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Turbidity Removal from Aqueuse Solution by three Materials Coagulates

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Abstract

The addition of coagulation chemicals to turbid water, which contains molecules, plankton, and colloids, is known as coagulation and flocculation. Three of Coagulants are the most widely utilized coagulants in water treatment. process were tested for their efficacy in reducing turbidity in this study. Aluminum sulfate (alum), ferric chloride, and date seed powder are the ingredients. Experiments were carried out with synthetically prepared turbid water containing kaolin, and a Jar test instrument was used to determine the best dosage and pH for each chemical. The effectiveness of Alum, Ferric Chloride, and Date Seeds powder was tested at different pH values of 5.5, 7.5, and 9.5, as well as coagulant dosages of 10 mg/l to 50 mg/l, to determine the best operating conditions for turbid waters with turbidities of 60 NTU, 150 NTU, and 300 NTU. The results revealed that pH and coagulant dose affects turbidity removal and the water's turbidity at the start for each of the coagulants used. Over the applied turbidity range, the highest removing turbidity efficiency was within (95.2-96), (94-96.41), and (91.3-94) percent for Alum, Ferric Chloride, and Date Seeds powder, respectively.

Keyword: Coagulation, Alum, Ferric Chloride, Date Seeds powder**,** Jar test.

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1. Introduction

Human life is inextricably linked to water as it is necessary for life to exist. Every human being has the right to get clean and safe water to drink and use in their daily life. Water that is pure and safe is in high demand as a result of all of these activities. The most often utilized treatment procedures in the manufacture of drinking water are as follows: flocculation, coagulation, sedimentation, filtration, and disinfection. The separation of solid particles from water relies heavily on coagulation/flocculation processes. Coagulants are added to water to destabilize colloidal particles, which causes coagulation. To combine the coagulant and flocculation processes fast, rapid mixing is required. Flocculation is the production of destabilized colloidal particle aggregates and it necessitates moderate mixing to allow effective particle collisions that result in massive flocs that may could be sedimented out of water. Colloidal particles are tiny particles suspended in water, due to their light weight and charge, cannot be settled or removed by gravity [1]. Turbidity is caused by these particles in the water. Turbidity is also linked to a number of pollutants that are harmful in terms of human health, such as metals and certain organic synthetic compounds. As a result, turbidity that is effective removal is required to make certain the removal of a variety of pollutants that are harmful to one's health. It is possible that removal will be necessary to improve the effectiveness of subsequent procedures for water treatment. Chemical coagulants such as both alum and ferric chloride utilized in a lot of water treatment facilities around the entire world. Literature has reported findings on various coagulation processes [2]. The ability of coagulants, namely Alum, The most prevalent forms of coagulants used in water treatment plants are ferric chloride and calcium chloride,to reduce turbidity of synthetic water, were investigated in this study. Their efficiency was impressive tested at various pH levels as well as coagulant dosages in order to determine the best operating the circumstances for various muddy waters. The process of removing turbidity from water is critical due to colloids can endanger human health either directly or indirectly. Through the following investigations, the aim of this study is to reduce turbidity from aquese solution by:

1.Coagulant dosages and pH of chemical coagulants that work best (alum).

2.Optimal coagulant dosages and pH levels for chemical coagulants (Chloride of iron).

3.The optimal dose of coagulant and pH of a Coagulant (natural) (Date Seeds powder).

1.1Turbidity

Turbidity is induced by a variety of factors light suspended or dissolved particles in water, resulting in foggy or murky water.Particulate matter includes sediment, notably fine organic and inorganic materials, soluble colored organic compounds, algae,bacteria, and other tiny materials, including clay and silt creatures [2]. The amount of suspended particles in the water can be influenced by a variety of physical landscape features in watersheds, resulting in murky or turbid water. Sediment from rock weathering, dead plant waste, and phytoplankton are also natural sources of material. Substances in storm water from metropolitan areas (roads, parking lots), upland industrial activities, building and land removal, and activities that occur

directly in water bodies, such as power boating and car use, are all examples of human-caused causes. Turbidity can change in the long run, seasonally, or geographically depending on variances in precipitation, gradient (slope), geology, flow, and disturbances such as landslides [3].

1.2 Effects of pH

The pH of the interaction between coagulant and particle is critical for successful neutralization as well as floc agglomeration. Furthermore, pH (4–8) affects the solubility of metal hydroxide species. As a result, altering the pH before introducing the coagulant is essential for controlling the chain reactions that will take place. Through a double-layer compression, a metal-based ion in inorganic coagulants or polymers that are effective can alter floc formation [4]. As the pH rises, these organisms become charged, causing a shift in mechanism. The pH affects protonation when the colloids are hydrophilic, such as acids.

2.Experiment Work

2.1 Material

1. kaolinite

kaoliniteis a Clay is a mineral that belongs Industrial minerals are a type of mineral that can be found in a variety of forms and has the substance formula $Al_2Si_2O_5(OH)_4$.It's a silicate mineral with layers having one sheet of tetrahedral connected to one alumina octahedral sheet by oxygen atoms 2.6 [7].

2.Alum

The coagulant used was Aluminum Sulfate [$Al_2 (SO_4)_3.18H_2O$], from which an alum solution was prepared at a strength of 1%and used at different doses.

3.Ferric chloride

The coagulant used was ferric chloride ($FeCl_3. 6H_2O$) ,from which an ferric chloride solution was prepared at a strength of 1% and used at different doses.

4. Seeds of Date palm

Iraqi date palm were available locally obtained derived from date palms and seeds were sown sorted in this investigation. The seeds were then rinsed soaked in tap water and dried in a 50°C oven for six hours. The seeds had been planted then crushed and ground in a flour milling machine before being through sieved 250-mesh sieve. For coagulation process enhancement, stock these natural coagulant's solutions (seed dates coagulant)were made 100 grams of seed powder dissolved in one liter of distilled water, resulting in a seed coagulant solution of 100 mg/l concentration in one ml of this stock. In order to be successful, confident that this answer was devoid of remaining particles, 1 m filter paper was used to filter it. Then, using methods of titration, five varied seed coagulant concentrations (10, 20, 30, 40, 50 mg/l) were created.

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2.2 Apparatus

1. Jar test apparatus

Using a jar test, the optimal concentration of coagulant for alum, ferric chloride, and seeds of dates can be determined and added to the aqueous solution. Jar test experiments were carried out at pH levels of 5.5, 7.5, and 9.5. Coagulants that are commonly employed in various water treatment plants across the world were Aluminium Sulphate Ferric Chloride [$Al_2(SO_4)_3.18H_2O$] ($FeCl_3.\ 6H_2O$),and Date Seeds in the current research. Kaolin clay was mixed with distilled water to create raw turbid water. A 24 hour soak time was allowed for the mixed clay sample. After that, to achieve a uniform and homogeneous sample, the suspension was agitated in a fast stirrer.

The resulting suspension was discovered to be colloidal, and it was utilized as a stock solution for the production of turbid water samples. A stock sample of kaolin clay was diluted in tap water according to the specifications to obtain the appropriate turbidity.The pH of turbid water was adjusted with sodium hydroxide and sulphuric acid. Alum, Ferric Chloride, and Date Seeds were used to make stock solutions. 500 mL of synthetic turbid was in a 1000 ml beaker, combine all ingredients and stir well for 2 minutes at 300 rpm (rapid mixing). For flocculation, for 10-20 minutes, the mixing speed was dropped to 30 rpm (slow mixing). Any floc that had formed was left to settle in the beakers for 30-60 minutes. For turbidity measurements Supernatant is found 20 mm below the water's surface samples. Using an Equiptronics digital turbidity meter, supernatant turbidity was measured and represented in Nephelometric Turbidity Units (NTU). The indicator of performance was residual turbidity. In the jar test experiments Both Aluminium Sulphate and Ferric Chloride are used the optimal pH and dose for turbidity removal were identified. The jar testing was cooled to room temperature. For the jar test studies, The following are the experimental characteristics: as presented in Table below (1).

Table 1: The experimental characteristics of the jar test experiment used in this research.

Characteristic	Description
Coagulants	Aluminium Sulfate, Ferric Chloride, and Date Seeds
Dose range for a coagulant	10 – 50 mg/l
pH levels	5.5, 7.5 & 9.5
Turbidity at the start	60 NTU, 150 NTU & 300 NTU
Rapid blending	2 minutes at 300 rpm
Slowly combine the ingredients.	10-20 minutes at 30 rpm
It's time to settle down	30-60 minutes

3. Results

3.1 The optimum (alum) dose

Figures (1,2,3) depicts the efficacy of removing turbidity as a function of Alum dose for pH levels of 5.5, 7.5, and 9.5. Initially, the turbidity of water samples was set to 60, 150, and 300 NTU, respectively. Because high initial turbidities are common in many storm waters, they were

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taken into account in this project. Water with a low turbidity is difficult due to low stable particle concentrations to coagulate and turbidity is sometimes artificially added to the water to make the flocs heavier , something that can be resolved. The turbidity with the least amount of applied turbidity (60 NTU) in the current study, however, was not too low as to cause the coagulation process to be disrupted.

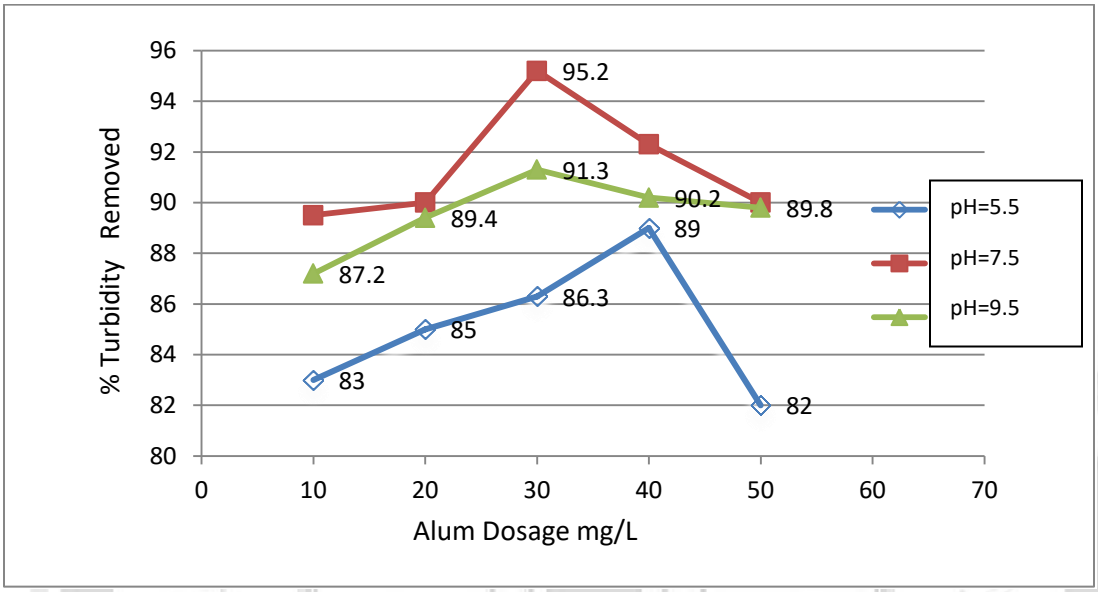

Figure 1: Turbidity removal by Alum dose at various pH levels for initial turbidity of 60NTU.

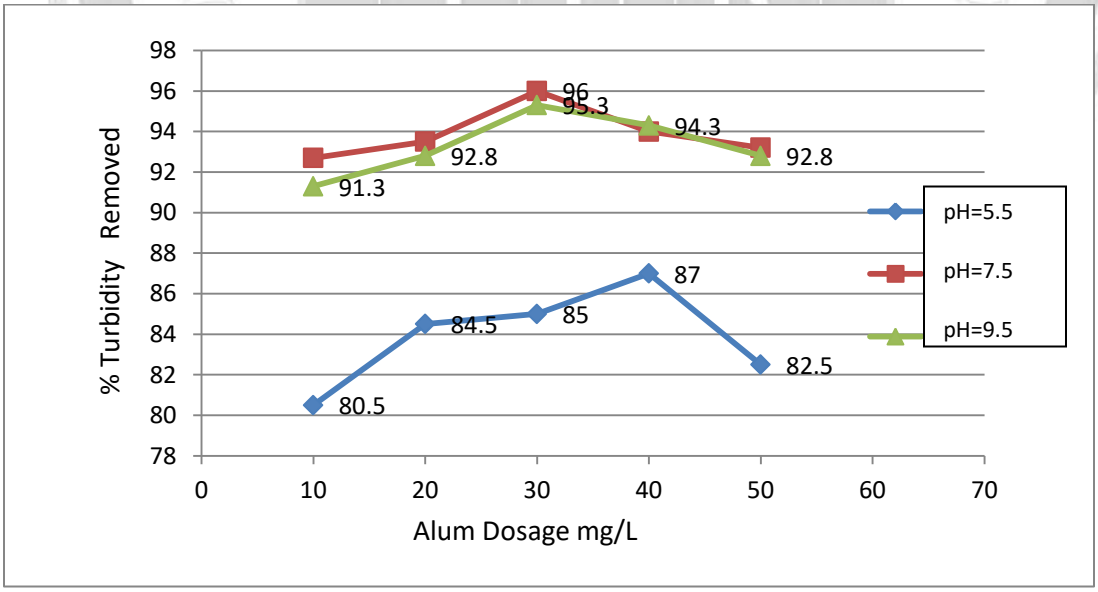

Figure 2: Alum dose for removing turbidity at varying pH of initial turbidity=150NTU.

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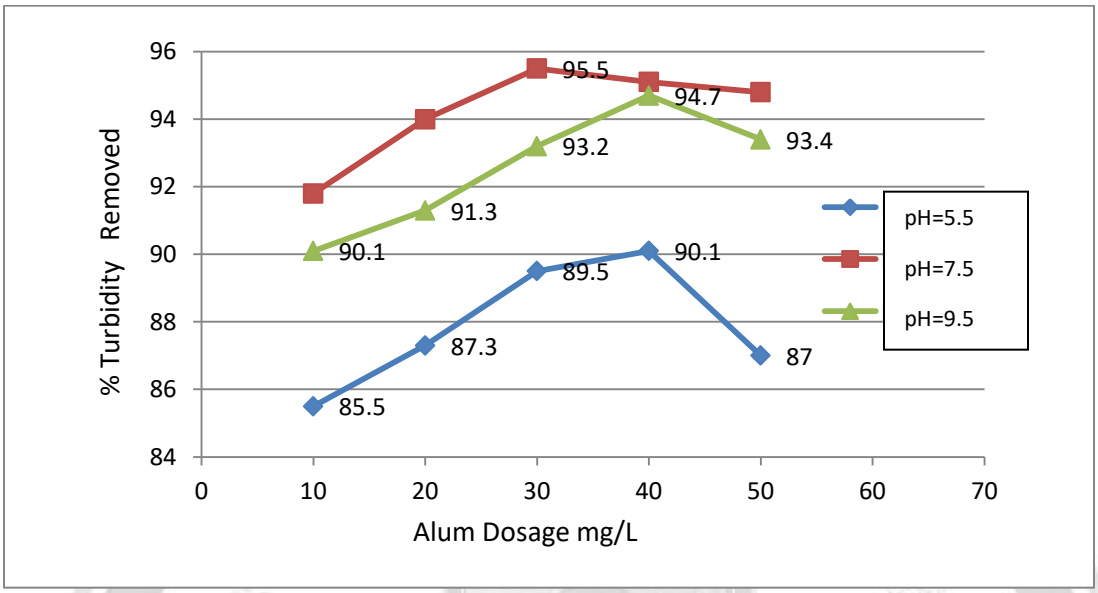

Figure (3): Alum dose removal of turbidity for various pHs of initial turbidity=300NTU.

3.2 Optimum (Ferric Chloride) dose

The effect of Ferric Chloride dosing on turbidity elimination at varying pH values of 5.5, 7.5, and 9.5 is the turbidity of the water at the beginning in the figures (4), (5), and (6). The water's initial turbidity samples were set to 60, 150, and 300 NTU respectively .

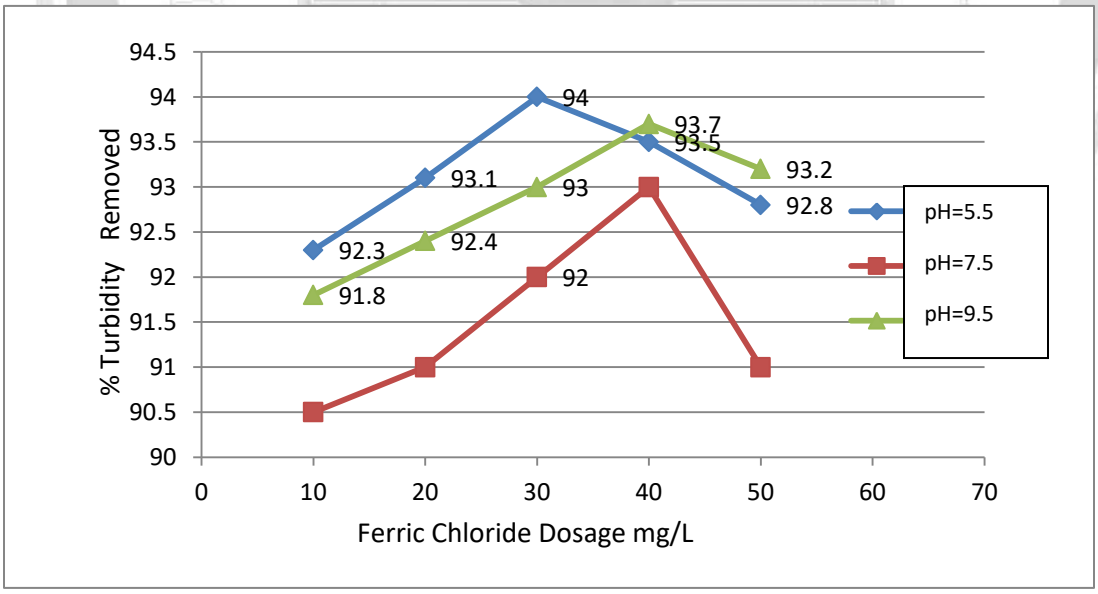

Figure (4): Turbidity removal by Ferric Chloride dose at various pH levels for initial turbidity of 60NTU

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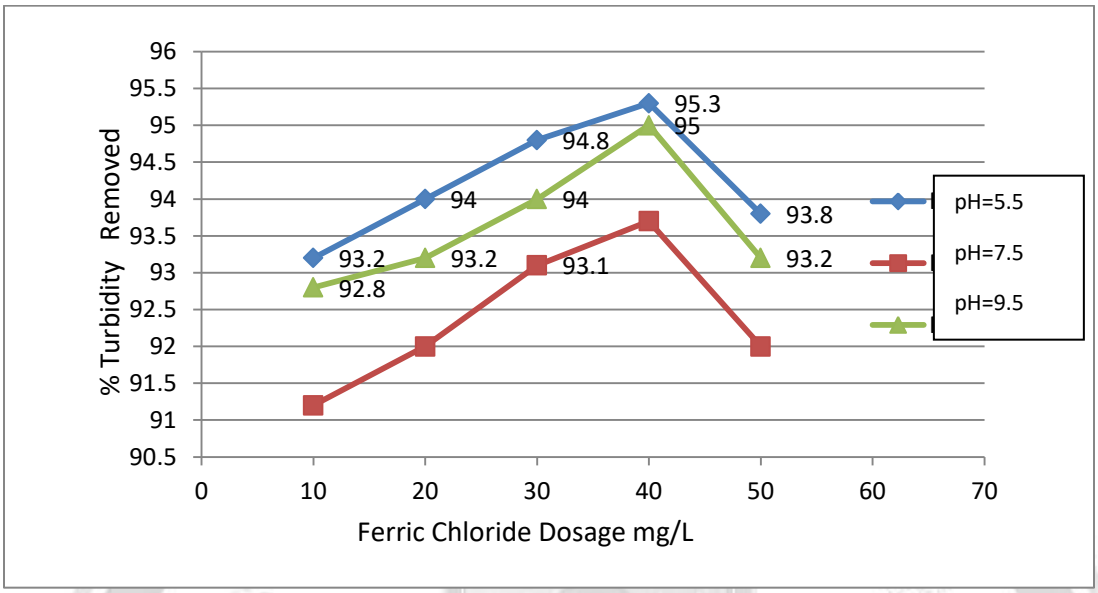

Figure (5): Turbidity removal by Ferric Chloride dose at various pH levels for initial turbidity of 150NTU.

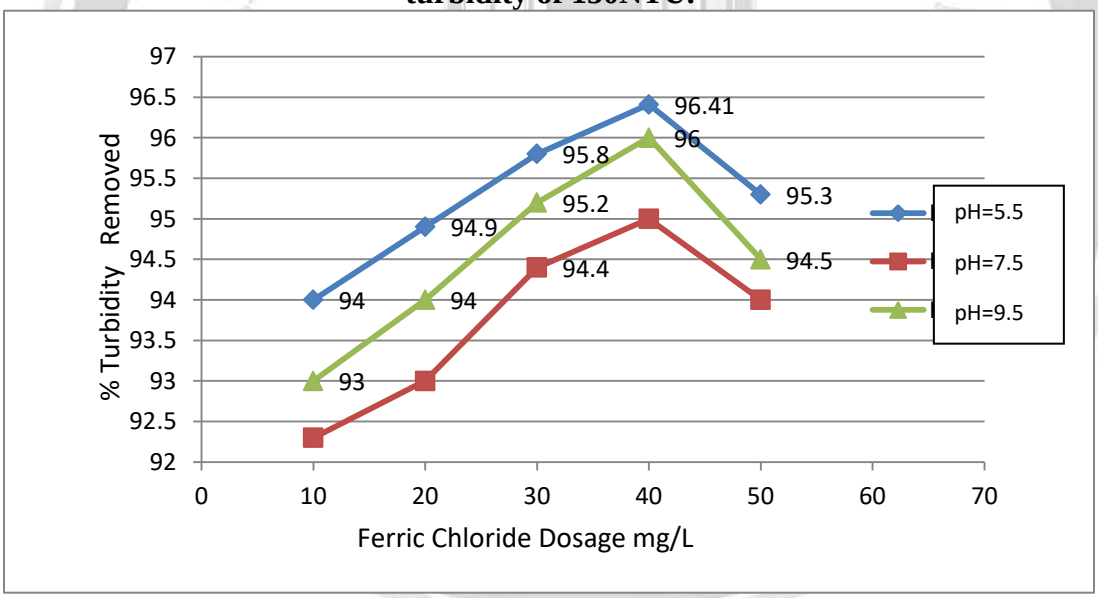

Figure (6): Turbidity removal by Ferric Chloride dose at various pH levels for initial .turbidity of 300NTU

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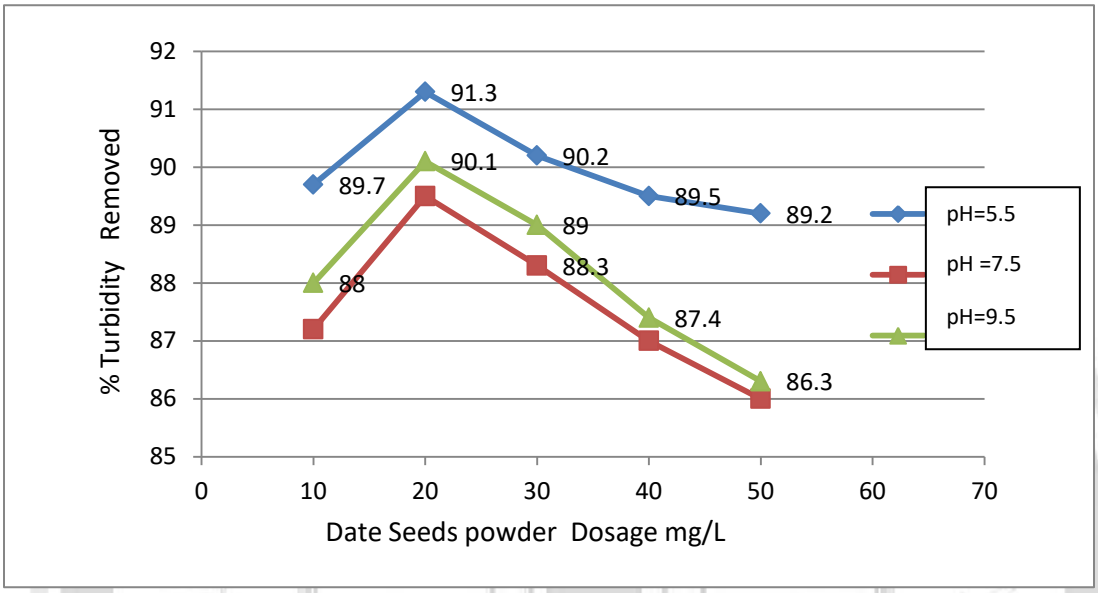
3.3 Optimum (Date Seeds powder) dose.

The effect of date seeds powder dose on turbidity removal at different pH levels of 5.5, 7.5, and 9.5 as shown in Figures (7), (8), and (9) respectively. The initial turbidities of water samples were set to 60, 150, and 300 NTU, respectively.



Figure(7): Turbidity removal by Date Seeds powder dose at various pH levels for initial turbidity of 60NTU.

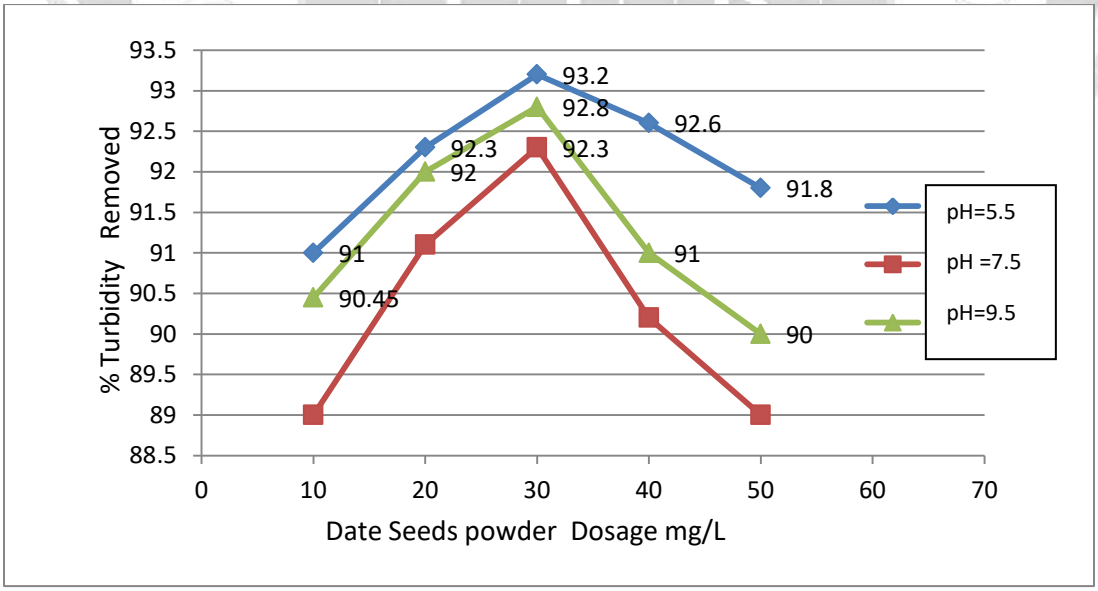


Figure (8): Turbidity removal using Date Seeds powder doses at various pH levels for initial turbidity of 150NTU.

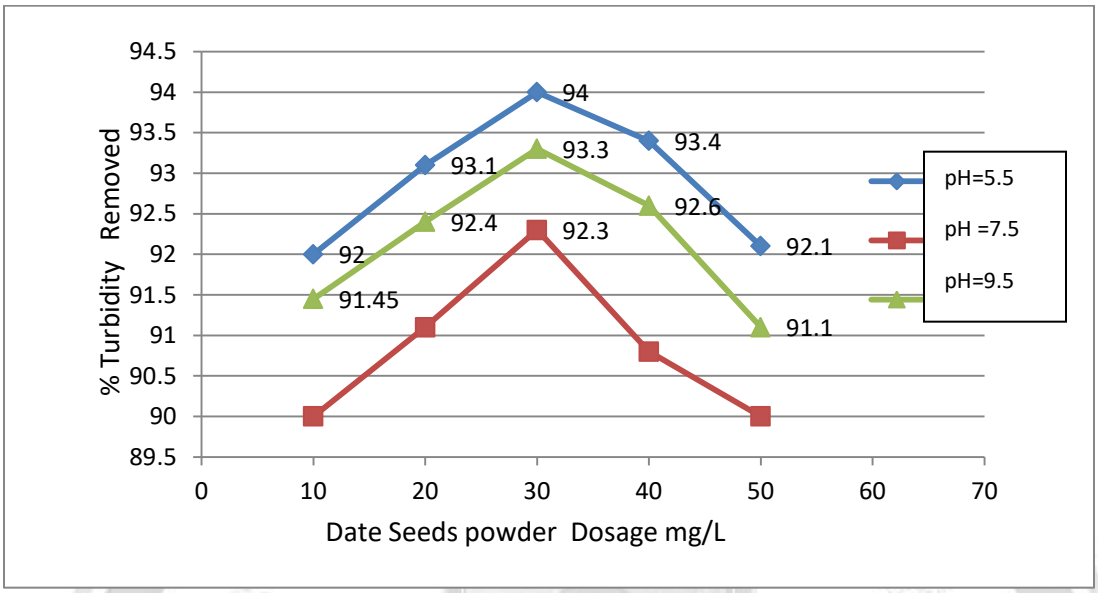


Figure 9): Turbidity removal by Date Seeds powder dose at various pH levels for initial turbidity of 300NTU.

3.4. Discussion

3.4.1 Alum

The best performance of Alum over the selected range of turbidity was observed at pH 7.5, However, its performance deteriorated to a degree at pH values of 5.5 and 9.5, as shown in figure (1, 2,3). Alum's coagulation efficiency at pH 9.5 was almost identical to that at pH 7.5. When an initial turbidity of 30 mg/l Alum was applied, of 300 NTU, the highest turbidity removal was achieved at pH 7.5. At pH 7.5 Alum had the most effective method for eliminating turbidity from water, followed by pH 9.5. Within the prescribed dose range of 30-40 mg/l, Alum's coagulation effectiveness remained practically constant. In other words, the findings revealed that the Alum dose range required for optimal coagulation was within acceptable limits. In this study was almost unlimited. Salts of aluminum and iron, in general, rapidly hydrolyze in water to produce a variety of products, cationic species. Efficiencies in removing turbidity of Alum at the optimum conditions (optimal dose and pH) were 95.2, 96, and 95.5 percent for initial turbidities of 60, 150, and 300 NTU, respectively. pH, Alum dose, and the turbidity at the start of the water were all discovered to affect turbidity removal efficiency. The findings are consistent with those of [5]. Who found that the pH of coagulation was the most important factor in removing turbidity from water. The results showed that increasing the turbidity level at the start 60-150 and 300 NTU reduced to some extent, turbidity removal efficiency. Alum dosage should be increased which may help remove turbidity caused by waters with a high turbidity level. However, as many texts have stated, coagulation with alum can cause an increase in the amount of aluminum in drinking water.

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3.4.2 Ferric Chloride

As demonstrated in figures, Ferric chloride's coagulation efficiency improved in the range of dosages of 20-40 mg/ l at pH levels of 5.5, 7.5, and 9.5. (4,5,6). Ferric Chloride functioned best at pH 5.5, and it also behaved well at pH 9.5. For turbidity at the start of 60 NTU, 30 mg/l Ferric Chloride was shown to be the optimal coagulant dosage. However, at the start of the turbidity of 150 and 300 NTU, respectively, the most turbidity is effectively removed when 40 mg/l Ferric Chloride was utilized. At the ideal pH and Ferric Chloride dosage, Efficiencies of Ferric Chloride in Removing Turbidity were 94, 95.3, and 96.41 percent for turbidity at the start of 60, 150, and 300 NTU, respectively. The effective maximum turbidity removal for Ferric Chloride was practically over and over the turbidity range that has been tested (more than 90 percent).The outcomes are consistent with those obtained by [6].

3.4.3 Date Seeds powder

Based on data figure (7, 8, 9) pH values of 5.5, 7.5, and 9.5, Within the prescribed dose range of 20-30 mg/ l, the coagulation efficiency of Date Seeds powder enhanced. Date Seeds powder at pH 5.5 and then pH 9.5 produced the greatest results. The best initial turbidity coagulant dose of 60 NTU when it was obtained 20 mg/L date seeds powder was utilized. In the case of initial turbidity of 150 and 300 NTU, the turbidity that is the highest reduction was found when 30 mg/l date seeds powder was utilized. Efficiencies in removing turbidity by date seeds powder at the ideal pH and the powder dosage was (91.3, 93.2, and 94 percent) for initial turbidities of (60, 150, and 300 NTU) respectively.

4. Conclusions

1- To remove the turbidity of the aqueous solution using three coagulants such as(Ferric Chloride, date seeds powder, Alum) and the study of the influencing factors such as the pH and the dose of alum, the initial turbidity of the water are all factors to consider.

2- The most turbidity is removed. was achieved when pH was kept at or near its ideal level (5.5 and 9.5 for Ferric Chloride, Date Seeds powder, and 7.5 for Alum).

3- Within this range, the maximum turbidity reduction effectiveness was achieved. (95.2-96), (94-96.41), and (91.3-94), respectively, for Alum, Ferric Chloride, and Date Seeds powder.

References

[1] Wen Po Cheng, Fung Hwa Chi, Chun Chang Li, Ruey Fang Yu, “A study on the removal of organic substances from low-turbidity and low-alkalinity water with metal-polysilicate coagulants” ELSEVIER, 2008.

[2] Akbar Baghvand, Ali DaryabeigiZand, Nasser Mehrdadi and AbdolrezaKarbassi “Optimizing Coagulation Process for Low to High Turbidity Waters Using Aluminum and Iron Salts”, American Journal of Environmental Sciences 6, 2010.

[3] AnnaduraiG., S.S. Sung and D.J.Lee, “Simultaneous removal of turbidity and humic acid from high turbidity stormwater”. Adv. Environ. Res., 8: 713-725. 2004.

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[4] Cotruvo, J. A. and Vogt, C. D.; "Rational for Water Quality Standers and Goal in Water Quality and Treatment", A Handbook of Community Water Supplies, edited by Pontius, F. W.; American Water Works Association 4th edition, McGraw Hill Inc., New York, 1990.

[5] Volk, C., K. Bell, E. Ibrahim, D. Verges, G. Amy and M. Lechevaller, "Impact of enhanced and optimized coagulation on removal of organic matter and its biodegradable fraction in drinking water." Water Res., 34: 3247-3257. DOI:10.1016/S0043-1354.00.00033.6 , 2000.

[6] Mohsinkhan,P., KolateSuraj ., LondheSagar ., & Mate Umesh "Comparative study of alum and ferric chloride for removal of turbidity from water". International Journal of Innovative Research in Science and Engineering 2016.

[7] John Wiley &Sons . Handbook of Public Water Systems. Second Edition; HDR Engineering Inc: New York. 2001.

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ازالة كدرة المحاليل المائية بأستخدام ثلاث مواد مخثرة

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الخلاصة

تُعرف إضافة المواد الكيميائية الخاصة بالتخثر إلى المياه العكرة ، والتي تحتوي على جزيئات وعوالق وغرويات ، باسم التخثر والتلبيد. تم اختبار ثلاثة من أكثر المواد المخثرة كفاءة في عملية معالجة المياه من حيث فعاليتها في تقليل التعكر في هذه الدراسة. المكونات هي كبريتات الألومنيوم (الشب) وكلوريد الحديديك ومسحوق بذور التمر. تم اجراء التجارب باستخدام الماء العكر المحضر صناعياً المحتوي على الكاؤلين ، وتم استخدام أداة اختبار الجرة لتحديد أفضل جرعة ودرجة الحموضة لكل مادة كيميائية تم اختبار فعالية الشب وكلوريد الحديديك ومسحوق بذور التمر بقيم مختلفة من الأس الهيدروجيني ٥.٥ ، ٧.٥ ، ٩.٥ ، بالإضافة إلى جرعات التخثر من ١٠ مجم / لتر إلى ٥٠ مجم / لتر ، لتحديد أفضل ظروف التشغيل للعكر للمياه ذات العكارة NTU300 NTU ١٥٠ NTU ٦٠. اظهرت النتائج أن إزالة العكارة تتأثر بالأس الهيدروجيني وجرعة التخثر والعكارة الأولية للماء لكل من مواد التخثر المستخدمة. على مدى نطاق العكارة المطبق ، كانت أعلى كفاءة لإزالة العكارة ضمن (٩٥.٢-٩٦) ، (٩٤-٩٦.٤١) ، (٩١.٣-٩٤) نسبة مئوية لمسحوق الشب وكلوريد الحديديك وبذور التمر على التوالي.

الكلمات الدالة: التخثر، الشب، كلوريد الحديديك، مسحوق بذور التمر، فحص الجرة.