SURVEY AND EVALUATION OF DOMESTIC WASTEWATER TREATMENT SYSTEM AT THU DAU MOT CITY, BINH DUONG

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Abstract

This study focused on the wastewater treatment system in Thu Dau Mot City, Binh Duong, aiming to assess its operational effectiveness. The research was carried out over a period of six weeks, with data collected at regular intervals during the 1st, 2nd, 3rd, 4th, 5th, and 6th weeks. The results demonstrate that the treatment process is highly efficient, achieving impressive removal rates across multiple parameters. Specifically, the average treatment efficiency for color was 93.10%, TSS (total suspended solids) was 98.62%, COD (chemical oxygen demand) reached 93.24%, BOD5 (biochemical oxygen demand) was 99.28%, NH4+ (ammonium) removal was 99.16%, while total nitrogen and total phosphorus were treated at 87.80% and 86.57%, respectively. Notably, the system exhibited the highest performance in coliform removal, with an actual treatment efficiency of 99.62%.

Keywords: domestic wastewater, Thu Dau Mot city wastewater treatment system, treatment efficiency

1. Introduction

Water is essential to human life, serving not only daily needs but also playing a crucial role in industrial production processes (Chowdhary et al., 2020). The improper management and control of wastewater can lead to significant environmental pollution, including water contamination, adversely affecting natural ecosystems, urban aesthetics, and the health of residents in polluted areas (Qadir et al., 2010). Previous studies have highlighted the impact of wastewater on both local ecosystems and public health, underscoring the urgent need for effective wastewater management strategies (Nguyen et al., 2020; Le et al., 2018).

In particular, the domestic wastewater management issue in urban areas has gained increasing attention in environmental protection programs, especially within the context of Binh Duong province's transitional development and the broader Southeast Asia region (Nguyen et al., 2020; Le et al., 2018). The Dong Nai and Saigon River basin systems are under significant pressure from pollution, exacerbated by wastewater from urban domestic sources and industrial activities (Noi et al., 2015; Vo, 2007). Additionally, groundwater resources in these areas are at risk due to the improper disposal of domestic waste.

To safeguard the environment and ensure healthy living conditions, effective control and management of wastewater sources are essential. In response to these challenges, the Thu

Dau Mot City wastewater treatment facility was established with a commitment to protecting the surrounding environment and public health. The facility primarily employs Advanced Sequencing Batch Reactor (ASBR) technology, enhancing activated sludge aerobic biological treatment methods (Factory, 2024). This automated operating system ensures that treated wastewater complies with Vietnamese national technical regulations, specifically QCVN 14:2008/BTNMT and QCVN 40:2011/BTNMT (QCVN, 2008; QCVN, 2011).

The facility has significantly improved residents' quality of life, enhanced the urban landscape of Thu Dau Mot City, and played a vital role in protecting the water resources of the Saigon River. Consequently, a survey and evaluation of the domestic wastewater treatment system at Thu Dau Mot City, Binh Duong, will provide valuable insights into current wastewater treatment technologies and their effectiveness in addressing local environmental challenges.

2. Methods

2.1. Collect data

Collect information and secondary data: data of Thu Dau Mot wastewater treatment factory, Binh Duong province. After collecting secondary data, the data was presented and processed to effectively use these actual data. Based on the data obtained above, it was used to compare the wastewater treatment efficiency of the surveyed factory to evaluate the treatment process in more detail. On that basis, scientific and objective conclusions are drawn from the results of research and investigations on this topic.

2.2. Sample analysis

Sampling method, sample preservation and on-site measurement: Take wastewater samples from the system according to the procedure in Vietnam standard 5999:1995. Preserve samples according to Vietnamese standards 6663 - 3 (ISO 5667-3: 2003), water quality - sampling (Instructions for sample preservation and handling). Parameters are measured and analyzed on site: pH, temperature (T^o), odor, color and flow. Other monitoring parameters: total suspended solids (TSS), BOD_5 at 200°C, COD, ammonium (as nitrogen), total N, total P, Coliforms.

Sample analysis: the parameters are analyzed according to the standards in Table 1.

TABLE 1. Analytical methods

Parameters	Analytical method
pH	TCVN 6492: 2011
Temperature	TCVN 4557: 1988
Color	TCVN 6185: 2015
TSS	TCVN 6425: 2000
DO	TCVN 5499: 1995
COD	TCVN 6491: 1999
BOD_5	TCVN 6001- 2:2008
Total Nitrogen	TCVN 6498: 1999
Total phosphorus	TCVN 6202: 2008

TCVN: Vietnam Standard

2.3. Data analysis

After 6 weeks of monitoring and sampling for analysis of parameters (pH, color, TSS, COD, BOD_5, NH_4^+, Total N, Total P, and coliform) of input and output wastewater at the factory, Data are processed using Excel and Statgraphics software.

3. Results and discussion

3.1. Survey results of the wastewater treatment system at the factory

Domestic wastewater collection network: This is a separate wastewater treatment system, collected directly from the front of each local household's house through the installation of manholes to connect domestic wastewater from households enter this manhole. The wastewater is then transferred to the treatment plant for treatment without mixing with rainwater, which makes it easy to control odors and facilitates management, inspection and maintenance. The main system's materials are made from UPVC and HDPE plastic pipes with high corrosion resistance. The wastewater collection system includes a total pipe length of 169,859 m in the inner city area with an area of 752 hectares. Figure 1 and Table 2 shows the actual processing performance of the parameters at the factory.

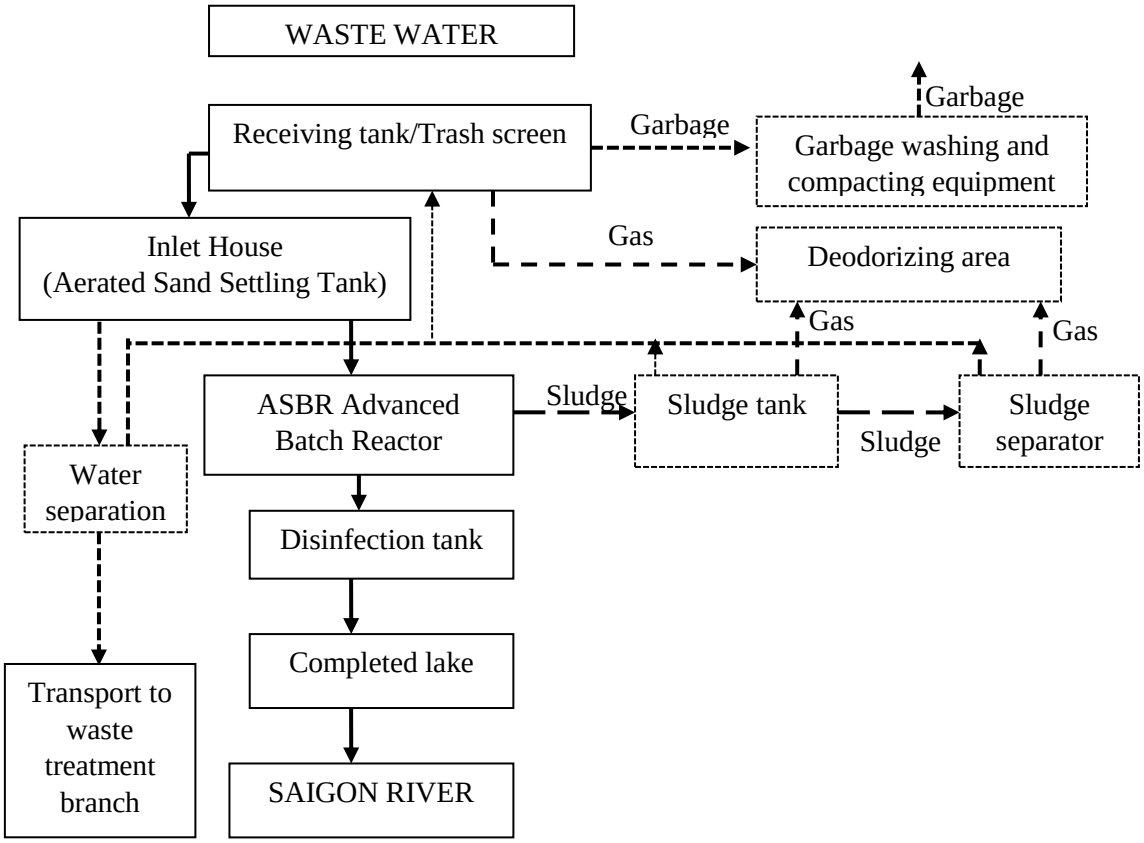

Figure 1. Domestic wastewater treatment technology diagram

TABLE 2. Processing performance of the parameters

No.	Parameters	Unit	The average value		Processing performance
			Input	Output	
1	Color	Pt/Co	377	26	93.10%
2	TSS	mg/l	217	3	98.62%
3	COD	Mg/l	296	20	93.24%
4	BOD_5	mg/l	161,99	1,17	99.28%
5	$N\text{-}NH_4$	mg/l	35,8	0,3	99.16%
6	Total Nitrogen	mg/l	41	5	87.80%
7	Total phosphorus	mg/l	6,7	0,9	86.57%
8	Coliform	MNP/100ml	95167	263	99.62%

Domestic wastewater treatment methods at Thu Dau Mot wastewater factory have proven highly effective, especially the ASBR biological tank complex. This system is capable of handling more than 90% of important pollution indicators, such as COD, BOD_5, and N-NH_4. Other components, such as total nitrogen and total phosphorus, are also effectively treated, achieving a treatment rate of 80% or more.

The high performance of this treatment system not only ensures compliance with Vietnam's environmental standards but also contributes to improving the quality of output wastewater before being discharged into the natural environment. This helps minimize negative impacts on the ecosystem and public health. Maintaining pollution indices within the allowable threshold according to Vietnam's national wastewater standards (QCVN 14:2008/BTNMT and QCVN 40:2011/BTNMT) is clear evidence of the effectiveness of the wastewater treatment system management at the factory.

In addition, the use of ASBR technology also helps enhance the ability to eliminate harmful bacteria, reduce odors, and reduce toxic emissions through advanced deodorization and exhaust treatment measures. The combination of mechanical, biological, and chemical treatment processes has created a comprehensive system, ensuring that treated wastewater is not only cleaner but also safer when discharged into the environment.

The results of Table 2, it shows high treatment efficiency. The domestic wastewater treatment system at Thu Dau Mot wastewater factory is a typical model of technology and efficiency in treating, managing, and protecting water resources.

3.2. Evaluate the effectiveness of wastewater treatment

Table 3 and Table 4 show the monitoring of average input-output water quality indicators over 6 weeks with the following indicators: color, TSS, COD, BOD_5, NH_4^+, Total N, Total P, and cofliform.

TABLE 3. Results of input parameter analysis

No. Parameters	pH	Color	TSS	COD	BOD_5	NH_4^+	Total N	Total P	Coliform
1st week	6.6 ± 0.15^{ab}	347 ± 2^{b}	254 ± 1^{d}	288 ± 1^{a}	156.4 ± 0.1^{b}	34.8 ± 0.1^{b}	39 ± 1^{a}	6.9 ± 0.1^{c}	$1.1.10^{5} \pm 0.1^{b}$
2nd week	6.83 ± 0.01^{c}	463 ± 1^{e}	335 ± 1^{e}	294 ± 1^{c}	159.05 ± 0.01^{c}	35.2 ± 0.2^{c}	39 ± 3^{a}	12.5 ± 0.1^{e}	$1.7.10^{5} \pm 0.1^{d}$
3rd week	6.52 ± 0.01^{a}	317 ± 2^{a}	203 ± 3^{c}	290 ± 2^{b}	155.44 ± 0.01^{a}	36.9 ± 0.1^{d}	40 ± 1^{a}	7.9 ± 0.1^{d}	$1.4.10^{4} \pm 0.01^{a}$
4th week	6.66 ± 0.01^{b}	370 ± 1^{c}	181 ± 2^{b}	286 ± 1^{a}	160.45 ± 0.01^{d}	34.5 ± 0.1^{a}	40 ± 2^{a}	4.6 ± 0.1^{b}	$1.3.10^{5} \pm 0.1^{c}$
5th week	6.66 ± 0.03^{b}	370 ± 2^{c}	181 ± 1^{b}	286 ± 2^{a}	160.45 ± 0.02^{d}	34.5 ± 0.2^{a}	40 ± 1^{a}	4.6 ± 0.2^{b}	$1.3.10^{5} \pm 0.2^{c}$
6th week	6.64 ± 0.01^{b}	397 ± 1^{d}	149 ± 1^{a}	330 ± 1^{d}	180.13 ± 0.02^{e}	38.6 ± 0.1^{e}	39 ± 1^{a}	3.9 ± 0.1^{a}	$1.7.10^{4} \pm 0.01^{a}$
QCVN 14:2008/BTNMT (Column A)	**5-9**	**-**	**50**	**-**	**30**	**5**	**-**	**-**	**3000**
QCVN 40:2011/BTNMT (Column A)	**6-9**	**50**	**50**	**75**	**30**	**5**	**20**	**4**	**3000**

TABLE 4. Results of output parameter analysis

No / Parameters	pH	Color	TSS	COD	BOD_5	NH_4^+	Total N	Total P	Coliform
1st week	6.36 ± 0.01^a	20 ± 1^a	3 ± 1^a	12 ± 1^a	0.54 ± 0.01^b	0.22 ± 0,01^b	2.6 ± 0.1^a	0.10 ± 0.01^a	240 ± 1^b
2nd week	6.69 ± 0.01^c	23 ± 1^b	2 ± 1^a	22 ± 2^b	0.31 ± 0.01^a	0.22 ± 0,02^b	3.6 ± 0.1^b	0.60 ± 0.1^c	280 ± 1^d
3rd week	6.98 ± 0.01^e	23 ± 2^b	2 ± 1^a	22 ± 1^b	0.58 ± 0.01^c	0.28 ± 0,02^c	4.5 ± 0.1^c	1.90 ± 0.1^d	260 ± 1^c
4th week	6.34 ± 0.01^a	35 ± 1^d	2 ± 1^a	12 ± 1^a	1.61 ± 0.02^d	0.26 ± 0,02^c	7.4 ± 0.2^e	2.43 ± 0.01^e	300 ± 2^e
5th week	6.83 ± 0.03^d	26 ± 1^c	2 ± 2^a	24 ± 1^{bc}	2.04 ± 0.01^e	0.17 ± 0,01^a	4.8 ± 0.1^d	0.31 ± 0.01^b	280 ± 2^d
6th week	6.59 ± 0.01^b	26 ± 2^c	4 ± 1^a	26 ± 1^c	1.96 ± 0.01^f	0.35 ± 0,01^d	4.7 ± 0.1^{cd}	0.31 ± 0.02^b	220 ± 1^a
QCVN 14:2008/BTNMT (Column A)	**5-9**	**-**	**50**	**-**	**30**	**5**	**-**	**-**	**3000**
QCVN 40:2011/BTNMT (Column A)	**6-9**	**50**	**50**	**75**	**30**	**5**	**20**	**4**	**3000**

a, b, c, d, e and f: represent statistically different values.
QCVN 14:2008/BTNMT and QCVN 40:2011/BTNMT: Vietnamese national standards

Input analysis results from Table 3 show the average over 6 monitoring periods, showing that most indicators exceed the allowable level according to QCVN 14:2008/BTNMT, column A. However, after the processing, output water quality has improved significantly, with obvious changes in many indicators. Specifically:

The average results of the input and output pH indicators did not have a significant difference, both within the neutral level.

In 6 monitoring times from the first week to the 6th week, the color index before and after treatment showed a difference of 14.5 times, proving the ability to effectively remove color.

The TSS index before and after treatment has a difference of up to 72.3 times, reflecting a very high ability to remove suspended solids.

The COD index before and after treatment is 14.8 times different, and the BOD_5 index is 138.45 times different, showing that the treatment system is very effective in removing organic substances.

The NH_4^+ (ammonium) concentration before and after treatment was 119.3 times different, demonstrating the ability to treat ammonium very well.

Total nitrogen before and after treatment had a difference of 1.34 times, and total phosphorus before and after treatment had a significant difference, up to 361.85 times, showing the ability to remove these nutrients very effectively. The coliform index before and after treatment decreased significantly and was within the limits of Vietnamese national standards.

4. Conclusions

The research utilized a combination of monitoring and analytical methods to assess the efficiency of the wastewater treatment plant, achieving significant and reliable results. The treatment system demonstrated an overall efficiency exceeding 90%, with key pollutants such as COD, BOD_5, NH_4^+, total nitrogen, and total phosphorus achieving removal rates of over 80%. Notably, coliform removal efficiency was nearly 99%, showcasing the system's effectiveness in reducing microbial contaminants.

After six weeks of monitoring, the results consistently confirmed that all measured wastewater quality indicators conformed to the stringent requirements of column A of the QCVN 14:2008/BTNMT standard, ensuring that the treated effluent meets national discharge standards. This compliance not only highlights the robustness of the treatment system but also affirms its role in safeguarding public health and protecting the surrounding water resources, particularly the Saigon River.

Additionally, similar studies on ASBR-based wastewater treatment systems, such as those by Singh et al. (2011) and Zhang et al. (2017) have reported comparable high treatment efficiencies, reinforcing the findings of this research. These results underscore the plant's capability to maintain consistent operational performance, even under variable load conditions, thus contributing to sustainable wastewater management practices in urban areas like Thu Dau Mot City.

In conclusion, the findings of this study provide valuable evidence that the wastewater treatment system not only achieves compliance with national standards but also plays a critical role in environmental protection, improving water quality, and promoting public health in the region.

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