Case Study on 145MLD Sewage Treatment Plant (STP) (SBR Technology) in Gwalior

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Abstract: ***Water scarcity and pollution are major environmental challenges faced by many cities in the world. The treatment of waste water was introduced to overcome and find a solution to water scarcity. A key by implementing Sewage Treatment Plant was aimed at treating the wastewater generated by the city and making it suitable for reuse, at least for agricultural purposes. With time there are many technologies to set up an STP. Nowadays, as the land prices of the cities are increasing and the land in the cities is limited, advanced and new STP technologies are introduced that require less space as compared with the older technologies also, with an advanced treatment process called Sequential Batch Reactor (SBR), which has several advantages over conventional activated sludge processes. The SBR technology has been successful in achieving high efficiency of removing 95% of organic matter and suspended solids, and the treated wastewater can be used for industrial and agricultural purposes, reducing the use of freshwater resources for agriculture and gardening purposes. Implementing the STP has also led to the rejuvenation of nearby water bodies, reducing the pollution in rivers and thus maintaining rivers. The success of this project sets an example for other cities to follow and adopt sustainable wastewater management practices.***

Keywords: Sewage treatment plant (STP)1, Waste Water Treatment, Environmental impact, Sequential Batch Reactor (SBR), Agricultural use, Sustainable wastewater management practices

1. Introduction

This case study of 145 MLD sewage treatment plants (STP) implemented in Gwalior city, Madhya Pradesh, India. The city was facing a severe water crisis due to the depletion of freshwater resources. With a rapidly increasing population and urbanisation, the demand for freshwater resources has increased, leading to the depletion of these resources. Moreover, the discharge of untreated wastewater into water bodies has led to severe pollution, further exacerbating the water crisis. To address this issue, the local government of Gwalior decided to implement a new sewage treatment plant (STP) and enhancing the treatment capacity to 145 MLD (million litres per day). The STP was designed to treat the wastewater generated by the city and make it suitable for use in agriculture and parks (municipal), thereby reducing the usage of freshwater resources. This case study will also discuss its impact on the environment and the community. The study will also highlight the technology SBR for STP and its practical results. The visit of this Gwalior plants elaborates with the TSS intake side and the TSS at outflow, and practically by seeing the data I confirm the effectiveness of the STP plant. SBR technology is energy-efficient and requires less maintenance compared to other wastewater treatment processes. This is because SBR plants operate in a batch mode, which allows for greater flexibility and control over the treatment process. Additionally, SBR technology can reduce the amount of sludge produced during treatment, resulting in lower disposal costs and a more sustainable treatment process.

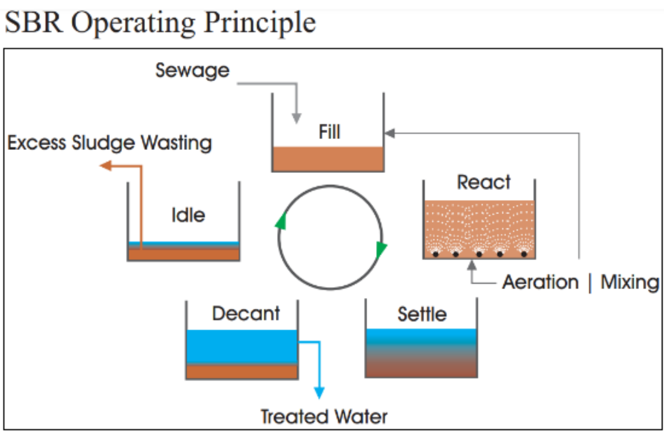


Figure 1: Flow chart of SBR

1.1 How SBR Technology works

The SBR (Sequential Batch Reactor) technology is a type of wastewater treatment process used in Sewage Treatment Plants (STP). The SBR process is a batch process that involves the following stages:

a) **Fill Phase**: In this phase, the SBR reactor is filled with the incoming wastewater until it reaches a predetermined level.
b) **Screening Phase**: Screening is the process of removing large particles from incoming wastewater using a mechanical screen, to protect downstream equipment and improve treatment efficiency.
c) **Grit removal Phase**: Grit removal is the use of screens or sedimentation tanks to remove heavy solids, such as sand and gravel, from wastewater before it undergoes biological treatment. The separated grit is then typically disposed of in a landfill or recycled for use in construction materials.
d) **Aeration tank Phase:** Aeration tank in STP plants using SBR technology is where biological treatment occurs through the introduction of oxygen to support the growth of microorganisms that break down organic matter in wastewater. The aeration process is typically followed by a

settling period, after which the treated water is discharged or subjected to further treatment.

e) **Settle Phase:** After the aeration or mixing is stopped, and the wastewater is allowed to settle. The aerobic microorganisms settle to the bottom of the reactor, forming a sludge layer, and the treated water remains above the sludge layer.

f) **Decant Phase:** In this phase, the treated water is decanted or drawn off from the top of the reactor. This process removes the clear, treated water from the reactor while leaving the sludge layer undisturbed at the bottom.

g) **Idle Phase:** After decanting, the reactor remains idle for a specific duration to allow any remaining sludge to settle. The duration of this phase is dependent on the specific requirements of the wastewater being treated.

h) **Waste Sludge Removal:** After the Idle Phase is complete, the remaining sludge is either removed for further treatment or returned to the reactor for further digestion, depending on the treatment process.

The SBR technology offers several advantages over other types of wastewater treatment processes, such as its flexibility to treat a wide range of wastewater quality and quantity, and its ability to operate in a compact footprint. Additionally, the process can be easily automated and controlled, which reduces the need for manual intervention. SBR technology has been increasingly adopted by large-scale wastewater treatment plants across the globe, due to its versatility, flexibility, and efficiency. The 145 MLD STP plant is a good example of how SBR technology can treat large volumes of wastewater while achieving high-quality effluent.

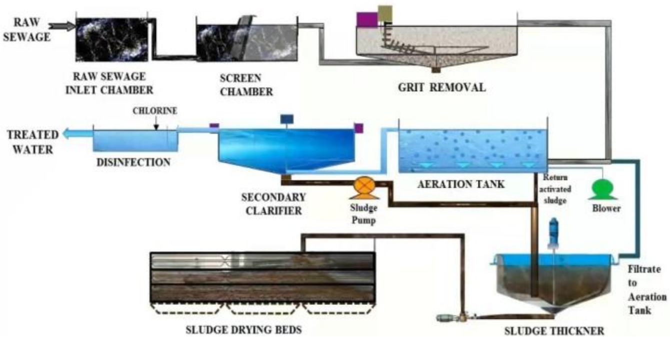


Figure 2: Diagrammatic representation of SBR technology

The SBR technology used in the Gwalior 145 MLD STP plant is highly advanced and automated, with sophisticated control systems and sensors that monitor and regulate the treatment process. The plant also uses state-of-the-art equipment, such as fine screens, grit chambers, and sand filters, to ensure that the wastewater is treated to the highest standards. Overall, the SBR technology used in the Gwalior 145 MLD STP plant is an efficient, reliable, and cost-effective method for treating wastewater. It is a sustainable solution for meeting the growing demand for water in the city while protecting the environment and ensuring public health.

The plant has a treatment capacity of 145 million liters per day (MLD), which is a significant improvement over the previous plant's capacity of 52 MLD. This increased capacity has enabled the plant to treat a larger volume of wastewater, which has helped to reduce the pollution load on the Chambal River, a major source of water for the city.

Pic 1: Entrance of STP plant

Pic 2: Arial view of STP

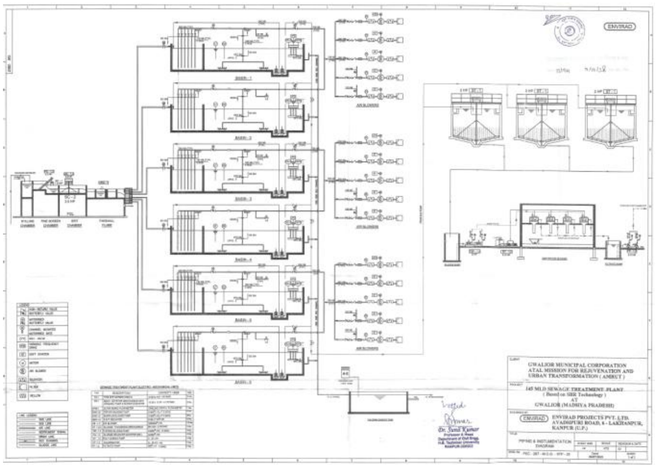
The construction of the STP plant was completed in 2020, and the plant was inaugurated by the Chief Minister of Madhya Pradesh. The plant has been successful in achieving a removal efficiency of over 95% for organic matter and suspended solids and is contributing significantly to the conservation of freshwater resources in the region and been used in farming. The SBR for wastewater treatment. SBR is a type of activated sludge process that treats wastewater in a batch-wise manner. The SBR technology is highly efficient in treating wastewater and is known for its flexibility and adaptability to different treatment scenarios.

The SBR technology involves a series of steps, including filling, aeration, settling, and decanting. During the filling stage, the reactor is filled with wastewater, and during the aeration stage, oxygen is added to the wastewater to stimulate the growth of microorganisms that break down the organic matter in the wastewater. After aeration, the wastewater is allowed to settle, and the clear water is decanted from the top. The settled sludge is then recycled to the next batch or removed from the system.

Table1: Important Waste Water Contaminants

S.No.	Contaminants	Source	Environmental significance
1	Suspended solids	Domestic use, Industrial waste	Cause sludge deposits and anaerobic condition in aquatic environment, reduces permeability of river bed.
2	Biodegradable organics	Domestic use, Industrial waste	Cause biological Degradation, D.O depletion
3	Pathogens	Domestic use, Industrial waste	Transmit communicable Disease
4	Nutrients	Domestic use, Industrial waste	Cause eutrophication
5	Refractory organics	Domestic use, Industrial waste	Cause taste and odour problems, causes health issues & detrimental to aquatic life.

2. Layout Plan of 145 MLD STP Plant



Geo Location of the plant: 26.259427685279938, 78.1661817

3. About the 145 MLD Plant

3.1 Screening: The first step in the treatment process involves screening the incoming wastewater to remove large particles and debris. The wastewater is passed through a series of screens to remove objects such as plastic bags, cloth, and other large debris. 2 no's of Screen chamber is provided with manually cleaned bar rack of medium size. Width of the each screen chamber is 1.6 m and depth is 2 m. The bars are rectangular sharp edged having clear spacing of 25 mm. and inclined at 60⁰ with horizontal.

Figure 3.1: Screening

3.2 Grit removal: After screening, the wastewater is passed through a grit chamber where heavy particles such as sand and gravel settle to the bottom due to their weight. Grit chamber with parshal flume weir is a rectangular tank with 4.5 m x 10 m sides and 1.2 m depth.

Figure 3.2: Grit Removal

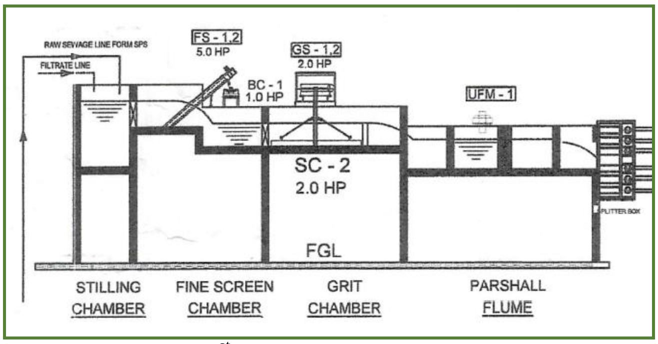


Figure 2.1: STP 1st Stage --- On Site Drawings and Plans

3.3 Primary settling: The wastewater then flows to a primary settling tank, where the remaining suspended solids, organic matter, and smaller particles settle to the bottom by gravity. This step helps in the removal of about 30-35% of total suspended solids (TSS). Stabilization pond is a rectangular pond having 655m length, 130m width and 1.6m depth.

Figure 3.3: Primary Settling

3.4 Aeration: In this step, the wastewater is transferred to the SBR reactors, where air is pumped in to provide oxygen to the microorganisms present in the wastewater. These microorganisms break down the organic matter in the waste water and reduce the biological oxygen demand (BOD). This step helps in the removal of 90-95% of BOD. There are 6 Ariation Tanks also known as Basins. Each basin is marked from 1 to 6.

Figure 3.4: Aeriation from Bottom

3.5 Settling: After the aeration process, the wastewater is allowed to settle in the SBR reactors, allowing the suspended solids and microorganisms to settle to the bottom of the reactor. This step helps in the removal of remaining suspended solids and microorganisms, achieving total suspended solids (TSS) removal efficiency of over 95%.

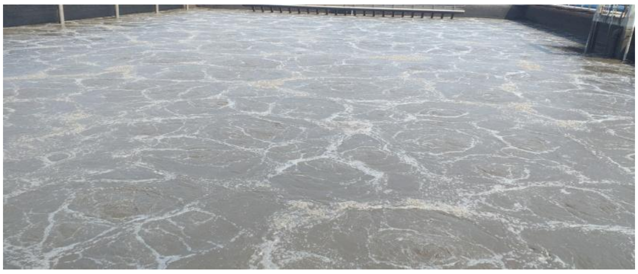


Figure 3.5: Aeration condition while the tank is filled.

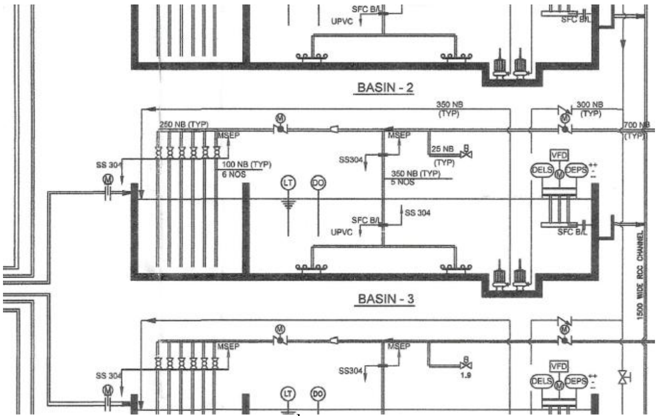
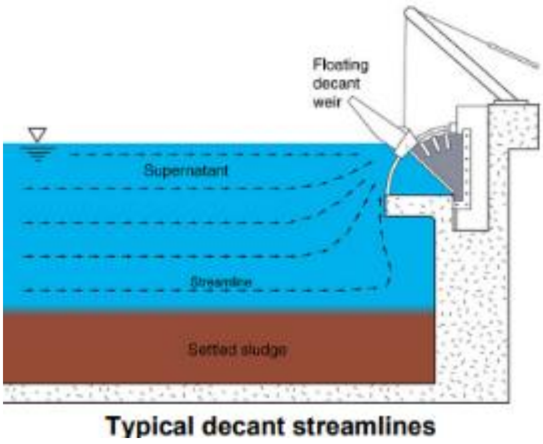


Figure 4.2: STP stage 2nd -- On Site Drawings and Plans

3.6 Decanting: Decanting in STP plants using SBR technology involves the process of separating treated

Figure 3.5 --- water at rest

Figure 3.6 --- Chlorine channel Process



water from the settled sludge by draining the clear water from the top of the tank and leaving the sludge at the bottom. The decanting process is typically automated and timed to ensure that the appropriate amount of treated water is discharged while minimizing the loss of solids. In short, removal of the top layer of the water after settlement of 4 to 6 hrs of the water in the basin.

3.7 Tertiary treatment: The water collected after decanting is then subjected to tertiary treatment. In this STP plant also they use chlorination in teritary treatment process. Chlorination is widely used disinfection method applied in the last stages of sewage treatment. As a strong oxidizer, chlorine reacts with organic compounds, with negative effects on human health and the environment. In the disinfection step, the treated water is disinfected using chlorine, to kill any growth of the bacteria or any other harmful. Then the chlorinated water is passed through the open long channels before supplying it for agriculture use.

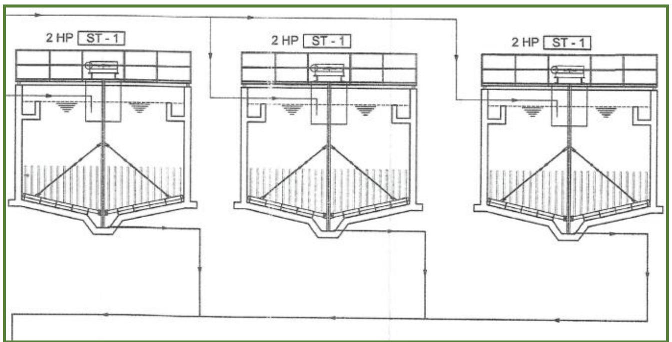


Figure 4.3: STP stage 3rd -- On Site Drawings and Plans

3.8 Sludge treatment: The sludge generated during the treatment process is treated separately in sludge treatment facilities, which include sludge thickeners and dewatering units. The treated sludge is then disposed of or used as a fertilizer. In the Plant, the sludge from the basin comes to the sludge thickener, and from there, after processing the sludge the water is sent back to the basin and the sludge is pumped to the Centrifuge. The centrifuge separates more water from the sludge. Then the sludge is converted to manure.

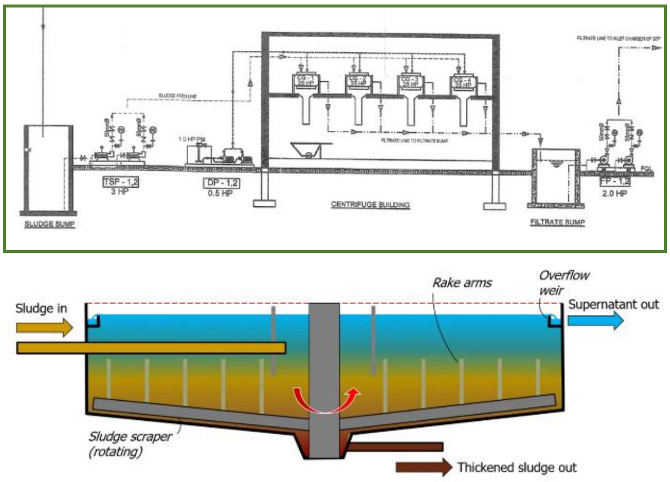


Figure 4.2: STP stage 4th -- On Site Drawings and Plans

4. Some more picks of the Plant

Figure 6.1: Separated Grit

Figure 6.2: Blower unit

Figure 6.3: Sludge Thickener

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Figure 6.4: Centrifuge

5. Conclusions

The plant's advanced Sequential Batch Reactor (SBR) technology has proven to be highly efficient in treating wastewater. The treated water meets the Central Pollution Control Board's (CPCB) discharge standards for reuse in irrigation, landscaping, and other non-potable uses. The plant has also reduced the biochemical oxygen demand (BOD) and total suspended solids (TSS) levels in the wastewater, which are key indicators of water quality. The treated water is used in the agriculture purpose by the local body and the sludge is after centrifuge is used as the manure by providing it to the farmers and the gardners.

The plant has been designed with advanced treatment processes, such as fine screening, grit removal, and sand filtration, which have helped to remove pollutants and other impurities from the wastewater.

Overall, the Gwalior 145 MLD STP plant has been successful in achieving its goals of treating wastewater to meet the city's growing water demand while protecting the environment and ensuring public health. The plant is a sustainable solution for managing wastewater in the city and serves as a model for other cities in India and around the world.

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