Huai Muang Water Treatment Plant

Tak Province, Thailand

1. Background information

Tak is one of the Northern provinces in Thailand. It is distanced about 500 km from Bangkok. Moei River (a tributary of the Salween River) is the main water source, which runs through 327 km. Huai Muang Water Treatment Plant (HMWTP) is owned and operated by the Provincial Waterworks Authority (PWA) of Thailand, a state-owned company established in 1979. This water treatment plant is one of the 233 water treatment plants under PWA. It was constructed in 2008 with the capacity of 18,000 m^3/d.

Table 1 Overall Information of Huai Muang Water Treatment Plant

Constructed Year	2008
Water Source	Moei River
Number of connections	10,711
Design capacity (m^3/d)	18,000
No. of operators working at the plant	4
Treated water standard	Royal Thai Government Gazette (1978)
Automation	No
Date of access of the source information	2015
Reference	Ratchanet (2013)

The main units of treatment process are hydraulic mixing basin, sedimentation tank with the mechanical sludge collector system, fine sand media filter, and clear water well. In 2014, HMWTP supplied 14,419 m^3/d of tap water to 10,711 households in Mae Sot district of Tak province.

2. Water treatment process flow

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

Raw water extraction (Moei river) → Raw water pumping → Hydraulic mixing (alum) → Flocculation (baffled channel type) → Sedimentation (rectangular, mechanical sludge collection) → Rapid sand filters → Disinfection (chlorine) → Clear Well → High lift pump building

Sludge generated from sedimentation tank and backwash process is drained directly to Moei River.

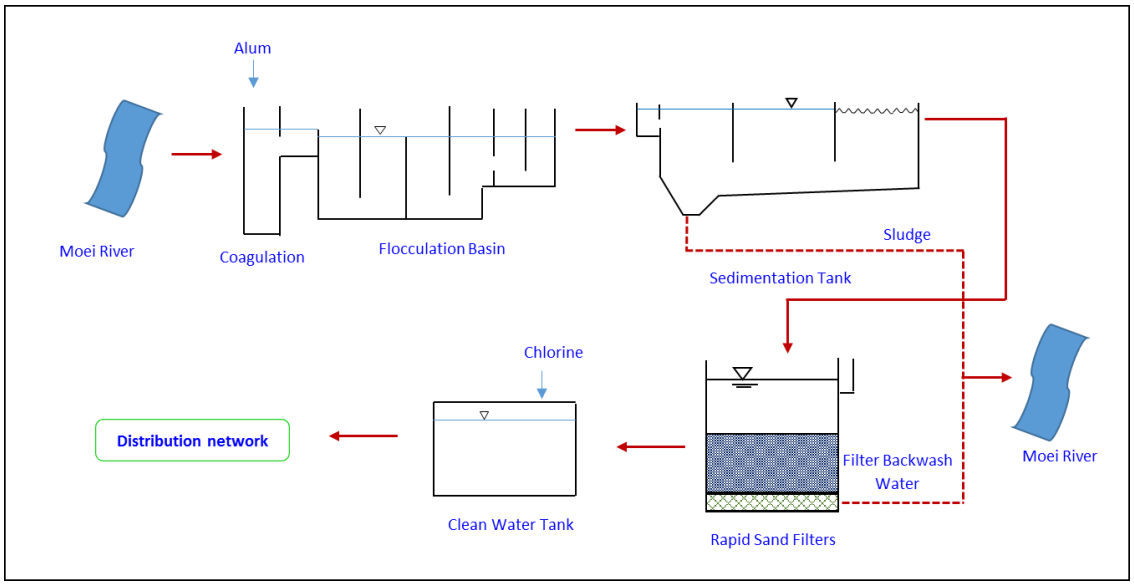

Figure 1 Water Treatment Process

2.1 Chemicals used and hydraulic mixing

Powder poly aluminum chloride (PAC) and liquid chlorine are two kinds of chemicals mainly used at HMWTP for water treatment process. Powder PAC is a coagulant that is stronger and more effective than alum salt and ferric chloride. PAC has a polymeric structure which leads to higher coagulation power than alum salt. It helps to create the bigger flocs size and faster settling. Solid PAC is firstly dissolved in water in the solution tanks (**Figure 2**). Chlorine (for pre-and-post chlorination) used is a liquid chlorine form, in a 100 kg container (**Figure 3**). The main purpose of pre-chlorination is to prevent algae growth in flocculation and sedimentation basins.

Liquid PAC is transferred from the solution tank to receiving well (**Figure 4**) to inject into the water by a hydraulic jump (**Figure 5**). The alternative method involves injecting PAC and chlorine (for pre-chlorination) by the static mixing method in the inflow pipeline.

Figure 2 PAC Solution Tank

Figure 3 Chlorine Container

Figure 4 Receiving Well

Figure 5 Hydraulic Jump

2.2 Flocculation

Commonly, there are two method to achieve flocculation; hydraulic methods and mechanical devices. For small WTP, hydraulic methods are used most often, because it is simple and effective to the relative constant flow. However, the gradient velocity (G) is not adjusted easily in hydraulic flocculator (AWWA, 2005). HMWTP is now using the horizontal baffle channel type (around-the-end flow) **(Figure 6, 7)**, and the hydraulic retention time of water in flocculation tank is 38 minutes.

Figure 6 Baffle Channel Type

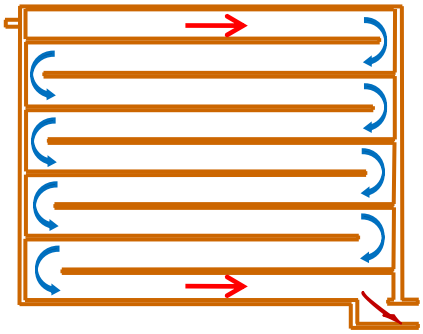

Figure 7 Horizontal Baffled Channel

2.3 Sedimentation

Sedimentation tank at Huai Muang WTP was designed with the rectangular type **(Figure 8**). The surface loading rate of sedimentation tank is 1.9 $m^3/m^2 \cdot h$. Typically, the surface loading rate should be in the range from 0.8 to 2.5 $m^3/m^2.h$ (Kawamura, 2000). Settled solids are collected by mechanical solids collector system and drained to Moei River. There were two ponds in WTP to store the sludge, but the new water treatment plant is now under construction at that site. According to Kawamura, the hydraulic retention time of the conventional sedimentation tank ranges from 1.5 to 3.0 h, and that value at HMWTP is 1.9 h. The HMWTP has totally 3 sedimentation tanks.


Figure 8 settling Part (left) and Effluent Part of Sedimentation Basin (right)

2.4 Filtration

At HMWTP, fine sand media is used in the rapid filter (8 basins). The fine sand media has the effective size of 0.7 mm, with a uniform coefficient of 1.5 and filter depth of 67 cm. This depth is satisfied the guideline to design the conventional filtration tank (about 70 cm, according to AWWA (1999)). However, this fine sand media has a drawback, i.e., the particles are removed mainly on the top surface, not throughout the filter depth as expected in deep bed filtration. Backwash method of HMWTP is water backwash with surface washing and use an elevated tank filled by pumping water from clear well. The average filter run time is 2 days.


Figure 9 Filter Tank and Entrance Part of Filter

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

HMWTP discharged sludge directly to the water sources (Moei River) because there is no sludge disposal facility. As it can be seen in **Figure 10**, there are two water ponds to store sludge generated from sedimentation and filtration. However, a new water treatment plant is under construction at the location of these two ponds. Therefore, there is no scope of constructing a sludge disposal facility in future due to lack of space in the HMWTP premises.

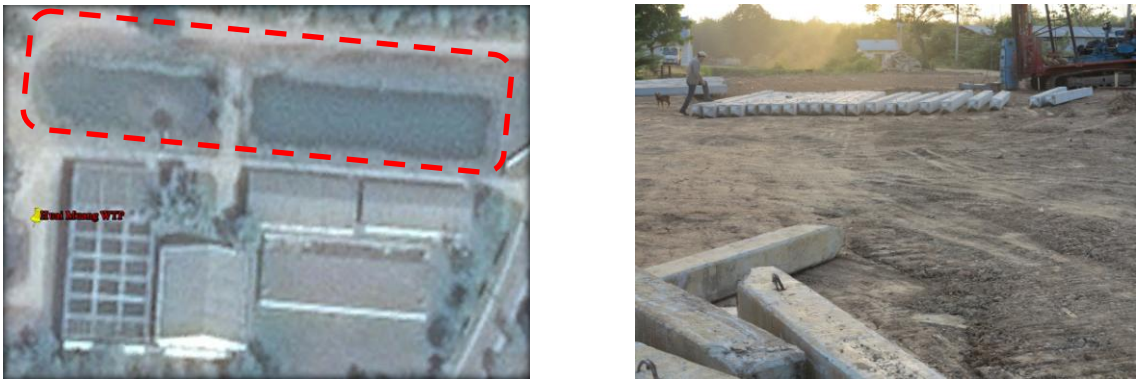

Figure 10 Existing Water Ponds (left) and New WTP under Construction (right)

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

The water level of the Moei River reduces in dry season, hence additional pumping facility has to be installed for abstracting from Moei River to intake channel **(Figure 11).** Such pumping activities increases the energy consumption by twice during the dry season as compared to the rainy season.

(a) Low water level in the dry season

(b) Dredging of sand in Moei River

(c) Additional pumping equipment installed

(d) Inflow of water intake channel

Figure 11 Water Intake from Moei River in the Dry Season

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

The issue of lack of water quantity in the dry season will be continued in future because of the sand excavation from Moei River in Myanmar side (the border between Thailand and Myanmar is located at the center of Moei River). Moreover, once the construction work of the new water treatment plant is finished, the raw water demand will increase greatly in the future. It is not easy to solve this issue because there are a lot of stakeholders, such as local residents of Thailand and Myanmar, local governments, authorities (PWA, Royal Irrigation Department).

6. Recent investment made for the plant's improvement

HMWTP installed the roof on the sedimentation basins in 2014 **(Figure 12)**. The roof helps to improve the effectiveness of the pre-chlorination in preventing algae growth during the treatment process, especially prevent the strong sunlight in the dry season. This roof is also expected to protect the basins from other debris (leaf, dust).

Figure 12 Roof of the Sedimentation Basin

Most of the treatment plants under PWA clean the sedimentation tank manually with a regular cycle (per two or three months) without any continuous sludge collector system. HMWTP installed the mechanical sludge collector system to improve the unit's performance and treatment efficiency **(Figure 13, 14)**. The submerged sludge collector is operated by the principle of gravity using advantage of different head. Water pressure in the main tank forces the sludge through the header collector into the outlet piping, and away to the sludge removal trough (Leopold, 2010). It is expected to improve treated water quality from the sedimentation basin.

Figure 13 Mechanical Sludge Collector Motor

Figure 14 Sludge Collector System

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

Looking at the existing status of the HMWTP, the following changes in infrastructure, facilities, and process are recommended for the betterment of the HMWTP**.**

- The most urgent thing is to abstract raw water sufficiently in the dry season. Thus, HMWTP is required to install some infrastructure for securing raw water intake, such as a weir, raw water pond or finding the new site of water intake.

- Continuous water quality monitoring devices need to be introduced for full time monitoring of water quality change in Moei River. Especially, continuous turbidity meter is required to inject optimum coagulant dosage through quick response, according to the changing quality of raw water.

- HMWTP discharges sludge directly to the water sources without any appropriate sludge disposal handling system. Sludge drying beds are recommended.

- Dual filter media can be a good option for improving the filtration cycle of the existing filters at HMWTP. The result of a research by Zouboulisa (2007) showed that the dual filter media produced higher filtered water than the fine sand media (over 10 %) by a longer filtration cycles, and also, the filtrated water has the same high quality.

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

According to the complaint data of HMWTP (**Table 2**), most complaints were related to the water quantity aspect (46.1 %) and new connection to tap water (38.5 %).

Table 2 Complains of Huai Muang Water Treatment Plant (between 2013 and 2014)

Complains	Water quantity	Water quality	New connection	Service	Others
Number	6	1	5	1	-
Percentage	46.1	7.7	38.5	7.7	-

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

No advanced technology is in use at the Huai Muang WTP.

10. Water quality data

All measured parameters are under Thailand national standard for drinking water. The water quality data observed in 2013 and 2014 are presented in **Table 3**.

Table 3 Water quality data

Parameters	Unit	Raw water (2013)		Treated water (2014)		Standard (Thailand)
		Min	Max	Min	Max	
pH	-	7.9	8.5	7.7	8.4	6.5-8.5
Turbidity	NTU	5.2	1516	0.31	2.3	5
Conductivity	µs/cm	181	368	133	351	-
Total hardness	mg/L	80	184	68	200	500
Sulfate	mg/L	3.4	12	1.8	8.1	200
Iron	mg/L	-	-	0.02	0.10	0.5
Manganese	mg/L	-	-	0.01	0.07	0.5
Chloride	mg/L	6	19	6	13	250

11. References

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