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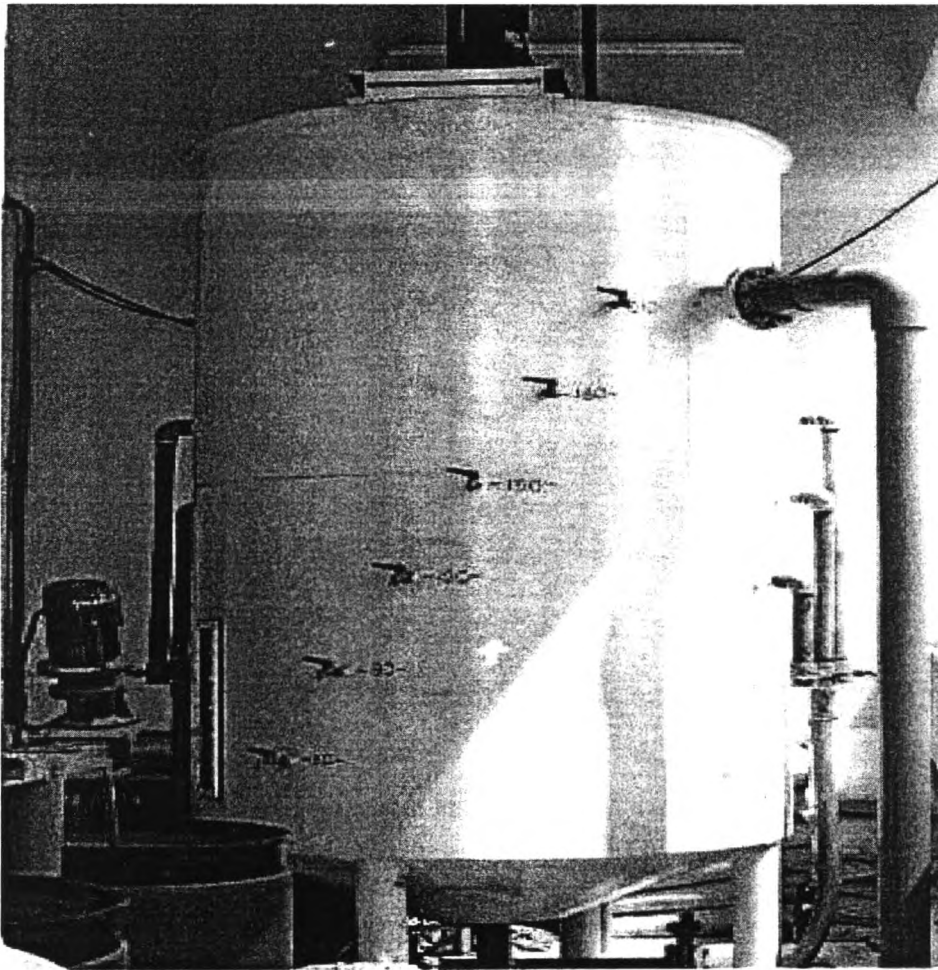# APPENDICES
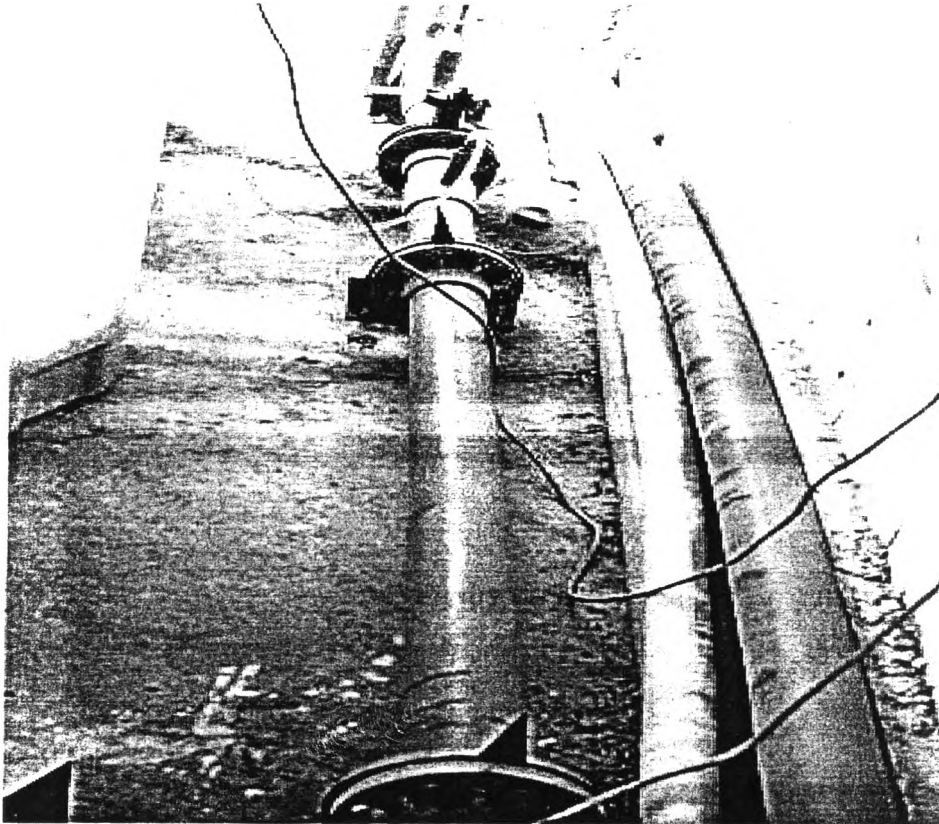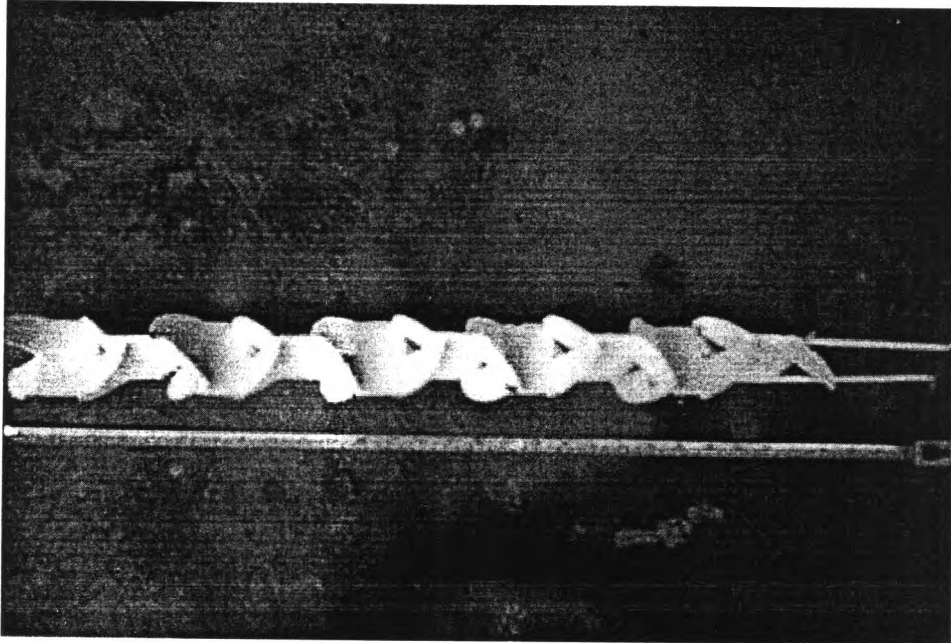
APPENDIX A

UP-FLOW PELLETIZATION PROCESS

Figure A-1 Pelletizer
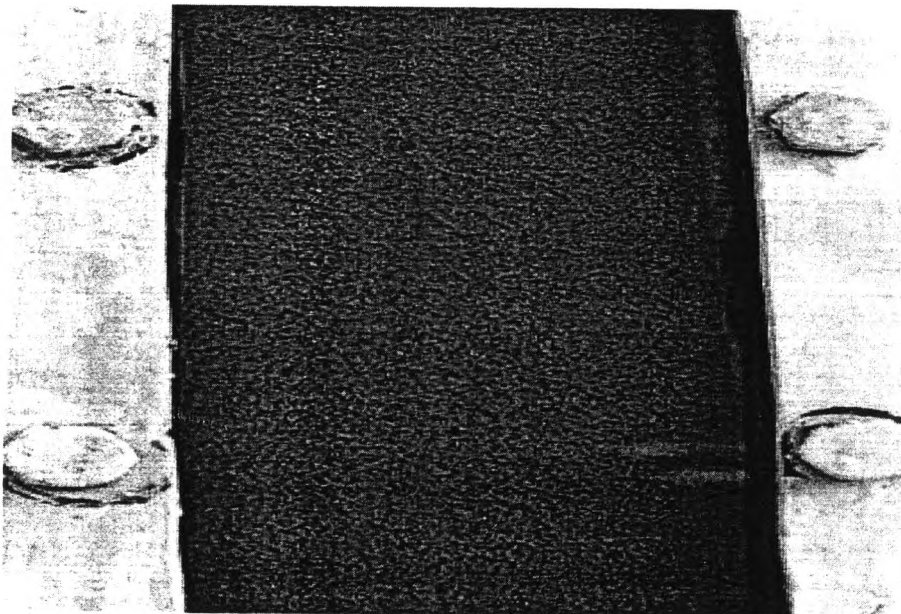
Figure A-2 Chemicals pipe

Figure A-3 Static mixer

Figure A-4 Characteristic of pellets

APPENDIX B

DETERMINATION THE MEAN VELOCITY GRADIENT

1. Velocity gradient in Pelletizer

1.1. The root mean square velocity gradient (G) can be calculated by equations of Metcalf & Eddy (1991) as follows:

$$G = (P/V\mu)^{0.5}$$

Where:

G = velocity gradient (s^{-1})

P = power applied to stirring, W (ft-lbf/s = HPx 500)

V = reactor volume m^3 (ft^3)

μ = dynamic viscosity N-s/m^2 (lbf-s/ft^2)

1.2. Power requirements are determined from;

$$P = C_D A \rho V^3 / 2$$

where:

P = power applied to stirring, W (ft-lbf/s = HPx 500)

C_D = coefficient of drag (of paddle moving perpendicular to fluid paddles; C is approximately 1.8)

A = paddle area, m^2 (ft^2)

ρ = fluid density, kg/m^3 (slugs/ ft^3)(for water at 25°C; ρ = 997 kg/m^3)

V = relative velocity of paddles in fluid (m/s[fps]), typically about 0.6 to 0.75 of paddle tip speed (v_p)

v_p = paddle tip speed; $2\pi rN / 60 (\text{m/s}^{-1})$

Solution

➢ G values at 6 blades, 2 rpm.

   Paddles have 2 size

   Size A: width 12 cm. length 60 cm.; 4 blades   A = 0.072 m²

   Size B: width 6 cm. length 45 cm.; 2 blades   A = 0.027 m²

   a. Calculation P of paddle size A

   $P_A = 0.5 \times 1.8 \times 0.288 \times 997 \times (0.75 \times 2\pi \times 0.6 \times 2 /60)^3$

   $= 0.216$ W

   b. Calculation P of paddle size B

   $P_B = 0.5 \times 1.8 \times 0.054 \times 997 \times (0.75 \times 2\pi \times 0.6 \times 2 /60)^3$

   $= 0.041$ W

   $P_A + P_B = 0.257$ W

   d. Calculation G

   $G = (0.257/(8.9 \times 10^{-4} \times 2.25))^{0.5}$

   $G = 11.33 \text{ s}^{-1}$

➢ G values at 4 paddles, 2 rpm.

   Paddle size: width 12 cm. length 60 cm.; 4 blades   A = 0.072 m²

   a. Calculation P of paddle

   $P_A = 0.5 \times 1.8 \times 0.288 \times 997 \times (0.75 \times 2\pi \times 0.6 \times 2 /60)^3$

   $= 0.216$ W

   b. Calculation G

   $G = (0.216/(8.9 \times 10^{-4} \times 2.25))^{0.5}$

   $G = 10.39 \text{ s}^{-1}$

➢ G values at 2 paddles, 2 rpm.

Paddles size: width 12 cm. length 60 cm; A = 0.072 m^2

a. Calculation P

P = 0.5 x 1.8 x 0.144 x 997 x (0.75 x 2π x 0.6 x 2 /60)^3

= 0.108 W

b. Calculation G

G = (0.108/(8.9 x 10^{-4} x 2.25))$^{0.5}$

G = 7.34 s^{-1}

2. Velocity gradient in static mixer

2.1 G values in static mixer can be calculated by equations as follows:

$$G = (\rho g H_s/\mu t)^{0.5}$$

where:

G = velocity gradient (s^{-1})

ρ = fluid density, kg/m^3 (slugs/ ft^3)(for water at 25°C; ρ = 997 kg/m^3)

g = 9.8 m^2/s^{-1}

ρ = fluid density, kg/m^3 (slugs/ ft^3) (for water at 25°C; ρ = 997 kg/m^3)

μ = dynamic viscosity N-s/m^2 (lbf-s/ft^2) (for water at 25°C; μ = 8.95 x 10^{-4} kg/m^3)

t = time for water flow though static mixer (s^{-1})

2.2 Calculation head loss (H_s)

$$H_s = h(\text{pipe}) + h(\text{static mixer})$$

where:

h(pipe) = 1.15 x 10^{-3} $LV^{1.95}/D^{1.25}$

h(static mixer) = 3.24 x 10-3 (1.5+0.12R_C)$^{0.5}$

L = length of static mixer (s^{-1})

V = velocity in pipe (m/s^{-1})

D = diameter of pipe (m)

R_C = Renold number; $R_C = \rho VD/\mu$

Solution

a. Calculation head loss in pipe

h(pipe) = 1.15 x 10^{-3} x 0.35 x 1.47$^{1.95}$ /0.06$^{1.25}$

= 0.028 m

b. Calculation head loss in static mixer

R_C = 997 x 1.47 x 0.06 / 0.000895)

= 98804

h(static mixer) = 3.24 x 10-3 (1.5 + 0.12 x 98804$^{0.5}$)

= 0.127 m

c. Calculation head loss

H_s = 0.028 + 0.127

= 0.155 m

d. Calculation Gt values

G = (997 x 9.8 x 0.155)/(0.00089 x 0.24)

= 2662 s^{-1}

Gt = 2662 x 0.24

= 639

APPENDIX C

COAGULANT AND COAGULANT-AID

Table C-1 Properties of Polyaluminium Chloride

Code name	PAC
Appearance	Liquid
Al_2O_3	10%
SO_4^{-2}	3.5 max
Basicity	45-65%
pH	3.5-5 (at 1%/wt/v)
Specific Gravity	1.19 min (g/cc, at 25°C)

Table C-2 Properties of Nonionic Polymer

Code name	Kurita C-1330
Type	Nonionic
Main ingredient	Polyacrylamide
Appearance	White granular powder
Molecular weight	Approximately 12 millions
pH	5.5-7.5 (0.1%sol at 25°C)

APPENDIX D

REAGENTS FOR TOC ANALYZER

Reagents

Reagent Water: Distilled or deionized water containing TOC of less than 200 ppbC is recommended.

Sodium Persulfate ($Na_2S_2O_8$): The optimum concentration of sodium persulfate solution depends on the range of carbon to be detected. Prepare a 100g/L or 200g/L solution of sodium persulfate by dissolving 100 or 200 g $Na_2S_2O_8$ into reagent water (1L total volume). Stirring may be necessary, but do not heat. Transfer a portion of this solution to the appropriate reagent bottle provided with the Model 1010. Shelf life is approximately three weeks. Sodium persulfate and reagent are available from OI Analytical.

Phosphoric Acid (H_3PO_4)(5% vol/vol): Prepare a 5% by volume solution of phosphoric acid by adding 59mL of ACS Reagent Grade 85% H_3PO_4 to reagent water (1L total volume). The acid solution may be purified, if hight organic contamination of the solution is suspected, by adding 10 mL of the persulfate solution and immersing the vented container in boiling water for at least two hours at 100 °C. The cooled solution should then be purged for several minutes to remove any CO_2 from oxidation of organics. The decrease in reagent blank resulting from this procedure is not generally worth the purification effort unless the acid solution is found to be abnormally high in TOC.

Potassium Biphthalate Stock Solution (KHP) (1000 ppmC): Prepare a stock solution by adding 2.128 g of KHP (previously dried to constant mass at 110 C°) into a 1000 ml volumetric flask. Dilute to volume with reagent water. Lower concentration standards can be prepared from this stock. . Self-life is approximately three weeks.

Sodium carbonate stock solution (Na$_2$CO$_3$) (100 ppm): Prepare a stock solution by adding 8.826 g of Na$_2$CO$_3$ (previously dried to constant mass at 110 C°) to a 1000 ml volumetric flask. Dilute to volume with reagent water. Lower concentration standards can be prepared from this stock. Self-life is approximately three weeks.
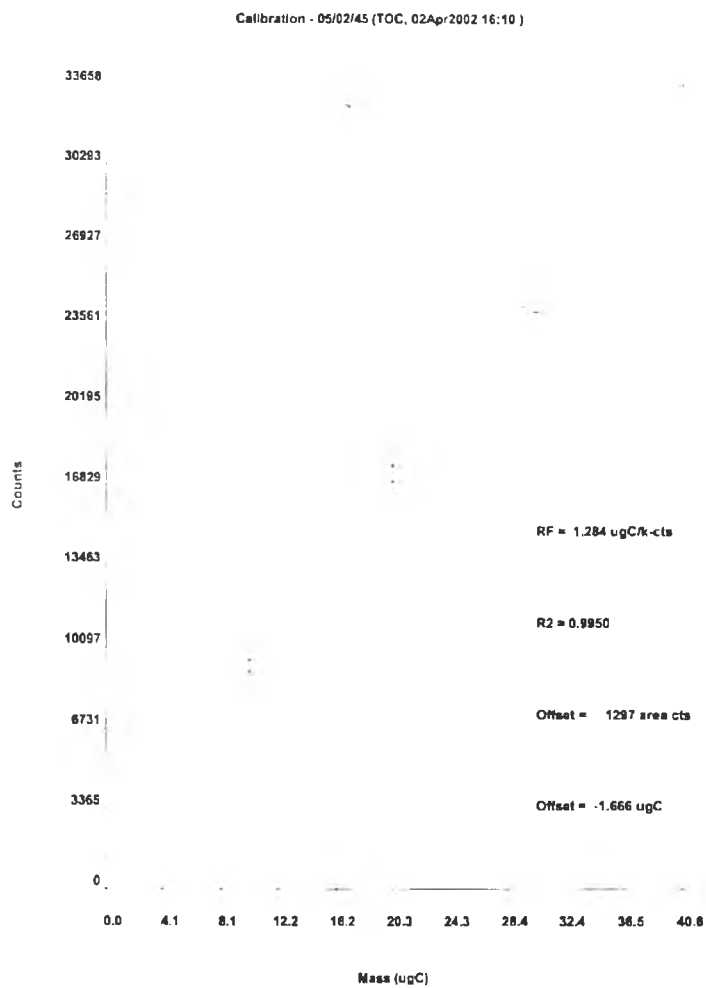
STANDARD CURVE

Calibration - 05/02/45 (TOC, 02Apr2002 16:10)

Figure D-1 Calibration curve for TOC

APPENDIX E

THM FORMATION POTENTIAL

Reagent

1. Chlorine stock solution

Chlorine stock solution was prepared by diluting 10 % sodium hypochlorite (NaOCl) solution in distilled deionized water to the required concentration (1 mg/L). This solution was then stored in a brown, glass-stoppered bottle kept overnight and standardized using iodometric method I, as according in the *Standard Method* (1985), every time before use.

2. Stock THM standard solution

THM mixture standard of 1 mg/mL of chloroform, 20 mg/mL of bromoform, 1 mg/mL of bromodichloromethane, 4 mg/mL of dibrochloromethane and in methanol. The working standard solutions were then prepared by diluting the stock standard mixture to 5, 10, 20 and 40 times with purified methanol. These standards were kept in serum vials, sealed with paraffin paper, septum and aluminum cap and kept in the refrigerator before use.

Sample Preparation

Chlorinated two liters of water sample with appropriate amount of hypochlorite solution under a well-mixed condition using a magnetic stirrer. The amount of hypochlorite solution was measured with a pipette and dosed instantaneously. Samples for THM analysis were collected in sterile flask to which 0.5 ml of 5% sodium thiosulphate had already been added (to neutralize the chlorine in the water)

Procedure

The Head Space Method as outlined in the Recommended Standard Methods for Water and Wastewater Analysis was adopted for the determination of the THM formation. Exactly 20 mL of the water to be tasted was pipetted into each of the 25 mL serum vials and immediately sealed with silicone septum vial closer. After shaking vigorously the serum vials were allowed to stand upside down for one hour prior to the gas chromatographic analysis. 200 μL of headspace vapor were removed with a gas-tight microsyringe and injected into the gas chromatograph. Computed on a Shimadzu C-R4A chromatopac data processor, were obtained by measuring the retention time and peak area on the chromatogram and compared to a standard curve previously prepared using the same method with a know THM previously prepared using the same method with a known THM mixture standard solution.
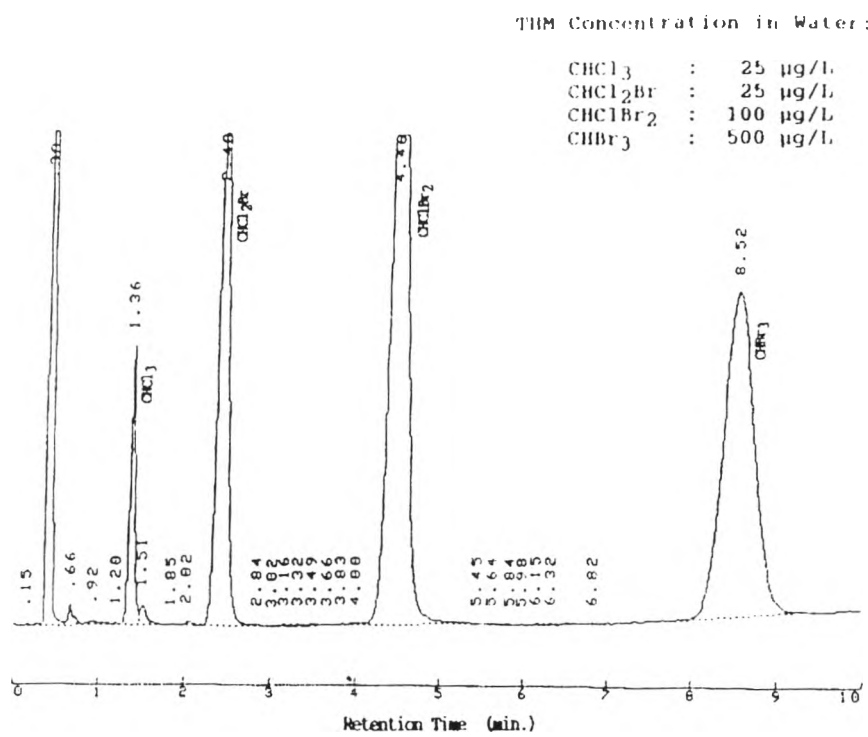
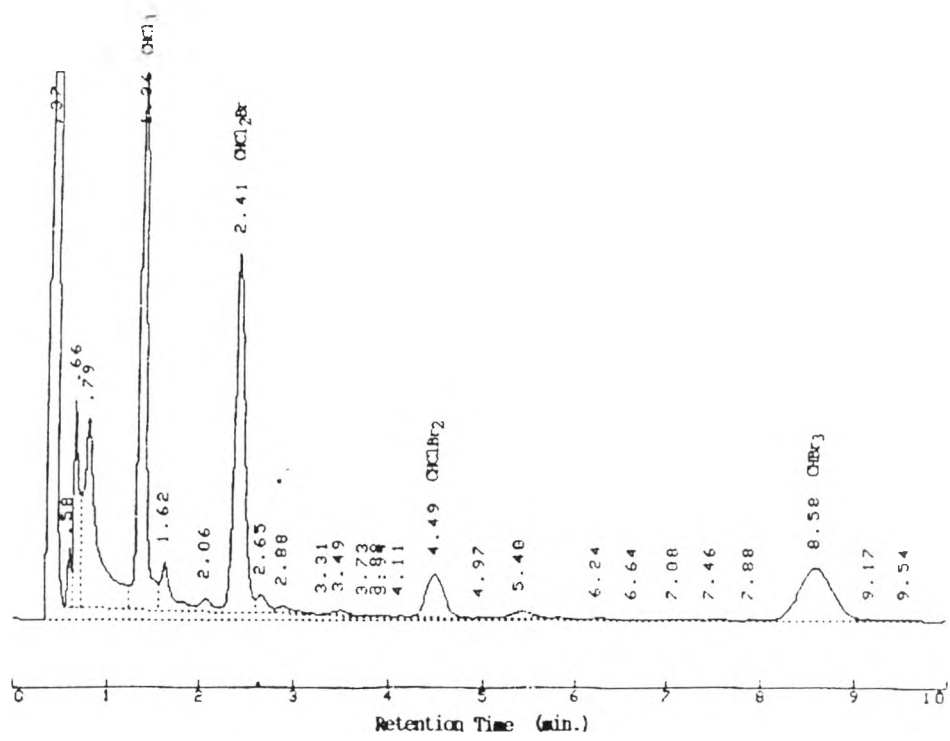**Figure E-1** Typical chromatogram of THM mixture standard in water

Figure E-2 Typical chromatogram of THMFP occurrence in water sample.
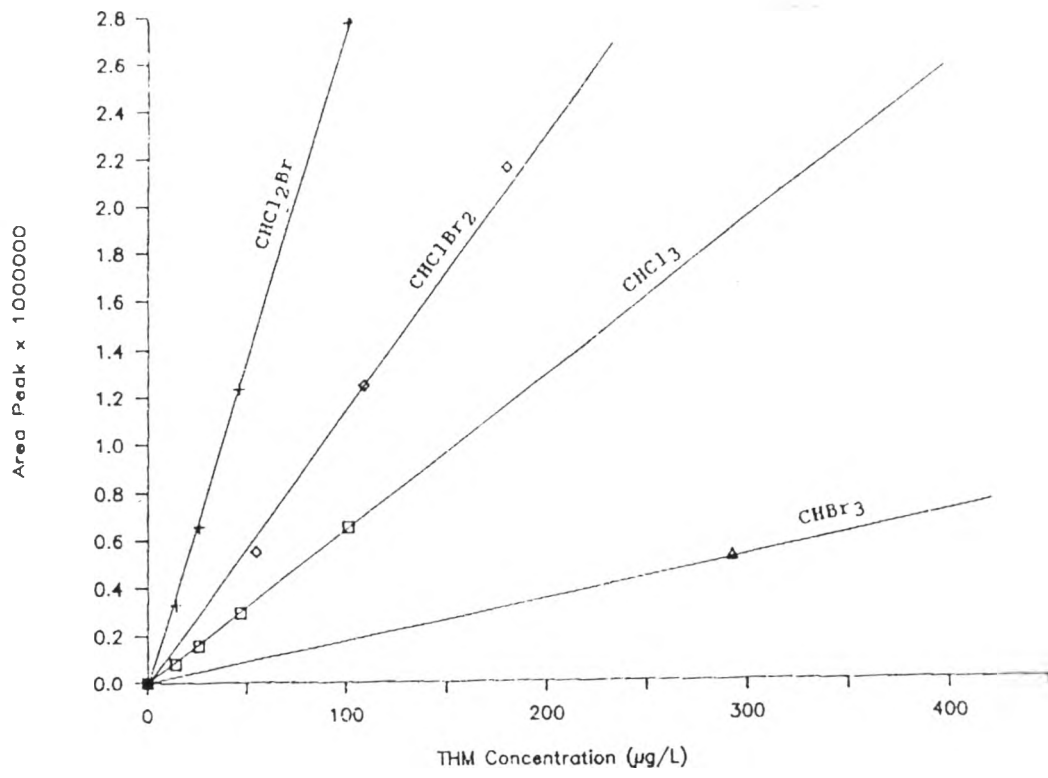
Figure E-3 Calibration curve for THMFP

BIOGRAPHY

Miss Pornpimon Limtrakul was born on 12 June, 1977 in Bangkok. she studied in the major of General Science in Faculty of Science at Chulalongkorn University and graduated a Bachelor of Science in March,1999. She continued her further study for Master's degree in International Environmental Management Science at Chulalongkorn University and achieved her Master's degree in April, 2002.