PROCESS SUMMARY CROMAFLOW

Effective reduction of organic material entering the CromaFlow Sequencing Batch Reactor (SBR) is accomplished biologically through millions of microorganisms (bacteria). These bacteria degrade wastewater through the addition of atmospheric oxygen and biochemical reactions. Through the operation of automatic time clocks, the CromaFlow SBR maintains a controlled environment. This enables various process control strategies to be achieved.

The CromaFlow SBR process descriptions are as follows:

A. Screening/Pre-Aeration -Raw wastewater enters the solids retention section for a separation process of organic biochemical oxygen demand (BOD)/ inorganic materials (e.g., toilet paper, feminine hygiene products, etc.). This reduces the potential for any of the above to become lodged in any of the pumps and prevent normal operations.

B. Aeration – This is the phase for biological degradation of organic material thereby reducing pollutants. At pre-programmed times, submersible pumps are activated to provide adequate mixing to allow BOD and bacteria (workers) to come in contact with one another. The dissolved oxygen is supplied via pumps when the wastewater is directed through a unique air induction device. As wastewater is being pumped, atmospheric oxygen is drawn into the intakes provided. This supplies the aerobic bacteria with an energy source for growth and reproduction. As the microorganisms consume the organic waste, additional waste is created.

This is the whole basis of the activated sludge process: organic material as the food source placed into an aerobic environment with microorganisms serving as the workers in the absence of other extraneous conditions (e.g., pH, toxicity, low levels of alkalinity, low dissolved oxygen). All of this working together with adequate retention time for the biological/chemical reactions occurring should produce a quality effluent (treated sewage).

C. Anoxic/Denitrificatio: This phase refers to the degradation of inorganic byproducts of Ammonia Nitrogen (NH_3-N) to gaseous nitrogen and CO_2 in the absence of dissolved oxygen. This process becomes important in selected geographical areas due to high concentrations of nitrates found in drinking water. High levels of nitrates sometimes found in soils have been linked to a disease known as methomoglobinimia or BLUE BABY SYNDROME. The CromaFlow SBR has the capability to create an environment, which can ultimately reduce these concentrations to a safe level for human consumption. This is accomplished via control valve placed in line with an existing air pipe. Following the aeration cycle, most of the Ammonia Nitrogen levels have been reduced to nitrates (NO_3). Automatically controlled air valves close, thus creating an environment with little or no free oxygen present. Specific bacteria already contained in the system begin to utilize available NO_3 as an oxygen source for energy. Through careful monitoring, these NO_3 levels are eliminated or reduced to levels that pose no threat to human consumption.

D. Settling- The specific intent for this phase is to provide a quiescent environment (i.e., in the absence of air and mixing) such that solid/liquid separation occurs. The aerobic bacteria, through the introduction of oxygen, mixing, and food, begin to secrete mucoproteins and polysaccharides that provide a sticky surface for sludge particles to adhere to. As a result, the sludge particles coagulate to form a mass (floc) that has a high specific gravity. The dense floc is now permitted to settle to the bottom of the clarifier and the clear effluent (supernate) remains above. This effluent is high quality; virtually free from BOD and total suspended solids.

E. Decant – All processes thus far have been biological in nature. The microorganisms have provided the tools necessary to degrade the waste to an environmentally safe product. Submersible decant pumps, located in the clarifier compartment, are activated automatically through the remote control panel. Once running, a floatable discharge suction line begins to remove the supernatant and dispose to the predesigned source (e.g., sub-surface drain field, surface water supply, etc.).

CROMAFLOW TREATMENT PROCESS DESCRIPTION

The CromaFlow Sequencing Batch Reactor stabilizes wastewater and reduces organics through aerobic treatment. Utilizing the stages previously listed, the environment is manipulated in order to allow the enzyme systems for selected bacteria to operate more efficiently. By understanding these enzyme mechanisms, we can utilize the batch mode of treatment to achieve very specific goals (i.e., final effluent treatment objectives).

The CromaFlow SBR uses this biological tool to achieve the following results:

♦ Reduction of Carbonaceous BOD (i.e., particulate and soluble BOD).

♦ Reduction of Nitrogenous BOD (i.e., ammonia, proteins, etc.).

BOD removal involves the addition of oxygen to create an environment, which allows these bacteria to perform their duties. Once a specific concentration of oxygen becomes dissolved in the wastewater, organic pollutants are broken down into simpler components for bacterial assimilation. This represents Step 1 for biological treatment. Step 2 involves reduction NBOD. This is the required environment for the heterotrophic bacteria, in the absence of oxygen, to utilize their enzyme systems capable of reducing oxidized nitrogen (i.e., Denitrification).

The CromaFlow treatment process involves the following phases:

- Step 1: Aerobic/Aeration
- Step 2: Anoxic/Denitrification
- Step 3: Settling
- Step 4: Discharge

Step 1: Aerobic/Aeration

Addition of air is accomplished via submersible pumps identified as P1, 2, & 3 located in aeration compartment. (Refer to diagrams Section II). As well as supplying oxygen to the system, these pumps also provide adequate mixing to allow the wastewater and bacteria to come in contact. This is of utmost importance to facilitate the waste degradation process. Biological reduction of Ammonia Nitrogen (NH_3-N) proceeds once BOD levels fall below inhibition thresholds - typically 5–80 mg/l low molecular weight soluble BOD. During this process, alkalinity is destroyed via production of nitrous acid. Since nitrifying bacteria utilize bicarbonate alkalinity as a source for structural growth and reproduction, it becomes very important to monitor alkalinity levels within the aeration basin for process control.

It must be noted that pH and alkalinity should not be considered synonymous.

Nitrifying bacteria will be inhibited if sufficient alkalinity is not present, regardless of pH. Approximately 7.14 mg of alkalinity is destroyed to convert 1 mg of Ammonia Nitrogen to nitrite. The second biochemical reaction involves the conversion of nitrite to nitrate also under aerobic conditions. Three pumps are designated to mix/aerate for a pre-programmed time dependent upon treatment objectives.

Step 2: Anoxic/Denitrification

Denitrification is the biological conversion of nitrate-nitrogen to more reduced forms, ultimately di-nitrogen gas. Nitrogen removal occurs when the nitrogen gas is allowed to escape into the atmosphere. Denitrification is brought about by a variety of facultative bacteria that utilize nitrate instead of oxygen for respiration. Alkalinity is produced during this process due to the de-animation of organic compounds. Approximately ½ of the alkalinity destroyed during nitrification is replaced during Denitrification resulting in a slight increase in pH. The organic source available and its relative concentration dictate the rate of Denitrification. Rates are highest with a readily biodegradable source, such as methanol. Rates also increase with increasing temperature and with decreasing oxygen concentrations.

At pre-programmed times, aeration pumps P1 & 2 along with aeration/transfer pump P3 continue to run without the introduction of air. This can occur via electrically operated solenoid valves which close the air supply to the system. The programmed time is to allow the facultative bacteria to consume all available dissolved oxygen and nitrate. The duration of the cycle is determined via the analysis of the mixed liquor suspended solids filtrate for dissolved NO3. At completion, the air valve will automatically re-open and the aeration process will resume for another batch.

Step 3: Settling

Following BOD oxidation, nitrogen removal, and subsequent nitrate removal, the CromaFlow SBR process will enter into a quiescent period for solid/liquid separation. This is accomplished by the deactivation of pump P3 via pre-programmed time clock. The unique attribute of a CromaFlow SBR versus a conventional flow through system is found in the clarifier compartment. During settle phase, no additional flow is allowed to enter this compartment, thus minimizing short-circuiting or solids washout. This process control allows the bacteria to efficiently utilize the space provided, and polish the effluent.

Following 30 minutes of settling, concentrated sludge is either returned back to the pre-aeration chamber for additional treatment or wasted to an optional sludge holding tank through the operation of P4. This represents the primary control tool available to the operator for maintaining a specific food to microorganism (F/M) ratio. By controlling the biomass inventory in the treatment process relative to the amount of food contained in wastewater, a healthy population of heterotrophic and autotrophic bacteria can be maintained for treating additional wastewater. This is the primary objective behind activated sludge.

Step 4: Discharge

In order to complete the SBR batch process, a known volume of clear settled supernatant is discharged following an additional settling period of 30 minutes. A 30-minute pump cycle is designated to remove approximately 625 gallons from the clarifier compartment. Pumps P5 & 6 is allocated for this task. The clear supernatant is pumped via floatable suction line and is designed to shut off before entering the settled sludge blanket. The pump shut-off is controlled via float switch (DF) suspended in the clarifier.