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Comparative Analysis of Activated Sludge Process and Moving Bed Bio-Reactor (MBBR) Technology of Nesapakkam Sewage Treatment Plant-40mld

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Abstract:
Technical progress in the field of municipal wastewater treatment, which includes removal of eutrophicating pollution loads, has in the past few years significantly improved the process flow of sewage treatment plants. More attention is now being paid to the high number of disease-causing germs in the sewage treatment plant effluent. Micro and ultra filtration, combined with the ASP, has turned out in recent years to be a suitable method for minimizing the effluent load. Tightening discharge standards for sewage treatment effluents can thus be met, without the need for the conventional aeration and secondary clarification tanks or filtration and disinfection plants. The MBBR system can be installed in existing plants for increasing capacity and nutrient removal without requiring additional tanks. Therefore project duration is shortened and space required for additional reactors is not required. The flexibility of the system also makes it a cost effective solution for the construction of new plants.

Keywords: Activated sludge process, MBBR system, sewage treatment effluent, cost effective, flexibility

I. INTRODUCTION

The importance of water as a global resource for human life is irrefutable. It follows then that the need to manage and protect this resource has been recognized for centuries, such that it is now a conservation priority the world over. Advancements in the efficiency, convenience and sanitation of human society have owed directly to the development and distribution of large-scale dependable supplies of high-quality potable water (Oswald, 1988b). Unfortunately, these same developments have also allowed for the convenient aqueous disposal of objectionable, infectious and toxic wastes away from their points of origin and, most commonly, into the nearest natural body of water (Oswald, 1988b; Shiny *et al.*, 2005). It is this aqueous waste, or 'wastewater', and the processes involved with its remediation that form the basis of this thesis. A prominent threat to global water quality in general is its contamination with human derived wastes of residential, industrial and commercial origins. This is particularly the case for freshwater resources, where human-derived wastewaters are one of the major sources of contamination and pollution (Craggs *et al.*, 1996). In recent times, a general decline in environmental water quality—a consequence of anthropogenic interactions— has given rise to significant environmental problems and public health concerns (Hoffmann, 1998). These pollution-associated issues have, therefore, justifiably received increasing levels of attention, to the extent that they are nowadays of major concern to modern society (de la Noüe *et al.*, 1992). Pollution in its broadest sense includes all changes that curtail natural utility and exert deleterious effect on life. The crisis triggered by the rapidly growing population and industrialization with the resultant degradation of the environment causes a grave threat to the quality of life. Degradation of water quality is the unfavorable alteration of the physical, chemical and biological properties of water that prevents domestic, commercial, industrial, agricultural, recreational and other beneficial uses of water. Sewage and sewage effluents are the major sources of water pollution. Sewage is mainly composed of human fecal material, domestic wastes including wash-water and industrial wastes. The growing environmental pollution needs for decontaminating waste water result in the study of characterization of waste water, especially domestic sewage. In the past, domestic waste water treatment was mainly confined to organic carbon removal. Recently, increasing pollution in the waste water leads to developing and implementing new treatment techniques to control nitrogen and other priority pollutants. Sewage Treatment Plant is a facility designed to receive the waste from domestic, commercial and industrial sources and to remove materials that damage water quality and compromise public health and safety when discharged into water receiving systems. It includes physical, chemical, and biological processes to remove various contaminants depending on its constituents. Using advanced technology it is now possible to re-use sewage effluent for drinking water.

II. SEWAGE TREATMENT PLANT

Sewage Treatment Plant is a facility designed to receive the waste from domestic, commercial and industrial sources and to remove materials that damage water quality and compromise public health and safety when discharged into water receiving systems. The Principal objective of waste water treatment is generally to allow human and industrial effluents to be disposed of without danger to human health or unacceptable damage to the natural environment. Conventional wastewater treatment consists of a combination of Physical, chemical, and biological processes and operations to remove solids, organic matter and, sometimes, nutrients from wastewater. Sewage treatment generally involves three stages, called primary, secondary and tertiary treatment. Preliminary treatment removes coarse solids and other large materials often found in raw wastewater. Removal of these materials is necessary to enhance the operation and maintenance of subsequent treatment units. Preminary treatment operations typically include coarse screening and grit removal.

Primary treatment stage sewage flows through large tanks, commonly called "primary clarifiers" where the sludge gets settled at the hopper bottom which is removed at regular time intervals while grease and oils rise to the surface and are skimmed off.

Secondary treatment is the further treatment of the effluent from primary treatment to remove the residual organics and suspended solids. In most cases, secondary treatment follows primary treatment and involves the removal of biodegradable dissolved and colloidal organic matter using aerobic biological treatment processes.

Tertiary treatment is the final treatment stage to further improve the effluent quality before it is discharged to the receiving environment (sea, river, lake, ground, etc.). More than one tertiary treatment process may be used at any treatment plant. If disinfection is practiced, it is always the final process. It is also called "effluent polishing."

III. ACTIVATED SLUDGE PROCESS

The **screening** of waste water is generally done by sieving the influent on bar screens which is separated by vertical bars. Sand and similar heavy particles are removed next in a **grit chamber** where they settle to the ground. This chamber only wants to remove coarse grit and the waste water spends only a relatively short period in it.

Primary sedimentation in a municipal wastewater treatment plant is generally plain sedimentation without the use of chemicals. In treating certain industrial wastes chemically aided sedimentation may be involved. In either case, it constitutes **flocculent settling**, and the particles do not remain discrete as in the case of grit, but tend to agglomerate or coagulate during settling. Thus, their diameter keeps increasing and settlement proceeds at an over increasing velocity. Consequently, they trace a curved profile. The settling tank design in such cases depends on both **surface loading** and **detention time**. Scale-up factors used in this case range from 1.25 to 1.75 for the overflow rate, and from 1.5 to 2.0 for detention time when converting laboratory results to the prototype design. For primary settling tanks treating municipal or domestic sewage, laboratory tests are generally not necessary, and recommended design values given in table may be used. Using an appropriate value of surface loading from table, the required tank area is computed. Knowing the average depth, the detention time is then computed. Excessively high detention time longer than 2.5 h must be avoided especially in warm climates where an-aerobicity can be quickly induced. After this primary treatment the pre-treated wastewater is mixed with the concentrated underflow activated sludge from the secondary clarifier in an aerated tank. Aeration is provided either by mechanical surface agitators or by submerged diffusers of compressed air. Aeration provides oxygen to the activated sludge and at the same time thoroughly mixes the sludge and the wastewater. During aeration and mixing, the bacteria form small clusters. The bacteria in the activated sludge degrade the organic substances in the wastewater. They use the organic substance for energy, growth and reproduction.

Table.1. the Treatment Unit Is Designed and It Is Represented Below

S.NO	DESCRIPTION	NO OF UNITS	DIMENSION
1	Inlet chamber	1	6.3mx3mx2.7m
2	Manual coarse screen Mechanical coarse screen Mechanical fine screen	1 1 1	9mx2.79mx1.3m 9mx2.79mx1.3m 9mx2.79mx1.3m
3	Grit chamber	2	10.9mx10.9mx1m
4	Parshall flume	2	0.9mx0.6mx0.075m
5	Primary clarifier	1	3.5m(depth)x46m(dia)
6	Primary sludge sump	1	3.5m(depth)x 3m(dia)
7	Aeration tank	1	45mx45mx4.53m
8	Secondary clarifier	1	3.5m(depth)x46m(dia)
9	Sludge re-circulation sump	1	5m(depth)x 6(dia)
10	Sludge thickener	1	31.3(dia)
11	Dilution water sump	1	8mx3mx2.5m
12	Thickened sludge sump	1	8.2mx3.5mx2.5m
13	Sludge digester	1	11(depth)x 30(dia)
14	Gas holder	1	5.7(depth))x 25(dia)
15	Sludge balancing tank	1	3.5mx3.5mx3.5m
16	Supernatant and centrate sump	1	5mx4mx2m
17	Gas burner	1	8mx6mx4m
18	Chlorine contact tank	1	38mx11.7mx3m

IV. MOVING BED BIO-REACTOR (MBBR) TECHNOLOGY

Moving Bed Bio-film Reactor (MBBR) processes improve reliability, simplify operation, and require less space than traditional wastewater treatment systems. MBBR technology employs thousands of polyethylene bio-film carriers operating in mixed motion within an aerated wastewater treatment basin. Each individual bio-carrier increases productivity through providing protected surface area to support the growth of heterotrophic and autotrophic bacteria within its cells. It is this high-density population of bacteria that achieves high-rate biodegradation within the system, while also offering process reliability and ease of operation. This technology provides cost-effective treatment with minimal maintenance. Since MBBR processes self-maintains an optimum level of productive bio-film. Additionally, the bio-film attached to the mobile bio-carriers within the system automatically responds to load fluctuations. The MBBR process uses small plastic carrier elements to provide sites for bacteria attachment in a suspended growth medium. The carrier elements allow a higher biomass concentration to be maintained in the reactor compared to a suspended growth process, activated sludge. This increases the biological treatment capacity for a given reactor volume. The carrier elements can be installed in either an anoxic reactor or aeration basin. A screen or sieve assembly with 5 mm slot openings is used to retain the carrier elements in the reactor. These processes are intended to enhance the activated sludge process by providing a greater biomass concentration in the aeration tank and thus offer the potential to reduce the basin size requirements. They have also been used to improve the volumetric nitrification rates and to accomplish the de-nitrification in aeration tanks by having anoxic zones within the bio-film depth. However, the process does not require backwashing of the retention screens which retain the carriers. The carrier elements are continuously kept in suspension by either a mixer or an aeration system. The agitation pattern in the reactor is designed to provide an upward movement of the carriers across the surface of the retention screen which creates a scrubbing effect to prevent clogging. Coarse bubble and jet aeration are typically used to provide oxygen for an aerobic reactor. Reports using fine bubble aeration in an MBBR system indicate the media cause the bubbles to coalesce, thereby reducing oxygen transfer efficiency. Jet aeration is recommended for new installations due to its intense mixing and improved oxygen transfer efficiency when compared to coarse bubble aeration. The treatment unit is designed and it is represented below

Table.2. treatment Unlit is designed and it is represented below

S.NO	DESCRIPTION	NO OF UNITS	DIMENSION
1	Inlet chamber	1	6.3mx3mx2.7m
2	Manual coarse screen Mechanical coarse screen Mechanical fine screen	1 1 1	9mx2.79mx1.3m 9mx2.79mx1.3m 9mx2.79mx1.3m
3	Grit chamber	2	10.9mx10.9mx1m
4	Parshall flume	2	0.9mx0.6mx0.075m
5	Equalisation tank	1	33.34mx33.34mx3m
6	BOD and nitrification unit	2	13mx12mx5m
7	Clarifier	2	3m(depth)x 40m(dia)
8	Sludge sump	1	2.5m(depth)x 11.4m(dia)
9	Sludge thickener	1	3.5m(depth)x 22.1m(dia)
10	Sludge digester	1	11m(depth)x 30m(dia)
11	Gas holder	1	5.7m(depth)x 25m(dia)
12	Sludge balancing tank	1	3.5mx3.5mx3.5m
13	Supernatant and centrate sump	1	4mx3mx2m
14	Gas burner	2	8mx6mx4m
15	Chlorine contact tank	1	8mx11.7mx3m

Table.3. Comparison of ASP and MBBR Technology

S.NO	ACTIVATED SLUDGE PROCESS	MOVING BED BIO-REACTOR (MBBR) TECHNOLOGY
1.	**Recycling** is done	Recycling is not done, **single flow process**
2.	Un Stable under large load variations	Stable under large load variations
3.	Un reliable and more operator intensive treatment plant	Reliable and least operator intensive treatment plant
4.	If there is sudden increase in the volume of sewage or if there is a sudden change in the characteristics of sewage, there are adverse effects on the working of the process and consequently effluent of bad quality is obtained.	The existing plant **capacity can be increased** by adding more media into the MBBR Tank.
5.	**High land area** requirement.	**Compact** and occupy very less space.
6.	**High power** consumption.	**Low power** consumption.
7.	Good quality effluent.	Quality of the effluent is much better than ASP

V. CONCLUSIONS

Design of Nesapakkam Sewage treatment plant- 40 MLD using Activated Sludge process and MBBR (Moving bed bio-reactor) technology was done and the following advantages were found in MBBR after the comparative study with ASP:

1. The flow scheme in Activated Sludge Process (ASP) involves the pattern of sludge return to the aeration tank from the secondary clarifier whereas Moving bed bio reactor (MBBR) does not involve the re-circulation of sludge. It is a single flow process.
2. Moving bed bioreactor technology is a space saving technique. Its module based design allows the capacity to be easily increased when needed.
3. MBBR has self-regulating biomass which is an added advantage.
4. MBBR is fully automated, the processes are inherently simple and as a result minimal operator intervention is required in regard with ASP.
5. More stable under large load variations
6. Adding carriers for greater performance, adding parallel units for greater capacity in Moving Bed Bio Reactor (MBBR) would be the better solution when compared with ASP.
7. Both the maintenance cost and installation cost is lower as compared with ASP because of their compact size in confined space.

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