IJISET - International Journal of Innovative Science, Engineering & Technology, Vol. 3 Issue 6, June 2016
ISSN (Online) 2348 – 7968 | Impact Factor (2015) - 4.332
www.ijiset.com

Domestic Wastewater Treatment By Activated Sludge Technology: Efficiency, Energy Consumption and Waste Generation The case of Binh Hung Wastewater Treatment Plant, Ho Chi Minh City, Vietnam

[*]Dieu, T. T. M., [**]Mai, H. N. P., [***]Son T. K.

[*]Department of Environmental Technology and Management, Van Lang University, [**]Center for Environmental Technology and Management, and [***]Ho Chi Minh City Urban Drainage Company Limited.

Ho Chi Minh City, 70000, Vietnam

Abstract

By analyzing data reported from practical operation of Binh Hung WWTP, it is allowed to conclude that suspended growth activated sludge technology is able to treat domestic wastewater in Ho Chi Minh City to meet the National Technical Regulation QCVN 14:2008/BTNMT class B before discharged. However, because of common sewer system in the serviced basin collected both rain water and domestic wastewater, Binh Hung WWTP usually receives low strength wastewater, especially during rainy season. This leads to the situation of overloading in term of volume but lacking of pollutant loading and wastes real treatment capacity of the plant. Electricity demand of 0.184 ± 0.019 kWh/m^3 of treated wastewater, and clean water needed is only 0-0.0077% amount of treated wastewater. Approximately 0.0132±0.0035 m^3 of solid waste/10^3 m^3 of wastewater and 0.010-0.034 m^3 of grits/10^3 m^3 of wastewater was removed from screens and grit chambers. Raw sludge from primary sedimentation tanks and bio-solid from secondary sedimentation creates about 69±10 kg of dry solid/10^3 m^3 of wastewater needed to be further treatment. This can be reused as a source of biomass in other waste recycling facilities.

Key words: *Domestic wastewater, activated sludge technology, energy consumption, waste generation, Binh Hung.*

1. Introduction

Binh Hung Wastewater Treatment Plant (WWTP) was built at Hamlet 5, Binh Hung Commune, Binh Chanh District, Ho Chi Minh City, Vietnam. By December 2008, the plant was installed completely on an area of 14 ha (phase 1 of the plant) with capacity of 141,000 m^3/day. Domestic wastewater from District 1, 3, 5 and a part of District 10 of Ho Chi Minh City (HCMC) is collected to Dong Dieu Pumping Station before pumped into Binh Hung WWTP. Activated sludge technology is applied to remove pollutants from the domestic wastewater. Based on the data monitored from operation of the WWTP in the period of 2011-2014, the paper focuses on analysis of wastewater characteristics received at the plant, pollutant removal efficiency of the applied technology, electricity and water demand for operation as well as types and amount of waste generated from operation of the plant. These practical operation data is not only basic for evaluation the efficiency of the activated sludge technology to remove pollutants from low strength wastewater as domestic wastewater from HCMC, Vietnam, but also a valuable reference for other investment projects on domestic wastewater treatment in the future.

2. Materials and methods

The study was conducted based on reported data from practical operation of Binh Hung WWTP. In order to evaluate pollutant removal efficiency of the plant, statistical monitoring data of characteristics of the influent and the effluent for the period of 2011-2014 was used.

Operation diaries of the plant supply in detail electricity and clean water consumed as well as amount of secondary waste generated, including solid waste collected from screens, grits and inorganic particles from grit chambers, raw sludge from primary sedimentation tanks and biosolid from secondary sedimentation tanks. These values were compared to those of other operating WWTPs using the same treatment technology to see what needs to improve for the case of Binh Hung WWTP.

3. Results and discussions

3.1 Characteristics of domestic wastewater received at Binh Hung WWTP

Statistical data of characteristics of domestic wastewater received at Binh Hung WWTP given in Table 1 shows that main pollutants need to be treated to meet the National Technical Regulation on Domestic Wastewater (QCVN 14:2008/BTNMT, class B) includes organic matter (in terms of BOD_5 and COD), N-ammonia, coliform and sometimes suspended solid (SS) and S^{2-}.

Monitoring data on variation of characteristics of domestic wastewater received at Binh Hung WWTP during 24 hours of a day was conducted for 7 days continuously, from 17th April 2012 to 23rd April 2012. It was found that average concentration of organic matter, in term of BOD_5 was in the range of 33-80 mg/L, the maximum BOD_5 concentration reached 200 mg/L and the minimum BOD_5 concentration was only 15 mg/L. The highest concentration of BOD_5 often appears during 12:00-14:00, while the lowest concentration often appears during 2:00-10:00 am and 18:00-22:00 pm.

IJISET - International Journal of Innovative Science, Engineering & Technology, Vol. 3 Issue 6, June 2016
ISSN (Online) 2348 – 7968 | Impact Factor (2015) - 4.332
www.ijiset.com

Table 1 Characteristics of domestic wastewater received at Binh Hung WWTP in the period of 2011-2014

Parameters	Unit	Statistical values				QCVN 14:2008/BTNMT	
		2011	2012	2013	2014	A	B
pH	-	6.3 - 7.0	6.68 – 6.90	6.48 – 7.01		5-9	5-9
COD_{total}	mgO_2/L	80 - 147	68 – 104	28 – 257	82 - 53		
BOD_5	**mgO_2/L**	**31 - 67**	**31 – 42**	**11 – 116**	**34 - 87**	**30**	**50**
TSS	**mg/L**	**45 - 74**	**29 – 46**	**10 – 110**	**33 - 126**	**50**	**100**
TDS	mg/L	12 - 210	7.83 – 12.7	**140 – 1929**	-	**500**	**1000**
Cl^-	mg/L	-	-	**22 – 953**	**102**		
$N\text{-}NH_4^+$	**mg/L**	**9.4 - 19.3**	**7.83 – 12.70**	**0.91 – 26.32**	**14.3**	**5**	**10**
N_{total}	mg/L	10.4 - 25.5	10.20 – 18.45	11.20 – 52.64	17.4 – 24.3		
P_{total}	mg/L	1.3 - 1.9	0.39 – 0.78	0.55 – 12.50	1.22 – 1.9		
$N\text{-}NO_3^-$	mg/L	-	-	0.02 – 0.38	-	30	50
$P\text{-}PO_4^{3-}$	mg/L	-	-	0.31 – 3.86	-	6	10
S^{2-}(as H_2S)	**mg/L**	**0.2 - 8.5**	**0.71**	**0.17 – 2.50**	**0.2**	**1.0**	**4.0**
As	mg/L	-	-	0.00 – 0.10	ND	-	-
Hg	mg/L	-	-	0.00	ND	-	-
Zn	mg/L	0.03 - 0.26	0.01 – 0.02	-	0.134	-	-
Ni	mg/L	ND	-	-	0.005	-	-
Pb	mg/L	ND - 0.001	0.00	0.01 – 0.14	ND	-	-
Cd	mg/L	ND - 0.0006	-	0.00 – 0.02	ND	-	-
Gross activity	mg/L	1.0 - 3.6	0.02	-	-	5	10
Total mineral fats and oils	mg/L	0.3 - 1.0	-	0.00	3.0	-	-
Other fats and oils	mg/L	0.7 - 1.4	0.40	1.20 – 5.60	-	10	20

ND = non-detected, "-" = no data.
Source: Binh Hung WWTP (2015).

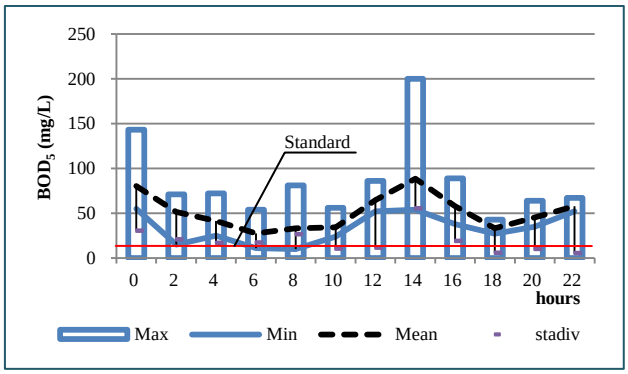

Fig. 1 Variation of BOD_5 concentration of domestic wastewater received at Binh Hung WWTP during hours a day, monitoring data of 2012.

Monitoring data during 12 weeks from 27th March to 30th October 2013 also showed that average, maximum and minimum BOD_5 concentration was in the range of 34-66 mg/L, 116 mg/L and 11 mg/L, respectively. The highest BOD_5 concentration of the wastewater usually appears on 18:00 p.m and 24:00 p.m.

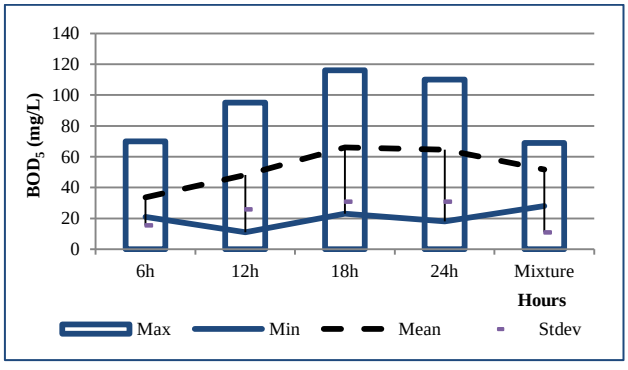

Fig. 2 Variation of BOD_5 concentration of domestic wastewater received at Binh Hung WWTP during hours a day, monitoring data of 2013.

Monitoring data of 2012-2013 allows concluding that typical value of BOD_5 concentration of domestic wastewater received at Binh Hung WWTP is in the range of 50 to less than 100 mg/L. This value gets highest distribution frequency of 50.0% for the data of 2012 and 41.7% for the data of 2013. Figure 3 and Figure 4 also shows that approximately 20% of untreated wastewater samples monitored in 2012 and 2013 had BOD_5 concentration less than 30 mg/L (meet QCVN 14:2008/BTNMT, class A). If compared to the National Technical Regulation QCVN 14:2008/BTNMT class B, 47.4% of untreated wastewater samples monitored in 2012 and 51.7% untreated wastewater samples monitored in 2013 had BOD_5 concentration less than 50 mg/L. In the other words, organic pollution in term of BOD_5 in domestic wastewater received at Binh Hung WWTP is low. It is attributed to dilution from rain water collected in the same sewer system or influence of the tide.

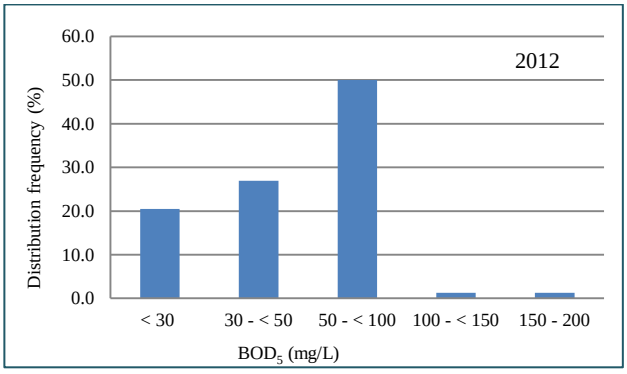

Fig. 3 Distribution frequency of BOD_5 concentration of domestic wastewater received at Binh Hung WWTP, monitoring data of 2012.

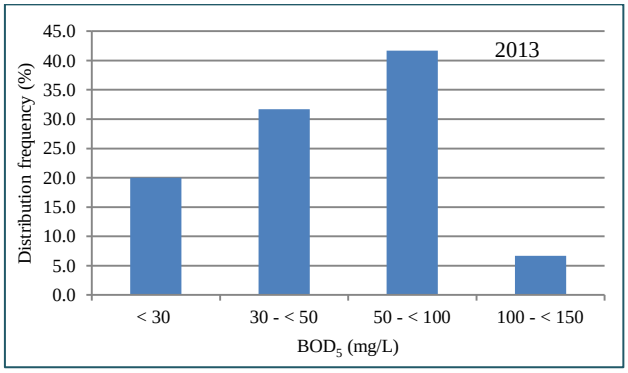

Fig. 4 Distribution frequency of BOD_5 concentration of domestic wastewater received at Binh Hung WWTP, monitoring data of 2013.

COD concentration in the domestic wastewater received at Binh Hung WWTP ranged from 27 mg/L to 417 mg/L in 2012 and from 28 mg/L to 257 mg/L in 2013. Typical COD value is in the range of 75 mg/L to less than 150 mg/L. The National Technical Regulation QCVN 14:2008/BTNMT does not regulate allowable discharged concentration in term of COD for domestic wastewater. However, if applied QCVN 40:2011/BTNMT, only 60% of untreated wastewater samples of Binh Hung WWTP had COD concentration higher than 150 mg/L and need to be treated to meet QCVN 40:2011/BTNMT class B.

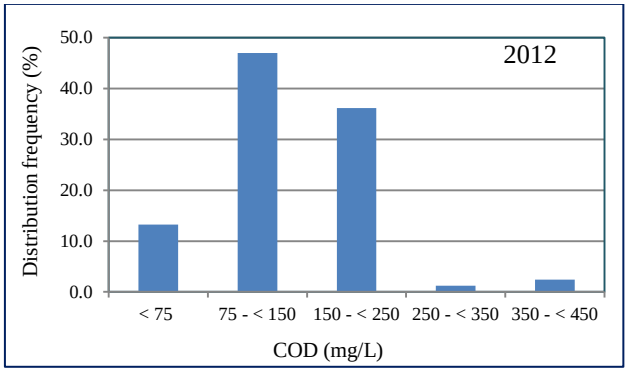

Fig. 5 Distribution frequency of COD concentration of domestic wastewater received at Binh Hung WWTP, monitoring data of 2012.

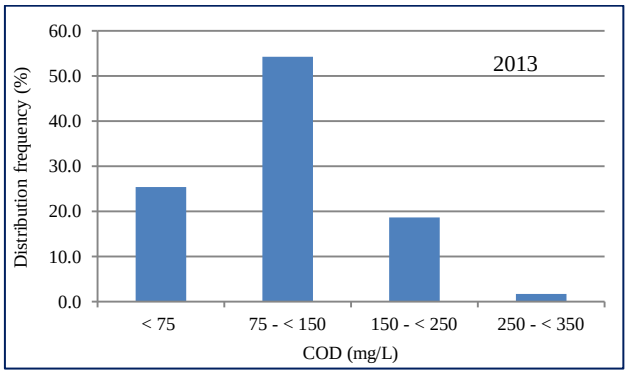

Fig. 6 Distribution frequency of COD concentration of domestic wastewater received at Binh Hung WWTP, monitoring data of 2013.

Average N-ammonia concentration was 14.81±5.65 mg N-ammonia/L. The highest value was 26.32 mg N-ammonia/L and the lowest value was 0.91 mg N-ammonia/L (monitoring data of 2013). The monitoring data shows that N-ammonia concentration of domestic wastewater received at Binh Hung WWTP is often higher than allowable concentration (based on QCVN 14:2008/BTNMT, class B) and need to be converted from N-ammonia into $N\text{-}NO_3^-$ before discharged into the receiving. Typical N-ammonia concentration is in the range of 10-20 mg N-ammonia/L. The monitoring data in 2014 shows that average N-ammonia concentration was 23.8±1.8 mg N-ammonia/L, the highest and lowest value was 23.8 mg N-ammonia/L and 20.9 mg N-ammonia/L, respectively. These values are higher than those of 2013. During July to September 2015, N-ammonia concentration was in the range of 16.8-28.8 mg N-ammonia/L.

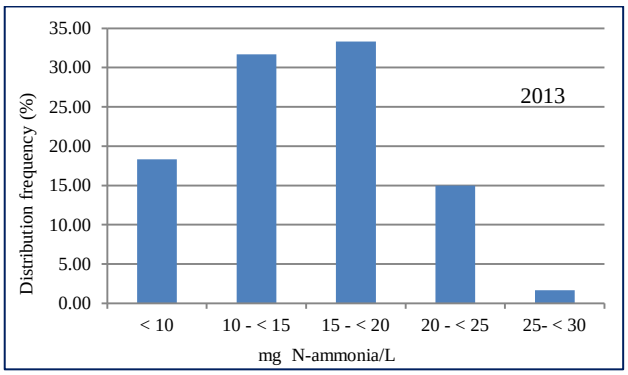

Fig. 7 Distribution frequency of N-ammonia concentration of domestic wastewater received at Binh Hung WWTP, monitoring data of 2013.

Typical suspended solid concentration was less than 50 mg/L with the highest distribution frequency of monitoring data in 2012 and 2013 of 63% and 65%, respectively. Monitoring data 2014 and 2015 showed that, suspended solid concentration of the wastewater received at Binh Hung WWTP was in the range of 30 to 119 mg/L and it was less than 100 mg/L for most of the days in a year.

3.2 Domestic wastewater treatment technology at Binh Hung WWTP and its treatment efficiency

Domestic wastewater treatment technology applied at Binh Hung WWTP is described briefly in Fig. 8. Before entered WWTP, collected domestic wastewater is pretreated to remove grits, inorganic particles, and solid wastes at a lift pump station. Wastewater from the lift pump station is pumped into an intermediate tank and then distributed into 10 primary sedimentation tanks via a rectangle channel. After removed suspended solids, wastewater is distributed into 10 suspended growth activated sludge tanks (called aeration tank) for organic and N-ammonia removal. Each aeration tank consists of four compartments interconnected by interstice of its wall. Air from air blowers is supplied into the aeration tanks via air diffusion pipe system submerged in each compartment of the tank. Notch weir is installed in the last compartment of each aeration tank for collecting the effluent. The effluents from the aeration tank enter secondary sedimentation tanks for solid - liquid separation. A proportion of sludge is returned to the aeration tank to maintain sludge concentration. Excess sludge is further treated by sludge treatment system including sludge thickeners and sludge presses. The effluent from secondary sedimentation tanks flow into contact tanks using NaClO as disinfectant before discharged into Tac Ben Ro channel.

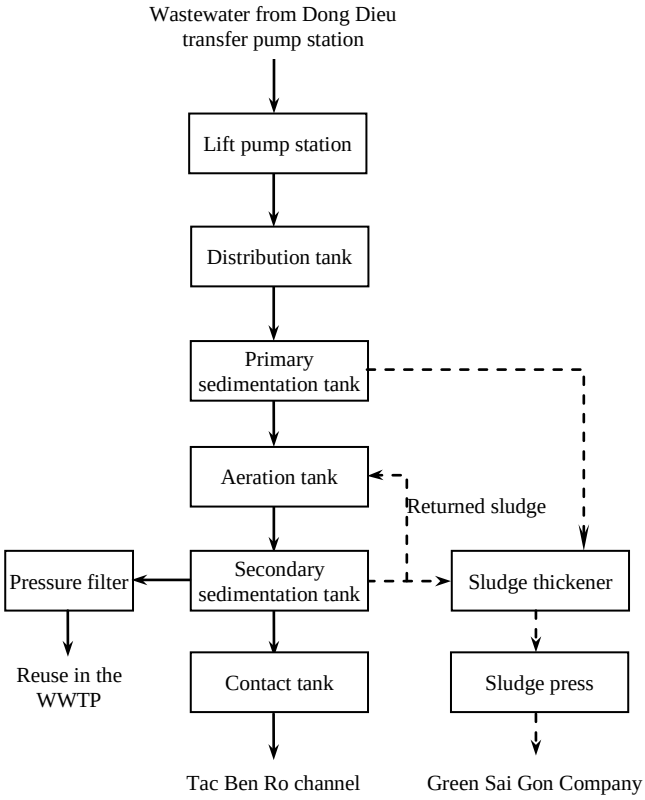

Fig. 8 Wastewater treatment technology applied at Binh Hung WWTP.

Efficiency of Binh Hung WWTP is evaluated based on the decrease in pollutants' concentrations of the influent compared to those of the effluent during the period of 2011 to 2014. The monitoring data for 4 years show that the effluent of Binh Hung WWTP always reaches the National Technical Regulation QCVN 14:2008/BTNMT class B before discharged into Ben Tac Ro channel (Table 2).

Table 6 Pollutants' removal efficiency of Binh Hung WWTP for the period of 2011-2014

Parameter	Unit	Influent	Effluent	Efficiency (%)	
				Range	Average
pH	-	5.88 - 7.81	5.97 - 7.53		
SS	mg/L	20 - 364	1 - 19	77-98	88
BOD_5	mg/L	18 - 170	1 - 22	78-96	83
COD	mg/L	38 - 256	12 - 61	53-94	70
$N\text{-}NH_4^+$	mg/L	0.91-26.32	0.47-13.10	27-98	64
N_{total}	mg/L	4.9 – 29.1	1.4 - 20.2	7.9-90	34
P_{total}	mg/L	0.4 – 3.9	0.2 - 1.24	18-88	57

3.3 Electricity and water supply demand

Electricity demand

Electricity needed for operation of a WWTP is accounted by kWh/m^3 of treated wastewater. Electricity needs for operating air supply system, pumps, mixers, sludge dewatering facilities, etc. Electricity demand varies depending on treatment capacity, wastewater characteristics, and wastewater treatment technologies (European Commission, 2012). Report on electricity demand for operating Binh Hung WWTP in 2014 show that it is required 0.184±0.019 kWh/m^3 treated wastewater. Compared to other WWPTs using suspended growth activated sludge technology, electricity consumption for operation of Binh Hung WWTP is much lower. A *municipal wastewater treatment plant energy baseline study* conducted by Pacific Gas and Electric Company (PG&E) in the framework of Energy Management Program in 2003 shows that electricity demand for operation of a WWTP varies in the range of 0.284 kWh/m^3 to 1.225 kWh/m^3 depended on wastewater treatment technology and capacity of the WWTP. About 0.447 to 1.132 kWh/m^3 of treated wastewater to operate a WWTP applied aerobic activated sludge system with capacity in the range of 6,426-43,470 m^3/day. So far, highest electricty consumed during operation of Binh Hung WWTP is only 0.39 kWh/m^3 of treated wastewater. It is attributed to high capacity of Binh Hung WWTP (126,449 ± 15,749 m^3/day) compared to other WWTPs (only in the range of 9,072-43,470 m^3/day). However, it is also important to note that other WWTPs using different technologies as RBC (rotating biological contactor), AAS-N/D (aerobic activated sludge with nitrification and denitrification), HPO (high purity oxygen activated sludge), required higher electricity demand compared to that of Binh Hung WWTP. Figure 9 shows that electricity demand in term of kWh/m^3 of treated wastewater decreases as treatment capacity increases.

Table 3 Influence of wastewater treatment technology and capacity to electricity demand for operation

WWTP	Technology	Capacity (m^3/day)	Electricity (kWh/m^3)
A	RBC	6,804	0.284
B	Biotower/AAS	38,178	0.393
C	AAS	9,072	1.132
D	AAS	43,470	0.447
E	AAS	6,426	0.668
F	AAS-N/D	73,332	1.225
H	HPO	20,790	1.064
I	HPO	74,844	0.605
J	HPO	238,140	0.373

Source: PG&E, 2003.

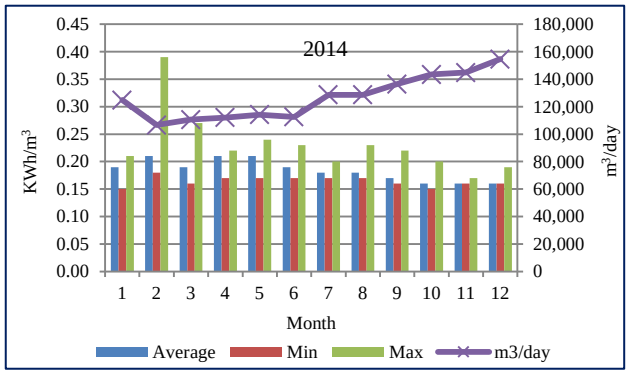

Fig. 9 Electricity demand for operation of Binh Hung WWTP in 2014.

Fresh water demand

During operation of a WWTP, fresh water is needed to clean screen, grit chambers, filters, pipes, etc. and for domestic usage of workers. Amount of fresh water supplies to a WWTP can be reduced significantly if rain water or effluent of the WWTP is reused. In general, water

demand of a WWTP that is operated effectively can be varied as follows (European Commission, 2012):

- Amount of fresh water needs to clean screen varies depending on types of screen. If fine screen with continuous cleaning is used, amount of fresh water used equal to about 0-5% of treated wastewater.
- Absorption reactors for order removal usually consumed 2-3 L (water/s)/(m^3 of polluted gases/s)

Amount of fresh water used at Binh Hung WWTP in 2014 was 18.75±5.12 m^3/day in average to operate the plant to treat 126,449±15,749 m^3/day of wastewater. In the other words, amount of water needed equals 0.015± 0,003% amount of treated wastewater. Maximum amount of clean water used is only 0.077% amount of treated wastewater and minimum amount of clean water used is 0%. This achievement of Binh Hung WWTP is attributed to well application of reuse effluent from the plant.

Table 4 Amount of clean water used to operate Binh Hung WWTP in 2014

Month	Wastewater treatment capacity (m^3/day)	Clean water supplied (m^3/day)			Percentage of clean water used compared to amount treated wastewater (%)		
		Average	Max	Min	Average	Max	Min
1	124,788	20	41	0	0.016	0.033	0
2	106,582	19	82	0	0.018	0.077	0
3	110,606	19	67	0	0.017	0.061	0
4	112,111	19	53	0	0.017	0.047	0
5	114,154	18	45	0	0.016	0.039	0
6	112,530	18	48	0	0.016	0.043	0
7	128,680	15	54	0	0.012	0.042	0
8	128,631	13	41	0	0.010	0.032	0
9	136,445	14	47	0	0.010	0.034	0
10	143,369	16	66	0	0.011	0.046	0
11	144,841	21	61	0	0.014	0.042	0
12	154,650	33	104	0	0.021	0.067	0

Source: Summarized from Report of operation of Binh Hung WWTP in 2014.

3.4 Waste generated from operation of WWTP

Waste generated from a domestic WWTP usually includes solid waste (screenings) from screen, grits and inorganic particles from grit chamber, fresh sludge from primary sedimentation tank, sludge from secondary sedimentation tank. Amount of these types of waste vary depending on treatment capacity, characteristics of wastewater, treatment technology and treatment efficiency. Data of operation of Mangere WWTP in New Zealand with capacity of 300,000 m^3/day using suspended growth activated sludge technology indicates that approximately 6 m^3 of solid waste/day from screens (equivalent to 0.02 m^3 of solid waste /10^3 m^3 of wastewater); 3.4 m^3 of grits and inorganic particles/day from grit chambers (equivalent to 0.011 m^3 grits/10^3 m^3 of wastewater); 2,000 m^3 of sludge/day (equivalent to 0.0067 m^3 of sludge/m^3 of wastewater) (Wansbrough and Packer, 2003; Murphy et al., 2008). Amount of waste generated from some WWTPs in USA with capacity in the range of 11,400 to 1,260,000 m^3/day reported by WEF (1998) and US. EPA (2003) shows that amount of grits and inorganic particles ranges from 0.003 to 0.017 m^3/10^3 m^3 of treated wastewater while amount of solid waste from screens ranges from 0.004 to 0.009 m^3/10^3 m^3 of treated wastewater. Amount of waste per 10^3 m^3 of wastewater decreases as treatment capacity increases.

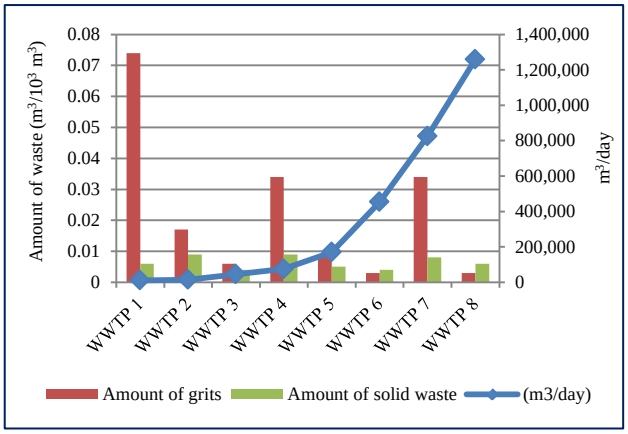

Fig. 10 Amount of waste generated from WWTPs with different capacities (WEF, 1889; US. EPA, 2003).

As mentioned above, wastewater is collected via a common sewer system to Dong Dieu transfer pump station before pumped into the lift pump station of Binh Hung WWTP. Data of operation of Dong Dieu transfer pump station in 2013 shows that amount of solid waste collected at screen system is much higher than that of other WWTPs referred in Fig. 10. Average amount of solid waste collected at sreen systems was as high as 0.0133 ± 0.0046 m^3 of solid waste/10^3 m^3 of wastewater. The lowest amount was 0.0052 m^3 of solid waste/10^3 m^3 of wastewater and the highest value was 0.0221 m^3 of solid waste/10^3 m^3 of wastewater. In 2014, amount of solid waste collected from screen system of Dong Dieu transfer pump station is less than that of 2013, but it was still as high as 0.0088 ± 0.0023 m^3 of solid waste/10^3 m^3 of wastewater, the lowest and highest amount was 0.0061 and 0.0135 m^3 of solid waste/10^3 m^3 of wastewater. Variation of solid waste collected at screen system of Dong Dieu transfer pump station in the period of 2013 and 2014 is described in Fig. 11.

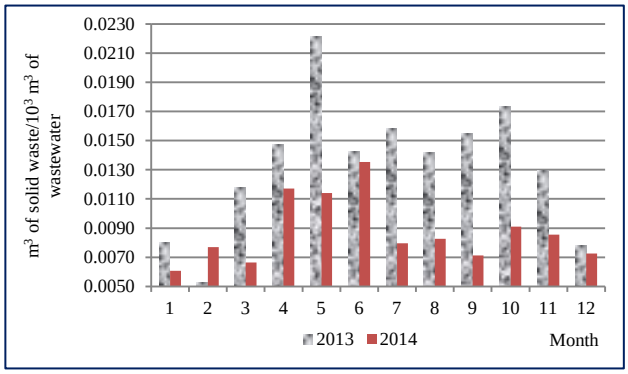

Fig. 11 Amount of solid waste collected at screen system of Dong Dieu transfer pump station in the period of 2013-2014.

Though Dong Dieu transfer pump station has installed screen system to remove solid waste from wastewater, the wastewater Dong Dieu transfer pump station entered Binh Hung WWTP still contains solid waste. Amount of solid waste removed from wastewater received at Binh Hung WWTP in 2014 was 0.0044 ± 0.0012 m^3 of solid waste/10^3

m^3 of wastewater in average, the highest and the lowest amount was 0.0068 and 0.0028 m^3 of solid waste/10^3 m^3 of wastewater, respectively (Fig. 12). Thus, total amount of solid waste removed from wastewater was 0.0132 ± 0.0035 m^3 of solid waste/10^3 m^3 of wastewater in average. This includes solid waste removed from Dong Dieu transfer pump station and Binh Hung WWTP. This value is much higher than those referred from other WTTPs (only in the range of 0.004-0.009 m^3 of solid waste/10^3 m^3 of wastewater) (US. EPA, 2003).

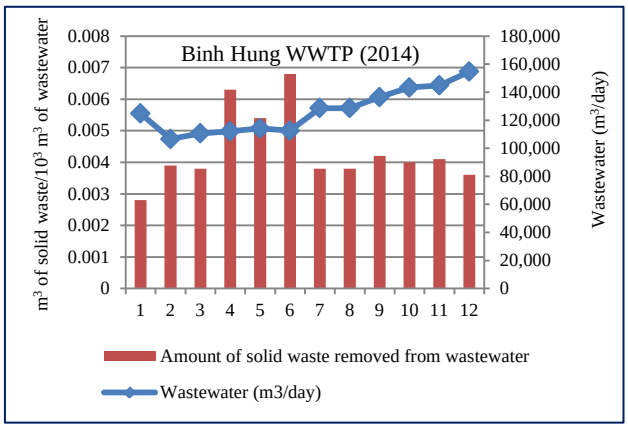

Fig. 12 Amount of solid waste collected from wastewater received at Binh Hung WWTP in 2014.

Amount of grits and inorganic particles collected from grit chambers at Dong Dieu transfer pump station varied in the range of 0.013 - 0.033 and 0.010-0.034 m^3 of grits/10^3 m^3 of wastewater in 2013 and 2014, respectively. Figure 13 shows that compared to other WWTPs with the same treatment capacity referred from US. EPA (2003), amount of grits removed from wastewater received at Binh Hung WWTP is also higher.

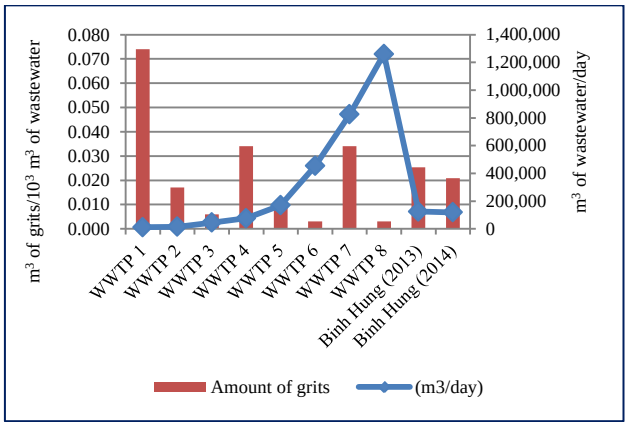

Fig. 13 Amount of grits and inorganic particles removed from wastewater received at WWTPs.

It is found from practical operation of Binh Hung WWTP in the period of 2013 and 2014 that amount of sludge generation from amount of raw sludge from primary sedimentation tanks was in the range of 6-8 $m^3/10^3$ of wastewater (in 2013) and 4-8 $m^3/10^3$ of wastewater (in 2014), while amount of excess sludge from secondary sedimentation tanks was in the range of 2-4 $m^3/10^3$ of wastewater in both years.

Table 5 Amount of raw sludge generated from Binh Hung WWTP

Month	Wastewater (m^3/day)		Raw sludge ($m^3/10^3$ m^3 of wastewater)	
	2013	2014	2013	2014
1	141,092	124,788	8	7
2	145,601	106,582	6	8
3	143,170	110,606	6	7
4	126,611	112,111	7	8
5	131,591	114,154	7	7
6	153,514	112,530	6	4
7	140,641	128,680	6	-
8	127,518	128,631	6	-
9	137,016	136,445	6	6
10	152,263	143,369	6	7
11	138,903	144,841	6	7
12	147,272	154,650	6	6

Source: Summarized from Report of operation of Binh Hung WWTP in 2013-2014.

Table 6 Amount of excess sludge generated from Binh Hung WWTP

Month	Wastewater (m^3/day)		Excess sludge ($m^3/10^3$ m^3 of wastewater)	
	2013	2014	2013	2014
1	141,092	124,788	4	3
2	145,601	106,582	3	4
3	143,170	110,606	3	4
4	126,611	112,111	3	4
5	131,591	114,154	3	4
6	153,514	112,530	3	3
7	140,641	128,680	3	3
8	127,518	128,631	3	4
9	137,016	136,445	2	3
10	152,263	143,369	3	2
11	138,903	144,841	3	2
12	147,272	154,650	2	2

Source: Summarized from Report of operation of Binh Hung WWTP in 2013-2014.

Raw sludge from primary sedimentation tanks and excess sludge from secondary sedimentation tanks are gathered in sludge thickners before transferred into sludge press for dewatering. After dewatered, sludge has moisture content of 76±1.8% and amount of mixture of sludge generated in 2013 and 2014 was 243±22 kg of wet sludge/10^3 m^3 of wastewater and 288±42 kg of wet sludge/10^3 m^3 of wastewater, respectively. In term of dry weight, amount of sludge generated from Binh Hung WWTP in 2013 and 2014 was 58±5 kg of dry solid/10^3 m^3 of wastewater and 69±10 kg of dry solid/10^3 m^3 of wastewater. This value is comparable to the value mentioned in the report of Chen et al. (2016) that about 70-100 kg dry solid is generated from activated sludge system treating 10^3 m^3 of wastewater.

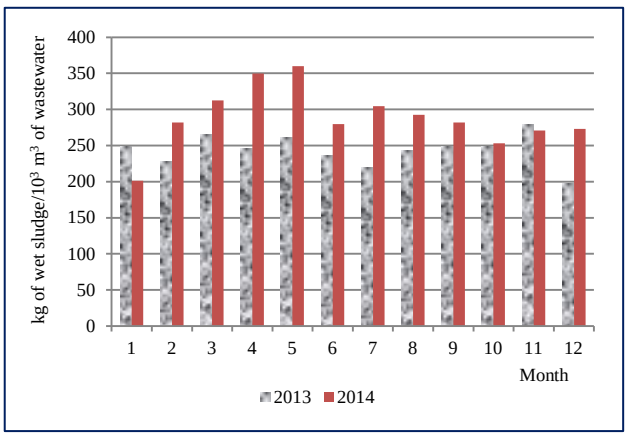

Fig. 14 Amount of wet sludge after dewatered generated from Binh Hung WWTP.

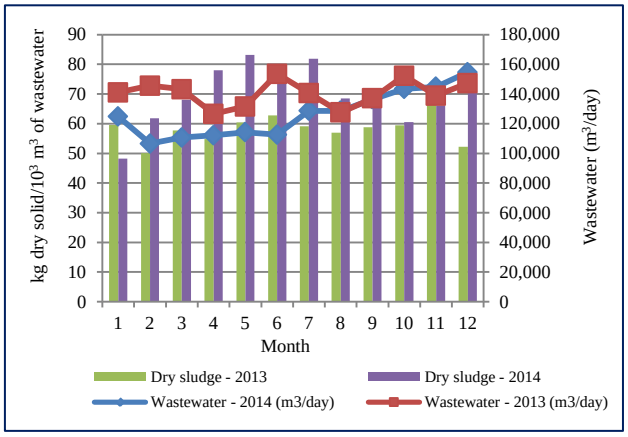

Fig. 15 Amount of dry solid generated from Binh Hung WWTP.

4. Conclusions and recommendations

4.1 Conclusions

Wastewater received Binh Hung WWTP has low organic matter in term of BOD_5. In average, BOD_5 concentration was in the range of 33-80 mg/L. The maximum BOD_5 reaches 200 mg/L and the minimum value was only around 10 mg/L. Ratio of BOD_5/COD is about 0.4-0.6. COD concentration varied in the range of 27 to 417 mg/L. Typical COD value ranged from 75 mg/L to less than 150 mg/L. Average N-ammonia concentration was 23.8±1.8 mg N-ammonia/L and always needed to be treated before discharged. Suspended solid concentration was less than 100 mg/L around a year. Organic matter (in terms of BOD_5 and COD), N-ammonia, coliform and sometimes suspended solid (SS) needed to be treated to meet QCVN 14:2008/BTNMT class B.

By analyzing data reported from practical operation of Binh Hung WWTP, it is allowed to conclude that suspended growth activated sludge technology is able to treat domestic wastewater in Ho Chi Minh City to meet the National Technical Regulation QCVN 14:2008/BTNMT class B before discharged. However, because of common sewer system in the serviced basin collected both rain water and domestic wastewater, Binh Hung WWTP usually receives low strength wastewater, especially during rainy season. This leads to the situation of overloading in term of volume but lacking of pollutant loading and wastes real treatment capacity of the plant.

Electricity demand of 0.184 ± 0.019 kWh/m^3 of treated wastewater indicates that the operation of the plant is well controlled. By reusing the effluent as fresh water supply within the plant, clean water needed is only 0-0.0077% amount of treated wastewater.

Amount of solid waste, grits and inorganic particles contained in wastewater received at Binh Hung WWTP is much higher than those of other referred WWTPs. Approximately 0.0132±0.0035 m^3 of solid waste/10^3 m^3 of wastewater and 0.010-0.034 m^3 of grits/10^3 m^3 of wastewater was removed from screens and grit chambers. Raw sludge from primary sedimentation tanks and bio-solid from secondary sedimentation creates about 69±10 kg of dry solid/10^3 m^3 of wastewater needed to be further treatment. This can be reused as a source of biomass in other waste recycling facilities.

4.2 Recommendations

Further improvement of effluent quality while reduction electricity and clean water demand as well as minimization of secondary waste generation from operation of Binh Hung WWTP is the next question needed to be solved.

References

[1] Chen G. H., An K. J., Saby S., and Mo H. K. (2016). New approaches to minimize excess sludge in activated sludge system. Department of Civil Engineering, the Hong Kong University of Science and Technology, Clear Water Bay, Kowloon, Hong Kong. Referred from www.eng.hokudai.ac.jp/COE-area/workshop/jul7_ghchen.pdf.

[2] European Commission (2012). GPP Criteria wastewater infrastructure. Report for European Commission.

[3] Pacific Gas and Electric Company (PG&E) (2003). Municipal wastewater treatment plant energy baseline study. Energy Management Program.

[4] Murphy R. B., Young B. R. and Kecman V. (2008). Optimising operation of a biological wastewater treatment application. ISA Transactions, Vol. 48, Iss. 1, pp. 93-97.

[5] US. EPA (2003). Wastewater Technology Fact Sheet: Screening and Grit Removal.

[6] Wansbrough H. and Packer J. (2003). Sewage Treatment. Referred from nzic.org.nz/ChemProcesses/water/13C.pdf

[7] WEF (Water Environment Federation) (1998). Design of municipal wastewater treatment plants. Water Environment Federation. Alexandria, Virginia.

[8] Operation diary of Binh Hung Wastewater Treatment Plant from 2011-2015.