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RESEARCH PAPER

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Physico-chemical parameters of four sewage treatment plants in Al-Kut Province and their effected in Tigris River, Iraq

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Key words: Tigris River, Water properties, Sewage treatment plants

Abstract

The aim of the present study is to know the water specification which ejected from Al-Kut sewage treatment plants in the Tigris River the main great river in Iraq and going through Al- Kut City the center of Wasit Province. It is located 32.51 latitude and 45.82 longitudes and it is situated at elevation 22 meters above sea level. Al Kut City has a population of 315,162 making it the biggest city in Wasit. Four sewage treatment plants stations were selected in Al-Kut City, Bimonthly sampling was carried out from January 2016 till December 2016; two samples were taken each month. Station one was AL- Kafaat plants. The second station was AL-Dewan plants, the third station is AL- Anwar plants and the four stations is AL-Karemia plants. In the present study thirteen physical and chemical parameters were selected on the importance of these parameters. These thirteen parameters are ranged as follows:, water temperature 14 to 35 °C, pH 7 to 8, EC 1330 to 4800 µS/cm, BOD_5 45 to 219 mg/L, TDS 1000 to 2600 g/L, TSS 40 to 340 mg/L, NO_3^{-2} ND to 10 mg/L PO_4^{-2} ND to 19 mg/L, Sulfate 205 to 1028 mg/L, Cl^- 117 to 501 mg/L, NH_3 13 to 84 mg/L, $NO_2^=$ ND to 0.9 mg/L, H_2S 3 to 68 mg/L, COD 108 to 614 mg/L and Oil& Greas 35 to 240 mg/L. Concluded from the current study, all wastewater treatment has a direct impact on the water characteristics of the Tigris River.

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Introduction

Water is the most important natural resource in the world. It is an essential element in the maintenance of all forms of life. Without it life cannot exist and most industries could not operate (Cheepi, 2012), Approximately, 20% of the world's population lacks safe drinking water and nearly half the world population lacks adequate sanitation. This problem is acute in many developing countries, which discharge an estimated 95% of their untreated urban sewage directly into surface waters. Iraq, which is one of the nine Middle Eastern countries have insufficient fresh water (Pimental *et al.*, 2004).

Water pollution is a major global problem. It has been suggested that it is the leading worldwide cause of deaths and disease (Yehia, and Sabae, 2011). Surface waters are most exposable to pollution due to their easy accessibility for disposal of wastewaters (Samarghandi *et al.*, 2007). The term "sewage" means gray water that generated by the many activities in the process of meeting his various living requirements.

The sewage can be described as wastewater from a community. Wastewater refers to spending or used water containing dissolved or suspended matter. Wastewater from residential areas is referred to as domestic sewage (Porteous, 2000; EPA, 2012). Sewage from various homes and institutions (private and public) in a community constitute municipal sewage (Uwidia and Ademoroti, 2011).

The aim of the present study is to determines the effect of sewage plant discharge of the Al-Kut City on physical and chemical characteristics of Tigris River. Also this study is complementary to studies Rasha *et al.* (2017) which was conducted at other sewage plant in Al-Kut City.

The water specification which ejected from Al-Kut sewage treatment plants to Tigris River the main great river in Iraq and going through Al- Kut City the center of Wasit Province.

Methods and materials

Study Area

Wassit AL-Kut is located in eastern Iraq, on the border with Iran. Tigris River divides the city into a right and left sections with a flow direction from north to south. Wassit shares internal boundaries with the governorates of Diyala, Baghdad, Babil, Qadissiya, Thi-Qar and Missan. Wassit is intersected by the Tigris River, along which a ribbon of irrigated farmland runs, giving way to a dry desert landscape to the north east (Fig. 1).

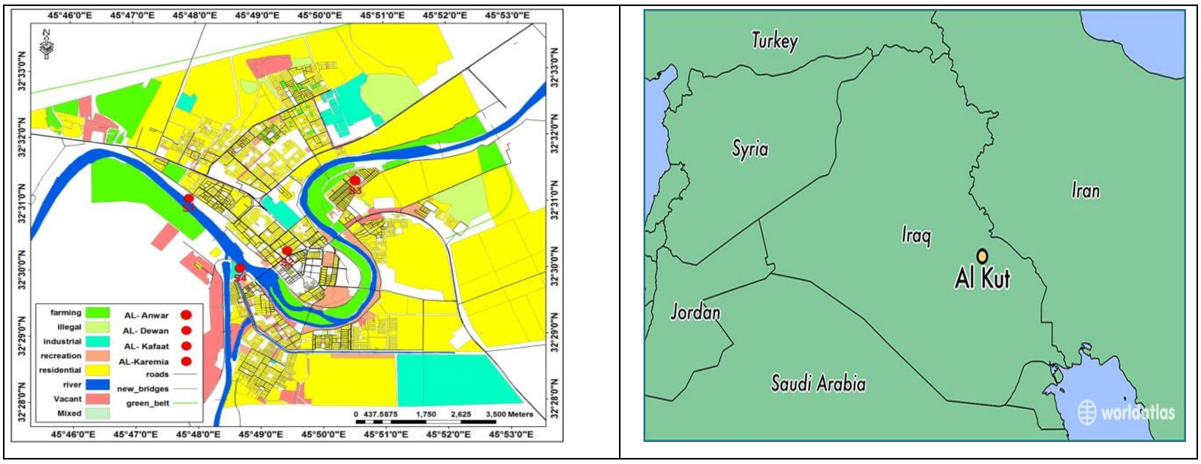

Fig. 1. Maps of Iraq and Al-Kut Province shows the sampling site on the Tigris River, Iraq.

Statistical Analysis

Samples for physical and chemical variables were performed from four stations during 2016 period. Station one is AL- Kafaat was located at 574947.43X, 3598107.07Y. The second station was AL-Dewan situated at 577403.571X, 3596645.287Y. Third station is AL-Anwar located at 579105.104X, 3598603.818Y. The fourth station is AL-Karemia situated at 576227.0214X, 3596155.215Y.

Methodology

Water samples were collected for Physio-chemical analysis by using polyethylene bottle 5L capacity, which was washed by water sample twice before filling. The sample collected under the surface water about 20-40 cm, then kept at 15^{o}C in refrigerator until the sample is examined (WHO, 1996). Physical and chemical parameters included:- Water temperature (by using precise mercury thermometer), Hydrogen ion concentration (by using pH-meter), Electrical conductivity and total dissolved solid (by using EC-meter), Biological oxygen demand and Chemical oxygen demand (Winkler methods), Nitrate, Nitrite, Phosphate, Ammonium, Sulphat, Total Suspended Solid (by using spectrophotometric methods), Chloride and H_2S (by using titrimetric methods), measured according to (APHA, 1998; APHA, and WFF, 2005). Oil & Grease (by using Soxhlet) and use hexane as a solvent (Abumoghli and Ghuneium, 1991). In this study, the water properties were applied and tested for all the sites on the Tigris River using of Iraqi standard guidelines for waste water discharged to the water course (Standard Specification of Drinking Water, Iraq, 2001)

Results and discussion

Table (1) shows monthly changes in water temperature for the four selected stations. Values ranged from 14°C in station-2 during January (2016) to 35°C in station-4 during July (2016) (Fig. 2). Water temperature is an important factor in any aquatic environments affecting on biological processes, This result was similar to previous studies done by (Abumoghli and Ghuneium, 1991) Monthly changes in values of Oil & Grease ranged from 35 mg/L in station 4 during January 2016 to 240 mg/L in station 2 during January (2016) (Fig. 3). It was found that the values of the indicators of the pollution of sewage water are large, So in areas with a high social level the values were lower than other rest regions, and this fact has been observed (Bush, 2000). Oil & Grease ranged were exceeding the standard value for wastewater discharged into the watercourse in all sites.

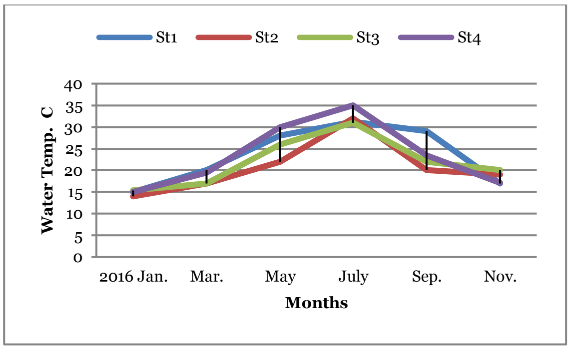

Fig. 1. Variation of water temperature.

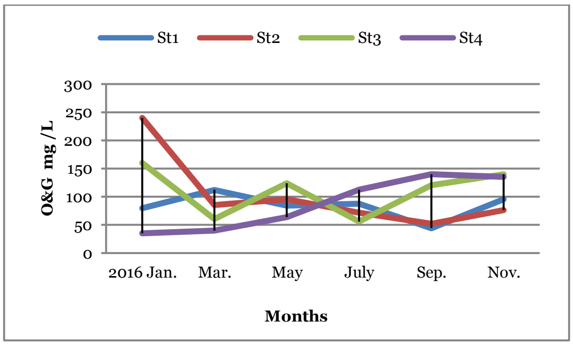

Fig. 2. Variation of oil and grease.

Monthly changes in values of biological oxygen demands (BOD_5) shows the lowest value 45 mg/L was recorded in May 2016 from station 4 and the highest 219 mg/L was in July 2016 at station 3 (Fig. 3). The biological oxygen demand is defined as the quantity of DO which is able to oxidize the organic components in the water with the assistance of microorganisms under defined experimental conditions (Fahad, 2005). Generally, results indicate that increasing levels of BOD_5, especially at station 3 during the July, this may be due to decomposition of organic matters that run directly to the river with domestic sewage. These results were slightly higher than that reported by (Sadek and Kamel, 2007; Lind, 1979). The results denoted that the mean concentrations of BOD_5 were exceeding permissible levels recommended by Iraqi standard guideline value for wastewater discharged into the watercourse in all sites.

The lowest of monthly changes in values of The Chemical oxygen demand 108 mg/L was recorded in September 2016 at station 3 and the highest 614 mg/L was in July 2016 at station 3 (Fig. 4). Chemical oxygen demand is defined as the amount of a specified oxidant that reacts with the samples under controlled conditions (Abed Al-Razzaq, 2011) also is often used as a measurement of pollutants in wastewater and natural water. COD ranged were exceeding the standard value for wastewater discharged into the watercourse in all sites.

Monthly variation in pH values varied from the lowest value 7 was recorded in May 2016 at station 1 and 2 and July in station 3 whereas the highest value 8 was in March 2016 recorded at station 2 and November in station 3 (Fig. 5). The pH of water is directly related to carbonate and bicarbonate ions present in it which is closely associated with CO_2 pressure and the ionic strength in the aquatic solutions. It is well known that the pH is an important parameter in evaluating the acid-base balance of water. The pH value of water at sewage plant which received a discharge from the Paper Mill area was found was usually higher than that of the river water. Water having a pH greater than 8 contains carbonates and pH range 4.5-8 contains bi-carbonates and carbonic acids. The waters having a pH less than 4.6 contain carbonic acid. Monthly changes in values of Chloride were recorded the lowest 117 mg/L was measured from station 2 in September 2016 and the highest 501 mg/L was observed in March 2016 from station 3 (Fig. 6). Chloride is a natural substance present in all portable water as well as sewage effluents as metallic salt. Generally high concentration of chloride indicates to organic pollution in the water (Al-Kuraishi, 2011). Our result was similar to previous studies done by (Rasheed, 1994; Al-Saadi *et al.*, 1989).

Fig. 5. Variation of pH.

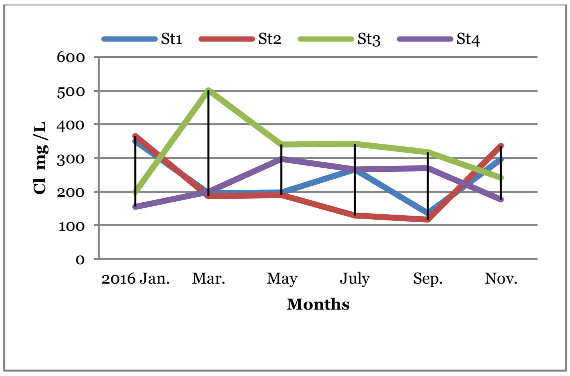

Fig. 6. Variation of Chloride.

The monthly variation in values of electrical conductivity was recorded the lowest 1330 µs/cm was measured from station 4 in January 2016 and the highest was 4800µs/cm that observed in January 2016 from station 3 (Fig. 7). Electrical conductivity used as an indicator of water quality based on total dissolved salts (Joseph *et al.,* 2011). The increase EC values at station 2 reflect the strong effect of domestic sewage effluent discharge in this area. Also, EC values recorded in the present study is coincided with findings of **(**Rasheed, 1994; Al-Saadi *et al.*, 1989). The monthly changes in total dissolved solid were recorded the lowest 1000 mg/L encountered on March 2016 at station1, also on September 2016 at station 2, 3, and on November at station 4. Whereas the highest value 2600 mg/L was recorded in March 2016 at station 3 (Hashim, 2010), (Fig. 8). Total dissolved solids (TDS) are the term used to describe the inorganic salts and small amounts of organic matter present in solution in water. These results were slightly lower than that reported by (AL-Zamili, 2007). The results denoted that the mean concentrations of Electrical conductivity and total dissolved solid within permissible levels recommended by Iraqi standard guideline value for wastewater discharged into the watercourse in all sites.

The monthly variations in total suspended solid was recorded the lowest 40 mg/L was observed in May and September 2016 at station 1, the highest value 340 mg/L was observed in March 2016 at station 4. High concentration of total suspended solids can cause multiple problems affecting the water body and aquatic life, such as:- stop the production of DO due to non-entry of light into the depths causing the lack of ability of plants to carry out photosynthesis, and also due to the increasing of the temperature of the surface water because the suspended particles absorb heat from sunlight and decrease the proportion of DO in the water (Lawson, 2011) .

Table 1. Minimum and maximum (First Line), mean and standard deviation (Second Line), for physical and chemical characteristics at study stations.

Stations Parameters	1	2	3	4
COD mg/L	206.16 ±114.3 (110 –412)	±65.5 217 (120-310)	300.5±212.21 (108-614)	182.66±24.09 (150-219)
Water Temp. °C	23.38 ±6.86 (15 – 31.2)	20.6±6.18 (14 – 32)	21.9±5.822 (15.4 – 31)	23±7.80 (15 – 35)
O&G mg/L	84±22.62 (44 – 112)	103.5±68 (52 – 240)	110±42.68 (56 – 160)	87.66±47.28 (35 – 140)
E .C µS/cm	1991.6±669.15 (1339 –3200)	2218±854 (1510 –3600)	2860±1206.98 (1864 – 4800)	2019±681.18 (1330 – 2900)
H_2S mg/L	24.66±9.179 (15 – 39)	38±21 (11 – 68)	12±4. 9 (3 – 17)	18.16±8.886 (10 – 34)
TDS mg/L	1350±308.22 (1000 –1800)	1483±466.5 (1000 – 2200)	1800±606.63 (1000 – 2600)	1516±402.07 (1000 – 2100)
$NO_2^=$ mg/L	0.4±0.31 (ND – 0.9)	0.316±0.23 (ND – 0.6)	0.38±0.248 (0.1 – 0.8)	0.45±0.242 (0.1 – 0.8)
TSS mg/L	125±53.8 (40 – 185)	119±41.28 (80 – 180)	163±90.70 (80 – 320)	234.16±75.65 (140 – 340)
pH	7.33±0.24 (7.1– 7.7)	7.5±0.3 (7 – 8)	7.53±0.417 (7 – 8)	7.38±0.318 (7– 7.8)
NH_3 mg/L	27.8±15 (15 – 56)	31.3±13.35 (13 – 50)	381±18.424 (16 – 61)	38±27.18 (16 – 84)
BOD_5 mg/L	125±50 (79 – 185)	145.8±50.39 (68 – 216)	137±51 (70 – 219)	127.16±56.52 (45 – 216)
Cl^- mg/L	240±78 (136 – 350)	220.6±105.2 (117 –365)	323±104.18 (199 – 501)	277±57.57 (155 – 297)
SO_4 mg/L	441.5±215.7 (205 – 699)	570.3±207.2 (288 – 790)	671.6±274.88 (370 – 1028)	433.16±123.61 (329 – 658)
$NO_3^=$ mg/L	4.416±3.441 (ND – 10)	2±1 (ND – 3)	3.33±2.581 (ND – 7)	3.516 ±2.180 (1.9 – 7.7)
PO_4 mg/L	11.8±7.34 (ND– 19)	10±6.73 (ND – 14)	8.6± 4.451 (5.2 – 15)	10.48±3.366 (6 – 14)

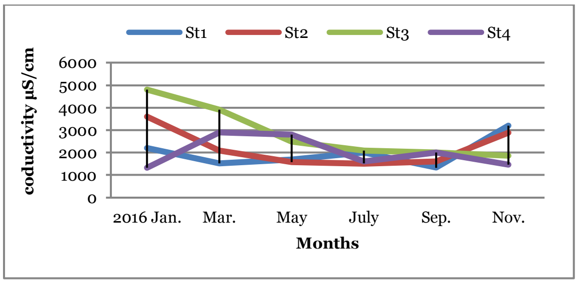

Fig. 7. Variation of conductivity.

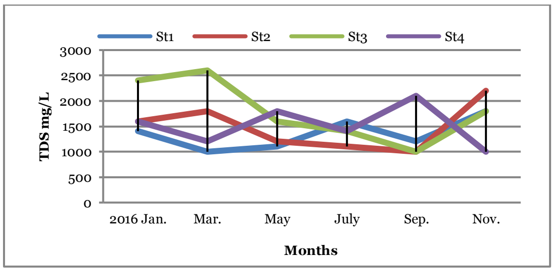

Fig. 8. Variation of TDS.

The highest TSS in a water body can often mean higher concentrations of bacteria, nutrients, pesticides, and metals in the water because suspended particles provide attachment places for these other pollutants (Health Canada. 2012), (Fig. 9). TSS ranged was exceeding the standard value for wastewater discharged into the watercourse in all sites.

The lowest monthly variations in Nitrite ND mg/L were observed in January 2016 at station1and 2, whereas the highest value 0.9 mg/L was observed in November 2016 at station 1. Anaerobic conditions may result in the formation and persistence of Nitrite is a consequence of microbial activity and may be intermittent (WHO, 2006). Nitrite ion is never found in pure water source of nitrite in sewage wastewater come from the common usage of detergents may cause decreased. Nitrite concentration in sewage because of high organic matter content (Elhatip, and Gullu, 2005) (Fig. 10).

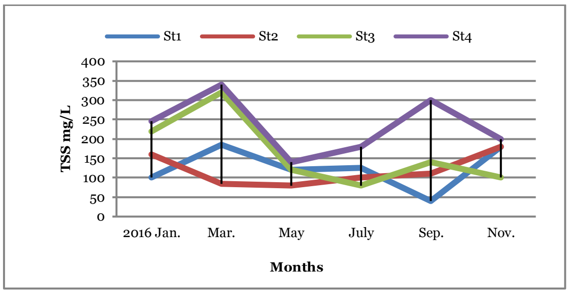

Fig. 9. Variation of TSS.

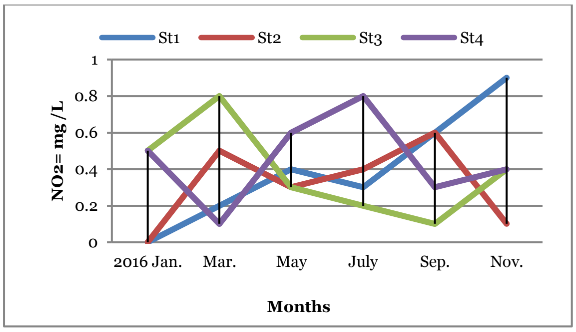

Fig. 10. Variation of Nitrite.

The lowest monthly variations of Nitrate ND mg/L was in January 2016 from station, 2, and 3 While as the higher 10 mg/L was observed on May 2016 at station 1 (Fig. 11). Nitrate is the stable form of combined nitrogen and it is an important factor which might limit growth of phytoplankton (Al-Lami *et al*., 1999). The results of nitrate have agreed with those of (Al-Ani*,* 2002*;* Maulood *et al*, 1994). The monthly variation in the values of Reactive phosphate recorded the lowest NDmg/L was observed on January 2016 at station 1 and 2, Whereas the higher 19 mg/L was observed on May 2016 at station 1 and 4 (Fig. 12). Our result may be related to human activities as well as the use of detergents which was observed along the four study stations agricultural land-use, anthropogenic activities and industrialization. Farming operations around the area were said to have contributed immensely to elevated values of ammonia and phosphate (Olajire, and Imeokparia, 2000), Nitrate and Phosphate ranged were exceeding the standard value for wastewater discharged into the watercourse in all sites.

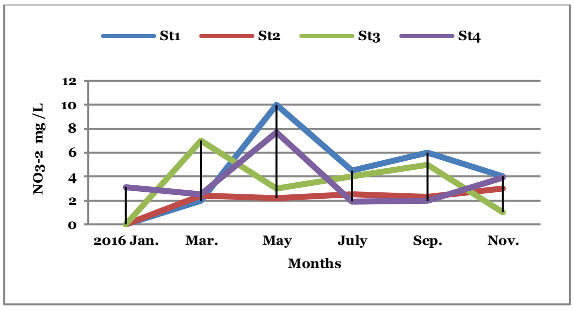

Fig. 11. Variation of Nitrate.

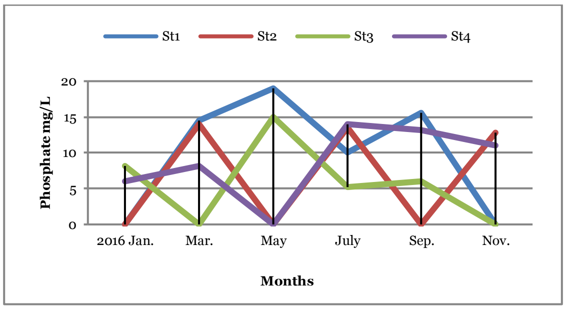

Fig. 12. Variation of Phosphate.

The values of sulfate varied from the low 205mg/L were observed on May 2016 at station 1, While as the higher 1028 mg/L was observed in March 2016 at station 3 (Fig. 13). Sulphate is widely distributed in nature and may be present in natural waters. The main source of Sulphate is the rocks present near the water bodies and biochemical action of anaerobic bacteria (WHO, 1996). The results denoted that the mean concentrations of Sulphate were exceeding permissible levels recommended by Iraqi standard guideline value for wastewater discharged into the watercourse in all sites.

The monthly variation in values of Ammonia varied from the lowest 13mg/L was observed in November 2016 at station 2, Whereas the highest value 84 mg/L was observed in May 2016 at station 4 (Fig. 14). The term ammonia includes the non-ionized NH_3 and ionized NH_4 species higher concentrations of ammonia in sewage samples give arise to heavy pollution power, sources of ammonia in sewage effluent reflect influence of liquid wastes, high usage of detergent and increasing organic substances, which lead to ammonification (Yuce *et al*., 2006). An increased of ammonia in sewage wastewater are reused for irrigation in farmlands and can cause plant and tree damage (Priestly, 2002).

The results denoted that the mean concentrations of Ammonia within permissible levels recommended by Iraqi standard guideline value for wastewater discharged into the watercourse in all sites.

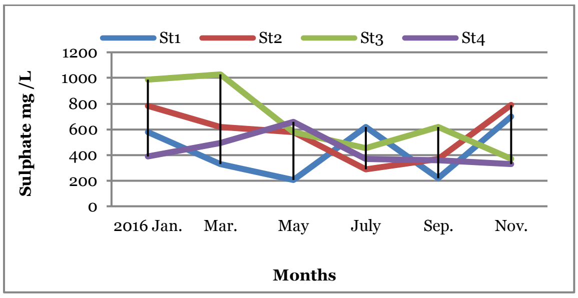

Fig. 13. Variation of Sulphate.

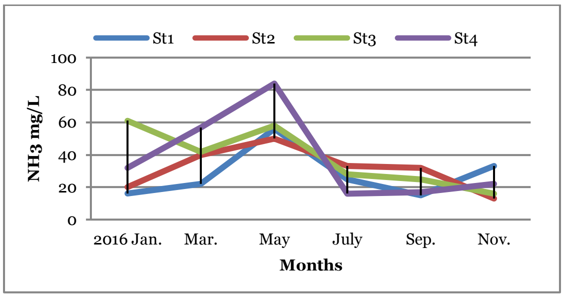

Fig. 14. Variation of Ammonia.

The monthly variation in values of Hydrogen sulfide varied from the lowest 3mg/L was observed on September 2016 at station 3, Whereas the higher 68 mg/L was observed on November 2016 at station 2 (Fig. 15). Hydrogen sulfide is a gas with offensive "rotten eggs" odor that is detectable at very low concentration is formed when sulfides are hydrolyzed in water the tastiest. Also odor threshold of sulfides in well aerated or chlorinated water, and hydrogen sulfide levels in oxygenated water supplies are normally very low, natural waters subjected to unusual conditions maintain high concentration of hydrogen sulfide (Hem, 1985), hydrogen sulfide forms in sewage water in the absence of dissolved oxygen may be results from the action of bacteria that is normally present in the sewage and acts on the sulfur containing organic matters, sewage waste water sample show high (H_2S) concentration which may be derived from detergents, sulfates and bacterial actions (Canada, 2006).

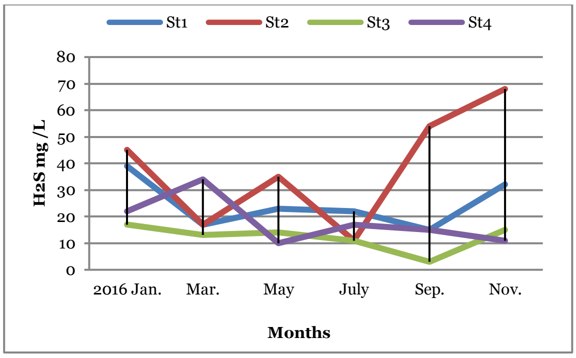

Fig. 15. Variation of Hydrogen sulfide.

Conclusions

It was concluded by the current study, all wastewater treatment plants have a direct impact on the quality of the Tigris River due to be exceeding permissible levels recommended by Iraqi standard guideline value for wastewater discharged into the watercourse in all sites.

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