IQRA NATIONAL UNIVERSITY PESHAWER

ASSIGNMENT # 02

ENVIRONMENTAL MANAGEMENT

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Activated Sludge Process

The **Activated Sludge Process** is one of several biological wastewater treatment alternatives in Secondary Treatment. When Activated Sludge is added to wastewater, the organisms in this mixed liquor quickly decompose the wastes in the wastewater being treated. After a required period of aeration and agitation in the aeration tank, the mixed liquor usually flows to a separate tank called a clarifier where the activated sludge is allowed to settle out and the remaining liquid is discharged as effluent. The settled sludge is either disposed of as waste activated sludge or reused in the aeration tank as return activated sludge. Some sludge must always be returned to the aeration tanks to maintain an adequate population of organisms.

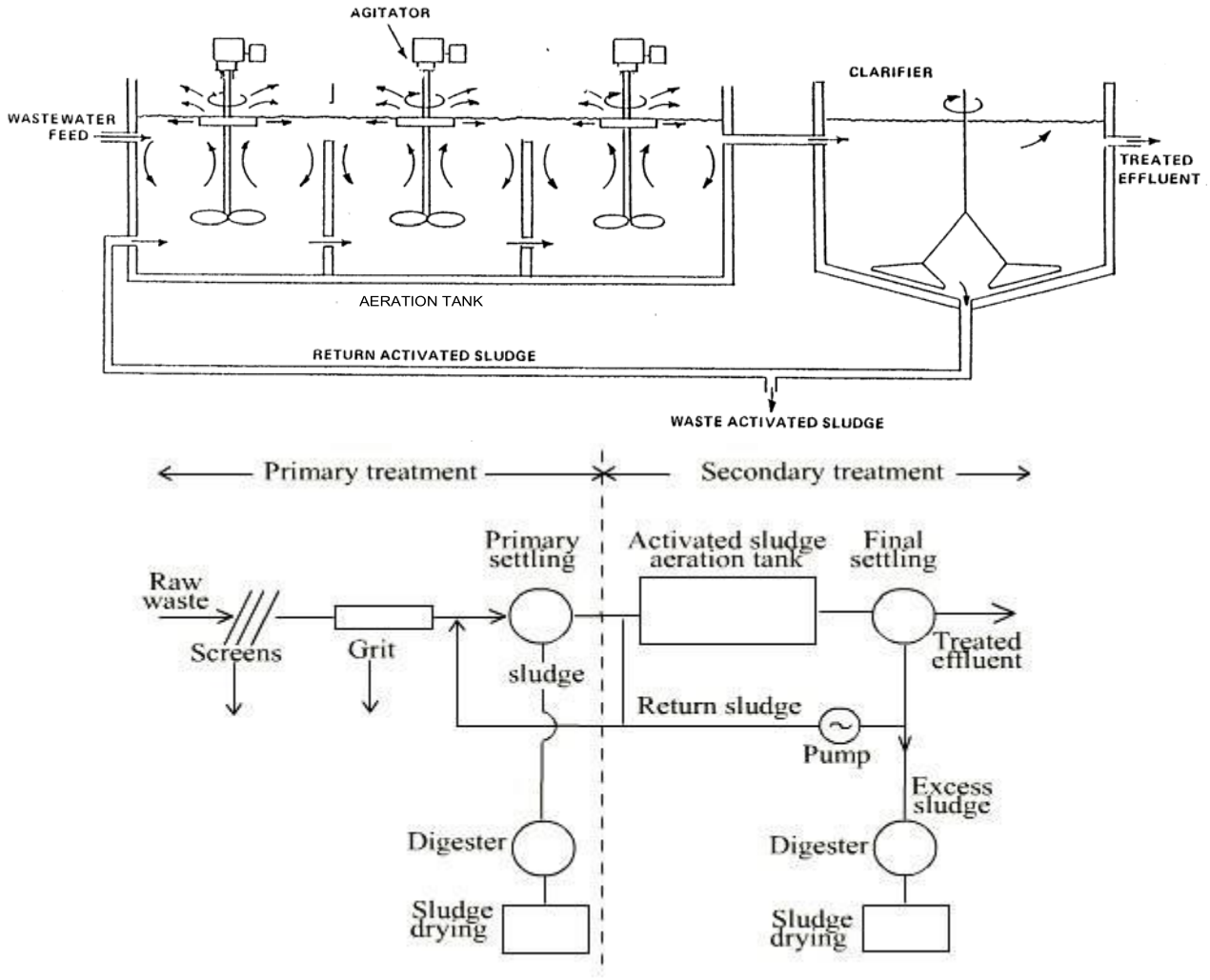


Figure 1.1 Diagram of aeration system in the activated sludge process

- **Process uses microorganisms to speed up decomposition of wastes**.
  - Food is known as Biochemical Oxygen Demand (BOD). BOD is the measure of oxygen demand in the incoming wastewater. A strong wastewater will have a high demand, whereas a weak wastewater will have a lower demand. BOD is the measure of how much oxygen it will take to stabilize the waste (or food) that is in the wastewater.
  - Organism mass is called Mixed Liquor Volatile Suspended Solids (MLVSS).
  - The overall concentration of suspended solids in an aeration tank is called Mixed Liquor Suspended Solids (MLSS). This consists mostly of microorganisms and non-biodegradable suspended matter.

- **When wastewater is added to activated sludge:**
  - Microorganisms feed and grow on waste particles in the wastewater.
  - As organisms grow and reproduce, waste is removed and wastewater is partially cleaned.
  - Organisms need a balance of food (BOD) and oxygen. BOD is inherent in the wastewater and oxygen is added by aeration equipment.
  - The balance of food to organism mass is known as F/M ratio, food to microorganism ratio.

An appropriate F/M ratio is necessary to obtain proper performance from the activated sludge process.

- Oxidation and removal of soluble or suspended solids is the result of the activated sludge process in waste treatment.
  - This treatment takes place in a few hours in an aeration tank.

- Stabilized soluble or suspended solids occur when organisms partially oxidize solids.
  - Organism activity forms carbon dioxide, water, sulfate, and nitrate compounds.
  - Remaining solids are changed to a form that can be settled and removed as sludge during sedimentation.

- For the activated sludge process to work properly, the operator must control the number of organisms and the dissolved oxygen level in the aeration tank, and the treatment time in the aeration tank. When these factors are under control, the process will operate as it should.

THE ACTIVATED SLUDGE PROCESS

Organisms

Activated sludge is full of many different living organisms that are responsible for the decomposition of wastes during the activated sludge process. The organisms are the workers in the activated sludge treatment process. They use the wastes as food and an energy source for survival and for reproduction.

The most effective and quickest decomposition of wastes is achieved by organisms that thrive in an oxygen-rich environment. These organisms are called aerobes (or aerobic organisms) and they require the presence of molecular oxygen, O_2, to survive. Another class of organisms found in activated sludge is facultative organisms, which can utilize either molecular oxygen or oxygen bound in inorganic compounds, such as nitrate, NO_3^-.

- **Aerobic** organisms are the most prominent organisms in an activated sludge plant. They…
  - Require a proper dissolved oxygen level (molecular oxygen, O_2).
  - Produce little to no odor.
  - Efficiently oxidize waste.
  - Grow relatively quickly

- **Facultative** organisms grow in either an aerobic or an anaerobic (no oxygen) environment. They…
  - Are less efficient organisms for waste processing than aerobes.
  - Produce foul-smelling products of decomposition and incomplete reactions when oxygen is scarce.
  - Grow somewhat more slowly than aerobes.

An increase in the food (BOD) supply stimulates the organisms' activity and the rate of oxidation. More organisms are produced, which further increases activity. Because the organisms need oxygen to maintain their activity and survive, the increased food supply creates a demand for more oxygen, which must be provided by the aeration system. This underscores the need to maintain a proper F/M ratio for stable operation of the activated sludge process and the ability to adjust the aeration rate as the oxygen demand varies.

Secondary Clarification

Secondary Clarifier Operation

Secondary Clarification is the physical process of removing microorganisms and solids from treated wastewater. The purpose of the clarifier is to produce a clear effluent suitable for discharge, to remove excess organisms from the activated sludge system, and to provide a source of organisms to return to the activated sludge process as required.

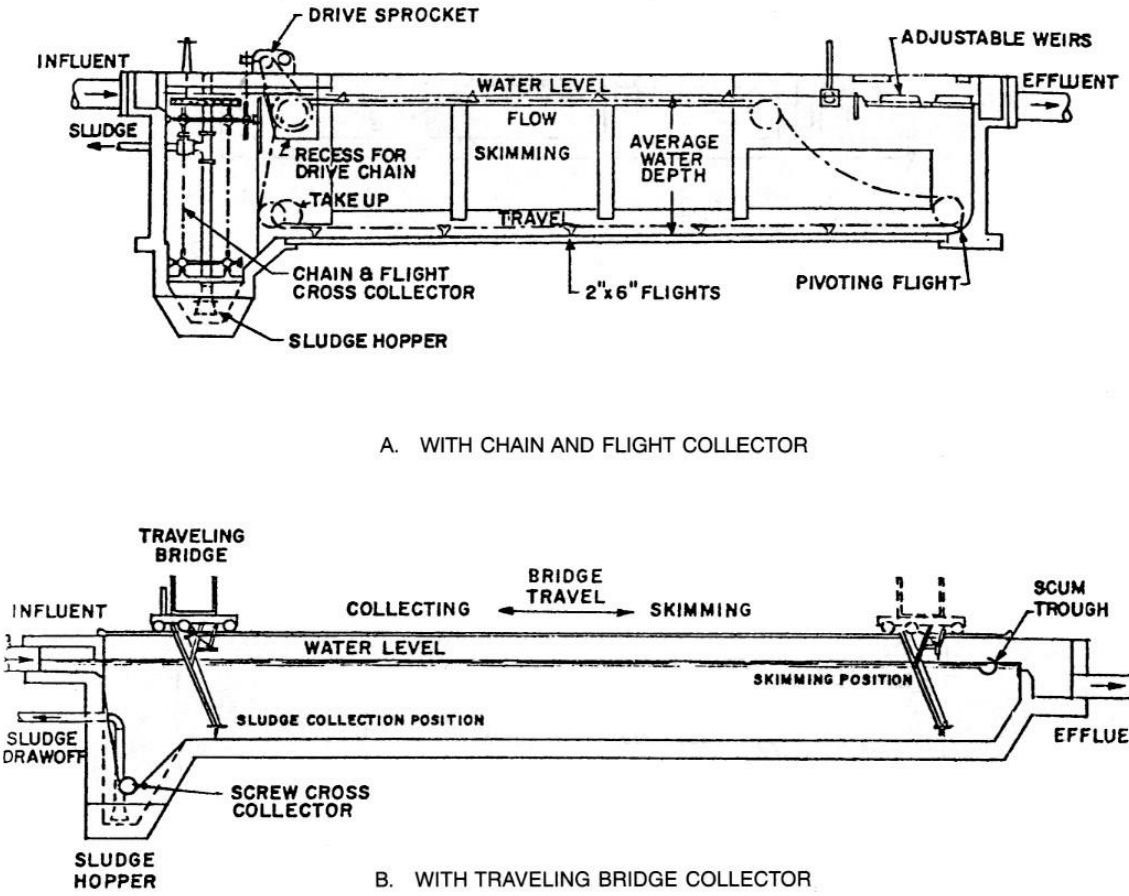
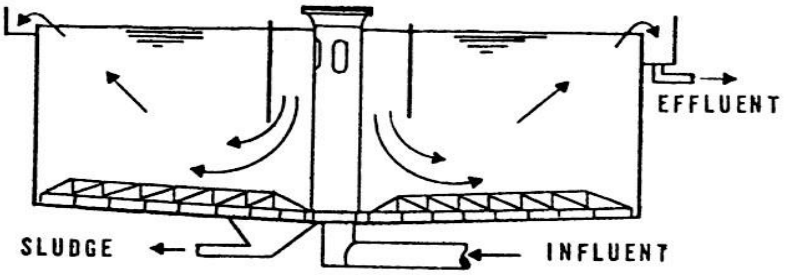
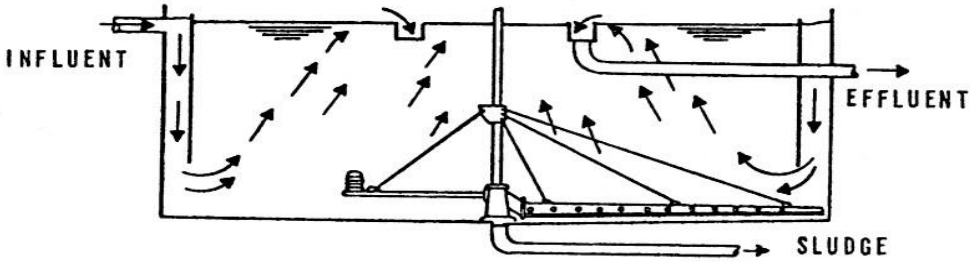


Figure 1.2 Rectangular Sedimentation Clarifiers: Chain and Flight (top) and Traveling Bridge (bottom) 2

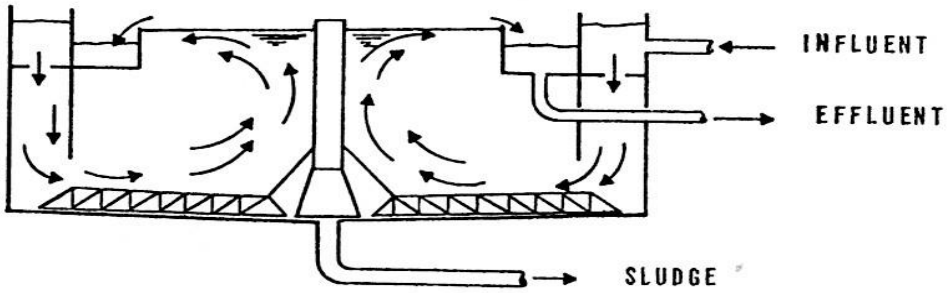
Typical circular clarifiers are shown in Figure 1.3.



(a) CIRCULAR CENTER-FEED CLARIFIER WITH A SCRAPER SLUDGE REMOVAL SYSTEM



(b) CIRCULAR RIM-FEED, CENTER TAKE-OFF CLARIFIER WITH A HYDRAULIC SUCTION SLUDGE REMOVAL SYSTEM



(c) CIRCULAR RIM-FEED, RIM TAKE-OFF CLARIFIER

How the operator manages the clarifier sludge will have an impact on how well the activated sludge process works. The clarified sludge will either be returned to the aeration tank or disposed of as waste.

Return Activated Sludge

Return Activated Sludge (RAS) refers to the sludge settled in the clarifier that is returned to the aeration tank.

Proper management of RAS is important to the efficiency of the activated sludge process because:

- RAS provides a source of organisms that is returned to the activated sludge process as required.
- By changing the RAS rate, the operator can control the concentration of organisms in the aeration tank in response to the food supply present in the incoming wastewater. This allows him to maintain the proper F/M ratio for good system performance.
- Increasing the RAS rate, decreases the hydraulic detention time in the aeration basin.

Decreasing the RAS rate, increases the hydraulic detention time.

- The well-being of the aerobic organisms deteriorates as long as they remain in the secondary clarifier. If the sludge remains in the clarifier too long, the aerobic organisms will die for lack of oxygen.
- Caution has to be taken when increasing RAS rates because hydraulic overloading of the activated sludge system can occur. Increasing the RAS rates increases the volume in the aeration tank and in turn decreases the hydraulic detention time.

Waste Activated Sludge

Waste Activated Sludge (WAS) is the sludge removed from the system to prevent buildup of excessive solids in the aeration tank and in the activated sludge process. This sludge is removed from the clarifier and disposed of at the plant's sludge disposal facility and is not reused in the process. Table 1.1 shows Standard Operating Procedures for WAS Control for four common activated sludge modifications.