Research Inventy: International Journal Of Engineering And Science
Issn: 2278-4721, Vol.2, Issue 2 (January2013), Pp 13-16
Www.Researchinventy.Com

Study of Hospital Wastewater Characteristic in Malang City

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***Abstract*:** *Hospital wastewater containing infectious, pathogens, toxid, biodegradable and radioactive contaminants that can cause pollution and health problems. The existence of the hospital adjacent to the residential potential to cause environmental problems as a result of waste discharged into the environment. The objective of study was to determine the waste water characteristics and efficiency of hospital wastewater treatment plant (WWTP) in Malang City. The study was conducted at three hospital in Malang City which determined by class hospital. The samples taken at the WWTP influent and effluent and then measured pollutant concentration using APHA method and compared with a standart of quality on Java Governor No 61 of 1999. The study of result showed that the characteristic of the wastewater effluent at three hospital in Malang City containing contaminants that exceeded the quality standart based on Java Governor No 61 of 1999, for example: 31% of BOD,24% of Ortho phospat, 50% of phenol, 42% of chlorine- free and 17% of lead were higher of standart limit with mean the average efficiency of the WWTP by 58%.*

Key Words: *infectious, influent, effluent, WWTP, efficiency*

I. Introduction

Hospital wastewater is wastewater generated from all activities of the hospital as medical and non medical activities from the operating, emergency & first aid, laboratory, diagnosis, radiology, kitchen and laundry activities (15,17). Hospital wastewater contains harmful pollutant, such as: pathogenic microorganisms (bacteria, viruses), residual of medicine and laboratory chemicals (antibiotics, phenol, chloroform), chemical toxid (Pb), and biodegradable organic material (protein, fat, carbohydrate) (6,14).The study by the Department of Health in 2004 in various hospitals in Jakarta, mention that the hospital wastewater consists of domestic waste (85%), infectious waste (9,5%), sewage pathogens (1.5%), and hazardous waste (4%). These pollutants can easily reach the water resources in the environment that causing environmental aquatic pollution and human health problems (3,7,8). While in Degree of East Java Governor No 61 of 1999, there are a few parameters to be monitored in wastewater, among others: Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Suspended Solid (TSS), Amonia - free, Anionic Detergents, Phenol, Chlor- free Residual, pH, Fecal Coli and Lead (Pb) (1). As in other developing countries, Malang City – Indonesia has a total of 12 hospital that in a location adjacent to the residential and has a wastewater sewer connected to a river or municipal sewage networks which has potential to cause pollution to the environment (12,17). Although hospital wastewater was diluted and treated in wastewater treatment plant (WWTP), however the result of the investigation showed that some parameters of wastewater still exceed the quality standart set, for example: TSS, Ammonia, Total Phospat, Detergent and Chlorine - free (4).

While the results of Assessment Directorate of Water Supply and Sanitation - the Ministry of Health which states that of 648 hospitals in Indonesia only 49% have incinerators and 36% had WWTP and the number of those that meet the water quality standards of hospital waste is only 52% (3) The research objective was to determine the waste water characteristics and efficiency of hospital wastewater treatment plant *(WWTP)* in Malang City. With this research is expected to contribute through the application of wastewater treatment technologies for more efficient according to the characteristics of waste water.

II. Materials And Methodes

The study was conducted in the period May - August 2012 by taking three hospitals as study sites where the selection of three hospitals were taken at random from each type / class of hospitals is type A, type B and type C. To obtain the data of hospital wastewater characteristics, done taking data directly and indirectly through library documents, SOP of WWTP, and sampling at the WWTP influent and effluent at each hospital at the time of maximum load of wastewater.

Parameters measured include Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Suspended Solid (TSS), Amonia-free, Anionic Detergents, Phenol, Chlor-free Residual, pH, Fecal Coli and Lead (Pb). These parameters are consider as significant factors by quality standart of hospital wastewater on East Java Governor No 61 of 1999. Sample analysis was done according to the standart methodes (APHA, 1998) (5). All of the analyses were conducted in the Laboratory of Analysis Instrumentation, Chemical Engineering Department, State of Polytechnic Malang, Indonesia.The results of laboratory analysis in the form of experimental data and then performed the analysis using SPSS and EXCEL software to describe a statistical (average, minimum, maximum and standard deviation).

III. Result And Discussion

Malang City has 12 hospitals comprising: 1 hospital (type A), 3 hospitals (type B) and 8 hospitals (type C). By using the method of random sampling was taken 3 locations that represent the three types of hospitals are RSSA, RSKZ, and RSIA (3). Observations indicate that the WWTP in RSSA using Fluidized Bed Biofilm Aeration (FBBA) technology with a flow rate of 450 m3 per day - 900 m3 per day, WWTP in RSKZ using Activated Sludge (AS) technology with a flow rate of 30 m3 per day - 50 m3 per day, while the WWTP RSIA using Extended Aeration (EA) technology with a flow rate of 5 m3 per day - 15 m3 per day.

Each hospital providing services including: inpatient, emergency, operations, radiology, laboratory, pharmacy, kitchen, laundry, administrative, education and training, and other supporting services. While the difference between the type of hospital A, hospital B and hospital C is a variety of services, load services and the amount of labor (2). Furthermore, the results of weekly sampling at 3 hospitals in the wastewater influent and effluent obtained the following data.

Table 1. The average concentration of pollutant in the influent and effluent WWTP

PARAMETER	INFLUENT			EFFLUENT			Quality Standarts
	RSSA	RSKZ	RSIA	RSSA	RSKZ	RSIA	
pH	8.35	7.97	8.07	7.00	6.90	6.8	7
BOD (mg/lt)	238.98	105.15	86.96	43.52	27.52	16.58	30
COD (mg/lt)	350.88	134.95	109.82	71.18	35.83	27.02	80
TSS (mg/lt)	83.33	42.70	57.27	22.92	14.39	15.07	30
Ammonia-free (NH3)(mg/lt)	0.45	0.35	0.89	0.13	0.09	0.14	0.10
Ortho Phospat (mg/lt)	6.25	3.52	2.31	2.62	1.70	1.26	2
Phenol (mg/lt)	0.04	0.02	0.01	0.02	0.02	0.01	0.01
Detergent (MBAS) (mg/lt)	0.65	0.62	0.61	0.26	0.24	0.24	0.50
Chlorine-free (mg/lt)	1.63	1.42	1.04	0.86	0.65	0.42	0.50
Fecal coli, MPN/100 ml	2,172	1,038	677	299	255	153	40,000
Lead (Pb), mg/lt	0.025	0.01	0.00	0.012	0.005	0.000	0.01

Table 1 shows that the average influent wastewater generated from the three hospitals containing pollutants that exceed the quality standards except for fecal coli while the lead was not detected in RSIA. The RSSA hospital wastewater in the influent WWTP have characteristics with average pollutant concentrations greatly exceeded the quality standard, include: pH (16%), BOD (87%), COD (77%), TSS (64%), Ammonia-free (77%), Ortho phosphate (68%), Phenol (75%), Chlorine-free (69%) and Lead (60%). This is influenced by The volume, the number and intensity of services provided by hospitals RSSA, especially in radiology and pharmacy services which discharged wastewater can produce lead (Pb) from use of X-ray films, use of aseptic materials that containing chlorine, laboratory activities and floor cleaners containing phenol, and the activities of kitchen containing organic materials (BOD,COD). While the use of excessive detergent on laundry activities causing detergent concentration on the third hospital above quality standards (16).

Characteristics of influent wastewater RSKZ seen from the high pollutant concentrations that exceed standards, include: BOD (71%), COD (41%), Ammonia-free (71%), Ortho phosphate (43%), Phenol (50%) and Chlorine-free (65%).While the characteristics of influent wastewater RSIA seen from the high pollutant concentrations that exceed standards, include: BOD (66%), Ammonia-free (89%), and Chlorine-free (52%). Thus the overall characteristics of the waste water from all three hospitals is containing organic matters (BOD, COD), TSS, Ammonia-free, Chlorine-free, with a high concentration of phenol. The quality and quantity of wastewater generated by hospitals is influenced by the type and level of service, volume of water use and water use efficiency (13,18).

Quality of hospital wastewater effluent is indicated by the presence of some pollutan containing concentrations exceeding quality standards, among others BOD (31%), Ortho phosphate (24%), Phenol (50%), Chlorine-free (42%) and Lead (17 %). Thus overall WWTP which is operated in each hospital, especially FBBA still not able to decrease the concentration pollutan to quality, thereby potentially adversely affect to the surrounding environment especially the aquatic environment. The quality of the WWTP effluent generated from the hospital affected by the type of technology, the flow rate of waste water, pollutant load fluctuations, and the competence of the operator (17,18).

Efficiency of each WWTP hospitals in Malang City acquired data as Figure 2 which The results of calculations using SPSS shows that the average efficiency of the processing of each WWTP hospital can reduce pollutants by 63% (RSSA), 56% (RSKZ) and 58% (RSIA). However, the processing technology used by each hospital has varied characteristics which RSSA using FBBA more efficient than the AS and EA technologies in reducing pollutants such as BOD (82%), COD (80%), Ammonia-free (71%), Fecal coli (85%) and Lead (50%). FBBA efficiency in reducing pollutants indicated by the growth of microorganisms on the media attached (biofilm) is optimal to degrade organic matters and nitrification goes well.The attached growth process has high efficiency in the biodegradation of organic matter and fecal coli but less effective in degrading phenol and heavy metals (Pb) (20). While The using of Integrated Anaerobic - Aerobic Fixed Film Bioreactor can produce processing efficiency for COD (82.2%), BOD (88.89%), NH4-N (86.11), Turbidity (94.74%) , Coliforms (90%) and E. coli (98.12%) (19). However, because the pollutant load is too high, and chlorine free (as inhibitor) in the influent RSSA is a very high (1,63 ppm) so the process of denitrification disturbed that the concentration of free ammonia and chlorine free in effluent quality standard was exceeded.

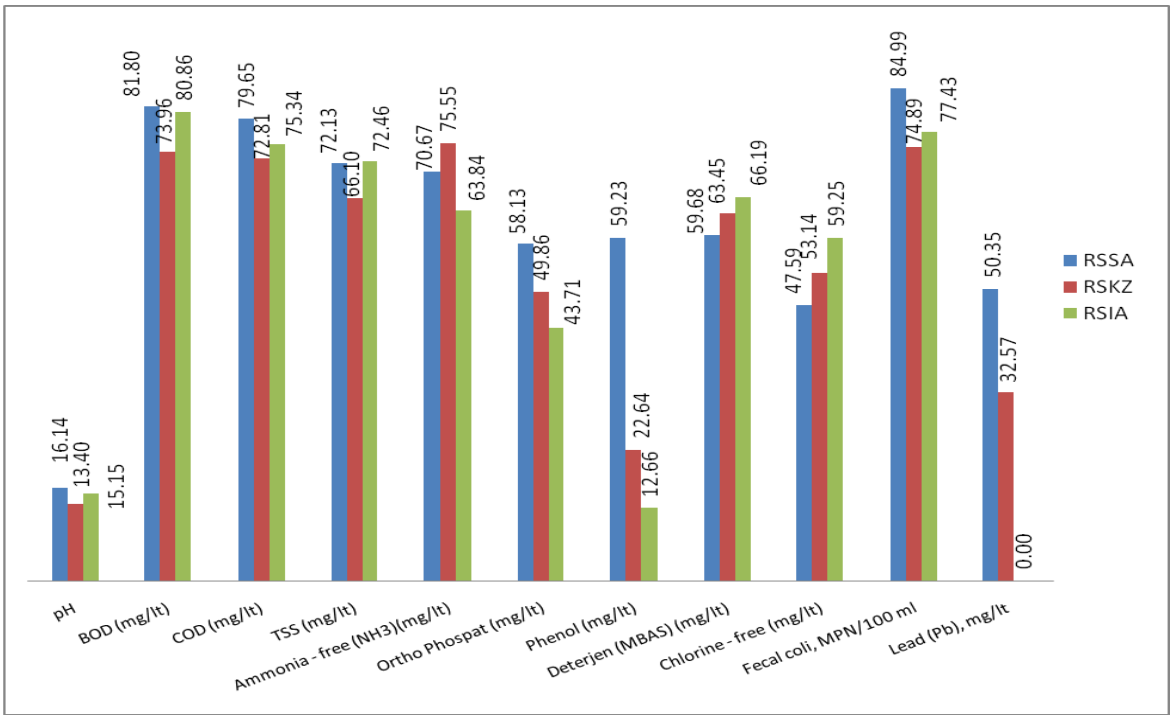

Fig 2: The procentage WWTP efficiency in hospitals Malang

RSKZ using activated sludge process more efficient in reducing BOD (74%), COD (73%), ammonia-free (76%), fecal coli (75%) and detergents (63%) but less efficient in reducing Ortho phosphate (50%), Phenol (12%) and Lead (38%).These conditions indicate that supplies oxygen in the activated sludge process are optimal so that the process of nitrification and denitrification went so well that can reduce organic matter and ammonia-free was significantly (9). But the use of phenol and excessive nutrients causing phenol and ortho phosphate concentration did not drop significantly. The use of Activated Sludge - Biological Contactor (ASBC) process was able to decrease the concentration of pollutants as COD (87.8%), Total N (71.2%), Total P (83.6%), Coliform (99, 98%) (11). While Activated Sludge performance depend on Mixed Liqour Suspended Solids (MLSS) concentration, nutrients, solids retention time, floc formation and oxygen transfer (10).

RSIA using extended aeration process shows performance more efficient in reducing pollutant 81% of BOD, 75% of COD, 77% of Fecal coli, 66% of Detergents and 59% of Chlorine but less efficient in lowering the

concentration 13% of Phenol and 44% Ortho phosphate. While the concentration of lead in the influent and effluent was not detected. These conditions indicate that the performance of the extended aeration are optimal use by hospitals with a low flow rate (5 -15 m3 per day) with a load that is not too high pollutant.The extended aeration in WWTP of Gatot Subroto Hospital - Jakarta can reduce the concentration of pollutants as COD, BOD, Organic, TSS, pH up to standard quality but the content of phosphate and fat still not meet the effluent quality standard (21).

IV. Conclusion

Influent wastewater hospital in Malang has characteristics contain organic matters (BOD, COD), TSS, Ammonia-free, Chlorine-free, Phenol and Lead to high concentrations, while pollutant concentrations in effluent still exceed the quality standards, among others: 31% of BOD, 24% of Ortho phosphate, 50% of Phenol, 42% of Chlorine-free and 17% of Lead. WWTP are used by hospitals in Malang have their advantages and disadvantages which efficient in reducing pollutant concentrations of BOD, COD, TSS, ammonia-free, detergent and Fecal coli but not efficient in reducing pollutant concentrations ortho posphat, phenols, chlorine and lead. While the average efficiency of WWTP are 58%.

V. Acknowledgement

The authors would like to thank environmental health units' authorities of Malang City Hospitals

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