Overview of Different Aerobic and Anaerobic technologies for Wastewater Treatment

Pratibha[1] Dr Govind Pandey[2]
[1]Research Scholar [2]Associate Professor
[1,2]Department of Environmental Engineering
[1,2]Madan Mohan Malaviya University of Technology

Abstract— For the treatment of industrial and municipal wastewater aerobic and anaerobic systems have been employed for many years. This paper provides a review of the various types of both anaerobic and aerobic techniques for the treatment of wastewater. A wide variety of technologies for wastewater treatment are available, which include both aerobic and anaerobic treatment processes. This paper reviews about different treatment technologies, along with their characteristic features.

Key words: wastewater, sequential batch reactor(SBR), MBR (membrane biological reactor), ASBR (anaerobic sequencing batch reactor), SRT (solid retention time), Biological filtration and oxygenated reactor(BIOFOR)

I. INTRODUCTION

Wastewater can be defined as the liquid waste which has been generated from the community after the utilisation of water by them. Thus wastewater can be recognised as a combination of residential wastes , institutional wastes and various commercial and industrial wastes. The decomposition of organic matter present in untreated wastewater leads to nuisance condition resulting in the production of malodorous gases. The branch of environmental engineering consists of a potential branch ;wastewater engineering, which deals with the basic principles of science and engineering to solve the issues associated with wastewater treatment and its reuse. The ultimate goal of wastewater treatment is to establish healthy relationship between public and environment along with economic social and political concerns.

Different approved technologies for wastewater treatment has been included in this paper:

A. AEROBIC TREATMENT PROCESS:

- Membrane bio-reactor
- Sequencing batch reactor
- BIOFOR

B. ANAEROBIC TREATMENT PROCESS:

- Anaerobic contact process
- Complete mix process
- Anaerobic sequencing batch reactor

II. TECHNOLOGIES ANALYZED

A. Aerobic treatment process:

1) Biological treatment with Membrane separation

Membrane biological reactors (MBRs), which consist of a biological reactor (bio reactor) along with suspended bio mass and solids separated by nominal pore size micro filtration membrane(ranging from 0.1-0.4 micro -meter) which have several applications in treatment of wastewater. Membrane biological reactor systems can be applied both with aerobic and anaerobic suspended growth bio reactors. So as to separate treated wastewater from the active biomass. The effluent quality produced through this membrane system is of same quality as the combination of treatment through secondary clarification and effluent micro filtration. Membrane biological reactors have been practised for treatment of municipal and industrial wastewater (Brindle and Stephenson, 1996; Van Dijkand Roncken,1997;Trussell Et Al.,2000) and for applications of water reuse (Cicek Et Al.,1998).

2) Overview of membrane Biological reactors

The concept of MBR basically deals with combining and utilising a bio reactor and micro filtration as one unit process for treatment of wastewater and as a result in some cases finally replacing and supplementing, the function of solid separation of both secondary clarification and effluent filtration.

With an approach to eliminate secondary clarification and operation at higher concentration of MLSS provides the following advantages –

[1] Higher rates of volumetric loading thereby shorter reactor times of hydraulic retention
[2] Less sludge production due to longer SRTs
[3] Potential for simultaneous operation of nitrification and de nitrification at low DO concentrations, in long SRT designs.
[4] Effluent generated is of high quality in terms of TSS, BOD low turbidity and bacteria
[5] *Disadvantages* Include high capital cost, high energy costs, high cost involved in periodic replacement of membrane

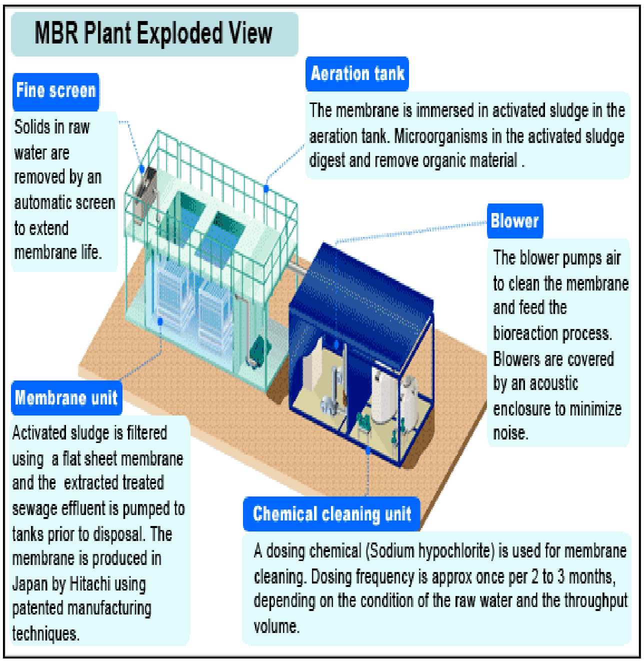


Fig. 1:

B. Sequencing batch reactor process

The sequencing batch reactor (SBR) process works with fill-and-draw reactor which undergoes complete mixing after the filling operation during batch reaction step, followed by subsequent steps of aeration and clarification occurring in the same tank. All SBR consists of five steps which goes through proper sequence as follows; 1. Fill, 2. React (Aeration), 3.Settle (Sedimentation/Clarification), 4. Draw (decant), 5.Idle. Two SBR tanks must be provided for continuous –flow applications ,so that when one tank receives flow other completes its treatment cycle. (Metcalf and Eddy; TATA McGRAW-HILL)

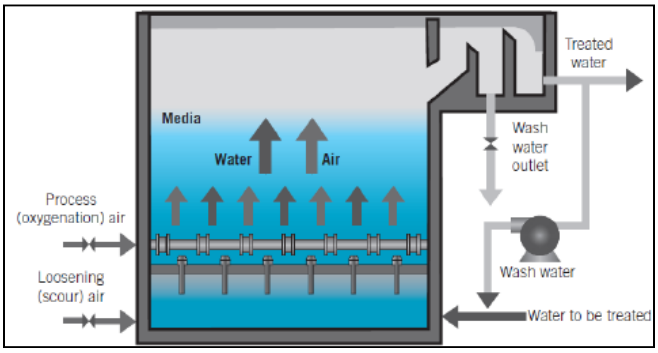
C. Sludge wasting in SBRs

Another most important step in the SBR operation is sludge wasting. The amount and frequency of sludge wasting is decided by performance requirements. During operation of SBR sludge wasting occurs usually during the react phase so as to maintain uniform discharge of solids which includes fine materials and large floc particles. An important feature of the SBR system is that there is no requirement of return activated sludge system(RAS), as both aeration and settling operation occurs in the same chamber thus no wastage of sludge in the react step and hence none has to be returned to maintain the solid contain in the reaction chamber.

Fig. 2:

D. BIOFOR® process

The Biofor® process is an upflow submerged aerobic attached growth process, which has been used at more than 100 installations in Europe and North- America(Ninassi Et Al.,1998).It has atypical bed depth of 3m but designs falls in the range of 2-4 m bed depth have been used(Pujol Et Al,1994).The packing material, termed as Biolite®, which is basically an expanded clay material having density greater than 1.0 and a 2-4mm size range . Distribution of influent wastewater up through the bed is done through inlet nozzles, and it consists of an air header (Oxazu® system) to provide process air across the bed area . Backwashing is performed once per day to expand the bed with a water flush rate of 10-30m h^{-1}. To protect the inlet nozzles fine screening of the wastewater is needed. This process has been utilised for BOD removal and nitrification and denitrification.



E. Anaerobic treatment process

1) Anaerobic contact process

Without recycling the anaerobic contact process overcome the disadvantages of complete –mix process to make the process where SRT is longer than *r*, biomass is separated and returned to the complete mix or contact reactor. The anaerobic reactor volume is reduced by separating the STR and *r* values. Before sludge recycling, gravity separation is most common step for solid separation and thickening. In place of gravity separation, separation of solids has been focussed on gas floatation process by dissolving the process off-gas under pressure. As the reactor sludge contains gas which is produced in an aerobic process, as a result of which separation of solid- liquid can be hindered. Several methods have been applied so as to neglect the effect of trapped gas bubbles in the sludge-settling step. These methods include gas stripping by agitation or vacuum degasification, inclined plate separator, and use of coagulant chemicals (Malina and Pohland, 1992).

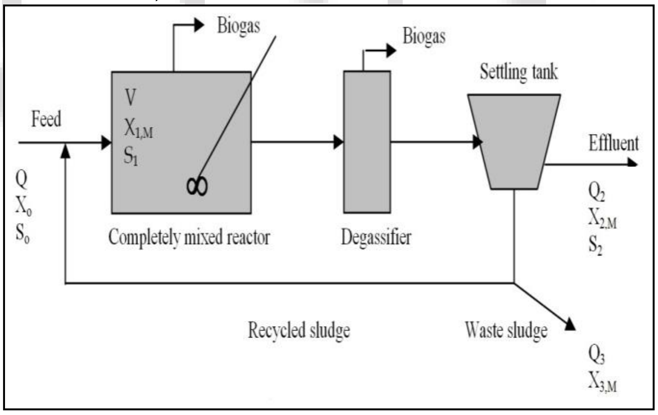


Fig. 3:

F. Anaerobic sequencing batch reactor:

The anaerobic sequencing batch reactor (ASBR) process can be categorised as suspended growth process. ASBR is most commonly like aerobic sequencing batch reactor in which solid-liquid separation occurs in same vessel. The success determination of ASBR is the development of good settl8ing granulated sludge same as observed in up flow anaerobic sludge blanket (UASB) processes (Speece,1996).The operation of ASBR divided into four steps: (1)feed (2)react (3) settle(4)decant/effluent withdrawal. During the reaction period, to provide uniform distribution of substrates and solids; intermittent mixing for a few minutes each hour is done (Sung and Dague, 1995). At temperatures ranging from 5ºC-25ºC treatment of non-fat dry milk synthetic substrate with a 600mg/litre feed COD concentration (Banik and Dague 1996); the feasibility of the process was demonstrated in the laboratory reactors. By selecting hydraulic retention times ranging from 6.0-24.0h ;the organic loading of the process was changed.

An important feature of the ASBR process is the settling velocity of the sludge before effluent decanting during the settle period.

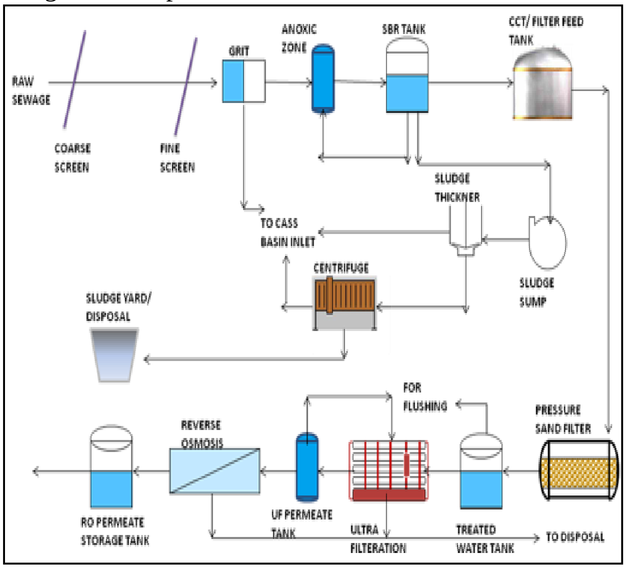


Fig. 4:

G. *Anaerobic suspended growth processes*

1) *Complete mix process*

The hydraulic retention and solids retention times are equal (r= SRT). For operation and process stability, to provide sufficient safety factors the reactor r may be in the range of 15-30d (Parkin and Owen, 1986). The complete mix digester without recycle of sludge is more suitable for wastes with high solids concentration or high concentration of dissolve organics, where thickening of the effluent solids is more difficult so as to make it practically to operate with the condition where r=SRT(METCALF and EDDY; TATA McGRAW-hill.)

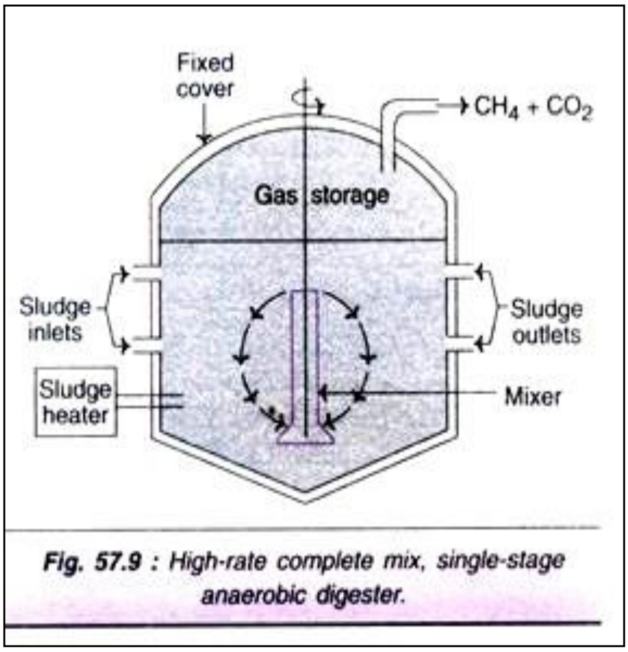


Fig. 5: Volumetric organic loading, Kg.COD/m3. d (1.0-5.0), Hydraulic retention time r,d(15-30)

III. CONCLUSION

From the overall discussion it has been concluded that for the purpose of agriculture and as drinking water supplement; sewage treatment and reuse of treated effluent is currently attracting attention as a reliable source of water. Impact of untreated or inadequately treated wastewater on the environment and public health is of great concern and should be monitored properly. As, it has been noticed untreated wastewater causes proliferation of pathogens; which may create several health related problems. To avoid this problem proper treatment of wastewater followed by regular monitoring, proper planning and an appropriate legislations must be followed. (A.K. Por, O.B. and Muchie M,2011)

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