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Evaluation of the Quality of Drinking Water- Kirkuk, Iraq

Maryam Hassan Ahmed Sulyman
Northern technical university, Technical College, Kirkuk, Iraq

Corresponding Author email: Sahasan86@yahoo.com

ABSTRACT

This study was conducted to evaluate the quality of drinking water in the city of Kirkuk for the period (2015-2016). The results of the analyzes showed that the values of the Electrical Conductivity (EC), PH, Total Dissolved Solids (TDS), and Total suspended solids (TSS) was within and accordance the Iraqi and the world health organization (WHO) drinking water standards. The results also showed that alkaline levels, Chloride (Cl^-), sulfate (SO_4) and Hardness are within the permissible limits. Furthermore, the study showed that the tolerances of the permissible parameters of the measured values of (Ca^{+2}), (Mg^{+2}) and nitrate (NO_3), and fluoride (F) for the Kiwan drinking water treatment plant, ranged (75.66.25.8%), while, the AL-Dabs plant (83,33,16%), respectively, and the fluoride values of the plant was within the permissible limits. The study also compares the efficiency of the turbidity removal. The efficiency rates ranged between (8 - 96)%, (5-94)% for both the Kiwan and the AL-Dabs drinking water treatment plants, respectively.

Keywords: Drinking Water Quality, Drinking Water Treatment Plant, Kirkuk

1. INTRODUCTION

Water is an essential element for all living organisms. Industrial, commercial, and other human activities, has affected the water quality and it exists. Many water resources were affected by this pollution. Innovations and human need made the treatment of these resources possible and easy. Water treatment plants now are very sophisticated and efficient. New technologies made it possible to treat all kind of pollutants. However, the design of the treatment plant will depend on the water quality, resource, usage and the flow. Drinking water is water that has no color, taste or odor, which contains the mineral elements in certain percentages, without the existence of these elements water will note consider safe.

Clean water should not contain radioactive elements and should be free of any disease-causing organisms. Drinking water should be clean and safe. Therefore, water quality should be tested in regular basis especially when the water resource is open and close to human activities. Different water resources in different countries would require more complex levels of conventional treatment. This would add additional costs to the production of potable water. Iraq is a reach country considering the diversity of the available water resources. However, the quality of surface water was always under threat. Many researches have addressed this issue. Hamed, 2015 conducted an investigation study for water quality for the city of Kirkuk. The study revealed that the water samples were free of bacterial contaminants and that the water of the Kirkuk network is the best in the country. Another study conducted by Saleh , 2010, has evaluated the water treatment plants at Kirkuk, the study also confirmed the high effecincy of the treatment. This also confirm in early study by Ramal, 2010. The study found that the concentration of most of the studied properties is within the Iraqi standard fro drinking water except the sulfate ion and the EC was higher Mohammed, 2010, has evaluated the performance of the water treatment project in Baghdad. The study included five factors: brownish, TDS, temperature, pH and chlorine values. The study concluded that the brownish values were within the

specifications. The values of TDS was relatively high. The current research intend to study the physical and chemical properties of the treated water in Kirkuk General Project (Kiwan) and Al-Dabs drinking water treatment plants, for the purpose of assessing the quality and extent of their conformity with the Iraqi and international determinants. Furthermore, to compare of the efficiency of removing the turbidity in both drinking water treatment plants.

2. MATERIALS AND METHODS

2.1. Description of the study area

2.1.1. Kiwan drinking water treatment plant (KI)

Kiwan drinking water treatment plant is located at the north of Kirkuk. The main water supply for the project is Zab channel, founded in 1986, and with a capacity of 15450 m^3/h. The treatment plant consist of the followings:

A. The low lift pumping station: it include eight pumps and each one of them work 2700 m^3 in one hour with a pressure reached to (40) m. This station is located on the Kirkuk liquefaction water channel, one km away from Kirkuk liquefaction water station project, it supply the water from the channel to the liquefaction.

B. Water treatment station. The water is collected in the treatment plant in 16 tanks with 42m widths and 9m depth. The station includes also 80 filters capacity of 5m^3. The chlorine is added in this stage. The filter is washed by 6 pumps. The station also includes two storages and the capacity of each (16000) m^3 for each, these tanks store the water after treatment.

C. The high pushing up station. This station include7 pumps with the pumping power of 2520 m^3/h and elevation 40-80m.

2.1.2. AL-Dibs drinking water treatment plant (DIBS).

AL-Dibs drinking water treatment plant is located at the Zab River. The plant consists of the followings: 1. Channel for water supply 2. Sedimentation tanks 3. Gravel Filters: 4. Ground reservoirs.

2.2. Laboratory work

Analyis was conducted in the laboratories of the Technical College and according to the standard methods of water anlysis (APHA-AWWA-WPCF,1976). The results were compared to different characteristics with Iraqi (Iraqi Standard,1986) and with WHO standards (WHO, 1971). For measuring the PH a device type (Pw4 / 8pm) and to measure the EC a device type (LF) 530WTW was used. Satnderd anlytical chemistry method and EDTA were used to measure the calcium, cloride and magnesium. Flam Photometer is used to measure the Sodium and the sulphates using ultravioliate visible light. For the turbidity we used (Orbeco - Hellige Turbidity meter).Finally, we used photometer to measure nitrates and fluoride

3. RESULTS AND DISCUSSION

3.1. Discuss the physical properties

3.1.1. Temperature

The temperature was measured and it was within the average of 20.4 C˚ at the Kiwan treatment plant and 18.4 C˚ at the AL-Dibs treatment plant, please see Fig. 1. Temperature measurement is necessary because it affects various water properties such as viscosity, density, solubility of chemicals and bacteriological activity (AL-Layla et al., 1977). The

temperature affects chlorine effectiveness in water sterilization where chlorine is more effective in sterilizing water with increasing water temperature (Saleh and Habib, 2013).

Table 1 shows the drinking water standards (Iraqi, 1986 and WHO, 1971).

Table 1. The Iraqi (1986), and WHO standard (1971)

Limiting	IRAQ standard		WHO standard
	Maximum desired values	Maximum allowed value mg/l	
Temperature C°	13 − 35	-	13− 35
Electrical Conductivity(EC) µS/cm	1000	-	1000
Total dissolved solids (TDS) mg/l	500	1500	1000
Total suspended solids (TSS) mg/l	60	-	30
Turbidity (NTU°)	5	25	1 – 5
PH	7 -8.5	5.2-6	6.5 − 8.5
Magnesium (Mg+2) mg/l	50	150	50 −150
Calcium (Ca+2) mg/l	75	200	200
Hardness (T.H) mg/l	100	500	250 -500
Nitrate (NO3) mg/l	20	40	10
Sulfates (SO4) mg/l	200	400	400
Chloride (CL-) mg/l	200	600	250
Alkaline mg/l	170	200	125
Fluoride (F) mg/l	-	1	0.5 − 1.5

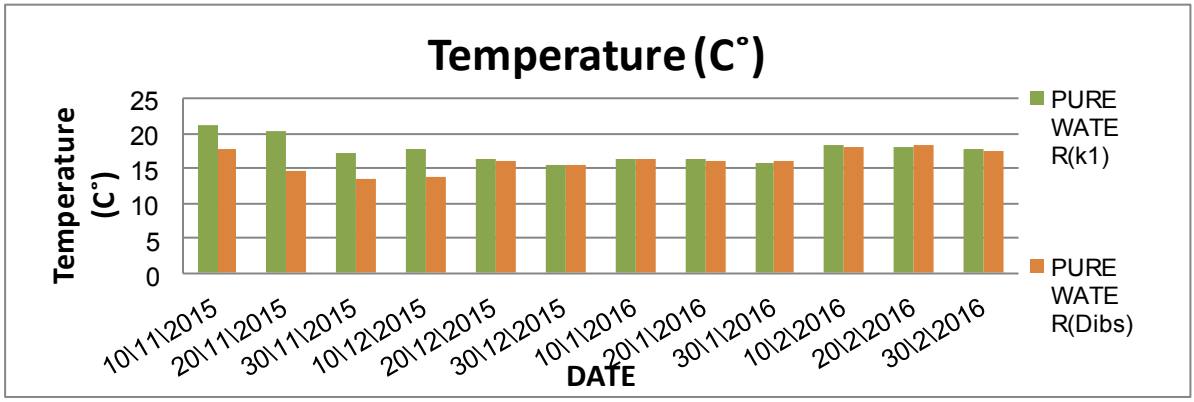

Figure 1. Shows the temperature measurement of supplied water for K1 and for DIBS

3.1.2. Electrical conductivity (EC).

The electrical conductivity analysis ranged from (107 to 409 µS/cm) in the Kiwan treatment plant while their values ranged from (106 to 280 µS/cm) in the Al-Dibs treatment plant as shown in Fig. 2. The analysis result for EC was within the standards

and matches previous studies conducted by (Hamed, 2015), however, at the Kirkuk drinking water treatment plant, it was decreased (340- 400 µS/cm).

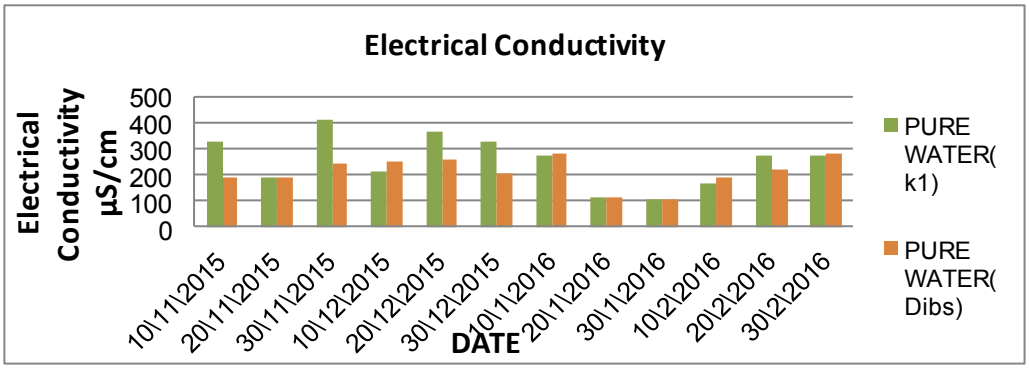

Figure 2. The EC analysis for supplied water for K1& DIBS

3.1.3. Total Dissolved Solids (TDS)

Dissolved salts Includes all inorganic salts and some soluble organic substances in water, namely calcium and magnesium salts, The TDS in this study ranged between (194 to 290 mg/l)in Kiwan treatment plant and (99 to 352mg/l) in the AL-Dibs treatment plant as shown in Fig. 3. The analysis result for TDS was within the standards and matches previous studies conducted by (Hamed, 2015; Saleh , 2010) which reached (230-269 mg/l),(200-300 mg/l) respectively.

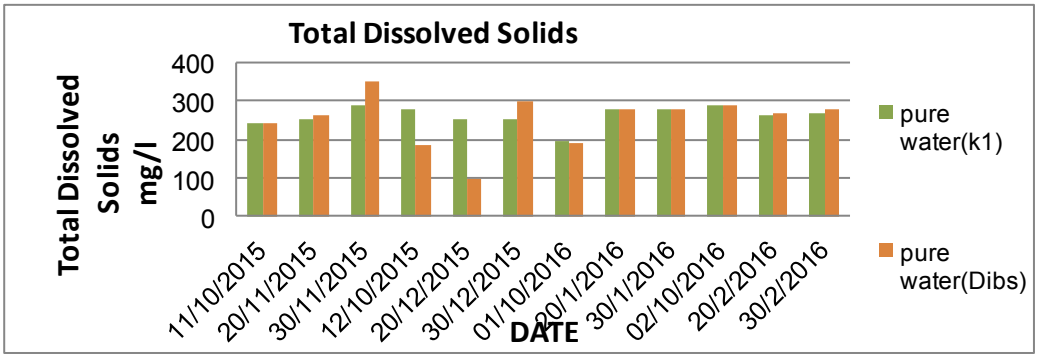

Figure 3. The TDS for supplied water for K1& DIBS

3.1.4. Total Suspended Solids (TSS)

The suspended solids consists of organic and clay materials, and contains some microorganisms such as algae and bacteria. In the current study the values of TSS ranged from (0.3 to 1.8 mg/l) in Kiwan treatment plant and (0.2 to 3.8 mg/l) in the AL-Dibs treatment plant as shown in Fig. 4. The analysis result for TSS was within the standards.

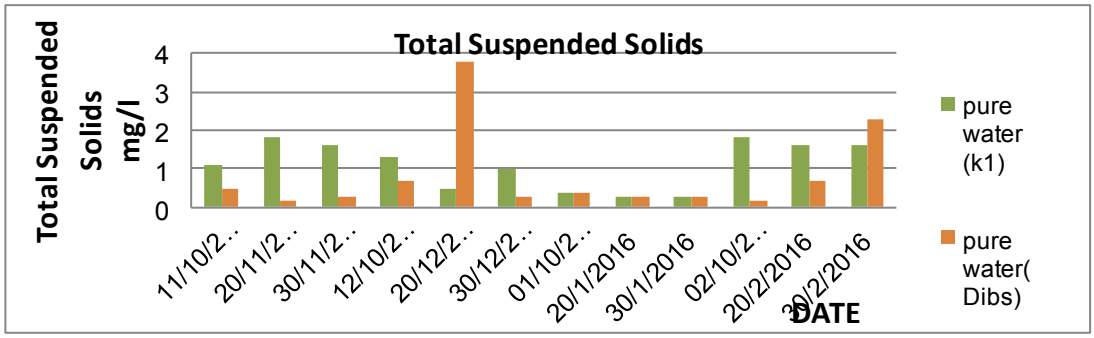

Fig.4. The TSS for supplied water for K1& DIBS

3.1.5. Turbidity

There is a relationship between turbidity and water quality (AL washli, 2009), There is also a relationship between turbidity and bacterial content in water, the turbidity reduce the chlorine's effectiveness in sterilizing the water and therefore water need more chlorine to eliminate the bacteria and pathogens. The analyis showed that the rang value of Turbidity within the range of (1.4 to 64.3 NTU) Kiwan treatment plant and (2.05 to 36.4 NTU) in the AL-Dibs treatment plant as shown in Fig. 5. The analysis result for turbidity was exceeding the standards by (50%) in kiwan station and (33%) in AL-Dibs station. The possible reason could be because of the runoff and rainfall during the analyzing period. When comparing the measured values of this study with the values of the previous study(Saleh, 2010), which reached (3- 4.5NTU) we find that the average values have increased.

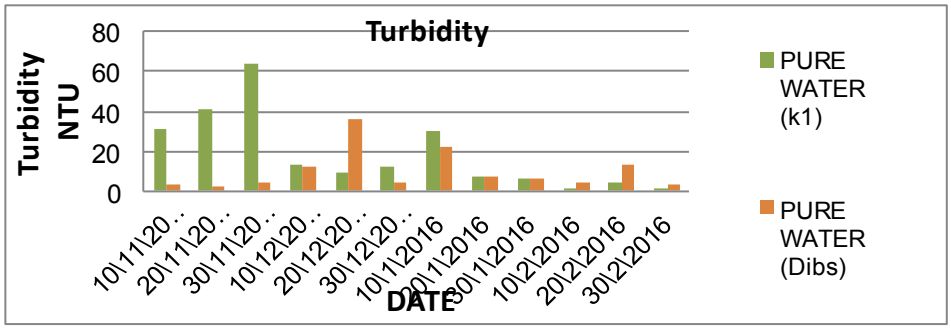

Figure 5. Turbidity for supplied water for K1& DIBS

3.1.6. Efficiency for Turbidity

The removal of turbidity from water was considered to be one of the main objectives of liquidation of water plants, due to the fact that suspended particles that cause turbidity are mostly particulate particles with precise sizes. Some substances must be added to the water so that the turbidity can be removed through sedimentation or filtration. In this study, the sample showed that the efficiency of the turbidity removal of the Kiwan treatment plant Fig. 6 ranged between (8 to 96)% and the treatment plant of AL-Dibs was from(5 to 94)%. Please see fig. 6.

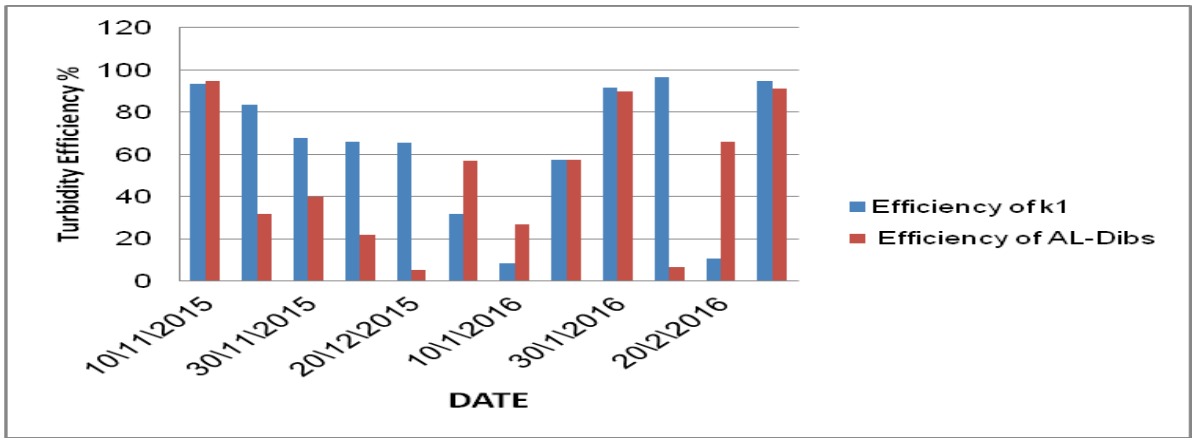

Figure 6 . The Efficiency of turbidity removal from K1& DIBS

3.2. Discuss chemical properties
3.2.1. PH

The average PH analysis was found to be (8.5) Kiwan treatment plant and(8.5)in the AL-Dibs treatment plant as shown in Fig. 7. The analysis result for PH was within the standards and matches previous studies conducted by (Hamed, 2015; Saleh , 2010), which reached(7.5-8) respectively.

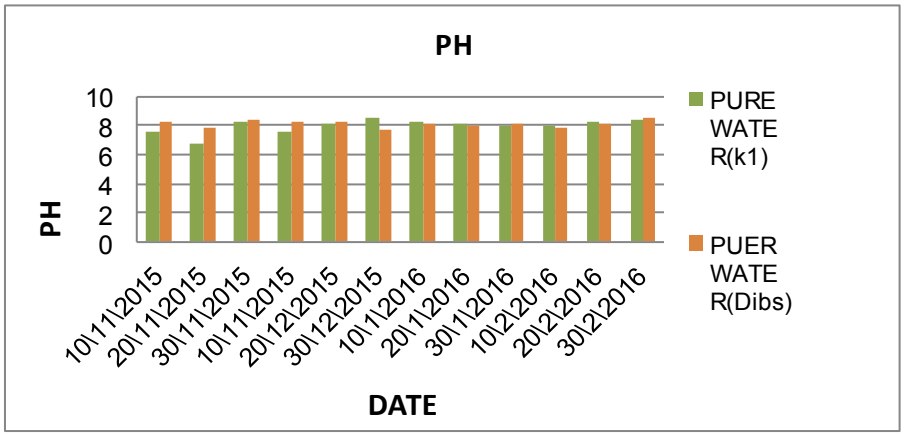

Figure 7. The PH for supplied water for K1& DIBS

3.2.2. Magnesium (Mg^{+2})

The analysis of Mg^{+2} concentration was ranged from 0 to164 mg/l in Kiwan treatment plant and from 0 to 152 mg/l in the AL-Dibs treatment plant as shown in Fig. 8. These results exceed standard by (66%) and AL-Dibs treatment plant (33%). However, when compared to pervious results (Hamed , 2015; Saleh , 2010) the concentration which reached (18.8-27 mg/l),(11.4-32.4 mg/l) respectively, the maximum limits have increased.

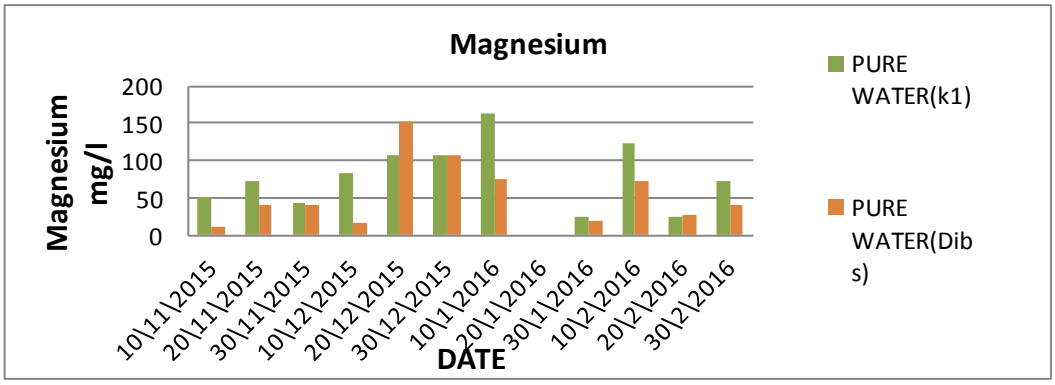

Figure 8. The concentration of (Mg^{+2}) for supplied water for K1& DIBS

3.2.3. Calcium (Ca^{+2})

The analysis of Ca^{+2} concentration was ranged from 34 to 152 mg/l in Kiwan treatment plant and from 2 to 208 mg/l in the AL-Dibs treatment plant as shown in Fig. 9. These results exceed standard by (75%) and AL-Dibs treatment plant (83%). The reason for this increase is related the decomposition of minerals within the filtration stage containing sand and gravel. However, when compared to pervious results (Hamed , 2015; Saleh , 2010) which reached (39-44mg/l),(36-54mg/l) respectively, the maximum limits have increased.

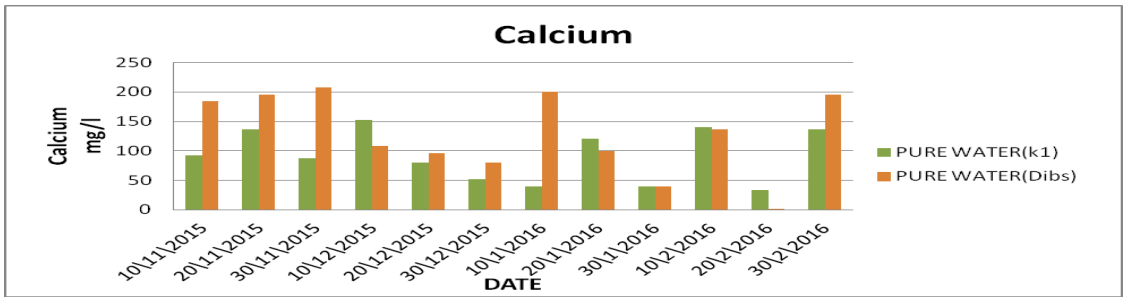

Figure 9. The concentration of (Ca^{+2}) for supplied water for K1& DIBS

3.2.4. Total Hardness

The analysis of total hardness was in the range of (58 to 264 mg/l) in Kiwan treatment plant and (30 to 276 mg/l) in the AL-Dibs treatment plant as shown in Fig. 10. These results were within the standard. However, when compared to pervious results (Hamed, 2015; Saleh, 2010) which reached (116-198mg/l),(136-228mg/l) respectively, the maximum limits have increased.

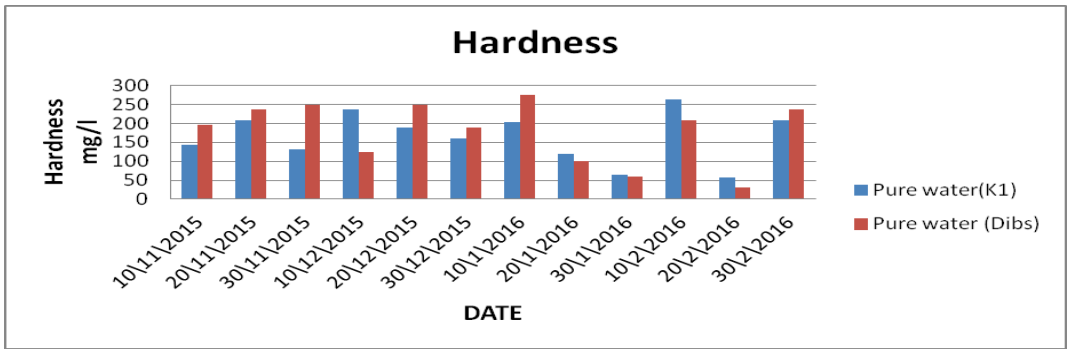

Figure 10. The Hardness for supplied water for K1& DIBS

3.2.5. Nitrate (NO3)

The analysis of nitrate was in the range of (1.38 to 89.4 mg/l) in Kiwan station and (2.46 to 86.24 mg/l) in the AL-Dibs treatment plant as shown in Fig.11. These results exceed standard by (25%) in kiwan treatment plant and (16%) in AL-Dibs treatment plant. The reason for this increase is related to the water pollution from industrial waste, which is dropped illegally in river. However, when compared to pervious results (Hamed, 2015) for Kirkuk drinking water treatment plant, which reached (6-8.5 mg/l), it has increased.

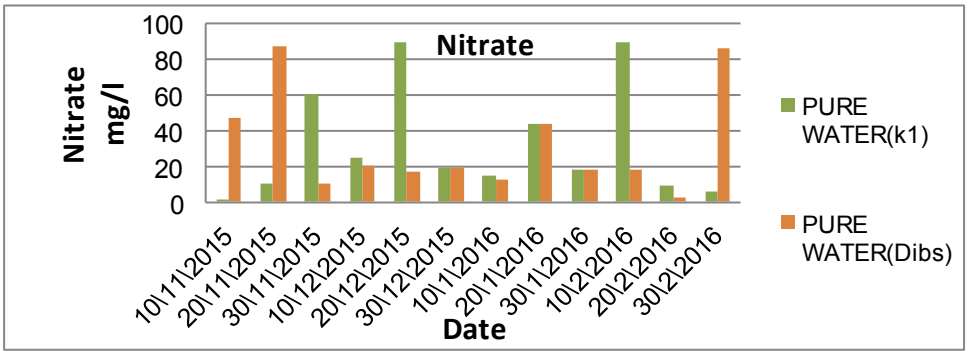

Figure 11. The nitrate concentrations for supplied water for K1& DIBS

3.2.6. Sulphate (SO_4)

The analysis of sulphate was in the range of (0 to 8.064 mg/l) in Kiwan treatment plant and (1.05 to 7.165 mg/l) in the AL-Dibs treatment plant as shown in Fig.12. These results were within the standard. However, when compared to pervious results (Hamed, 2015)for Kirkuk drinking water treatment plant, which reached (38- 48 mg/l), it has decreased.

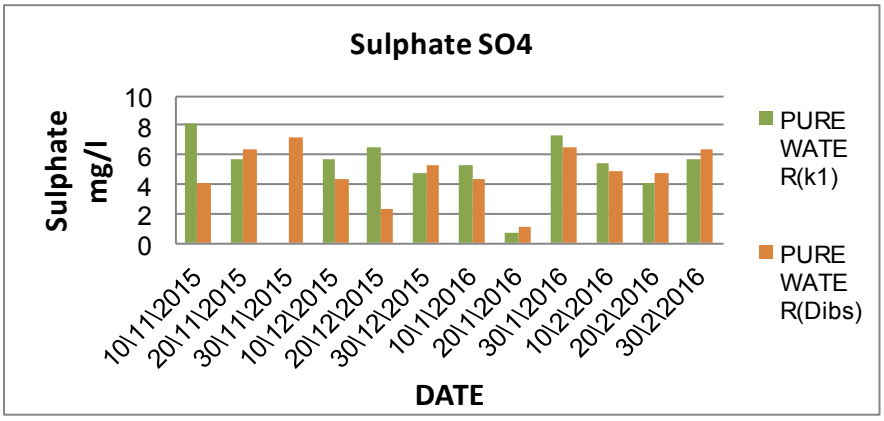

Figure 12. The Sulphate concentration for supplied water for K1& DIBS

3.2.7. Chloride (CL^-)

The analysis of chloride was in the range of 0.01 to 1.092 mg/l in Kiwan treatment plant and 0.01 to 5.85 mg/l in the AL-Dibs treatment plant as shown in Fig. 13. These results were within the standard. However, when compared to pervious results (Hamed, 2015; Saleh , 2010). which reached (16-20mg/l),(10-15mg/l) respectively, the limits have decreased.

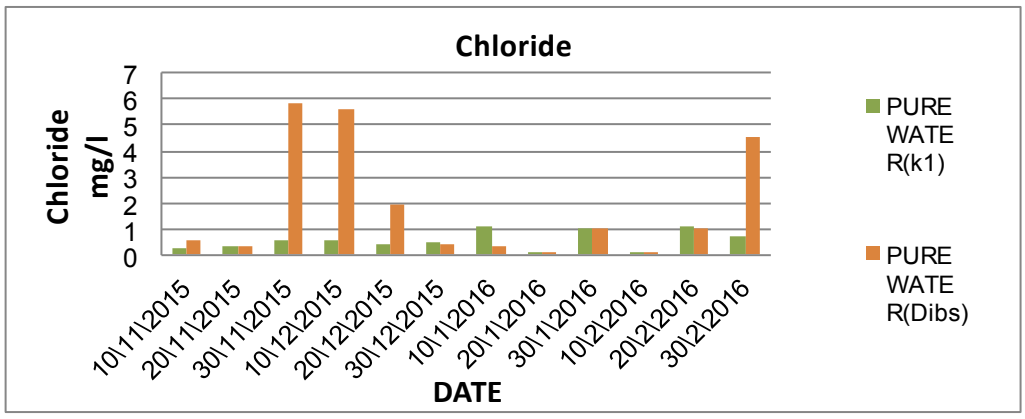

Figure 13. The Chloride concentration for supplied water for K1& DIBS

3.2.8. Alkaline

The analysis of alkaline was in the range of (20 to 108 mg/l) in Kiwan treatment plant and (24 to 60 mg/l) in the AL-Dibs treatment plant as shown in Fig.13. These results were within the standard. However, when compared to pervious results (Saleh, 2010) which reached (115-164mg/l) , the limits have decreased.

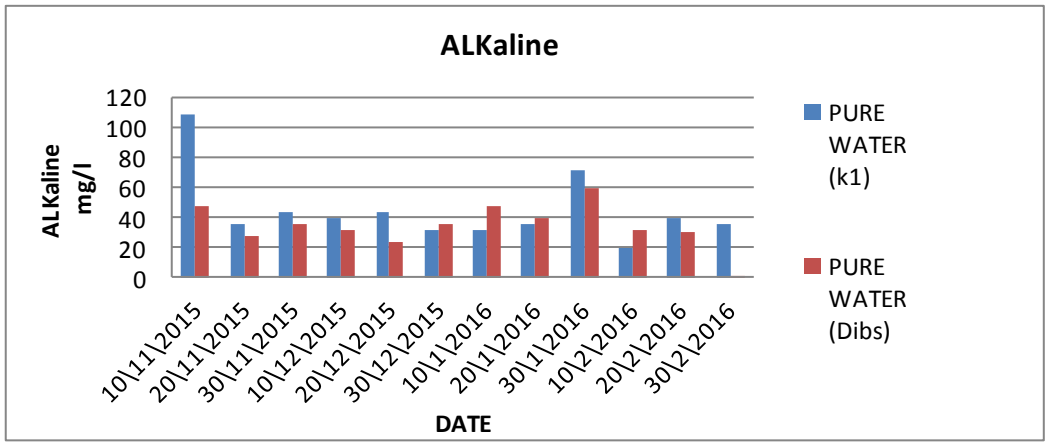

Figure 14. The Alkalinity for supplied water for K1& DIBS

3.2.9. Fluoride

The analysis of fluoride was in the range of (0.1 to 2.48 mg/l) Kiwan treatment plant and (0.03 to 0.58 mg/l) in the AL-Dibs treatment plant as shown in Fig. 15. These results exceed standard by (8%).

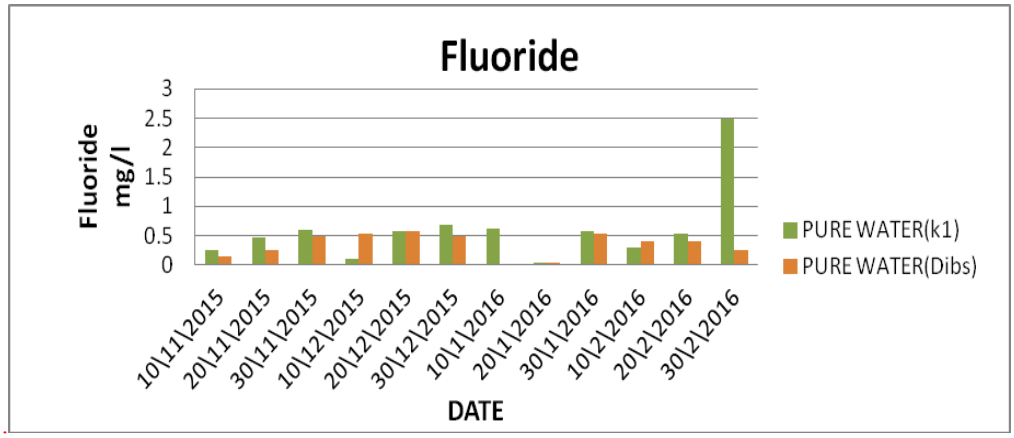

Figure 15. The fluoride for supplied water for K1& DIBS

4. CONCLUSIONS

The measurement of Temperature, EC, TDS, and TSS were within the parameters permitted by the Iraqi drinking water and WHO standards, while the study showed that 50% of the Kiwan treatment plant and 33%of the AL-Dibs treatment plant from the recorded values of the turbidity plant samples exceeded the standards.

The study also showed that the efficiency of the turbidity removal of the Kiwan treatment plant was higher than in the AL-Dibs treatment plant. The chemical analysis for pH, Alkaline, sulphate, chloride, and Hardness were within the permissible limits for both drinking water treatment plant, while the percentage of exceeded the permissible limits value of the calcium, magnesium and nitrate for the samples from the Kiwan treatment plant was(75, 66 and 25%), respectively, while the AL-Dibs treatment plant ratio exceeded (83, 33 and 16%), respectively, and the fluoride values exceeded the permissible limits at the Kiwan treatment plant only by 8%.When comparing the values of treated properties of treated water in the current study of each treatment plant with the measured values of the same characteristics of treated water for the Kirkuk plant in previous studies

(Hamed , 2015; Saleh , 2010). The higher values of TSS, acidity, turbidity, magnesium, calcium, total hardness and nitrates increased, and the values of sulfur, chloride and Alkaline have decreased.

5. RECOMMENDATION

Its recommended to conduct a comprehensive research to measure the performance efficiency of the sedimentation and filtration tanks and improve the work of the treatment plant and study the typical residence time and study the efficiency of filters. The water supply from Zab River is located within an agricultural area where the soil is heavy contaminated by pesticides and chemicals. More analysis for possible contamination of the supply source is recommended.

6. REFERENCES

ALwashli, A. A., 2009. Training Manual On Water. Accessed from Internet: www.watsanmissionassistant.wikispaces.com

Hamed, H. H., 2015. An analytical study on the specification of city of Kirkuk's water and compare it with the water areas of Alton- kopry and Daquq for human use, *Kirkuk University Journal*. 10 (3),42-58. ISSN 1992 – 0849

Saleh , R. A., 2010. Evaluation study of water treatment at Kirkuk unified water supply, *Technical magazine* – 23(1)

Ramal , M. M., 2010. Evaluating the Drinking Water Quality Supplied by Large Treatment Plant in Ramada city, *Qadisiyah Journal of Engineering Sciences*, 3(2).

WHO, 1971. International standards for drinking water, World *Health Organization*, 3 rd edition. Geneva.

Al-Layla, M.A., Ahmed, Sh., and Middlebrooks, E.J. 1977. Water Supply Engineering Design, *Ann Arbor Science Publisher, INC.*

Saleh, S. M., Habib ,S. M. 2013. Study the effect of turbidity on the sterilization process in drinking water, Tikrit University Department of Environmental Engineering. Unpublished report.

Jarry, Roger L., Miller, Henry C. 1956. The Density of Liquid Fluorine between 67 and 103 °K. *Journal of the American Chemical Society* .1552 :78 doi/10.1021:ja01589a012

Safe Drinking Water. 1979. Drinking Water. Accessed from Internet: http://WWW.unicef.org/specialsession/about/sgrepoprt-pdf/03_Safe.