Major components of hvac system engineering essay

The Mechanical and Electrical Division of ETA ASCON Group has been a forerunner in the field of electromechanical contracting in the UAE for over 25 years. ETA M & E has established itself as a symbol of quality and innovation. Customers of ETA M & E are guaranteed and satisfied with the competitive service packages. M & E division is dedicated to quality of workmanship and investment in " state of the art" technology for the Client's benefit.

The division offers a wide range of services including supply and installation for the following system:

Air Conditioning Systems

Electrical Systems

Sanitary Systems

Plumbing Systems

Fire Protection Systems

Kitchen Systems, and

ELV Systems such as:

Security system

Telephone PABX System

CO Detection system

Fire Alarm System

PA/BGM System

CCTV System

Building Management System

Door Access control System

M & E provides system integration and inter operability for all these systems.

M&E compliments the skills of its staff by using the latest technology. For accurate design, the design and engineering wing is equipped with a modern Computer Aided Design (CAD) system and drafting facilities. M&E have done projects for a number of prestigious buildings both commercial and residential, hotels, shopping malls, banks, cinemas, hospitals, universities, Airports, Railways/Metro stations, IT Parks, communication and Industrial Projects.

M&E has capacity and capability to handle projects of any magnitude and stand on commitments towards satisfying client's requirements. M&E has also extended its operation in Egypt, Kuwait, Qatar, Yemen and India. [1]

Quality Awards

M&E is the first electro-mechanical company in the UAE, who have been awarded

ISO 9001-2000 certification by LRQA.

Dubai Quality Appreciation Program, Dubai.

Sheikh Khalifa Excellence Award, Abu Dhabi.

ISO certificate: M&E Division is the first MEP Contracting Company in UAE, to receive the ISO 9001-2000 Accreditation for International Quality Project Management by Lloyd's Register Quality Assurance Ltd, UK.

Dubai Quality Award 2002: The first Electromechanical Company in the UAE to be awarded with the prestigious Certificate of Appreciation under the Dubai Quality Appreciation Program Award 2002 instituted by the Government of Dubai and presented by H. H General Sheikh Mohammed Bin Rashid Al Maktoum, Crown Prince of Dubai and Defence Minister of UAE.

Sheikh Khalifa Award 2002: The first Electromechanical Company in the UAE to win the coveted Quality Appreciation Certificate Fourth Cycle (2002-2003) under Sheikh Khalifa Excellence Award Committee instituted by Government of Abu Dhabi. [1]

Listing few of the projects executed:-

Hotels, Shopping Malls & Cinemas

Conference Palace Hotel, Abu Dhabi.

Emirates Tower Hotel, Dubai.

Sofitel Hotel, Sherm-el-Sheikh, Cairo.

Al Ghurair City, Dubai.

Deira City Centre, Dubai.

Cineplex & Cine Star, Dubai.

Commercial and Residential Buildings, Banks & Airports

Dubai Internet City.

Dubai Media City.

Dubai Marina.

21st Century & Capricorn Towers.

First Gulf Bank & National Bank of Abu Dhabi.

Dubai International Airport - Renovation & expansion of Terminal 1.

Emirates Engineering Centre.

Cargo Terminal & Customs Import Building, Sharjah International Airport.

Public Utilities, Hospitals & Industrial Projects.

Abu Dhabi Municipality Complex.

ETISALAT Building, Dubai & Al Ain.

Dubai Health Care City.

Sheikh Zayed Cricket Stadium, Abu Dhabi.

Kalba Hospital.

New Medical Centre.

Oilfield Extraction Plant, Jebel Ali.

ENOC Processing Plant, JAFZA.

Caterpillar Logistics, Jebel Ali.

Neo Pharma, Abu Dhabi.

Central Plants & Industrial Kitchens

Central Chiller Plants for Emirates Tower, Dubai Marina and Deira City Centre.

Industrial Kitchens for Conference Palace Hotel and Emirates Tower.

The division's activities have expanded to retail trade, sale of equipment through showrooms, turnkey projects, maintenance service contracts and re-export to other countries.

Other prestigious projects executed are:

Emaar properties.

Dubai Police Projects.

Al Maha Resort.

Palm Island sales office.

All EMARAT, ENOC and EPPCO filling stations in UAE. [1]

Chemical Treatment/Dosing System

The function of heat rejection system in air-conditioning installation is to reject heat to the environment. Cooling towers and evaporative condensers cools the warm water by allow direct contact between atmospheric air and the water. Because of the large volume of air, organic material and other debris can be accumulated. It is recommended that the system be maintained clean and a suitable water treatment program be used.

Chemical Dosing is such a chemical treatment system that injects a dosage chemical solution into a process.

HVAC System

2. 1 INTRODUCTION

HVAC stands for the closely related functions of " Heating, Ventilating, and Air Conditioning"- the technology of indoor environmental comfort. HVAC system design is a major sub discipline of mechanical engineering, based on the principles of thermodynamics, fluid mechanics, and heat transfer.

HVAC is particularly important in the design of medium to large industrial and office buildings such as skyscrapers and in marine environments such as aquariums, where safe and healthy building conditions are regulated with temperature and humidity, as well as " fresh air" from outdoors.

2. 2 Major Components of HVAC System

2. 2. 1 Cooling Towers

Fig 2. 1 Cooling Tower Operation

2. 2. 1. 1 Operation

Cooling tower systems reduce the temperature of water by conduction and evaporation.

Conduction is directly proportional to the amount of water - air surface interface and the difference between the water temperature and the ambient air dry bulb temperature. This sensible heat transferred by direct air contact amounts to 1 Btu for each pound of water cooled 1o F. Heat transfer by evaporation is proportional to the difference between the water temperature and the ambient air wet bulb temperature. Approximately 1, 000 Btu's of heat are removed when one pound of warm water is evaporated. This latent heat is given up by the recirculating water, thus lowering its temperature.

In practice, warm process water is pumped to the upper portion of the tower above the fill where it enters distributors which spread the water evenly over the fill. The water cascades downwards as droplets and is collected in the basin for use in the cooling system.

Heated water is returned to the tower for cooling and reuse.

2. 2. 1. 2 Types of Cooling Towers

The two major categories of cooling towers are the natural draft and mechanical draft.

Natural draft towers can be further sub-divided into atmospheric and hyperbolic towers. Natural draft towers maintain a flow of air upward through the tower because the cool, heavy air at the bottom forces the lighter, water saturated air out the top. Considerable windage is required to obtain full heat transfer with this type of tower. Hyperbolic towers utilize their great height, which provides a

chimney effect, to move large volumes of air upward through the tower.

Mechanical draft cooling towers use fans to control the airflow.

When fans are located at the air entrance at the base of the tower, it is called a forced draft tower; when fans are located at the top of the tower, it is called an induced draft tower.

2. 2. 2 Chillers

2. 2. 2. 1 Operation

Fig 2. 2: Chiller Operation

A chiller is a machine that removes heat from a liquid via a vapor-compression or absorption refrigeration cycle. A vapor-compression water chiller comprises the 4 major components of the vapor-compression refrigeration cycle (compressor, evaporator, condenser, and some form of metering device). These machines can implement a variety of refrigerants. Adsorption chillers use municipal water as the refrigerant and benign silica gel as the desiccant. Absorption chillers utilize water as the refrigerant and rely on the strong affinity between the water and a lithium bromide solution to achieve a refrigeration effect. Most often, pure water is chilled, but this water may also contain a percentage of glycol and/or corrosion inhibitors; other fluids such as thin oils can be chilled as well.

In air conditioning systems, chilled water is typically distributed to heat exchangers, or coils, in air handling units, or other type of terminal devices which cool the air in its respective space(s), and then the chilled water is re-circulated back to the chiller to be cooled again. These cooling coils transfer sensible heat and latent heat from the air to the chilled water, thus cooling and usually dehumidifying the air stream. A typical chiller for air conditioning applications is rated between 15 to 1500 tons (180, 000 to 18, 000, 000 BTU/h or 53 to 5, 300 kW) in cooling capacity. Chilled water temperatures can range from 35 to 45 degrees Fahrenheit or 1. 5 to 7 degrees Celsius, depending upon application requirements.

Fig 2. 3 Chiller

2. 2. 1. 2 Types of Chillers

Water chillers can be either water cooled, air-cooled, or evaporatively cooled.

Water-cooled chillers incorporate the use of cooling towers which improve the chillers' thermodynamic effectiveness as compared to air-cooled chillers. This is due to heat rejection at or near the air's wet-bulb temperature rather than the higher, sometimes much higher, dry-bulb temperature. Water cooled chillers are typically intended for indoor installation and operation, and are cooled by a separate condenser water loop and connected to outdoor cooling towers to expel heat to the atmosphere.

Evaporatively cooled chillers offer efficiencies better than air cooled, but lower than water cooled.

Air Cooled and Evaporatively Cooled chillers are intended for outdoor installation and operation. Air cooled machines are directly cooled by ambient air being mechanically circulated directly through the machine's condenser coil to expel heat to the atmosphere. Evaporatively cooled machines are similar, except they implement a mist of water over the condenser coil to aid in condenser cooling, making the machine more efficient than a traditional air cooled machine. No remote cooling tower is typically required with either of these types of packaged air cooled or evaporatively cooled chillers.

2. 2. 1. 3 Chiller By-Pass Operation

Fig 2. 4 Chiller By- Pass Arrangement

In order to economize on the power consumption of a chiller, these units are sometimes by-passed and shut down during the early part and the latter part of the air-conditioning season.

As indicated, connections on the hot and cold side of the chiller circulating water are made to the hot and cold side of the cooling tower circulating water and isolating valves are added.

During the early and latter parts of the air-conditioning season, the chiller is isolated and shut down, thus allowing the cooling tower to provide cooling for the air-conditioner.

As the system cooling load increases, the cooling tower may not have the capacity to remove the required amount of heat. During these periods, the cooling tower is isolated and the chiller is brought into operation.

CHEMICAL DOSING

3. 1 Introduction

Chillers represent a substantial capital investment and are a major contributor to operating costs in institutional and commercial facilities. For many organizations, chillers are the largest single energy users, and comprehensive maintenance is critical to ensure their reliability and efficient operation.

While some organizations use predictive maintenance - including vibration analysis, infrared thermography, and rotor bar testing - to diagnose problems in advance, a comprehensive preventive maintenance (PM) plan remains the key to ensuring the best performance and efficiency of a chiller.

Chemical Dosing System is a chemical treatment system that injects a dosage chemical solution into a process. A condition of the process is sensed by a sensor, communicated to a controller and used as a basis for varying in real time the dosage of the chemical solution. The sensor, the controller, a pump and the process are disposed in a closed control loop. The controller controls the operation of the pump (speed, duty cycle and the like) to vary the dosage based on the sensed condition, which is disclosed as a corrosion and/or scale of an element of the process, although other conditions can control the dosage as well.

There is a need for a chemical treatment system and method that overcome the above mentioned problems for the control of corrosion and scale.

3. 2 Major Components

A chemical treatment system of the present invention injects a chemical solution into a process. The chemical treatment system comprises

A chemical tank containing the chemical solution.

A pump is disposed to provide a dosage of the chemical solution from the tank to the process.

A sensor and a controller are disposed in a closed loop with the process and the pump to vary in real time the dosage of the chemical solution provided by the pump based on a condition of the process sensed by the sensor and communicated to the controller.

A dosing pot

Stirrer (Agitator)

Interconnecting Piping Instruments like Pressure Gauges, Level Gauges, Level Switches, PRV

3. 2 Operation of Chemical Dosing System

Chemical injection systems range from simple self-sufficient/self monitoring chemical dosing systems with small tanks, to multichemical injection systems, controlled by process feedback via programmable logic controllers (PLC's). Regardless of the application, dosing systems are usually designed to operate with minimum possible use of pre and post treatment chemicals. They are inherantly chemical-lean and only use what is necessary to make minor adjustments to the balance and nature of constituents in the feed and product water.

A water treatment system that relies on the extremely efficient use of chemicals, reduces operating costs, environmental impact and, in many cases, reduces or eliminates the need for waste disposal.

In the pneumatic area of the pump, the compressed air produces a diaphragm's movement that pushes out the liquid through the delivery hose. The vacuum created by the diaphragm movement takes the liquid inside the pump head from the suction hose.

3. 3 Advantages of Chemical Dosing:

Low Capital Cost Pre or Post Treatment of Process Water

Small Space Requirements

Low Operating Cost

Extremely Important Component of Pretreatment Strategy for RO

The Larger the Water Demand from and RO, the more likely that Chemical Dosing will be the most Cost-effective Choice

MAJOR CAUSES OF DAMAGE & THEIR TREATMENTS

Depending on the design and location and water Chemistry, water treatment program may include some or all of the following:

1) Corrosion Inhibitor

2) Dispersant

3) Biocide

4) Scale Inhibitor

4. 1 Corrosion

4. 1. 1 Introduction

Figure 4. 1: Corroded Surface

Corrosion is an electrochemical reaction converting the metal into its oxide. Corrosion requires an anode, cathode & an electrolyte. The metal acts as an anode & cathode while water acts as an electrolyte.

4. 1. 2 Factors affecting the rate of Corrosion

a) Metallurgy of the system

b) PH of circulating water

c) Dissolved gases

d) Dissolved and suspended solids

e) Water velocity

f) Temperature

g) Microbial growth

Figure 4. 2: Under Deposit Corrosion View after Cleaning

4. 1. 3 Important types of Corrosion frequently found in Cooling Water Systems

a) General type of corrosion

b) Localized corrosion

c) Corrosion due of velocity

d) Corrosion due to mechanical stress

4. 1. 4 How do Corrosion Inhibitors work

Figure 4. 3: Basic Process

The Corrosion Inhibitors present in Water Treatment Chemicals form the passivation film on the metal surface. Thus this surface is impervious to ions transfer or oxygen attacks and this barrier is arresting the corrosion.

As the film is very thin, it in no way affects the heat transfer.

Inhibitor dosage systems therefore use a water meter in the make-up supply to the cooling tower to operate chemical dosing pump to add chemicals in direct proportion to the make up water flow.

4. 2 Scaling

Figure 4. 3: Scaling

4. 2. 1 Introduction

Scaling is defined as the hard and adherent deposits formed due to precipitation of sparingly soluble salts in water. The most commonly occurring scalants in cooling water systems are carbonates, sulphates, phosphates and silicates of calcium and magnesium.

Scale Deposition:-

The scale deposits give rise to the following problems in cooling water systems:

a) Reduced heat transfer decreasing the heat transfer efficiency.

b) Increased pressure drop on water side.

c) Under Deposit Corrosion.

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a) Reduced heat transfer decreasing the heat transfer efficiency.

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Following are the factors which affect the scaling in cooling water system:-

a) Temperature

b) pH

c) Solubility

4. 2. 2 How do antiscalants work

For scaling to form, the crystal of scaling salt has to grow sufficiently in size.

When the crystal is growing the Antiscalant is absorbed on the crystal, blocking the growth site. Thus the crystal cannot grow in size. Even it the crystal grows, it is imperfect and the structure is very fluffy. The small or fluffy crystals cannot form hard deposits hence Scaling does not occur. In presence of Antiscalant, the metal surface remains free from Scaling.

The Antiscalants inhibit scale formation by increasing the solubility of scalants in water and help to remain higher levels of scalants in dissolved form.

Figure 4. 4: Electron Photomicrographs showing scale without antiscalant

Figure 4. 5: Electron Photomicrographs showing scale with antiscalant

4. 3 FOWLING

Figure 4. 6: Fowling

4. 3. 1 Introduction

Fouling is the deposition of suspended particles. The particulate matter generally accumulates at low velocity areas in the cooling water system. If cooling water is on the shell side of the heat exchanger then because of low velocity the fouling material settles on the shell side

4. 3. 2 Potential Foulants in Cooling Water System

a) Dust and silt.

b) Corrosion Products.

c) Sand

d) Natural organics

e) Microbial matter

4. 3. 3 Factors Affecting Fouling of the system

a) Water characteristics

b) Temperature

c) Water velocity

d) Microbial growth

4. 3. 4 How do Antifowlants work

Figure 4. 7: Working of an antifoulant

For fouling to take place, small suspended particles have to come together to form Agglomerate. Most of the suspended matter is in the colloidal state and have a small electric charge on them.

ANTIFOULANT is polymeric in nature and when it is absorbed on suspended particles, it will increase the negative charge on the particle. As like charges repel, the suspended particles are thus kept apart, preventing their agglomeration. The particles thus stay dispersed in the water and are prevented from depositing and fouling the system.

4. 4 Microbial Growth

4. 4. 1 Introduction

Cooling water gives the excellent conditions for growth of various microorganisms. The temperature and pH of circulating water are ideal conditions for the growth of algae and various bacteria's. Also the organic matter, inorganic salts, sunlight etc. provides abundance of nutrients for the growth of these microorganisms. Following are the problems faced because of various microorganisms:

4. 4. 2 Major Microbes

4. 4. 2. 1 Algae:

Figure 4. 8: Algae

Air, water & sunlight are the three basic requirements for algae growth. Excessive growth of algae on the deck of cooling tower can choke the distributor nozzles and reduce the water flow through cooling tower thus reducing its efficiency. Excessive growth on the louvers, fill material increases the load on structure and may cause the failure of structure. Algae mass can also get carry into the heat exchangers and plug the exchanger tubes.

4. 4. 2. 2 Bacteria

Figure 4. 9: Bacteria as seen under an microscope

There are various species of bacteria found in cooling water system.

Common Cooling Tower Bacteria:

I Pseudomonas: These are aerobic bacteria, which secrete slime. This slime acts as a binding material and fouls the System.

II Sulphate Reducing Bacteria: These are anaerobic bacteria which reduces sulphate ions to sulphides. These bacteria grow under the deposits and yields under deposit corrosion.

There are also other aerobic bacteria like nitrifying bacteria, which reduces the pH of circulating water and iron bacteria and sulphur oxidizing bacteria which hamper the efficiency of the system.

4. 4. 2. 3 Biocides

Biocides are chemicals that interfere with basic life process of a cell.

Figure 4. 10: Biocides

Biocides act as a poisonous material to the Algae cells. They will either rupture the cell wall or get into the cell and damage the metabolism inside the cell.

Biocides kill Algae in few days of time. Regular dosage of Biocides will not allow Algae to grow, once destroyed. Killing of Algae is the visible sign of the action of Biocides as the dead Algae will turn from Green to Yellowish-brown.

However, if initial growth of Algae is very high, it will be desirable to clean the Algae manually as much as possible. Otherwise, there is a chance of dead Algae becoming a large mass of foulants in the water and chocking the strainers in the pipelines.

Two options are available:-

Non-Oxidising Biocides - Normally shot dosed on an alternating basis, usually once or twice per week using timer controlled dosing pumps. Typically, non-oxidising biocides require a contact time of 4 hours at a set concentration to destroy bacteria. As previously indicated, where conductivity bleed-off systems are fitted a bleed lockout system is required to prevent dilution and loss of biocide to bleed-off.

Oxidising biocides - Chlorine or Bromine. Chlorine should only be used where pH levels are between 6. 5 and 7. 8. At higher pH, chlorine is relatively unreactive and a poor biocide. Its use is therefore confined to industrial cooling towers incorporating pH control. Bromine is effective at pH levels up to 9. 0, above which its biocidal effect drops significantly requiring excessive dosage rates.

Oxidising biocides are normally dosed continuously at a low level to maintain a set disinfectant level in the recirculating water. The level of disinfectant can be monitored electrically using Redox (Oxidation Reduction Potential - ORP) or a specific chlorine monitor. Because of their cost and sensitivity to contamination specific chlorine or bromine monitors are rarely used.

Redox (ORP) control measures the oxidation and reduction potential in millivolts in the water over a range of 0 to 1000 mV. This is related to the level of bromine oxidant present and uses simple technology similar to pH measurement. Whilst Redox is affected by changes in pH this has no significant effect on their performance in cooling water treatment as most cooling towers operate at a stable pH level.

CHEMICAL TREATMENT IN COOLING TOWERS

Water related problems associated with the operation of cooling towers include:

Corrosion

Fouling

Scaling

Microbiological growths.

The first element of cooling water treatment is the control of cycles of concentration, resulting from evaporative losses, by regulating the bleed or blowdown from the system. Target cycles of concentration are determined by calculating the Ryznar Index, the value of which is a function of the make-up water characteristics. Actual cycles of concentration are calculated usually by comparing the concentration of chlorides in the make-up water to the

concentration of chlorides in the recirculating water. Proper control of cycles of concentration reduces both scaling and corrosion.

A second element of cooling water treatment is the maintenance of a protective concentration of corrosion inhibitor. This inhibitor is commonly in the form of chromate, phosphate, zinc, or proprietary compound, the concentrations of which are largely dependent on the characteristics of the make-up water.

Feed of sulfuric acid, used to control the scaling or fouling nature of the circulating water, is a frequent third control element. Feed of chlorine and/or biocide, used to eliminate micro-biological activity is the fourth control element.

CHEMICAL TREATMENT IN CHILLERS

Water related problems associated with the operation of Chillers include:

Corrosion

Fouling

Scaling

The chilled water loop, which operates both internally and externally, to the chiller should be considered as being a closed cooling water system which has a negligible amount of make-up.

Chemical treatment to combat problems of corrosion and fouling include filling the system with water having a pH within the range of 7. 0 to 8. 5, and maintaining a residual of sodium sulfite at 20 - 60 ppm.

The condenser cooling water, if " once-through", is not normally chemically treated.

DESIGN ANALYSIS OF CHEMICAL DOSING SYSTEM OF CHILLER & CONDENSER WATER STREAMS IN A SHOPPING MALL

8. 1 Description of the Location of the Design System

The Chemical Dosing System is to be designed for Shopping Mall is located at a premier location in the city with a built up area of 269000 sq meters accommodating 428 shops including line shops, Food & Beverage Outlets. The facility has an Energy Center of 2300 sq meters which houses all the major equipment for MEP Services such as six Centrifugal Chillers, 6 Cooling Towers, 6 Primary Chilled Water Pumps, 6 Condenser Water Pumps, Transfer Pumps etc.

Chilled Water System

The chilled water primary system of the mall caters the chilled water from energy centre to different pump rooms located at roof via 6 no's. Primary pumps.

The primary - secondary interfacing includes DPCV, motorised valves, commissioning sets and a by pass, all the valves are located inside the individual pump rooms.

The primary header size varies from 1000mm-400mm all over the roof.

The secondary pumps circulate the water to the entire mall from 8 different pump rooms located at roof.

Condenser Water System

The condenser water system consists of two independent networks.

Condenser Circuit I consists of 3 Nos. condensers & 3 Nos. cooling towers.

The Condenser Circuit II consists of 4 (3+1Future) condensers & 4 (3+1Future) Cooling towers.

Type of Design

For complete water treatment program to be fully effective, correct chemical dosing is required. If treatment levels are too low, then scale and corrosion and fouling may result. Unfortunately, manual dosing is quite unreliable but better results are achieved by automatic dosing which maintains a high level of accuracy.

Automatic Controller is complete with fully automatic controller, dosing pump, chemical tank, suction & discharge fittings, tubing, conductivity measuring cells and cell connector etc.

8. 3 Design Considerations

The sketch above shows a typical arrangement for a chemical dosing system.

The following are the main components of a system.

8. 3. 1 Dosing Tank

The dosing tank should be sized to hold sufficient chemical for the system to operate between regular maintenance checks. Most membrane systems are monitored at least daily, therefore these tanks could theoretically be sized to hold 24 hours supply. However, providing good housekeeping is practiced, the chemical may be stored in the tank for many weeks without detriment to the chemical or its effectiveness.

The tank should be provided with a close fitting lid to prevent dirt ingress to the tank. Overflows and drains should be directed to the chemical waste system, or to a bund from which any waste can be handled correctly. The most common materials for the tanks are plastics, particularly high-density polyethylene.

If the sizing of the dosing pump has necessitated the dilution of the chemical, the tank should permit some method of mixing the antiscalant with the dilution water. A hand operated paddle mixer is the most normally employed, as the required mixing energy is very low and once fully homogenised the solution will not separate and therefore will not require further mixing.

Dosing tanks should be maintained in a clean condition. This is especially important where dilute chemical is applied and it is suggested that the dosing tank is cleaned out every 6 months to prevent bacterial growth. Alternatively, a preservative could be added

to the solution.

8. 3. 2 Dosing Pump

The dosing pumps should be sized to allow the specified dose at between 40 - 80% of the capacity of the pump. This will allow the dose rate to be increased should the water quality change, and it is necessary to change the dose rate.

The majority of membrane systems operate at constant or near constant flow rates, and therefore most chemicals are dosed at a fixed rate. If the flowrates are to vary by more than 20%, then it may be necessary to vary the dosing rate with the flowrate to the membrane system. The dosing pump should be designed to give as smooth a flow of chemical to the plant as possible. With positive displacement dosing pumps regular pulses of chemical are preferred - generally the pulse should operate at an absolute maximum of 5 second intervals. Care needs to be taken to prevent siphoning of the chemical tank contents during dosing pump shutdown periods.

8. 3. 3 Mixing

It is not normally necessary to make special arrangements for the mixing of antiscalants, coagulants, biocides or mineral additives into the main process stream as all are very miscible with water.

8. 3. 4 Calibration Tube

Although a good approximation of the dosing pump delivery rate can be made by reference to the pump curve, it is strongly recommended that a calibration tube is fitted to the suction side of the pump to allow the dose rate to be calculated exactly.

Dosing errors occur when chemical feed pumps are not calibra