CHAPTER III

METHODOLOGY

3.1 Wastewater Collection

Primary wastewater from the Si Phraya wastewater treatment plant (WWTP), Bangkok, Thailand was used as influent for bench-scale TF and RBC while that from the MBK Department Store WWTP, Bangkok, Thailand was used for all three bench-scale wastewater treatment systems. MLSS from the aeration tank of the Si Phraya WWTP was collected and used immediately after collection as a seed during the start-up periods of the AS and RBC systems. The plant uses a contact stabilization AS process with an approximate capacity of 8 MGD (or 30,000 m^3/day) and a SRT of 28 days.

3.2 Experimental Setup and Operation

3.2.1 Activated Sludge (AS)

3.2.1.1 Experimental Setup

A bench-scale activated sludge unit was constructed from Plexiglas with an 8.8-litre completely mixed aeration zone and a 6.6-litre internal sedimentation zone as shown in Figures 3.1 and 3.2. To maintain DO at 2-3 mg/L, fine bubble ceramic diffusing stones were used to provide air to the aeration zone.

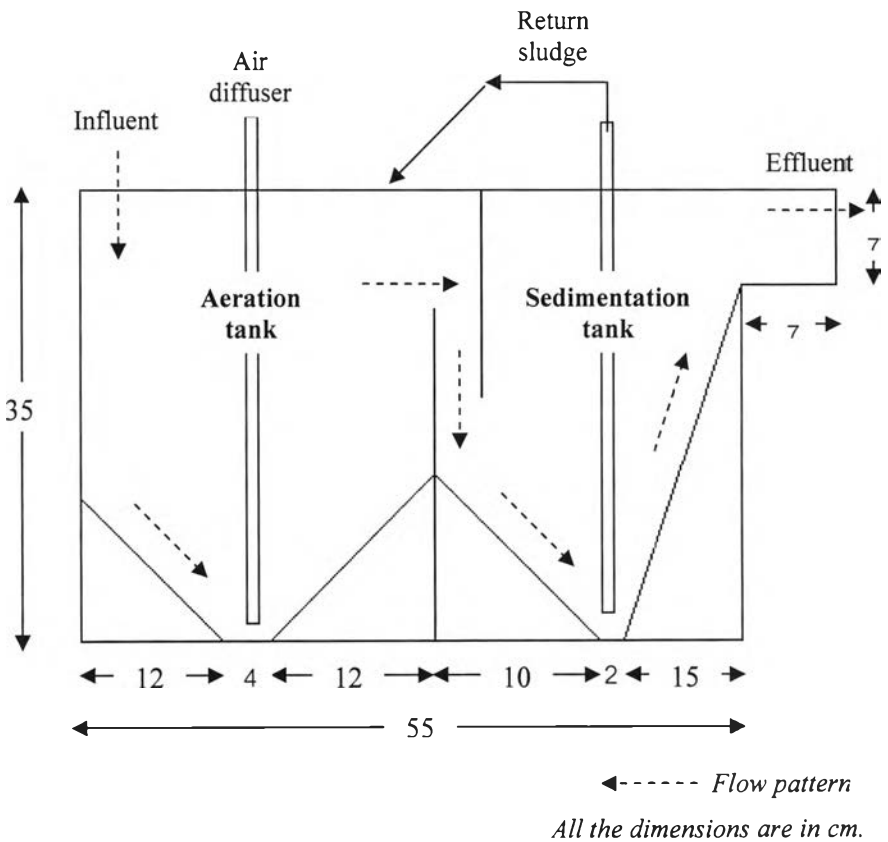

Figure 3.1 Diagram of activated sludge bench-scale system

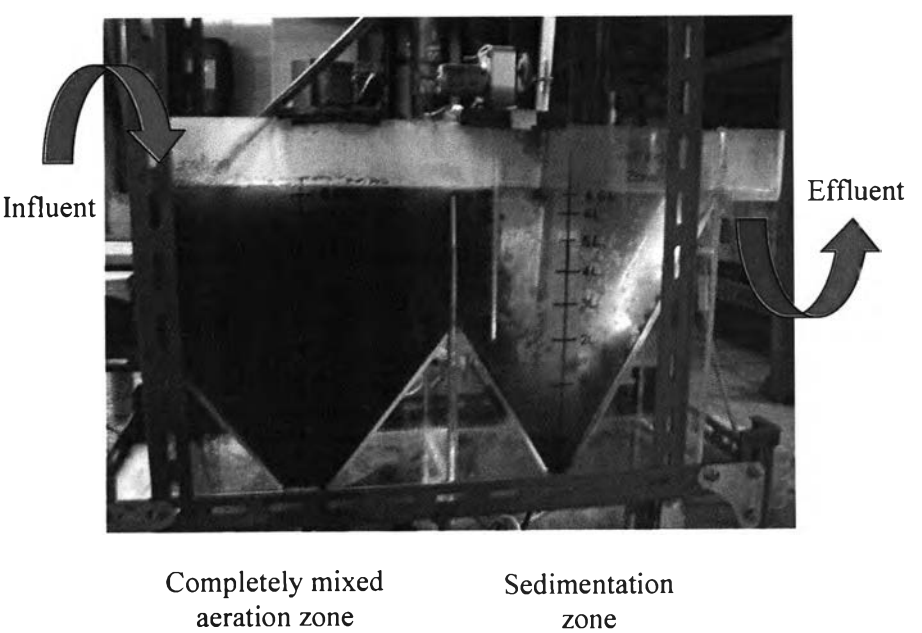

Figure 3.2 The activated sludge bench-scale system during normal operation

3.2.1.2 Experimental Operation

AS was operated with the MBK store primary wastewater only. To start the operation, the wastewater was continuously pumped into the aeration zone and MLSS from the aeration tank of the Si Phraya Wastewater Treatment Plant was seeded into the wastewater. The system was continuously operated for about 2-3 weeks at a constant SRT of 1 day until the steady-state condition was reached (pH and MLSS concentration variations were less than 10%). Settled solids were constantly returned to the aeration zone by pumping at the same flow rates as the influent feeding rates, for 100% sludge returning. The same batch of wastewater was used for each SRT, which was controlled by manually wasting sludge from the aeration zone.

Five SRTs, 1, 3, 5, 7 and 10 days, representing a typical range of SRT used in AS plants, were studied. For each SRT, the reactor was operated until the steady-state was achieved (variations of MLVSS and effluent $BDOC_5$ were less than 10%). Then, influent and effluent samples were collected twice a day at 8:00am and 6:00pm for 5 days after steady-state was achieved. At each SRT, the system was operated until 10 samples were collected.

3.2.2 Trickling Filter (TF)

3.2.2.1 Experimental Setup

Figures 3.3 and 3.4 show the diagram of TF bench-scale system and its setting at the Si Phraya and MBK WWTPs, respectively. A TF tower was constructed from a length of PVC pipe with 30-cm inside diameter and 50-cm height. Rock media, with a 25-mm approximate diameter, were packed in the tower to make a 25-cm deep filter bed. Rock media were placed on an overlapping sheet of plastic net and a sturdy plastic mesh.

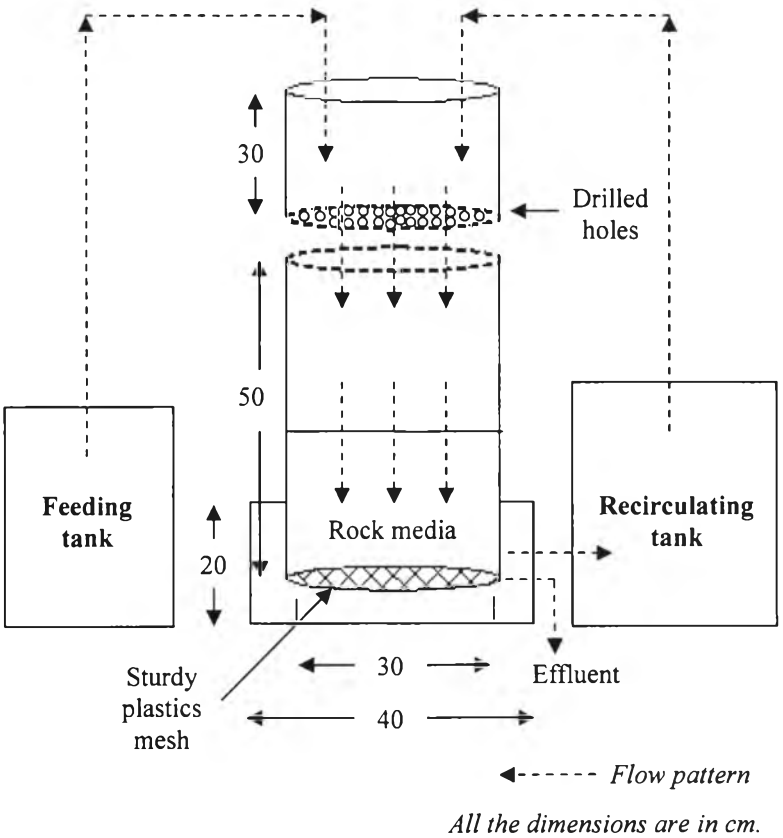

Figure 3.3 Diagram of trickling filter bench-scale systems

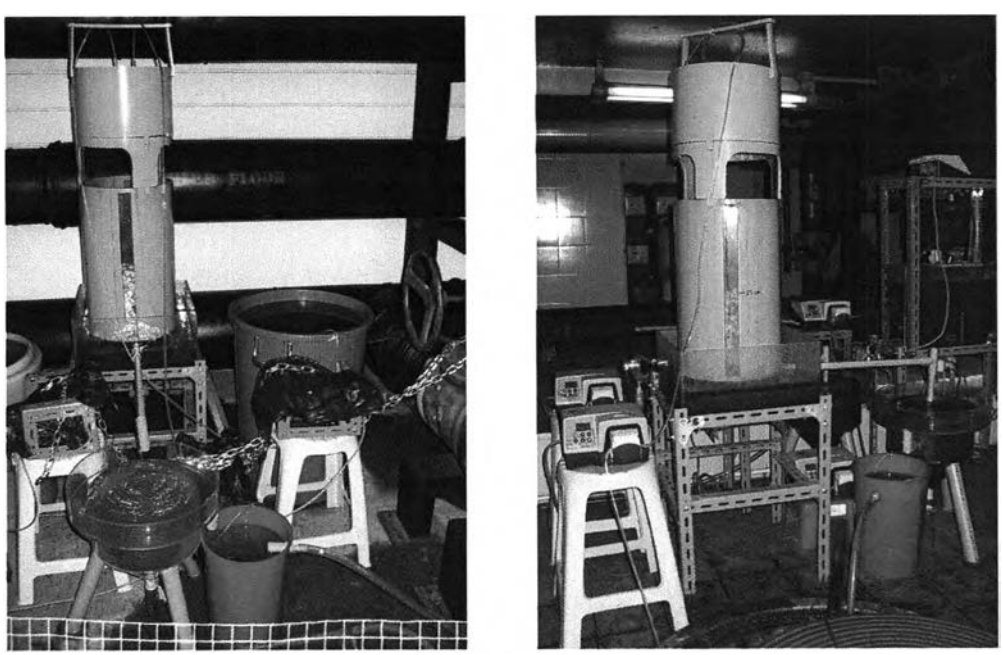

Figure 3.4 Trickling filter bench-scale systems during normal operation at the Si Phraya WWTP (left) and at the MBK Department Store WWTP (right).

The tower was on a collecting basin made of Plexiglas with 40, 40 and 20 cm of width, length and height, respectively. An influent distributor was constructed from a 20-cm long PVC pipe with a 30-cm inside diameter. One end of the pipe was closed with a sturdy plastic sheet, which was drilled evenly to make 1-mm diameter holes for influent distribution. A separate sedimentation tank, which received a mixture of treated wastewater and solids from the collecting basin, was a Plexiglas tank with a 40-cm inside diameter and a 60-degree angle cone at the bottom. A 10-litres plastic bucket was used as a recirculation tank. All the components are shown in Figures 3.5 and 3.6.

(a) (b) (c)

Figure 3.5 Components of TF: (a) a fixed film biological tower, (b) rock media in the tower, and (c) sedimentation tank.

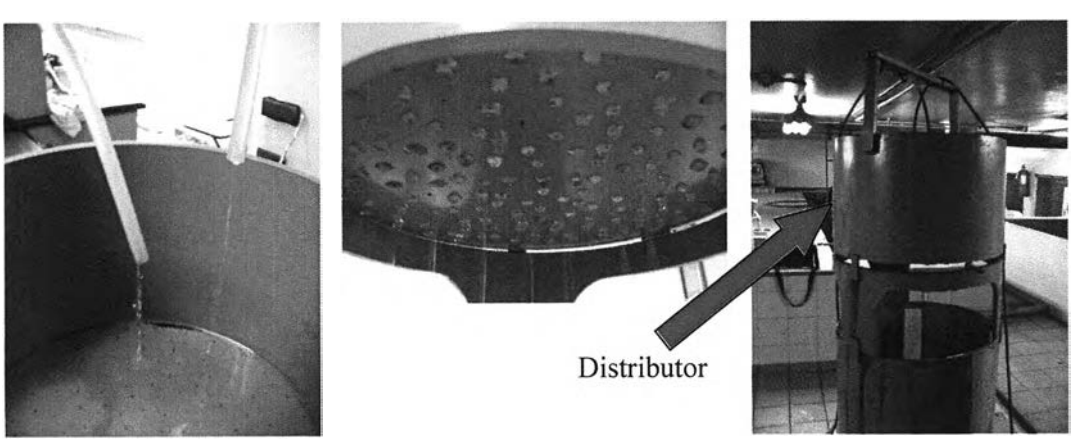

Figure 3.6 Influent distributor of TF.

3.2.2.2 Experimental Operation

For the start-up of the system, primary wastewater was circulated for about three weeks to promote the formation of the fixed microbial film. To maintain sufficient substrate in the tower, a new batch of primary wastewater from the same collection was fed every other day. The primary wastewater of MBK Department Store was pumped at five different flow rates to achieve five different HLRs: 3, 7, 9 and 15 m^3/m^2-day. Only the first three HLRs were investigated on primary wastewater of Si Phraya WWTP. These HLRs represent typical HLRs used for full-scale TFs: 3 m^3/m^2-day for low or standard rate, 7 and 9 m^3/m^2-day for intermediate rate, and 15 m^3/m^2-day for high rate. The overflow effluent was recirculated to the distributor at the same rate as the feeding rate (100% recirculation).

For each HLR value, the reactor was operated until achieving the steady-state (Effluent $BDOC_5$ concentration variations were less than 10%). After that, influent and effluent samples were collected following the same protocol for the AS experiment.

3.2.3 Rotating Biological Contactor (RBC)

3.2.3.1 Experimental Setup

A single stage RBC unit was used and consisted of a Plexiglas tank, a series of circular Plexiglas discs, a stainless steel shaft and a motor, as illustrated in Figures 3.7 and 3.8.

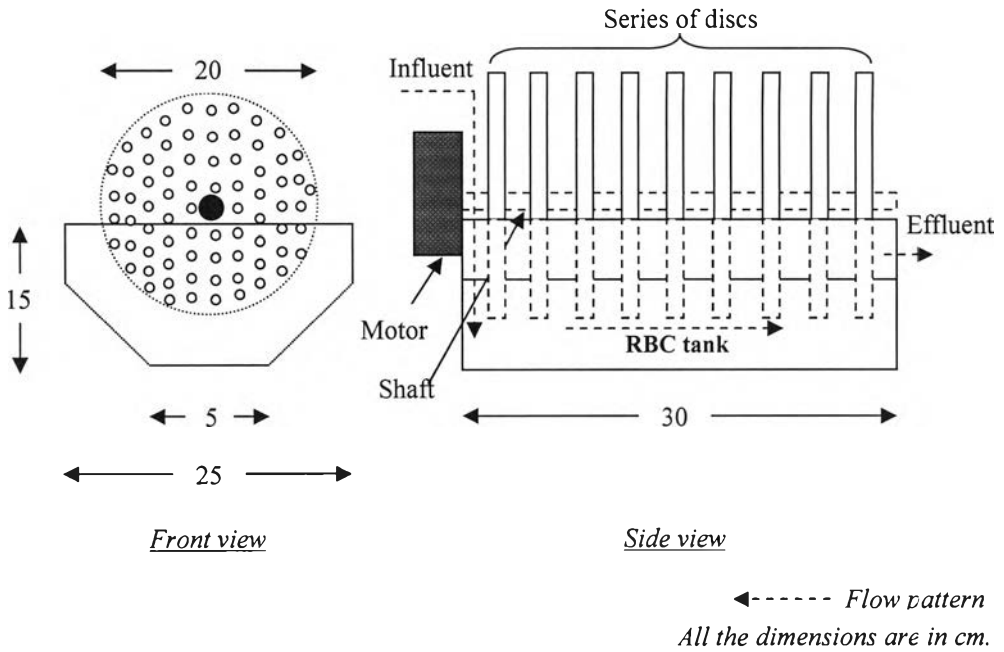

Figure 3.7 Diagram of rotating biological contactor bench-scale system.

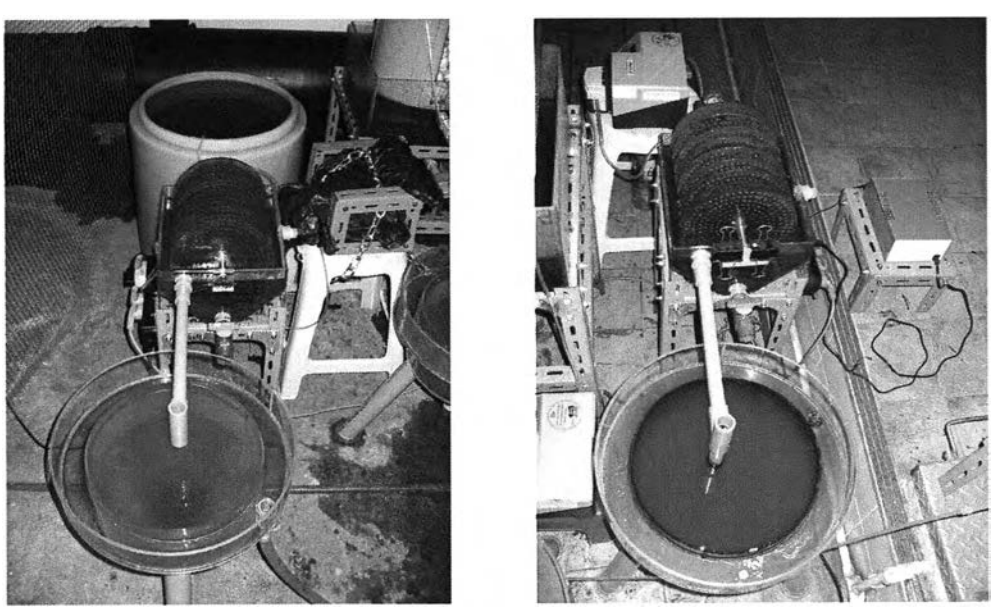

Figure 3.8 Rotating biological contactor bench-scale system during normal operation at the Si Phraya WWTP (left) and at the MBK Department Store WWTP (right).

The tank was 25-cm wide, decreasing to 5 cm at the base, 30-cm long and 15-cm deep. This RBC unit had 9 discs; each disc was 20 cm in diameter. All the discs were supported by a shaft rotated by a motor at 1-2 rpm. To increase the surface area of the discs for microbial attachment, every disc was drilled for 1-mm holes evenly all over the discs as shown in Figure 3.9. The sedimentation tank had the same design as that of the TF system.

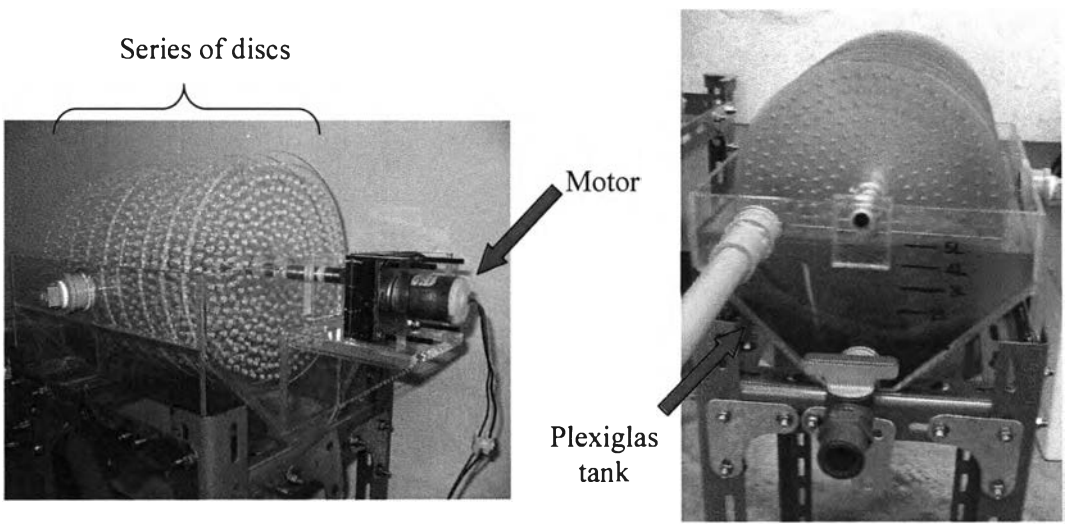

Figure 3.9 Components of single stage RBC unit.

3.2.3.2 Experimental Operation

MLSS from the Si Phraya WWTP was used to start up the system. Primary wastewater was circulated through the RBC unit for about 2 weeks to promote the growth of fixed film microorganisms on the discs as shown in Figure 3.10. After that, five HLRs, 0.08, 0.12, 0.16 and 0.30 m^3/m^2-day, were studied. Only the first three HLRs were studied on the primary wastewater of Si Phraya WWTP. The HLRs chosen were typical for full-scale RBC operation. HLR was controlled by pumping the primary wastewater into the system with five different feeding rates. The steady-state determination and sampling were the same as those for AS.

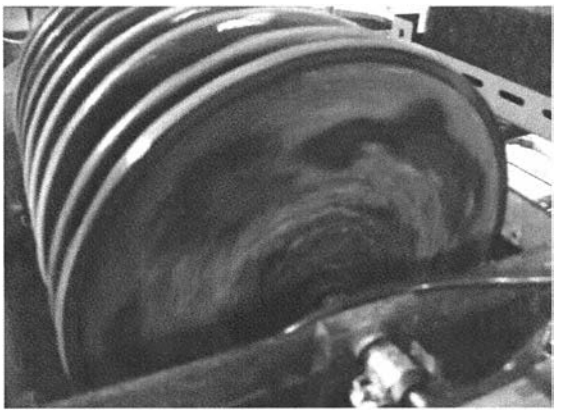

Figure 3.10 Growth of fixed film microorganisms on the RBC discs.

3.3 Analyses

pH, MLSS, DOC, $SBOD_5$, SCOD and UV_{254} of the influent and effluent samples were determined according to *Standard Methods* (1998). $BDOC_5$ and $BDOC_{28}$ were measured following Khan *et al.* (1999). Each sample was analyzed in duplicate.