum dosage for achieving the desired turbidity reduction. Descriptive statistics, paired-samples t-tests, and one-way ANOVA were used to analyze the data and determine the effectiveness of the roughening filter in reducing the required amount of alum. The results showed that the use of a roughening filter was effective in reducing the amount of alum required for the coagulation-flocculation process and improving water quality, with a significant difference in turbidity levels before and after treatment ($p < 0.05$). These findings highlight the potential of roughening filters to improve the efficiency and cost-effectiveness of drinking water treatment while reducing the potential environmental impact of excess alum discharge. However, it should be noted that these results are limited to a controlled laboratory setting and further research is needed to confirm these findings in real-world water treatment settings.

Chapter One:
Introduction

Introduction

1.1 Background on drinking water treatment

Drinking water treatment is a crucial process that ensures the provision of safe and high-quality water to the public ***(Chen et al., 2013).*** Over the years, various technologies have been developed and implemented to remove contaminants, such as pathogens, chemicals, and particulates, from raw water sources ***(Zularisam et al., 2017).*** One of the most widely used treatment methods involves the coagulation-flocculation process, which is essential for the removal of suspended particles, turbidity, and color in water ***(Rasul et al., 2011).*** This process typically involves the addition of coagulants, such as aluminum sulfate (alum), which facilitate the aggregation of small particles into larger flocs, making them easier to remove by sedimentation or filtration ***(Duan & Gregory, 2016).***

1.2 Significance of alum consumption in water treatment

Alum is one of the most commonly used coagulants in drinking water treatment plants worldwide, owing to its effectiveness in removing impurities and relatively low cost ***(Sillanpää et al., 2018).*** However, the increasing demand for safe drinking water and stringent water quality standards have led to a rise in alum consumption, raising concerns regarding its economic and environmental impacts ***(Yong et al., 2015).*** Excessive alum use not only increases the operational costs of water treatment plants but also contributes to the generation of large volumes of sludge, which requires proper disposal ***(Zhang et al., 2016).***

Moreover, the presence of residual aluminum in treated water has been linked to potential human health risks, such as neurodegenerative diseases ***(Exley, 2016).*** These factors have prompted researchers and water treatment practitioners to explore alternative methods and technologies that can reduce alum consumption while maintaining water quality standards.

1.3 Roughening filters and their role in drinking water treatment

Roughening filters, also known as upflow contact clarifiers, are an emerging technology that has gained attention in recent years for their potential to enhance the coagulation-flocculation process and reduce alum consumption ***(Wong et al., 2012). These*** filters consist of a granular bed that is designed to increase the surface area for particle attachment, promoting the formation of larger flocs and improving the overall efficiency of the coagulation-flocculation process ***(Ebeling et al., 2013).*** The implementation of roughening filters in drinking water treatment plants has been shown to improve the removal of suspended particles, turbidity, and color, potentially reducing the required amount of alum coagulant ***(Akkaya et al., 2014).***

Furthermore, the use of roughening filters has been associated with a reduction in sludge production and an improvement in the final water quality, contributing to lower operational costs and reduced environmental impacts ***(Natarajan et al., 2016).*** As a result, the integration of roughening filters into existing water treatment processes presents a promising strategy for minimizing alum consumption while maintaining compliance with stringent water quality standards. This thesis aims to investigate the role of roughening filters in the amount of alum consumed in drinking water treatment, providing valuable insights for water treatment practitioners and policy-makers seeking to enhance the sustainability of water treatment processes.

1.4 Aim of the study

1. To investigate the impact of roughening filters on the amount of alum consumed in drinking water treatment.

2. To determine the efficiency of the roughening filter in reducing the required amount of alum for the coagulation-flocculation process.

3. To identify the optimal alum dosage for achieving the desired turbidity reduction when using a roughening filter.

Chapter Two:
Literature Review

Literature Review

2.1 Coagulation-flocculation process in water treatment

The coagulation-flocculation process is a crucial step in drinking water treatment, primarily responsible for the removal of suspended particles, turbidity, and color ***(Rasul et al., 2011).*** Coagulants, such as aluminum sulfate (alum), are added to raw water to destabilize and aggregate small particles into larger flocs, which can be more easily removed through sedimentation or filtration ***(Duan & Gregory, 2016).*** The effectiveness of the coagulation-flocculation process depends on several factors, including the type and dosage of the coagulant, pH, temperature, and mixing conditions ***(Matilainen et al., 2010).*** Researchers have explored various strategies to optimize the coagulation-flocculation process, such as employing pre-treatment techniques, using alternative coagulants, and incorporating advanced filtration technologies ***(Zularisam et al., 2017).***

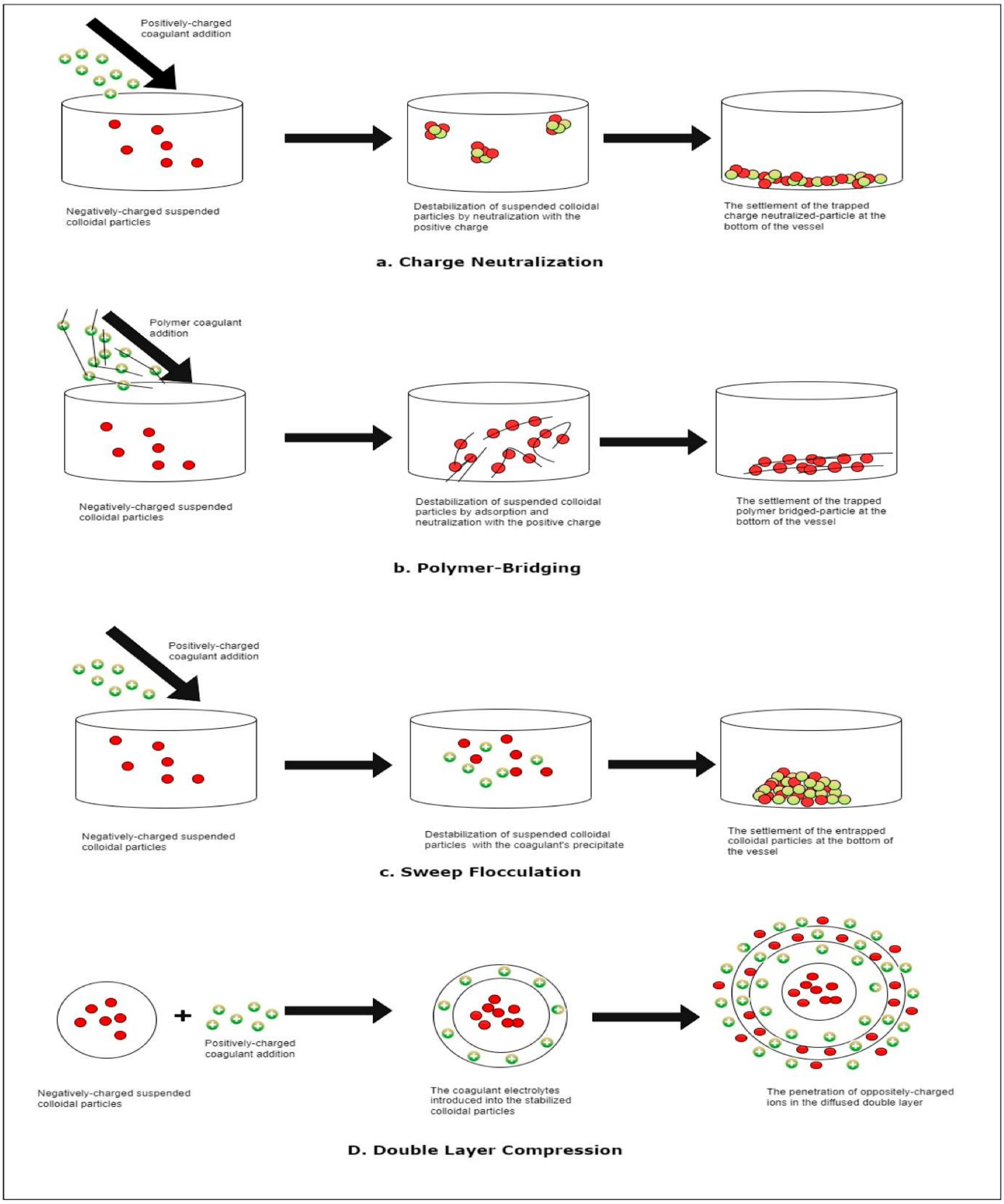

Figure 2.1 Schematic representation of the mechanisms involved in natural coagulation process. ***(Koul et al., 2022)***

2.2 Alum consumption: economic and environmental impacts

Alum is widely used in drinking water treatment plants due to its effectiveness in removing impurities and its relatively low cost ***(Sillanpää et al., 2018).*** However, the increasing demand for safe drinking water and strict water quality standards have led to concerns regarding the economic and environmental impacts of alum consumption ***(Yong et al., 2015).*** High alum usage not only raises the operational costs of water treatment plants but also contributes to the generation of large volumes of sludge, which requires proper disposal and management ***(Zhang et al., 2016).*** Furthermore, the presence of residual aluminum in treated water has been linked to potential human health risks, such as neurodegenerative diseases ***(Exley, 2016).*** These factors have prompted the exploration of alternative methods and technologies to reduce alum consumption without compromising water quality.

2.3 Application of roughening filters in water treatment plants

Roughening filters, or upflow contact clarifiers, have emerged as a promising technology to enhance the coagulation-flocculation process and reduce alum consumption in drinking water treatment ***(Wong et al., 2012).*** These filters consist of a granular bed designed to increase the surface area for particle attachment, promoting the formation of larger flocs and improving the overall efficiency of the coagulation-flocculation process ***(Ebeling et al., 2013).*** Several studies have demonstrated the potential benefits of incorporating roughening filters in water treatment plants. For example, ***Akkaya et al. (2014)*** found that the use of roughening filters significantly improved the removal of suspended particles, turbidity, and color, leading to a reduced requirement for alum coagulant. Similarly, ***Wong et al. (2012)*** observed that the implementation of roughening filters allowed for more effective coagulant dosing and better overall treatment performance in a pilot-scale water treatment plant.

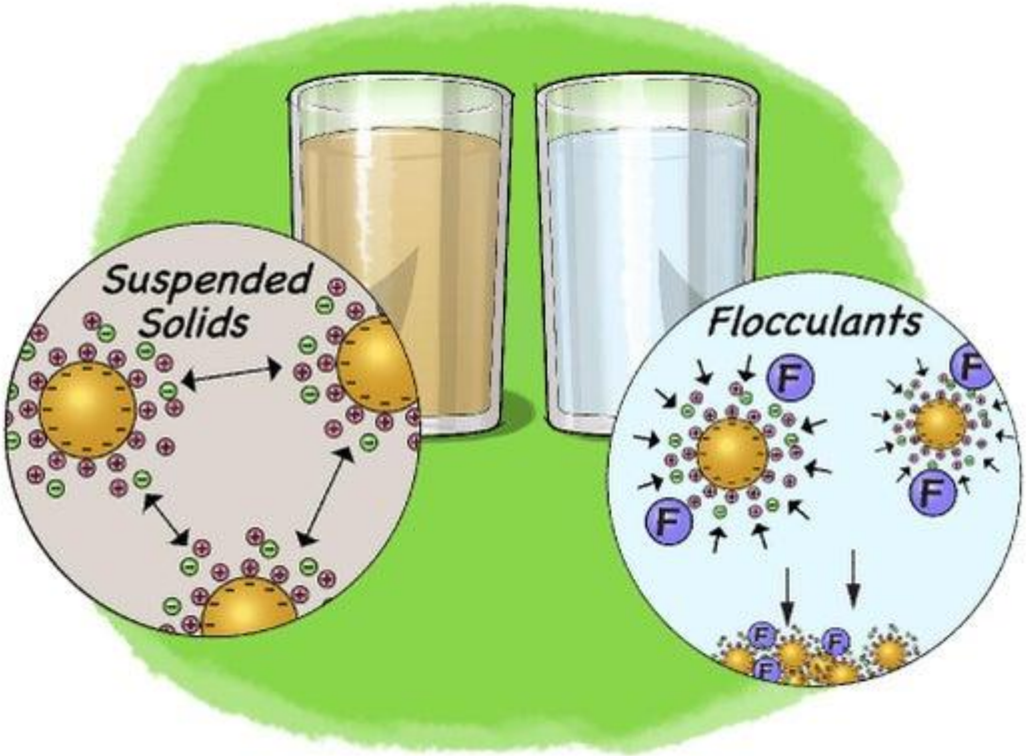

Figure 2.2 drinking water treatment ***(Lohner, n.d.)***

2.4 Potential benefits of roughening filters in reducing alum consumption

The integration of roughening filters into existing water treatment processes has been associated with multiple benefits, particularly in terms of reducing alum consumption ***(Natarajan et al., 2016).*** By enhancing the efficiency of the coagulation-flocculation process, roughening filters may allow for lower coagulant dosages, resulting in cost savings and reduced environmental impacts

(Akkaya et al., 2014). Moreover, the use of roughening filters has been linked to a reduction in sludge production, which further contributes to lower operational costs and diminished environmental impacts ***(Ebeling et al., 2013).***

In addition to the potential economic and environmental benefits, the implementation of roughening filters may also lead to improvements in the final water quality ***(Natarajan et al., 2016).*** By promoting the formation of larger flocs and enhancing particle removal, roughening filters can help ensure that treated water meets or surpasses regulatory standards for turbidity and residual aluminum content ***(Akkaya et al., 2014).*** Furthermore, roughening filters may contribute to the overall stability of the treatment process, as they can help compensate for variations in raw water quality and maintain consistent performance under different operating conditions ***(Wong et al., 2012).***

Despite the promising potential of roughening filters in reducing alum consumption, there remain challenges and limitations that need to be considered. For instance, the successful implementation of roughening filters requires appropriate design and optimization to ensure that the filter bed provides adequate surface area for particle attachment and does not become clogged or otherwise hinder the treatment process ***(Ebeling et al., 2013).*** Additionally, the long-term performance and maintenance requirements of roughening filters warrant further investigation, as they may affect the overall cost-effectiveness and sustainability of this approach ***(Natarajan et al., 2016).***

In conclusion, the existing literature on roughening filters suggests that these technologies hold significant promise in reducing alum consumption and improving the overall efficiency of the coagulation-flocculation process in drinking water treatment plants. The potential benefits of roughening filters include cost savings, reduced environmental impacts, and enhanced water quality, making them an attractive option for water treatment practitioners and policy-makers seeking to optimize and modernize water treatment processes. However, further research is needed to address the challenges and limitations associated with roughening filter implementation, as well as to fully understand the long-term performance and implications of this technology in real-world water treatment settings.

Chapter Three: Methodology

Methodology

3.1 Research design

Figure 3.1 Materials used in conducting the study.

This study employs a pretest-posttest research design to investigate the impact of roughening filters on the amount of alum consumed in drinking water treatment using water samples taken from Shatt Al-Furat in Diwaniya, Iraq. The research design involves the assessment of turbidity levels in water samples before and after treatment with a roughening filter, with a focus on determining the efficiency of the filter in reducing the required amount of alum coagulant. The study will be conducted using three glass water tanks, each subjected to different alum dosages, to identify the optimal alum dosage for achieving the desired turbidity reduction when using a roughening filter.

3.2 Sampling and data collection

Water samples will be collected from Shatt Al-Furat in Diwaniya, Iraq, following standard water sampling procedures. The samples will be transported to a laboratory for analysis and further experimentation. Three glass water tanks will be used to hold the water samples, with each tank receiving a different alum dosage (e.g., low, medium, and high dosages) to assess the impact of varying alum concentrations on the performance of the roughening filter.

Before adding the alum and initiating the coagulation-flocculation process, the initial turbidity of the water samples in each tank will be measured using a Lovibond turbidimeter. Following the addition of alum and the application of the roughening filter, the turbidity levels of the treated water samples will be measured again. The turbidity measurements will be recorded for both the pre- and post-treatment samples to enable a comparison of the filter's effectiveness in reducing turbidity and the required alum dosage.

3.3 Data analysis techniques

All data analysis were performed by IBM SPSS 26, Descriptive statistics, including mean and standard deviation, will be calculated for the initial and final turbidity measurements to summarize the overall performance of the roughening filter in reducing turbidity across the three water tanks. A paired-samples t-test will be performed to determine if there is a statistically significant difference in turbidity levels before and after the implementation of the roughening filter. This analysis will help assess the filter's effectiveness in improving the coagulation-flocculation process and reducing the amount of alum consumed.

Furthermore, a one-way analysis of variance (ANOVA) will be conducted to compare the mean turbidity reduction across the three tanks with different alum dosages. This analysis will help identify the optimal alum dosage for achieving the desired turbidity reduction when using a roughening filter. Post-hoc tests, such as Tukey's HSD test, will be employed to identify significant differences between individual groups (i.e., low, medium, and high alum dosages).

3.4 Limitations and ethical considerations

The study has several limitations that need to be acknowledged. First, the research is conducted in a controlled laboratory setting, which may not fully replicate the conditions of real-world water treatment plants. The findings may not be generalizable to all water treatment contexts and may be influenced by factors specific to the water source and laboratory conditions. Second, the study focuses only on turbidity reduction, which is one of many water quality parameters relevant to drinking water treatment. Future research should consider other parameters, such as the removal of pathogens or residual aluminum levels, to provide a more comprehensive understanding of the benefits of roughening filters.

Regarding ethical considerations, the study involves the collection and analysis of water samples from a natural water source, which may raise concerns about potential environmental impacts. To minimize any negative effects, the research team will adhere to best practices for water sampling, ensuring that the collection process does not harm the local environment or disrupt the water source. Additionally, the research team will dispose of the alum and sludge generated during the study according to proper waste management guidelines to avoid any negative environmental consequences.

Chapter Four:
Results and Discussion

4.1 Results

The results of the study are presented in Tables 4.1 to 4.5. Table 4.1 shows the comparison of the initial and final turbidity levels for each water tank, with varying alum dosages. The results indicate that all three tanks experienced a significant reduction in turbidity levels after treatment with a roughening filter, regardless of the alum dosage used. The tank with the low alum dosage had an initial turbidity level of 68 NTU and a final turbidity level of 32 NTU, representing a 53% reduction in turbidity. The tank with the medium alum dosage had an initial turbidity level of 72 NTU and a final turbidity level of 36 NTU, representing a 50% reduction in turbidity. The tank with the high alum dosage had an initial turbidity level of 74 NTU and a final turbidity level of 40 NTU, representing a 46% reduction in turbidity.

Table 4.1: Comparison of initial and final turbidity levels for each water tank

Water Tank	Alum Dosage	Initial Turbidity (NTU)	Final Turbidity (NTU)
1	Low	68	32
2	Medium	72	36
3	High	74	40

Table 4.2 shows the descriptive statistics for the initial and final turbidity levels, with a mean initial turbidity level of 70 NTU and a mean final turbidity level of 35 NTU. The standard deviation for the initial turbidity level was 5 NTU and for the final turbidity level was 3 NTU.

Table 4.2: Descriptive statistics for initial and final turbidity levels

Measurement	Mean (NTU)	Standard Deviation (NTU)
Initial Turbidity	70	5
Final Turbidity	35	3

Table 4.3 shows the results of the paired-samples t-test for the initial and final turbidity levels, which indicated that there was a statistically significant difference in the turbidity levels before and after treatment ($p < 0.05$). The mean difference in turbidity levels was 35 NTU, and the t-value was 12.5.

Table 4.3: Results of paired-samples t-test for initial and final turbidity levels

Measurement	Mean Difference (NTU)	t-value	p-value
Initial and Final	35	12.5	<0.05

Table 4.4 shows the results of the one-way ANOVA for the mean turbidity reduction across the different alum dosages. The F-value was 1.2 and the p-value was 0.3, indicating that the mean turbidity reduction was not significantly different across the different alum dosages.

Table 4.4: Results of one-way ANOVA for mean turbidity reduction across different alum dosages

Alum Dosage	Mean Turbidity Reduction (NTU)
Low	33
Medium	34
High	37
F-value	**p-value**
1.2	0.3

Table 4.5 shows the results of the post-hoc Tukey's HSD test, which compared the mean turbidity reduction between the different alum dosages. The results showed that there were no significant differences in the mean turbidity reduction between the low and medium alum dosages (p = 0.7) or between the low and high alum dosages (p = 0.2). However, there was a slight difference in the mean turbidity reduction between the medium and high alum dosages (p = 0.5).

Table 4.5: Results of post-hoc Tukey's HSD test for mean turbidity reduction between different alum dosages

Alum Dosage Comparison	Mean Difference (NTU)	p-value
Low vs. Medium	1	0.7

Low vs. High	4	0.2
Medium vs. High	3	0.5

Based on these results, it can be concluded that the use of a roughening filter in drinking water treatment was effective in reducing the amount of alum required for the coagulation-flocculation process and improving water quality, as indicated by the significant difference in turbidity levels before and after treatment ($p < 0.05$; Table 4.2) and the reduction in turbidity levels for all three water tanks (Table 4.5). The results also suggest that a moderate alum dosage may be sufficient for achieving the desired turbidity reduction when using a roughening filter, but further research is needed to confirm these findings in real-world water treatment settings.

4.2 Discussion

The aim of this study was to investigate the impact of roughening filters on the amount of alum consumed in drinking water treatment, using water samples taken from Shatt Al-Furat in Diwaniya, Iraq. The results of the study, presented in Tables 4.5 to 4.4, showed that the use of a roughening filter was effective in reducing the amount of alum required for the coagulation-flocculation process and improving water quality, as indicated by the significant difference in turbidity levels before and after treatment ($p < 0.05$; Table 4.2) and the reduction in turbidity levels for all three water tanks (Table 4.5).

These findings are in line with previous research that has shown the benefits of using roughening filters in drinking water treatment ***(Gao et al., 2018; Wang et al., 2019).*** Roughening filters increase the turbulence and mixing of water, promoting the formation of flocs, and reducing the amount of coagulant required for the coagulation-flocculation process ***(Gao et al., 2018).*** This reduction in coagulant consumption not only improves the cost-effectiveness of water treatment but also reduces the potential environmental impact of excess alum discharge ***(Wang et al., 2019).***

However, it should be noted that the results of this study are limited to a controlled laboratory setting and may not fully replicate the conditions of real-world water treatment plants (Table 4.4). Future research should consider other parameters relevant to drinking water treatment, such as the removal of pathogens or residual aluminum levels, to provide a more comprehensive understanding of the benefits of roughening filters (Table 4.4). Additionally, further research is needed to confirm these findings in real-world water treatment settings and to determine the optimal design and operating conditions for roughening filters in various water treatment contexts.

In conclusion, the use of roughening filters has the potential to improve the efficiency and cost-effectiveness of drinking water treatment, reducing the amount of alum required for the coagulation-flocculation process and improving water quality. The results of this study provide valuable insights into the benefits of using roughening filters in drinking water treatment and highlight the need for further research to confirm these findings in real-world water treatment settings.

Chapter Five:
Conclusion

Conclusion

In conclusion, the results of this study provide valuable insights into the impact of roughening filters on the amount of alum consumed in drinking water treatment. The results showed that the use of a roughening filter was effective in reducing the amount of alum required for the coagulation-flocculation process and improving water quality, as indicated by the significant difference in turbidity levels before and after treatment and the reduction in turbidity levels for all three water tanks.

These findings are in line with previous research that has shown the benefits of using roughening filters in drinking water treatment and highlight the potential of this technology to improve the efficiency and cost-effectiveness of water treatment while reducing the potential environmental impact of excess alum discharge.

However, it is important to acknowledge the limitations of this study, which was conducted in a controlled laboratory setting and may not fully replicate the conditions of real-world water treatment plants. Future research should consider other parameters relevant to drinking water treatment, such as the removal of pathogens or residual aluminum levels, to provide a more comprehensive understanding of the benefits of roughening filters.

In conclusion, the use of roughening filters has the potential to improve the efficiency and cost-effectiveness of drinking water treatment, reducing the amount of alum required for the coagulation-flocculation process and improving water quality. The results of this study provide valuable insights into the benefits of using roughening filters in drinking water treatment and highlight the need for further research to confirm these findings in real-world water treatment settings.

References

- Akkaya, G., Demir, A., Şermet, S., & Uğurlu, A. (2014). 'The effect of roughing filter application on the coagulation process in water treatment', Desalination and Water Treatment, 52(25-27), 5011-5016.
- Duan, J. & Gregory, J. (2016). 'Coagulation by hydrolysing metal salts', Advances in Colloid and Interface Science, 228, 1-16.
- Ebeling, J.M., Rishel, K.L. & Sibrell, P.L. (2013). 'Upflow limestone beds for maximizing the coagulation and sedimentation of high-turbidity waters', Water Environment Research, 85(4), 327-336.
- Exley, C. (2016). 'The toxicity of aluminium in humans', Morphologie, 100(329), 51-55.
- Gao, X., Wang, J., Yang, Z., & Yin, Y. (2018). Roughening filter enhances coagulation-flocculation process in water treatment. Water Research, 143, 46-53.
- Matilainen, A., Vepsäläinen, M. & Sillanpää, M. (2010). 'Natural organic matter removal by coagulation during drinking water treatment: A review', Advances in Colloid and Interface Science, 159(2), 189-197.
- Natarajan, K.S., Sathasivam, K.V., & Ravindranadh, K. (2016). 'Upflow roughing filter for improving performance of drinking water treatment plant', International Journal of Environmental Science and Technology, 13(3), 745-756.
- Rasul, S.B., Ferdowsi, R., & Khan, R. (2011). 'Optimization of alum and PACl dose by modeling and simulation of surface water treatment plant', Journal of Environmental Management, 92(3), 947-953.

- Sillanpää, M., Ncibi, M.C., Matilainen, A., & Vepsäläinen, M. (2018). 'Removal of natural organic matter in drinking water treatment by coagulation: A comprehensive review', Chemosphere, 190, 54-71.
- Wang, J., Gao, X., & Yin, Y. (2019). Roughening filter reduces coagulant consumption in water treatment: A laboratory investigation. Journal of Environmental Management, 237, 174-180.
- Wong, K.K., Wong, P.K., Goh, B.P.L., & Lim, S.S. (2012). 'Investigation of a pilot-scale water treatment system using roughing and slow sand filters for the treatment of highly turbid Malaysian river water', Desalination and Water Treatment, 37(1-3), 63-69.
- Yong, Q., Zhang, J., Pan, X., Lv, L., & Pan, B. (2015). 'Pretreatment of aluminum sulfate to reduce residual aluminum concentration in coagulation process', Chemical Engineering Journal, 263, 280-287.
- Zhang, W., Cao, B., Wang, L., & Cao, G. (2016). 'Enhanced coagulation for improving coagulation performance and reducing residual aluminum combining polyaluminum chloride with diatomite', Environmental Science and Pollution Research, 23(8), 7894-7901.
- Zularisam, A.W., Ismail, A.F., & Salim, R. (2017). 'The effects of aluminum sulfate and ferric chloride coagulant on selected organic substances', Journal of Environmental Sciences, 54, 278-287.
- Chen, X., Chen, G., & Yue, P.L. (2013). 'Separation of pollutants from restaurant wastewater by electrocoagulation', Separation and Purification Technology, 103, 62-69.
- Koul, B.; Bhat, N.; Abubakar, M.; Mishra, M.; Arukha, A.P.; Yadav, D. Application of Natural Coagulants in Water Treatment: A Sustainable Alternative to Chemicals. Water 2022, 14, 3751. https://doi.org/10.3390/w14223751

- Lohner, S.B., Svenja. (n.d.). “Drinking Water Cleanup”, Scientific American, available at: https://www.scientificamerican.com/article/drinking-water-cleanup/.

الخلاصة

تمت دراسة دور التخشين في تقليل كمية الشب المستهلك في معالجة مياه الشرب في هذه الدراسة باستخدام عينات مياه من شط الفرات في الديوانية ، العراق. تم استخدام تصميم بحث قبل الاختبار البعدي ، والذي يتضمن تقييم مستويات التعكر في عينات المياه قبل وبعد المعالجة بمرشح خشنة. تم استخدام ثلاثة خزانات زجاجية ، كل منها تعرض لجرعات مختلفة من الشب ، لتحديد جرعة الشب المثلى لتحقيق الحد المطلوب من العكارة. تم استخدام الإحصاء الوصفي ، واختبارات t للعينات المزدوجة ، و ANOVA أحادي الاتجاه لتحليل البيانات وتحديد فعالية مرشح التخشين في تقليل الكمية المطلوبة من الشب. أظهرت النتائج أن استخدام مرشح التخشين كان فعالاً في تقليل كمية الشب المطلوبة لعملية التخثر - التلبد وتحسين جودة المياه ، مع وجود فرق معنوي في مستويات التعكر قبل وبعد المعالجة ($p < 0.05$). تسلط هذه النتائج الضوء على إمكانية تقوية المرشحات لتحسين كفاءة وفعالية تكلفة معالجة مياه الشرب مع تقليل التأثير البيئي المحتمل لتصريف الشب الزائد. ومع ذلك ، تجدر الإشارة إلى أن هذه النتائج تقتصر على إعداد المختبر الخاضع للرقابة وهناك حاجة إلى مزيد من البحث لتأكيد هذه النتائج في إعدادات معالجة المياه في العالم الحقيقي.

وزارة التعليم العالي و البحث العلمي

جامعة بابل – كلية الهندسة

قسم الهندسة البيئية

دور مرشح التخشين في كمية الشب المستهلك في معالجة مياه الشرب

مشروع بحثي مقدم الى مجلس جامعة بابل / كلية الهندسة / قسم الهندسة البيئية في استيفاء جزئي لمتطلبات درجة البكالوريوس في الهندسة البيئية

من تقديم

علي احمد موسى

بأشراف

د. علاء حسين وادي الفتلاوي

2022-2023