



Wastewater Treatment Package Plants

An Online Continuing Education Course for Engineers

Course Number: EN-2001

Credit: 2 Hours / 2 PDH / 2 CPD

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Description

Package plants are pre-manufactured treatment facilities used to treat wastewater in small communities or on individual properties. According to manufacturers, package plants can be designed to treat flows as low as 0.002 MGD or as high as 0.5 MGD, although they more commonly treat flows between 0.01 and 0.25 MGD (Metcalf and Eddy, 1991). The most common types of package plants are extended aeration plants, sequencing batch reactors, oxidation ditches, contact stabilization plants, rotating biological contactors, and physical/chemical processes (Metcalf and Eddy, 1991). This course focuses on the first three, all of which are biological aeration processes.

Extended Aeration Plants

The extended aeration process is one modification of the activated sludge process which provides biological treatment for the removal of biodegradable organic wastes under aerobic conditions. Air may be supplied by mechanical or diffused aeration to provide the oxygen required to sustain the aerobic biological process. Mixing must be provided by aeration or mechanical means to maintain the microbial organisms in contact with the dissolved organics. In addition, the pH must be controlled to optimize the biological process and essential nutrients must be present to facilitate biological growth and the continuation of biological degradation.

As depicted in Figure 1, wastewater enters the treatment system and is typically screened immediately to remove large suspended, settleable, or floating solids that could interfere with or damage equipment downstream in the process. Wastewater may then pass through a grinder to reduce large particles that are not captured in the screening process. If the plant requires the flow to be regulated, the effluent will then flow into equalization basins which regulate peak wastewater flow rates. Wastewater then enters the aeration chamber, where it is mixed and oxygen is provided to the microorganisms. The mixed liquor then flows to a clarifier or settling chamber where most microorganisms settle to the bottom of the clarifier and a portion are pumped back to the incoming wastewater at the beginning of the plant. This returned material is the return activated sludge (RAS). The material that is not returned, the waste activated sludge (WAS), is removed for treatment and disposal. The clarified wastewater then flows over a weir and into a collection channel before being diverted to the disinfection system.

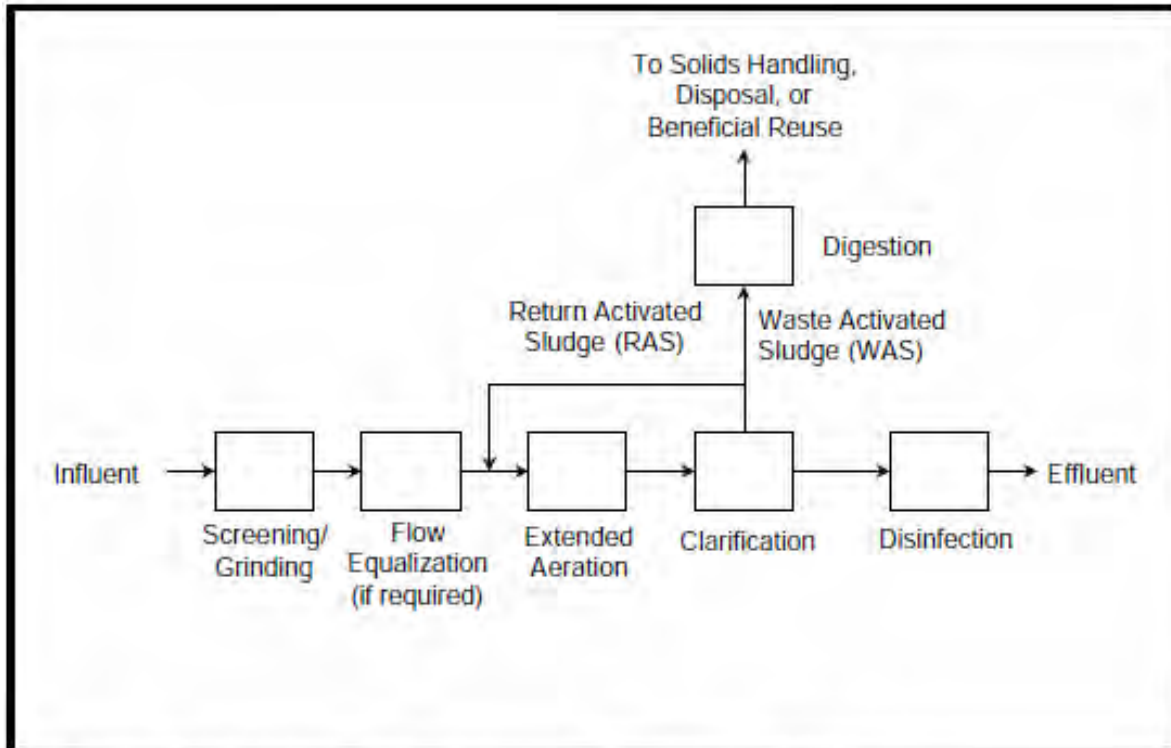


Figure 1: Process Flow Diagram for a Typical Extended Aeration Plant

Extended aeration package plants consist of a steel tank that is compartmentalized into flow equalization, aeration, clarification, disinfection, and aerated sludge holding/digestion segments. Extended aeration systems are typically manufactured to treat wastewater flow rates between 0.002 to 0.1 MGD. Use of concrete tanks may be preferable for larger sizes (Sloan, 1999).

Extended aeration plants are usually started up using "seed sludge" from another sewage plant. It may take as many as two to four weeks from the time it is seeded for the plant to stabilize (Sloan, 1999).

Sequencing Batch Reactors

A sequencing batch reactor (SBR) is a variation of the activated sludge process. As a fill and draw or batch process, all biological treatment phases occur in a single tank. This differs from the conventional flow through activated sludge process in that SBRs do not require separate tanks for aeration and sedimentation (Kappe, 1999). SBR systems contain either two or more reactor tanks that are operated in parallel, or one equalization tank and one reactor tank. The

type of tank used depends on the wastewater flow characteristics (e.g. high or low volume). While this setup allows the system to accommodate continuous influent flow, it does not provide for disinfection or holding for aerated sludge.

There are many types of SBR systems, including continuous influent/time based, non-continuous influent/time based, volume based, an intermittent cycle system (a SBR that utilizes jet aeration), and various other system modifications based on different manufacturer designs. The type of SBR system used depends on site and wastewater characteristics as well as the needs of the area or community installing the unit. Package SBRs are typically manufactured to treat wastewater flow rates between 0.01 and 0.2 MGD; although flow rates can vary based on the system and manufacturer.

As seen in Figure 2, the influent flow first goes through a screening process before entering the SBR. The waste is then treated in a series of batch phases within the SBR to achieve the desired effluent concentration. The sludge that is wasted from the SBR moves on to digestion and eventually to solids handling, disposal, or beneficial reuse. The treated effluent then moves to disinfection. An equalization tank is typically needed before the disinfection unit in batch SBRs in order to store large volumes of water. If the flow is not equalized, a sizable filter may be necessary to accommodate the large flow of water entering the disinfection system. In addition, SBR systems typically have no primary or secondary clarifiers as settling takes place in the SBR.

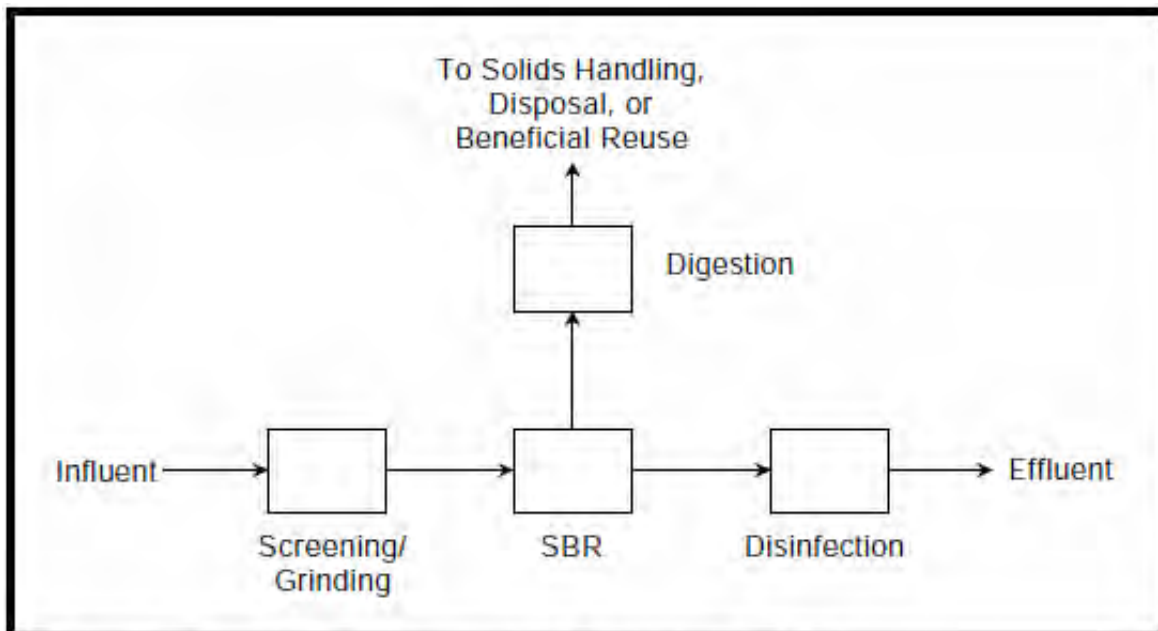
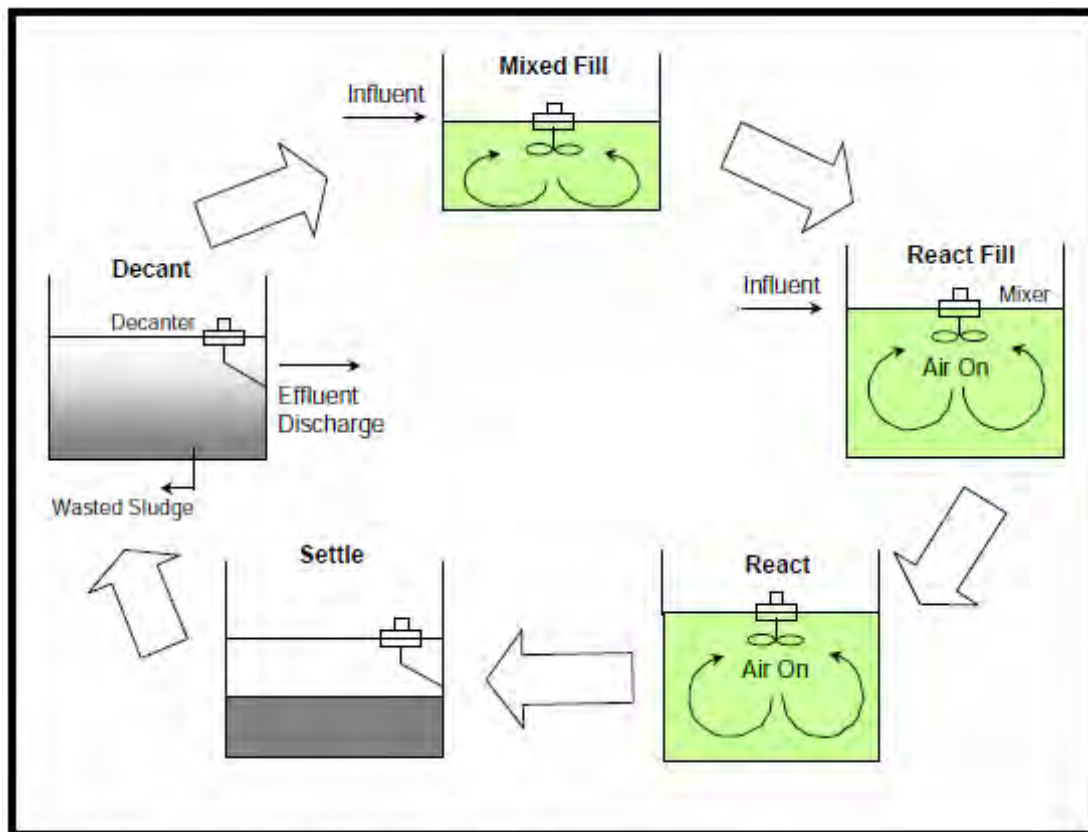


Figure 2: Process Flow Diagram for a Typical SBR

There are normally five phases in the SBR treatment cycle: fill, react, settle, decant, and idle. The length of time that each phase occurs is controlled by a programmable logic controller (PLC), which allows the system to be controlled from remote locations (Sloan, 1999). In the fill phase, raw wastewater enters the basin, where it is mixed with settled biomass from the previous cycle. Some aeration may occur during this phase. Then, in the react phase, the basin is aerated, allowing oxidation and nitrification to occur. During the settling phase, aeration and mixing are suspended and the solids are allowed to settle. The treated wastewater is then discharged from the basin in the decant phase. In the final phase, the basin is idle as it waits for the start of the next cycle. During this time, part of the solids are removed from the basin and disposed of as waste sludge (Kappe, 1999). Figure 3 shows this sequence of operation in an SBR.



Source: CASS Water Engineering, Inc., 2000.

Figure 3: SBR Sequence of Operation

Sludge wasting is an important step in the SBR process and largely affects system performance. It is not considered a basic phase since the sludge is not wasted at a specific time period during the cycle. The quantity and rate of wasting is determined by performance requirements. An SBR

system does not require an RAS system, as both aeration and settling occur in the same tank. This prevents any sludge from being lost during the react step and eliminates the need to return sludge from the clarifier to the aeration chamber (Metcalf and Eddy, 1991).

Oxidation Ditches

An oxidation ditch, a modified form of the activated sludge process, is an aerated, long term, complete mix process. Many systems are designed to operate as extended aeration systems. Typical oxidation ditch treatment systems use a multi-channel configuration within a ring, oval, or rectangular configuration. Mechanically mounted aerators provide aeration, and the aerators also provide mixing.

Package oxidation ditch systems are designed to handle wastewater flow rates between 0.01 and 0.1 MGD. Wastewater entering the oxidation ditch is first screened before entering the oxidation chamber. The oxidation chamber may be required to be equipped with mechanical aerators. The aerators are mounted around the channel at a depth of 1.5 to 2.0 feet. The aerators are used to propel the mixed liquor and to ensure that there is sufficient oxygen transfer to the mixed liquor. The aerator ensures constant contact between the mixed liquor and the oxygen (Metcalf and Eddy, 1999).

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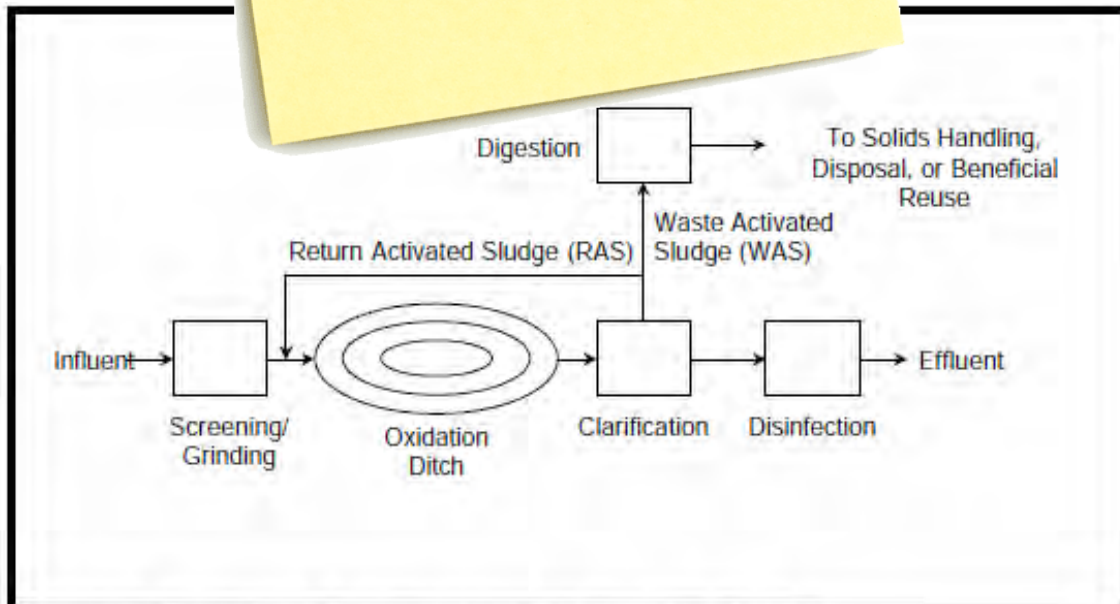


Figure 4: Process Flow Diagram for a Typical Oxidation Ditch