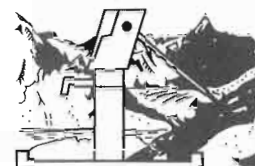




WATER, ENVIRONMENT AND MANAGEMENT

Plastic media for waste water treatment

Nanayanaswamy Venkataraman

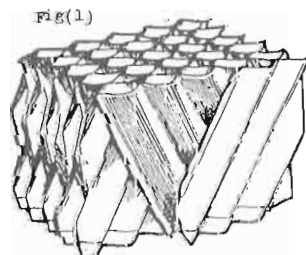
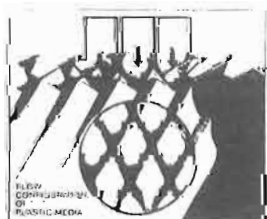


INTRODUCTION

Engineers always design a treatment plant to accomplish a particular degree of treatment, but a complete or 100% removal of the pollutant is uneconomical and never aimed at. Distilleries, paper and pulp, to name a few, discharge high strength biological effluents; treatment of the biological waste has to be carried out for cost efficient and for low recurring cost. Fixed film plastic media in the form of modular sheets has been extensively used for aerobic and anaerobic processes and the plastic media in the form of hexagonal tubes has been used for sedimentation process. This paper deals with the salient features and performance of these plastic media in waste water treatment.

FEATURES OF MODULAR MEDIA

Basically there are two types of plastic media - random and modular. Modular media is again of two types - straight lateral and cross flow. This paper deals with the cross flow type. The plastic material would be of PVC and thermoformed to form sheets having triangular wave like flutes. Each sheet is corrugated at 60° and is glued to the next sheet to form a particular criss cross pattern (fig 1). There are nearly 4000 contact



points per cu.m. of module and this provides internal mixing & redistribution which increases the liquid film diffusion of the waste water across the biomass. Around 95% voidage is there in the module

for free access of air and has a specific surface area of 100 - 240 sq.m / cu.m.

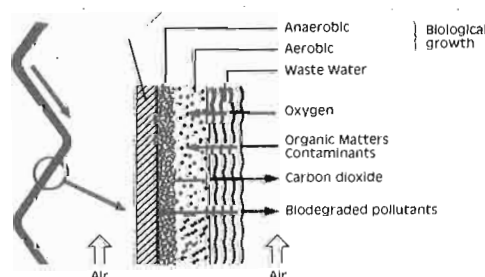
FEATURES OF TUBULAR MEDIA

The plastic media in the form of tubes are a form of parallel plate gravity separators and are called as Tubesettlers. These tubesettlers are manufactured from PVC, that follows the formation of tubes in various configuration. The tubes are hexagonal in cross section and has a perimeter of 50 cms. The tubesettler has a specific surface area of 11 sq.m / cu.m and are inclined at 60°. The individual tubes are joined together to form a bundle of tubes.

APPLICATIONS

Bio Filter Treatment

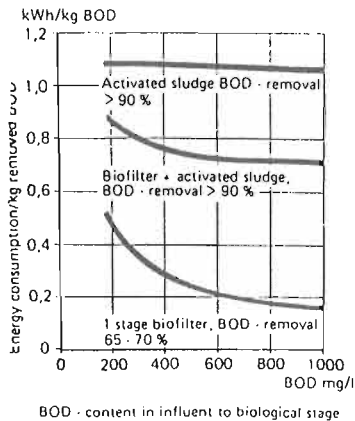
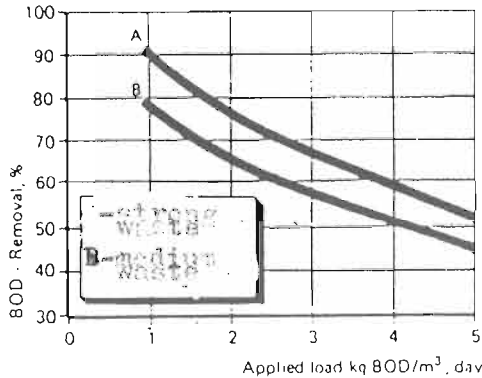
Trickling filter or bio filter is a reliable system for reducing high and medium strength BOD₅ in the waste water. The waste water is spread over the plastic media in the bio filter. On the media a bio film is growing and builds up by itself. The process of conversion is explained in fig 2. The voidage of the media gives enough room for developing the bio film without bridging one sheet to the other and



without disturbing the air flow. Modified VELZ equation has been considered to be the best mathematical modelling for the optimum design of high rate bio filter with plastic media.

$$\ln\left(\frac{S_i}{S_o}\right) = \frac{K_{20} \times A_s \times D \times Y^{(T-20)}}{Q^n}$$

where S_i , S_o are inlet and outlet BOD_5 in ppm, K_{20} the rate constant, A_s specific surface area in sq.m / cu.m, D_s the depth of the media in M, Y the temperature coefficient, T the operating temperature in °C, Q the feed flux in cu.m/ sq.m./hr, n the constant. Experimentally, it has been determined the value of K_{20} to be .0024 for A_s of 100. Often it has been found, that it is more economical to use bio filters in the roughing stage, wherein BOD_5 is reduced by 50 - 60%, further which it is subjected to other processes. Fixed film bio filters used in conjunction with the primary and secondary clarifiers can reduce BOD_5 and suspended solids to above 90%. Graph 1, gives the broad design criteria and conditions for the design of bio filters using plastic media and Graph 2 gives the relative energy consumption of various treatment options. Bio filters provide



an effective means of oxidising ammoniacal nitrogen to nitrite nitrogen of secondary treated waste water. To treat a paper mill effluent having a flow of 14100 cu.m/d, BOD_5 of 650 ppm, plastic media volume was around 6300 cu.m to reduce the BOD_5 to 20 ppm by 2 stage bio filter. Following table gives the performance of bio filters, where the flow is in MGD, BOD_5 in ppm, and the media volume in cu.ft.

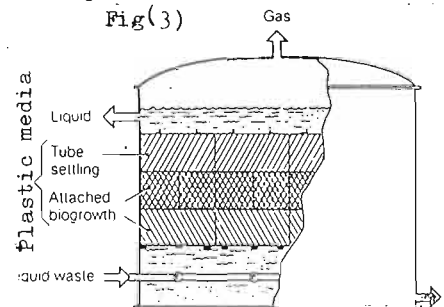
Flow (MGD)	BOD_5 in (ppm)	BOD_5 out (ppm)	Media Volume (cu.ft)
0.6	210	10	19,300
1.8	240	20	25,000
2.3	127	10	31,400
7.0	135	18	265,000

Revamping Bio Filters

The high performance of plastic media makes it an ideal way to upgrade the existing bio filter fitted with stone media. Revamping the existing bio filter with stone media by plastic media may be necessary due to a) non availability of area to construct new filters, b) increase in applied, organic or hydrolic loads, c) demand for better effluent standards and d) deterioration of the stone media. For each of the above conditions, replacement by plastic media is economical and efficient. It is possible to increase the height of the existing bio filter to 6 M high without changing the supporting and distributing system, to achieve the desired efficiency. Upgrading rock media with plastic media has reported high results at Seneca army depot, New York, Florida waste water treatment plant, Bridgeport Pennsylvania waste water treatment plant and others.

Anaerobic treatment

Plastic modular media in the anaerobic digesters offer a greater strength to the attached growth, while enhancing the tube settling action to retain the solids in the reactor and the growth of the active bio mass in the reactor. The surface within the media is specially designed that a controlled flow distribution is achieved, which is essential to ensure an intense contact between the biomass and the waste water. At a nominal film thickness of 3mm, about 300 Kgs of anaerobic sludge per cu.m will be available as an attached growth totally unaffected by the hydraulic fluctuations. A rough schematic is shown in fig 3.



Following table gives the plastic media volume for various duty conditions when used in the anaerobic digestors.

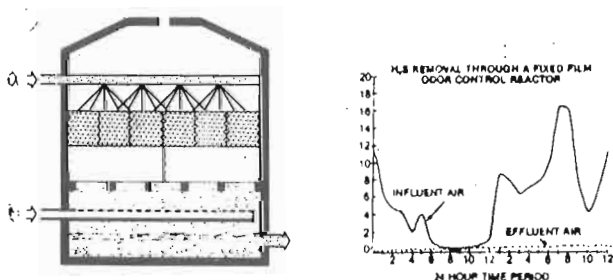
Sl#	Flow	BOD ₅ in	COD in	Media vol	Source
1	125	50000	90000	850	distillery
2	225	40000	100000	2000	distillery
3	200	2500	3500	40	fruit pulp
4	420	1400	2100	75	dairy

Flow in cu.m/d, BOD₅, COD in ppm, and media volume in cu.m.

Reduction of 90% BOD₅ were achieved in all the above cases. Sl# 1 & 2 are for biogas generation. The gas yield was noticed at 0.3 NM³ / Kg of COD destroyed. The main constituent of the gas was methane with 65%. There are reports of anaerobic processes operating at a specific loading of 27 Kg COD/d/cu.m. Bacardi process developed by Larsen of U.S. are the pioneers in using plastic media for use in anaerobic digestors to treat cane sugar based mollasses distillery effluent.

Odour Scrubbing

Objectionable odour in the form of Hydrogen Sulphide generated from waste water treatment facilities can be effectively oxidised with plastic media having specific surface area of 240M²/M³. In a scrubber, similar to that of a scrubber in a degassification plant. The air containing the abnoxious compound is biologically oxidised by the biomass sustained on the plastic media. This oxidation occurs as the treated waste water is applied across the top of the media counter to the upward flow of the air being treated. H₂S removal to below 2ppm can be accomplished as shown in Graph 3. Other traditional methods calls for chemical storage, feed control and sludge generation which are totally eliminated in this scrubber (see fig 4).



a. Applied hydraulics
b. Foul air from filter/other source

Sedimentation

The conventional mechanical clarifier operate at an overflow rate of 1-2 cu.m/sq.m/Hr, while these hexagonal tube settlers operate at 7-9 cu.m/sq.m/hr, making it atleast 3 times more efficient. The criteria for designing the tube settler are the settling velocity, particle size and the sludge volume index of the suspended matter. The tube settlers has a specific weight of 65 Kg/cu.m and can be housed with simple supports. These tube settlers can also be used in conjunction with the existing clarifier mechanism and while doing so they increase the efficiency of the system. It is also possible to use the tube settler as a total replacement of the existing clarifier. Advantages of tube settler include a) reduced size of clarifier, which means reduction in initial investment, b) no power requirement and c) no moving parts which means nil recurring cost. Care should be taken to size the tube settler for clarification. Normally, tube settlers are of 0.5 - 1 metre in vertical height. Among the other geometry available, it is found that hexagonal tube settlers are more efficient.

CONCLUSIONS

Plastic media being inert to most chemical and biological can be effectively used in the bio filters, anaerobic digestors and in the clarifier systems. The normal practice is to use PVC, but the latest trend is shifting towards PP material, due to its ability to withstand higher operating temperatures when handling high to medium strength biological waste water and medium to low suspended solids, plastic media are an effective and economical alternative.

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