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Characteristics of Domestic and Industrial Wastewater Effluent in Dong Thap Province, Vietnam

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Abstract

The quest for optimality and stability of the tungsten inert gas welding process has been a major concern to the welding researchers. The welding process involves the transformation of solid metals into liquid state in which it is exposed to harmful gases like hydrogen. It is proven that a sufficient amount of hydrogen if present in a weld microstructure can be harmful to the welded joint. Hydrogen gas gets dissolved in the structure of steel during the fabrication process which causes defects in the welded joint. The objectives of this research study targeted the ultimate tensile strength of the weld specimen. The genetic algorithm was applied using the Matlab software. The genetic algorithm model was developed to help maximize the strength of the weld and its adequacy validated. The results obtained showed that the model possessed low mean square error values and its predicted values is in reasonable agreement with the observed values.

1. Introduction

Water is an extremely important resource and an essential component of life. However, the process of exploiting and using water resources inappropriately has reduced the quality of this resource. One of the major challenges in water resource management is from socio-economic development activities, including the discharge of domestic wastewater, wastewater from traditional villages and wastewater from industrial zones. The amount of untreated wastewater is increasingly discharged directly into the environment, making water quality in some water bodies severely degraded [1-2]. The composition and properties of the wastewater depend on the types of processing types. In which, domestic wastewater generated from households, agencies, schools, markets and other structures accounts for about 80% of the water supplied for domestic use [1]. Inappropriate treatment of wastewater is one of the causes of water pollution, disease transmission and public health impacts [1-2]. Meanwhile, industrial and traditional village wastewater are generated from traditional villages, industrial clusters etc. The pollution characteristics of industrial wastewater depend on the type of production and water treatment technology. Unsatisfactory industrial wastewater treatment also seriously affects the quality of the surrounding environment. Dong Thap is a province in the Mekong Delta, in the Dong Thap Muoi sub-region, it is located between the Tien and Hau rivers. The section of Tien River and Hau River flowing through Dong Thap province is about 120 km and 30 km in length, respectively [3]. Favorable natural conditions help the socio-economic situation in

Dong Thap province develop strongly. According to Dong Thap People's Committee (2019) [4], estimated GRDP growth reached 6.9% over the same period in 2018, the agriculture-forestry-fishery sector increased 4.43%, industry-construction increased 8.09%, trade and service rose 8.17%. In which, industrial production maintained a good growth. Frozen pangasius products continued to play a key role, leather shoes, garments, and animal feed also achieved good growth. However, the socio-economic development has affected surface water quality in the province [5]. This study describes the characteristics of the effluents from domestic, aquaculture, industrial and traditional village wastewaters in Dong Thap province for scientific database and for future reasonable management measures.

2. Methodology

2.1 Description of the study area

Dong Thap is a province in the Mekong Delta, with a natural area of 3,375.4 km^2 with a population of over 1.6 million people, population density of 506 people/km^2. Dong Thap is located at 10007058 'north latitude and 105012’-105056' east longitude. The North borders Pray Veng province (Cambodia) with a border length of 48.7 km with 4 border gates: Thong Binh, Dinh Ba, My Can and Thuong Phuoc. The South borders Vinh Long and Can Tho City. West: border with An Giang. East: border with Long An and Tien Giang. Dong Thap province includes 12 districts and cities. The current center of Dong Thap is Cao Lanh city, 165km southwest of Ho Chi Minh city. Dong Thap is located in a tropical, homogeneous climate in the whole province, with 2 distinct seasons, the rainy season from May to November, the dry season from December to April [4]. Dong Thap Muoi is located at the source of the Mekong River, has a plentiful surface water source, all year-round alluvial sedimentation along with a cramped canal system, convenient for aquaculture, water transport and tourism. Characterized by being located between the southern key economic region and the dynamic economic region of Can Tho - An Giang - Ca Mau - Kien Giang, being affected by the two major centers of Ho Chi Minh City and Can Tho city [4]. The position is deviated from National Highway 1A from Ho Chi Minh City to the Mekong Delta provinces and the province's boundary is divided by the Tien River. The level of economic exchange and investment attraction in the industry and trade sector in the province is very open. The industrial sector of Dong Thap province is relatively low compared to the provinces in the North of Tien River. However, thanks to its location close to the upstream of Tien River with waterway transport routes across the Vietnam - Cambodia border, Dong Thap province has many advantages in external economic relations to Southeast Asian countries and is the gateway of the Long Xuyen quadrangle towards the southern key economic region. In parallel with the ceaseless socio-economic development of Dong Thap province, especially the activities of industrial production, agriculture, and services always have negative impacts on water environment.

2.2 Water sampling and analysis

Data on domestic wastewater and wastewaters from traditional villages and industries were collected from the Department of Natural Resources and Environment of Dong Thap province. Water samples were collected twice, March 2019 and September 2019 at 10 locations (Table 1). The samples of domestic wastewater were collected at five locations, including three at the markets (denoted by S1, S2, S3), one at urban residential area (S4) and one at rural residential area (S5). Wastewaters from traditional villages and industries were collected at five locations, including two samples at the aquacultural fish ponds (S6, S7), two at traditional villages (S8, S9) and one at industrial zone (S10). The quality of domestic wastewater was assessed using 10 water quality

indicators of pH, biochemical oxygen demand (BOD), total suspended solids (TSS), total dissolved solids (TDS), ammonium (NH_4^+-N), nitrogen nitrate (NO_3^--N), orthophosphate (PO_4^{3-}- P), sulfide (S^{2-}), oil and grease. Meanwhile, the quality of industrial and traditional village wastewater parameters of pH, biochemical oxygen demand (BOD), chemical oxygen demand (COD), total suspended solids (TSS), total nitrogen (TN), ammonium (NH_4^+-N), nitrate (NO_3^--N), total phosphorus (TP), sulfide (S^{2-}), mineral oil and coliform. Particularly, pH was in-situ measured while the remaining parameters were analyzed in the laboratory according to the standard methods [6].

Table 1. The sampling locations of wastewater samples in Dong Thap province

No.	Code	District	Characteristics
1	S1	Cao Lanh city	Urban market
2	S2	Hong Ngu town	Urban market
3	S3	Thap Muoi	Urban market
4	S4	Cao Lanh	Urban residential area
5	S5	Thap Muoi	Rural residential area
6	S6	Cao Lanh	Intensive fish pond
7	S7	Tam Nong	Intensive fish pond
8	S8	Chau Thanh	Traditional village
9	S9	Hong Ngu	Traditional village
10	S10	Sa Dec	Industrial wastewater treatment plant

2.3 Data processing

The domestic wastewater quality parameters are compared with the national technical regulation on domestic wastewater (QCVN 14: 2008/BTNMT (column A)) [7]. For industrial and traditional village wastewater, the parameters were compared with QCVN 40: 2011/ BTNMT, National Technical Regulation (column A) on industrial wastewater [8[. The values of pollution parameters in column A of these two regulations are presented in Table 2. The extracted maximum allowable values of wastewater discharged into water sources used for domestic water supply purposes are presented in Table 2.

Table 2. The limited values of wastewater quality parameters for domestic and industry

No.	Parameter	Units	Limit values	
			QCVN 14:2008/BTMNT, Column A	QCVN 40:2011/BTNMT, Column A
1	pH	-	5.0-9.0	6.0-9.0
2	BOD	mg/L	30	30
3	COD	mg/L	-	75
4	TSS	mg/L	50	50
5	TDS	mg/L	500	-
6	TN	mg/L	-	20
7	NH_4^+-N	mg/L	5	5
8	NO_3^--N	mg/L	30	-
9	TP	mg/L	-	4
10	PO_4^{3-}-P	mg/L	6	-
11	S_2^-	mg/L	1	0.2
12	Oil and grease	mg/L	10	-
13	Mineral oil	mg/L	-	5
14	Coliform	MPN/100mL	3000	3000

3. Results and discussion

3.1. Characteristics of domestic wastewater effluent

pH: pH in domestic wastewater ranged from 6.94 to 7.52 (Table 3), the lowest and highest pH values were respectively recorded at the position S1 (dry season) and S4 (rainy season). The dry season has pH values ranging from 6.94 to 7.06 (averaged at 7.00 ± 0.02) while pH values in the rainy season range from 7.08 to 7.52 (averaged at 7.37 ± 0.08). This study result is consistent with the former study reported that pH in the effluent of domestic wastewater in Can Tho city ranging from 6.9 to 7.8 [9]. The results showed that pH value was within the permissible limit of QCVN 14: 2008/BTNMT (column A) [7] suitable for the purpose of water supply for domestic use.

Biological oxygen demand (BOD): The effluent of domestic wastewater in Dong Thap province had BOD concentration ranging from 28-241 mg/L (Table 3). During the rainy season, BOD was found the lowest at the location S4 (28 mg/L), and the highest at position S2 (86 mg/L). Meanwhile, BOD in the dry season was the lowest at S1 (55 mg/L) and the highest at S3 (241 mg/L). Average BOD value in the dry season was 129.40 ± 41.09 mg/L which was higher than that in the rainy season (46.60 ± 10.37 mg/L). The results of previous studies showed that the BOD in domestic wastewater ranged from 10-185 mg/L [9], averaging 137.8 ± 121.8 mg/L [10]. The surveyed locations in this study had BOD exceeding QCVN 14: 2008/BTNMT [7], the highest position exceeding 8 times the allowable limit value in column A of the standard. High organic matters could be from wastewater of daily life, animal husbandry and production activities of the people.

Total suspended solid (TSS) and total dissolved solids (TDS): Concentration of TSS in domestic wastewater ranged from 28 to 875 mg/L, the average values of TSS were 92.20 ± 27.82 mg/L and 210.20 ± 166.33 mg/L in the dry and rainy seasons, respectively. During the dry season, TSS fluctuated between 32-162 mg/L, the lowest value was measured at position S4 and the highest value at position S5. TSS concentration in the rainy season ranges from 28-875 mg/L, position S1 had the lowest TSS value and position S3 had the highest value. The study results showed that three out of five positions had TSS exceeding the allowable limit of QCVN 14: 2008/BTNMT, Column A [7]. TSS concentration in this study was also higher than that in the previous study (89.9-293.6 mg/L) [11]. The reason for the high concentration of TSS in water is due to the amount of organic matters and microorganisms. In addition, run-off water also significantly contributes the high concentration of TSS in surface water. Suspended solids are usually insoluble, making the water cloudy or dirty. At the same time, suspended solids also limit the depth of the water layer being shone by light, affecting the photosynthesis of algae, and making water unsuitable for living purposes. In this study, TDS ranged from 53.4 to 472 mg/L (Table 3). The average value of TDS in the dry season was 123.62 ± 41.03 mg/L, lower than the average value of TDS in the rainy season (182.08 ± 81.81 mg/L). The lowest TDS concentration in both dry and rainy seasons was recorded at S3 with the concentration of 53.4 mg/L (dry season) and 57.6 mg/L (rainy season). Meanwhile, the highest TDS concentration in both monitoring sessions was recorded at the position S5. The highest values of TDS were 267.3 and 472 mg/L in the dry and rainy seasons, respectively. Through the study results, it can be seen that TDS at all the monitoring positions in Dong Thap province are within the allowable limits of QCVN 14: 2008/BTNMT [7].

Table 3. The characteristics of the effluent of domestic wastewater

Parameter	Dry season			Wet season			QCVN 14:2008/BTNMT, Column A
	Min	Max	Mean ± Std	Min	Max	Mean ± Std	
pH	6.94	7.06	7.00±0.02	7.08	7.52	7.37±0.08	5.0-9.0
BOD	55	241	**129.40±41.09**	28	86	**46.60±10.37**	30
TSS	32	162	**92.20±27.82**	28	875	**210.20±166.33**	50
TDS	53.4	267.3	123.62±41.03	57.6	472	182.08±81.81	500
NH_4^+-N	5.31	28.85	**19.25±3.84**	2.82	4.46	3.86±0.33	5
NO_3^--N	1.2	52.5	17.70±10.05	2.19	13.25	8.91±2.66	30
PO_4^{3-}-P	8.74	31.5	**21.31±4.23**	2.7	3.95	3.55±0.23	6
S_2^-	0.01	2.52	1.01±0.56	0.03	1.93	0.96±0.39	1
Oil and grease	0	0.9	0.54±0.16	0.3	1.4	1.06±0.19	10
Coliform	4600	4600000	**1024320±897989.44**	4600	1100000	**322520±212447.34**	3000

Nutrients (NH_4^+-N, NO_3^--N, PO_4^{3-}- P): Ammonium (NH_4^+-N) in water is the product of decomposition of organic substances (especially proteins), they exist as dissolved ions between NH_4^+ or NH_3 and are dependent on pH. Up to 65% of domestic wastewater is NH_4^+-N due to urea decomposition of urine [12]. In Dong Thap province, NH_4^+-N in the effluent of domestic wastewater ranged from 2.82 to 28.85 mg/L. Location S2 and S3 were the sites with the lowest and highest NH_4^+-N concentrations in both monitoring phases. The lowest value of NH_4^+-N in the dry season was 5.31 mg/L and the highest was 28.85 mg/L. the effluent of domestic wastewater in the rainy season had the lowest and highest NH_4^+-N concentrations of 2.82 mg/L and 4.46 mg/L, respectively. The limit value of NH_4^+-N in QCVN 14: 2008/BTNMT (column A) [7] is also specified at 5 mg/L. This shows that concentrations of NH_4^+-N at all sampling locations in the dry season exceeded the permitted standard. Nitrate is the end product of nitrogen-containing compounds in human and animal waste. The high concentration of NO_3^-- N is a good nutrient medium for the growth of algae and this is one of the factors affecting the quality of water environment. The fluctuation ranges of the NO_3^--N concentration in the study area was 1.2-52.5 mg/L (Table 3). The average value of NO_3^--N in the dry and rainy season were 17.70 ± 10.05 mg/L and 8.91 ± 2.66 mg/L, respectively. During the dry season, the location S3 had the lowest NO_3^--N concentration (1.2 mg/L) and the position S1 had the highest NO_3^--N concentration (52.5 mg/L). In contrast, the position S1 had the lowest NO_3^--N concentration (2.19 mg/L) during the rainy season over the observation period. In general, the monitoring locations in the province had NO_3^--N concentration within the allowable limits of QCVN 14: 2008/BTNMT [7], except for the position S1 in the dry season. Thus, it can be seen that nitrogen-containing compounds in domestic wastewater are still in the transition to nitrate, because the ammonium concentration is higher than specified while the nitrate concentrations is lower than the current regulations. Orthophosphate (PO_4^{3-}- P) concentrations in the study areas ranged from 2.7 to 31.5 mg/L. Average value of PO_4^{3-}- P in the dry season (21.31 ± 4.23 mg/L) was higher than that in the rainy season (3.55 ± 0.23 mg/L). PO_4^{3-}- P concentrations were the highest and the lowest in the dry season were measured at S2 (31.5 mg/L) and S3 (8.74 mg/L), respectively. Meanwhile, in the rainy season, the highest PO_4^{3-}- P concentration was 3.95 mg/L at the location S3 and the lowest PO_4^{3-}- P concentration was 2.7 mg/L at the location S4. The study results showed that the PO_4^{3-}- P concentration in the dry season exceeded the permitted limit in column A of QCVN 14: 2008/BTNMT [7]. The origin of PO_4^{3-}- P is from daily activities such as washing, bathing and daily use detergents [13].

Sulfide (S_2^-): The characteristic of domestic wastewater is the decomposition of organic matter that leads to the formation of hydrosulfide (H_2S) in an anaerobic environment, which is the main factor causing odor pollution [14]. S^{2-} concentrations at the five monitoring locations ranged from 0.01 to 2.52 mg/L, the average value in the dry season was 1.01 ± 0.56 mg/L and in the rainy season was

0.96 ± 0.39 mg/L (Table 3). The highest concentration of S^{2-} during the dry season was in Cao Lanh market (S1) while this concentration during the rainy season was measured in the residential area (S5). In general, the concentration of S^{2-} in the study area was found to be relatively high, but it is still within the allowable limit of QCVN 14: 2008/BTNMT [7].

Oil and grease: The concentration of oil and grease arises mainly from the preparation of food [15]. In the study area, the oil and grease concentration ranged from 0 to 1.4 mg/L (Table 3). The variation range of this parameter in the dry season was 0-0.9 mg/L, lower than the range of 0.3-1.4 mg/L in the rainy season. The locations with the lowest and highest oil and grease in the dry season were S1 and S2. In contrast, S2 is the site with the lowest concentration of oil and grease during the rainy season and S1 is the site with the highest concentration. The research results showed that the concentration of oil and grease in the province is still within the permissible limit in column A of QCVN 14: 2008/BTNMT [7].

Coliform: The research results showed that domestic wastewater in markets and residential areas of Dong Thap province is contaminated with high levels of microorganisms with the density of coliform ranging from 4,600 to 4,600,000 MPN/100mL (Table 3). The average density of coliforms in the rainy and dry seasons was 322,520 ± 212,447.34 MPN/100mL and 1,024,320 ± 897,989.44 MPN/100mL, respectively, far exceeding the limit value specified in QCVN 14: 2008/BTNMT column A (3,000 MPN/100mL) [7]. The lack of centralized waste treatment systems and the use of toilets without septic tanks are responsible for the very high concentrations of coliform detected. This can be the source of disease spread and cause risks to the surface water environment of Dong Thap province.

3.2 Characteristics of the industrial wastewater effluent

pH: pH values in the wastewaters of aquaculture, traditional villages and industry in Dong Thap province ranged from 6.76 to 7.42, the average value in the wet and dry seasons was 7.19 ± 0.07 and 6.98 ± 0.10, respectively (Table 4). The lowest pH value was recorded at the S7 position in both monitoring phases. Meanwhile, the highest pH was measured at position S10 (rainy season) and S8 position (dry season). In general, pH in the study area fluctuated within the allowable limits of the column A of QCVN 40: 2011/BTNMT [8]. Wastewater from different industries will have different pH values. For example, industrial wastewater from pulp production usually has a quite high pH (10-11), plating wastewater usually has a rather low pH (2.5-3.5), while industrial wastewater from rubber processing has pH in the range of 4-4.5 [15].

Biological oxygen demand (BOD) and chemical oxygen demand (COD): BOD concentration in the study area in the dry season ranged from 12 to 223 mg/L and reached an average of 65.60 ± 39.80 mg/L, which was higher than that in the rainy season. The range of BOD fluctuations in the rainy season was 17-56 mg/L with the average value of 30.40 ± 7.65 mg/L (Table 4). BOD concentrations in the study area exceeded the permissible limit in column A of QCVN 40: 2011/BTNMT [8]. The location S7 has the highest BOD concentration, exceeding 7.43 times in dry season and 1.87 times in rainy season. Similar to BOD, COD concentrations in the study area was also recorded at a rather high level. Specifically, COD concentrations in the dry season fluctuated from 19 to 376 mg/L and reached the average value of 107.80 ± 67.72 mg/L (Table 4). In the rainy season, COD concentrations was in the range of 22-94 mg/L, averaged at 47.80 ± 14.12 mg/L (Table 4). Similar to BOD analysis results, the highest COD concentrations was recorded at the position S7. Because this is an industrial fish farming area, in addition to easily decomposable organic matter sources such as excess food and feces, there are also the presence of chemicals, antibiotics. From the analysis results, only Hung fish farming area had COD concentration exceeded the limit value in QCVN 40: 2011/BTNMT (column A) [8], the remaining monitoring positions had the COD within the allowable limit. Previous research by Huong et al. (2008) [16] also recorded BOD pollution (exceeding 1.5-10 times) and COD (exceeding 1.1-6 times) in some residential areas in

Dong Thap, Vinh Long and Can Tho provinces in 2006. BOD concentrations and high COD will reduce dissolved oxygen concentrations in water, affecting aquatic life.

Total suspended solids (TSS): TSS concentrations in the study area varied in a wide range from 0 to 357 mg/L and tended to be higher during the rainy season (Table 4). Specifically, TSS concentrations in the rainy season ranged from 3 to 357 mg/L and the average value was 90.44 ± 67.76 mg/L. Meanwhile, TSS concentrations in the dry season only ranged from 0 to 186 mg/L, averaged at 62.08 ± 33.18 mg/L. S7 position (industrial fish pond in Tam Nong district) had the highest TSS concentration in both monitoring times and exceeded the permitted limit in QCVN 40: 2011/BTNMT (column A) [8]. The cause of this pollution is due to the surplus supply of fish feed and inappropriate waste treatment resulting excess feed and fish excretion remains highly persistent in the water [17]. In some studies, only about 17% of feed is absorbed by fish and the rest will be dissolved in water into decomposable organic matter [18]. This shows that the wastewater from pangasius ponds has a great impact on the water quality and living activities of human beings.

Table 4. Characteristics of industrial wastewater effluents in the study area

Parameter	Dry season			Rainy season			QCVN 40:2011/BTNMT, Column A
	Min	Max	Mean ± Std	Min	Max	Mean ± Std	
pH	6.76	7.35	6.98±0.10	7	7.42	7.19±0.07	6.0-9.0
BOD	12	223	**65.60±39.80**	17	56	**30.40±7.65**	30
COD	19	376	**107.80±67.72**	22	94	47.80±14.12	75
TSS	0	186	**62.80±33.18**	3	357	**90.44±67.76**	50
TN	5.3	17.6	8.75±2.32	6.28	109.7	**29.10±20.19**	20
NH_4^+-N	0.42	6.82	2.69±1.20	0.82	27.25	**7.26±5.03**	5
NO_3^--N	1	8.7	3.08±1.42	1.31	55.74	21.13±9.16	-
TP	0.28	15.72	**4.25±2.91**	0.25	17.22	**4.67±3.19**	4
S^{2-}	0.005	0.263	0.11±0.05	0.005	1.22	**0.29±0.23**	0.2
Mineral oil	0.0014	0.0051	0.0029±0.00	0.0022	0.0432	0.0117±0.01	5
Coliform	2400	24000	**12860±4682.48**	930	24000	**11566±5116.90**	3000

Nutrients (NH_4^+-N, NO_3^--N, TN, TP): Concentrations of total nitrogen, ammonium, nitrate and total phosphorus tended to increase in the rainy season (Table 4). In which, TN concentrations ranged from 5.3 to 109.7 mg/L, the average value reached 8.75 ± 2.32 mg/L (in the dry season) and 29.1 ± 20.19 mg/L (in the rainy season). The concentrations of NO_3^--N and NH_4^+-N ranged between 1-55.7 mg/L and 0.42-27.25 mg/L, respectively. Average values of NO_3^--N recorded in the dry season was 3.08 ± 1.42 mg/L and the rainy season was 21.13 ± 9.16 mg/L. The average values of NH_4^+-N in rainy and dry seasons were 7.26 ± 5.03 mg/L and 2.69 ± 1.2 mg/L, respectively. Besides, the analytical results showed that the total phosphorus concentration ranged from 0.25 to 17.22 mg/L. The average value of TP in the dry season was 4.25 ± 2.91 mg/L and the rainy season was 4.67 ± 0.23 mg/L. The nutrient indicators (NH_4^+-N, NO_3^--N, TN, TP) had the highest values at the position S8 (the flour making village). This was also the only location where the concentration of nutrient parameters exceeded the permitted limit of QCVN 40: 2011/BTNMT (column A) [8]. The flour production has a large amount of generated wastewater averaging from 240 to 300 million m^3 of wastewater per year and contains several water pollutants [4]. According to the research by Long et al. (2019) [20], wastewater from a cassava starch processing plant had TN and TP concentrations 150-180 mg/L and 27-44 mg/L, respectively, which were higher than the value recorded in the current study. High nutrient concentrations will cause eutrophication of water sources, causing odors due to the formation of NH_3, CH_4, H_2S gases, affecting humans and aquatic species [12;14].

Sulfide (S_2^-): The S^{2-} concentration in industrial and traditional village wastewater in Dong Thap province ranged from 0.005 to 1.22 mg/L (Table 4). Thus, the concentration S^{2-} in the dry season

ranged from 0.005 to 0.263 mg/L with the average value of 0.11 ± 0.05 mg/L. The location with the highest concentration of S^{2-} was in the farming area of Hung Ca Company (S7), the reason was possibly due to residual chemicals and antibiotics in the farming process. During the monitoring period in the rainy season, the concentration S^{2-} reached the average value of 0.29 ± 0.13 mg/L and ranged from 0.005 to 1.22 mg/L, higher than the concentration S^{2-} in the dry season. The highest value of S^{2-} was recorded in the centralized wastewater treatment system of zone C, Sa Dec Industrial Park. This is an industrial park that concentrates many types of production, especially production of aquatic products and mushrooms. The research results showed that the concentration of S^{2-} in the rainy season was relatively high and exceeded the allowable threshold in column A of QCVN 40: 2011/BTNMT [8].

Mineral oil and grease: Mineral oil and grease observed in Dong Thap province in 2019 ranged from 0.0014 to 0.0432 mg/L (Table 4), within the allowable limits of QCVN 40: 2011/BTNMT column A (5 mg/L) [8]. Average values of mineral oil and grease in the rainy and dry seasons were 0.0117 ± 0.01 and 0.0029 ± 0.00 mg/L, respectively. In both monitoring phases, the position with the highest mineral oil and grease concentrations was S8 with 0.0051 mg/L (dry season) and 0.0432 mg/L (rainy season). In addition, the lowest mineral oil and grease concentrations was measured at position S10, in the dry season 0.0014 mg/L and in the rainy season at 0.0022 mg/L.

Coliform: The density of coliform in the samples of aquaculture, traditional village and industrial wastewater ranged from 930-24,000 MNP/100mL (Table 4), several times lower than the concentration of coliform recorded in domestic wastewater. Thus, the density of coliform fluctuated between 930-24,000 MNP/100mL (rainy season) and 2,400-24,000 MNP/100mL (dry season). Average values of coliform in the dry and rainy seasons were 12,860 ± 4,682.48 MNP/100mL and 11,566 ± 5,116.90 MNP/100mL, respectively, exceeding the allowable limit of QCVN 40: 2011/BTNMT [8], column A. In general, water quality in the study area was polluted with BOD, TSS, TP and coliform in both monitoring phases. Besides, water quality parameters of TN, NH_4^+-N and S^{2-} were also polluted during the rainy season. Polluted wastewater from production activities when discharged into receiving sources will cause many impacts on aquatic ecosystems and affect water sources for domestic water supply purposes [16;20].

4. Conclusion

The results of research on the quality of wastewater effluents in Dong Thap province in 2019 showed that the effluent water had signs of pollution of organic matter and microorganisms. For domestic wastewater, TSS (rainy season) and BOD, NH_4^+-N, PO_4^{3-}- P and coliform (in dry season) had a very high concentration and exceeded the allowable limits of QCVN 14: 2008/BTNMT. In the dry season, the quality of aquaculture, industrial and traditional village wastewater effluents was polluted with BOD, COD and coliforms while it was polluted by indicators TSS, TN, NH_4^+-N and TP in the rainy season. The findings showed that wastewater effluents in Dong Thap province need to be collected and treated with appropriate technologies before being discharged into the receiving water to limit the impact on the quality of surface water.

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