Introductions to Tap Water Purification Treatment System

A diagram of water treatment process :



Descriptions of water purification treatment equipment

1. Distribution well

Distribute raw water (reservoir, surface water or groundwater) to water purification equipments upon the water level of steady raw water, measure the function of raw water flow

2. Flash mixer

In order to absorb and agglomerate suspended solid of raw water, and add in PAC and other coagulants, to achieve a rapid mixing effect through mixture in various forms (hydraulic jump of density current or electric mixer).

3. Flocculation Basin (flash mixer)

- Flocculation particles (suspended solids absorbed by coagulants) is generated in the raw water after flash mixing (mix with medicine), to make small flocculation to gradually combine with bigger and heavier flocculation upon coagulation effect through flocculation mixing in terms of a speed from fast to slow.
- 4. Clarifier
- The raw water with flocculation to separate bigger flocculation particles and suspended solids in raw water through settling effect of density after enough retention time.

5. Rapid filter

- Remove the tiny suspended substance and microscopic organisms in the precipitated raw water through isolation, precipitation, absorption and chemical reaction effects of filter material, and to maintain the cleanness of filter material through backwash mechanism.
- 6. Clean water tank
- The primary function of clean water after rapid filtering that enter the clean water tank by Chlorine disinfection, is to sustain the regulation ability of water volume at water purification station and ensure retention time of Chlorine disinfection to foster disinfection effect

Descriptions of water purification treatment equipment

- 1. Sewage tank
- Collect the sludge and wastewater generated from flocculation tank, sedimentation tank, rapid filter, water purification process.
- 2. Primary clarifier of sewage
- Have the waste water collected from sewage tank delivered to primary clarifier, in which the supernatant can be reused after it was recycled through natural overflow after being separated by solid and liquid state, the bottom sludge will be centered to the outfall through sludge scraper and to be delivered to sludge recycling tank

- 3. Sludge thickening tank
- Have the sludge from sludge recycling tank separated by solid and liquid state again, the wastewater to have another treatment at wastewater tank through natural overflow, the bottom sludge to center on outfall through sludge scraper and deliver to sludge storage tank.
- 4.Sludge storage tank
- To have solidification and drying treatment on the collected sludge.
- 5. Dewatering equipment
- To rapidly dry the thickened sludge as sludge cake through various machinery dewatering devices to facilitate collection and disposal
- 6. Sludge cake storage tank
- A temporary storage space for sludge cake, which wait to be collected and disposed.

Water purification treatment process



The treatment process of tap water is divided into intake, conveying, purification and supply processes, in which intake refers to deliver the raw water to from water source to water conveying channel (intake point) by a manner of water pumping or natural gravity, while conveying is to have the collected raw water delivered to water purification station through water conveying channel. In which the raw water that enter water purification station will become the tap water after purification process, called purified water. Lastly, the water supply, a process of distributing the tap water to the location of the user through water pipe.

Trash rack. Grit channel. Water intake point

A trash rack is set at water intake point in order to hinder trash and branches, also, a grit channel is set in order to lower the speed of water flow and to conduct preliminary precipitation of sands with bigger and heavier particles. Have moderate raw water transported to distribution well of water purification station through water conveying channel afterwards.



Distribution well

A function to regulate water volume and water flow; have raw water after grit disposal distributed to various water purification treatment units. A dosing process will be conducted in this stage by partial water purification stations, add PAC or aluminum sulfate coagulant into the water after the quality of raw water is checked, make the miscellaneous substance in the water coagulated as small particles so as to facilitate subsequent clarification and filtering treatments for water purification ; add chlorine in the water to attain disinfection effect. Add NaOH to adjust the pH value of water quality to keep a neutral pH of water quality if necessary.



Flash mixer. Coagulation basin

A rapid stirring by mixing machine of raw water in the flash mixer enables a complete combination of residual impurity and medical additive, in which "particle" suspended particle is formed. A slow and continuous stir after particles suspended in the water enter the coagulation basin, will cause a collision and absorption between particles which gradually become bigger and heavier, a suspended substance called "flocculation" is formed and being adopted in the sedimentation tank again.



Sedimentation tank

After raw water coagulated flows through the front end of sedimentation tank, the impurities with bigger particle will precipitate to the bottom tank, be the inclined pipe with special design in the tank will increase a chance of collision between flocculation, in which the clean water on the upper layer will gather and flow to the rapid filter after the flocculation gradually precipitates through the inclined tube.



Rapid filter

the filter bed composed of Anthracite Coal, filter sand, gravel layer by layer in terms of particle size, there are channels in row on the filter bed, which allow a horizontal flow down gently. The tiny particles in the water to filter water with true purity and cleanness through isolation effect of sand layer of filter bad. A so-called "backwashing of sand" shall be conducted as the filter effect of filter layer will be reduced by impurities accumulated after for a period of time. Use strong water pressure to backwash the filter material from the bottom with clean water in order to remove the impurities in the filter layer to ensure good filter effect.



Clean water tank. Water pumping station

The clean water after filtering will have last disinfection, with chlorine added on the clean water tank, this is tap water that fully comply with drinking water treatment standards. The water pumping station is set above the clean water tank, which uses water pump to distribute the tap water to distribute the tap water to distribution reservoir through delivery pipe and then sub-distribute to the water tower of every household.



Sewage tank

The precipitated sludge and wastewater of sand filtering by backwash generated from water purification treatment process will all inject into the sewage tank, and then use sewage pump to deliver the sludge to sludge treatment plant. Have the sludge pressed as sludge cake in the sludge treatment plant through thickening and dewatering processes, then process the sludge cake through a manner of reuse, i.e. to turn the waste material into raw material, making water purification station a environmental-friendly industry with 0 pollution and emission.



Overview of Advanced Water Purification Station

What is advanced water purification treatment

- There is common glossary and definition about "advanced water purification treatment "in the world for now, e.g. "Advanced Treatment" or "Special Treatment" is named in Europe and USA, "height treatment" in Japan, "advanced treatment" in Mainland China while a term of "advanced tratement" which generally used in Taiwan is originated from "Advanced Treatment" commonly used in Europe and USA, which is in opposition to conventional treatment.
- The so-called "advanced treatment" reports no fixed treatment process, in which a comprehensive judgment of raw water, requirement for clean water quality after treatment, treating cost, land in use, environment, regulations etc. is normally, consisted of conventional water purification treatment unit and special treatment unit.

Why Advanced Treatment

- Remove biodegradable organic matter and inorganic matters which cannot be effectively removed by conventional treatment
- Reduce the damage of carcinogenic substance (THMs) caused by chlorine disinfection
- Satisfy the quality requirements of the public on mouthfeel, sense of tase.
- React to drinking water quality standard that get strict from time to time.

Process of Advanced Treatment

- Raw water >> Preozonation >> Coagulation/ sedimentation >> Softing >> Filtering >> Postozonation >> Absorpt ion by Active Carbon >> Disinfection >> Supply water
- Raw water Preozonation Coagulation/sedimentation
 Filtering Microfiltration Nanofiltration Disinfection
 Supply water

The Flowchart of Advanced Water Purification Station Treatment System





Sedimentation Behavior

Principle of sedimentation

- When water inflows a big tank with big section, the flow speed will be reduced while the water is at a static condition, in which the particle with higher mass density (comparing to peripheral liquid) will move downwards (sedimentation).
- On the contrary, those particles with lower mass density will move upwards (float). Therefore, the suspended particles in the water are scum formed on the water surface and sludge on the tank bottom and being separated from water, then the water them becomes clear.

Principle of sedimentation





Sedimentation



Inclined tube sedimentation tank in rectangular shape



Pulsatube

Structure of rapid filter

Filtering



Backwash



1.filter material-channels for
anthracite coal and sand2.channels for filtered water,
air and backwashed water3.outfall valve for backwashed water4. entrance orifice for cross
flow water5.V-shape channelflow water
6.channel for backwashed

wastewater discharge

Purpose of Filtration

Filtration is an unit operation by solid separation

Raw water to pass filter material interface with multiple holes in order to remove the tiny suspended particles



A continuous increase in water source loss will lead to difficult filtration, and will worsen the water quality of filtration



BACKWASH



Backwash a sand (air backwashing)



Backwash a sand (backwashing starts)



Backwash a sand (backwashing done)



Rapid filter

Oxidation of ozone

- Ozone is one of strongest oxidizers reporting disinfection, oxidation and dissolution of organic matters capabilities.
- Be able to disinfect, remove scale, stink, ferric oxide and Mn of raw water, facilitate coagulation effect and foster a function of granular activated carbon to absorb the pollutents.
- THMs caused by chlorine disinfection will be reduced.

Ozone generation system

Ozone generator



- Functions of preozonation
 - Remove algae
 - Oxidize organic mattes to remove stink and scale
 - Foster sedimentation effect

Ozone treatment equipment



Functions of postozonation
Remove biodegradable organic matter
(residual micro- insecticides, Phenol,
cleanser), which help reduce the
ingredients of Careinogen.
Reduce the forming of by-products caused
by chlorine disinfection, which help reduce
the ingredients of Careinogen.

Advanced water purification station~ report of ozone system

Overview of ozone system

- Ozone generation system
- Ozone contact system
- Ozone destruction system
- Case studies of ozone treatment

I.Overview of ozone system

(Pressure Swing Absorption / Vacuum Swing Absorption)



II.Ozone generation system-principles



• Ozone generation is a gas with oxygen molecule, what enables a division of oxygen molecule is oxygen atom, oxygen atom to combine with molecular oxygen and become ozone molecule

 $3O_2 \rightarrow 2O_3^-$

Ozone generation system-equipment



0,

Ozone generator

Dielectric

Cooling water Ground electrode Discharge Gap Dielectric

High Voltage Electrode

O₃

A reaction between ozone and chemical compound can be

divided into two paths

 \emptyset a direct reaction of ozone upon molecule

Ø Ozone to firstly decompose as free radicals, and to react indirectly upon free radicals, which is mainly the OH[.]

Ozone treatment equipment



Ozone generation system ozone generator



Ozone generation system structure of ozone generator





Ozone generation system Dielectric



III.Ozone contact system-flow



Ozone contact system-pipelines for ozone affluent



Ozone contact system-disc diffuser



IV. Ozone destructive system catalytic ozone destructor

(Catalytic ozone destructor)

Remaining ozone



Ozone destruction system destructive equipments





treatment

disinfection.

- A mature application of ozone on water purification and sewage treatment technologies overseas
- > Ozone is gradually applied to the domestic water purification and sewage technologies

Pellet Softening

- Add silicon sand in the reactor to enable a manner of fluidization.
- Add neutralization agent (e.g.NaOH, Ca(OH)2) to enable a pH value up to 8.5~10.8 in the control tank, make the crystallization of CaCO3 adhered to silicon sand to attain a purpose of hardness removal

Fundamental reaction:

 $OH^- + HCO_3^- \rightarrow CO_3^{2-} + H_2O$ $Ca^{2+} + CO_3^{2-} \rightarrow CaCO_{3(S)} \downarrow$

Pellet softening treatment process



Principle of pellet softening

Use CaCO3 that reports a feature of low dissolution, add lye in the raw water to form undissolvable CaCO3 and make it adhered to the silica sand type on the softener to Attain a purpose of Hardness removal in the water

- Treated water in high hardness
- Functions of pellet softening reduce the hardness of calcium and magnesium in the water, reduce incrustation and improve mouthfeel



Advanced Water Purification Station ~softening objectives

- \blacktriangleright softening objectives- reduce total hardness to under 150 mg/l as CaCO₃
- > A variance of raw water' s hardness is 160 to 300 mg/l as $CaCO_3$, with average value around 228 mg/l as $CaCO_3$
- The ratio of calcium and total hardness is around 60%, therefore an objective is attained by simply removing the calcium away.
- According to the following equations, a Crystallization of Calcium Carbonate in solid state will be enabled by adding lye in the water:

 $Ca^{++} + 2 HCO_{3}^{-} + 2 Na0H \Leftrightarrow CaCQ_{3} + Na_{2}CO_{3} + 2 H_{2}O$ $Ca^{++} + Na_{2}CO_{3} \Leftrightarrow CaCO_{3} + 2 \frac{Na^{+}}{1}$

Advanced Water Purification Station ~pellet softening principle



Advanced Water Purification Station~ Pellet Softening Treatment



Advanced Water Purification Station ~ Pellet Softening Treatment

- <u>Benefits of pellet softening:</u>
- Replace the 4 processes of conventional sedimentation treatment : flash mix, flocculation, sedimentation and sludge dewatering, and simply them as one
- Fast reaction rate, efficient removal, low investment cost, low power consumption, reduction of manpower by automatic control
- Small area occupied, easy operation



Absorption of AC

- Can be divided as power activated carbon and granular activated carbon
- AC reports an extremely large surface area, which is reachable to the organic matters, stink, scale in the water, to further absorb and remove it.
- Cooperated with ozone, the granular activated carbon before absorption will be able to become a BAC to prolong its service and reduce cost

BAC Filtration

- Use the treated water to enable a gradual absorption of microorganism on BAC so as to achieve an effect of filtration absorption and bio-degradation of organic matters in the water, called BAC.
- It not only remove the stink substances but also remove the bio-degradable organic matters such as insecticides and other pollutants in the water.

BAC treatment process

Functions of BAC

- Remove biodegradable organic matter in the water
- Lower amount of chlorine
- Remove substances that cause stink and other micropollutants
- Improve the mouthfeel of drinking water

Descriptions of BAC system

AC is a superior porous absorbent with massive surface area derived from some carbonic substances with carbonized and activation treatment. The BAC not only reports absorption effect on pollutants but also report a capability in biodegradation, therefore is called BAC.

BSC treatment equipment

Membrane treatment

- Membrane treatment is a method to coercively separate impurities in the water through membrane with tiny pore under the circumstance of pressure.
- It can be divided as MF (microfiltration at 1-0.1 μ m), UF (ultrafiltration at 0.1-0.01 μ m), NF(nanofiltration at 0.01-0.001 μ m), RO(reverse osmosis < 0.001 μ m) in terms of size, which could apply to different purposes of use.</p>
- NF reports over 90% of removal rate in terms of divalent metal ions such as the hardness of calcium and Magnesium in the water (however it reports poor removal effect on valence metal ions such as sodium and chlorine), therefore, it is developed as a technology for hard water softening in recent years

A flowchart of advanced treatment equipments at water purification station

A Diagram of advanced Water Purification Station

Pellet Softening Reactor

A treatment process for water purification station to install advanced water purification equipment

Operation Center

Low Pressure Reverse Osmosis(LPRO)

