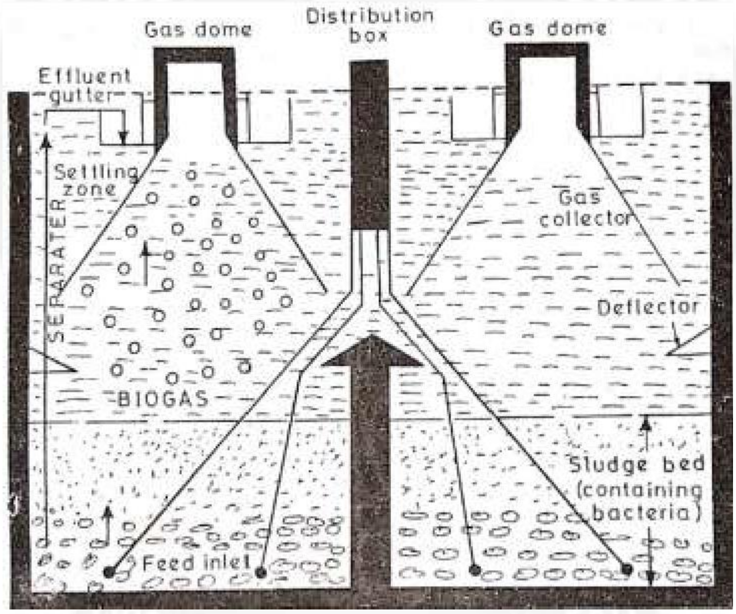
5.2 UASB (UPFLOW ANAEROBIC SLUDGE BLANKET) REACTOR

The UASB reactor maintains a high concentration of biomass through the formation of highly settle able microbial sludge aggregate. The waste water flows upwards through alayer of very active sludge to cause anaerobic digestion of organics of the waste waterat the top of the reactor, these phase separation between gas-solid-liquid takes place anybiomass leaving the reaction zone is directly recirculated from the settling g zone. The process is suitable for both soluble waste waters as well as waste water containing particulate matter.

The large scale adoption of this technique for treating municipal waste waters is comparatively of recent origin .This reactor consists of an Up flowing treatment tank, provided with a feed inlet distribution system at the tank bottom. A gas solid-liquid separator (GSS) device is provided at the top to help provide a quiescent zone at the top of the reactor.



The wastewaters enter the tank from the bottom and flows upward through the sludge bed. The sludge bed develops micro-organisms capable of Flourishing in an oxygen deficient environment. The sludge bed (blanket) traps the suspended organics of the up moving wastewater. The suspended solids trapped in the sludge bed are degraded by the producing methane and CO 2(ie, biogas, which is a mixture of 65-70% methane, and 30-35% CO2.The biogas produce of during the anaerobic decomposition reducing the BOD and suspended solids of the wastewater. The methane or biogas is collected at the top of the tank in a gas collector from Where it can be withdraw n for use as a by- product, while the water sludge mixture is made to enter a setting tank where the sludge mixture is made to enter a setting tank where the sludge settles down and f lows back into the bottom of the reactor.

The sludge will show good settling properties after an initial start up period, followed by granulation forming a sludge blanket or sludge bed in the lower part of the reactor. Retention of the bacteria contacting sludge in the reactor is one of the most important features of the UASB process. The bacteria in the sludge continue to perform their function of treating the incoming effluent. The continuous bacterial presence and activity enables retention time in the reactor to be reduced to about 6-8 hours, as compared to at least 30 hrs that is required in conventional sewage treatment systems. The treated effluent is collected in gutters, and discharged out of the reactor. The sludge is periodically shifted in to the drying beds to be used as a soil enriches, The methane generated can be used as a gas for domestic or industrial use it may also be used for generation of electricity for running the plant, after the approximated hydration and cleaning. This process can be reactivated even after the plant remains shut down for days or months, or after power breakdowns and interruptions in wastewater supply Like other high rate anaerobic systems.

The various advantages offered by UASB systems are

The space requirement of the system is quite comparable to that of an Activated sludge ie, about 0.5 acres per MLD, as compared to 2.5 acres per MLD required for oxidation ponds, and 1.5 acres for Aerated lagoons.

The capital cost investment of such a plan it s about Rs.20 lakh/MLD as compared oabout Rs.35 lakh/MLD for an Activated sludge plant, Rs.75 lakh/MLD for oxidation ponds and Rs.15lakh/MLD f or Aerated lagoons.

The system requires lesser and simpler electromagnetic parts as compared to the ones required in an Activated sludge plant, leading to lower operation and Maintenance cost.

Electricity consumption in this system , like all anaerobic systems is quite low, and the system is quite capable of withstanding long power failures.

The sludge Production system is low, and the produced sludge is having quick dewatering characteristics.

The system enables quicker sludge digestion, as compared to the conventional digestors.

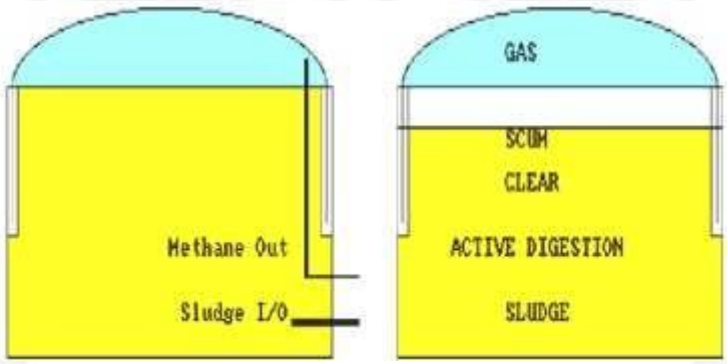
Biogas is produced in the system as a by-product, which can be used to produce electricity to run the system.

BIOGAS RECOVERY FROM SLUDGE:

In India about 30% of energy consumed by public is biological in nature. The fermentation of organic waste is carried out between 35 to 50^{0}C. Biogas, as a renewable energy, can be produced from a variety of organic raw materials and utilized for various energy services, such as heat, combined heat and power or as a vehicle fuel. Biogas can be produced by anaerobic digestion or fermentation of biodegradable materials such as biomass, manure, sewage, municipal waste, green waste, plants material and energy crops. Biogas is currently produced mostly by digestion of sewage treatment sludge, with minor contributions from fermentation of gasification of solid waste.

In today‘s energy demanding life style, biogas as the typical renewable as well as eco- friendly new energy source will replace fossil fuel inevitably. Anaerobic digestion (AD) or methane fermentation is an economical and eco-friend process for biomass, organic matter conversion to produce biogas; which mainly consists of methane and carbon dioxide. It is a biological conversion of complex substrates into biogas and inert digestate by microbial activity in oxygen free environment.

The digestion process involves four main steps, namely hydrolysis, acidogenesis, acetogenesis and methanogenesis. Sewage sludge used as substrate in this study was collected from municipal waste treatment plant (WWTP). Sludge sample was characterized before use. The used raw sludge was freshly collected and rich in anaerobic bacteria. At the end of the digestion, an average volume of biogas generated was evaluated.



The gas is collected in a steel gas holder placed at the top of digestion tank; the average composition of biogas is as follows Methane-55%, Carbondioxide 35%, Hydrogen 7.4% and Nitrogen 2.6%. Biogas improves local sanitation and health. The main objective during AD is to recover methane gas which could serve as combustible in various area of the economy, including generation of electricity, heating, and in kitchen.

5.2.1 SEQUENCING BATCH REACTORS (SBR)

The sequencing batch reactor is a fill and draw activated sludge system for waste water treatment. In this system, wastewater is added to a single “batch” reactor, treated to remove undesirable components, and then discharged. Equalization, aeration, and clarification can all be achieved using a single batch reactor. To optimize the performance of the system, two or more batch reactors are used in a predetermined sequence of operations.

SBR systems have been successfully used to treat both municipal and industrial wastewater. They are uniquely suited for wastewater treatment applications characterized by low or intermittent flow conditions.

An SBR serves as an equalization basin when the vessel is filling with wastewater, enabling the system to tolerate peak flows or peak loads in the influent and to equalize them in the batch reactor. In many conventional activated sludge systems, separate equalization is needed to protect the biological system from peak flows, which may wash out the biomass, or peak loads, which may upset the treatment process.

APPLICABILITY

SBRs are typically used at flow rates of 5 MGD or less. The more sophisticated operation required at larger SBR plants tends to discourage the use of these plants for large flow rates. As these systems have a relatively small footprint, they are useful for areas where the available land is limited.

In addition, cycles within the system can be easily modified for nutrient removal in the future, if it becomes necessary. This makes SBRs extremely flexible to adapt to regulatory changes for effluent parameters such as nutrient removal. SBRs are also very cost effective if treatment beyond biological treatment is required, such as filtration.

ADVANTAGES AND DISADVANTAGES

Some advantages and disadvantages of SBRs are listed below:

Advantages:

a) Equalization, primary clarification (in most cases), biological treatment, and secondary clarification can be achieved in a single reactor vessel.

b) Operating flexibility and control.

c) Minimal footprint.

d) Potential capital cost savings by eliminating clarifiers and other equipment.

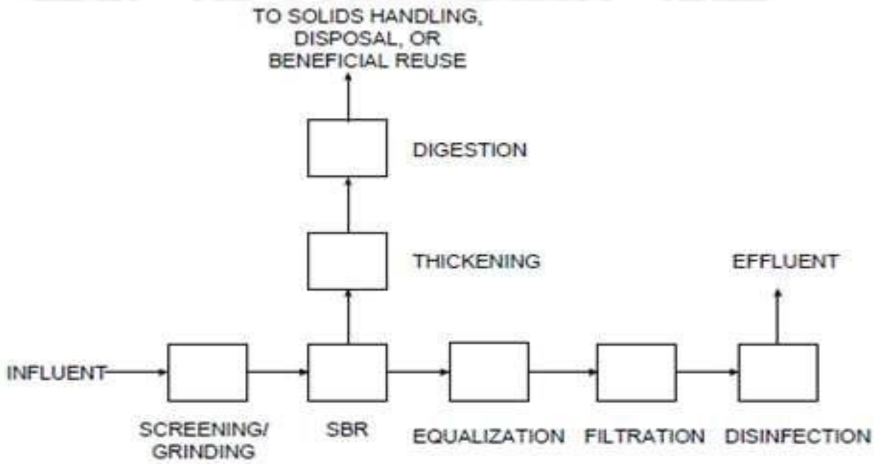
Disadvantages

a) A higher level of sophistication is required (compared to conventional systems), especially for larger systems, of timing units and controls.

b) Higher level of maintenance (compared to conventional systems) associated with more sophisticated controls, automated switches, and automated valves.

c) Potential of discharging floating or settled sludge during the DRAW or decant phase with some SBR configurations.

d)Potential plugging of aeration devices during selected operating cycles, depending on the aeration system used by the manufacturer.



Process flow diagram for a typical SBR

Construction

Construction of SBR systems can typically require a smaller footprint than conventional activated sludge systems because the SBR often eliminates the need for primary clarifiers. The SBR never requires secondary clarifiers. The size of the SBR tanks themselves will be site specific, however the SBR system is advantageous if space is limited at the proposed site.

Tank and Equipment Description

The SBR system consists of a tank, aeration and mixing equipment, a decanter, and a control system. The central features of the SBR system include the control unit and the automatic switches and valves that sequence and time the different operations. SBR manufacturers should be consulted for recommendations on tanks and equipment.

It is typical to use a complete SBR system recommended and supplied by a single SBR manufacturer. It is possible, however, for an engineer to design an SBR system, as all required tanks, equipment, and controls are available through different manufacturers. This is not typical of SBR installation because of the level of sophistication of the instrumentation and controls associated with these systems.

The SBR tank is typically constructed with steel or concrete. For industrial applications, steel tanks coated for corrosion control are most common while concrete tanks are the most common for municipal treatment of domestic wastewater.

For mixing and aeration, jet aeration systems are typical as they allow mixing either with or without aeration, but other aeration and mixing systems are also used. Positive displacement blowers are typically used for SBR design to handle wastewater level variations in the reactor.

PERFORMANCE

The performance of SBRs is typically comparable to conventional activated sludge systems and depends on system design and site specific criteria. Depending on their mode of operation, SBRs can achieve good BOD and nutrient removal. For SBRs, the BOD removal efficiency is generally 85 to 95 percent.

SBR manufacturers will typically provide a process guarantee to produce an effluent of less than:

i) 10 mg/L BOD

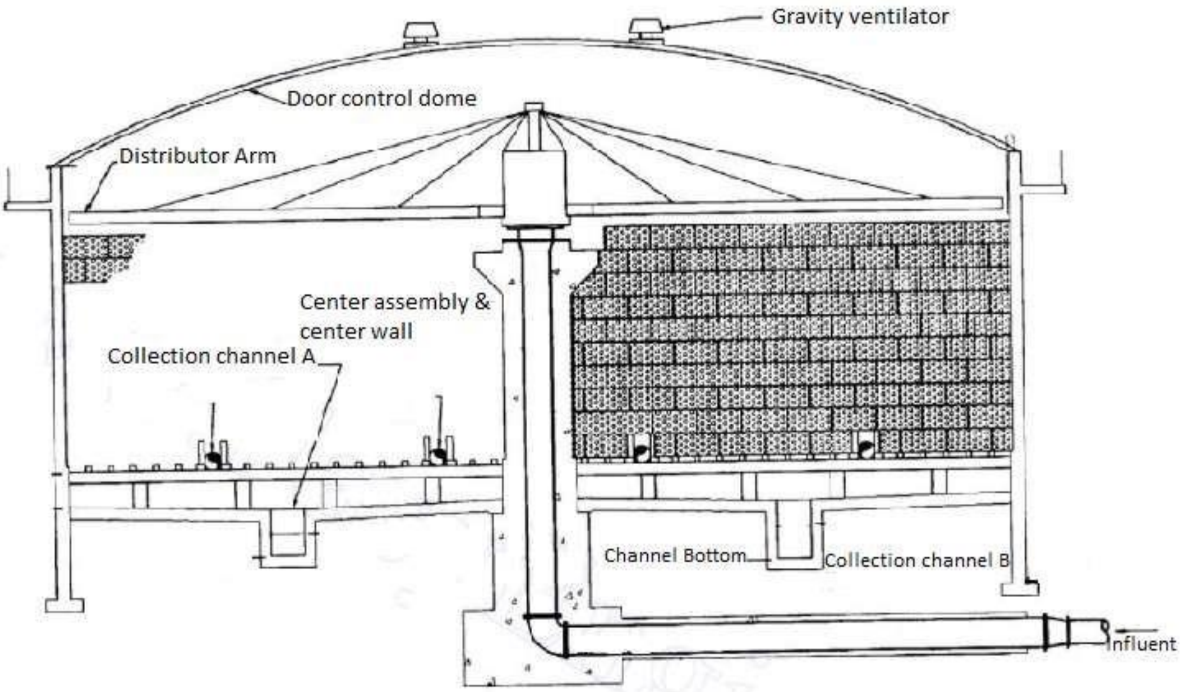
ii) 10 mg/L TSS

5.2.2 TRICKLING FILTERS

Trickling filter is an attached growth process i.e. process in which microorganisms responsible for treatment are attached to an inert packing material. Packing material used in attached growth processes include rock, gravel, slag, sand, redwood, and a wide range of plastic and other synthetic materials.

Process Description

1. The wastewater in trickling filter is distributed over the top area of a vessel containing non-submerged packing material.
2. Air circulation in the void space, by either natural draft or blowers, provides oxygen for the microorganisms growing as an attached biofilm.
3. 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 t he f lowing wastewater is synthesized into new cellular material.
4. The thickness of the aerobic layer is limited by the depth of penetration of oxygen into the microbial layer.
5. 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 slim layer and lose their ability to cling to the media surface. The liquid then washes the slime of the medium and a new slime layer starts to grow. This phenomenon of losing the slime layer is called sloughing.
6. The sloughed off film and treated wastewater are collected by an under drainage which also allows circulation of air through filter. The collected liquid is passed to a settling tank used for solid- liquid separation.



Types of Filters

Trickling filters are classified as high rate or low rate, based on the organic and hydraulic loading applied to the unit.

S.No	Design Feature	Low Rate Filter	High Rate Filter
1.	Hydraulic loading, $m^3/m^2.d$	1 - 4	10 - 40
2.	Organic loading,kg BOD / m^3.d	0.08 - 0.32	0.32 - 1.0
3.	Depth, m.	1.8 - 3.0	0.9 - 2.5
4.	Recirculation ratio	0	0.5 - 3.0 (domestic wastewater) upto 8 for strong industrial wastewater.

1. The hydraulic loading rate is the total flow including recirculation applied on unit area of the filter in a day, while the organic loading rate is the 5 day 20°C BOD, excluding the BOD of the recircular, applied per unit volume in a day.

2. Recirculation is generally not adopted in low rate filters.

3. A well operated low rate trickling filter in combination with secondary settling tank may remove 75 t o 90% BOD and produce highly nitrified effluent It is suitable for treatment of low t o medium strength domestic wastewaters.

4. The high rate trickling filter, single stage or two stage are recommended for medium

to relatively high strength domestic and industrial wastewater. The BOD removal efficiency is around 7 5t o 90% but the effluent is only partially nitrified.

5. Single stage unit consists of a primary settling tank filter, secondary settling tank and facilities for recirculation of the effluent. Two stage filters consist of two filters in series with a primary settling tank, an intermediate settling tank which may be omitted in certain cases and a final settling tank.