CHAPTER 3

EXPERIMENTAL

Static Test

General Information

Instruments

- Spectrometer
- Conical Flask
- 0.45 μ membrane filter
- Titration apparatus
- Thermostatic water bath

Materials

- 2-Phosphonobutane-1,2,4-Tricarboxylic acid, (PBTC), $C_7H_{11}O_9P$, 50% Active Ingredient.
- 1-Hydroxyethylidiene-1,1, diphosphonic acid, (HEDP), $C_2H_8O_7P_2$, 60% Active Ingredient.
- Amino tri (methylene phosphonic acid),(AMP), $C_3H_{12}O_9NP_3$, 50% Active Ingredient.
- Polycarboxylate (Sodium Salt), (PC), 45% Active Ingredient.
- Sodium Hexametaphosphate, (SHMP), Powder form 66.5-68.0% P_2O_5

- Acrylic-2-Acrylamido-2-Mythyl Propyl Sulfonic acid co-polymer, (AA/AMPS), 40% Active Ingredient.
- Phosphono-Phosphino-Maleic acid co-polymer, (PPMC), 40% Active Ingredient.

Test Method

- Total Hardness
- Total Alkalinity
- Total Phosphate

Procedure

a. Calcium Carbonate Stabilizer

A synthetic water composition was prepared according to Table 3.1 $CaCl_2$ 0.2775 g, $MgSO_4 \cdot 7H_2O$ 0.2465 g and $NaHCO_3$ 0.5040 g

Table 3.1 Synthetic Water Composition (Scaling Test)

Calcium	=	250 ppm as	$CaCO_3$
Magnesium	=	100 ppm as	$CaCO_3$
Bicarbonate	=	300 ppm as	$CaCO_3$
Chloride	=	70 ppm	Cl^-
Sulfate	=	100 ppm	SO_4^{2-}

were dissolved in 950 ml deionized water. The synthetic water was mixed with inhibitors with concentration of 0.5, 1.0 and 1.5 ppm The pH was adjusted to a desired level by NaOH or HCl. These solutions were placed in 1 litre glass bottles, and tested for hardness, total alkalinity, and pH. The glass rods were placed into the glass bottles before being sealed. After 24 hrs at 40°, 60°, or 80° C the samples were observed for encrustations, sludgeds, or turbidity. The samples were then filtered through a 0.45 μ membrane and analysed for total hardness. % Residual Hardness was finally calculated by the following equation;

$$\% \text{ Residual Hardness} = a/b \times 100$$

a = Hardness of the sample after testing

b = Hardness of the sample before testing

b. Calcium Phosphate Stabilizer

Stock solutions of calcium chloride (0.05 M), sodium bicarbonate (0.1 M), potassium dihydrogen phosphate (0.0105 M) and scale inhibitor 0.1% (1 mg/l as bulk) were prepared by using reagent grade chemicals and deionized water. A specified amount of the stock solutions of 25 ml 0.05 M $CaCl_2$, 25 ml 0.1 M $NaHCO_3$ and 5 ml 0.0105 M K_2HPO_4 were added to deionized water to make pH adjustment easier and to simulate actual cooling water which always contains a certain amount of M-alkalinity. Scale Inhibitors were added to test solutions prior to the addition of the orthophosphate stock solution. The pH of test solutions was then

adjusted by NaOH or HCl. All the containers which were sealed with "Saran-film" were immersed in a thermostatic water bath and kept stagnant at 60° C. After 40 hrs, the samples were filtered through a 0.45 μ membrane and analysed for total phosphate from:

$$\% \text{ Residual Phosphate} = a/b \times 100$$

a = Total Phosphate in the sample after testing

b = Total Phosphate in the sample before testing

Experiments for Cooling Tower Systems Model

General Information

Instruments

- Heat Exchanger (Fig. 3.1)
- Cooling Tower (Fig. 3.2)
- Make-up water Tank (Fig. 3.3)
- Corrosion Test Rack (Fig. 3.4)
- Pump
- Corrosion Meter
- Water Flow Meter

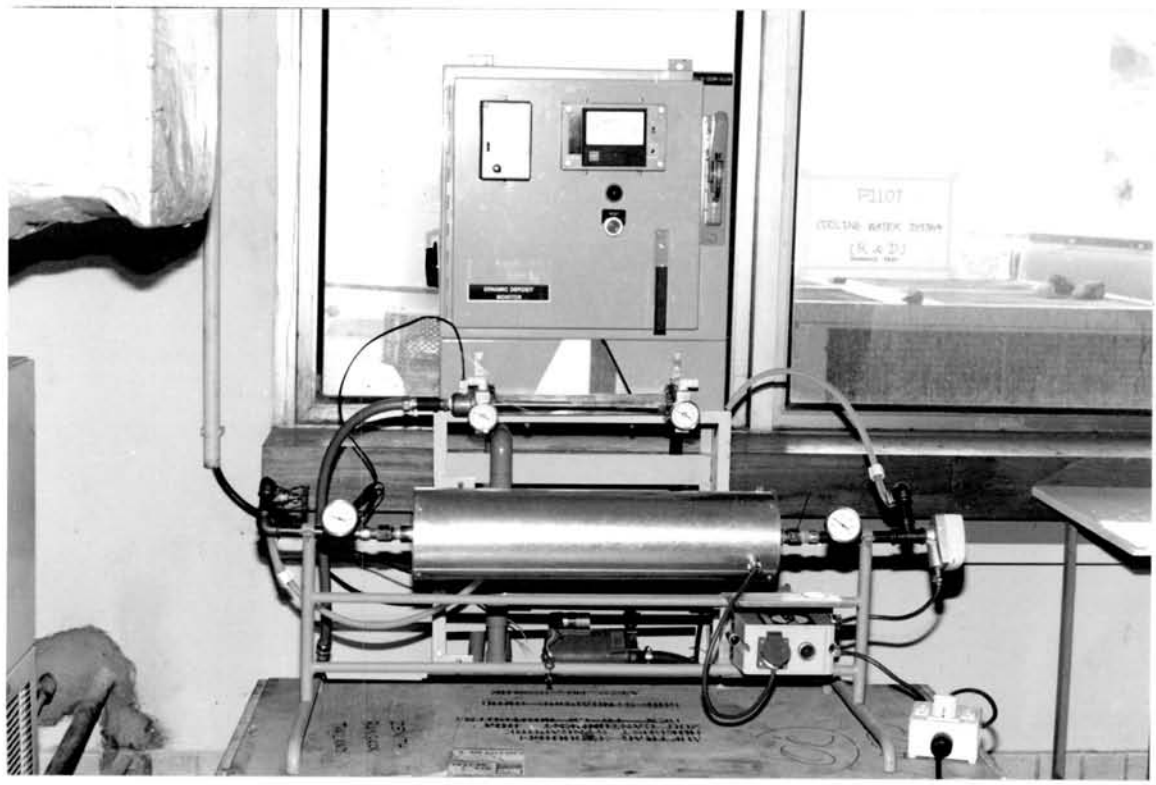

Fig.3.1 Heat Exchanger in Model Cooling Tower Systems

Fig.3.2 Cooling Tower in Model Cooling Tower Systems

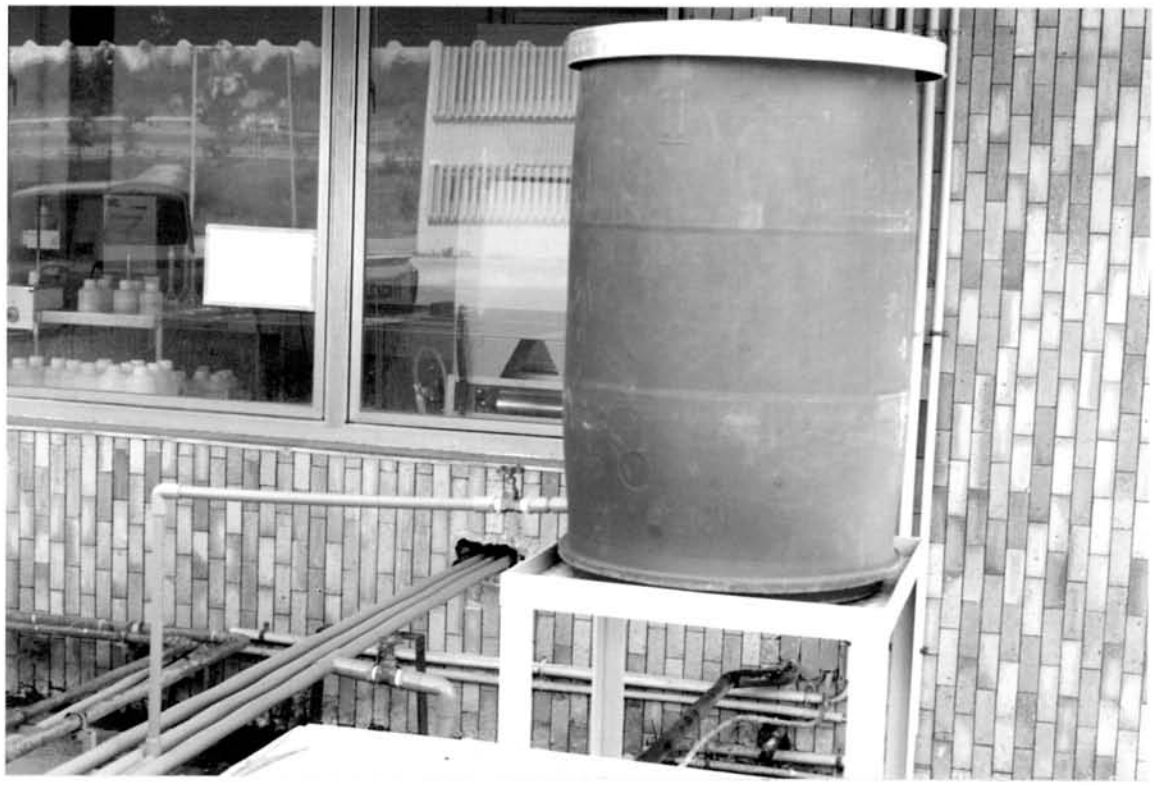

Fig.3.3 Make-up water tank in Model Cooling Tower Systems

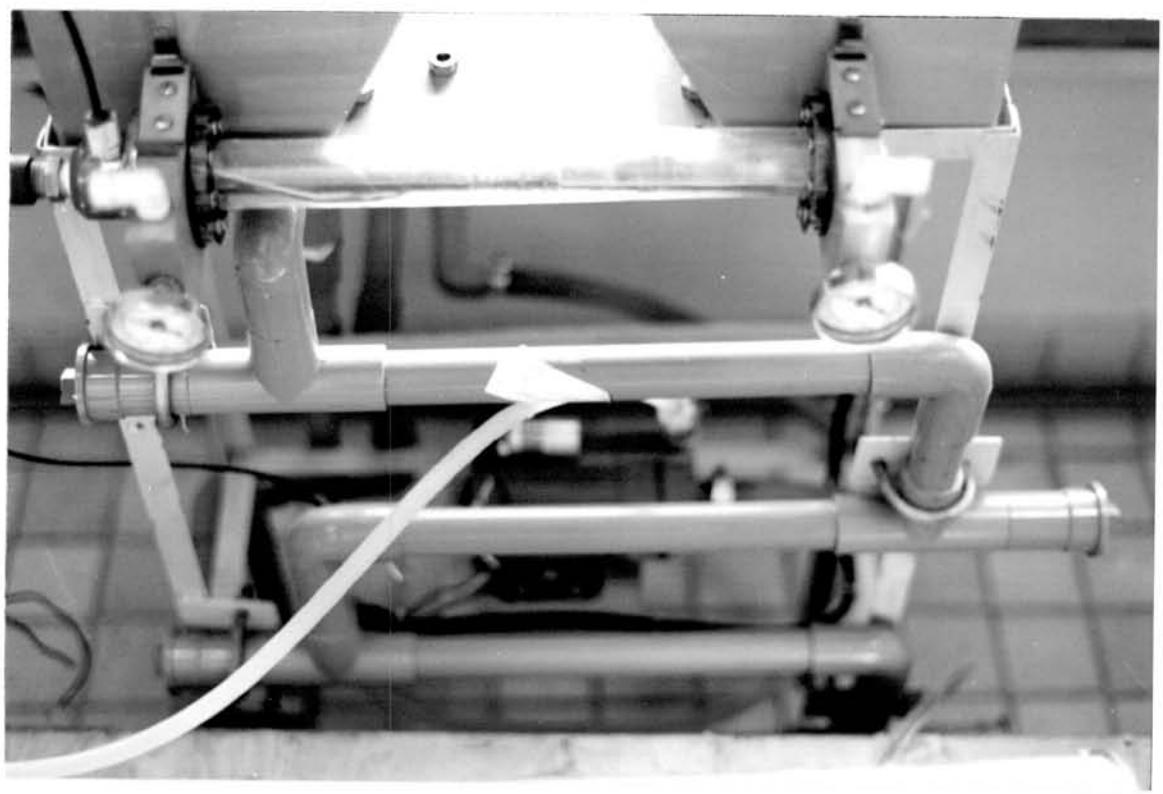

Fig.3.4 Corrosion test Rack in Model Cooling Tower Systems

Materials

- Trade name Chemicals for MAE MOH Power plant
- Sodium Hexametaphosphate, (SHMP), Power Form, 66.5-68.0% P_2O_5
- Acrylic-2-Acrylamido-2-Methyl Propyl Sulfonic acid co-polymer, (AA/AMPS), 39% Active Ingredient.
- Phosphate-Phosphino-Maleic acid co-polymer,(PPMC), 40% Active Ingredient.
- Glutaraldehyde (15% Active Ingredient)
- Calcium Hypochlorite (60-66% Active Ingredient)

Procedure

A flow diagram of the model plant is shown in Fig. 3.5

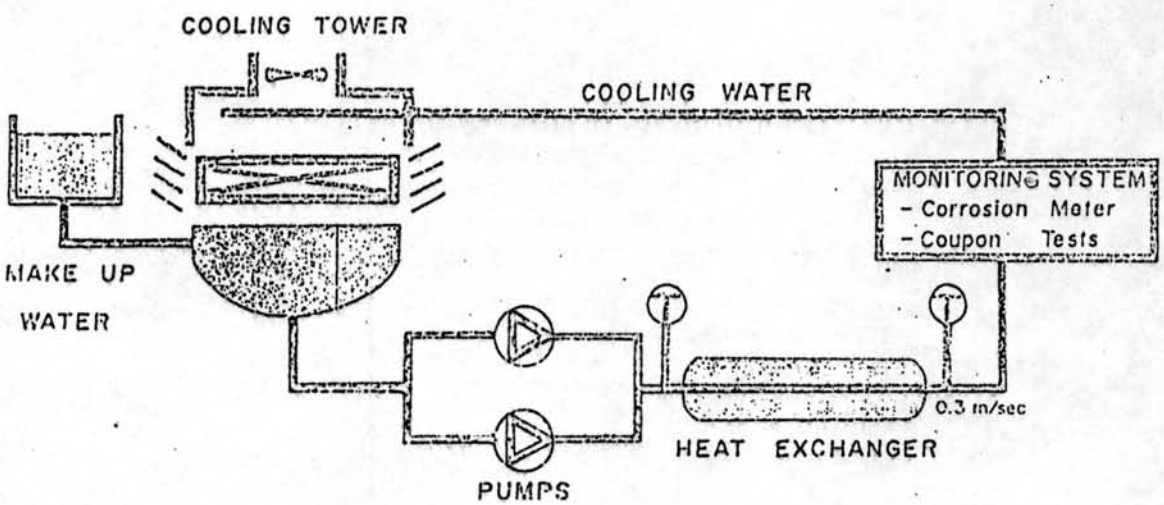

Fig 3.5 Open recirculating cooling water treatment systems

together with main test conditions. The heat exchanger electric heater contained an aluminium brass tube which was 620 mm long, 19 mm outside diameter, and 2 mm thick, with its total heat transfer surface area of 400 cm^2. In operating the cooling tower systems model, clearwell water from MAE MOH POWER PLANT UNIT 4, 5 and 6, 7 was used as make-up water and the cycle number of recirculating water was controlled at 6-7. Corrosion Test Rack contained coupon test pieced and linear polarization probes on-line monitoring which were mild steel and copper/nickel. Flow rate of recirculating water was 5 l/min (0.30 m^3/hr). Tests No. 1-3 were conducted as follows:

Test 1

- Old treatment program of MAE MOH POWER PLANT

scale & corrosion inhibitor	=	5 ppm base on make-up water
biocide (Glutaraldehyde)	=	50 ppm base on system volume once a week
chlorine	=	Total Residual Chlorine 0.5-1.0 ppm two hours per day
Time	=	30 days

Test 2

- Sodium hexametaphosphate (SHMP) and Phosphono-phosphino-maleic acid co-polymer were scale and corrosion inhibitor

SHMP = 2.5 ppm base on make-up water

PPMC = 4.5 ppm base on make-up water

biocide (Glutaraldehyde) = 50 ppm base on system volume once a week

chlorine = Total Residual Chlorine 0.5-1.0 ppm two hours per day

Time = 30 days

Test 3

- Sodium hexametaphosphate (SHMP) and Acrylic-2-Acrylamido -2 Methyl propyl Sulfonic acid co-polymer (AA/AMPS) were scale and corrosion inhibitor

SHMP = 2.5 ppm base on make-up water

AA/AMPS = 3.5 ppm base on make-up water

biocide (Glutaraldehyde) = 50 ppm base on system volume once a week

chloride = total Residual Chloride 0.5-1.0 ppm two hours per day

Time = 30 days