

Vinh Bao Water Treatment Plant

Hai Phong, Vietnam

1. Background Information

Vinh Bao Water Treatment Plant (VBWTP) is located in Vinh Bao district, Hai Phong city, Vietnam with total area of 7.84 km². This water treatment plant (WTP) has been managed and operated by Hai Phong Water Supply Company, Ltd. since 2008 with the capacity of 2,500 m³/d and serves for 1,300 households in Vinh Bao town. It also has distribution network extended to the other surrounding area of the Vin Bao Town. Until now, approximately 2.2 million USD has been invested to increase the capacity of this WTP to 5,000 m³/d and has expanded its service to other communities in Vinh Bao district. The raw source for the Vin Bao water treatment plan is the Luoc River and the Hoa River. General information of VBWTP is shown in **Table 1**.

Table 1 Overall Information of Vinh Bao water treatment plant

Constructed Year	2008
Water Source	Luoc River and Hoa River
Number of connections (by 3/2013)	5,441
Households	5,347
Administrations	54
Industries	38
Business and services	2
Design capacity (m³/d)	5000 m ³ /d
Topography	Plain/Tropical
Date of access of the source information	27/9/2015
Reference	Water Safety Plan (2013) Hai Phong Water Supply Company

2. Water treatment process flow

The major water treatment unit processes are presented as follow (**Figure 1**):

Water intake → Pre-sedimentation → 1st pumping station → Coagulation-Flocculation → Sedimentation → Filtration → Disinfection → Storage Tank → 2nd pumping station → Distribution system → Customers

Sludge generated from sedimentation tank and filtration backwash is collected and dried at the sludge drying beds.

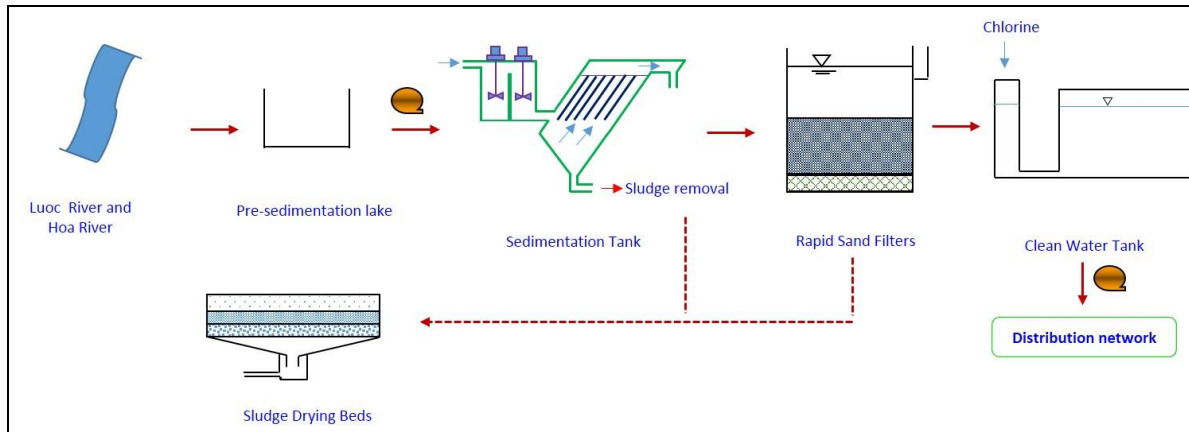


Figure 1 Water Treatment Process

2.1 Water intake

Most of the raw water is extracted from Luoc River and the rest from Hoa River. The water from these two rivers is transferred by Chanh Duong and Ba Dong canals respectively. The pipelines (DN400 and DN500) are used to convey raw water from these canals to pre-sedimentation tanks.

2.2. Pre-sedimentation tank

The pre-sedimentation tank (**Figure 1**) has an area of 1,600 m² and volume of 6,000 m³. The water level varies in the range of 1.0-3.7 m. The retention time is 48 hour in the case of production capacity of 2,500 m³/d.



Figure 1 Pre-sedimentation tank

2.3 Chemical Building

PAC (**Figure 2**) (Poly aluminum chloride) or Alum sulfate ($Al_2(SO_4)_3$) are normally used as coagulants. The chemical doses are calculated through Jar test method in the technical quality department. This department also measures the characteristics of water source.



Figure 2 Chemical Building

There are two mixing tanks and one solution tank with the total volume of 1.45 m³. The average concentration of solution is around 5 %. The mixer operates with the capacity of 0.4 KW and 81 rpm speed. There is a metering pump which has two entrances with a flow rate is 0.6 m³/h. This pump is used to transfer chemical solution to the mixing tank.

2.4 Sedimentation tank (Lamella mode)

VBWTP consists of vertical sedimentation tank with the capacity of 849 m³. The tank consists of four sections (**Figure 3**), each with the dimension of 5.2m x 5.2m x 3.98m (L x B x H). The tank has the retention time of 3 h.



Figure 3 Sedimentation tank

This tank now is improved into Lamella settler by setting up Lamella sheets with the thickness of 0.45 mm, slope of 60° and 36 sheets/m³.

Sludge is discharged into the sludge tank. To dispel coagulated sludge layer from the bottom of the tank, a jacuzzi sludge pipeline system had also been installed.

2.5 Rapid Filtration

There are four rapid filtration tanks, each having the dimensions of 2.5 m x 2.6 m x 4.75 m (**Figure 4**). The filtration media is silica sand with 1.2 m in thickness. The filter operates in semi-automatic mode with the backwash cycle of 24 hour in summer and 48 hour in winter. VBWTP utilizes water

backwash techniques for the backwashing. The backwash water is then sent to the sludge drying bed.

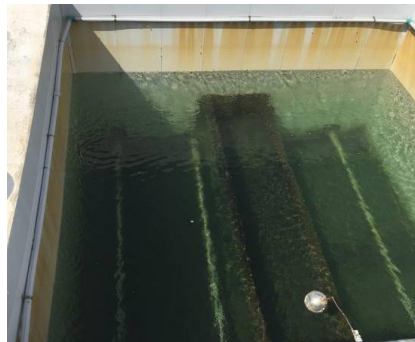


Figure 4 Rapid filtration tank

2.6 Pumping station

VBWTP consists of a common pumping station (**Figure 5**) and it consists of raw water pumps, treated water pumps and backwash pumps. Specifications of the pumps are shown in **Table 2**.

Table 2 Pumps used in Vinh Bao water treatment plant

Pump	Type - Model	Capacity (m ³ /h)	Total head (m)	Power Motor (KW)	Current I (A)
Raw water	BEARINGS 6307 UU	125	15	11	23
	BEARINGS 6307 UU	125	15	11	23
Treated water	BEARINGS 6307 UU	55	52	15	30.8
	BEARINGS 6307 UU	95	52	22	41.7
	BEARINGS 6307 UU	95	52	22	41.7
Backwash	BEARINGS 6307 UU	351	13	22	45.3



Figure 5 Pumping station

2.7 Disinfections

Liquid chlorine is used for disinfection of the treated water. The required dose is determined based on Jar test of the technical quality room. To test the free chlorine in water, DPD (Poly-(1,4) D-glucosamine) tablet test or orthotolidine test is conducted.

VBWTP has two clorators (one of which is reserve clorator) with the operating capacity of 2.2 KW and flow rate of 150 L/h.

2.8 Purified water storage tank

There is a purified water storage tank (**Figure 6**) with the capacity of 500 m³. Chemical disinfectant is added in the water pipeline before it ends up in the storage tank. The chemical contact time for this process is around 120 min.



Figure 6 Pure water storage tank

2.9 Distribution system

The treated water is supplied to the consumers through water supply network. The main pipelines (D90 to D250) has the total length of 13.8 km. Smaller pipelines (D32-D75) has the total length of 58.7 km. The smallest pipeline (D25) that links to the final connections has a total length of 27.5 km. The leakage ratio of water supply network as reported in 2012 is 18.79 %.

3. Aspects of treatment processes posing most difficulty for daily operation

Overview, the plant is now under well operation. However, the raw water from the source is contaminated mostly by organic pollutants from domestic wastewater and fertilizers which causes increased dosage of coagulant, chlorine and PAC (Powder Activated Carbon) resulting in the rise of treatment cost.

4. Aspects of water services management in general posing most difficulty at the moment

There are many point and non-point sources from where the pollutants contaminate the raw water source (Luoc river and Hoa River). These pollutant sources are posing great difficulties in the effective operation of the plant:

- Illegal discharge of domestic wastewater from some communes, such as: An Duong, Le Loi, Dang Cuong, Hong Thai, Dong Thai and An Dong.
- Solid waste, wastewater and chemical runoff (i.e. pesticide, insecticide) from the farmland along the river.

5. Measures taken now to cope with 3) and 4)

Hai Phong water supply company has implemented the water safety plan (WSP) since 2011. The main objectives of WSP are indicated as following:

- Ensuring the maintenance of water pressure, stable and adequate supply of water and meeting the required water quality standards.
- Planning to cope with unexpected incident and hazards which may occur during the entire production process (water intake to distribution).
- Contributing to protect public health, reducing water-related disease, disease prevention
- Contributing to reduce wastage, saving water resources and environmental protection

6. Recent investment made for the plant's improvement

Biological Contact Filter (BCF, capacity: 5,000 m³/d) was installed in 2014 with the help of JICA donation (**Figure 8**) for the nitrification purpose and partially treatment of organic pollutants.



Figure 8 Biological Contact Filter

7. Technologies, facilities or other types of assistance needed to better cope with operational and management difficulties in 3) and 4).

- Upgrading the management quality by application of GIS based information technology
- Innovating and diversifying revenue collection methods to improve labor productivity

8. Customer's opinion on water quality and water services in general

The schedule to check the customer's satisfaction is conducted frequently once a year. More than 99 % of surveyed people were satisfy with the service.

9. Advanced technology used in this water treatment plant or any points to improve the process, water quality and capacity.

VBWTP has installed biological filtration columns (capacity of 5,000 m³/day) to treat ammonium and nitrate which is impossible for conventional treatment methods. This technology was transferred by the water supply center of Kitakyushu city, Japan.

- Almost all the parameters are measured manually,
- Only residual chlorine parameter has the online monitor system
- There is an online system to monitor some important parameters, such as pH and residual chlorine.

10. Other Highlights

The percentage of non-revenue water is 18.79% according to the data reported in 2012 and the VBWTP is trying to reduce it to less than 10%. To reduce the NRW, the plant is replacing the old water distribution system (PVC) by the new material (HDPE). The pressure at the endpoint of the main distribution system is maintained to be higher than 1.3 bar. Currently, Vinh Bao WTP is constructing one more storage tank (2,000 m³).

11. Water quality data

Table 3 presents the quality of raw water and treated water at VBWTP in 2014. All the measured parameters of treated water were found to be under the national drinking water standard regulated by Ministry of Health, Vietnam.

Table 3 Raw Water and Treated Water Quality in 2014

No	Parameters	Unit	Raw water		Treated water		QCVN 01:2009/BYT - Standard
			Min	Max	Min	Max	
1	Color	PT- Co	NA	NA	<5	<5	≤ 15
3	Turbidity	NTU	11.88	35.85	0.12	0.23	≤ 2
4	pH		7.24	7.59	7.23	7.59	6.5-8.5
5	Total Ca and Mg	mgCaCO ₃ /L	82	144	81	139	≤ 300
6	Cl ⁻	mgCl ⁻ /L	11.00	32.84	13.40	41.98	≤ 250
7	Permanganate	mgO ₂ /L	2.32	4.15	0.77	1.51	≤ 2.0
8	Mn	mg/L	0.074	0.353	0.007	0.037	≤ 0.3
9	Nitrate/N	mg/L	0.418	1.133	0.480	1.320	≤ 11.36
10	Nitrite/N	mg/L	0.011	0.132	<0,002	0.039	≤ 0.91
11	Total Fe	mg/L	0.095	1.093	<0.02	<0.025	≤ 0.30
12	Sulfate	mg/L	NA	NA	11.00	78.00	≤ 250
13	Residual chlorine	mg/L	NA	NA	0.50	0.73	0.3-0.5
14	Total Coliform	MPN/100mL	2225	6875	0	0	0
15	Fecal Coliform	MPN/100mL	1000	2450	0	0	0

(NA: Not Available)

12. Other graphical information

Table 2 Water sampling in Vinh Bao water treatment plant

No.	Monitoring parameters	Units	Raw water sampling		Treated water sampling		Water sampling in distribution system	
			Sampling Frequency	Total Samples	Sampling Frequency	Total samples	Sampling Frequency	Total samples
1	Turbidity	NTU	1 time/week	50	1 time/week	50	1 time/week	48
2	pH							
4	Cl ⁻	mgCl ⁻ /L	1 time/week	50	1 time/week	50	1 time/week	48
5	Permanganate	mgO ₂ /L	1 time/week	50				
6	TSS	mg/L	1 time/week	50	ND	ND	ND	ND
7	Hardness	mgCaCO ₃ /L	1 time/month	12	1 time/week	50	1 time/week	48
8	TDS	mg/L			1 time/month	12	1 time/month	12
9	Mn	mg/L						
10	DO	mg/L	1 time/week	50	1 time/year	1	ND	ND
11	Ammonium	mg/L	1 time/week	50	1 time/month	12	1 time/month	12
12	COD	mg/L	1 time/week	50	ND	ND	ND	ND
13	Nitrate	mg/L			ND	ND	1 time/month	12
14	Nitrite	mg/L			1 time/month	12		
15	Total Fe	mg/L						
16	Phosphorous	mg/L	1 time/year	1	ND	ND	ND	ND

13. References

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