



Characteristics of Effluents from Industrial, Hospital, Aquacultural and Domestic Wastewater Treatment in Tien Giang Province, Vietnam

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Abstract

This study evaluates the quality of wastewater effluent collected from domestic wastewater, industrial wastewater, medical wastewater, and aquaculture wastewater in Tien Giang province, Vietnam. The quality of domestic wastewater effluent is assessed using Vietnamese standard QCVN 14:2008/BTNMT while the effluent quality of industrial, medical and aquaculture wastewater is assessed using QCVN 40:2011/BTNMT. The effluent quality indicators of pH, temp, BOD, COD, TSS, N-NH₄⁺, N-NO₃⁻, P-PO₄³⁻, TN, TP, S²⁻, CN⁻, As, Hg, Ni, Pb, Phenol, Oil & grease, Coliform, Shigella, Salmonella, Vibrio cholerae were used in the assessment. The results showed that TSS, N-NH₄⁺, TP, Coliform in industrial wastewater effluent; N-NH₄⁺ in medical wastewater effluent; TSS and coliform in aquaculture wastewater effluent; TSS, N-NH₄⁺ and coliform in domestic wastewater effluent at some locations exceeded the allowable limits. The effluent quality of industrial, medical, aquaculture and domestic wastewater was seasonally fluctuated. COD, BOD, TSS in industrial wastewater in the rainy season were higher than those in the dry season, while BOD and COD in medical wastewater, livestock wastewater and domestic wastewater in the dry season were higher than those in the rainy season. In all types of wastewater effluent, the concentration of nutrients in the rainy season were lower than those in the dry season. The effluent quality indicators of heavy metals, sulfide, cyanide and groups of pathogenic microorganisms were not detected in wastewater effluents. Oil and grease were detected only at the AW2 site during the dry season. The results showed that there is a need for technological solutions to improve the thorough treatment of TSS, N-NH₄⁺, TP, coliform in wastewater to reduce risks to the natural environment and human health.

1. Introduction

Tien Giang is a province both in the Mekong Delta and in the Southern Key Economic Zone, located 70 km south of Ho Chi Minh City and 90 km north of Can Tho city. Tien Giang province has North and Northeast bordering Long An and Ho Chi Minh City, West bordering Dong Thap, South bordering Ben Tre and Vinh Long, bordering the East Sea to the east. Tien Giang is located along the north bank of the Tien River (a tributary of the Mekong River) with a length of 120 km [1]. Tien Giang has a natural area of 251,061 hectares, accounting for about 6% of the area of the Mekong River Delta, 8.1% of the area of the Southern Key Economic Zone, and 0.7% of the whole country. The province's population is 1,765,962 people, of which the urban population is 247,583 people [1]. Tien Giang has 11 administrative units including 1 city, 2 towns and 8 districts with 172 commune-level administrative units, including 7 townships, 22 wards and 143 communes. The province's land is mostly neutral alluvial soil, less acidic along the Tien River, accounting for about

53% of the province's area, favorable for fresh water, which has long been put into exploitation and use, forming a high productivity of rice production area. The coastline is 32 km long with thousands of hectares of coastal alluvial soil, many advantages in aquaculture, marine economic development [1]. Tien Giang's climate is inland tropical - sub-equatorial and has a tropical monsoon climate, so the average temperature is high and hot all year round. The average temperature in the year is 27°C - 27.9°C. With two distinct seasons, the rainy season and the dry season. The dry season is from December to April of the following year, the average rainfall is 1,210 - 1,424 mm/year and is distributed less and less from north to south, the rainy season is from May to November [1]. Tien Giang has played the role of a major center for rice production, aquaculture and seafood processing, making a great contribution to the country's agricultural and aquatic exports; economic exchange with a large quantity of goods and export turnover of the following year higher than the previous year, etc., towards the goal of becoming a province with a dynamic economy, modern economic structure, and increasing significant contribution to the economy of the Mekong Delta, making an important contribution to the construction of the country's economy [1]. Currently, Tien Giang province is promoting industrialization and modernization, so socio-economic development activities will generate environmental problems due to the incomplete treatment system and inefficient operation [2]. Therefore, environmental quality monitoring is necessary to promptly detect pollution problems and have appropriate management solutions [2-4]. This study evaluates the quality of effluent wastewater collected from domestic wastewater, industrial wastewater, medical wastewater, and aquaculture wastewater. The results provide useful information on the effectiveness of water quality management in the study area.

2. Materials and methods

Effluent wastewater samples were collected at 11 locations in June and September 2020 (Table 1). Domestic water (DW) effluent was collected at domestic wastewater sewer in My Tho city to analyze indicators such as pH, Temp, BOD, COD, TSS, N-NH₄⁺, TN, TP, S²⁻, Oil & grease, Coliform. Industrial wastewater effluent was collected at the sewers of My Tho, Tan My Chanh, Tan Huong and Long Giang industrial zones (IW1-IW4) to analyze the indicators of pH, Temp, BOD, COD, TSS, N-NH₄⁺, TN, TP, S²⁻, Oil & grease, Coliform, CN⁻, As, Hg, Ni, Pb, Phenol. Hospital wastewater effluent was collected at locations including Tien Giang, Cai Lay, and Cho Gao General Hospitals (HW1-HW3) to analyze the parameters of pH, Temp, BOD, COD, TSS, N-NH₄⁺, N-NO₃⁻, P-PO₄³⁻, S²⁻, Oil & grease, Coliform, Shigella, Salmonella, Vibrio cholerae. Aquaculture wastewater effluent was collected at aquaculture areas in My Tho, Vam Lang and Phu Tan cities (AW1-AW3) to analyze parameters such as pH, Temp, BOD, COD, TSS, N-NH₄⁺, TN, TP, S²⁻, Oil & grease, Coliform. The indicators such as temperature, pH were in-situ measured while the remaining parameters were collected, preserved, transported and analyzed in the laboratory according to standard methods [5]. The measurement and analysis methods are presented in Table 2.

Table 1. The sampling sites

Code	Description
DW	Domestic wastewater effluent
IW1	Industrial wastewater effluent 1
IW2	Industrial wastewater effluent 2
IW3	Industrial wastewater effluent 3
IW4	Industrial wastewater effluent 4
HW1	Hospital wastewater effluent 1
HW2	Hospital wastewater effluent 2
HW3	Hospital wastewater effluent 3
AW1	Aquacultural wastewater effluent 1

AW2 Aquacultural wastewater effluent 2
AW3 Aquacultural wastewater effluent 3

Table 2. Wastewater effluent parameters and analytical methods

Parameter	Description	Unit	Methods
pH	pH	-	TCVN 6492:2011
Temp	Temperature	°C	SMEWW2550B:2012
BOD	Biological oxygen demand	mg/L	TCVN 6001-1:2008
COD	Chemical oxygen demand	mg/L	SMEWW 5220C:2017
TSS	Total suspended solids	mg/L	SMEWW 6625:2000
N-NH ₄ ⁺	Ammonium	mg/L	SMEWW 4500 NH ₃ .B&F : 2017
N-NO ₃ ⁻	Nitrate	mg/L	SMEWW 4500-NO ₃ -.E:2017
P-PO ₄ ³⁻	Orthophosphate	mg/L	SMEWW 4500P.E:2017
TN	Total nitrogen	mg/L	TCVN 6638:2000
TP	Total phosphorus	mg/L	SMEWW 4500-P.B&E:2017
S ²⁻	Sulfide	mg/L	SMEWW 4500-S ₂ -.F:2017
CN ⁻	Cyanide	mg/L	SMEWW 4500-CN-.C&E:2017
As	Arsenic	mg/L	SMEWW 3120B:2017
Hg	Mercury	mg/L	SMEWW 3112B:2017
Ni	Nikel	mg/L	SMEWW 3120B:2017
Pb	Lead	mg/L	SMEWW 3120B:2017
Phenol	Phenol	mg/L	TCVN 6216:1996
Oil & grease	Oil and grease	mg/L	SMEWW 5520 F:2017
Coliform	Coliform	MPN/100 mL	TCVN 6187-2:1996
Shigella	Shigella	MPN/100 mL	SMEWW 9260E:2017
Salmonella	Salmonella	MPN/100 mL	TCVN 9717:2013
Vibrio cholerae	Vibrio cholerae	MPN/100 mL	SMEWW 9260H:2017

The quality of domestic wastewater was assessed using Vietnamese standard QCVN 14:2008/BTNMT [6] while the quality of industrial, medical and aquaculture wastewater was assessed using QCVN 40:2011/BTNMT [7].

3. Results and discussion

3.1 Characteristics of industrial wastewater effluent

Table 3. Analytical results of industrial wastewater effluent quality

Parameter	IW1		IW2		IW3		IW4		QCVN 40:2011/BTNMT, A
	Jun	Sep	Jun	Sep	Jun	Sep	Jun	Sep	
pH	7.74	7.23	7.65	7.66	7.75	7.56	8.32	7.96	6 ÷ 9
Temp	31.6	29.8	31.3	29.3	31.2	31.2	33.3	31.2	40
BOD	17	12	21	24	12	7	9	11	30
COD	33	30	44	52	30	12	28	34	75
TSS	27	27	61	63	45	35	29	76	50
N-NH ₄ ⁺	6.32	6.48	16.45	15.24	0.16	0.18	0.34	1.26	5
TN	12.7	12.4	21.6	18.46	1.5	2.1	2.4	1.7	20
TP	4.76	3.68	3.73	4.37	1.84	0.94	1.18	0.12	4
S ²⁻	0	0	0	0	0	0	0	0	0.20
Oil & grease	0	0	0	0	0	0	0	0	5
Coliform	640	150	34000	26000	360	260	160	0	3,000
CN ⁻	0	0	0	0	0	0	0	0	0.07
As	0	0	0	0	0	0	0	0	0.05
Hg	0	0	0	0	0	0	0	0	0.01
Ni	0	0	0	0	0	0	0	0	0.20
Pb	0	0	0	0	0	0	0	0	0.10
Phenol	0	0	0	0	0	0	0	0	0.10

The analysis results of industrial wastewater quality are presented in Table 3. pH ranges from 7.23 to 7.96, temperature ranges from 29.3 to 33.3°C. Both pH and temperature are within acceptable limits. BOD ranges from 7 to 24 mg/L, highest at IW2 and lowest at IW4. The values of BOD in the dry season tend to be higher than in the rainy season. BOD is within the allowable limits of QCVN 40:2011/BTNMT, Column A. BOD needs to be further treated to meet QCVN 08-MT: 2015/BTNMT, column A before being discharged into surface water. COD ranges from 12 to 52 mg/L. The COD at IW2 and IWI was higher than the rest. COD has seasonal variation in which COD at IW1 and IW3 during the wet season tends to be higher than in the dry season while at locations IW2 and IW4 the COD in the dry season tends to be higher than that of the rainy season. However, the values of COD are all within the allowable limits. TSS fluctuates from 27 to 76 mg/L, in which TSS is highest at location IW4 in the rainy season (beyond the allowable limit). TSS at IW2 in both rainy season and dry season exceeded the allowable limit of QCVN 08-MT: 2015/BTNMT, column A. N-NH_4^+ concentration at IW1 and IW2 exceeded the allowable limit, especially at IW2. The IW3 and IW4 positions are low and within acceptable limits. N-NH_4^+ at the IW site has a marked seasonal variation in N-NH_4^+ in the rainy season, which tends to be higher than in the dry season. Total phosphorus values ranged from 0.94 to 4.76 mg/L. TP at positions IW1 (in the dry season) and IW2 (in the rainy season) have exceeded the allowable limit. Coliforms were present at the survey sites (except for the IW site in the dry season). In which, coliform at IW2 was higher than the allowable limit. Oil and grease, sulfide, cyanide, phenol and heavy metals (As, Hg, Ni, Pb) were not detected at the study sites. The research results show that industrial wastewater with TSS, N-NH_4^+ , TP, Coliform criteria has not completely met the discharge requirements at some locations, especially IW1 and IW2. Indicators have seasonal fluctuations in which the values of the indicators tend to be higher in the rainy season than in the rainy season.

3.2 Characteristics of hospital wastewater effluent

Some indicators of wastewater discharged from medical facilities are presented in Table 4. The results show that the temperature and pH are in the range of 6.91-8.11 and 29.8-32.5°C. BOD and COD ranged from 7-12 mg/L and 21-38 mg/L, respectively. BOD and COD at HW1 and HW3 during the wet season were higher than those in the dry season while at the HW2 site the opposite was true. This shows that organic matters tend to fluctuate according to different seasons at the study sites. However, BOD and COD are both within the allowable limits of QCVN 08-MT: 2015/BTNMT, column A. TSS values range from 25-38 mg/L and seasonal fluctuations are similar to BOD and COD. TSS value is within allowable limits. The ammonium nitrogen content at the HW1 site is higher than the N-NH_4^+ at the HW2 and HW3 sites. Particularly, N-NH_4^+ value at the HW1 site in the rainy season (6.56 mg/L) is higher than the allowable limit while the remaining locations all meet the discharge requirements. The N-NO_3^- ranges from 0.72 to 1.45 mg/L. N-NO_3^- at HW2, HW3 tends to be higher than the HW1 position. The P-PO_4^{3-} ranges from 1.65 to 2.62 mg/L. Similar to nitrate, P-PO_4^{3-} at the HW2 and HW3 positions tends to be higher than that at HW1. The concentration of nutrients in the rainy season tends to be higher than in the dry season. Coliform was detected at all sluices except the HW1 site during the rainy season. The coliform density ranges from 150 to 950 MPN/100 mL and were all within the allowable limits of QCVN 08-MT: 2015/BTNMT, column A. The indicators such as sulfide, oil and grease and microorganisms (Shigella, Salmonella, Vibrio cholerae) were not detected. Thus, medical wastewater only has N-NH_4^+ at HW1 in the rainy season exceeding the allowable limit, the rest of the criteria all meet the discharge standards. The content of organic matter and coliform in the rainy season tends to be higher than those in the dry season; The concentration of nutrients in the rainy season tends to be lower than those in the dry season.

Table 4. Analytical results of hospital wastewater effluent quality

Parameter	HW1		HW2		HW3		QCVN 40:2011/BTNMT, A
	Jun	Sep	Jun	Sep	Jun	Sep	
pH	7.46	7.23	8.07	8.11	8.04	6.91	6.5 ÷ 8.5
Temp	32.5	29.8	32	31.4	31.9	32.4	-
BOD	11	12	9	11	7	11	30
COD	23	38	28	23	21	25	50
TSS	27	30	34	25	35	38	50
N-NH ₄ ⁺	3.45	6.56	0.38	0.26	0.24	0.28	5
N-NO ₃ ⁻	0.72	1.18	1.45	1.32	1.45	1.36	30
P-PO ₄ ³⁻	2.08	1.65	2.62	2.26	2.1	1.85	6
S ²⁻	0	0	0	0	0	0	1
Oil & grease	0	0	0	0	0	0	10
Coliform	150	0	150	200	600	950	3000
Shigella	0	0	0	0	0	0	0
Salmonella	0	0	0	0	0	0	0
Vibrio cholerae	0	0	0	0	0	0	0

3.3 Characteristics of aquacultural wastewater effluent

The quality of wastewater from aquaculture is presented in Table 5. The temperature and pH ranged from 7.55-9.07 and 28.9-34.4°C, respectively. The pH at the AW2 site in the rainy season exceeds the allowable limit. BOD, COD and TSS are in the range of 12-20 mg/L, 25-42 mg/L, 42-147 mg/L, respectively. Only TSS at location AW3 in the rainy season exceeded the allowable limit of QCVN 08-MT: 2015/BTNMT, column A. This group of organic matter indicators in the rainy season tends to be higher than those in the dry season. The group of nutrients indicators including N-NH₄⁺, TN and TP are in the range of 0.26-1.86 mg/L, 1.0-3.7 mg/L, 0-2.05 mg/L. Nutrient parameters in the dry season tend to be higher than those in the rainy season. Values of nutrients in the aquaculture area are within the allowable limits of QCVN 08-MT: 2015/BTNMT, column A. Coliform was detected at all survey sites, in which coliform at position AW1 was significantly higher than that of other sites and exceeded the allowable limit. Oil and grease was detected only at AW2 position in the rainy season (3.62 mg/L). Sulfide was not detected at all sampling sites. Thus, suspended solids and coliforms in aquaculture wastewater at some locations need to be treated to meet discharge requirements.

Table 5. Analytical results of aquacultural wastewater effluent quality

Parameter	AW1		AW2		AW3		QCVN 40:2011/BTNMT, B
	Jun	Sep	Jun	Sep	Jun	Sep	
pH	7.55	7.66	7.78	9.07	8.52	7.11	5.5 ÷ 9
Temp	31.5	29.3	34.4	30	31.6	28.9	40
BOD	14	15	15	12	12	20	50
COD	27	27	32	25	25	42	150
TSS	63	46	42	51	56	147	100
N-NH ₄ ⁺	0.26	0.34	1.86	1.72	0.62	0.68	10
TN	1.8	1.5	3.7	3.4	1	1.2	40
TP	0.72	0	2.05	0.2	1.82	0.72	6
S ²⁻	0	0	0	0	0	0	0.5
Oil & grease	0	0	3.62	0	0	0	10
Coliform	16000	21000	640	950	750	630	5000

3.4 Characteristics of domestic wastewater effluent

The quality of domestic wastewater is presented in Table 5. The pH ranges from 7.59-7.60 while the temperature ranges from 28.1-31.2°C. BOD and COD are in the range of 17-18 mg/L and 37-41 mg/L in which BOD and COD in rainy season tend to be lower than in dry season. The organic matter content is within the allowable limit of QCVN 14:2008/BTNMT, A. TSS ranges from 46 to 52 mg/L, in which TSS in rainy season tends to be higher than TSS in dry season. TSS in domestic wastewater in the rainy season has exceeded the allowable limit. The N-NH₄⁺ in the rainy season is higher than that in the dry season. N-NH₄⁺ has exceeded the allowable limit. TN and TP are in the range of 11.7-12.3 mg/L and 1.25-1.36 mg/L, of which TN and TP in the dry season are higher than TN and TP in the rainy season. TN and TP are not specified in QCVN 14:2008/BTNMT. The number of coliforms ranged from 4200-6400 MPN/100 mL, exceeding the allowable limit. Coliform in the rainy season tends to be lower than that in the dry season. Sulfide and oil and grease were not detected in domestic wastewater. Thus, TSS, N-NH₄⁺ and coliform are indicators that need to be treated to prevent pollution of the natural environment.

Table 6. Analytical results of domestic wastewater effluent quality

Parameter	DW		QCVN 14:2008/BTNMT, A
	Jun	Sep	
pH	7.59	7.6	5 ÷ 9
Temp	31.2	28.1	-
BOD	18	17	30
COD	41	37	-
TSS	46	52	50
N-NH ₄ ⁺	8.04	8.78	5
TN	12.3	11.7	-
TP	1.36	1.25	-
S ²⁻	0	0	1
Oil & grease	0	0	-
Coliform	6,400	4,200	3000

4. Conclusion

The results showed that TSS, N-NH₄⁺, TP, Coliform in industrial wastewater effluent at some locations (IW1 and IW2) have not completely met discharge requirements. N-NH₄⁺ in medical wastewater at HW1 in the rainy season exceeds the allowable limit. Meanwhile, TSS and coliform in aquaculture wastewater effluent at some locations need to be treated to meet discharge requirements. TSS, N-NH₄⁺ and coliform in domestic wastewater effluent need to be treated to meet permissible standards before being discharged into the environment. The seasonal variation is very different among the effluents of industrial, medical, aquaculture and domestic wastewater types. COD, BOD, TSS in industrial wastewater effluent in the rainy season are higher than those in the dry season. Meanwhile, BOD and COD in the effluents of medical wastewater, aquacultural wastewater and domestic wastewater are higher in the dry season than in the rainy season. In all types of wastewater effluents, the concentrations of nutrients in the rainy season is lower than those in the dry season. The indicators of heavy metals, sulfide, cyanide and groups of pathogenic microorganisms were not detected in wastewater effluents. Oil and grease were detected only at the AW2 site during the dry season. The results show that there is a need for technological solutions to improve the treatment of TSS, N-NH₄⁺, TP, coliform in wastewater, and reduce risks to the natural environment and human health.

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References

- [1] People Committee's Tien Giang Province. (2020). Report on current state of environment in Tien Giang province in 2020.
- [2] Ministry of Natural Resources and Environment (MONRE). (2019). State of the National Environment in 2019-Management of domestic solid waste.
- [3] Ministry of Natural Resources and Environment (MONRE). (2017). State of the National Environment in 2017-Waste Management.
- [4] Ministry of Natural Resources and Environment (MONRE). (2018). State of the National Environment in 2018-Water environment of river basins.
- [5] American Public Health Association, American Water Works Association, Water Environment Federation. (1998). Standard Methods for the Examination of Water and Wastewater, 20th Ed. American Public Health Association: Washington, D.C.
- [6] Ministry of Environment and Natural Resources. (2008). National technical regulation on domestic wastewater (QCVN 14: 2008/BTNMT). Hanoi, Vietnam: MONRE.
- [7] Ministry of Environment and Natural Resources. (2011). National technical regulation on industrial wastewater (QCVN 40:2011/BTNMT). Hanoi, Vietnam: MONRE.