Network on Water Technology in Asia and Pacific

Tan Hiep Water Treatment Plant
Ho Chi Minh City, Vietnam

1. Background Information of the Water Treatment Plant

The Tan Hiep Water Treatment Plant (THWTP) was constructed in 1992. It is located at Thoi Tay 1 commune, Tan Hiep ward, Hoc Mon district, Ho Chi Minh city, Vietnam. The treatment plant is located on a 16 ha campus and affiliated with the Saigon Water Corporation. On 23 July, 2009, treated water from the THWTP was integrated officially to the water supply network of Ho Chi Minh City (HCMC). The operation of the plant added a new water source and satisfied the needs of clean water for more than 3 million people in the area of districts 6, 8, 10, 11, 12, Go Vap, Tan Binh and Tan Phu, Binh Tan, Nha Be and Binh Chanh. **Table 1** shows the critical overview of THWTP.

Table 1 Overall Information of Tan Hiep Water Treatment Plant

Water Supply Scheme	Tan Hiep
Type of source	Surface water
Name of the source	Saigon river
Investment cost (US$)	44.6 million
Year of construction	1992
Year of commissioning	2004
Year of integration with the HCMC water network	2009
Design capacity (m^3/d)	300,000
Present production (m^3/d)	270,000
Treated water quality standard	QCVN 01/2009-BYT
Number of connections	172,660
Number of consumers	3 million
Distribution length (km)	979
Climate	Tropical climate
Automation	Supervisory Control and Data Acquisition

THWTP supplies between 285,000 and 300,000 m^3/d. Extracting raw water from the Saigon River, Hoa Phu pumping station delivers water to the THWTP. Here, the water is treated in a traditional manner using the following processes: flocculation, primary sedimentation, sand filtration, disinfection, storage.

2. Water Treatment Process

The major process is as follows:

Saigon river → Raw water pumping station (lime, chlorine) → Function tank → Mixing tank (PAC) → Sedimentation tank → Rapid Sand filter tank → Backwash water chamber (fluoride) → Clean water reservoir (chlorine) → Clean water pumping station → Distribution network.

There is no sludge treatment system in THWTP.

Figure 1 below presents the overall water treatment flow of the THWTP. In this process, fluorine is added into filtrated water to prevent the dental decay.

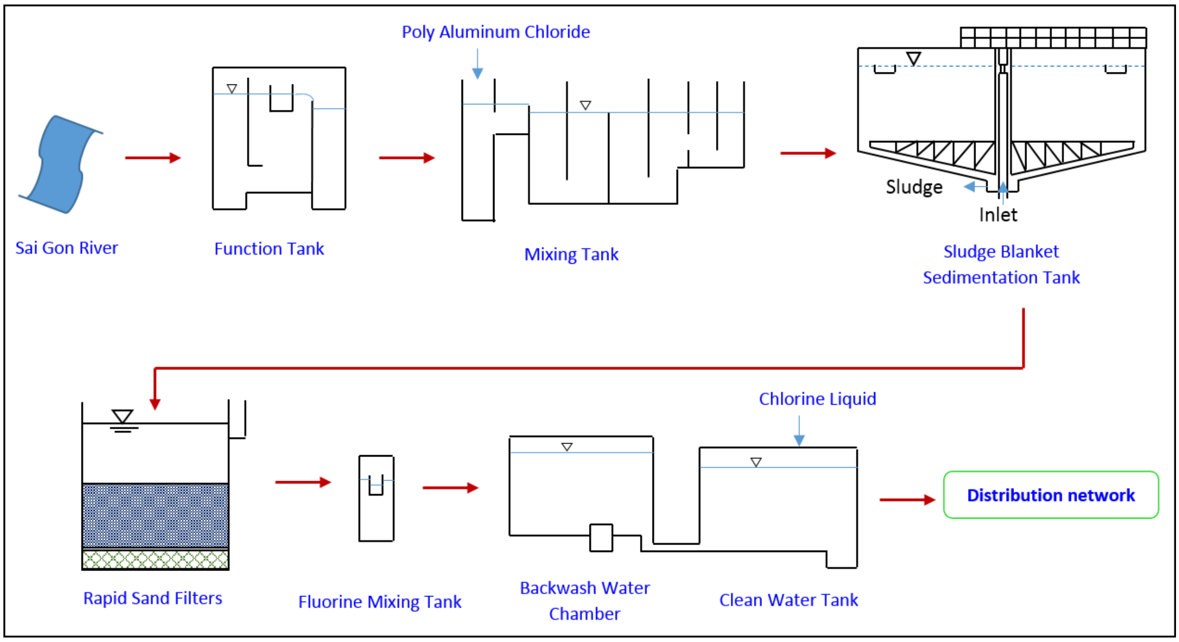

Figure 1 Water Treatment Process at Tan Hiep Water Treatment Plant

2.1 Catchment

At Hoa Phu pumping station, lime is added to the raw water to increase pH of about 7.1 - 7.5 (with an initial pH is in the range 5.5 - 6.5). At the same time, chlorine kills algae and moss to protect pipelines and to pre-chlorination. Raw water is pumped into function tank at THWTP through a concrete pipeline of DN 1500 mm. With a total length of about 10 km, the raw water pipeline provides a sufficient chlorine contact time for the reduction reactions of iron, manganese, organic matter and ammonia occur in raw water. THWTP uses liquid chlorine for pre-chlorination.

Figure 1 Saigon River

2.2 Treatment Processes

At THWTP, raw water is firstly stored at function tank **(Figure 3)** to stabilize the flow before distributing to the treatment works. Water from function tank is transferred to mixing tank by canal with the width and height of 2 x 2 m. Mixing tank is the hydraulic form with vertical flow direction walls. Previously, aluminum sulfate ($Al_2(SO_4)_3.16H_2O$) was used as flocculant with dosage of 16-30 mg/L (depending on the raw water quality), but since December 2009, liquid PAC (Poly aluminum chloride, 10%) is being used. PAC has better flocculation efficiency and more facilitate operational management than aluminum sulfate.

Figure 2 Hoa Phu Raw Water Pumping Station

Figure 3 Function Tank

To optimize the flocculation process, lime is added at the end of mixing tank **(Figure 4)** to adjust the pH of approximately 6.5 - 6.9. Water from the mixing tank is directed into sedimentation tank through a drain system. Sedimentation tank is designed with suspended sludge blanket type **(Figure 5)**. Maintaining the sludge blanket helps to determine performance of the sedimentation tank. To ensure that the sludge blanket is not too thick, the amount of excess sludge from the settling tank is discharged automatically after each 15 minutes. The hydraulic retention time of sedimentation tank is 2 h with the surface loading rate of 2.36 $m^3/m^2.h$. The each sedimentation tank is cleaned frequently once every 6 months.

Figure 4 Mixing Tank

Figure 5 Sludge Blanket Sedimentation Tank

After settling, settled water is transferred to the rapid sand filter tank (**Figure 6**). There are 12 filters with an average surface loading rate of 9 - 9.5 $m^3/m^2 \cdot h$. The filtration velocity is 8.3 - 9.96 m/h. The effluent water from filtration tank has the turbidity of 0.38 NTU. The water is filtered through quartz sand of effective size 0.7 - 1.2 mm and sand layer thickness of 0.9 m. After operating of 48-72 h, the backwash step (water wash with air scour (**Figure 7**)) for filtration tank is conducted. Backwash consumes 10 – 12 % of clean water produced.

Figure 6 Filtration tank

Figure 7 Air pump system for filtration tank

Lime, fluorine and chlorine are added to filtered water to stabilize water, to fight tooth decay and to disinfect water. Clean water after leaving the clean water reservoir (**Figure 8**) is added with chlorine again in order to maintain the amount of residual chlorine in the water supply system before being pumped to the water network. **Figure 9** shows the clean water pumping station at THWTP.

Figure 8 Clean water reservoir

Figure 9 Clean water pumping station

A surge tower (**Figure 10**) is located near the main gate of the plant. This tower serves multiple functions, such as;

- to provide clean water to turbine at startup phase,
- to prevent collapse of penstocks because of water pressure drop at turbine start up, and
- to prevent penstock explosion at turbine shut down due to pressure increase since momentum of water from head pond-pressure is dissipated up into the tower.

Table 2 presents different kind of chemicals used at THWTP.

Figure 10 Surge tower

Table 2 Information of Chemicals Used at THWTP

Chemical	Injecting point	Dosage
Lime	Mixing tank	50 mg/L
Chlorine	Receiving box Clean water reservoir	2 - 4 mg/L 0.3 – 0.5 mg/L
PAC	Mixing tank	5 mg/L

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

The decline in water level and the increase of saline intrusion is complicating the water supply system. It creates difficulty as most WTPs are not able to handle salt water. In the dry season, when salinity of the Saigon River increases up to 350 mg/L, THWTP needs to shut down temporarily. It otherwise causes interruption of raw water and clean water pumps (i.e. vibration), errors of inverter control software and damaged devices (valves, chemical dosing system). In the dry season, filter blockage happens caused by the growth of algae in the filter tank. The phenomenon of floating sludge in sedimentation tank also occurs (due to large amount of sediment, adhesive and uplift sludge due to air bubbles generated from the anaerobic decomposition of organic components in the sludge).

Demand for surface water use for domestic and industrial use in Ho Chi Minh City has increased rapidly due to pressure from the population growth, boosting of the industrial production along the basin of major rivers, especially the Saigon river water source. According to Triet and Ha (2007) and Binh (2009), the quality of drinking water source of Saigon River has been deteriorating rapidly due to water pollution generated from human activities in the upstream basin catchment (COD concentration of 8.08 – 13.82 mg/L). Particularly, high manganese concentration creates the sedimentation during water distribution pipes after handling at THWTP. To enhance the efficiency of manganese treatment, the plant uses chlorine to pre-oxidized water before entering the flocculation, sedimentation and filtration tanks. However, high ammonia, iron, organic (COD, TOC) concentration in Saigon river water (many times excess regulations permitting) lead to a significant increase in chlorine consumption for pre- and post-chlorination. Also, due to the high chlorine use along with the presence of natural organic matters in water, the formation ability of the disinfection by-products (DBPs) at THWTP increases. Additionally, the use of chlorine disinfection chemicals at the end pipes lead to risk incurring DBPs concentration in treated water.

Although the previous studies show that the concentration of Trihalomethanes (THMs) in treated water from THWTP complies with the Vietnamese standard, it is still relatively high compared to the corresponding world standards. Currently, there is a big gap between the Vietnamese and the world standards about the concentration of DBPs in drinking water. Furthermore, the use of chlorine at high levels in term of organic pollution in river water will continue to increase the potential risk of DBPs components in drinking water in the future.

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

The water quality of Saigon River is degraded by human life, industry and agriculture activities. It forces the chemical dosing system (chlorine) to operate at maximum design capacity. The amount of chemicals used tend to increase too.

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

For salinity problem, the THWTP coordinates with the watershed lake to discharge water for pushing saltwater. However, if salinity exceeds 250 mgCl/L, the WTP will conduct the following options:

- Stop taking raw water
- Regulatory operation mode of reservoirs, clean water pumping station (storage of clean water and decrease of water supply pumping capacity).
- Regulatory water supply network, increase capacity of the other plants to support.
- Ready for emergency water supply measures (road tankers, wells stations, etc.)

When the raw water is polluted by high turbidity, color, organic matter, coliforms and ammonia content, the THWTP will adjust the dosages of PAC and chlorine. In the dry season, to prevent the floating sludge and filter blockage, the WTP conducts sludge discharge, clarifier hygiene, pre-chlorine to kill algae in the raw water pumping station and chlorine soaked at sand filter tank. To ensure the quality of clean water for the city, application of the new treatment technologies which has both effective treatment and control of the unwanted byproducts such as DBPs are essential requirements for THWTP.

Currently, the plant is not using any technology to solve the DBPs issue. However, some key measures to control the formation of DBPs are known as technical measures applied in the preliminary treatment of raw water, such as: remove primary chlorine consuming agents such as iron, manganese, ammonia, organic compounds to reduce the amount of chlorine used; replace chlorine by other oxidizing agent / disinfections with little or without undesired DBPs formation; control and minimize organic matter in raw water to mitigate the risk of forming DPBs by a combination of organic matter and chlorine (or the oxidant / disinfection others).

6. Recent investment made for the plant's improvement

In the existing water collection system at filter tank, it is likely to appear the dead spots due to the filter material layer. Therefore, the WTP is implementing the improvement of the filter with higher advantage HDPE filter technology (**Figure 11**).

Current technology Improved technology

Figure 11 New Drainage Technology Applying for Filter Tank

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

In the study of Trang et al. (2014), a pilot scale plant using Ozone/UV process combined with biological activated carbon filter (BAC) was studied on eliminating the organic matters and the DBPs formation in drinking water. Studying on the effluent from sedimentation tank at THWTP, this combination of Ozone/UV – BAC showed a good efficiency on removing TOC, DOC, UV_{254} and SUVA with the reductions of 19.1%, 17.6%, 30.7% and 16.4%, respectively. The efficiency of this combinative process was always higher than the sum of treatment efficiency of each process (Ozone/UV or BAC) alone. It confirmed that the pre-treatment of Ozone/UV could help to increase the organic removal in BAC filter. According to the organic reduction, the concentration of DBPs in water has decreased considerably with 70.6% (trihalomethanes) and 67.7% (haloacetic acids) removal. DBP formation potential decreased to 39.3% (for trihalomethane formation potential) and 46.1% (for Haloacetic acid formation potential).

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

The operations and management of whole plant are controlled automatically by supervisory control and data acquisition (SCADA) system. It helps to monitor the plant's equipment more easily. All data are saved and are easily accessed when needed.

9. Other Highlights

Chemical used: solid PAC, liquid chlorine, fluorine and lime.

10. Water quality data

Table 3 shows the raw water and treated water quality data obtained from THWTP in 2014. As it can be clearly observed, all parameters are under the national standard for drinking water (QCVN 01/2009-BYT).

Table 3 Water quality data (SAWACO, 2015)

Parameters	Unit	Raw water	Treated water	QCVN 01/2009-BYT (level)
pH	-	6.0	7.7	6.5-8.5 (A)
Residue Chloride	mg/L	-	0.95	250-300 (A)
Turbidity	NTU	23	0.38	2 (A)
Salinity	mg/L	17	19	-
Color	Pt-Co	189	-	15 (A)
Total alkalinity	$mgCaCO_3/L$	21	-	-
Total hardness	mg/L	21	-	300 (A)
BOD_5	mg/L	4.7	-	-
COD	mg/L	-	0.73	
Iron	mg/L	0.69	0.02	0.3 (A)
NH3-N	mg/L	0.195	0.01	3 (B)
Total manganese	mg/L	0.066	0.014	0.3 (A)
Microorganism	MPN/100mL	-	0	-

*Notes:

1. For parameters under A level:
   a) Test at least 1 time per week, to be done by water providers;
   b) Test, monitor and experiment at least 1 time per month by functional agencies.
2. For parameters under B level:
   a) Test at least 1 time per 6 months, to be done by water providers;
   b) Test, monitor and experiment at least 1 time per 6 months by functional agencies.
3. For parameters under C level:
   a) Test at least 1 time per 2 years, to be done by water providers;
   b) Test, monitor and experiment at least 1 time per 2 years by functional agencies

11. References

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