

CHAPTER 3

General Study of Water Treatment Project Management

3.1 General

3.1.1 Water source and characteristic

Water is an important factor for all industrial fields because it will be used as the utility such in the production (e.g. rinsing the component) or in the general use (e.g. cooling tower and boiler feed). Thus the water, various from one place to another, must be treated before use. Basically, there are two main sources: deep well water and surface water. Having the different specific nature, the process to treating them will be different.

Water source

1. Surface water

Surface water includes rivers, lakes, ponds, and stream. Usually surface water contains lower mineral contents than deep well water but it contains more oxygen, organism, and suspended solids and exhibit lower clarities.

2. Well water

Well water mostly found the iron and manganese present as soluble ferrous and manganese ions. Groundwater is more clarity than surface water.

In the general water, the characteristic of water comprises two charged ions: cation and anion. Cation or positive ion consist of calcium, magnesium, sodium, and potassium ion whereas negative ion consist of bicarbonate alkalinity, sulfate, chloride, phosphate, nitrate, and free carbon dioxide. The different areas cause the number of each ion different, accordingly. As results, treatment process will be selected by specific requirement to removing any ions.

3.1.2 Water Treatment System

XYZ company offers a board range of experience and expertise in water and wastewater treatment system design, manufacture, installation, commissioning and maintenance. A team of specials who collectively cover all aspects of water chemistry techniques and environmental and chemical engineering are readily available to help our customers resolve all types of water and wastewater treatment problems. An XYZ designed system comes complete with the necessary instrumentation and safety devices. XYZ specials in the following areas:

1. Ultrapure Water

This is the system that using state-of-the-art equipment and techniques for the water fabrication and semiconductor industries. It is designed to produce ultrapure water incorporates a combination of pretreatment process including, reverse osmosis, deionisation, microfiltration, ultrafiltration, ultraviolet irradiation and ozonation. The system design ensures efficient removal and control of the total ionic content, particle count for a given size, total organic carbon, bacteria levels, dissolved oxygen and silica.

2. Pharmaceutical and Haemodialysis Grade Water

This is the system that to be used for drug and intravenous solution formulation aids which surpass the standards set out in the national pharmacopoeias for “purified water” and “water for injection”. The systems include similar process used in the production of ultrapure water with special controls for bacteria and pyrogens.

3. Desalination

XYZ offers both hollowfibre and spiral wound reverse osmosis membranes for desalination of brackish water or sea water. Reverse osmosis is used in a board spectrum of potable, industrial and specific water desalination applications. Hybrid membrane systems based on RO technology are also available for process recovery applications.

4. Potable Water and Pretreatment

XYZ offers a broad range of clarification and filtration processes to produce potable water and as a pretreatment for industrial requirements. Whether our customers need to remove and control turbidity, pH, suspended solids, color, iron, bacteria, cysts, other organic matter or chlorine, a XYZ system is designed to minimize pressure drops and ensure high removal efficiency.

5. Process Purification

XYZ offers a system for the purification of fluids through the use of catalysis, chemical reactions and filtration.

3.2 Process and equipment package for water treatment plant

3.2.1 Water Treatment Process

1. Multimedia Filter

Process description

The purpose of multimedia filter operation is removing suspended particulate matter from the raw water. Typically, there are three layers of media to be selected for their particle size, specific gravity, and proven ability to trap particles of specific size ranges. The top layer is for trapping the larger particles and debris, the middle layer is for trapping coarse and intermediate size particles, and the bottom is for trapping particles as small as 10 microns. Hence, water flows through the sand bed will encounter the layer that the porosity will be gradually decreased. As a result, the water can function effectively in trapping particle sizes.

This process is an efficient means of providing high clarity water for direct use as pretreatment of the other systems, e.g. water softener, deionization, and Reverse Osmosis.

2. Activated carbon Filter

Process Description

The main purpose of the activated carbon filters is to remove free chlorine, tastes, color, and odor in the raw water. Basically, the activated carbon filter has three main actions for the treatment of industrial process water: physically, as an adsorbent, and as a catalyst. The physical operation of the carbon is removing suspended solids although it may cause the performance of others actions declination. In the action as an adsorbent, the carbon will adsorb the organic matter in the solution. And the final action, as a catalyst, the carbon will reduce the excess chlorine and generate HCl and oxygen.

3. Water Softener

Process Description

A water softener is an ion exchange process, which use strong acid cation exchange resin to remove calcium and magnesium from raw water by replacing positive charged ions with sodium. This resin has a higher selectivity for hardness ions than the sodium ion. The procedure of water softener consists of four steps: service, backwash, regeneration, and rinse.

Therefore, during the service stage the following reaction will occur:



However, the ion exchange resin can return to the predominant sodium form by the use of 10% NaCl solution. The reaction will occur as follow:



4. Reverse Osmosis system

Process Description

With the basic osmosis phenomenon, a semipermeable membrane will separate water or dilute solution from a more concentrate solution. Water molecules have a stronger tendency to escape from water than from a solution. Water, therefore, will pass through the membrane from the dilute side to the concentrated side in an effort to equalize

the osmotic pressures of the two solutions. On the other hand, with the reverse osmosis phenomenon, the dilute water would be forced through the membrane from the concentration side to the dilute side by the impression of osmotic pressure upon the concentration side.

5. Demineralization

Process Description

As well as water softener process, demineralization is an ion exchange process. But the exchange resin to be used are both cation and anion resin, thus all charge ions in the water will be removed. In the typical operation, the individual cation-exchange resin bed is the first ion exchange unit the water encounters. The cations (e.g. sodium and calcium) will be removed by the exchange with hydrogen ions from the resin. The water outlet from cation resin will be acidic. Decationized water flows through the anion exchange resin bed to remove hydroxyl ion such as sulfate and chloride ion. The emerging solution is pure water.

Finally, individual water treatment process can be combined with others to creating water treatment system: for example the ultrapure water system must use Multimedia and Activated Carbon filter as pretreatment and use Reverse Osmosis unit to producing pure water. The final operation use Demineralization unit in creating high pure water (Resistivity more than 1 megaohms-cm)

3.2.2 Equipment and Instrument Required

1. Pumps

In water treatment plant, there are numerous types of pump to be used for transferring the raw water to the process or dosing chemical to the process (e.g. centrifugal, metering, and positive displacement). Typically, the selection of pump is depending on the application; for example if the system requires a pump to draw the raw water into the filter tank, centrifugal pump will be chosen. Further, centrifugal pump can be categorized to single stage and multistage centrifugal pump (Vertical and Horizontal). In addition, single stage centrifugal consists of end suction and self-priming. Because of

having more production line of pump, in this research will describe only the pump that mostly installed in the water treatment plant.

The following pumps are selected to use in most process.

- End suction pump
- Split case pump
- Chemical pump

Material of pump part is also an important criterion in the selection of pumps. If the application is for drinking water, only stainless steel part, contact with the water, will be used. The general pretreatment plant will use cast iron component because it is available, low cost, and more manufacture produce.

2. Storage tank

It is necessary for most water treatment plant requires the storage tank to contain either raw water, in process water, or treated water. In addition, chemical storage tank is also needed in containing several chemicals. Storage tank will be selected according to its application and customer requirements. Material of storage tank to be used as raw water storage is Fiberglass Reinforce Plastic (FRP) since its weight is lighter, its cost is cheaper, and its strength is heavier than others materials. Sometimes, the concrete tank is constructed for storing the raw water, if the area is no strict.

For the treated water storage tank, the material to be selected is either FRP or stainless steel, depending on the customer production line. In foods and beverages industrial, most of them require 304 or 316-grade stainless steel only because the treated water will be blended with the crude material in producing some foods or beverages.

In providing the day tank of all chemicals, polypropylene is properly material to be used. This is because its property can resist more varieties of chemicals, the cost is low, and the weight is light. Anyway, there are more industrials use the chemical in their process, thus the vast storage tank is needed to store such chemical approximately 1 month. With this application, Fiberglass Reinforce Plastic, Bisphenol resin type, is appropriate material.

3. Pressure filter vessel

Both Filtration and Ion exchange processes require the pressure filter vessel to containing the filter media such as sand, anthracite, carbon, and ion exchange resin. Most of vessel will be fabricated by mild steel. For the filtration process, vessels are internally coated with epoxy and externally painted with zinc rich primer. And for the ion exchange process, deionization, the internal of tank must be lined with hard rubber in order to resisting the acid and caustic applied during the regeneration process. However, stainless steel material can replace the mild steel in some case of the customer requirement.

FRP pressure vessel, imported product, can be used instead steel tank conform to the customer requirements. This vessel is light weight, strength, and less corrosion for outdoor application.

4. Control valve

Control valve is used for controlling the direction of the water in the procedure of each process. For example the procedure of multimedia filter process consist of service, backwash, and rinse. The direction of the water in service stage is flow through form the top of the tank to the bottom and the direction of the water in backwash stage is flow upward from the bottom to the top. Therefore, control valve will permit the water flow through the pipe due to the direction of that stage.

There are more various types of valve to be used in water treatment process. They include ball valve, butterfly valve, diaphragm valve, globe valve, needle valve, and gate valve. The selection of each valve is depending on the application and its diameter; normally ball valve is used for general application, which the diameter of valve is equal to 2 inches or smaller for instance. If the system requires since 2 ½" inches diameter, butterfly valve will be the appropriate valve selected.

Either automatic or manual operation is a criterion in selecting the control valve type. For the automatic operation, diaphragm valve is proper since, in fact, automatic operation requires the accessory part, pneumatic or electric actuator, which total cost is lower.

5. Pipe

Pipe is a device used to transferring the water within the plant, from one tank to the next tank, and including transfer chemical from storage tank to the system. There are more piping materials to be used in water treatment plant. They include Polyvinyl Chloride (PVC) pipe, steel pipe, galvanized steel pipe, PP-lined steel pipe, and 304 or 316 stainless steel pipe.

PVC, UPVC or CPVC, pipe is a generally piping system to be used in several process and has outstanding feature that can replace other materials because of having more physical characteristics. The physical properties, for example, are has chemical resistance over a board range of concentrations and reagent mixtures, low heat transfer for good insulation quality, resistant to abrasion with slurries in complete suspension, etc. In addition, it is a low material cost, ease to work, ease to maintenance, and available.

Galvanized steel pipe and steel pipe are only used for pretreatment plant since they are limited by their physical properties. They can not be used with the process that must inject some chemical into the process. However, they are proper piping system used in case of large capacity requires the pipe diameter greater than 4 inches.

For the 304 or 316 stainless steel and PP-lined steel, they are less application use. Only the demineralization plant, which all pipes must contact with acid and caustic, requires using such pipes. These materials are high cost, not available, long lead-time, and difficult to install. Anyway, 304 or 316 stainless steel can use for drinking water system.