Tampere University of Applied Sciences

Wastewater treatment system assessment at the treatment station in Dong Nai Industrial Zone in Vietnam

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BACHELOR'S THESIS

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ABSTRACT

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This work was carried out to gain more knowledge on the function and efficiency and to provide monitoring and maintaining system plan for a wastewater treatment system of an industrial zone of Dongnai Province, Vietnam.

The purpose of this thesis was to assess the efficiency of the wastewater treatment plant by measuring several water quality parameters of the influent and effluent of a wastewater treatment plant receiving the wastewater of 35 operating companies. The quality of wastewater was followed and compared to Vietnamese standards and legislations.

The results show that the criteria of wastewater quality set by the Vietnamese standards were fulfilled. As a consequence, the impact of wastewater effluent at Nuoc Chong stream are not significant. The proposed monitoring and managing the wastewater treatment system was approved and applied to for further improvements.

Key words: wastewater treatment, operating efficiency, impact assessment.

CONTENTS

ABBREVIATIONS AND TERMS

TSS	Total suspended solids
BOD	Biological Oxygen Demand
COD	Chemical Oxygen Demand
SAA	Surfactant Active Agent
DO	Dissolved Oxygen

1 INTRODUCTION

1.1 General concept of wastewater treatment

In recent years, the effort to sustainably develop environmental protection portion of economy has been crucial to many countries around the world.

Many developing countries including Vietnam, however, face significant challenges to improve the quality of water environments, which are often polluted by toxic substances and compounds created by industrial activities. These activities may include construction, chemicals, agriculture, and manufacturing, among others. The higher the rate of social and industrial growth, the greater the threat posed by water pollution, especially when poor standards allow polluting companies to damage the environment without restrictions.

Therefore, with the central goal for access to clean water, wastewater purification or wastewater treatment is required to maintain the environmental health generally and human health specifically.

Wastewater is any water that requires purification after use for domestic using and industrial purposes. Additionally, rainwater is considered wastewater, as it contains undesired chemical pollutants that impair the air, soil and water. (Juli, 2005)

One of the aims of wastewater management is to keep water clean and protected from dangerous pollutants so that it not only serves as potable water for community members, but also is safe enough to be released into water bodies (Juli, 2005).

1.2 Background of the work

The process of industrialization and modernization of the country is creating huge pressure on the environment. With regards to its socio-economic development, the speed of urbanization is increasing. Although the government has made great

efforts through policies and laws to implement environmental protections, water pollution remains a very worrying issue.

Currently, most domestic wastewater from households, together with wastewater from factories and industrial parks, are directly discharged into the drainage system without any treatment. Specifically in Vedan case, a Taiwanese company has discharged untreated wastewater into Thi Vai River that caused serious pollution to the involved areas. (Vietnamnews, 2009)

Furthermore, in large urban areas, water drainage systems are not separated from rainwater drainage and daily-life wastewater. Due to unsecured drainage systems, the area often floods in the rainy season and leads to dirty water spills on the streets. This pollution ultimately flows into households, affecting the health and living environment of the people.

Furthermore, according to Vietnamese legislation, wastewater must meet wastewater quality standard of QCVN 40:2011/BTNMT, column B before it is sent to the wastewater treatment plant. Meanwhile, the quality of effluent should be treated so that it meets the standard of QCVN 40:2011/BTNMT, column A before releasing into the environment. All the requirements and principles are presented in the tables listed in appendix 1.

Therefore, based on established criteria, the evaluation of the operational efficiency of wastewater treatment plants is extremely urgent and deserves significant scientific attention. In order to reach the estimation, the analysis of parameters of influent and effluent was conducted and assessed based on the concepts of standards and licenses.

In the process of operation, Dong Nai Industrial Park discharges an estimated industrial wastewater quantity of about 1300m^3 / day. Wastewater from enterprises is preliminarily treated to meet the prescribed standards of industrial zones before being taken to the centralized wastewater treatment plant. The input wastewater of the centralized wastewater treatment system has specific water quality indicators such as TSS, BOD_5, COD, Nitrogen, Phosphorus, Coliform, etc. After being treated, the wastewater is discharged into Nuoc Chong stream.

1.2.1 Information about operating activities of Dong Nai Industrial Park

35 operating companies utilize the wastewater treatment operation plant. They are listed in the table below.

TABLE 1: Companies participating in wastewater treatment (Dong Nai, 2018)

Company and firm	Area(m^2)	Types of business	
A first Vina Ltd	33.474	Clothing	SS, SAA, COD, BOD
Art Timber Ltd	56.079	Timber	SS, BOD, COD, color, sulphide
Anh Binh Minh Ltd	46.000	Package	SS, BOD, COD, color, sulphide
Do Moc Chien Ltd	141.432	Timber	SS, BOD, COD, color, sulphide
Son Dai Hung Ltd	32.958	Intumescent Paint	Color, fragrance, SS, COD, heavy metal
Gi Wang VN Ltd	10.001	Plastic	SS, BOD, COD, N, P
Hai Ngoc Timber Jsc	5.063	Timber	SS, BOD, COD, color, sulphide
Tan Duong Ltd	40.012	Timber	SS, BOD, COD, color, sulphide
Hua Da Furniture Ltd	64.899	Timber	SS, BOD, COD, color, sulphide
JohnSon Wood Ltd	132.085	Timber	SS, BOD, COD, color, sulphide
LeeFu Wood Ltd	138.921	Timber	SS, BOD, COD, color, sulphide
Ngoi Sao Ltd	7.008	Timber	SS, BOD, COD, color, sulphide
Phu Tai JSC	24.105	Timber	SS, BOD, COD, color, sulphide
Poh Huat Ltd	123.894	Timber	SS, BOD, COD, color, sulphide
Pro-concepts Ltd	49.557	Timber	SS, BOD, COD, color, sulphide
Shenbao Furniture Ltd	29.972	Timber	SS, BOD, COD, color, sulphide
Timber Industry Ltd	158.488	Timber	SS, BOD, COD, color, sulphide
Toan Tam Private Enterprise	13.549	Timber	SS, BOD, COD, color, sulphide
Vuong Ngoc Ltd	14.920	Timber	SS, BOD, COD, color, sulphide
Washi Washi Ltd	20.346	Laundry	SS, SAA, COD, BOD, color
Yuan Chang Ltd	45.441	Timber	SS, BOD, COD, color, sulphide
Shyange Paint	20.191	Paint	Color, fragrance, SS, COD, heavy metal
Gia My Ltd	50.321	Timber	SS, BOD, COD, color, sulphide
Cariyan Wooden Ltd	35.000	Timber	SS, BOD, COD, color, sulphide
Armajaro Ltd	20.000	Farm process	SS, BOD, COD, coliform
Hanh Phuc Ltd	24.000	Farm process	SS, BOD, COD, coliform
Chempack VN Ltd	30.032	Plastic	SS, BOD, COD, N, P
Viet Tinh Ltd	3.000	Civil engineering	SS, BOD, COD
An Giang Coffee Ltd	14.951	Farm process	SS, BOD, COD, coliform
Thach Viet Ltd	11.022	Handicraft articles	SS, BOD, COD, color, sulphide
Pisico Tam Phuoc JSC	32.441	Timber	SS, BOD, COD, color, sulphide
Segis Viet Nam Ltd	10.010	Timber	SS, BOD, COD, color, sulphide
Vina Uc Package Ltd	10.000	Package	SS, BOD, COD, color, sulphide
Thinh Nguyen Phat Ltd	9.500	Timber	SS, BOD, COD, color, sulphide
Khai Toan JSC	55.465	Electrical devices	SS, COD, heavy metal

1.2.2 Water use and wastewater discharge

The total water demand of enterprises that are connected to the wastewater treatment station of Dong Nai Industrial Park is in average 48806 m^3/ month or 1627 m^3 / day (Dongnai, 2018).

Detailed statistics on water demand and wastewater discharge of enterprises are shown in the appendix 2.

1.2.3 Description of wastewater collection system

Wastewater in Dong Nai Industrial Zone has been completely isolated from rainwater runoff. The industrial wastewater collecting system from factories in the industrial park to the treatment plant is a reinforced concrete sewer system, with a diameter of 300mm to 1000mm. The sewage pipes are arranged along with the roads in the industrial zones. Statistics of types of pipes and lengths of sewers are shown in appendix 3.

1.2.4 Description of rainwater runoff collection

Rainwater collection system in industrial zone includes many types of reinforced concrete with the diameters from 400mm to 1500mm. Similar to the wastewater collection system, they are located along with the roads in Dong Nai industrial zone. They are listed in the appendix 4.

1.2.5 Description of working principle of the treatment process

The treatment system is built according to the 3rd generation of aerobic UNITANK technology, which is a process of wastewater treatment by artificial aerobic method. There are three main stages in the process.

The first stage is called primary treatment, which includes screening, addition of chemicals, and sedimentation to remove debris and rough substances that might cause block in the treatment facilities. (Gabriel, 2011). In this stage wastewater from all of enterprises is collected to gathering tank of the treatment plan then water travels through the bar screen, where large sized solids will be isolated before it enters to the plant. Then, the lighter or fine solids which have the density less than water continue floating to the refinement layer, or sand trap, before traveling to an equalization tank and coagulation/flocculation tank.

The next stage is called secondary treatment where biological and chemical process occur. At this stage when the physio-chemical treatment also takes place, pH is neutralized; polymer anion and chemical coagulants are added to accelerate the dehydration and sedimentation process. One of the advantages of polymers is assembling the larger scale particles and smaller scale particles together in the flocculation process. After that, the sludge is automatically collected to the sludge tank and the wastewater flows to an aerobic biological treatment tank where denitrification is performed.

At the aerobic biological treatment stage, wastewater is continuously treated in microbiological environment to decompose organic matter.

Once wastewater is biologically treated, the wastewater in the surface layer is led into a disinfection tank to remove all the bacteria, enabling the wastewater to be discharged into the environment.

After the biological treatment stage, sludge is pumped to the compressed tank to perform sludge dewatering, then it is pumped to the filler press where sludge will be pressed dry up to 10-15%. The water after the pressing process will flow back to the balance tank.

Through physiochemical treatment, COD, TSS, heavy metal substances can be removed.

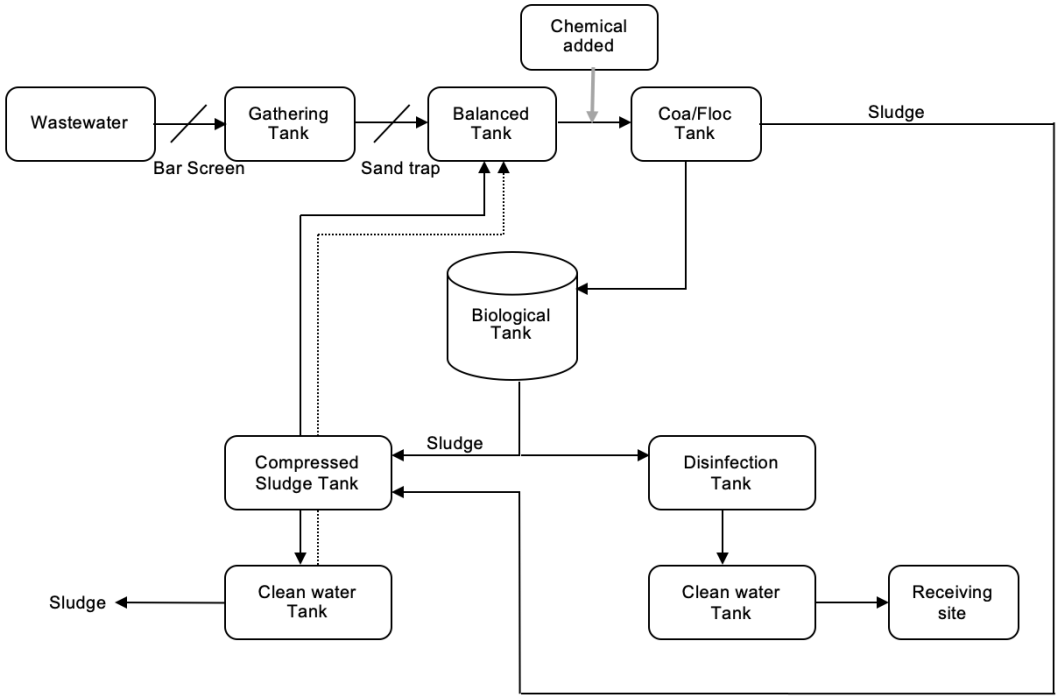

FIGURE 1: Wastewater treatment process (Dongnai, 2018)

1.2.6 Description of the discharge of wastewater after treatment

After being treated, the wastewater will flow through the concrete drain system with 15m of length to clean water tank with a volume of 330 m^3. From this tank, it discharges into the Nuoc Chong stream through the reinforced concrete gate.

1.2.7 Features of receiving wastewater site

To evaluate the features of the receiving site, topographic of Dongnai zone was examined. It showed that the terrain of the area is quite flat; the slope is from the North to the Southwest. Moreover, Dongnai's climate is classified as tropical which is influenced by the monsoons. In particular, it is divided into two distinct

seasons. The rainy season is from May to November and dry season is from December to April.

Also, air temperature directly affects in the process of emission pollutants. In addition, it also changes the evaporation of organic pollutants. The table below is the annual average temperature at Bien Hoa station.

TABLE 2: The annual average temperature at Bien Hoa station (Dongnai 2018)

Month	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**IX**	**X**	**XI**	**XII**	**Av**
T(^{0}C)	25.9	27.4	28.5	28.2	27.1	26.7	27.2	26.4	26.2	25.8	24.9	25.9	28.5

Meanwhile, air humidity depends on seasons the humidity changes differently. In rainy season, it can reach to 88.8% from July to October. During the day, the air humidity varies in inverse proportion to the temperature. For instance, the lowest ration is from 1-2pm and the highest at 7am.

TABLE 3: Analysis of the annual humidity (Dongnai, 2018)

Month	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**IX**	**X**	**XI**	**XII**	**Av**
Humid	76.2	73.3	72.2	74.4	80.8	85.3	86	86.5	88.8	87.6	84.3	78.4	25.9

The amount of rainfall normally average 1855.4mm. The quality of rainwater depends on the air quality in the wide space

TABLE 4: Analysis of the annual rainfall (Dongnai, 2018)

Month	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**IX**	**X**	**XI**	**XII**	**Av**
Rain-fall (mm	10.9	5.7	12.8	64.8	176.4	267.9	299.9	287.7	288.7	285.3	115.5	39.9	1855.4

Besides that, the solar radiation is a climate factor that directly affects temperature, regional humidity, atmospheric sustainability thereby it can affect the dispersal and metabolism of pollutants.

TABLE 5: Analysis of the solar radiation (Dongnai 2018)

Month	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**IX**	**X**	**XI**	**XII**	**Av**
Sun-shine (hour)	251.3	246.4	271.5	245.9	211.2	185.7	190.9	176	169.3	183.3	200.6	219.4	212.6

Additionally, the wind speed has a great influence on the dispersal of pollutants in the air, evaporation process as well as organic substances presenting in surface water and wastewater. The smaller the wind speed is, the greater the pollution level around the contaminated area.

TABLE 6: Analysis of the wind speed (Dongnai 2018)

Month	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**IX**	**X**	**XI**	**XII**	**Av**
Wind speed (m/s)	1.4	1.5	1.7	1.7	1.4	1.4	1.4	1.4	1.3	1.3	1.3	1.4	1.4

2 SCOPE OF THE THESIS

The scope of this work was to evaluate the operational efficiency of the wastewater treatment plant in Dong Nai industrial park based on the influent and effluent water quality parameters and by comparison to the standardized requirements. Additionall scope was to assess the impact of wastewater effluent on Nuoc Chong stream and to suggest further wastewater monitoring options in order to reduce or prevent pollution.

3 MATERIALS AND METHODS

3.1 Data collection

Data collection was done by measuring water quality indicators such as color, pH-temperature, DO, COD, TSS, ammonium, nitrate and total phosphorus. Firstly, sensors for measuring pH-temperature, DO, TSS and COD were measured by embedding sensors in the water at the sampling site, water is taken directly from the drainage ditch. Next, ammonium, nitrate and total phosphorus were determined by digital sensors. All of the works have been carried out at the laboratory treatment station of Bien Hoa City.

3.2 Methods

The analytical methods were done based on Vietnam Regulations. According to the guidance of National Standards, wastewater was evaluated that its quality in accordance with the requirements. Specifically, to determine water quality of temperature, TCVN 4557:1998 was applied. Likewise, water quality for determination of pH based on TCVN 6492:2011 (ISO 10523:2008). Another determination methods are listed below:

- TCVN 6185:2008 – Water quality – Examination and determination of color
- TCVN 6001-1:2008 (ISO 5815-1:2003) – water quality – Determination of biochemical oxygen demand after n day (BODn)
- TCVN 6491:1999 (ISO 6060:1989) – Water quality – Determination of chemical oxygen demand

4 RESULTS AND DISCUSSIONS

4.1 Analysis of influent water quality indicators

To assess the quality of waste water before the treatment system of the centralized wastewater treatment plant of Dong Nai industrial park, waste water samples were sent to Dong Nai Environmental Monitoring and Technical Center to analyze. The results of the input of wastewater are shown in Table 7.

TABLE 7: Analysis of wastewater samples before being treated (Dongnai, 2018)

Parameters	Value	Required values
Smell at 20^0C and 60^0C	Odor	Normal
pH	7.1	6-9
TSS	142	< 100 mg/l
Color (pH=7)	27	< 150 Pt-Co
BOD_5	442	< 50 mg/l
COD	797	< 150 mg/l
Total phosphorous	5.52	< 6 mgP/l
Total nitrogen	52.9	< 40 mgP/l
Lead	<0.01	< 0.5 mg/l
Cadmium	<0.002	< 0.1 mg/l
Mercury	<0.0005	< 0.01 mg/l
Arsenic	<0.001	< 0.1 mg/l
Coliform	$2.4x10^6$	< 5000 mg/l

The table above shows that the color, odor, TSS, BOD_5, COD, Total Nitrogen and Coliform exceed the permissible limit. It is of particular significant that coliform levels exceed the standard by 800 times. The remaining indicators are within the allowable limitation.

4.2 Analysis of the characteristic of rainwater runoff.

In the rainy season, rainwater running through the industrial zone area will lead to solid waste falling along the water flow, which are sources of pollution that cause pollution of overflow rainwater. Estimation of concentrations of pollutants in rainwater runoff are shown:

TABLE 8: Concentrations of pollutant in rainwater runoff

Total nitrogen	0.5 – 1.5 mg/l
Total phosphorous	0.004 - 0.03 mg/l
COD	10 – 20 mg/l
TSS	10 – 20 mg/l

Compared with industrial wastewater, rainwater is quite clean. Nowadays, Dongnai Industrial Park has built a rainwater collection and drainage system independently from its sewer system. Rainwater is collected by reinforced concrete sewer system which has the diameter from 400 to 1500mm, discharging directly to the environment.

4.3 Treated wastewater analysis

To evaluate the performance of Dongnai Industrial Park wastewater treatment station, Dong Nai Department of Natural Resources and Environment has sampled and inspected wastewater. Results are exhibited in the table beneath.

TABLE 9: Analysis of wastewater samples after being treated (Dongnai, 2018)

Parameter	Result	Required values
Odor at 20^0C, 60^0C	Normal	Normal
pH	7.3	6-9
TSS	4	< 50 mg/l
Color (pH=7)	6	< 50 Pt-Co
BOD_5	2	< 30 mg/l
COD	35	< 75 mg/l
Total Phosphorous	0.06	< 4 mg/l
Total Nitrogen	22.3	< 20 mg/l
Lead	<0.01	< 0.1 mg/l
Cadmium	<0.002	< 0.05 mg/l
Mercury	<0.0005	< 0.005 mg/l
Arsenic	<0.001	< 0.05 mg/l
Coliform	KPH	3000 MPN/100ml

As can see from the table, the wastewater treatment system of Dongnai Industrial Park operates moderately efficiently and the nature of waste water after the treatment meets requirement standards. The results of analysis of waste water quality after treatment at the time of sampling illustrated that the analytical criteria fulfil the allowed standards especially total nitrogen exceed the requirement by 1.65 times.

In order to evaluate the effectiveness of the treatment system, during the monitoring and operation of the wastewater treatment system, the laboratory of Dong Nai Industrial Park Wastewater Treatment Station has also conducted periodical sampling analysis listed in the table below.

TABLE 10: Evaluating the efficiency of the treatment system (Dongnai, 2018)

Date	COD (mg/l)			SS (mg/l)			PHOSPHOROUS (mg/l)		
	*	**	Effi-ciency (%)	*	**	Effi-ciency (%)	*	**	Effi-ciency (%)
1/9/18	1350	38	97.19	1125	3.8	99.66			
4/9/18	754	44	94.16	660	5.2	99.21			
6/9/18	778	24	96.92	465	8.0	98.28			
14/9/18	855	14	98.36	418	5.6	98.66	1.97	0.43	78.17
18/9/18	932	39	95.82	495	26.0	94.75	2.13	0.25	88.26
19/9/18	771	21	97.28	555	5.0	99.10	1.89	0.03	98.41
24/9/18	901	28	96.89	443	2.0	99.55	1.53	0.56	63.40
25/9/18	900	53	94.11	295	16.0	94.58	1.41	0.32	77.30
26/9/18	1138	40	96.49	680	10.8	98.41	1.20	0.25	79.17
28/9/18	914	48	94.75	790	18.5	97.66	0.97	0.68	29.90
29/9/18	889	47	94.71	547	22.0	95.98	1.42	KPH	100.00
1/10/18	448	44	90.18	400	9.2	97.70	0.94	0.35	62.77
2/10/18	573	42	92.67	280	16.0	94.29	0.87	0.21	75.86
3/10/18	500	38	92.40	360	35.6	90.11	0.78	0.2	74.36
4/10/18	776	45	94.20	570	32.0	94.39	1.04	0.55	47.12
5/10/18	619	47	92.41	305	33.6	88.98	0.98	0.27	72.45
6/10/18	631	49	92.23	460	61.0	86.74	1.13	0.35	69.03
8/10/18	753	44	94.16	460	15.5	96.63	1.53	0.41	73.20
9/10/18	821	39	95.25	480	12.0	97.50	0.85	0.31	63.53
10/10/18	505	5	99.01	380	11.2	97.05	1.42	0.30	78.87
11/10/18	662	55	91.69	460	25.2	94.52	2.13	0.48	77.46
12/10/18	875	33	96.23	570	22.4	96.07	0.78	0.18	76.92
13/10/18	581	41	92.94	265	5.6	97.89	1.38	0.24	82.61
Average value	**779.39**	**38.17**	**94.78**	**498.3**	**17.49**	**95.99**	**1.32**	**0.34**	**73.44**

Note: * Influent samples

** Effluent samples

According to the result table above, the efficiency of the parameters of COD, SS and phosphorous was quite high and stable. The efficiency of COD reached 94.78% in general; SS achieved 95.99% and phosphorous was 73.44%

4.4 Environment impact assessment.

4.4.1 Impact on water quality of receiving source

There is no irrigation system in the Nuoc Chong area as well as any water supply facilities and organizations. Therefore, planning of water exploitation and use of Nuoc Chong stream is mainly for aquatic protection.

Typical pollution wastewater parameters of enterprises include pH, BOD_5, COD, SS, Total Nitrogen, Total phosphorus and Coliform. Thus, the discharge of wastewater into water sources may cause some impacts such as increasing the content of suspended solids in water that lead to increase turbidity in the river and reducing the ability to receive light as well as reducing photosynthetic efficiency and reducing dissolved oxygen in water. (Frank, 2007). Also, wastewater discharge is responsible for increasing organic pollutant load (BOD_5, COD) discharges into water sources.

Furthermore, during the operation process especially in the dry season, the receiving volume is quite small, meaning that any discharge into the environment will have an amplified effect in contaminating water sources. For that reason, Dongnai Industrial Park needs to implement thorough management, operation and monitoring of its treatment system and, officials must make compiling with regulations.

4.4.2 Impact on the environment and aquatic ecosystems

Exposure to untreated or under permitted wastewater standards into the receiving source may cause deleterious issues in the environment and aquatic ecosystem in the receiving source. As untreated wastewater discharges into the environment, it can lead to increased turbidity, preventing light from entering through surface water which in turn photosynthetic efficiency.

Besides, some aquatic species living in the area will experienced reduced oxygen absorption. There is no doubt that living conditions of domestic organisms are closely related to the amount of dissolved oxygen in water, temperature, light and nutrients. The reduction of any of these factors will negatively impact the species.

The result of sampling wastewater after treatment shows that most of the indicators are within the permitted standards. So the effluent does not significantly affect the quality of receiving source.

4.5 Monitoring and managing the wastewater treatment system

When the operation has been performed successfully, monitoring and managing the wastewater should be taken into account in order to maintain the efficiency of the treatment system. After being discussed and considered, the schedule and plan was adjusted and applied. The work has been presented in the table 11 below

TABLE 11: Monitoring and managing of the treatment system

Monitoring		Frequency	Standard	Parameters
Wastewater treatment system	Operating time	Daily		
	Effluent Discharge	Hour		
	Discharge Cycle	Daily		
	Sludge Disposal	Monthly		
Influent and Effluent	Dongnai environ-mental center	Every 3 months	QCVN 40:2011/BTNMT	pH, Color, SS, BOD_5, COD, Zn, Cu, Pb, As, Hg, Cd, total N, P and Coliform
	Laboratory treatment station	Daily	QCVN 40:2011/BTNMT	pH, SS, COD, photphorous
Receiving Discharge Site		Every 6 months	QCVN 40:2011/BTNMT	pH, color, SS, NO_2^-, NO_3^-, BOD_5, COD, to-tal Fe, Cr^{3+}, Cr^{6+}, Zn, Cu, Lead, As, Hg, Cd, fat and coliform.

5 DISCUSSION

Numerous experiments have been carried out to see the whole process of how the wastewater being treated. As can be seen from the results table that the amount of TSS, BOD_5, COD, total nitrogen and Coliform in wastewater samples exceeded the standard requirements before they were treated. As a result of the treatment process, quality of wastewater obtained the parameters: TSS was reduced to 4 mg/l, BOD_5 about 2 mg/l, COD below 35 mg/l and the amount of total Nitrogen was minimized from 52.9mg/l to 22.3 mg/l.

According to Vietnamese regulations, in order to define where effluent should be discharged, many analysis of the features of receiving site have been determined including air temperature, air humidity, annual rainfall, solar radiation, wind speed as well as hydrological characteristics to calculate allowable amounts of wastewater discharged to the water body.

Moreover, during the treatment process where extra sludge that was residual, it can be utilized for composting as raw-material to reach the zero-waste goal.

This process can be expanded upon in the future to achieve a zero-waste goal. The treatment process and industrial mechanisms are consistent and repeatable if executed properly, which prevents costly and harmful mistakes and discharges

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APPENDICES

Appendix 1. QCVN 40:2011/BTNMT - National technical regulation.

QCVN 40:2011/BTNMT

NATIONAL TECHNICAL REGULATION

ON INDUSTRIAL WASTEWATER

Foreword

QCVN 40:2011/BTNMT supersedes QCVN 24:2009/BTNMT, is submitted by the Vietnam Environment Administration, the Science and technology Administration, and the Legal Department, and promulgated together with the Circular No. 47/2011/TT-BTNMT dated December 28, 2011 of the Minister of Natural Resources and Environment.

NATIONAL TECHNICAL REGULATION

ON INDUSTRIAL WASTEWATER

1. GENERAL PROVISIONS:

1.1. Scope of regulation

This Regulation provides for the maximum values of pollution parameters of industrial wastewater being discharged into receiving waters.

1.2. Subjects of application

1.2.1. This Regulation is applicable to organizations and individuals involved in the discharge of industrial wastewater into receiving waters.

1.2.2. Industrial wastewater of special industry is subject to separate National Technical Regulations.

1.2.3. Industrial wastewater being discharged into the collecting system of centralized wastewater treatment plants shall comply with the charters of the plants.

1.3. Interpretation of terms

In this Regulation, the terms below are construed as follows:

1.3.1. Industrial wastewater is wastewater produced from the technological processes of industrial facilities, from centralized wastewater treatment plants that are connected to the sewer system of industrial facilities.

1.3.2. Receiving waters are drainage system of urban areas and residential areas, rivers, streams, canals, channels, lakes, ponds, swamps; coastal water that have defined purposes.

2. TECHNICAL PROVISIONS

2.1. The maximum permissible values of pollution parameters in industrial wastewater being discharged into receiving waters.

2.1.1. Maximum permissible values of parameters of industrial wastewater being discharged into receiving waters are calculated as follows:

$$C_{max} = C \times K_q \times K_f$$

- Cmax is the maximum permissible value of a pollution parameter of industrial wastewater being discharged into receiving waters.

- C is the value of a pollution parameter of industrial wastewater specified in Table 1;

- Kq is the coefficient of receiving waters specified in Point 2.3 which is correspond to the flow rate of the rivers, streams, canals, channels, or the volume of the lakes, swamps, or the purposes of coastal water;

- Kf is the coefficient of the flow rate of the receiving waters specified in Point 2.4 which corresponds to the total flow rate of wastewater discharged by industrial facilities into receiving waters;

2.1.2. Apply the maximum permissible value Cmax = C (not Kq and Kf) to the following parameters: temperature, color, pH, coliform, gross α activity, and gross β activity.

2.1.3. Industrial wastewater being discharged into the drainage systems of urban areas and residential areas without centralized wastewater treatment plants shall apply the value Cmax = C in Column B of Table 1.

2.2. Values of parameter of industrial wastewater (C) are specified in Table 1

Table 1. Values of parameter of industrial wastewater (C)

No.	Parameter	Unit	Value (C)	
			A	B
1	Temperature	^{o}C	40	40
2	Color	Pt/Co	50	150
3	pH	-	6 to 9	5.5 to 9
4	BOD_5 ($20^{o}C$)	mg/l	30	50
5	COD	mg/l	75	150
6	Suspended solids	mg/l	50	100
7	Arsenic	mg/l	0.05	0.1
8	Mercury	mg/l	0.005	0.01
9	Lead	mg/l	0.1	0.5
10	Cadmium	mg/l	0.05	0.1
11	Chromium (VI)	mg/l	0.05	0.1
12	Chromium (III)	mg/l	0.2	1

13	Copper	mg/l	2	2
14	Zinc	mg/l	3	3
15	Nickel	mg/l	0.2	0.5
16	Manganese	mg/l	0.5	1
17	Iron	mg/l	1	5
18	Total cyanide	mg/l	0.07	0.1
19	Total phenol	mg/l	0.1	0.5
20	Total mineral fats and oils	mg/l	5	10
21	Sulfide	mg/l	0.2	0.5
22	Fluoride	mg/l	5	10
23	Ammonium (as N)	mg/l	5	10
24	Total nitrogen	mg/l	20	40
25	Total phosphorus (as P)	mg/l	4	6
26	Chloride (not applicable when discharging into saline water and brackish water)	mg/l	500	1000
27	Excess Chlorine	mg/l	1	2
28	Total organochlorine pesticides	mg/l	0.05	0.1
29	Total organophosphorus pesticides	mg/l	0.3	1
30	Total PCB	mg/l	0.003	0.01
31	Coliform	bacteria/100ml	3000	5000
32	Gross α activity	Bq/l	0.1	0.1
33	Gross β activity	Bq/l	1.0	1.0

Column A in Table 1 indicates the values of parameters of industrial wastewater (C) when it is discharged into the water sources serving tap water supply;

Column B in Table 1 indicates the values of parameters of industrial wastewater (C) when it is discharged into the water sources not serving tap water supply;

The purpose of receiving waters is determined at the location into which wastewater is discharged.

2.3. Coefficient of receiving waters (Kq)

2.3.1. Coefficients Kq corresponding to the flow rate of rivers, streams, canals, channels, etc. are specified in Table 2 below:

Table 2: Coefficients Kq corresponding to the flow rate of receiving waters

Flow rate of receiving waters (Q) Unit: m^3 per second	Kq
$Q \leq 50$	0.9
$50 < Q \leq 200$	1
$200 < Q \leq 500$	1.1
$Q > 500$	1.2

Q is calculated according to the average flow rate of receiving waters in 3 driest months in 3 consecutive years (according to the data of meteorology and hydrography agencies).

2.3.2. Kq corresponding to the volume of receiving waters that are lakes, swamps are specified in Table 3 below:

Table 3: Kq corresponding to the volumes of receiving waters

Volume of receiving waters (V) Unit: m^3	Kq
$V \leq 10 \times 10^6$	0.6
$10 \times 106 < V \leq 100 \times 10^6$	0.8
$V > 100 \times 10^6$	1.0

V is calculated according to the average volume of the receiving lake or pond or swamp in 3 driest months in 3 consecutive years (according to the data of meteorology and hydrography agencies).

2.3.3. If the flow rate of receiving waters which is a river, stream, canal, or channel is unknown, then Kq = 0.9; if the volume of a lake, pond, or swamp is unknown, then Kq = 0.6.

2.3.4. Kq of receiving waters that are coastal saline water, coastal saline and brackish swamps.

For coastal saline water used for aquatic conservation, water sports and water recreation, coastal saline and brackish swamps, Kq = 1.

For coastal saline water not being used for aquatic conservation, water sports and water recreation, Kq = 1.3

2.4. Coefficient of discharge rate Kf

The coefficients of discharge rate Kf are provided in Table 4 below:

Table 4. Coefficients of discharge rate Kf

Discharge rate (F) Unit: $m^3/24h$	Kf
$F \leq 50$	1.2
$50 < F \leq 500$	1.1
$500 < F \leq 5{,}000$	1.0
$F > 5{,}000$	0.9

The discharge rate F is calculated according to the highest discharge in Environmental Impact Assessment Reports, Environment Protection Commitments, or Environment Protection Schemes.

3. DETERMINATION METHODS

3.1. Wastewater shall be sampled to evaluate quality in accordance with the guidance of the following National Standards:

- TCVN 6663-1:2011 (ISO 5667-1:2006) – Water quality -- Sampling -- Part 1: Guidance on the design of sampling programmes and sampling techniques;

- TCVN 6663-3:2008 (ISO 5667-3: 2003) – Water quality - Sampling. Guidance on the preservation and handling of water samples;

- TCVN 5999:1995 (ISO 5667 -10: 1992) - Water quality - Sampling - Part 10: Guidance on sampling of wastewaters.

3.2. Values of pollution parameters in industrial wastewater shall be determined according to the following national and international standards:

- TCVN 4557:1988 – Water quality – Method for determination of temperature;

- TCVN 6492:2011 (ISO 10523:2008) - Water quality -- Determination of pH;

- TCVN 6185:2008 – Water quality - Examination and determination of color;

- TCVN 6001-1:2008 (ISO 5815-1:2003), Water quality - Determination of biochemical oxygen demand after n days (BODn) -- Part 1: Dilution and seeding method with allylthiourea addition;

- TCVN 6001-2:2008 (ISO 5815-2:2003), Water quality - Determination of biochemical oxygen demand after n days (BODn) -- Part 2: Method for undiluted samples;

- TCVN 6491:1999 (ISO 6060:1989) - Water quality - Determination of the chemical oxygen demand;

- TCVN 6625:2000 (ISO 11923:1997) Water quality - Determination of suspended solids by filtration through glass-fibre filters;

- TCVN 6626:2000 - Water quality - Determination arsenic - Atomic absorption spectrometric method (hydride technique);

- TCVN 7877:2008 (ISO 5666:1999) – Water quality – Determination of mercury;

- TCVN 6193:1996 – Water quality – Determination of cobalt nickel, copper, zinc, cadmium, and lead. Flame atomic absorption spectrometric methods.

- TCVN 6222:2008 – Water quality- Determination of chromium - Atomic absorption spectrometric method;

- TCVN 6658:2000 - Water quality – Determination of chromium (VI). Spectrometric method using 1,5-diphenylcarbazide;

- TCVN 6002:1995 - Water quality – Determination of manganese - Formaldoxime spectrometric method;

- TCVN 6177:1996 - Water quality – Determination of iron - Spectrometric method using 1,10-phenantrolin;

- TCVN 6665:2011 (ISO 11885:2007) - Water quality -- Determination of selected elements by inductively coupled plasma optical emission spectrometry (ICP-OES);

- TCVN 6181:1996 (ISO 6703 -1:1984) - Water quality - Determination of total cyanide;

- TCVN 6494-1:2011 (ISO 10304 -1:2007) - Water quality -- Determination of dissolved anions by liquid chromatography of ions -- Part 1: Determination of bromide, chloride, fluoride, nitrate, nitrite, phosphate and sulfate;

- TCVN 6216:1996 (ISO 6439:1990) - Water quality -- Determination of phenol index -- 4-Aminoantipyrine spectrometric methods after distillation;

- TCVN 6199-1:1995 (ISO 8165/1:1992) - Water quality -- Determination of selected monovalent phenols -- Part 1: Gas-chromatographic method after enrichment by extraction;

- TCVN 5070:1995 – Water quality - Weight method for determination of oil and oil product;

- TCVN 7875:2008 – Water - Determination of oil and grease - Partition-infrared method;

- TCVN 6637:2000 (ISO 10530:1992) - Water quality - Determination of dissolved sulfide - Photometric method using methylene blue;

- TCVN 5988:1995 (ISO 5664:1984) - Water quality -- Determination of ammonium -- Distillation and titration method;

- TCVN 6620:2000 - Water quality - Determination of ammonium - Potentiometric method;

- TCVN 6638:2000 – Water quality - Determination of nitrogen - Catalytic digestion after reduction with devarda's alloy;

- TCVN 6202:2008 (ISO 6878:2004) - Water quality -- Determination of phosphorus -- Ammonium molybdate spectrometric method;

- TCVN 8775:2011 - Water quality - Total coliform - Membrane-filter technique.;

- TCVN 6187-1:2009 (ISO 9308-1:2000) - Water quality - Detection and enumeration of Escherichia coli and coliform bacteria - Part 1: Membrane filtration method.

- TCVN 6187-2:1996 (ISO 9308 -2:1990(E)) – Water quality - Detection and enumeration if coliform organisms, thermotolerant coliform organisms, and presumptive Escherichia coli - Part 2: Multiple tube (most probable number) method;

- TCVN 6225-3:2011 (ISO 7393-3:1990) - Water quality - Determination of free chlorine and total chlorine - Part 3: Iodometric titration method for the determination of total chlorine;

- TCVN 7876:2008 – Water - Determination of organochlorine pesticides content. Liquid-liquid extraction gas chromatographic method

- TCVN 8062:2009 - Organophosphorus compounds by gas chromatography - Capillary column technique

- TCVN 6053:2011 - Water quality - Measurement of gross alpha activity in non-saline water - Thick source method;

- TCVN 6219:2011 - Water quality - Measurement of gross beta activity in non-saline water.

3.3. The analysis methods with equivalent or higher accuracy than that of the standards cited in Point 3.2, and the new national and international standards that are not cited in this Regulation are accepted.

4. IMPLEMENTATION

4.1. This Regulation supersedes QCVN 24:2009/BTNMT - National Technical Regulation on Industrial Wastewater promulgated together with the Circular No. 25/2009/TT-BTNMT dated November 16, 2009 of the Minister of Natural Resources and Environment.

4.2. People's Committees of central-affiliated cities and provinces shall announce the purposes of water sources and the coefficient Kq when planning the use of water sources and zoning receiving waters.

4.3. State agencies in charge of environmental issues shall select typical parameters and basic values (C) in Table 1 to control environmental pollution depending on the characteristics of industrial wastewater and the purposes of the receiving waters.

4.4. When the national standards cited in this Regulation are amended or superseded, the new standards shall apply.

Appendix 2. Demand for water usage and wastewater discharge

N⁰	Company	Input (m^3/month)	Output (m^3/month)
1	A first Vina Ltd	1679	1343
2	Art Timber Ltd	2341	1873
3	Anh Binh Minh Ltd	368	294
4	Do Moc Chien Ltd	1692	1354
5	Son Dai Hung Ltd	432	346
6	Gi Wang VN Ltd	616	493
7	Hai Ngoc Timber Jsc	81	65
8	Tan Duong Ltd	324	259
9	Hua Da Furniture Ltd	2280	1824
10	JohnSon Wood Ltd	7312	5850
11	LeeFu Wood Ltd	4248	3398
12	Ngoi Sao Ltd	213	170
13	Phu Tai JSC	1224	979
14	Poh Huat Ltd	4856	3885
15	Pro-concepts Ltd	1934	1547
16	Shenbao Furniture Ltd	763	610
17	Timber Industry Ltd	1507	1206
18	Toan Tam Private Enterprise	111	89
19	Vuong Ngoc Ltd	481	385
20	Washi Washi Ltd	6509	5207
21	Yuan Chang Ltd	623	498
22	Shyange Paint Ltd	341	273
23	Gia My Ltd	1438	1150
24	Cariyan Wooden Ltd	1545	1236
25	Armajaro Ltd	2477	1982
26	Hanh Phuc Ltd	475	380
27	Chempack VN Ltd	1144	915
28	Viet Tinh Ltd	47	38
29	An Giang Coffee Ltd	339	271
30	Thach Viet Ltd	45	36
31	Pisico Tam Phuoc JSC	242	194
32	Segis Viet Nam Ltd	206	165
33	Vina Uc Package Ltd	176	141
34	Thinh Nguyen Phat Ltd	80	64
35	Khai Toan JSC	657	526
TOTAL		**48.806**	**39.046**

Appendix 3. Reinforced sewage system

N^0	Types	Diameter (mm)	Length(m)
1	Reinforced concrete	Φ300	6248
2	Reinforced concrete	Φ400	4510
3	Reinforced concrete	Φ600	1759
4	Reinforced concrete	Φ800	1249
5	Reinforced concrete	Φ1000	411
TOTAL			14125

Appendix 4. Reinforced rainwater runoff system

N^0	Type	Diameter (mm)	Length (m)
1	Reinforced concrete	Φ400	3687
2	Reinforced concrete	Φ600	15743
3	Reinforced concrete	Φ800	4561
4	Reinforced concrete	Φ1000	3513
5	Reinforced concrete	Φ1200	1291
6	Reinforced concrete	Φ1500	780
TOTAL			30335