1.0 PURPOSE

The purpose of the Wastewater Treatment System is to remove contaminates from plant wastewater so that it may be sent to the Final Plant Effluent Tank and eventually discharged back into the final out fall. Under normal conditions, the Wastewater Treatment System will discharge approximately 100 gpm of treated effluent into the Final Plant Effluent Tank, where it mixes with Demin Regen Waste flowing at 20 gpm and Cooling Tower Blowdown flowing at 300 gpm. The Final Plant Effluent Tank, in turn, sends 450 gpm of plant wastewater to the battery limit.

2.0 SAFETY AND ENVIRONMENTAL CONSIDERATIONS

Treated wastewater effluent from the Plant is to be returned to the out fall in "better condition" than it was received. Several outfall parameters must be regulated according to environmental permits. The main parameters of interest include chlorine, Biological Oxygen Demand (BOD), pH, phenol, benzene, and Total Suspended Solids (TSS).

The wastewater feed stream contains many different hydrocarbon types, some of which can pose a significant health hazard, such as phenol and benzene. In addition, several chemicals are used in the Wastewater Treatment System, including acid, caustic, cationic polymer, anionic polymer, sodium bisulfite, ferric chloride, lime, and chlorine. Special precaution should be taken when dealing with chlorine gas, which is a toxic respiratory irritant. Please consult the plant MSDS sheets for exposure and handling details for these chemicals.

For specific details of these and other safety precautions, please consult the unit Job Work Instructions (JWI's) and the Safety Standards Manual.

3.0. GENERAL PROCESS OVERVIEW

3.1 Wastewater Equalization

Wastewater containing condensate, effluent from dikes and sumps, neutralized spent caustic, oil/froth from the IGF (Induced Gas Flotation), demineralization regeneration waste, decant water, saturator blowdown, effluent from the Quench Area Drain Tank, and discharge from the Stormwater Holding Tank Transfer Pump enters the Wastewater Equalization Tank at 110 gpm, 100°F, and 25 psig. The tank is equipped with two mixers to aid in the separation of the oil and water. The oil separates from the water, is recovered by the Tank Oil Skimmer, and is then transferred to the Wet Slop Oil Holding Tank by the WW Equalization Tank Oil Skimmer Pump. The water is pumped to the CPI (Corrugated Plate Interceptor) Oil/Water Separator by the WW CPI Separator Feed Pump.

3.2 Oily Water Separators (CPI/IGF)/Slop Oil System

Wastewater is pumped from the EQ Tank through Inline Mixer where it mixes with either acid or caustic depending on the pH of the stream. From the mixer the stream flows into the CPI Oily Water Separator. The CPI Separator has two 60% separators. During low flow scenarios one can be taken out of service for maintenance while the other remains in service.

The separator consists of three principal elements: the Corrugated Plate Interceptor packs, the adjustable oil weir, and the adjustable effluent weir. In the separator the oily water passes through the corrugated packing, causing the tiny oil globules to contact one another and grow larger in size. As a result the "lighter" oil floats to the top forming a layer at the surface. Also, tiny solid particles contact one another and grow larger as well, but settle to the bottom instead due to "heavier" nature. This accumulated sludge is removed periodically.

After passing through the corrugated packing, a three phase system develops, with an oil layer at the surface, accumulated sludge on the bottom, and clean water in between. To ensure that only clean water leaves in the effluent stream, an underflow/overflow scenario is incorporated. The separated oil overflows the adjustable oil weir and is then pumped to the Wet Slop Oil Holding Tank or the Oily Sludge/Froth Holding Tank by the CPI Separator Slop Oil/Sludge Transfer Pump. The clean water underflows a baffle, overflows the adjustable effluent weir, and then gravity flows to the IGF Package, for further treatment. A carbon canister has been provided to trap any vapors that might be released to atmosphere.

Prior to entering the IGF, effluent from the CPI is mixed with Cation and Anion Polymer to increase the size of the colloidal particles and fine suspended solids. The Cation Polymer, also called "coagulant," serves to destabilize these particles, which usually possess a negative charge. The IGF Cation Polymer Injection Pump, has been provided to inject Cation Polymer from the IGF Cationic Polymer Injection Tank to the IGF Tank inlet. The Anion Polymer, also known as "flocculant," promotes agglomeration of the destabilized particles by chemically bridging them together. The IGF Anion Polymer Injection Pump, has been provided to inject Anion Polymer from the IGF Anionic Polymer Injection Tank to the IGF Tank inlet.

The wastewater stream then flows into the IGF where the suspended solids and emulsified oils in the wastewater are removed. The IGF is a cylindrical, horizontal vessel which is divided into three compartments, each separated by a pair of baffle plates. Located in each compartment is a downcomer which returns water saturated with nitrogen back into the compartment. This is achieved by a nozzle/eductor system inside the downcomer. Upon exiting the downcomer, nitrogen bubbles are released which carry the formed floc to the water surface. The oily froth layer which accumulates on the surface of the water is continuously removed by rotating skimmers. This froth accumulates within side compartments and is transferred by the IGF Froth Transfer Pump to the EQ Tank. Provisions have been made to transfer the froth to the Oily Sludge/Froth Holding Tank if required.

The wastewater stream flows through each compartment in an upflow/downflow manner due to the baffle arrangement. After leaving the third and final flotation compartment, the treated water enters the clean water compartment, where it is then transferred by the IGF Effluent Pump to the WW Steam Stripper. Provisions have been made to recycle the effluent stream back to the EQ Tank or to bypass the Steam Stripper completely and flow directly to the Bio-Oxidation Treatment Package. The Induced Gas Flotation Tank is equipped with a Carbon Canister to trap any vapors released.

3.3 Wastewater Steam Stripper

The Wastewater Steam Stripper is provided to remove benzene and benzene derivatives from the IGF effluent stream by using stripping steam as the separating agent. The following specified levels should not be exceeded within the effluent stream: 0.05 ppm benzene, 0.05 ppm toluene, 0.05 ppm ethyl benzene, 1.0 ppm C-10 hydrocarbons, and 0.05 ppm phenol.

Flowing at 105 gpm, 100°F, and 77 psig, wastewater from the IGF enters the Wastewater Steam Stripper Feed Preheater before entering the tower. As the wastewater flows downward through the tower, it comes into contact with stripping steam, which removes the benzene. A portion of the clean effluent water is sent to the Wastewater Steam Stripper Reboiler where it is vaporized by contacting low pressure steam and returned to the tower as vapor return. The overhead vapor containing benzene flows to the Steam Stripper Overhead Condenser where it is condensed against cooling water. The condensed water and hydrocarbons are then collected in the Steam Stripper Overhead Reflux Drum.

The reflux drum is provided with a baffle which allows the water to be separated from the condensed hydrocarbons. The hydrocarbon liquid overflows the water and is collected on the hydrocarbon side of the baffle. The hydrocarbon liquid is then sent to the Slop Oil Tank. The water is returned to the steam stripper as reflux by the Steam Stripper Reflux Pump. The stripper bottoms temperature must be a minimum of 240°F to ensure that no benzene is present in the effluent stream.

Effluent from the bottom of the Wastewater Steam Stripper Tower is pumped by the Wastewater Steam Stripper Effluent Pump to the Steam Stripper Feed Preheater and exchanges heat with the wastewater feed entering the Steam Stripper Tower. This stream is then pumped to the Steam Stripper Effluent Cooler where it is cooled by cooling water before being sent to the Bio-Oxidation System or recycled to the EQ Tank. The outlet temperature of this stream must be maintained at or below 140°F so as not to kill the bugs within the Bio Unit.

3.4 Bio-Oxidation/Sludge Removal

The Wastewater Bio-oxidation System removes soluble and particulate organic contaminates from the wastewater stream by a process known as *activated sludge*. The activated sludge process utilizes millions of microorganisms to convert the organic material into new cell growth and by-products. This conversion takes place in the aeration section of the Bio Unit. Several essential nutrients are required to promote the biodegradation process, such as carbon, hydrogen, oxygen, nitrogen, and phosphorus. Active sludge is developed when these organisms are allowed to collide together and form clumps, or “floc,” which are heavy enough to settle out in the clarification section of the Bio Unit, producing a clean effluent liquid. A portion of the settled active organisms are returned to the aeration section to mix with the incoming raw waste in order to provide continuous reseeding. This mixture of raw wastewater and returned active sludge is called mixed liquor. The relative amounts of incoming food and microorganisms in the mixed liquor controls how well the process will perform and is referred to as the F/M ratio.

Effluent from the Steam Stripper Cooler enters the aeration section of the Bio Unit at 105 gpm, 95°F, and 10 psig, where it mixes with nutrient feed from the Nutrient Feed Tank. The nutrient feed is sent by the Nutrient Feed Pump, and is used to supply the required nitrogen and phosphorus to the Bio Unit. Air is injected from the Bio Treatment Plant Aeration Plant Blower into the coarse air bubble diffusers located at the bottom of the aeration section. The air bubbles that are created serve to keep the solids uniformly mixed with the water and to supply oxygen that is required for biodegradation to occur. The carbon and hydrogen that are also needed to drive the process are obtained from the soluble and particulate organics in the waste stream. This organic material is commonly known as “food,” and it is measured by COD, or Chemical Oxygen Demand. This “food” feeds the microorganisms, which are also known as “bugs,” and they are measured by MLVSS, or Mixed Liquor Volatile Suspended Solids.

As the wastewater flows across the aeration section, more and more of the food is consumed by the bugs, producing water virtually free of soluble and particulate organics. However, a large amount of suspended solids are present which must be removed. The effluent from the aeration section then flows into the clarifier, where the suspended solids are removed from the water. The influent stream flows to the center of the clarifier, where the water is forced to underflow the walls of a centerwell. From here the water flows outward toward the sides of the circular clarifier and overflows the effluent weir into the weir trough. Because the bottom of the centerwell is below the top of the effluent weir, an underflow/overflow situation exists which ensures that solids do not overflow the weir. The water then enters the effluent pipe at the bottom of the weir trough, where it is injected with chlorine dioxide, and gravity flows to the Treated Wastewater Effluent Sump. The chlorine dioxide is used for destruction of phenols in the wastewater.

Because new solids are produced in the aeration section, more solids enter the clarifier than are recycled back to aeration. Therefore, part of the sludge blanket at the bottom of the clarifier must be wasted in order to maintain a constant bed depth. This sludge is “pushed” into the air lift system by the Clarifier Scraper and is then sent to the Aerobic Digester. In the Aerobic Digester wasted sludge is auto-oxidized, which means that microbes feed on other microbes. This results in approximately two-thirds of the cell mass being destroyed during aerobic digestion. When the Aerobic Digester is at a low level, air is sent to the course bubble air diffusers to provide oxygen and mixing for the sludge. During this stage, the level of sludge in the Digester is continually increasing. Once a high level is reached, air is shut off and solids are allowed to settle. After sufficient settling is achieved, supernatant water is removed and sent to aeration while thickened sludge is sent to the Sludge Conditioning Tank by the Digested Sludge Feed Pump at a maximum capacity of 50 gpm, and a temperature and pressure of 90°F and 10 psig, respectively.

Sludges from the Aerobic Digester and Raw Water Thickener Sump are combined in the Sludge Conditioning Mixing Tank and mixed with diatomaceous earth using the Sludge Conditioning Tank Mixer. This combined sludge is sent by the Filter Press Feed Pump to the Sludge Filter Press which physically separates the water from the sludge. Sludge cake drops to the dumpster for removal, while the filtrate resultant is transferred to the Wastewater Treatment Area Sump.

3.5 Wastewater Final Treatment

The Wastewater Final Treatment System completes treatment of the wastewater generated by the plant before it is released to the battery limit. Effluent from the Bio Unit gravity flows at 105 gpm, 90°F, and atmospheric pressure to the Treated Wastewater Effluent Tank where caustic or acid can be added in order to maintain pH between 6 and 9. The Treated Wastewater Effluent Tank Mixer assures that pH in the tank is uniform. After overflowing a weir, the treated wastewater is analyzed for pH again, and upon indication of high or low pH, the stream is sent back to the EQ Tank.

The Final Plant Effluent Tank accepts flow from the Demin Neutralization Sump at 20 gpm, 100°F, and 50 psig, Cooling Tower Blowdown at 300 gpm, 115°F, and 77 psig, and Treated Wastewater Effluent Tank at 115 gpm, 90°F, and 5 psig. Sodium Bisulfite, which destroys the chlorine residual by forming hydrochloric acid, is injected into the Cooling Tower Blowdown stream by the Cooling Water Blowdown Dechlorination Pump and can also be injected directly into the Final Plant Effluent Tank by the Wastewater Dechlorination Pump if analysis dictates. The final plant effluent overflows a weir to measure flow and then gravity flows to the battery limits. The final plant effluent flows at 450 gpm, 108°F, and atmospheric pressure.