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Design of Wastewater Treatment plant in Nagpur City: By Adopting SBR Techniques

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Abstract *-The treatment plant present in Bhandewadi, are one of the biggest water treatment projects of NMC & MAHAGENCO, Nagpur. The STP having 200 MLD capacities. The treatment plant are built totreat wastewater collecting from all the sewer line in Nagpur (having population 27.4 lac). In the plant , removal of many contaminants is focused, such as of BOD , COD , TSS , pH , SS ,TDS , DO & oil& grease .This paper gives an idea of importance or need of new STP for the preventing environment from pollution. In Nagpur about an average 345.40 MLD sewage produced and around 200 MLD sewage get treated in existing plant situated in Bhandewadi. This research gives need of STP for the better environment and Nagpur becoming truly one of the smartest city. The design of new wastewater treatment plant is based on C-Tech process(i.e. SBR) which is more efficient than conventional treatment plant. Removal of BOD up to 98% and stable suspended solid effluent was obtained by modified SBRs. Removal of phosphorous 80% was reached when SBR optimized.*

This paper gives aninformation's and the advantages of Sequential Batch Reactor technology along with some previous research work done by the researchers.

Keywords**: Wastewater,Sequential Batch reactor, Sludge, BOD, COD, TDS, Reuse.**

1. INTRODUCTION

Wastewater treatment plant (WWTP) is a complicated system in which processes of removingContaminants from municipal and/or industrial wastewater take place. Preliminary, primary and secondary processes are used to remove impurities present in sewage before their discharge to the receiver. The activated sludge treatment approach, which uses bacteria and other microorganisms to remove contaminants by assimilating them, has been widely adopted in most WWTPs.

Batch type WWTP, sequencing batch reactor (SBR), is a popular method of municipal wastewater treatment. SBRs are a special form of activated sludge treatment in which all processes take place in the reactor tank. SBR is used for small-scale wastewater treatment and also becomes useful as a decentralized wastewater treatment technology for on-site treatment and/or water reuse technologies related to the sustainable water system. A process sequence for SBR system is: filling, aeration or biological reactions (aerobic, anaerobic), sedimentation, decantation and idle state.

1.1 Sequential Batch Reactor (SBR)

Sequential batch reactor is a type of biological treatment system in which stabilization of organic matter, flocculation of generated cells and settling of cells occur in a safe tank. In its operations, the cycle processes FILL-REACT, REACT, SETTLE DRAW are controlled by time to achieve the objectives of the operation. Each process is associated with particular reactor conditions (turbulent/Quiescent, Aerobic/Anaerobic) that promote selected changes in the chemical and physical nature of the waste water. These changes lead ultimately to a fully treated effluent.

1.1.1 Process Description

1.1.1.1 Fill / Aeration (F/A):

The influent to the tank may be either raw wastewater (screened and de-gritted) or primary effluent. It may be either pumped in or allowed to flow in by gravity. The feed volume is determined based on a number of factors including desired loading and detention time and expected settling characteristics of the organisms. The time of Fill depends upon the volume of each tank, the number of parallel tanks in operation. The time dedicated to react can be as high as 50% or more of total cycle time (i.e. 1.5 hr)

1.1.1.2 Settling (S):

The air is turned off and influent to the reactor basin is stopped. During the first five minutes of this sequence, the residual mixing energy within the reaction basin is consumed. At this time gentle bio-flocculation initially takes place, a solids-liquid interface forms under partial hindered settling conditions. Rising sludge does not occur.

1.1.1.3 Decanting (D):

This sequence is an extension of the settle sequence and is also totally quiescent whereby a moving weir lowering decanter is used to take the operating liquid level in the basin to its designated bottom water level reference position. In this way supernatant is withdrawn from a subsurface position under laminar flow conditions. This allows optimum removal over the decant depth without entrainment of settled solids or floating debris. Upon completion of the treated water i.e. supernatant liquid removal sequence, the moving weir decanter returns to its rest position located out of liquid. Completion of the decant sequence terminates the designated use of the basin as a stratified, interrupted inflow reactor. Typically, fill sequencing begins while the decanter is travelling to its upper rest position. The time dedicated to decant can range from 5 to 30 % of total cycle time.

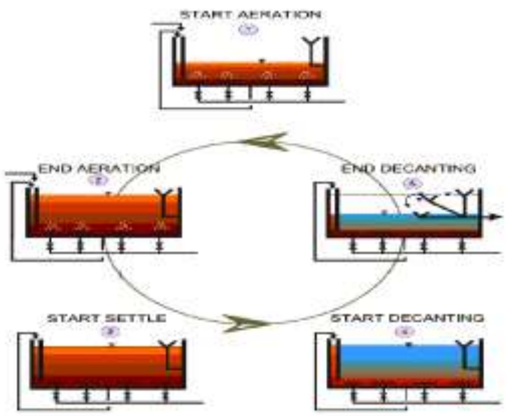

Fig 1 SBR process

1.1.2 BOD, Nitrogen and Phosphorus Removal Mechanism

More than 95% removal of BOD is noted in SBR. An important advantage of the SBR system is the control the operator can maintain over microorganism selection. Within a complete treatment cycle, the microorganism selection pressures are highly variable and severe. In this process provide oxygen availability, which ranges from anaerobic through anoxic to optimum DO conditions, and substrate availability, which ranges from famine to feast conditions. While certain of these selection pressures can occur in some conventional continuous flow systems, the SBR system provides the ability to easily select and extend or limit preferred conditions through time, allowing the preferential growth of desirable microorganisms. Two observations have been documented that illustrate the beneficial effects of this control ability.

Firstly, in an SBR system more microorganisms are capable of processing a greater quantity of substrate at a greater rate than in a conventional system. Secondly, it has been reported that a properly selected aeration strategy can result in the minimizing of the growth of filamentous microorganisms. These microorganisms, whose presence in quantity leads to problems with sludge bulking and foaming, are undesirable in the activated sludge floc in excessive numbers, and their control is an asset to system performance. Nitrogen removal can be achieved in the SBR system without additional equipment or chemicals. Nitrogen enters the system in the raw waste water in the form of organic nitrogen and ammonia (NH4). It is removed from the system in the form of organic nitrogen gas. Phosphorus removal by microbiological methods in SBR systems is well documented. The additional of chemical coagulant to the reactor that precipitates phosphorus into the sludge is a common phosphorus removal process applicable to both conventional continuous flow and SBR systems. The microbiological removal of phosphorus first requires an anaerobic period (absence of dissolved Oxygen and Oxidation nitrogen) during which substrate (raw waste) is present. This period should be followed by an aerobic period (high DO) that promotes the uptake of excess phosphorus by the sludge mass. Excess sludge should be removed from the reactor in suitable quantities before the onset of next anaerobic period. In term of SBR operation anaerobic conditions and aeration must be available during FILL-REACT period for phosphorus release and uptake by biomass. These conditions can also available in selector by recirculation of sludge.

1.2 DESIGN CRITERIA

For any wastewater treatment plant design, the first step is to determine the anticipated influentcharacteristics of the wastewater and the effluent requirements for the proposed system. Theseinfluent parameters typically include design flow, maximum daily flow BOD_5, TSS, pH, alkalinity,wastewater temperature, ammonia-nitrogen (NH_3-N), and totalphosphorus (TP)total Kjeldahl nitrogen (TKN),. For industrial and domestic wastewater, other site specific parameters may alsobe required.The state regulatory agency should be contacted to determine the effluent requirements of the proposed plant. These raw wastewater discharge parameters will be dictated by the state in the National PollutantDischarge Elimination System (NPDES). The parameters typically permitted for municipal systems are flowrate, BOD_5, TSS, and FecalColiform. In addition, many states are moving toward requiring nutrient removal. Therefore, total nitrogen (TN), NH_3-N, TP and TKN may also be required. It is imperative to establish effluent requirements because they will impact the operating sequence of the SBR. For example, if there is a nutrient requirement and NH_3-N or TKN is required, then nitrification will be necessary. If there is a TN limit, then nitrification and de-nitrification will be necessary.

TABLE 1 KEY DESIGN PARAMETERS FOR A CONVENTIONAL LOAD

	Municipal	Industrial
Food to Mass (F:M)	0.15 to 0.4 day	0.15 to 06 day
Treatment Cycle Duration	Upto4.0 hour	4.0 to 24 hour
Typically Low Water Level Mixed Liquor Suspended solid	2000 to 2500 mg/l	2000 to 4000 mg/l
Hydraulic Retention Time	6 to 14 hour	Varies

Source: AquaSBR Design Manual, 1995.

1.3 Design Requirement

SBR plants typically consist of a minimum two reactors in a plant. When one unit of reactors is in the fill mode, the other reactor(s) may be in the stage of react, settle, decant or idle. In the reaction stage, the oxygen supplied to the system within the time frame of reaction cycle. This generally requires higher oxygen capacity than a continuous flow system. All SBR plant must be designed to cater for peak flows. A minimum of a two (2) tank system is required. Proven control system in the form of Programmable Logic Controller with complete instruction is provided. All SBR systems musts must be preceded with complete preliminary works.

1.4 Performance Comparisons

The performance of SBRs is typically better to conventional activated sludge system 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 more than 95 percent. SBR manufactures will typically provide a process guarantee to produce an effluent of less than: (i) 10 mg/L Biochemical Oxygen Demand (ii) 10 mg/L Total Suspended Solids (iii) 5-8 mg/L Total Nitrogen (iv) 1-2 mg/L Total Phosphorus(EPA, 1995).

The advantages of Sequential Batch Reactor over conventional system are:

- Control system provides high flexibility. The control system automatically coordinates equipment operation through various phase of SBR cycle. This feature offers a high degree of flexibility allowing adaptation of the process cycle to meet the changing influent conditions through simple changes in control set points.

- No primary and secondary settling tanks, no return sludge pumping, hence lesser area requirement and ease in operation & maintenance.

- It is a proven process, which enhances the standard system through strategic cost, operating and biological advantage.

- Improved effluent quality: extended aeration mode, a special ability to handle extremely high organic and hydraulic shock loads, no washout of biomass, reliable performance. More than 95% BOD removal, advantage aeration processes.

- The process is also recommended for small-scale sewage treatment in CPHEEO manual, but due to the advancement in technology in last decade, these plants are very favourable for medium and large-scale sewage treatment applications. It is a proven process all over the world for sewage treatment. Many large-scale plants working efficiently around the globe.

- Nitrified effluent (no ammonia is present), doesn't consume further oxygen for nitrification and much beneficial for irrigation and fisheries.

- Expansion potential: Simplified expansion- Each unit forms a modular treatment unit. All basins have been built with common wall construction. This can be achieved by maintaining the same length for all tanks and increasing the width appropriately. The blower equipment is also sized proportionally to the capacity of each basin such that the same blowers are used before and after expansion.

1.5 Cost Factor

Moreover, US Environmental Protection Agency (EPA) did extensive study on construction cost comparison of SBR and conventional activated sludge process and found that SBR are much more promising than conventional activated sludge process for municipal sewage treatment. As shown that the differences between Sequential Batch Reactor and continuous flow Activated Sludge Processes are drastic. However, this comparison should only be used as an indication of the relative construction costs of SBRs and continuous flow ASPs. Clearly, the lack of need of a primary and secondary clarifier and return sludge pumping system offers potential saving in construction cost. '

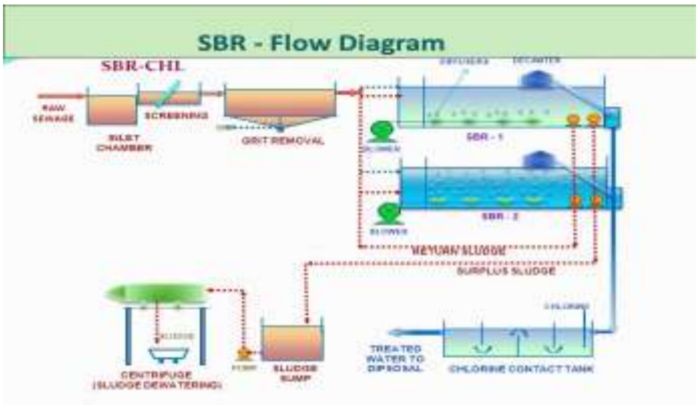

Fig 02 SBR flow diagram.

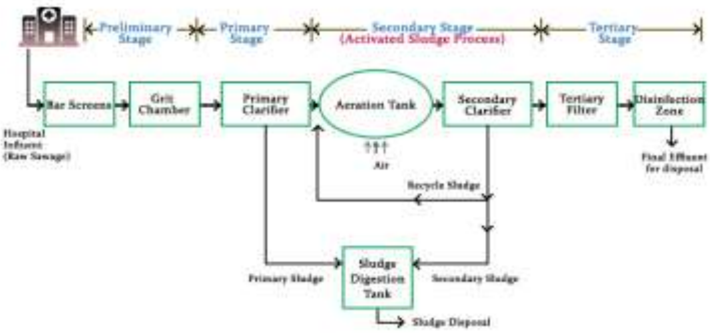

Fig 03 Conventional wastewater treatment plant.

1.6 Conclusion

The US Environmental Protection Agency (EPA) studied and found on construction cost comparison of SBR and conventional activated sludge process and found that SBR are much more promising than conventional activated sludge process for municipal sewage treatment. The control system of SBR automatically coordinates equipment operation through various phase of SBR cycle. This feature offers a high degree of flexibility allowing adaptation of the process cycle to meet the changing influent conditions through simple changes in control set points. It is also found that Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD) and Total Suspended Solids (TSS) are the main process efficiency parameters that have been used for reuse of waste water. It is concluded that the society may be convinced to reuse the wastewater for gardening purposes.

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