

CHAPTER III

METHODOLOGY

3.1 SOURCE OF SAMPLES

The natural water source used in this study was diverted from the Bangkok Water Treatment Plant and pumped to the pilot plant located at Bangkok Water Treatment Plant. This location allows working with Pra-Pa canal, which is the main water source for the Bangkok Metropolitan areas. The characteristics of raw water used here is shown in Table 3.1

Table 3.1 Characteristics of raw water

Parameter	Range of values
Temperature (C°)	22-25
pH	7-8.5
Turbidity (NTU)	20-200
Alkalinity (mgCaCO ₃ /L)	80-100
TOC (mg/L)	1-10
UVabsorbance at 260 nm	0.143-0.293

3.2 CHEMICALS, REAGENTS AND INSTRUMENTS

3.2.1 Chemicals and Reagents

Chemicals used in this study are all analytical grade: KHP (OI Analytical), $\text{Na}_2\text{S}_2\text{O}_4$ (OI Analytical), Kaolin clay (PT. Kaolindo, Indonesia), Polyaluminium chloride (Goshu Kaei Co., Ltd) and nonionic polymer (Kurita C-133, Kurita-GK Chemical Co., Ltd).

Polyaluminium chloride was used as a coagulant to neutralize charges of colloidal suspension and nonionic polymer were used as a coagulant aid to generate strength of floc in the system. Properties of coagulant and coagulant-aid can be found in **APPENDIX A**.

Reagents used in this study were 5% H_3PO_4 (Merck), KHP stock solution (OI Analytical), 0.02 H_2SO_4 (Merck), 0.1 N HCl (Merck), 0.1N NaOH (Merck), CHBr_3 (Merck), CHCl_2Br (Merck), CHCl_2Br (Merck), CHBr (Merck), 10% NaOCl (May and Baker) and 95% methyl alcohol (Merck).

3.2.2 Instruments

Many instruments were used, i.e., UV-Spectrophotometer (Model U-2000, Hitachi, Japan); pH meter (Accumet[®]pH Meter 910, USA.); Turbidity meter (HACH 2100N, USA.); TOC analyzer (Model 1010, O.I. Corp., College Station, TX), Gas Chromatograph equipped with an electron capture detector (Model GC-14A, Shimadzu.); Particle size analyzer (Masterizer X Version. 2.15, Malvern Instruments Ltd.); Refrigerator (Gold Spot, Korea); Oven (Memmert GmbH, Model 700, Schwabach, Germany); Suction (Hitachi, Japan).

3.3 EXPERIMENTAL SET-UP

The experimental apparatus used in this study consists mainly of static mixer for rapid mixing and a pelletization reactor. The reactor has a height of 3 m. and internal diameter of 3.5 m. A scheme of the pilot plant is shown in Figure 3.1.

3.4 EXPERIMENTAL PROCEDURE FOR PELLETTIZATION SYSTEM

A sufficient pellet mass was first developed in the reactor by a start-up process which was achieved by introducing a feed water of 150,000 mg/L kaolin to the system along with coagulant and coagulant-aid doses according to particular experiment. An ample mass of pellet could be obtained within approximately 1-3 h, after which the process was fed with real surface water from Bangkok Water Treatment Plant.

Both the 150,000 mg/L kaolin synthetic water and the real surface water were pumped into the static mixer unit while the PACl was introduced. The destabilized water was then mixed with the polymer before entering the bottom part of the pelletization reactor and flowing upwards through the height of the reactor, in which an agitator provided a sufficient degree of mixing for a good pelletization. The treated water then flows through the outlet and finally drains to a nearby gutter. With the continuous running, the total volume of pellets in the reactor increased. When it reached the full bed height of 150 cm. from the bottom of the reactor, excess pellet-flocs would continuously withdrawn to keep constant height of pellet bed.

3.4.1 Effects of the number of paddles and up-flow velocity on performance of the process

The investigation of the effects of number of paddles and up-flow velocity pelletization process on performance of the process in term of THM precursors removal was performed by varying the values of up-flow feed velocity and number of the paddles for running system.

In this part, fixed variables were PACl dosage, nonionic polymer dosage, rate of paddle agitation and pellet bed height, and independent variables were up-flow feed velocity and number of the paddles. The experimental conditions for determination of the optimum condition were shown in Table 3.2.

3.4.2 Effects of coagulant and coagulant aid dosages on performance of the process

The study of the effects of coagulant and coagulant aid dosages was performed by varying 3, 4 and 5 mg/L PACl dosages and nonionic polymer dosages 0.1, 0.2 and 0.3 mg/L. The experimental conditions for determining the effects of coagulant and coagulant-aid are shown in Table 3.3.

3.4.3 Determination the THM formation potential

Determination of THM formation potential (THMP) was performed by using raw and treated waters obtained from part II (at highest percentage removal of TOC and UV260). The experiments were conducted at 25 °C with 4 mg/L of chlorine. Samples were then taken at 3, 6, 9, 12 and 24 h intervals and analyzed for THM formation potential levels.

3.5 SAMPLING PROCEDURE

Water samples were taken from two locations in the pilot system (point S₁ and S₂ in Figure 3.1). For each pilot run, raw and treated waters were taken at 12 h. intervals for analysis of pH, turbidity, TOC and UV260.

The pellet samples were taken at 0, 30, 60, 90, 120 and 150 cm pellet height at 12 h. intervals for analysis of suspended solid (SS), size, and setting velocity.

3.6 ANALYTICAL METHOD

3.6.1 TOC

The samples were filtered through a pre-washed 0.45 μm membrane filter paper to remove suspended particles prior to measurement of TOC by a total organic carbon analyzer with the method of sodium persulfate oxidation (Standard Methods 5310-D, 1995). The analyzer was regularly calibrated with 1000 ppm potassium hydrogen phthalate (KHP) as recommended by the manufacturer.

3.6.2 UV260

Ultraviolet Absorbance (UVA) was measured at a single wavelength of 260 nm, using UV-Visible spectrophotometer with a 1 cm quartz cell. The instrument was calibrated to zero absorbance using a filtered, distilled, and deionized water sample. The samples were first filtered through a pre-washed 0.45 μm membrane filter paper to remove suspended particles, which can interfere with this measurement.

3.6.3 pH

The pH was measured using pH meter with an accuracy of ± 0.002 pH units; this unit was calibrated daily, using pH 7.0 and 9.18 buffer solutions.

3.6.4 Turbidity

Turbidity was measured with a Hach 2100A turbidimeter using latex solution standards which turbidity measurements with accuracy of 0.01 NTU could be obtained. Treated-water sample was gently mixed prior to measurement. The water turbidity was expressed in Nephelometric Turbidity Unit (NTU).

3.6.5 Pellet Size

The particle size of pellet samples was determined by using a Masterizer X Version. 2.15 particle size analyzer, (Malvern Instruments Ltd.). The lenses used in this experiment were 0.2 and 2000 μm . The sample was placed in a sample cell across a laser beam. This instrument measured the average particle size and standard size distribution. Consequently, the specific surface area was calculated from the particle diameter with the assumption of being a spherical particle.

3.6.6 Pellet Setting Velocity

Setting velocities of various pellet particles were measured by allowing the particles that were sampled through an undisturbed method to settle descent in a quiescent setting column.

3.6.7 THM Formation Potential

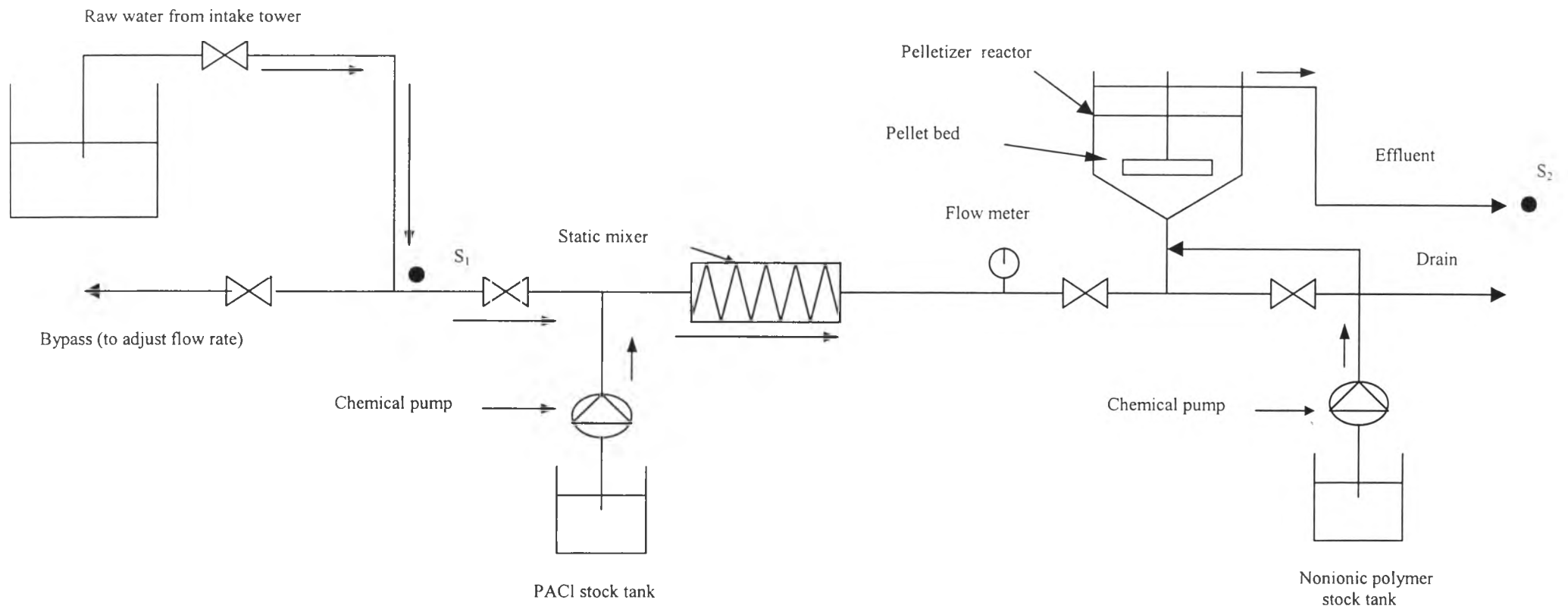
Procedures for determination of THM formation Potential (THMP) are shown in **APPENDIX D**. THMFP were measured according to the Head space method, using Capillary gas chromatograph equipped with an electron capture detector. The water used for the blanks and reagent solution was organic-free water produced by an all glass distillation system.

Table 3.2. Operational set up for determination of the effects of number of paddles and up-flow velocity

<i>Fixed variables:</i>	
Paddle speed	2 rpm
Pellet blanket height	150 cm (max)
Run time	48 h for each experiment
Chemical dose	1 mg/L of PACl 0.5 mg/L of nonionic polymer
<i>Independent variables:</i>	
Up-flow velocity	6, 8 and 10 m/h
Number of the paddles	2, 4, and 6

Table 3.3. Operational set up for determination of the effects of coagulant and coagulant aid dosages

<i>Fixed variables:</i>	
Paddle speed	2 rpm
Pellet blanket height	150 cm (max)
Run time	48 h for each experiment
Up-flow velocity	from Part I
Number of the paddles	from Part I
<i>Independent variables:</i>	
Chemical dose	3, 4 and 5 mg/L of PACl 0.1, 0.2 and 0.3 mg/L of nonionic polymer



Note ● sampling points

Figure 3.1 Process setup for the experiment.