Characteristics of Raw Domestic Sewage for Basrah City

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Abstract

The analysis of raw domestic sewage has a greater importance for design of an effective and economic rational sewage treatment. The objectives of this study are to determine the chemical, physical and Biochemical characteristics of raw domestic sewage for Basrah city. Results show that; the strength of Basrah raw domestic sewage can be classified as a strong strength concentration wastewater due to high levels of organic loading rate BOD_5 , COD. Also, it can be seen a very high concentrations of TDS , CL^- and increasing in EC levels above the typical limits due to the salinity of domestic water supply in Basrah. High concentrations of oil and grease were found as result of misuse of the sewerage system. While the values of pH, temperature, nutrients and the number of FC are within the typical acceptable limits.

خصائص مياه الصرف الصحي المنزلي الخام لمدينه البصرة

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الخلاصة

أن تحليل مياه الصرف الصحي المنزلي الخام له أهميه كبيره في تصميم اقتصادي وعقلاني لمحطات معالجه مياه الصرف الصحي. أن هدف هذه الدراسة هو أيجاد صفات مياه الصرف الصحي المنزلي الخام لمدينة البصرة. أظهرت النتائج بأن مياه الصرف الصحي المنزلي لمدينة البصرة يمكن تصنيفه على انه مياه مجاري قوي التراكيز بسبب ارتفاع تراكيز الأحمال العضوية التي تتمثل بارتفاع قيم المتطلب الحيوي للأوكسجين (BOD) و المتطلب الكيمائي للأوكسجين (COD). كما يمكن ملاحظة ارتفاع نسبة التوصيلية الكهربائية(EC) و تركيز المواد الصلبة الذائبة الكلية (TDS) إضافة إلى تركيز ايون الكلورايد (CL^-) بسبب استخدام مياه ذات ملوحة عالية للاستهلاك المنزلي في مدينة البصرة. كما لوحظ زيادة في تراكيز الزيوت والشحوم وذلك بسبب سوء استخدام منظومة الصرف الصحي. بينما كانت تراكيز المغذيات عدد البكتريا القولونية البرازيه (FC) وقيمة الأس الهيدروجيني (pH) ومعدل درجات الحرارة ضمن الحدود المثالية المقبولة لمياه الصرف الصحي المنزلي الخام.

1- Introduction

Domestic wastewaters originate principally from domestic, household activities but will usually include waters discharged from commercial and business buildings and institutions as well as ground water. Surface and storm waters may also be present. Domestic wastewaters are usually of a predictable quality and quantity [1].

In order to design onsite wastewater treatment systems, we must understand the nature of the wastewater as the effluent quality depends upon the influent characteristics. The treatment capacity and treatment efficiency of systems are calculated based upon the influent characteristics and the effluent requirements [2].

Wastewater is mostly water by weight. Other materials make up only a small portion of wastewater, but can be present in large enough quantities to endanger public health and the environment. The wastewater components that most wastewater facilities are designed to remove are suspended solids, biodegradable organics, and pathogenic organisms.

The important components of domestic wastewater are [3]:

1. **Inorganic**, inorganic minerals, metals, and compounds, such as sodium, potassium, calcium, magnesium, cadmium, copper, lead, nickel, and zinc.
2. **Nutrients**, wastewater often contains large amounts of nitrogen and phosphorus in the form of nitrate and phosphate, respectively, nutrients that promote plant growth.
3. **Organic Matter**, Organic materials are found everywhere in the environment. They are composed of the carbon-based chemicals that are the building blocks of most living things. The amount of oxygen organisms need to break down wastes in wastewater is referred to as the biochemical oxygen demand (BOD) and is one of the measurements used to assess overall wastewater organic matter.
4. **Solids**, Waste solids are classified according to gross physical properties and chemical composition. The three basic types of solids include: settleable solids, suspended solids, and dissolved solids.
5. **Pathogens**, Many disease-causing viruses, parasites, and bacteria also are present in wastewater and enter from almost anywhere in the community. These pathogens often originate from people and animals who are infected with or are carriers of a disease.
6. **Oil and Grease**, Oil and grease is the term given to the combination of fats, oils, waxes, and other related constituents found in wastewater.

The analysis of raw domestic sewage has a great importance for design of an effective and economic rational sewage treatment . In this study the important chemical, physical and Biochemical characteristics of raw domestic sewage for Basrah city are analyzed, such as ;

Biochemical Oxygen Demand (BOD_5), Chemical Oxygen Demand (COD), Electrical Conductivity (EC), Total Suspended Solid (TSS), Chloride (CL^-), Phosphate (PO_4), Nitrate(NO_3), Ammonia (NH_3), pH, Temperature and Fecal Coliforms Bacteria (FC) . Also, the estimation o the quantity of $BOD_5$and TSS for each person per day are performed.

2- Experimental Work

2-1 Study Area

The study was conducted on 75% of areas in Basrah city center, as shown in Fig. (1). These areas have a population of 940,000 inhabitants. The domestic wastewater of them are collected by sewer system and discharged to Hammdan sewage treatment plant, which receive 170,000 m^3 of wastewater per day[4,5]

2-2 Samples Collection

The samples were collected from the inlet zone of Hammdan sewage treatment plant. Three samples were taken monthly during the research period which were continued from November 2010 to August 2011, by using the grab method [6]. These samples were kept in dark bottles at 4°C and sent to the laboratory to perform the required analysis.

2-3 Samples Measurements

The samples were analyzed in Hammdan sewage treatment plant laboratory as described in the Standard Methods for the Examination of Water and Wastewater [6].

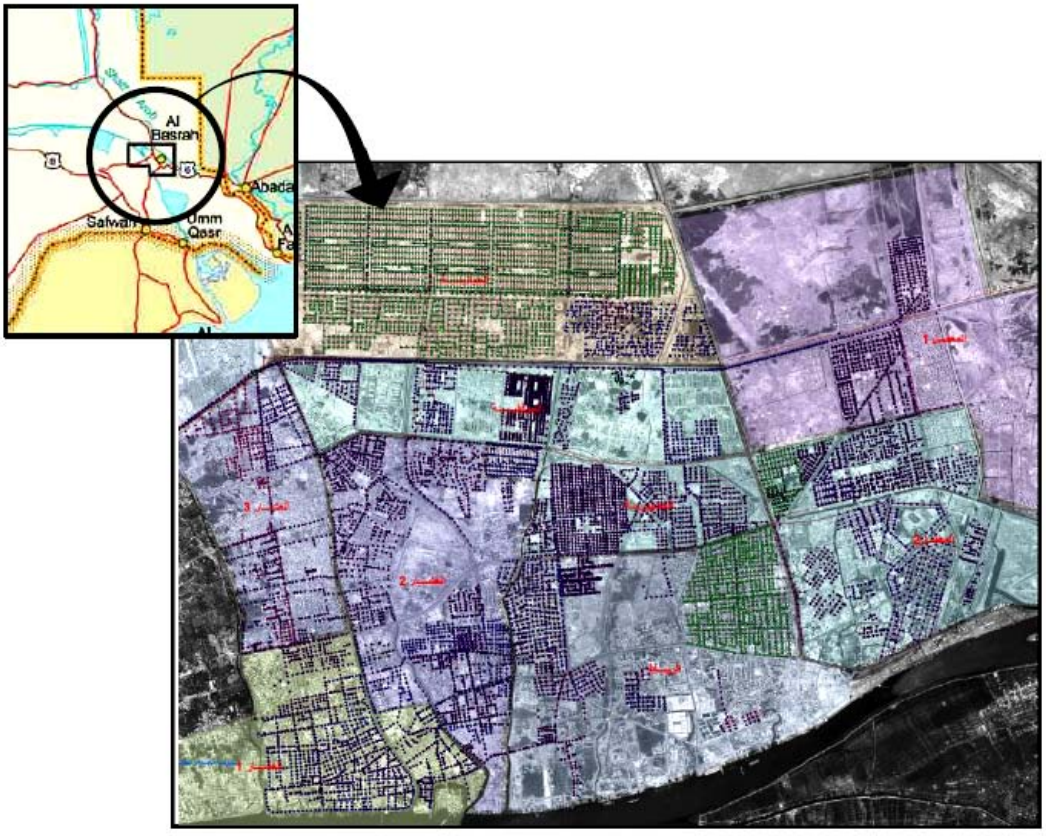

Fig.(1) Basrah Underserved Areas with Sewerage Systems (2011)

3- Results and Discussion

Results of the obtained characterization of domestic sewage are shown in Tables (1). The results represent mean values obtained for each month of study period

Table (1) Characterization of Raw Domestic Sewage for Basrah City

Mean values	Date									
	11/2010	12/2010	1/2011	2/2011	3/2011	4/2011	5/2011	6/2011	7/2011	8/2011
Temperature (°C)	29.7	20.3	19	19	20.7	27	29.8	31.1	33.4	32
pH	7.9	8.13	7.87	7.7	7.54	7.64	8.2	7.52	7.45	7.4
EC (μ s/cm)	6163	6731	6226	6990	13790	8192	11669	12240	6575	6001
BOD (mg/l)	270	200	250	320	500	375	270	180	240	160
COD (mg/l)	492	307	276	505	1211	800	380	355	360	240
TSS (mg/l)	196	292	328	300	320	306	140	440	220	180
TDS (mg/l)	4020	4276	4424	4544	4956	3850	4680	6120	4100	3630
CL^- (mg\l)	1273	1539	1092	1130	1758	1444	1739	1633	1115	1794
NH_3 (mg\l)	21	19.8	17.6	22	33	26.7	23.5	31	27	23.5
NO_3 (mg\l)	11.6	7.8	10	8.5	5.4	8.7	5	16	6.5	17.5
PO4 (mg\l)	3.5	13.4	2.59	10.6	5.4	4.8	9.6	9.96	5	18
Oil &Grease (mg\l)	186	153	100	180	152	300	260	400	420	350
Fecal Coliforms (Num./100 ml)	1.9×10^6	1.8×10^6	1.5×10^6	2×10^6	2.3×10^6	2.7×10^6	2.3×10^6	2×10^6	2.5×10^6	1.7×10^6

3-1 Data Analysis

To give a clear view about the results, the obtained data was compare with typical guide data [7, 8, 9] which used as reference for residential untreated wastewater as shown in Table (2).

Table 2. Typical Guide Values of Residential Untreated Wastewater

Constituent	Values			Constituent	Values		
	Min.	Max.	Typical		Min.	Max.	Typical
Temperature(°C)	4	38	25	CL^- (mg\l)	30	90	50
pH	6	9	7.5	NH_3 (mg\l)	12	45	25
EC (µs/cm)	500	1500	700	NO_3 (mg\l)	--	--	--
BOD (mg/l)	110	350	250	PO_4 (mg\l)	7	20	12
COD (mg/l)	250	800	500	Oil & Grease (mg\l)	50	100	70
TSS (mg/l)	120	400	220	Fecal Coliforms (Num./ 100ml)	10^3	10^8	10^5
TDS (mg/l)	270	860	500				

3-1-1 Organic Matter Analysis

Both terms of BOD_5 and COD are commonly used to measure the Organic matter. The results show that the values of BOD_5 range from 180 to 500 mg\l as shown in Fig. 2. While the values of COD range from 240 to 1122 mg\l as shown in Fig.3. These values are represent high strength domestic sewage, which an indicator of high content of organic matter.

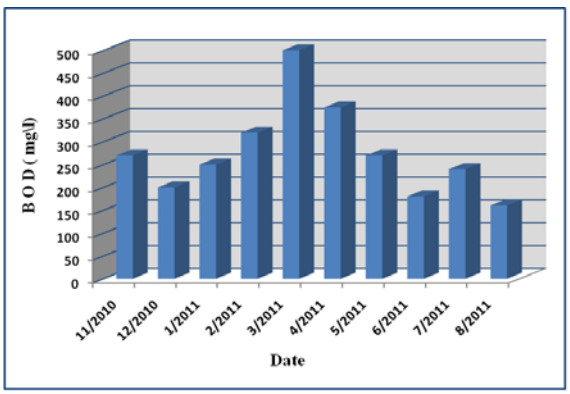

Fig.(2) Variation of BOD_5 during the study period

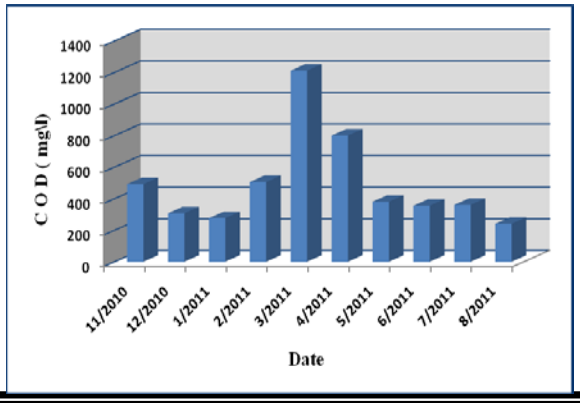

Fig.(3) Variation of COD during the study period

3-1-2 Solids Matter Analysis

Both of total suspended solids (TSS) and total dissolved solids (TDS) are refer to the quantity of solid in the waste water. The results show that the values of TSS range from 180 to 440 mg\l as shown in Fig. 4. These results are acceptable according to typical limit values as shown in Table 2 , so there are some quantity of solid like clay, silt and sand enter to domestic sewer pipes from manholes.

Also the results show that the values of TDS were range from 3630 to 6120 mg\l as shown in Fig.5. These values were relatively high because the most TDS is include ionized and nonionized matter , and it is reflected to water salinity.

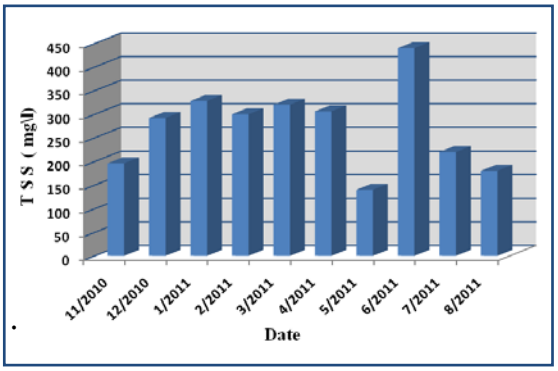

Fig.(4) Variation of TSS during the study period

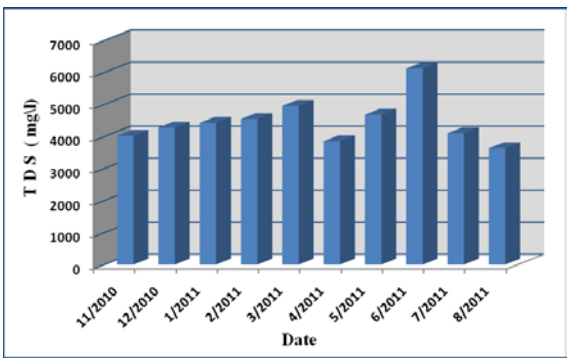

Fig.(5) Variation of TDS during the study period

3-1-3 Nutrients Analysis

Nitrogen and phosphorus compounds are represented of the nutrients matter in sewage. In this study the Nitrate (NO_3) and Ammonia (NH_3) are refer to Nitrogen compounds. The results show that the values of NO_3 ranged from 5 to 17.5 mg\l as shown in Fig. 6,

while the values of NH_3 are ranged from 17.6 to 33 mg\l as shown in Fig. 7. Another nutrient matter in domestic sewage is phosphorus compounds, elemental phosphorus does not persist naturally in aquatic systems as it is quickly oxidized by molecular oxygen to phosphate. The results show that the phosphate (PO_4) values were ranged from 3.5 to 18 mg\l as shown in Fig. 8. The values of NH_3 and PO_4 are lied within the range of natural domestic sewage as shown in Table (2).

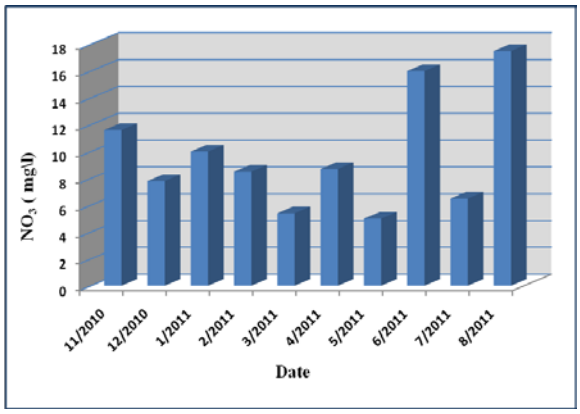

Fig.(6) Variation of NO_3 during the study period

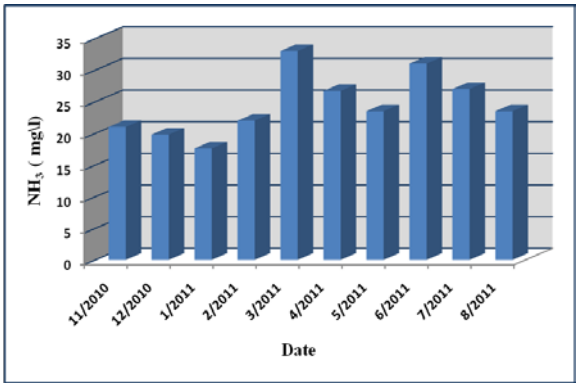

Fig.(7) Variation of NH_3 during the study period

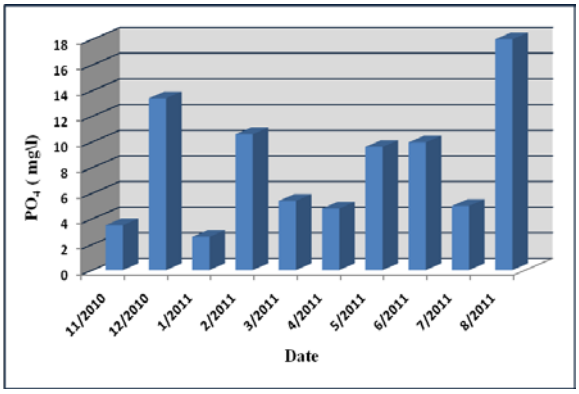

Fig.(8) Variation of PO_4 during the study period

3-1-4 Pathogens Analysis

The Fecal Coliforms bacteria (FC) refer to the rates of pathogens in domestic waste water. In this study the results shows that, the number of Fecal Coliforms (FC) are varied from 1.5×10^6 to 2.7×10^6 Num./100 ml. Figure (9) shows that, the number of Fecal Coliforms bacteria are approximately convergent values during all months of the year with slight increase in summer as the Fecal Coliforms are growing at an elevated temperature in a different, growth specific medium. Generally, the obtained values of FC lie within the range of typical values of domestic sewage as shown in Table (2).

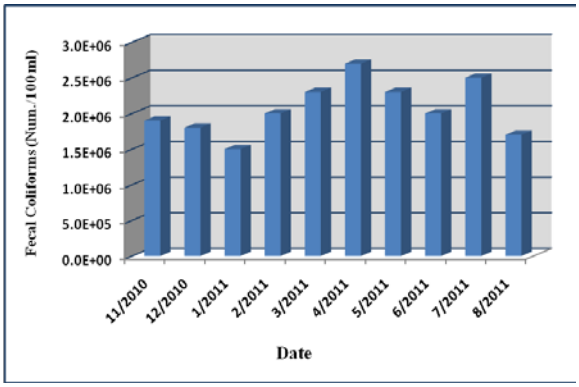

Fig.(9) Variation of Fecal Coliforms bacteria (FC) during the study period

3-1-5 Chloride (CL^-) & Electrical Conductivity (EC) Analysis

Both chloride ions (CL^-) and electrical conductivity (EC) are refer to the salinity of domestic waste water. Electrical conductivity is widely used to indicate the total ionized constituents of water. The results show that the E.C. values are ranged from 6001 to 13790 µS/cm as shown in Fig. 10 , the high concentration are indicator to high salts ions such as chloride ions in Basrah water. The Chloride ions (CL^-) is the most common phytoxic ions that may be present in municipal sewage. The results show that the chloride ions (CL^-) values are ranged from 1092 to 1794 mg\l as shown in Fig. 11. These values are very high, compare with typical values limits in Table 1, as the consumed domestic water used in Basrah city is very salty water. The high

values have negative effects on the wastewater treatment because the studies show that chloride concentrations exceed 8000 mg/l, it will be harmful for Biochemical process in wastewater treatment systems[7].

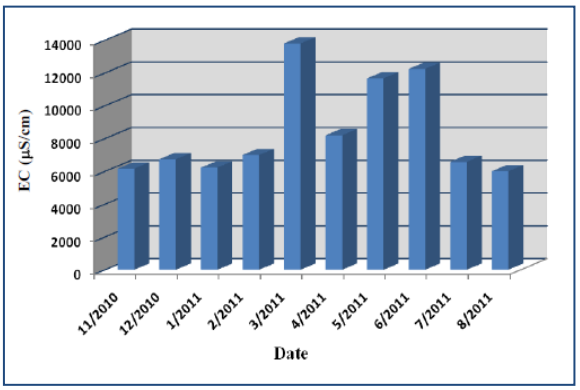

Fig.(10) Variation of E.C. during the study period

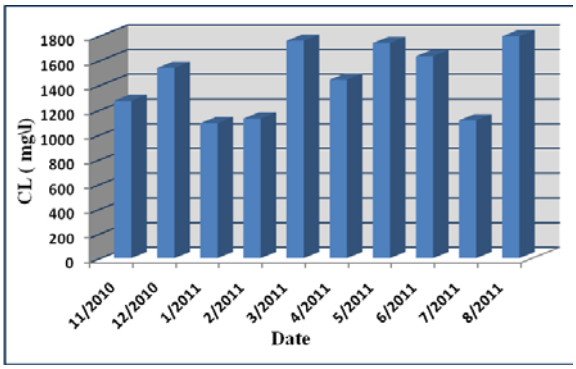

Fig.(11) Variation of CL^- during the study period

3-1-6 pH and Temperature Analysis

The acidity or alkalinity of wastewater affects both treatment and the environment as the concentration range suitable for most biochemical life existence is quite narrow and critical. The results show that the pH values ranged from 7.4 to 8.2 as shown in Fig. 12. The pH of wastewater needs to remain between 6 and 9 to protect beneficial organisms, therefore the obtained values are acceptable [8] . Temperature is a very important wastewater characteristic. The chemical equilibrium of complex wastewaters is very temperature dependent. The results show that the temperature values ranged from 33.4 to 19 ◌̊C as shown in Fig. 13. At low temperatures approximately (4◌̊C), biochemical and chemical reaction rates are extremely slow, and waste treatment operations are often severely limited. At temperatures greater than (38 ◌̊C), many waste treatment plants experience operating difficulty. Biochemical processes are impaired, air and oxygen volubility becomes limited, and other physical properties such as sludge density and settling rate affect overall waste treatment[7,8].

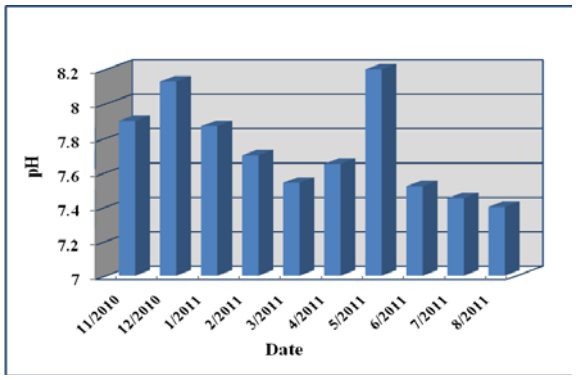

Fig.(12) Variation of pH during the study period

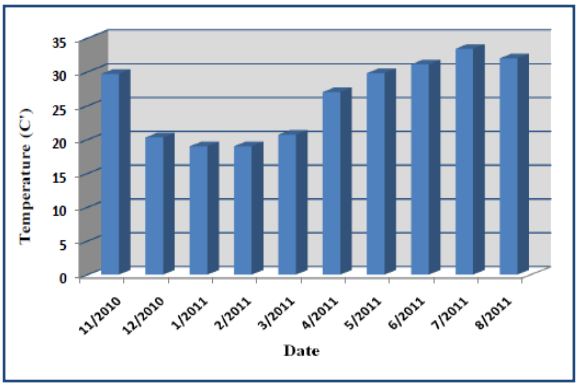

Fig.(13) Variation of temperature during the study period

3-1-7 Oil and Grease Analysis

Oil and grease are among the most stable organic compounds and are not easily decomposed by bacteria. The results show that the oil and grease values range from 100 to 400 mg\l as shown in the Fig. 14. These values are high, compare with typical values in Table (2) as large quantities of fatty acids, soaps, fats, waxes, oils discharged to sanitary sewer system pipes. In any case, oil and grease have to be removed prior Biochemical treatment as they will clog the flow distributing devices and air nozzles.

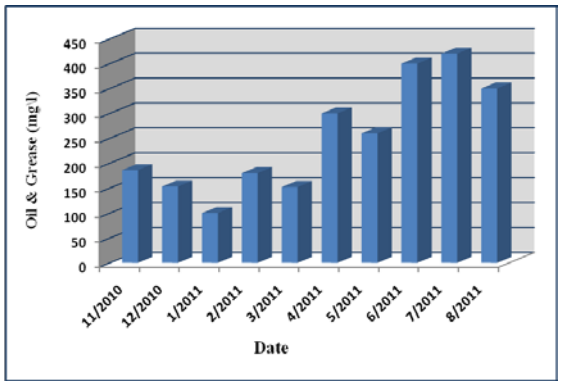

Fig.(14) Variation of Oil& Grease during the study period

3-2 Results Comparison

To achieve more benefit from this study, comparison is performed between the obtained values for examination characteristics of domestic sewage of Basrah city, and the other values of studies that conducted in the some countries. Table (3) shows that the characteristics of domestic sewage are different for each country depending on the living pattern and environment condition. Therefore, it's very important to know the characteristics of domestic sewage ,when the wastewater treatment plant was constructed.

Table (3), Comparison of the characteristics values of domestic sewage for Basrah city with other values in some countries

country	pH	BOD (mg/l)	COD (mg/l)	TSS (mg/l)	TDS (mg/l)	CL^- (mg\l)	NO_3 (mg\l)	PO_4 (mg\l)	Oil & Grease (mg\l)
Basrah	8.2-7.4	160-500	240-1211	140-440	3630-6120	1092-1794	5-17.5	3.5-18	100-400
Jordon [10]	---	770	1830	900	1170	---	---	----	----
Syria [11]	7.1-7.6	201-445	336-887	296-542	340-700	---	---	16-54	124-227
Egypt [12]	7.40	309	567	---	---	237	10	7.1	---
Bangladesh [13]	6.9 -6.2	108-168	---	100-200	200-400	42	0.2	---	80
Nigeria [14]	---	163-220	286-355	200-280	220-367	---	----	---	---
Canada [15]	7.8	223	333	134	---	---	1.12	---	---

Chennai [16]	6.5-7.3	200-300	300-400	---	---	180-220	---	---	---
Turkey [17]	6.5-8	200-360	360-570	350-750	---	---	0-30	3-22	50-150

The amount of BOD_5 and TSS in the unit of gram per capita per day are very important parameters which must be taken into consideration for wastewater treatment plants design purpose. In this study the amount of BOD_5 and TSS ranged from 29 to 90 and 25 to 79 g\capita\day, respectively. These values are compared with other values in studies which conducted in the some countries a shown in Table 4.

The comparison shows that Basrah domestic sewage has a high concentrations of organic loading rate and it can be described as a salty wastewater, also, the quantities of oil and grease are very high, compare with other countries.

Table(4), Comparison of BOD_5 and TSS in (g/capita/day) values of domestic sewage for Basrah city with other values in some countries [8 ,16]

Country	BOD (g\capita\day)	TSS (g\capita\day)
Basrah	29 - 90	25 - 79
Egypt	27 - 41	41 - 68
Palestine	32 - 68	52 - 72
Denmark	55 - 68	82 - 96
turkey	45 - 60	70 - 145
India	30 - 45	40 - 60
France	40 - 50	60 - 70
England	50 - 59	70 - 80
Italy	49 - 60	55 - 82

4- Conclusion

The results show that the raw domestic sewage of Basrah city have the following characteristics :

1- The values of BOD_5 ranged from 180 to 500 mg\l , while the values of COD were range from 240 to 1211 mg\l. The amount of BOD_5 in gram per capita per day ranged from 29 to 90. That's refer to high levels of organic loading rate.

2- The values of TSS ranged from 180 to 440 mg\l. the amount of TSS in gram per capita per day ranged from 25 to 79. While the values of TDS were range from 3000 to 6120 mg\l. These values were relatively high because the most TDS is include ionized and nonionized matter , and it is reflected to water salinity

3- The values of NO_3 and NH_3 ranged from 5 to 17.5 mg\l , 17.6 to 33 mg\l. While the values of PO_4 values were ranged from 3.5 to 18 mg\l. the nutrients compounds which study are lied within the range of natural domestic sewage.

4- The number of Fecal Coliforms (FC) varied from 1.5×10^6 to 2.7×10^6 Num./100 ml.

5- The values of E.C. are ranged from 6001 to 13790 µS/cm, while the Chloride ions (CL^-) values ranged from 1092 to 1794 mg\l. These values are very high as the consumed domestic is very salty water, which have negative effects on the wastewater treatment.

6- pH values temperature are within the acceptable values.

7- Oil and grease values ranged from 100 to 400 mg\l. These values are high as large quantities of fatty acids, soaps, fats, waxes, oils discharged to sanitary sewer system pipes.

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