

Evaluation of the quality of disposed wastewater in selected hospitals in Baghdad City

Ammar A. AlSultan¹, Rana J. Kadhem² and Waleed M. Sh. Alabdraba³

^{1,2}Building & Construction Engineering Department, University of Technology, Baghdad, Iraq

³Environmental Engineering Department, University of Tikrit, Tikrit, Iraq.

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Abstract

In this paper, four hospitals selected in Baghdad, Al-Risafaa sector, were investigated to evaluate their wastewater quality for the target of calculating the parameters of treatment design, and the period of study was five months from January 2014 to June 2014. Moreover, the hospitals' wastewater (HWW) creates serious environmental problems because of its contents, that it may contain viruses, poisonous medical materials such as toxic and radiation, heavy metals and normal domestic wastewaters. Therefore, hospitals' wastewater should be separated, high carefully treated after controlled and before disposing to the surface water or city sanitary network. Additionally, a package unit of treatment plant (PUTP) is the more convenient for those hospitals has not wastewater treatment yet, so as those schools, industries, and small community accommodation areas. The main point concluded from the research, and the quality of four hospitals' wastewater was close to that of the normal domestic wastewater excepted the toxic and radiation materials, also, we concluded that there is a variation between the quality of pollutants in the HWW during the period of study.

Key Words: Hospitals' wastewater (HWW), package unit of treatment plant (PUTP), BOD, SS.

Introduction

The hospitals' wastewater (HWW) which poses unfamiliar pollutants consider a significant environmental and economic problem, should not be neglected or overlooked. The most important of the aquatic environment pollution medical liquid and solid contaminants, and that lead to the injury of human and animal as well as plant badly damaged and dangerous in most cases, (Abbawee, and Sulaiman, 1997). The specification of the HWW including various dangers chemical pollutants, which subtract with the hospitals' wastewater to the treatment plant or sewer, such as chemicals used in chemotherapy and antibiotics operations, formaldehyde used for the purposes of sterilization, chemicals used for the purposes of photography and radiology (X-ray), (EU (European United), 2003; Pruss. A, Gironlt. E., and Rush, B. P. 1999). In additional, nuclear radiation materials, solvents, mercury,

dissolved anesthesia gasses, detergents used in the laundry and rooms, and finally, others (toxic substances, corrosive materials, and a variety of other materials), Environment Canadian, 2001. The Table 1 shows the resources of the chemical pollutants in the HWW.

Risk materials:

Risk materials containing in HWW offered the following items: Microbiological Pathogens, Hazardous Chemicals, Pharmaceuticals and Radioactive isotopes (CCLIN, Paris-Nord, 1999; Kummer, 2001; Safe, 2006). Researchers founded that the HWW in the hospitals and sanitation institutions similar in composition to the public sewage for cities, and differ from those of containing very different and diverse types of liquid waste with that very small quantities, but it contains many serious infectious liquid

* Corresponding author:
Dr. Waleed M. Sh. Alabdraba
✉ walabdraba@tu.edu.iq

and compounds resulting from patient care (Perrodina, *et al.*, 2005). In a study conducted in a hospital for chemicals used in the preparation of X-Ray found to be the reason behind the increase in the proportion of organic compounds that cause hallucination of wastewater (CCLIN, Paris-Nord, 1999). Furthermore, HWW also contains a solvent, which is different in composition and concentration in hospitals and laboratories of analysis, also, the Acetone, Xylene more widely used, is usually evaporate and discharged to sewers (Kummer, 2001). Additionally, in a German study of one hospital and found large amounts of halogenated compounds hallucinogenic rates (0.13 mg/ - 0.49 mg/), there is also another study of the remnants of a teaching hospital in France between the quantity (0.24mg/ - 0.38 mg/)(Emmanuel, *et al.*, 2001). Finally, there is another study which found that hospital wastes contain a high percentage of bacteria

that cause intestinal diseases (salmonella) and bacteria (E-coli) that causes inflammation of the stomach and intestines and concentrations of (2400 - 5000 / 100 m) (Bernet and Fines, 2000).

Methods of Disposal of HWW:

There are many ways to get rid of trace HWW in case of non-treated(EPA 625/R-00/008, U.S. EPA (2005); IWMI, (Feb. 24,2006).

1. Isolate the waste of patients with gastrointestinal diseases and sterilized.
2. Non-discharge the chemicals and drugs to the sewage network.
3. Drying the sludge from the hospital sink and chemically sterilized.
4. Non-use of wastewater from hospitals offered for agriculture.
5. None of the raw waste water hospitals put into water bodies.
6. In the case of existing small hospitals in rural towns is to dump the sewage porous soil.

| Main toxic materials and other chemical wastewater | Resources |
|---|---|
| Ethylene oxide [7]. | Used for sterilization and is classified by the Environmental Protection Organization (EPA), its impacts on the show birth defects, formation of harmful fumes that cause an outburst and risks resulting from the fires. |
| Sterilants, disinfectants and cleaning solvents [10]. | Include phenol baseband solution used for cleaning floors and other applications, |
| HWW from the others process [6, 10]. | <ul style="list-style-type: none"> - The remnants of the water treatment boilers include brine. - Interior walls corroded. - Deposits Boilers. - Wastewater of cleaning boilers. - Sludge cooling towers (sediment). |
| Waste of maintenances unit process [7]. | <ul style="list-style-type: none"> - Wastewater of oil for pumps and oily lamps. - Cleaning solvents. - Waste of dyes and paint. - Consuming fluorescent lamps. |

Table 1. The resources of the chemical pollutants in the HWW.

Methodology and Field Work

The sampling of HWW raised from the following four hospitals (Al-Elwia, Al-Wasti, Sheikh Zayed and Ibn Al-Nafis) during the period of study in five months (February, March, April, May, June of 2014), the sampling at a rate of twosamples every month. Due to the different terms of reference of the hospitals included in the study and the number

of staff and clinical capacity has been collecting samples and conduct tests as shown in the Table 2.

Bottle made of polyethylene, ethylene to collect samples; all tests were conducted in the laboratory where he cannot take place simultaneously at the site. It was mind filling the bottle to an end to avoid the error in reading the oxygen concentration when an

examination of (BOD), and the samples placed in the favorable conditions (dark place and temperature 4°C). Sampling has been taken by a special way to ensure not to irritate the previously deposited material, leading to greater accuracy in the laboratory results, (Abbawee, and Sulaiman, 1997; Metcalf and Eddy, 2003). In additional, it was taken from

the last manhole and before the link with the city sewer network, where samples took during the time 9 am to 12 noon (Alhabet and Altaher, 2007). The sampling was (15 ± 1 rounds per month per), so, the total number of samples was about 75 during the period of study. Another hand, in this research, we tested about 80 samples for all parameters.

| Parameters | Standard test method | Parameters | Standard test method |
|------------------|-----------------------------|-----------------|----------------------|
| BOD ₅ | APHA 5210B | pH | APHA 4500-PB |
| COD | APHA 5220B | SO ₄ | APHA 4500-SO4E |
| NH ₃ | APHA 4500 NH ₃ C | SS | APHA 2540B |
| CL | APHA 4500-CLD | TSS | APHA 2540D |

Table 2. The standard methods that used in laboratory tests conducted on the HWW samples in four hospitals samples.

Results:

The compression has been completed between the concentrations of pollutants for the HWW within the all hospitals, and the

concentrations of pollutants in the residential wastewater during period of study, as shown in the Table 3.

| Pollutant | Al-Elwia | Al-Wasti | Sheikh Zayed | Ibn Al-Nafis | Residential WW [17], [18] |
|------------------|------------------------------|----------|--------------|--------------|---------------------------|
| | Average Concentration (mg/) | | | | |
| SS | 891.8 | 766.8 | 77.4 | 109.6 | 120 - 360 |
| TSS | 922.2 | 795.8 | 154.4 | 415.8 | 250 - 400 |
| BOD ₅ | 875.2 | 870 | 315.4 | 494 | 110 - 400 |
| COD | 3830 | 2260 | 1291.4 | 1982 | 200 - 780 |
| BOD/COD | 0.257 | 0.465 | 0.244 | 0.273 | 0.19 - 0.22 |
| PO ₄ | 15.8 | 29.52 | 15.44 | 5.94 | 1.5 - 3.0 |
| NO ₃ | 887.8 | 1664 | 160.4 | 139.4 | 75 - 150 |
| NH ₃ | 235.6 | 86.6 | 83 | 201.2 | 50 - 85 |
| Mg ⁺⁺ | 222.6 | 283.2 | 67.2 | 80 | 35 - 80 |
| Cl ⁻ | 224 | 121 | 66 | 125 | 30 - 100 |
| Ca ⁺⁺ | 280.4 | 96.6 | 89 | 329 | 15 - 25 |
| pH* | 8.6 | 8.6 | 8.3 | 8.4 | 6.7 - 7.5 |
| Turbidity (NTU) | 423 | 241 | 80.4 | 208 | |
| E.C. (µmoh) | 215 | 33 | 120.6 | 221 | |

Table 3. The comparison between HWW and Residential WW in the period of study. pH*: is unit less.

Total Suspended Solid (TSS) and Suspended Solid (SS)

Fig. 1 and Fig. 2 shows the concentration of the SS and TSS in the HWW for the four hospitals. The concentrations of SS and TSS in

Al-Elwia and Al-Wasit hospitals is larger than others concentrations in the others as results of larger suspended solid in the wastewater that led to increasing the TSS.

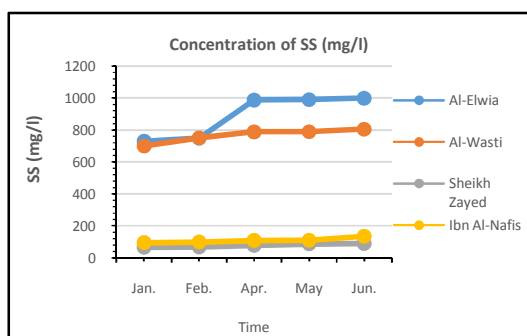


Figure 1. Variation of Suspended Solid for HWW with time.

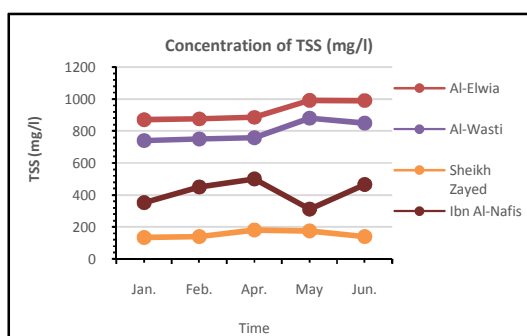


Figure 2. Variation of Total Suspended Solid for HWW with time.

Biological Oxygen Demand (BOD₅):

Fig. 3.express on the BOD₅ concentrations in the disposed HWW. It shows variation in the quality for the HWW for the four hospitals, the reason for this variation is the processes cleaning and washing of floors and other facilities that lead to the production of a semi-complex mix of waste water containing dissolved organic matter and organic matter outstanding, which are reflected on values of BOD₅. The difference in the temperature degrees during the sampling period led to also to the variation in BOD₅ concentrations.

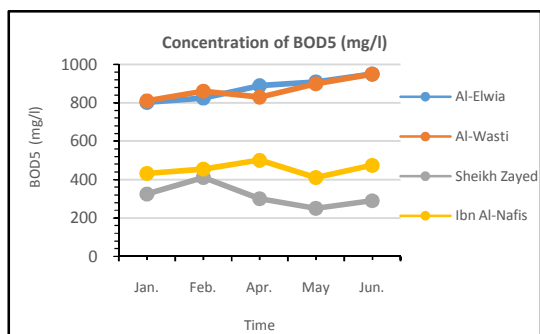


Figure 3. Variation of BOD₅ for HWW with time.

BOD/COD Ratio

BOD/COD ratio consider one of the important criteria to evaluate the organic load of the wastewater and design of the wastewater treatment plant, additionally, it is clear from Fig. 4. that the BOD/COD ratio decreased with rising temperatures degree of HWW, the reason for this matter is that rising in temperatures lead to the decomposition of chemicals materials in the HWW faster, which leads to increased values of COD, therefore the BOD/COD ratio will be decreased (Metcalf and Eddy, 2003).

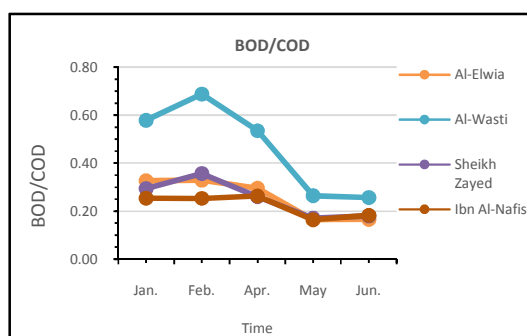


Figure 4. Variation of BOD₅/COD ratio for HWW with time.

Ammonium (NH₃) and Nitrate (NO₃):

Fig. 5 and Fig. 6. shows the results of the concentrations of NH₃ and NO₃ respectively for the four HWW. Nitrogen is a pollutant in the wastewater, another side, it is one of the nutrient for bacteria and algae and plants (Metcalf and Eddy, 2003). Nitrogen present in the wastewater in the form of organic nitrogen (40% - 59%) and ammonia (50% - 60%) NH₄⁺, nitrate and nitrite by (0% - 5%), dissolved organic nitrogen is mainly produced from urea and amino acids (Metcalf and Eddy, 2003). NH₃ and NO₃ present in the HWW, because of washing, cleaning water, as well as the urea produced water sinks and baths patients.

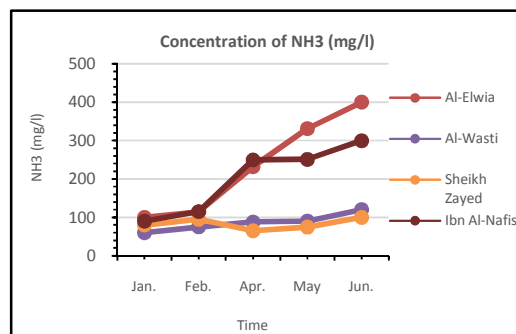


Figure 5. Variation of NH₃ for HWW with time.

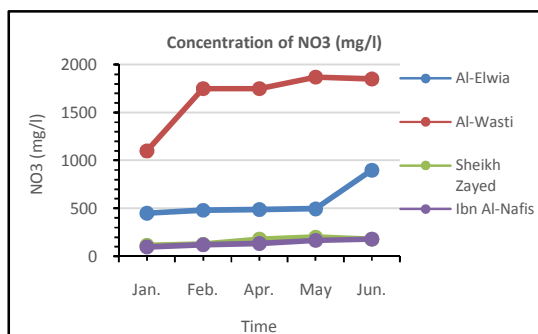


Figure 6. Variation of NO₃ for HWW with time.

Phosphorus (PO₄).

Phosphorus is a key nutrient for bacteria, as well as plants and lichens. It is to be reduced to the minimum acceptable limits by dumping the treated water to public water sources (Lake - River). In general, the primary sedimentation basins act to remove the phosphorus found in contaminated water at a rate ranging between (10% -30%) and the secondary treatment they characterized as a low effective in removing phosphorus brings one into existence because of the promiscuous form. It is clear from Fig. 7.that there is different in the PO₄ concentrations for the disposed wastewater for the hospitals during the study period.

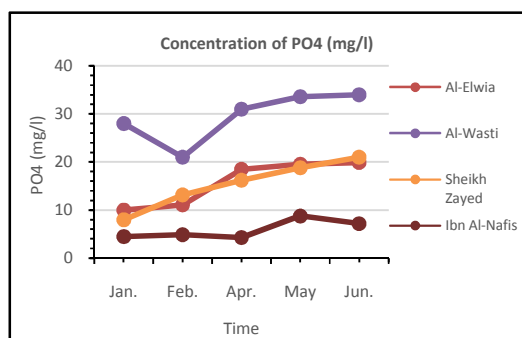


Figure 7. Variation of PO₄ for HWW with time

Effect of temperature degree:

The quality and concentration of the pollutants of HWW has been evaluated within a wide range of temperatures, and it is known that temperature affects the concentrations of pollutants through its impact on progress of chemical reactions leading to the dissolution of the compounds and their solubility in water(Metcalf and Eddy, 2003), and it is clear from Fig. 8the variation of the temperature degree of HWW.

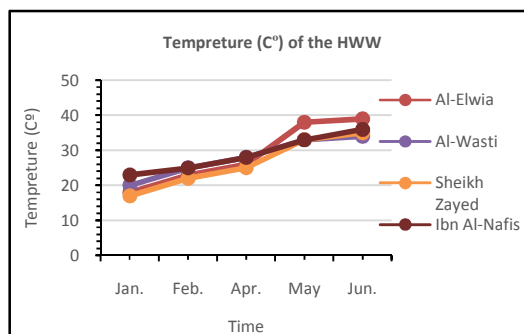


Figure 8. Variation of temperature degree of the HWW with time.

Conclusions

From the Table 3 and figures, we concluded the following notes:

1. The high value of SS at Al-Elwia hospital and Al-Wasti hospital gives proof of the large quantities of the suspended solids which can be organic and inorganic, also, which arise from the process of washing and cleaning, and it is impact on the value of BOD₅. See Fig. 1 and Fig. 2.
2. Note that the high COD values in HWW, given an indicator of the presence of high chemicals components in HWW due to of the use of detergents and chemicals.
3. There is an increase in the concentration of ammonia (NH₄) at Al-Elwia and Ibn Al-Nafis hospitals as result of the decomposition of organic nitrogen compounds in the waste water in the form of natural compounds such as proteins, nucleic acid and urea.
4. Table 3 shows the high acidic pH function for all the hospitals and this is due to an increase in the amount of waste resulting from the sterilization and cleaning floorsthat result in an increase in the concentration of the rules, which affect the value of pH.
5. It notes in the Table 3a rise in the value of chlorides and is the result of the higher use of chemical cleaners and disinfectants containing chlorine.
6. An increase in the value of the electrical conductivity, especially in Al-Wasti hospital and this is due to the high value of Total Dissolved Solid (TDS) which matching range of (0.5 – 0.9) of the total value of the conductivity. In additional,

the high value of the TDS is caused by melting chemicals raised either by the patient or due to the remnants of medication or the result of the materials used to clean the floors.

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الملخص العربي

تقييم جودة مياه الصرف الصحي في مستشفيات مختارة في مدينة بغداد

وليد محمد شيتالعبدي

· قسم هندسة البناء والإنشاءات الجامعة التكنولوجية
قسم الهندسة البيئية جامعة تكريت تكريت

الخلاصة

في هذا البحث تم إختيار أربعة مستشفيات في مدينة بغداد – الرصافة لغرض التحري عن نوعية مياه المطروحات لغرض الإستفادة منها في حساب المعاملات التصميمية لمحطات معالجة مياه المطروحات حيث إستمرت فترة البحث لمدة خمسة أشهر من شهر كانون الثاني ولغاية شهر حزيران . فإن مياه مطروحات المستشفيات تسبب مشاكل بيئية كبيرة نظراً لإحتواءها على العديد من الملوثات الطبية الخطرة كالمواد السامة والمشعة والمعادن الثقيلة فضلاً عن الملوثات التقليدية في مياه المطروحات المدنية لذا يستوجب معالجة مياه مطروحات المستشفيات قبل طرحها إلى المنافذ الأخرى. إستخدام وحدات المعالجة الجاهزة PUTP إلى أنه تبقى عملية المعالجة غير فعالة إلى حد ما بسبب سوء إدارة هذه الوحدات وعدم ديمومتها. إستنتجنا من خلال البحث والتحري إلى أن نوعية الملوثات التقليدية في مياه مطروحات المستشفيات عدا ذلك إستنتجنا أن هناك تباين واضح في نتائج الفحوصات المخبرية لنوعية ملوثات المستشفيات