Anbar Journal of Engineering Science (AJES)
P-ISSN: 1997-9428; E-ISSN: 2705-7440

Vol. 12 , No. 2 (2021) , pp. 139 ~145
DOI: https://doi.org/10.37649/aengs.2021.171172

Unviersty of Anbar

Anbar Journal Of Engineering Science©

journal homepage: http://www.uoanbar.edu.iq/Evaluate/

Evaluation and treatment of waste water effect on groundwater quality (the University of Anbar area as a case study)

Mohammed Freeh Sahab

Department of Dams and Water Resources Engineering, Universtiy of Anbar, Ramadi, Iraq

PAPER INFO

Paper history:
Received: 10 /6/2021
Revised 5/ 8/ 2021
Accepted 19 / 8/ 2021

Keywords:
Turbidity , Pollution , Wastewater , Alum , Lime , Removal Efficiency, coagulation

ABSTRACT

This research focuses on studying the impact of different sources of wastewater, such as domestic, industrial, agricultural, etc. upon groundwater. The swamp of contaminated water collection within the Al-Anbar University area was taken as a case study for this research. This swamp has a pond that works as a collection basin for different sources of wastewater mainly domestic waste coming from leakage of contaminated water from the septic-tank of the residential complex of students. This contaminated water will leak over time within the folds of soil due to permeability and the effect of land attraction and reach the levels of groundwater.

The presence of polluted water near groundwater is an environmental hazard and harmful because this leakage water has different diseases and germs, which could pose a danger to human health. Different samples of these sources were taken from different places at different times and some physical, chemical, and biological tests were then conducted. Wastewaters characterization was also investigated in this study to make an assessment for water quality and find out a proper treatment method. Data obtained from this study show different levels of pollutants, which could highly affect groundwater quality. A proper and advanced treatment method was also proposed in this study, depending on the wastewater characterization results. The purpose of this research is wastewater treatment using the physical method with coagulation and Flocculation processes with local coagulants to reduce pollutants impact on groundwater.The results showed the addition of alum at 35 mg/l increased the removal efficiency by 80.7% at the settling time of 60 min, and the addition of 35 mg/l of the lime increased the removal efficiency by 63.9% at the same settling time.It has been proven that the use of alum is more effective than lime for sedimentation suspended matter. The optimum dosage and settling time are 20 mg/l and 60 min respectively.

1. Introduction

Groundwater can be get it in the pores of sediments of rocks that formed through times that are very old or very recent for millions of years. The source of this water now is the seasonal rivers

* Corresponding author. : Mohammed Freeh Sahab ; : mohammed.sahab@uoanbar.edu.iq ; +9647904645446

or the permanent or rain or the water leaks and melting ice from the surface from the mountains.

The process of leakage depends on the type of soil of the earth surface that touches the surface water and when the soil is more disassembled while has large spaces and porous, therefore we will get the better leakage of water and thus the excellent storage of the groundwater for over time. Groundwater can be get by some ways: springs or feeding rivers, drilling of groundwater wells located in two different areas: the water-saturated zone, groundwater wells in the non-saturated zone. Also, ground water is an important source of water supply for agriculture, industry and municipalities where the properties of the porous media and subsurface geology govern both in direction and direction and rate of ground water flow in any aquifer system. The accidental spill of hazardous wastes or injection into pumping or aquifer of the aquifer for water supply may change the natural hydrologic flow patterns [1]. there are many studies concerned with the necessity of treating wastewater to reduce its impact on groundwater. Most wastewater undergoes some type of treatment and depends on the characteristics of the contaminated water [2]. The production of large quantities of wastewater has led to increased research to develop and improve treatment to remove pollutants [3]. Wastewater requires after treatment process to remove color and other organic pollutants before to discharge into nearest watercourse [4]. The Traditional method for treatment wastewater includes chemical precipitation, chemical oxidation, filtration, ion exchange and the application of membrane technology [5-6]. However, there are problems to these processes including the incomplete removal of materials, we also need expensive equipment and the generation of toxic sludge or other waste products [7].

The appropriate choice of treatment technology depend on the recovered water quality, natural organic materials size and the chemical composition of wastewater. normally, the coagulation process is used for the removal TSS along with undesired or toxic matter [4].The coagulation process is simple, effective, and has low energy consumption [8-9]. It is a well-known and beneficial for protecting the environmental and human health [10]. Aluminum and Iron are major coagulants for wastewater treatment, but they have disadvantage associated with their use include accumulation of sludge and heavy metals that are toxic and harmful to the ecosystem [9-11]. The problems mentioned above lead to high cost of the treatment system in addition to other technical disadvantages [12]. In the past decades, the use of coagulation and flocculation procedures was essential to reduce the organic load before starting post-treatment [13]. Coagulation is mechanism including the addition of coagulants responsible for the destabilization and neutralization of suspended particles they are shaped like large mass or aggregate [14-15]. These aggregate are removed by sedimentation, filtration [7].This study included adding natural coagulants such as Alum and Lime for the purpose of sedimentation of suspended matter, reducing turbidity and the rest of the harmful pollutants.

2- Methods and Materials

There are three main categories within which wastewater are treated:

- Physical treatment process:

It mainly depends on the physical properties of the impurities present in the pollutant, such as: specific gravity, viscosity, particle size, etc. Applied examples of this type of treatment process are screening, sedimentation, filtration and gas transport.

- Chemical treatment process:

It is based on chemical compositions of impurities or using chemical compositions of added reagents. The most important examples of a chemical treatment process are coagulation, sedimentation, and ion exchange.

- Biological treatment process:

It uses biochemical reactions to work on withdrawing dissolved or colloidal impurities from wastewater, an important process, and aerobic biological processes include biological filtration and activated sludge. There are important processes that are used as a method of biological treatment, which is anaerobic oxidation to stabilize organic sludge, or high-strength organic wastes may be used [16].

The method that was used to treat wastewaters is the physical method which includes adding coagulants such as alum and lime for the purpose of sedimentation of suspended materials and reduction of other pollutants through sedimentation, filtration and aeration processes. Samples of raw water (taken from the pond) were tested and confirmed presence of high pollution according to Iraqi standard no.25 of 1967. Used the jar test device to reduce turbidity and sedimentation of suspended materials by using alum and lime in different doses to obtain the optimal dose for treatment and compered alum to lime for obtaining the best coagulant for treatment and then the filtration and aeration stage.

2.1- Materials

1- Coagulants : Alum $Al_2 (SO_4)3.18H_2O$ Aluminum Sulfates.
2- Coagulant Aids : Lime.

2.2- Experimental Work

In the water quality control laboratory, Some of the devices shown in (Table 1) were used to test the raw water sample.

Table 1. Laboratory experiments on samples used a set of devices

Number	Device
1	COD Reactor
2	COD Check
3	Sensitive Balance 0.0001 gm
4	High Temperature Convection Oven With 30 Segments Programmable Temperature Controller (400 0C Max,14x18x18") 71 Liter
5	pH- meter
6	Turbidity Meter
7	Jar Tester ,Six-Paddle stirrer
8	Hotplate Stirrer T 450 0C
9	A bowl for sampling, Glove, Masks and Bottles for examination forms

3 – Case study

The University is surrounded by various activities that include the following:

1- The southern side: A residential complex under construction.
2- Southwest: Anbar oil depot.
3- The western side : A proposed residential complex.
4- Eastern Region: Residential neighborhood (Tas.).
5- The case study is about (50 meters) from the outer fence of the Female Students' Section.
6- The case study is about (50 meters) from the pumping station of raw water.
7- The case study is about (120 meters) from the housing complex for staff .
8- The northern side: includes the railway line (Al - Qaim - Baghdad), which separates the university and various government facilities (stores Directorate of sewage Anbar, stores of the Directorate of Electricity and stores Directorate of Commerce), in addition to the industrial zone and Block Laboratories. The attached picture shows the location of the pond inside Al Anbar University from the north-west side near the Female Students' Compound, which is about 4,500 square meters.

Figure 1. Areal Picture of Site Area

Figure 2. Areal picture of Site Area

Figure 3. Take a sample

4 – Results and Disscusion

Through the chemical and physical results of the raw water sample,It was found that the pond water is polluted and that the cause of the pollution is domestic waste water coming from the female students compound.

Table 2. Chemical test (Before Treatment)

seq.	Name of Item	Unit	Oxidation ponds	Iraqi standard (mg/l)
1	Ba	Mg/l	1	0.7
2	B	Mg/l	0.1	....
3	As	Mg/l	ND	0.01
4	Cu	Mg/l	ND	1
5	CN^{-1}	Mg/l	0.002	0.02
6	F^{-1}	Mg/l	ND	1
7	Fe	Mg/l	ND	0.3
8	Fe^{+3}	Mg/l	0.03	....

9	Fe^{+2}	Mg/l	0.02	....
10	Pb^{+2}	Mg/l	2	0.01
11	Mn	Mg/l	ND	0.1
12	Hg	Mg/l	0.1	0.01
13	NH_3	Mg/l	0.01	....
14	NO^{-3}	Mg/l	0.5	50
15	NO_2	Mg/l	4	3
16	Ni	Mg/l	2.8	0.02
17	Po_4	Mg/l	1.59	0.3
18	Phenols	Mg/l	0.004	0.05
19	Ag	Mg/l	ND	....
20	Zn	Mg/l	1.648	0.05
21	Cr	Mg/l	ND	0.05
22	Cd	Mg/l	ND	0.003

Table 3. Physical Tests (Before Treatment)

seq.	Name of Item	Unit	Oxidation ponds	Iraqi standard (mg/l)
1	PH	-	7.94	(6-9.5)
2	T.S.S	Mg/l	120	60
3	T.D.S	Mg/l	422	1500
4	DO	Mg/l	4.3	0
5	COD	Mg/l	69	100
6	BOD_5	Mg/l	65	40
7	E.C	ms/cm	2.1	---
8	Turbidity	NTU	86.7	5

(Table 2) shows the chemical tests for the water sample taken from the aeration pond, From the results there are high values when compared with Iraqi stenderd. The values of (pb,Ba,No_2,Ni,Po_4,Zn) (2,1,4,2.8,1.59,1.648) respectively are slighty higher than the standard, and this lead to pollution of the pond water due to domestic water from female students compound.Therafore,this water must be treated before it reaches the groundwater.

(Table 3) shows the physical tests for the water sample taken from the aeration pond,The value of BOD_5 and DO are (65mg/l and 4.3mg/l) respectively higher than the Iraqi standard,and this is an indicator of pond water pollution by domestic wastewater. The value of TSS and turbidity are (120 mg/l and 86.7) respectively higher than the Iraqi standard,therefore,initially the jar test experiment was used and try materials(Alum and Lime) to sedimentation the pollutants.

Table 4. The results of jar test experiment with Alum

Beaker No.	Alum Dose (Mg/L)	Initial Turbidity (NTU)	Residual Turbidity after 30 min.	Removal efficiency (30 min) %	Residual Turbidity after 45 min	Removal efficiency (45 min) %	Residual Turbidity after 60 min	Removal efficiency (60 min) %
control	0	86.7	48.9	43.5	30.6	64.7	43.5	49.8
2	5	86.7	48.5	44.0	24. 6	71.6	42.4	51.0
3	10	86.7	42.7	50.7	27.4	73.3	41.7	51.9
4	15	86.7	24.7	71.4	18.7	78.4	30.9	64.3
5	20	86.7	20.6	76.2	30.1	81.2	9.6	88.9
6	25	86.7	27.6	68.1	25.9	70.1	16.4	81.0
7	30	86.7	24.4	71.8	22.5	74.0	18.1	79.1
8	35	86.7	14.3	83.5	20.3	76.5	16.7	80.7

Table 5. The results of jar test experiment with Lime

Beaker No.	Lime Dose (Mg/L)	Initial Turbidity (NTU)	Residual Turbidity after 30 min.	Removal efficiency (30 min) %	Residual Turbidity after 45 min	Removal efficiency (45 min) %	Residual Turbidity after 60 min	Removal efficiency (60 min) %
control	0	86.7	54.6	37.02	50.5	41.7	49.8	42.5
2	5	86.7	52.0	40.1	48.8	43.6	48.4	44.1
3	10	86.7	50.8	41.3	46.1	46.7	46.1	47.8
4	15	86.7	39.9	53.9	39.1	54.8	37.4	56.8
5	20	86.7	33.2	61.6	31.7	63.4	28.1	67.5
6	25	86.7	35.4	59.1	34.5	60.1	32.6	62.3
7	30	86.7	34.3	60.4	34.1	60.6	32.3	62.7
8	35	86.7	34.6	60.0	32.5	62.5	31.2	63.9

From (Table 4 and 5), a comparison was made between alum and lime coagulants , and it was found that alum is more effective than lime for sedimentation suspended matter and reducing pollutants. The sample treated with alum was selected to complete the rest of the processing stage which include filtration and aeration.

Table 6. Chemical test (After Treatment)

seq.	Name of Item	Unit	Oxidation ponds	Flocc.	Filtr.	Aeration	Iraqi standard (mg/l)
1	Ba	Mg/l	1	0.85	0.79	0.71	0.7
2	B	Mg/l	0.1	ND	ND	ND	....
3	As	Mg/l	ND	ND	ND	ND	0.01
4	Cu	Mg/l	ND	ND	ND	ND	1
5	CN^{-1}	Mg/l	0.002	ND	ND	ND	0.02
6	F^{-1}	Mg/l	ND	ND	ND	ND	1
7	Fe	Mg/l	ND	ND	ND	ND	0.3
8	Fe^{+3}	Mg/l	0.03	ND	ND	ND	....
9	Fe^{+2}	Mg/l	0.02	ND	ND	ND	....
10	Pb^{+2}	Mg/l	2	0.61	0.24	ND	0.01
11	Mn	Mg/l	ND	ND	ND	ND	0.1
12	Hg	Mg/l	0.1	0.05	0.02	ND	0.01
13	NH_3	Mg/l	0.01	ND	ND	ND	....
14	NO^{-3}	Mg/l	0.54	0.5	0.3	0.28	50
15	NO_2	Mg/l	4	2.44	1.54	1.01	3
16	Ni	Mg/l	2.8	1.67	0.845	0.012	0.02
17	Po_4	Mg/l	1.59	0.88	0.72	0.52	0.3
18	Phenols	Mg/l	0.004	ND	ND	ND	0.05
19	Ag	Mg/l	ND	ND	ND	ND	....
20	Zn	Mg/l	1.648	1.321	0.056	ND	0.05
21	Cr	Mg/l	ND	ND	ND	ND	0.05
22	Cd	Mg/l	ND	ND	ND	ND	0.003

Table 7. Physical Tests (Aftere Treatment)

seq	Name of Item	Unit	Oxid.	Flocc.	Filtr.	Aeration	Iraqi standard (mg/l)
1	PH	-	7.94	7.81	7.65	7.55	(6-9.5)
2	T.S.S	Mg/l	120	67	55	23	60
3	T.D.S	Mg/l	422	4.8	412	400	1500
4	DO	Mg/l	4.3	3.61	1.78	0.55	0
5	COD	Mg/l	69	48.15	37.29	22.25	100
6	BOD_5	Mg/l	65	53	34	30	40
7	E.C	ms/cm	2.1	1.83	1.57	1.31	------
8	Tur.	NTU	86.7	16.7	8.4	4.5	5

(Table 6 and 7), show the chemical and physical results of the water sample after treatment, Which include (Flocculation, Filtration and aeration).The values of (pb,Ba,No_2,Ni,Po_4,Zn) became within the Iraqi standard. The values of BOD5,DO,TSS (30,0.55,23) respectively these are values within the Iraqi standard and this indicates that the pollution decreased after treatment.

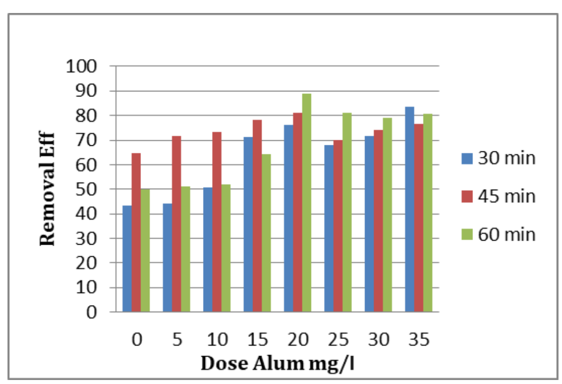

Figure 4. Alume dose and removal EFF.

(Fig. 4) the relationship between Alum added doses and removal efficiency, Increasing the added dose increases the removal efficiency. The optimum dose and settling time 20mg/l and 60 min ,respectively.

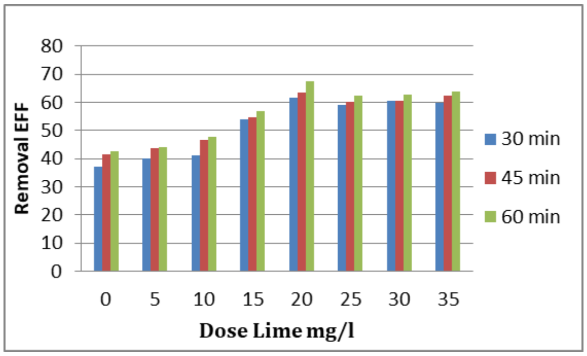

Figure 5. Lime dose and removal EFF.

(Fig. 5) shows the relationship between Lime added doses and removal efficiency, Increasing the added dose increases the removal efficiency. The optimum dose and settling time 20mg/l and 60 min respectively.

5 – Conclusion

In this research, tow coagulants were used (Alum and Lime) with different doses (5-10-15-20-25-30-35)mg/l to reduce the high turbidity and sedimentation of total suspended solid (TSS) and reduce the rest of the pollutants. From the result, Increased the dose of coagulants to 35mg/l increased the removal efficiency. Increasing the settling time to 60 min increased the removal efficiency . The optimum coagulants dose and settling time are 20 mg/l and 60 min, respectively. Alum is better than lime for sedimentation of suspended matter. After treatment , The chemical pollutants decreased and became within the specifications.

6 - Recommendation

improving all characteristics and conducting additional studies to use local and inexpensive materials such as eggshells to treatment wastewater and use treat water to irrigate fruitless trees.

Acknowledgements

The author is thankful to the Department of Dams and Water Resources Engineering / Universtiy of Anbar, for their support.

References

[1] Rachael E. M., Jana L., Edward A. M. and Beth P. ,Wastewater impacts on groundwater at a fractured sedimentary bedrock site in Ontario, Canada: implications for First Nations' source-water protetion *Hydrogeology Journal* 27.8, 2019: 2739-2753.

[2] Ifeanyi, U., Chukwudi, M.M.and Okechukwu, O.D., Effect of coag-flocculation kinetics on telfairia occidentalis seed coagulant (TOC) in pharmaceutical wastewater. *Int. J. Multidiscip. Sci. Eng.* 2012; (3): 22 – 33.

[3] Ahmed, S.N., Ali, S.J. and Ali, A.H., Improvement of organic matter removal in water produced of oilfields using low cost Moringa peels as a new green environmental adsorbent. *Global Nest* 2020; (22): 268 – 274.

[4] Hossain, S., Omar, F. and Asis, A.J, Effective treatment of palm oil mill effluent using FeSO4.7H2O waste from titanium oxide industry: Coagulation adsorption isotherm and kinetics studies. J. Clean. Prod. 2019; (219): 86 – 98.

[5] Vasudevan, S., Lakshmi, J. and Sozhan, G., Studies relating to removal of arsenate by electrochemical coagulation: Opti-mization, kinetics, coagulant characterization. *Sep. Sci. Technol*. 2010; (45): 1313 – 1325.

[6] Sher, F., Malik, A., Liu, H., Industrial polymer effluent treatment by chemical coagulation and flocculation. *J. Environ. Chem. Eng.* 2013; (1): 684b – 689.

[7] Tetteh, E.K., Rathilal, S., Application of magnetized nanomaterial for textile effluent remediation using response surface methodology. *Mater. Today Proc*. 2020.

[8] Zhao, S., Gao, B., Yue, Q. and Wang, Y., Effect of Enteromorpha polysaccharides on coagulation performance and kinetics for dye removal. *Colloids Surf. A Physicochem. Eng. Asp.* 2014; (456) 253 – 260.

[9] Zahrim, A., Dexter, Z., Joseph, C. and Hilal, N., Effective coagulation-flocculation treatment of highly polluted palm oil mill biogas plant wastewater using dual coagulants: Decolourisation, kinetics and phytotoxicity studies. *J. Water Process. Eng.* 2017; (16): 258 – 269.

[10] Nnaji, N., Ani, J., Aneke, L., Onukwuli, O., Okoro, U. and Ume, J., Modelling the coag-flocculation kinetics of cashew nut testa tannins in an industrial effluent. *J. Ind. Eng. Chem.* 2014; (20): 1930 – 1935.

[11] Kumar, P.S., Karthikeyan, R., Anbalagan, K. and Bhanushali, M.N., Coagulation process for tannery industry effluent treatment using Moringa oleifera seeds protein: Kinetic study, pH effect on floc characteristics and design of a thickener unit. *Sep. Sci. Technol.* 2016; (51): 2028 – 2037.

[12] Holkar, C.R., Jadhav, A.J., Pinjari, V., Mahamuni, N.M. and Pandit, A.B., A critical review on textile wastewater treat-ments: Possible approaches*. J. Environ. Manag*. 2016; (182): 351 –366.

[13] Saifuddin, N. and Dinara, S., Pretreatment of Palm Oil Mill Effluent (POME) Using Magnetic Chitosan. *E-J. Chem*. 2011; (8): S67 – S78.

[14] Balls, M., Relationships between Floc Properties and NOM Removal Using a Moorland Water Source," *University College London, University College London,* 2014.

[15] Sánchez-Martín, J., Beltrán-Heredia, J. and Peres, J.A., Improvement of the flocculation process in water treatment by using moringa oleifera seeds extract. Braz. J. Chem. Eng. 2012; (29):495–502.

[16] Tebbutt, T. H. Y., Principles of water quality control. *ButterWorth-Heinemann*, Oxford, England : Boston, 2013; (5): 235-341.