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A Survey of Tehran Hospitals Wastewater

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Abstract. Regarding health point of view, hospital wastewater is considered the most important among the various kind of wastewaters because of its pathogenic and other toxic organic compounds. This study was examined the wastewater of selected hospitals in Tehran. Accordingly, 14 hospitals were selected as the research community in which there were also general and specialty hospitals. Results show that the average of biochemical oxygen demand (BOD_5) of the wastewater of a hospital has direct relation with the different section of it, in which by increasing the infectious sections the BOD_5 increased, The average flow of little hospitals up to 400 beds were 1300 liters per bed and for large hospitals until 1000 beds were 750 liters per bed. The results show that there is direct relationship between biochemical oxygen demand and different sections of studied hospitals as well as hospital wastewater qualitative parameters are equal to the urban wastewaters of course with a little increase.

Keywords: Hospital Wastewater, Flow Quantity, Chemical Oxygen Demand.

1. Introduction

Hospitals represent an incontestable release source of many chemicals compounds in the aquatic environment due to laboratory activity or medicine excretion into wastewater [1]. The hospital effluents are discharged, usually, in the urban sewer system were they mix with other effluents and finally reach the sewage treatment plant The important contaminants of concern in wastewater treatment are include: suspended solid, biodegradable organics, pathogens, nutrients, priority pollutants, refractory organics, heavy metals, dissolved inorganic. Secondary treatment standards for wastewater are concerned with the removal of biodegradable organics, suspended solid, and pathogens. Many of the more stringent standard that have been developed recently deal with the removal of nutrients and priority pollutants. When wastewater is to be reused, standard include requirements for the removal of refractory organics, heavy metals, and in some cases dissolved inorganic solids [2]. The dosage of pollutants of hospital origin shows that certain substances, such as Anti-tumor agents, Antibiotics and Organ halogen compounds, leave mostly wastewater treatment plants [3]. By leaving the wastewater treatment plants, these chemical compounds can provoke the pollution of the natural environment by entailing a biological imbalance. In case the environmental conditions allowing the degradation of these substances are not gathered, they can exercise negative effects on the receiving waters and the living species [4].

The hospitals wastewaters in comparison with domestic wastewaters which include microorganisms, detergents, oil and grease, nitrogen, phosphor, organic and mineral material, contain microorganism, dangerous radioactive materials, detergents and etc. In the hospitals which used these materials, it should be consider that the conservation of public health and insurance the sanity in the society is one of the most important aim of collecting and treating of the wastewater that for treating this amount of substances, there is a necessary need at the hospital for wastewater treatment plant. If this kind of wastewater was not well

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treated and buried, it will be the source of pollution distribution [5]. In countries that do not experience epidemics of enteric disease and that are not endemic for intestinal Helminthiasis, it is acceptable to discharge the sewage of health-care establishments to municipal sewers without pretreatment, provided that the following requirements are need: (I) the municipal sewers are connected to efficiently operated sewage treatment plants that ensure at least 95% removal of bacteria; (II) the sludge resulting from sewage treatment is subjected to anaerobic digestion, leaving no more than one helminthes egg per liter in the digested sludge; (III) the waste management system of the health-care establishment maintains high standards, ensuring the absence of significant quantities of toxic chemicals, pharmaceuticals, radionuclide, cytotoxic drugs and antibiotics in the discharged sewage; (IV) excreta from patients being treated with cytotoxic drugs may be collected separately and adequately treated [3,4]. For constructing a wastewater treatment plant , there is a need to the quantitative and qualitative parameters like flow of water, BOD, COD, TDS, TSS, pH, and EC.

In Iran there is not more investigation about hospitals wastewater. Kathryn and et al. (2004) were investigated existence of antibiotic in the wastewater of dairy products, hospitals and urban wastewater [6]. Tsai and et al. (1999), investigated the impact of disinfecting the sludge of hospital wastewater by hypochlorite and chlorine dioxide [7]. Blanch and et al. (2003) were also compared the diversity of Entrococci population which were related to the urban and hospital waste [8]. Kummerer and et al (2001) inspected the part of the hospital wastes as one of the metal sources in the environment, and proved the existence of the heavy metals in this kind of wastewater [1]. As there is no precise information on quantitative and qualitative of Tehran's hospital wastewater, this article can help wastewater treatment plant (WWTP) by some basement information. Hospitals are defined in two categories, general and special. The sources of producing wastewater pollutions in a hospital are surgery room, labor room, laboratory, radiotherapy, radiology, C.T. scan room, clinic, sterilization section, laundry, disinfectant section, kitchen, and heating installation

The wastewater of remedial centers is like city waste with some materials of decomposable biochemical organic, mineral (liquid, colloidal), toxic metals, detergents, microbial pathogens, chemical toxics, Pharmaceutical matters, and radioactive isotopes.

2. Materials and Methods

The method of the article was field and laboratory studies. In this experiment, the hospitals of Tehran like private, governmental, under university control, or organizations like military and Charity have been explored and 14 hospitals, with beds and sections taken into consideration and with 100 beds and high capacity of 1000 beds, have been chosen. All of wastewater treatment plants in these hospitals were conventional activated sludge. These 14 hospitals wastewater have been analyzed in qualitative and quantitative. The sections of these hospitals are in Table 1.

Table 1. The number of hospitals parts

No Of Hospital	Pulmonary & kidney	Emergency &uric	Skin & Gland	hematology	Digestion	Nerves	C.C.U & I.C.U	psychiatry	infectious	Orthopedic	surgery relief	heart	Surgery eye	Surgery brain	Surgery common	parturition	Baby section	Internal	Parts
No 1	♦	♦		♦	♦		♦			♦	♦	♦	♦	♦	♦	♦		♦	13
No 2												♦		♦	♦	♦		♦	5
No 3					♦	♦	♦	♦		♦			♦	♦	♦	♦	♦	♦	11
No 4	♦	♦	♦	♦	♦	♦	♦	♦	♦	♦		♦		♦	♦	♦	♦	♦	16
No 5								♦											1
No 6		♦								♦	♦		♦	♦	♦	♦	♦	♦	9
No 7							♦								♦	♦		♦	4
No 8	♦			♦					♦						♦			♦	5
No 9	♦	♦		♦			♦		♦		♦	♦	♦					♦	9
No 10		♦			♦		♦			♦	♦	♦	♦	♦	♦	♦	♦	♦	12
No 11		♦		♦			♦					♦			♦			♦	6
No 12							♦									♦			2
No 13		♦					♦			♦				♦	♦	♦	♦		7
No 14													♦		♦		♦	♦	4

Experiment time takes 12 months. Sampling stations were placed in two places one before entering the wastewater to WWTP and second after exiting the WWTP. After sampling in momentum and compound from two stations, four samples were selected from each hospital and analyzed.

All samples analyzed with two methods of standard methods, 20th ed. (APHA, 1998) [9] and the colorimetrically using tests and photometer of the HACH firm standard with advanced and precise measurement instruments. The momentum samples were captured in simple way, but compound samples were taken each half hour in a half of liter and at last were compounded in 5 liters and were analyzed. The samples were carried from sampling site to laboratory in cold box, to prevent from transfer heat effect. For flow analyzing, we used rectangular weir that is based on the open channel Venturi meter.

3. Results and discussions

After inspecting the refined parameters, we look at the crude parameters of the wastewater. Table 2 indicates the crude of BOD, COD, TSS, and pH.

Table 2. Fluctuation range of BOD5, COD, TSS and pH in raw wastewater in compound sampling of Hospitals

No. of Hospital	BOD5 (mg/L)	COD (mg/L)	TSS (mg/L)	pH
No 1	342	503	984	7.2
No 2	314	419	852	6.6
No 3	318	481	914	5.9
No 4	379	645	987	5.6
No 5	281	467	744	7.4
No 6	323	581	915	7.1
No 7	293	478	822	6.8
No 8	294	449	794	6.4
No 9	315	497	878	6.3
No 10	317	456	911	7.3
No 11	372	687	893	6.5
No 12	279	411	787	6.9
No 13	353	607	993	7.8
No 14	285	459	818	7.3
Average	318.92	510	878	6.79
Standard Deviation	32.41	85.6	78.94	0.61

The results of this table are:

The BOD of the crude wastewater at the entrance of the refinery has the maximum and the minimum of 280 to 380 mg/L. The COD of the crude wastewater at the entrance of the refinery has the maximum and the minimum of 480 to 690 mg/L. The results which are archived from BOD and COD indicated that these results are higher than average amount in the urban wastewater, which are relevant to the different section in the hospital.

The TSS of the crude wastewater at the entrance of the refinery has the maximum and the minimum of 740 to 990 mg/L. The pH of the crude wastewater at the entrance of the refinery has the maximum and the minimum of 5.9 to 7.8. According to the results, for pH it is clear that the amounts are in average and are not acidity or alkalinity. The TSS amount is also higher than average range in the urban wastewater which is relate to the different section in the hospital and solid wastes such as clot blood , powder medicines and emulsion.

3.1. quantity measurements

After measuring the flow of the hospitals' WWTP, the results of flow compared with the standards and references like Water and Wastewater Technology written by Hammer [10], Environmental Engineering and Sanitation written by Salvato [5], Wastewater Engineering Treatment, Disposal, Reuse written by Tchobanoglous et al [2] and W.H.O standards [11]. These are indicated in Table 3.

Table 3. Comparison flow of hospitals WWTP and inspecting with different refrences

No. of Hospital	capitation (L/Bed/d)	Design flow (m3/d)	Salvato Joseph A. [5]	Hammer, Mark J [10]	W.H.O [11]	Tchobanoglous, G. et al [2]
No 1	1333	80	662 – 1514 (L/Bed/d)	568 – 1136 (L/Bed/d)	570 – 945 (L/Bed/d)	700 – 1200 (L/Bed/d)
No 2	1133	170				
No 3	727	400				
No 4	705	600				
No 5	1000	100				
No 6	1333	200				
No 7	1375	110				
No 8	1388	250				
No 9	1125	450				
No 10	1500	150				
No 11	1000	250				
No 12	1200	300				
No 13	750	750				
No 14	1500	150				

In the investigation of hospital wastewater quantity, the quantitative results, shows that the average flow of the hospital wastewater for little hospitals with 60 to 400 beds is 1300 liters per bed per day and for large hospitals with 400 to 1000 beds is 750 liters per bed per day. The maximum of the flow is 1500 liters day per bed and the minimum is 705 liters day per bed. These values are verified almost in all references' scope Hammer (568-1136), Salvato (662-1514), Tchobanoglous et al (700-1200), and W.H.O (570-945) and the most is Salvato with the largest scope. Five units between the research societies have near correlation with hammer and the other were in high range, In comparison with solvate reference, which covers more area, all the research society has concordance with this reference and half of the remains units are higher than this reference. Finally, the standard which W.H.O suggests is the standard in which 3 units of research society have concordance with it and the eleven of the remains units are more than this standard.

3.2. quality measurements

After sampling and analyzing of the qualitative parameters, the results are shown for each parameter in the following table considering that, all the treated hospital wastewater, are depleted to the surface water or interception wells, the treated wastewater should be in accordance to the Iran Environmental protection agency of Iran standards. Therefore, as the standards of wells and surface water are the same, the qualitative parameters of treated hospitals wastewater are comprised.

The results which are achieved for COD from analyzing treated wastewater in compound sampling and for BOD5, TSS and pH from analyzing treated wastewater in compound sampling are shown in table 4.

Table 4. Comparison of BOD5, COD, TSS and pH in treated hospitals wastewater

No. of Hospital	BOD_5 (mg/l)	COD (mg/l)	TSS (mg/l)	pH
No 1	39	69	49	7
No 2	44	64	55	6.8
No 3	53	81	67	6.9
No 4	68	113	82	7.2
No 5	26	39	28	7.8
No 6	42	67	61	7.4
No 7	48	89	66	7.1
No 8	28	37	50	7.3
No 9	45	42	57	7.2
No 10	25	39	33	7.1
No 11	55	92	69	6.5
No 12	27	56	31	7
No 13	49	73	63	7.8
No 14	36	57	44	6.9
Average	41.78	65.57	53.92	7.14
Standard Deviation	12.63	22.79	15.8	0.35

The maximum, medium and the minimum of the COD in table 4 are 113, 66 and 37 mg/L. In this table, just five of the hospitals have their COD level at the environmental protection agency of Iran standard level (60 mg/L). The maximum, medium and the minimum of the BOD in table 5 are 68, 42 and 25 mg/L; just four of the hospitals have their BOD level at the environmental protection agency of Iran standard level (30 mg/L).

The maximum, medium and the minimum of the TSS in table 5 are 82, 54 and 28 mg/L; just three of the hospitals have their TSS level at the environmental protection agency of Iran standard level (40 mg/L). The maximum, medium and the minimum of the pH are 7.8, 7.1 and 6.5; all of the hospitals have their pH level at the environmental protection agency of Iran standard level.

4. Conclusion

The results show that, in designing the wastewater treatment plant in the hospital, and selecting the method of treating, not only the capacity of the beds, but also the different section have important role. In other words the pollution of the wastewater of a hospital has direct relation with the different section of it, in which by increasing the infectious section the pollution increase too. For example, by increasing the number of beds there wasn't significant changes in the BOD5 concentration thus; the variation of BOD5 is only for the different section of the hospital. As it is observed in this research, the minimum concentration of BOD5 was related to the 5, 12, 14 hospitals which include the least section, while the maximum BOD5 was for the hospital number 4 that has maximum sections. The behavior of TSS was according to the BOD5, but the pH was varied in different hospitals.

According to the measurements of the hospitals outflow, by increasing the beds up to 400, the design flow rate is also increased, while for the hospitals of more than 400 beds the result was vice versa, therefore; the design flow should be decreased.

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