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Q 1

Briefing My Client Regarding Waste Water Treatment Plant in a Housing Society

Asalam-u-Alikum sir I'm here to guide you about wastewater treatment plant and giving some good ideas about treatment plant, and brief you for why wastewater treatment is necessary and which type of treatment plant is good for this housing society. We are doing our best for you.

WASTEWATER TREATMENT

- **It is a process used to convert wastewater into an effluent that can be returned to the water cycle with minimal environmental issues**
- **Instead of disposing of treated wastewater it is reused for various purposes, which is knows as water reclamation**
- **During the treatment process, pollutants are removed or broken down**
- **The infrastructure used for wastewater treatment is called a wastewater treatment plant or a sewage treatment plant in the case of municipal wastewater**

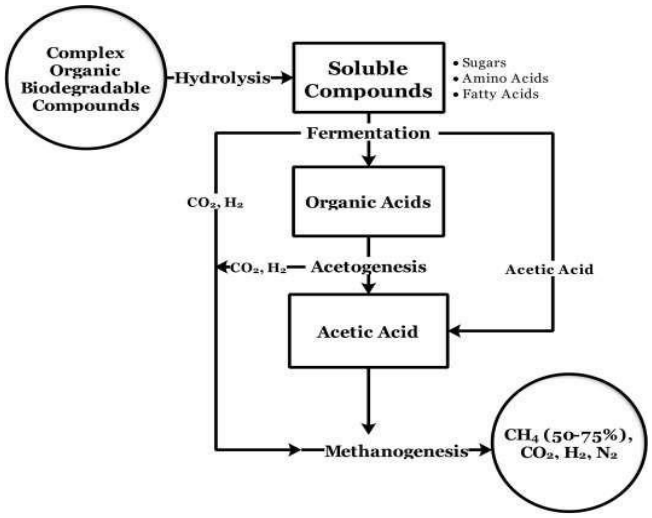
Two Types

- **Aerobic Wastewater Treatment**
- **Anaerobic Wastewater Treatment**

Aerobic treatment of wastewater is a biological process that uses oxygen to break down organic contaminants and other pollutants like nitrogen and phosphorous. Oxygen is continuously mixed into the wastewater or sewage by a mechanical aeration device, such as an air blower or compressor.

Anaerobic Wastewater Treatment

- **Anaerobic bacteria transform organic matter in the wastewater into biogas that contains large amounts of methane gas and carbon dioxide**
- **Energy-efficient process**
- **Often used to treat industrial wastewater that contains high levels of organic matter in warm temperatures**
- **It can be used as a pretreatment prior to aerobic**
- **municipal wastewater treatment**



Advantages

- **High degree of waste stabilization**
- **Low production of excess biological sludge that can be directly dried on sludge drying bed without further treatment**
- **Low nutrition requirements**
- **No oxygen requirement**
- **Production of valuable by product, methane gas**
- **Organic loading is not limited**
- **Less land requirement**
- **Non feed conditions for few month do not affect adversely to the system (can work seasonally)**

Disadvantages

- **Incomplete break-down of organic compounds**
- **No thorough nutrient removal**
- **Again later aerobic purification with nutrient removal is often needed**
- **Most efficient purification in the mesophilic range (30- 37°C) whereby the influent must be heated in most cases**
- **Less robust system with regards to toxicity and inhibition**
- **Risk of odor problems**

How does anaerobic wastewater treatment work?

Anaerobic wastewater treatment is a type of biological treatment where anaerobic microorganisms are used to break down and remove organic contaminants from wastewater. While anaerobic treatment systems may take a variety of forms, they generally include some form of bioreactor or repository capable of maintaining the oxygen-free environment needed to support the process of anaerobic digestion.

The anaerobic wastewater treatment process consists of two stages: an acidification phase followed by a methane production phase, with both processes occurring in dynamic equilibrium. In the initial acid-forming phase, anaerobes break down complex organic compounds into simpler, short-chain volatile organic acids. The second phase, known as the methane-production phase, consists of two steps acetogeneesis, where anaerobes synthesize organic acids to form acetate, hydrogen gas, and carbon dioxide; and methanogens, where the anaerobic microorganisms then act upon these newly-formed molecules to form methane gas and carbon dioxide. These byproducts can be reclaimed for use as fuel, while the wastewater can be routed for further treatment and/or discharge.

Depending upon specific application needs and facility requirements, anaerobic digester systems can be designed as single- or multi-stage units, meaning that they can be configured with a separate acidification tank and bioreactor unit. Common types of anaerobic wastewater treatment systems include the following:

Anaerobic lagoons

Anaerobic lagoons are large man-made ponds, typically ranging between 1-2 acres in size, and up to 20 feet deep. They are used widely for treatment of agricultural wastewater resulting from meat production, as well as treatment of other industrial wastewater streams, and as a primary treatment step in municipal wastewater treatment. Wastewater is typically piped into the bottom of the lagoon, where it settles out to form an upper liquid layer, and a semi-solid sludge layer. The liquid layer prevents oxygen from reaching the sludge layer, allowing a process of anaerobic digestion to break down the organic materials in the wastewater. On average, this process can take as little as a few weeks,

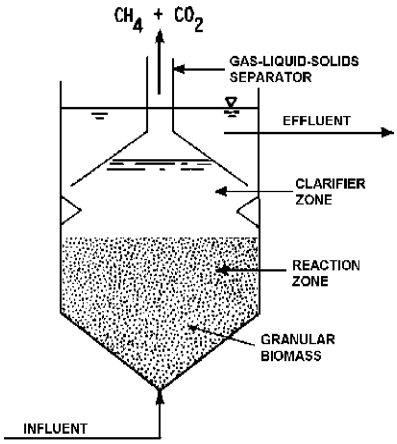
Anaerobic sludge blanket reactors

Sludge blanket reactors are a type of anaerobic treatment where wastewater is passed through a free-floating "blanket" of suspended sludge particles. As the anaerobes in the sludge digest the organic constituents in the wastewater, they multiply and collect into larger granules that settle to the bottom of the reactor tank, and can be recycled for future cycles. The treated effluent flows upward and out of the unit. Biogases resulting from the degradation process are collected by collection hoods throughout the treatment cycle.

Anaerobic sludge blanket reactors are available in a few different forms, including:

Up-flow anaerobic sludge blanket (UASBs):

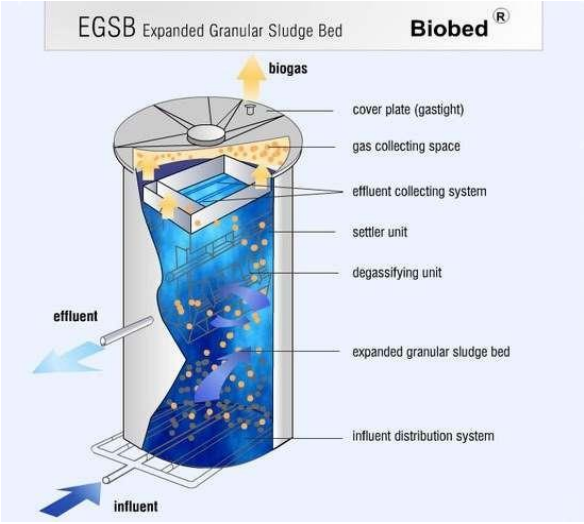
- **In UASB treatment, wastewater is pumped into the bottom of a UASB bioreactor with upward flow applied. This causes the sludge blanket to float as the wastewater flows through it.**



UPFLOW ANAEROBIC SLUDGE BLANKET REACTOR

Expanded granular sludge beds (EGSBs):

EGSBs are very similar to UASB technology, with the key distinguishing factor being that the wastewater is recirculated through the system to promote greater contact with the sludge. They are also typically taller than UASBs, and influent flows are sustained at a higher velocity. As a result, EGSBs are able to treat streams with higher loads of organics comparative to UASB systems.

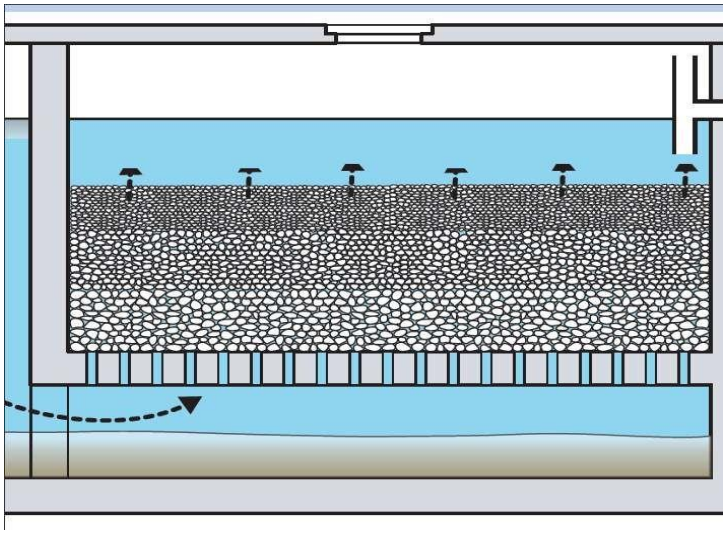


Anaerobic baffled reactors (ABRs):

- **ABRs are constructed with semi-enclosed compartments that are separated by alternating baffles. The baffles interrupt the smooth flow of the wastewater stream, encouraging greater contact with the sludge blanket as it travels from the reactor inlet to outlet.**

Anaerobic filter reactors

Anaerobic filter reactors are comprised of a reactor tank outfitted with a fixed filter medium of some kind. Anaerobic microorganisms are allowed to establish themselves on the filter media, forming what is known as a biofilm. Filter media vary from one system to the next, with common materials including plastic films and particles, as well as gravel, pumice, bricks and other materials. New filter media must be inoculated with anaerobes,



And the biofilm may take several months to become established to the point that it is ready for treatment at full capacity.

During treatment cycles, the wastewater stream is passed through the filter media, which serves to capture particles from the stream, while also providing ample surface area for exposing anaerobes in the biofilm to the organic materials present in the stream. Filter reactor performance must be carefully monitored over time, as the filter media will eventually become clogged with excess biofilm and particulate buildup, requiring maintenance steps such as backwashing and cleaning to maintain optimal performance.

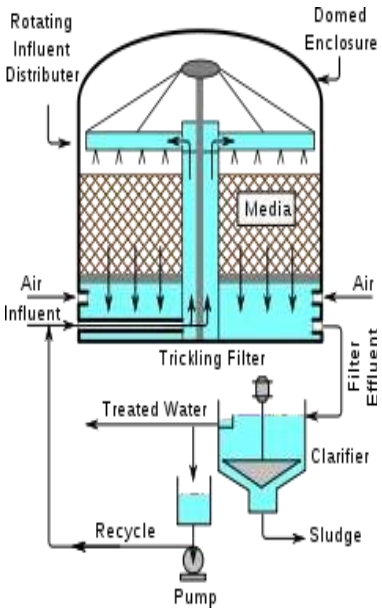
Thank You

Q 2

- **Asalam –u-Alikum guys**
- **How are you?**
- **I wish you all are fine**
- **I'm here to explain the trickling filter process to you. So let's go**

Trickling Filter

- **First used by Debden and Clowes**
- **It consists of rocks, lava, coke, gravel, slag, polyurethane foam, sphagnum peat moss, ceramic, or plastic media over which sewage flows downward and causes a layer of microbial slime (biofilm) to grow, covering the bed of media**
- **Aerobic conditions are maintained by splashing, diffusion, and either by forced-air flowing through the bed or natural convection of air if the filter medium is porous**

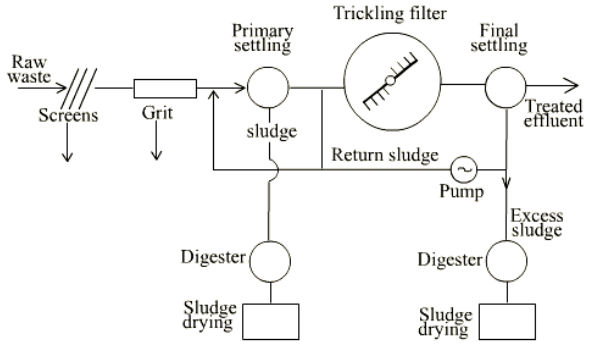


Process Description

- **The wastewater in trickling filter is distributed over the top area of a vessel containing non-submerged packing material.**
- **Air circulation in the void space, by either natural draft or blowers, provides oxygen for the microorganisms growing as an attached biofilm.**
- **During operation, the organic material present in the wastewater is metabolized by the biomass attached to the medium. The biological slime grows in thickness as the organic matter abstracted from the flowing wastewater is synthesized into new cellular material.**
- **The thickness of the aerobic layer is limited by the depth of penetration of oxygen into the microbial layer.**
- **The micro-organisms near the medium face enter the endogenous phase as the substrate is metabolized before it can reach the micro-organisms near the medium face as a result of increased thickness of the slime layer and loose their ability to cling to the media surface. The liquid then washes the slime off the medium and a new slime layer starts to grow. This phenomenon of losing the slime layer is called *sloughing*.**
- **The sloughed off film and treated wastewater are collected by an underdrainage which also allows circulation of air through filter. The collected liquid is passed to a settling tank used for solid- liquid separation.**

Process Design

Flow sheet of a trickling filter system



Generally trickling filter design is based on empirical relationships to find the required filter volume for a designed degree of wastewater treatment. Types of equations:

1. **NRC equations (National Research Council of USA)**
2. **Rankins equation**
3. **Eckenfilder equation**
4. **Galler and Gotaas equation**

NRC and Rankin's equations are commonly used. NRC equations give satisfactory values when there is no re-circulation, the seasonal variations in temperature are not large and fluctuations with high organic loading. Rankin's equation is used for high rate filters.

***NRC equations*: These equations are applicable to both low rate and high rate filters. The efficiency of single stage or first stage of two stage filters, E_2 is given by**

$$E_2 = \frac{100}{1+0.44(F_{1.BOD}/V_1.Rf_1)^{1/2}}$$

For the second stage filter, the efficiency E_3 is given by

$$E_3 = \frac{100}{[(1+0.44)/(1-E_2)]\,(F_{2.BOD}/V_2.Rf_2)^{1/2}}$$

where E_2= % efficiency in BOD removal of single stage or first stage of two-stage filter, E_3=% efficiency of second stage filter, $F_{1.BOD}$= BOD loading of settled raw sewage in single stage of the two-stage filter in kg/d, $F_{2.BOD}$= $F_{1.BOD}(1-E_2)$= BOD loading on second-stage filter in kg/d, V_1= volume of first stage filter, m^3; V_2= volume of second stage filter, m^3; Rf_1= Recirculation factor for first stage, R_1= Recirculation ratio for first stage filter, Rf_2= Recirculation factor for second stage, R_2= Recirculation ratio for second stage filter.

Rankin's equation: This equation also known as Tentative Method of Ten States USA has been successfully used over wide range of temperature. It requires following conditions to be observed for single stage filters:

1. **Raw settled domestic sewage BOD applied to filters should not exceed 1.2 kg BOD_5/day/ m^3 filter volume.**
2. **Hydraulic load (including recirculation) should not exceed 30 m^3/m^2 filter surface-day.**
3. **Recirculation ratio (R/Q) should be such that BOD entering filter (including recirculation) is not more than three times the BOD expected in effluent. This implies that as long as the above conditions are satisfied efficiency is only a function of recirculation and is given by:**

$$E = \frac{(R/Q) + 1}{(R/Q) + 1.5}$$

Advantages of trickling filtration plant

- **Simple and reliable process that is suitable in areas where large tracts of land are not available for a WSP treatment system**
- **Effective in treating high concentrations of organic material depending on the type of media used;**
- **Very efficient in removal of ammonia from wastewater;**
- **Appropriate for small- to medium-sized communities**

With the introduction of plastic filter media to replace the rock media, speed control, and more reliable rotary distributor mechanisms, the performance of trickling filters has been greatly enhanced.

- **Ability to handle and recover from shock loads**
- **Relatively low power requirements; they require power for pumping only and do not need large power-hungry aeration blowers. From motor-driven rotary distributors are powered by fractional horsepower electric motors.**

- **They produce less sludge than suspended-growth systems. The sludge tends to settle well because it is compact and heavy.**
- **Level of skill and technical expertise needed to manage and operate the system is moderate**
- **The cost to operate a trickling filter is very low.**

Disadvantages of Trickling filtration plant

- **Additional treatment may be needed for the effluent to meet strict discharge standards;**
- **generates sludge that must be treated and disposed of;**
- **Regular operators attention is needed;**
- **Relatively high incidence of clogging;**
- **Relatively low loadings required depending on the media;**
- **Limited flexibility and control in comparison with activated sludge processes. They require high maintenance costs of rotary distributor center mechanisms. Any maintenance service for the rotary distribution mechanism would require a crane and complete removal of the rotary distributor mechanism, guy rods, and arms.**
- **Potential for vector and odor problems**

Q3

What is Renewable Energy?

- **Renewable energy is energy from sources that are naturally replenishing but flow-limited; renewable resources are virtually inexhaustible in duration but limited in the amount of energy that is available per unit of time.**

Uses of Renewable Energy from Waste Water Sludge

BIODIESEL FROM SEWAGE SLUDGE

- **Sewage sludge produced from municipal can be turned into biodiesel fuel with existing technology.**
- **Which can compete with refineries within a few cents of conventional diesel fuel. The demand for biodiesel has led to the search for cost- effective or biodiesel raw materials.**

CONVERSION OF SEWAGE SLUDGE TO OIL AND GAS

- **Sludge can undergo chemical reactions to produce fuels that can be used to produce energy under strictly controlled conditions and extreme temperatures (450-1000 ° C). The newest innovative methods include gasification, which produces synthesis gas (similar to natural gas) and pyrolysis of bio-oil (similar to diesel oil).**
- **This sewage sludge fuel provides 100% of the thermal energy required to operate the sludge dryer.**

USE IN AGRICULTURE

- **At present, application of sludge to agriculture seems to be a most controversial but an inexpensive technique of sludge disposal. Application of sewage sludge to agriculture has proven advantageous and inexpensive for Eco cycling nutrients for land reclamation or land reuse.**