Wasit Journal of Engineering Sciences

Journal homepage: https://ejuow.uowasit.edu.iq

An assessment of physical-chemical and biological properties of industrial wastewater in Al-Kut textile factory

Hamza M H Al-Hachami [1], Hatem A Gzar [1]

Affiliations
[1] Department of Civil Engineering, Wasit University, Wasit, Iraq

Correspondence
Hamza M H Al-Hachami
Department of Civil Engineering, Wasit University, Wasit, Iraq
Hamzahh301@uowasit.edu.iq

Received
20-04-2022
Revised
23-06-2022
Accepted
20-7-2022
Doi: 10.31185/ejuow.Vol10.Iss3.316

Abstract

Most developing countries that bypass rivers are concerned about water pollutants. Water quality within the permissible limits for agricultural, industrial, and drinking reasons is a difficult problem to solve. On the basis of their importance, ten physical and chemical parameters were chosen for this investigation from Al Kut textile factory. For four years, physical-chemical parameters measurements of water samples have been researched for ten parameters are total dissolved solids TDS, total suspended solids TSS, Turbidity, Electrical conductivity EC, sulfate SO_4, Chloride, Phosphate, chemical oxygen demand COD, dissolved oxygen DO and biological oxygen demand BOD_5. The findings of the water quality examination were compared to the World Health Organization's maximum permitted limit concentration and Iraqi limitations spastically. Moreover, the water quality parameters were gradually decreased according to the findings. Results shows the annual variation of Al-Kut textile factory TSS concentration with decreasing rate of (71%), Turbidity concentration with decreasing rate of (11.44%), Chloride and Phosphate concentrations within its decreasing rate of 50 % and 70.23 % respectively during the study period of the last four years. While the average BOD_5 values decrease in concentration and the annual variation of Al-Kut textile factory DO concentration within its decreasing rate of (51%) during the study period of the four years.

Keywords: Al-Kut textile factory, Textile wastewater, Biological, chemical and physical properties.

الخلاصة: تشعر معظم الدول النامية التي تمر أنهار خلال أراضيها بالقلق بشأن ملوثات المياه. وعلى وجه الخصوص المشاكل التي يصعب حلها بالنسبة للحدود المسموح بها لنوعية المياه الصالحة للزراعة والصناعة والشرب بناءً على أهميتها للدول، ولهذا تم اختيار عشرة متغيرات فيزيائية وكيميائية لهذه الدراسة من مصنع نسيج وحياكة الكوت. خلال فحوصات اجريت على مدى أربعة سنوات فُحص خلالها عشرة متغيرات فيزيائية وكيميائية كالآتي : إجمالي المواد الصلبة الذائبة ، إجمالي المواد الصلبة العالقة TSS ، العكارة ، التوصيل الكهربائي ، كبريتات SO_4 ، كلوريد الفوسفات ، الطلب الأوكسجين الكيميائي COD ، الأكسجين المذاب DO و طلب الأكسجين البيولوجي BOD_5. بعدها تم مقارنة نتائج الفحوصات مع الحدود المسموحة بها من منظمة الصحة العالمية للتركيز والمواصفة العراقية فلوحظ انخفاض المستويات تدريجياً وفقاً للنتائج. أظهرت نتائج التباين السنوي لتركيز مصنع نسيج الكوت الكلي يتناقص بنسبة (٧١٪) وتركيز العكرة يتناقص بنسبة (١١,٤٤٪) وتركيزات الكلوريد والفوسفات ضمن نسب تناقص ٥٠٪ و ٧٠,٢٣٪ على التوالي خلال فترة الدراسة. من السنوات الأربعة بينما ينخفض متوسط قيم BOD_5 في التركيز يتناقص معدل الأوكسجين المذاب DO بمعدل (٥١٪) خلال فترة الدراسة.

1. INTRODUCTION

The most abundant natural resource on the planet is water. It is an essential component in practically all human activities such as municipal usage, irrigation, and drinking, also the usage fulfils industry demands, growing food, power generation, and recreational activities [1]. Nonetheless, water quality has worsened significantly in many big rivers throughout the world as a result of anthropogenic activities in the last two to three decades [2].

The discharge of untreated wastewater into aquatic habitats is linked to a slew of deadly illnesses. This issue is spreading around the world, particularly in poorer nations, owing to poor wastewater management. The most significant physical variables in wastewater treatment are temperature and solid concentration. However, alkalinity, biochemical demand (BOD), chemical oxygen demand (COD), dissolved gases, nitrogen compounds, pH, and phosphorus are the most important chemical properties. BOD is a measure of the amount of organic material in a body of water. The quantity of dissolved oxygen necessary for the biological breakdown of organic molecules and the oxidation of some inorganic elements such as iron and sulfites is referred to as BOD [3].

More than 20% of the world's population lacks access to safe potable water, and almost half lacks adequate access to clean water. This problem is especially significant in many developing nations, where an estimated 95 percent of untreated urban garbage is released straight into rivers. Iraq is one of nine Middle Eastern nations that lack adequate water sources [4]. Water contamination is a big worldwide issue. Continuous monitoring of water quality is required to determine the level of contamination in the river. Water contamination in lakes and rivers is becoming increasingly popular in many regions of the world [5].

An evaluation of biological, chemical, and physical water contamination is required for freshwater pollution reduction. The Tigris River is one of Iraq's greatest rivers and a key supply of potable water for Al Kut, Wasit Province [7]. Al-Kut's textile factory wastewater treatment plants are underutilized, particularly on the city's southern outskirts. As a result, a substantial volume of wastewater is released straight into the river or streams that run into the river. It hurts the environment and public health, in addition to the concerns associated with the dumping of domestic garbage on both banks of the river within the city [8].

Abu Bakar, et al., 2019 determine the concentration of the physico-chemical water quality parameters in textile wastewater taken from a textile factory at Sri Sulong, Batu Pahat, Johor of Malaysia using the parameters including temperature, pH, electrical conductivity (EC), turbidity, dissolved oxygen (DO), chemical oxygen demand (COD), biochemical oxygen demand (BOD), total suspended solids (TSS), colour, alkalinity, total dissolved solids (TDS), and heavy metals (cadmium, copper, manganese, lead, and zinc). The results indicated some of the parameters for final discharge textile wastewater could not be safely discharged such as COD, BOD, colour, TSS, cadmium, and zinc also showed that Textile wastewater is classified by pollution severity as strong wastewater.

The current study intends to evaluate the water quality specifications in the Tigris River inside Al Kut city. Displaying and comparing water quality data and associated information, as well as the spread of river contaminants with the increasing and decreasing rates.

2. MATERIALS AND METHODS

2.1 Description of the study area

AL-Kut textile factory is one of the largest factories in Wasit governorate located in the center of Kut city and occupies an area of about (386760) m^2 (GR6F+898,kut) as shown in Figure 1. It has high production capacity that benefits the country's economy and it is important for human consumption.

This factory went through many stages and changes and the characteristics of the factory effluents vary and depend on the type of textile manufactured and the chemicals used. The textile effluents contain trace metals like Cr, Cd, Cu, Fe and Zn, which are capable of harming the environment.

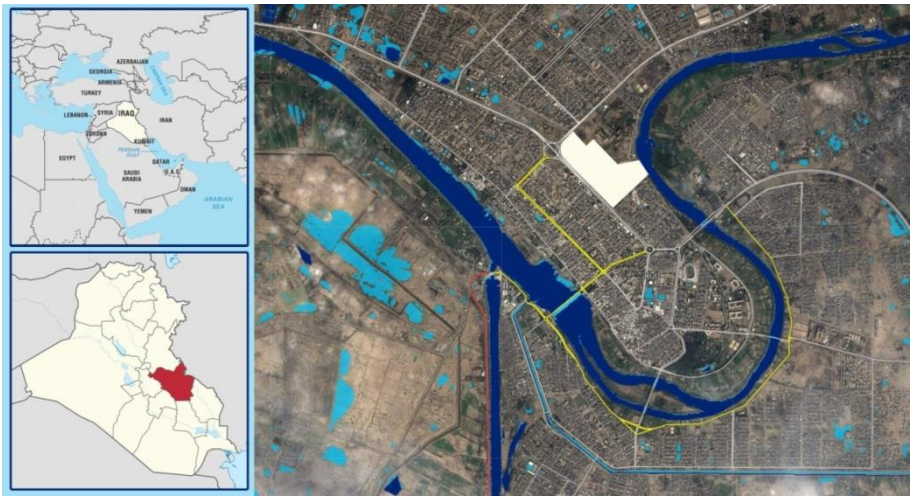

Figure 1 Al-Kut textile factory location on Tigris River. Scale 1:200000 for Print A1.

2.2 Data collection

In this study, data were collected from laboratory experiments for the previous four years, physical-chemical parameters measurements of water samples and it has been researched for ten parameters are total dissolved solids TDS, TSS, Tur., Electrical conductivity, sulfate SO_4, Chloride, COD, DO and biological oxygen demand BOD_5 of Al-Kut textile and Knitting Factory. Data were taken for the wastewater discharged from the factory and Table1 show sample of them in addition to the sample collection from the river as shown in Figure 2. Excel 2021 software were used for data analysis.

Tabl 1 Sample of data

No.	Parameter	Unit	2018					
			January		February		April	
			Before	After	Before	After	Before	After
1	Flowrate	m^3	29880	30220	30471	30878	31890	31488
2	BOD_5	mg\l	95	22	106	22	126	22
3	COD	mg\l	220	90	200	92	290	75
4	PH	----	8.6	8.4	8.9	8.5	8.2	8.2
5	Temp.	mg\l	23	21	22	20	29	25
6	Suspended Solids	mg\l	120	26	130	22	95	22
7	Electrical Conductivity	uS/cm	143 0	132 0	1500	1400	1700	1500
8	Turbidity	mg\l	55	11	75	11	65	10
9	CL (free chlorine)	mg\l	0.06	0.03	0.06	0.03	0.07	0.03
10	SO_4 (sulphate)	mg\l	388	380	380	376	410	390
11	PO4-P (Phosphate)	mg\l	0.45	0.18	0.75	0.18	0.54	0.18
12	Cr (Chrom.)	mg\l	0.06	0.05	0.06	0.05	0.07	0.05
13	Fe (Ferric)	mg\l	0.2	0.12	0.26	0.18	0.22	0.14
14	Cu (Copper)	mg\l	0.02	0.01	0.03	0.01	0.03	0.01
15	Pb (Lead)	mg\l	0.04	0.02	0.04	0.02	0.05	0.02
16	Cd (Cadmium)	mg\l	0.042	0.032	0.042	0.032	0.032	0.032
17	Zn (Zinc)	mg\l	0.46	0.32	0.46	0.32	0.46	0.26
18	N (Niterate)	mg\l	1.6	0.7	1.6	0.8	1.6	0.8
19	CaCO3	mg\l	190	180	200	190	205	190

Figure 2 Sample collection methed

3. RESULTS AND DISCUSSIONS

3.1 Physical properties

The total dissolved solids TDS is the sum of all the solids dissolved in a water sample, and the concentration of TDS is the most critical pollutant in the current research because of its role in the color appearance of the samples. In the present study, the annual variation of TDS values in Al-Kut city ranged from the lowest mean value of 552 mg/l for the year 2021 to the highest mean concentration of 943 mg/l at 2013, With a TDS content of 780.5 mg/l on average TDS levels above the regulatory limit of 500 mg/L. As a result, these water samples are classified as brackish (containing more than 1000 mg/l). These values can originate from suspended matter like dirt and fat, as well as animal waste from slaughterhouses (hair, fat, meat, and tripe). The findings were somewhat lower than those reported by [7,8]. TDS levels are highly correlated with discharge. On the other hand, when the river's water level drops, the concentration rises, resulting an increase in mud and turbidity in the river at the outlet.

In general, the the annual variation of all parmeters is shown in Table 2. The T.S.S TDS concentrations are in the narrow range and slightly alkaline, in accordance with WHO and Iraqi guidelines, The annual variation with decreasing rate of (54.3%) during the study period of the last four years as shown in Figure 3.

Table 2 The the annual variation of all parmeters with the max permessible level

Parameter	Maximum Permissible level	2013	2018	2019	2021
BOD_5	20	35	25	22	16
COD	30	86	63	62	50
CaCO3 (Totalalkalininty)	200	194	191.6667	190	146
Do	---	4.783333	3.15	2.6	2.341667
Suspended Solids	30	38	23.5	15.75	11
Electrical Conductivity	---	1561	1464	1249	1168
Turbidity	10	11.29167	10.83333	10.375	10
CL (free chlorine)	Trace	0.068	0.043	0.035	0.034
SO_4 (sulphate)	400	388	325	235.0833	216
PO4-P (Phosphate)	3	0.84	0.48	0.33	0.25
T.D.S.	110	943	888	740	552

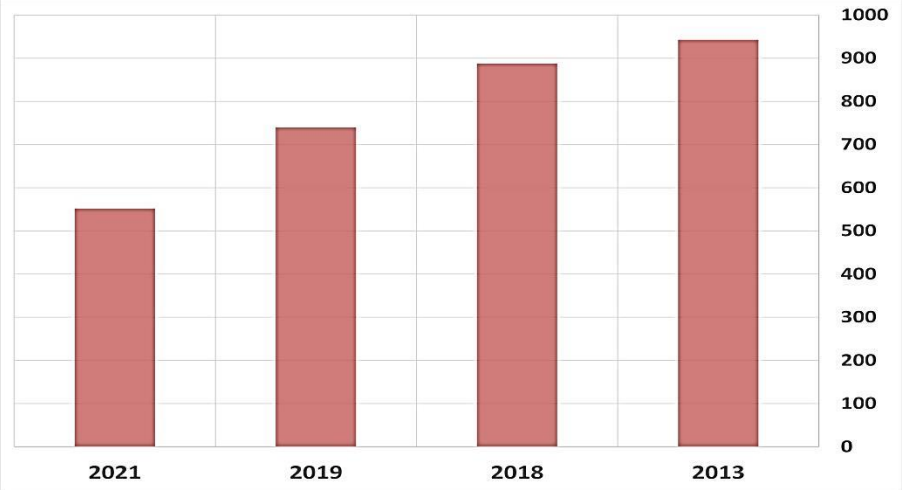

Figure 3 Annual variation of TDS during (2013-2021).

The annual variation of Al-Kut textile factory TSS concentration within its low and high ranges (11 – 38 mg/L) and an average of (22) mg/L with decreasing rate of (71%) While the annual variation of Al-Kut textile factory Turbidity concentration within its low and high ranges (10 -11.29 mg/L) and an average of (10.6) mg/L with decreasing rate of (11.44%) during the study period of the last four years as shown in Figure 4.

The comparison between yearly performances of Al-Kut textile factory wastewater for the physical parameter (i.e. TDS, TSS, turbidity) is shown above. The annual variations of the other parameters of electrical conductivity during the last four years (2013-2021) are shown in Figures 5 within its low and high ranges (1168 –1561) and an average of (1360.5) with decreasing rate of (25.2 %). The concentrations of TDS dropped over time as a result of advancements made in filter production, filter manufacturing methods, and the usage of filters in the Wasit textile and knitting business.

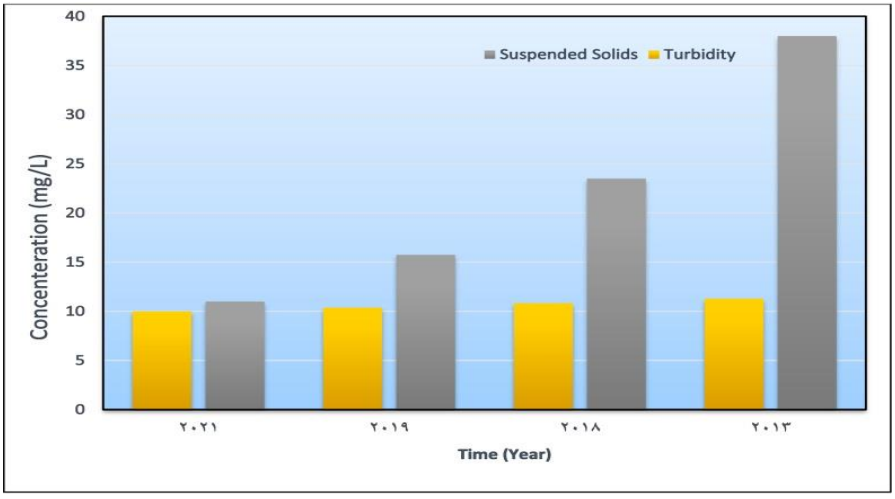

Figure 4 Annual variation of TSS and Turbidity during (2013-2021).

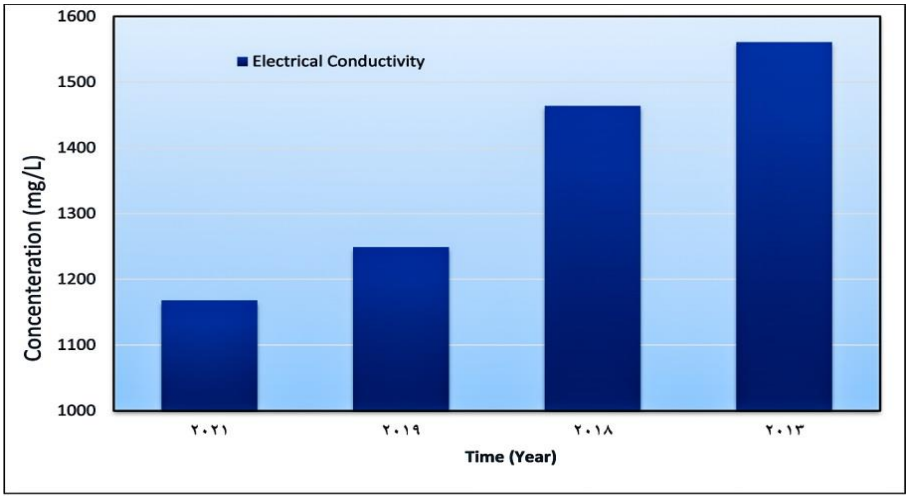

Figure 5 Annual variation of Electrical conductivity during (2013-2021).

3.2 Chemical properties

Industrial Wastewater contains different chemicals in various forms for example sulphates SO_4 is a soluble mineral in soil that may be transported to surface waters by discharge. SO_4 sulphate is present on water surfaces and is widely diffused in the environment. The primary sulphate source is rocks near a body of water and the metabolic impact of anaerobic bacteria. The average concentration of sulfate in the waste water after the treatment process was 291 mg /L with the highest concentration of sulfate is 388 mg/L and the lowest concentration of 216 mg /L as shown in Figure 6. The efficiency of the plant in reducing the sulfate was 44.33 % due to the lack of its own treatment unit. As for this simple reduction in concentrations Sulfate after treatment may be due to sedimentation processes and oxidation of some of it in the aeration ponds by the action of Consumption by aerobic bacteria.

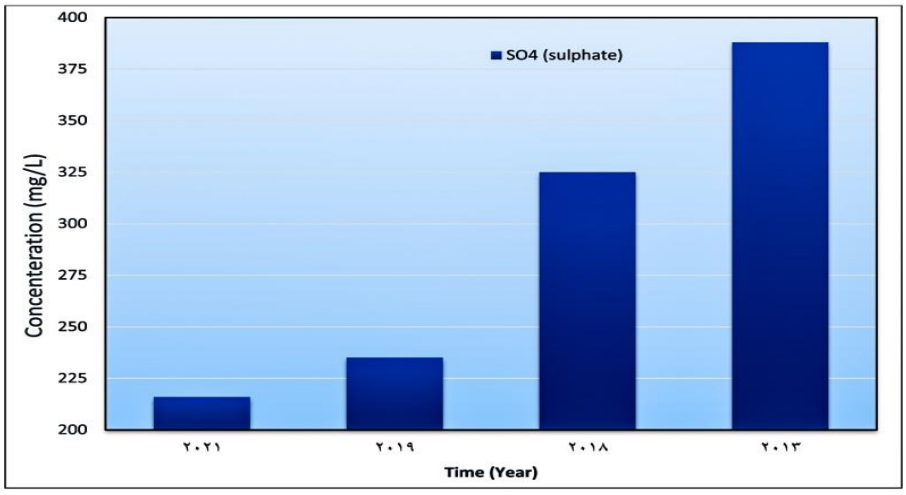

Figure 6 Annual variation of sulfate during (2013-2021).

All SO_4 values in the study region exceeded the WHO and Iraq criteria of 250 and 200 mg/l, respectively.

Another chemical characteristic of wastewater which plays a critical role in the wastewater treatment process are Chloride and Phosphate. The result of Figure 7 showed the annual variation of Al-Kut textile factory Chloride and Phosphate concentrations within its decreasing rate of 50 % and 70.23 % respectively during the study period of the last four years. The annual variation of Al-Kut textile factory CL concentration within its low and high ranges (0.034 – 0.068 mg/L) and an average of (0.045) mg/L, While the annual variation of Al-Kut textile factory Phosphate concentration within its low and high ranges (0.25 -0.84 mg/L) and an average of (0.475) mg/L.

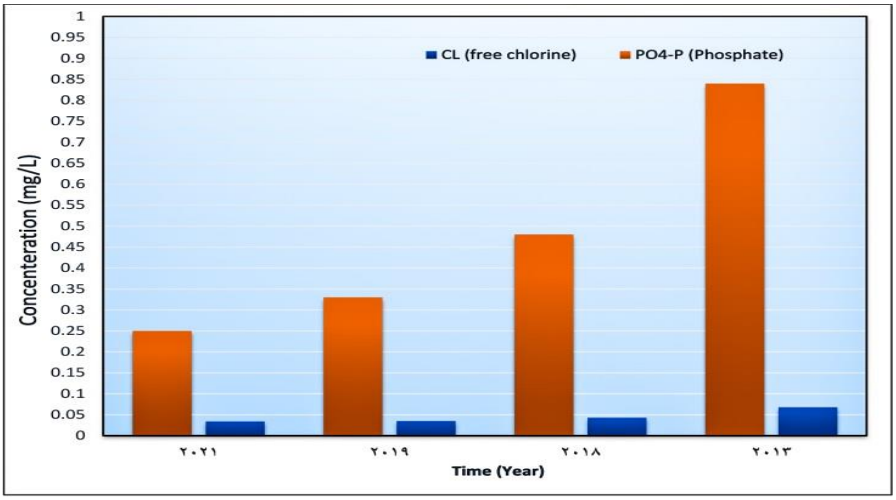

Figure 7 Annual variation of Chloride and Phosphate during (2013-2021).

The research results showed that the physical and chemical concentration in the wastewater of the AL-Kut textile factory was decreasing over time. This was attributed to the factory's numerous shutdowns since 2013 due to a lack of demand for its products, as the majority of its work was focused on producing beria for the army and the weakness of the product. It was also attributed to the materials used by various merchants and the change in dye, all of which had an impact on how much wastewater was produced.

3.3 Biological properties

Industrial wastewater usually has high biological due to presence of large number of organic matters and these properties like The Biological Oxygen Demand (BOD) of wastewater demonstrates the level of pollution and is a measure of organic material contamination. BOD is defined as the quantity of oxygen capable of oxidizing organic components in wastewater with the help of microorganisms under certain experimental circumstances. The average BOD_5 values of Al-Kut textile factory show a decrease in concentration from 2013 to 2021 with (minimum value of 16 mg/L) and (highest value of 35 mg/L) with an average value of 24.5 mg/L and decreasing rate of (54.3%), while the annual variation of Al-Kut textile factory COD concentration within its low and high ranges (50 – 86 mg/L) and an average of (65.25) mg/L with decreasing rate of (41.8%) during the study period of the last four years as shown in Figure 8.

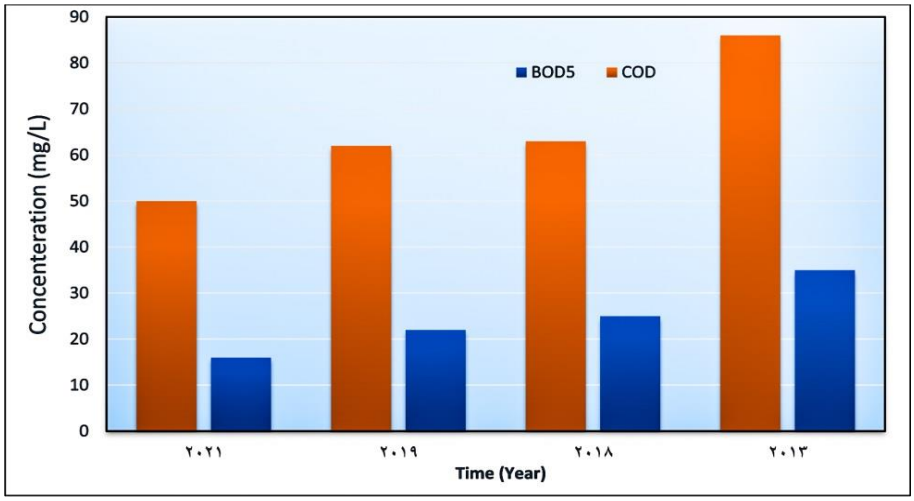

Figure 8 Annual variation of BOD_5 and COD during (2013-2021).

Finally, wastewater has relatively little dissolved oxygen due to the large concentration of microbial cells and biodegradable organic materials. As shown in Figure 9, the age and condition of the wastewater as well as the lower solubility of oxygen in it affect the annual variation of the DO concentration at the Al-Kut textile factory within its low and high ranges (2.3 - 4.8 mg/L) and an average of (3.2) mg/L and decreasing rate of (51%) during the study period of the last four years.

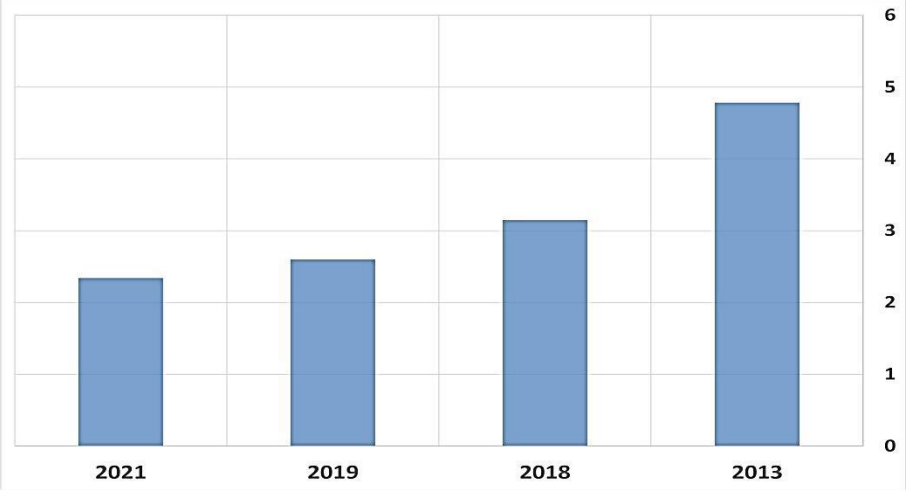

Figure 9 Annual variation of DO during (2013-2021).

In conclusion, the data suggest that the breakdown of organic chemicals that flow straight into the Tigris River may be the cause of a decrease in BOD5 content. The findings revealed that the average BOD5 concentrations over the entire site exceeded both the WHO's permitted limit and the value of Iraqi standard standards [5].

4. CONCLUSIONS

For the last four years, samples from selected locations in the study area were measured to assess ten physico-chemical concentration parameters in the selected sites. Total dissolved solids, total suspended solids TSS, turbidity, Electrical conductivity, sulfate SO_4, Chloride, COD, DO and biological oxygen demand BOD_5. The water quality parameter was gradually decreased for chosen stations along the Tigris River's water path in Al Kut city from upstream to downstream, according to the findings.

Results concluded, the annual variation of Al-Kut textile factory TSS concentration with decreasing rate of (71%), Turbidity concentration with decreasing rate of (11.44%), Chloride and Phosphate concentrations within its decreasing rate of 50 % and 70.23 % respectively during the study period of the last four years. While the average BOD_5 values decrease in concentration and the annual variation of Al-Kut textile factory DO concentration within its decreasing rate of (51%) during the study period of the last four years. According to the findings, the wastewater in Al-Kut city is significantly filthy, both by Iraqi and international standards. Pump stations are poorly maintained, and wastewater is practically never treated before being dumped into the river. As a result, there is a pressing need to clean these wastewaters before they are discharged into the environment. Filter manufacture, manufacturing techniques, and TDS concentrations have all improved over time as a result of their use in the Wasit textile and knitting business. Regarding this simple concentration decrease After treatment, sedimentation processes may produce sulfate, some of which may be eaten by aerobic microorganisms in aeration ponds. Wastewater's low dissolved oxygen level is also a result of the abundance of microbial cells and biodegradable organic substances in it.

ACKNOWLEDGEMENTS

The writers appreciate dr. Salah Al-Zubaidy for his support and assistance throughout this project. The staff of Al-Kut Textile Printing Dyeing and Finishing Industrial deserve special thanks for their help with the factory investigation and sample collecting.

REFERENCES

1. Mashaan, O. H., El-Mewafi, M., Awaadb, A., & Mossad, M. Evaluation of Wastewater in Drainage Network of Al-Kut City, Iraq by Using GIS Techniques.
2. Gzar, H. A., Al-Rekabi, W. S., & Shuhaieb, Z. K. (2021, August). Applicaion of Moving Bed Biofilm Reactor (MBBR) for Treatment of Industrial Wastewater: A mini Review. In *Journal of Physics: Conference Series* (Vol. 1973, No. 1, p. 012024). IOP Publishing.

3. Gzar, H. A. G. A., Jasim, N. A., & Kseer, K. M. (2020). Electrocoagulation and chemical coagulation for treatment of Al-Kut textile wastewater: A comparative study. *Periodicals of Engineering and Natural Sciences (PEN)*, ***8***(3), 1580-1590.
4. Zahraa, S. H., & Gzar, H. A. (2019, August). Evaluation of the performance of MBR-RO technology for treatment of textile wastewater and reuse. In *IOP Conference Series: Materials Science and Engineering* (Vol. 584, No. 1, p. 012049). IOP Publishing.
5. Ghalib, H. B. (2017). Groundwater chemistry evaluation for drinking and irrigation utilities in east Wasit province, Central Iraq. *Applied Water Science*, ***7***(7), 3447-3467.
6. Chabuk, A., Al-Madhlom, Q., Al-Maliki, A., Al-Ansari, N., Hussain, H. M., & Laue, J. (2020). Water quality assessment along Tigris River (Iraq) using water quality index (WQI) and GIS software. *Arabian Journal of Geosciences*, ***13***(14), 1-23.
7. WHO (World Health Organization) (2011). Guidelines for drinking water quality - 4th ed. Geneva: World Health Organization.
8. Khadim, H. J., & Oleiwi, H. O. (2021). Assessment of Water Quality in Tigris River of AL-Kut City, Iraq by Using GIS. *In E3S Web of Conferences* (Vol. 318, p. 04001). EDP Sciences.
9. Malakoutian, M., & Fatehizadeh, A. (2010). Color removal from water by coagulation/caustic soda and lime.
10. Berradi, M., Hsissou, R., Khudhair, M., Assouag, M., Cherkaoui, O., El Bachiri, A., & El Harfi, A. (2019). Textile finishing dyes and their impact on aquatic environs. *Heliyon*, ***5***(11), e02711.
11. Zahraa, S. H., Gzar, H. A., & Shaimaa, H. H. (2021, August). Evaluation of laboratory submerged membrane bioreactor and reverse osmosis system for treating textile wastewater and reuse. In *Journal of Physics: Conference Series* (Vol. 1973, No. 1, p. 012185). IOP Publishing.
12. Al-Maliky, E. A., & Gzar, H. A. (2021). Concrete Particles as Low-Cost Adsorbent for Fluoride Removal using Batch and Continued Systems. *Journal of The Institution of Engineers (India): Series C*, ***102***(6), 1419-1427.
13. Al-Maliky, E. A., Gzar, H. A., & Al-Azawy, M. G. (2021, September). Determination of Point of Zero Charge (PZC) of Concrete Particles Adsorbents. In *IOP Conference Series: Materials Science and Engineering* (Vol. 1184, No. 1, p. 012004). IOP Publishing.
14. Al-Ansari, N. (2019). Hydro geopolitics of the Tigris and Euphrates. In *Recent researches in earth and environmental sciences* (pp. 35-70). Springer, Cham.