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# Studying the effects of Industrial Wastes on Tigris water in Al- Grea't City-Baghdad-Iraq

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**ABSTRACT**

Tigris River is one of the main important surface water resources in Iraq. This necessitates continuous study of its quality . The present study is concerned with the characteristics and quality of Tigris water passing through in Baghdad city. (eight) samples were collected from the river in the area Grea't City. The study periods were carried over four season, which has been sampled once represent the every season. First sampling 12-11-2012 represent the autumn season The second sampling 20-1-2013 to represent the winter season. The third in 25-3-2013 to represent the Springer season. The fourth during 29-5-2013 to represent the summer spring season.

In order to specify the water quality, a group of physical and chemical analyses have been conducted. The physical measurements included the temperature, and the Specific electrical Conductance while the chemical analyses included measuring the pH , hardness , Salinity, alkalinity, Total Dissolved Solids(TDS) , and total suspended solids (TSS),Chemical Oxygen Demand (COD ) and measuring the quantity of greases and oils via the gravimetric methods. The chemical analyses also included measuring the anions such as the (Sulphate ($SO_4^{-2}$), phosphate ($pO_4^{-3}$) and Nitrate ($NO_3^-$) by using the techniques of the UV – VIS Spectrophotometer.In order to identify the main cations in the water , the concentration of $K^{+2}$,$Ca^{+2}$ and Mg+2 were measured . The above mentioned analyses varied from using the classical chemical analyses such as titration as in measuring the [$Cl^-$ , ($HCO_3^-$ ,$Ca^{+2}$ ,$Mg^{+2}$ ]Ions.Owing to the importance of assessing the trace and heavy metals in water due to their direct effect on human health and reliability, metals were measured; Flame Atomic Absorption spectrophotometer was used to measure the metals . Also, The correlation coefficients between the quality parameter pairs of the river water samples were calculated in order to indicate the nature and the sources of the polluting substances.all results are not matched with the values of national (Central Organization for Standardization and Quality Control) and international except(pH &E.C.) but ($HCO_3^-$ &$Mg^{+2}$ ,$Ca^{+2}$ ) and heavy metals where matched in some station and not in others.

**Keywords:** Tigris river ,Industrial Wastes, water pollution, Al- Grea't City-Baghdad-Iraq physicochemical characteristics.

## INTRODUCTION

Tigris River is one of the main important surface water resources in Iraq. This necessitates continuous study of its quality. Water pollution is merely pollutants present in water which are harmful for human health as well as for plants and living organism. **[**1**]**.

Although, water is an absolute necessity for life, there is an inherent health implication in the consumption of contaminated or polluted water. It can lead to many diseases and even death when contaminated with organic and/or chemical pollutants**[**2**]**.

Natural water contains different concentrations of metals. Some of the different states are soluble in water while others exist in the solid phase. The total concentration of metals in any natural water is the summation of soluble metals and insoluble metals or metals bound to colloids **[**3**]**. Toxic metals, including "heavy metals" are individual metals and metal compounds that negatively affect people's health. However, some metals are necessary in small amount to support life, although in larger amounts, they become toxic.

Environmentally, heavy metals are of great concern. They are toxic to the all-living beings. They are often discharged through the industrial and urban wastes into the water. Once present in water or soil, it is difficult to get rid of them **[**4**]**.

Nitrates and nitrites have also been linked to cancer as possible etiological factors, but the evidence thus far is inconclusive (4). Nitrates are not just a problem for human health; domestic animals may also be adversely affected by high NO3 concentrations in drinking water. Many plants and feeds are naturally high in NO3. If well water contaminated with NO3 is also given to animals, NO3 poisoning is possible, particularly in ruminants such as cows or sheep**[**5**]**.

The aim of this study is to examine the water quality analyses were carried out according to Standard of River and the correlations between different tested parameters were also discussed. The results of the study will also serve as baseline data for water quality study in the Local Government Area and Baileys State in the future.

 

## MATERIALS AND METHODS

### Study Area:

Eight sites were chosen, shown in Fig. 1.and Fig. 2 water passing through in Baghdad city. (eight) samples were collected from the river in the area Grea't City fixed stations as shown in Fig. 1 .The study periods were carried over four season, which has been sampled once every season .The first sampling 12-11-2012 represent the autumn season. The second during 20-1-2013 to represent the winter season .The third in 25-3-2013 to represent the summer season. The fourth during 29-5-2013 to represent the summer spring season.The water samples were collected from the subsurface layer in stopper polyethylene plastic bottles.

***Physico-Chemical Analyses*: [6].**

Field parameters (temperature, pH, electric conductivity (EC), total dissolved solids ,and were measured in-situ using multi-probe system HACH and rechecked in laboratory, Turbidity was measured by Nephelometric turbidity meter, Chemical Oxygen Demand(COD) and measuring the quantity of greases and oils via the gravimetric methods. The chemical analyses also included measuring the anions such as the (Sulphate ($SO_4^{-2}$), phosphate ($pO_4^{-3}$) and Nitrate ($NO_3^-$) by using the techniques of the UV – VIS Spectrophotometer type (Shimadzu UV- 160A). In order to identify the main cations in the water , the concentration of $K^{+2}$,$Ca^{+2}$ and $Mg^{+2}$ were measured .The above mentioned analyses varied from using the classical chemical analyses such as titration as in measuring the ($Cl^-$ , ($HCO_3$- ,$Ca^{+2}$ ,$Mg^{+2}$ )Ions

Owing to the importance of assessing the trace and heavy metals in water due to their direct effect on human health and reliability, metals were measured; Flame Atomic Absorption spectrophotometer type (Shimadzu A.A-160A)Atomic Absorption/Flame Emission Spectrophotometer.
was used to measure the metals .

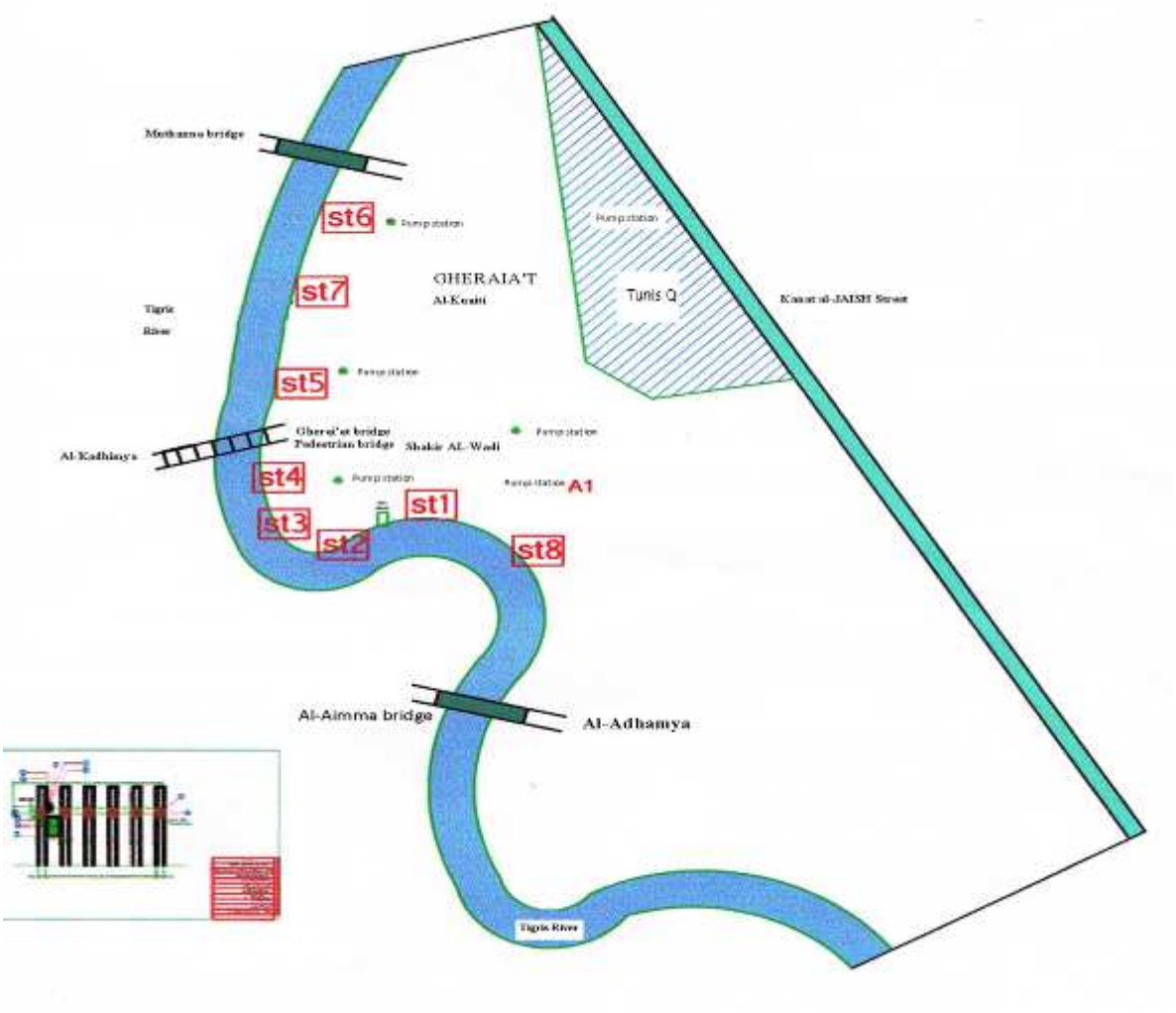


**Figure 1. Map of the study area. of Tigris water in Al- Grea't City-Baghdad-Iraq**

 


**Figure 2. photo showing the sampling locations.**

***ESULTS AND DISCUSSION***

The results of the physico-chemical analysis of the water samples are presented in Tables 1,2,3 and 4.Four months average was taken. the temperature Air(16-40) degree Celsius $^{o}$ C, Water temperature showed a noticeable seasonal trends with a lowest value (15.1 $^{o}$ C) recorded in winter and a highest (34$^{o}$C) in summer. Water temperature showed a positive one with air temperature during most seasons (Tables 1-4). This indicates that air temperature plays an important role for the heat budget of the Tigris water., (pH) range were (7.3-7.5) in the alkaline side Small local differences were observed with no clear seasonal variations. pH showed a negative [7-8].correlation with most studied parameter, Freshly distilled water has a conductivity of 0.5–2 μS/cm, and this value increases up to about 4μS/cm due to absorption of carbon dioxide and, to a lesser extent, ammonia from the atmosphere. For surface water, the conductivity is typically within the range 50–1000 μS/cm [9]..Electrical Conductivity (EC) range were (710.00- 1972.00) μs., 0.05<P with significant difference in relation to sites. This

 

is higher than that value of WHO guidelines(ie) 1000 µs. EC is an indicator of water quality and soil salinity, hence the relatively high values observed in some water samples show high salinity; thus the water may not be very suitable for domestic and agricultural use. [10] The mean value of total dissolved solids(TDS) was 760.87-892.50 mg/l. The values obtained for TDS is where more than WHO standard of 1000mg/l for the discharge of wastewater into surface water.

Chemical Oxygen Demand is the measure of amount of oxygen required to breakdown both organic and inorganic matters. The COD value of the sample was recorded as 8.00-490.00/l. Std. Deviation(54.82-166.6). This samples values was lese than that of WHO guidelines value of 1000 mg/l. [11] It showed positive correlation with many parameters like, for instance, Cl-, $SO_4$ 2-, $NO_3^{1-}$, Na, K, Ca and Mg ,during most seasons (Tables 1-4 & 5),

which constitute the major anions and cations present in the Tigris water and mean SAR & Class water as (Us salinity) in the water samples (Table 6).Trace amounts of minerals such as Na, Ca, and Mg were presented above than WHO recommended level in(Table 5).The presence of Na, Ca and Mg in excess makes water unfit for irrigation since its application increase problems of soils salinity and its permeability determination to crop plants[12-`13 ]. The World Health Organization (WHO)International Standard for Drinking Water (1998) [14 ]. <50 mg/L as soft water, 50 to 150 mg/L as moderately hard water and water hardness above 150 mg/L as hard CaCO3. As sifted water with a total hardness of CaCO3 Based on this classifications, all the water samples analysis are moderately hard water, thus the waters are suitable for domestic use in terms of hardness. Chloride concentrations varied between 16.07 to 29.54 $mgl^{-1}$. The chloride concentrations possessed a good positive relationship with most anions and cations. Sulphate showed a behavior similar to that of $Cl^-$. [7-8]Lead is a metal that has been used for a long period of time, for example in batteries, ammunition and alloying elements. The metal can cause toxic effects in humans and animals and is also an inhibitory substance for microbiological degradation processes. Chromium is a transition element located in group VI the periodic table and the most toxic form, the hexavalent Cr(VI),is usually associated with oxygen to form the chromate ($CrO_4^{2-}$)or dichromate ($Cr_2O_7^{2-}$; [15-17].Removal of Cr (VI) can be done by adsorption on a non-toxic natural substance [18].

[6] ***Table (1)*** Physico chemical characters were analyzed by using standard methods

| | Location | | 1 | 2 | 3 | 4 | 5 | Methods |
|---|---|---|---|---|---|---|---|---|
| | Date | | autumn 2012/11/12 | | | | | |
| NO. | Physico-chemical parameters | UNIT TEST | | | | | | |
| 1 | Temperatur | °C | 30 | 30 | 30 | 30 | 30-36 | Thermo-meter |
| 2 | PH | | 6.63 | 6.97 | 6.72 | 6.92 | 6.91 | PH-meter |
| 3 | Conductivity | µs/cm | 1130 | 885 | 1100 | 1340 | 1460 | Conductivity-meter |
| 4 | Total suspended solids (T.S.S) | mg/l | 230 | 92 | 8500 | 704 | 284 | Colourmetric |
| 5 | Chemical oxygen deamaned (COD) | mg/l | 204 | 57 | 205 | 208 | 210 | Gravimetric |
| 6 | Total dissolve solids (T.D.S) | mg/l | 688 | 592 | 690 | 776 | 785 | Gravimetric |
| 7 | Chloride as Cl | mg/l | 121 | 92 | 105 | 112 | 125 | Titration |
| 8 | Nitrate as $NO_3$ | mg/l | 7.9 | 23.9 | 22.6 | 7.08 | 7.9 | Turbiditimetric |
| 9 | Phosphate as $PO_4$ | mg/l | 3.85 | 5.04 | 4.40 | 4.70 | 5.46 | Colourmetic |
| 10 | Sulfate as $SO_4$ | mg/l | 245 | 183 | 209 | 276 | 290 | Colourmetic |
| 11 | Lead pb | mg/l | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | Atomic-absorption |
| 12 | Cr | mg/l | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | Atomic-absorption |
| 13 | Cu | mg/l | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | Atomic-absorption |
| 14 | Ni | mg/l | 0.01 | 0.0 | 0.0 | 0.0 | 0.01 | Atomic-apsorition |
| 15 | Fe | mg/l | 0.0 | 0.02 | 0.02 | 0.0 | 0.02 | Atomic-absorption |
| 16 | Cd | mg/l | 0.0 | 0.0 | 0.01 | 0.0 | 0.0 | Atomic-absorption |
| 17 | Oil and Grease | mg/l | 72 | - | - | - | 24 | Gravimetric |

 

| | Location | | 6Station | 7Station | 8Station | mean | Standard Deviation for 8-stations |
|---|---|---|---|---|---|---|---|
| | Date | | autumn 2012/11/12 | | | | |
| NO. | Physico-chemical parameters | UNIT TEST | | | | | |
| 1 | Temperatur | °C | 32 | 32 | 32 | 32 | |
| 2 | PH | | 7.43 | 7.11 | 7.45 | 7.2 | 0.29 |
| 3 | Conductivity | µs/cm | 807 | 02.0 | 994 | 1102 | 235.00 |
| 4 | Total suspended solids (T.S.S) | mg/l | 32 | 86 | 48 | 1102 | 235 |
| 5 | Chemical oxygen deamaned (COD) | mg/l | 58 | 315 | 60 | 168.00 | 91.42 |
| 6 | Total dissolve solids (T.D.S) | mg/l | 448 | 1810 | 658 | 804.62 | 420.36 |
| 7 | Chloride as Cl | mg/l | 71 | 145 | 79 | 106.25 | 24.76 |
| 8 | Nitrate as $NO_3$ | mg/l | 4.8 | 13.8 | 4.25 | 11.52 | 7.79 |
| 9 | Phosphate as $PO_4$ | mg/l | BDL | 4.33 | BDL | 4.63 | 0.56 |
| 10 | Sulfate as $SO_4$ | mg/l | 176 | 304 | 183 | 233.25 | 52.24 |
| 11 | Lead pb | mg/l | 0.0 | ND | ND | | |
| 12 | Cr | mg/l | 0.0 | ND | ND | | |
| 13 | Cu | mg/l | 0.0 | ND | ND | | |
| 14 | Ni | mg/l | 0.0 | ND | 0.01 | | |
| 15 | Fe | mg/l | 0.2 | 0.10 | 0.04 | | |
| 16 | Cd | mg/l | 0.0 | 0.01 | 0.0 | | |
| 17 | Oil and Grease | mg/l | - | 40 | - | 45.33 | 24.44 |

***Table (2)*** Physico chemical characters were analyzed by using standard methods[6]

| | Location | | Station 1 | Station 2 | Station 3 | Statio 4n | Station 5 | Methods |
|---|---|---|---|---|---|---|---|---|
| | Date | | winter season | | | 2013/1/20 | | |
| NO. | parameter | UNIT TEST | | | | | | |
| 1 | Temperatur | °C | 19 | 19 | 19 | 19 | 19 | Thermo-meter |
| 2 | PH | | 7.81 | 7.03 | 7.24 | 7.04 | 7.20 | PH-meter |
| 3 | Conductivity | µs/cm | 1650 | 927 | 1360 | 1149 | 970 | Conductivity-meter |
| 4 | Total suspended solids (T.S.S) | mg/l | 553 | 242 | 316 | 512 | 430 | Colourmetric |
| 5 | Chemical oxygen deamaned (COD) | mg/l | 262 | 189 | 336 | 214 | 185 | Gravimetric |
| 6 | Total dissolve solids (T.D.S) | mg/l | 950 | 830 | 702 | 662 | 588 | Gravimetric |
| 7 | Chloride as Cl | mg/l | 159 | 99 | 158 | 145 | 112 | Titration |
| 8 | Nitrate as $NO_3$ | mg/l | 4.98 | 4.49 | 4.96 | 4.68 | 2.39 | Turbiditimetric |
| 9 | Phosphate as $PO_4$ | mg/l | 8.27 | 1.2 | 4.55 | 4.89 | 3.67 | Colourmetic |
| 10 | Sulfate as $SO_4$ | mg/l | 588 | 243 | 553 | 311 | 255 | Colourmetic |
| 11 | Lead pb | mg/l | ND | ND | ND | ND | ND | Atomic-absorption |
| 12 | Cr | mg/l | ND | ND | 0.03 | ND | ND | Atomic-absorption |
| 13 | Cu | mg/l | ND | ND | ND | ND | ND | Atomic-absorption |
| 14 | Ni | mg/l | 0.01 | ND | ND | ND | 0.02 | Atomic-apsorition |
| 15 | Fe | mg/l | ND | 0.011 | 0.02 | 0.010 | ND | Atomic-absorption |
| 16 | Cd | mg/l | ND | ND | ND | ND | ND | Atomic-absorption |
| 17 | Oil and Grease | mg/l | 49.6 | 72 | 80 | 342 | 57.6 | Gravimetric |

 

| | Location | | 6Station | 7Station | 8Station | mean | Standard Deviation for 8-stations |
|---|---|---|---|---|---|---|---|
| | Date | | winter 2013 /1/20 | | | | |
| NO. | parameter | UNIT TEST | | | | | |
| 1 | Temperatur | °C | 19 | 19 | 19 | 19 | 19.5 |
| 2 | PH | | 7.40 | 6.92 | 7.50 | 7.34 | 0.25 |
| 3 | Conductivity | µs/cm | 907 | 1530 | 1972 | 1308.12 | 388.28 |
| 4 | Total suspended solids (T.S.S) | mg/l | 138 | 304 | 382 | 395.62 | 0.427 |
| 5 | Chemical oxygen deamaned (COD) | mg/l | 151 | 490 | 354 | 272.62 | 113.95 |
| 6 | Total dissolve solids (T.D.S) | mg/l | 586 | 862 | 1330 | 1308 | 388.28 |
| 7 | Chloride as Cl | mg/l | 145 | 118 | 184 | 140.00 | 28.33 |
| 8 | Nitrate as $NO_3$ | mg/l | 6.34 | 7.38 | 5.2 | 5.09 | 1.48 |
| 9 | Phosphate as $PO_4$ | mg/l | 0.83 | 5.86 | 5.69 | 106.71 | 291.04 |
| 10 | Sulfate as $SO_4$ | mg/l | 181 | 255 | 540 | 365.75 | 165.42 |
| 11 | Lead pb | mg/l | ND | ND | ND | | |
| 12 | Cr | mg/l | ND | ND | 0.01 | | |
| 13 | Cu | mg/l | ND | ND | ND | | |
| 14 | Ni | mg/l | ND | ND | ND | | |
| 15 | Fe | mg/l | ND | ND | ND | | |
| 16 | Cd | mg/l | ND | ND | ND | | |
| 17 | Oil and Grease | mg/l | 91 | 115 | 66 | 109.15 | 96.27 |

*Table (3)* Physico chemical characters were analyzed by using standard methods[6]

| Location | | 1Station | Station 2 | 3Station | 4Station | Station 5 | Methods | |
|---|---|---|---|---|---|---|---|---|
| | Date | | Springer 2013/3/25 | | | | | |
| NO. | Physico-chemical parameters | UNIT TEST | | | | | | |
| 1 | Temperatur | °C | 21 | 21 | 21 | 20 | 21 | |
| 2 | PH | | 6.65 | 7.05 | 7.11 | 7.68 | 6.77 | |
| 3 | Conductivity | µs/cm | 1378 | 1005 | 1855 | 1150 | 1518 | |
| 4 | Total suspended solids (T.S.S) | mg/l | 168 | 266 | 898 | 370 | 740 | |
| 5 | Chemical oxygen deamaned (COD) | mg/l | 65 | 157 | 45 | 31 | 112 | |
| 6 | Total dissolve solids (T.D.S) | mg/l | 986 | 726 | 988 | 826 | 1006 | |
| 7 | Chloride as Cl | mg/l | 145 | 80 | 132 | 79 | 107 | |
| 8 | Nitrate as $NO_3$ | mg/l | 18.5 | 16.4 | 8.3 | 3.22 | 5.23 | |
| 9 | Phosphate as $PO_4$ | mg/l | 3.55 | 1.77 | 8.56 | 3.7 | 5.9 | |
| 10 | Sulfate as $SO_4$ | mg/l | 218 | 221 | 230 | 281 | 249 | |
| 11 | Lead pb | mg/l | ND | ND | ND | ND | ND | |
| 12 | Cr | mg/l | ND | ND | 0.03 | ND | ND | |
| 13 | Cu | mg/l | 0.01 | ND | ND | ND | ND | |
| 14 | Ni | mg/l | 0.01 | 1.46 | 0.11 | 0.54 | ND | |
| 15 | Fe | mg/l | 0.52 | 0.011 | 0.02 | 0.010 | ND | |
| 16 | Cd | mg/l | ND | ND | ND | ND | ND | |
| 17 | Oil and Grease | mg/l | 8 | 2.9 | - | - | 20 | |

 

| | Location | | Station6 | 7 Station | 8Station | mean | Standard Deviation for 8-stations |
|---|---|---|---|---|---|---|---|
| | Date | | Springer 2013/3/25 | | | | |
| NO. | parameter | UNIT TEST | | | | | |
| 1 | Temperature | °C | 21 | 21 | 21 | | |
| 2 | PH | | 7.09 | 6.84 | 7.42 | 7.03 | 0.40, |
| 3 | Conductivity | µs/cm | 2000 | 967 | 801 | 1334.25 | 432.87 |
| 4 | Total suspended solids (T.S.S) | mg/l | 846 | 100 | 358 | | |
| 5 | Chemical oxygen deamaned (COD) | mg/l | 35 | 16 | 10 | 60.85 | 54.82 |
| 6 | Total dissolve solids (T.D.S) | mg/l | 1382 | 674 | 552 | 892.50 | 258.06 |
| 7 | Chloride as Cl | mg/l | 126 | 72 | 77 | 102.25 | 29.00 |
| 8 | Nitrate as $NO_3$ | mg/l | 13.0 | 18 | 20 | 12.83 | 6.47 |
| 9 | Phosphate as $PO_4$ | mg/l | 4.7 | 2.9 | 3.6 | 4.33 | 2.09 |
| 10 | Sulfate as $SO_4$ | mg/l | 400 | 198 | 183 | 247.50 | 68.52 |
| 11 | Lead pb | mg/l | ND | ND | ND | | |
| 12 | Cr | mg/l | ND | ND | ND | | |
| 13 | Cu | mg/l | ND | ND | 0.01 | | |
| 14 | Ni | mg/l | ND | ND | ND | | |
| 15 | Fe | mg/l | 0.18 | ND | 0.16 | | |
| 16 | Cd | mg/l | ND | ND | ND | | |
| 17 | Oil and Grease | mg/l | 28 | 13.6 | - | 12.70 | 20.14 |

***Table (4)*** Physico chemical characters were analyzed by using standard methods[6]

| | | | 1Station | 2Station | Station 3 | 4Station | 5Station |
|---|---|---|---|---|---|---|---|
| | Date | | summer 2013/ 5 / 29 | | | | |
| NO. | parameter | UNIT TEST | | | | | |
| 1 | Temperatur | °C | 29 | 30 | 30 | 28 | 28 |
| 2 | PH | | 6.47 | 6.67 | 6.47 | 6.69 | 6.68 |
| 3 | Conductivity | µs/cm | 1329 | 1170 | 1052 | 1150 | 1116 |
| 4 | Total suspended solids (T.S.S) | mg/l | 112 | 1844 | 13230 | 292 | 1948 |
| 5 | Chemical oxygen deamaned (COD) | mg/l | 129 | 480 | 315 | 193 | 408 |
| 6 | Total dissolve solids (T.D.S) | mg/l | 772 | 640 | 660 | 760 | 918 |
| 7 | Chloride as Cl | mg/l | 139 | 119 | 112 | 139 | 208 |
| 8 | Nitrate as $NO_3$ | mg/l | 2.29 | 4.43 | 4.43 | 3.95 | 4.74 |
| 9 | Phosphate as $PO_4$ | mg/l | 3.79 | 4.896 | 6.12 | 4.75 | 12.7 |
| 10 | Sulfate as $SO_4$ | mg/l | 218 | 221 | 230 | 281 | 249 |
| 11 | Lead pb | mg/l | ND | ND | ND | ND | ND |
| 12 | Cr | mg/l | ND | ND | 0.02 | ND | ND |
| 13 | Cu | mg/l | 0.01 | ND | ND | ND | ND |
| 14 | Ni | mg/l | ND | 0.03 | ND | 0.024 | ND |
| 15 | Fe | mg/l | 0.047 | 0.010 | 0.02 | 0.010 | ND |
| 16 | Cd | mg/l | ND | ND | ND | ND | ND |
| 17 | Oil and Grease | mg/l | 2.8 | 2.0 | 30.4 | 0 | 56 |

 

| | Location | | 6Station | Station 7 | Station 8 | mean | Standard Deviation for 8-stations |
|---|---|---|---|---|---|---|---|
| | Date | | summer 2013/5/29 | | | | |
| NO. | | UNIT TEST | | | | | |
| 1 | Temperatur | °C | 30 | 27 | 29 | | |
| 2 | PH | | 7.09 | 7.42 | 6.69 | 6.77 | 0.32 |
| 3 | Conductivity | µs/cm | 710 | 9.5 | 1815 | 1155 | 324.86 |
| 4 | Total suspended solids (T.S.S) | mg/l | 162 | 174 | 208 | 1155.87 | 324.86 |
| 5 | Chemical oxygen deamaned (COD) | mg/l | 80 | 78 | 129 | 217.50 | 166.61 |
| 6 | Total dissolve solids (T.D.S) | mg/l | 470 | 644 | 1223 | 760 | 370.5 |
| 7 | Chloride as Cl | mg/l | 60 | 109 | 159 | 130.62 | 42.87 |
| 8 | Nitrate as $NO_3$ | mg/l | 5.90 | 5.90 | 11.97 | 5.4513 | 2.871 |
| 9 | Phosphate as $PO_4$ | mg/l | 4.65 | 5.66 | 6.0 | 6.07 | 2.78 |
| 10 | Sulfate as $SO_4$ | mg/l | 196 | 2.1 | 400 | 246.12 | 70.27 |
| 11 | Lead pb | mg/l | ND | ND | ND | | |
| 12 | Cr | mg/l | ND | ND | ND | | |
| 13 | Cu | mg/l | ND | ND | 0.02 | | |
| 14 | Ni | mg/l | ND | ND | ND | | |
| 15 | Fe | mg/l | 0.12 | 0.02 | 0.20 | | |
| 16 | Cd | mg/l | ND | ND | ND | | |
| 17 | Oil and Grease | mg/l | 0 | 3.6 | 6.8 | 12.70 | 20.14 |

*Table (5)* Hardness , ($HCO_3^{-1}$ ) , % Na, SAR, Turbidity( NTU)
( cat ions (Na, k, Mg, Ca), in winter and summer

| NO. | %Na | SAR | Na | k | Mg | Ca | ($HCO_3^{-1}$ ) | Hardness mg.$l^{-1}$ $CaCO_3$ | NTU |
|---|---|---|---|---|---|---|---|---|---|
| | $\%Na = \frac{Na \times 100}{Na + K + Mg + Ca}$ | | | | | | | | |
| | winter | | | | | | | | |
| 1 | 31.34 | 5.70 | 34.8 | 1.7 | 53.808 | 20.7 | 233 | 273 | 16.1 |
| 2 | 31.94 | 6.39 | 42.5 | 2.3 | 63.536 | 24.7 | 363 | 323 | 20.3 |
| 3 | 33.18 | 6.16 | 37.2 | 2.2 | 51.011 | 21.7 | 224 | 264 | 11.8 |
| 4 | 33.04 | 6.03 | 36 | 1.8 | 50.950 | 20.2 | 222 | 260 | 25.9 |
| 5 | 37.72 | 9.06 | 59.5 | 12 | 61.712 | 24.5 | 375 | 315 | 64.6 |
| 6 | 32.88 | 5.96 | 35.2 | 2.1 | 48.153 | 21.6 | 212 | 252 | 31.6 |
| 7 | 45.81 | 12.83 | 85.6 | 12.3 | 62.441 | 26.5 | 423 | 323 | 12.8 |
| 8 | 32.53 | 6.049 | 37 | 1.9 | 53.321 | 21.5 | 333 | 273 | 18.3 |
| summer | | | | | | | | | |
| 1 | 54.45 | 16.19 | 101.4 | 6.4 | 52.713 | 25.7 | 551 | 281 | 19.0 |
| 2 | 47.157 | 13.71 | 92.6 | 12.6 | 63.96 | 27.2 | 431 | 331 | 70.3 |
| 3 | 38.24 | 8.20 | 49.6 | 6.9 | 52.77 | 20.4 | 368 | 268 | 21.6 |
| 4 | 27.41 | 6.57 | 53.8 | 8.5 | 99.34 | 34.6 | 495 | 495 | 18.6 |
| 5 | 38.00 | 9.16 | 61.5 | 10.2 | 65.60 | 24.5 | 531 | 331 | 45.5 |
| 6 | 31.93 | 5.87 | 36 | 1.6 | 55.32 | 19.8 | 377 | 277 | 39.9 |
| 7 | 43.61 | 11.89 | 81.6 | 11.4 | 69.98 | 24.1 | 398 | 348 | 21.6 |
| 8 | 46.91 | 15.27 | 120.5 | 11.9 | 93.57 | 30.9 | 662 | 462 | 163 |

 

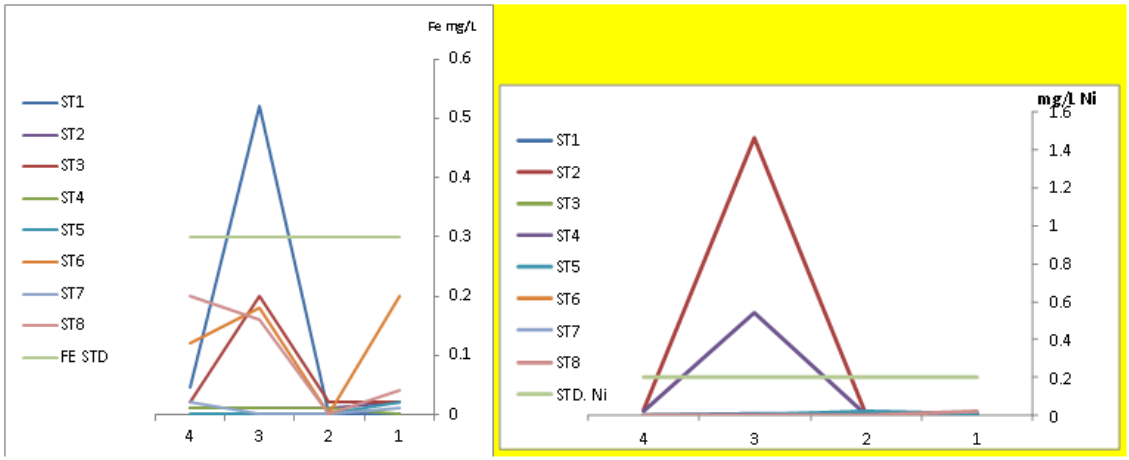


Figure 3. Distribution of ( Ni & Fe) mg/L in the water samples.

Table (6 ) Mean SAR& Class water (Us salinity) in the water samples

| Station No: | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| Mean SAR | 15.06 | 12.69 | 7.57 | 5.36 | 8.56 | 5.52 | 11.16 | 14.11 |
| Class water Us salinity | S2 | S2 | S1 | S1 | S1 | S1 | S2 | S2 |

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