# Comparative Study of Different Technologies Involved in Wastewater Treatment Plant

[1]Mohd Anas, [2]Dr. L.P. Singh, [3]Er. V.K. Kushwaha

[1]PG research scholar, [2]Associate Professor, [3]Assistant Professor

[1,2,3]Department of Mechanical Engineering,

[1,2,3]SHUATS, Prayagraj, U.P., India.

**Abstract-The pollution of our water resources is mainly due to the discharge of waste mainly produced by anthropogenic sources such as industrial purpose, agricultural waste and household and untreated wastewater. The need of the hour is to have a treatment for the waste water. Wastewater treatment is a process which is used to convert wastewater (highly polluted water) into an effluent that can either return to the water cycle with minimal environmental issues or reused safely. The different stages of treatment are preliminary, primary, secondary, and tertiary or advanced treatment. In secondary treatment, biological treatment is more cost-effective than chemical treatment. Biological treatment of waste water reduces the concentration of pollutant through microbial action and removal of non-settle able organic colloidal solids. There are various technologies used in the treatment of wastewater in the present times. The best technology can be selected for a particular place based on various parameters like area requirement, initial, operation and maintenance cost, power requirement, quantity as well as quality sludge produced etc. The paper aims to establish comparative analysis of three popular wastewater treatment techniques. The main technologies studied are as: (1) Sequencing Batch Reactor (SBR), (2) Rotating Biological Contractor (RBC), and (3) Soil Bio Technology (SBT).**

**Index Terms- Wastewater treatment, Sewage treatment plant (STP), Sequencing Batch Reactor (SBR), Rotating Biological Contractor (RBC), Soil Bio Technology (SBT).**

## 1. INTRODUCTION

Sewage treatment plant is the procedure for removing contaminants from the wastewater from the domestic, commercial & industrial sewage. It has to undergo the chemical, physical as well as the biological procedure to remove these contaminants and give out an environmentally safe and very well treated effluent. Available statistics reveals that India habitats 1/6th of the total world's population on 1/50th portion of the land and just with 1/25th of the total water resource. This depicts the need to treat & also reuse of waste water by taking effective measures for sustainable development.

The pollutants in the domestic waste water arise from residential and commercial cleaning operations, laundry, food preparation, and body cleaning functions, and also from body excretions. The composition of domestic water is relatively almost constant. Waste water is treated for removing the undesirable components both organic and inorganic, which are soluble and insoluble. If these pollutants are discharged without any proper treatment, it can harmful to the natural self-cleaning mechanism of water bodies. Various constituents of waste water are potentially harmful to the environment as well as for human health. In the environment, the pollutants cause destruction for marine life and also harmful to animals and plants life.

Thus, the treatments of these wastes are a very importance issue. Waste water treatment is mainly divided in 3 main stages. These stages are preliminary treatment, primary treatment, secondary treatment, and tertiary treatment. Preliminary treatment is used to remove big and solid objects that are often present in waste water. In primary treatment, the majority of organic and inorganic material, as well as contaminants in the water are removed. Secondary treatment of wastewater employs biological processes, the use of

microorganisms to rid the water of any organic compounds that may still be present. This stage stimulates what really happens in nature, when microorganisms break down the organic wastes.

## 2. MATERIALS AND METHODS

### 2.1- Sequencing Batch Reactor (SBR):

The Sequencing Batch Reactor (SBR) is an activated sludge process designed to operate under non-steady state conditions. The SBR operates in a true batch mode with aeration and sludge settlement both occurring in the same tank. The SBR is distinguished from conventional continuous-flow, activated sludge system as SBR tank carries out the functions of equalization, aeration sedimentation in a time sequence rather than in the conventional space sequence of continuous-flow systems.

In addition, the SBR system can be designed with the ability to treat a wide range of effluent volumes whereas the continuous system is based upon a fixed effluent flow rate. The SBR processes save more than 60% of the cost required for conventional activated sludge process in operating cost, also achieve high effluent quality in a very short cycle time. The complete process takes place in a single reactor, within which all biological treatments taking place sequentially. No additional settling unit / secondary clarifier is required. The complete biological operation is divided into cycles. Each cycle is of 3 – 5 hours duration, during which all treatment steps takes place.

**A basic cycle comprises:**

(i) Anoxic fill: The effluent wastewater is distributed throughout the settled sludge through the effluent distribution manifold to provide good contact between the micro-organism and the substrate.

(ii) Aerated fill: Mixed liquor is drawn through the manifold, mixed with the effluent flow in the motive liquid pump, and discharged, as motive liquid, to the jet aerator. Nitrification and denitrification occurs at the beginning of this stage.

(iii) React: During this period aeration continues until complete biodegradation of BOD and nitrogen is achieved.

(iv) Settle: Aeration is discontinued at this stage and solids separation takes place leaving clear treated effluent above the sludge blanket.

(v) Decant: This period is characterized by the withdrawal of treated effluent from approximately two feet below the surface of the mixed liquor by the floating solids excluding decanter.

(vi) Idle: The time in this stage can be used to waste sludge or perform backwashing of the jet aerator. The wasted sludge is pumped to an anaerobic digester to reduce the volume of the sludge to be discarded.

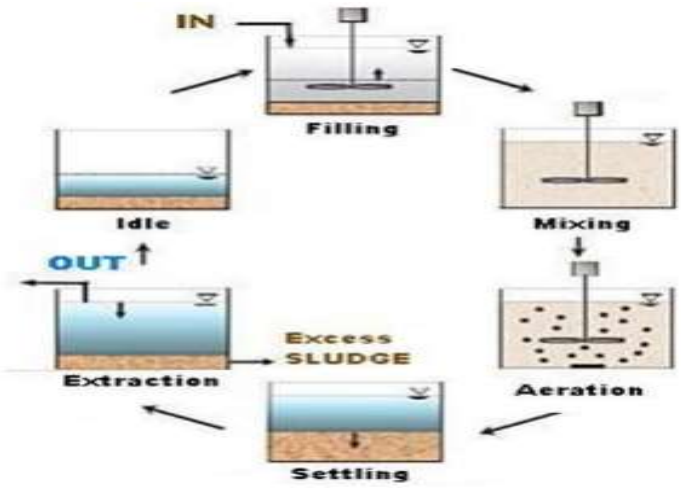


**Figure 1: Major Phases Of The SBR Operations Cycle**

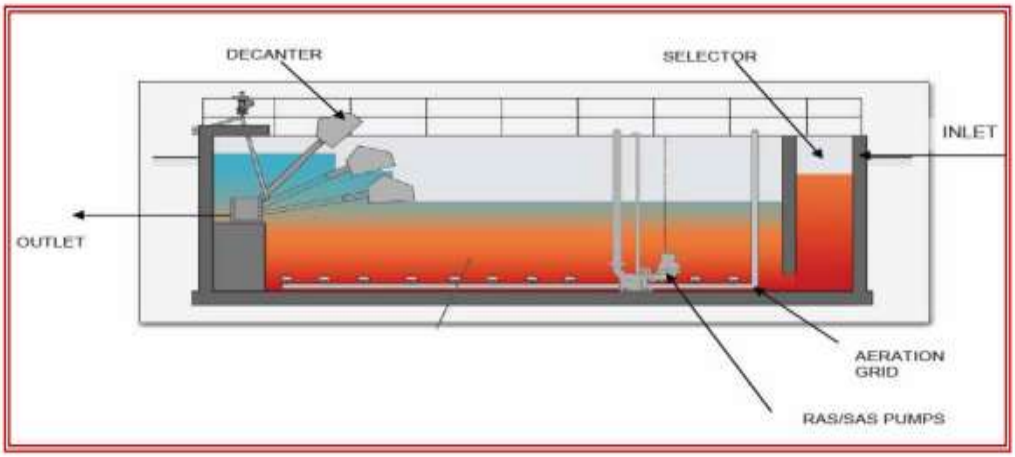


**Figure 2: Schematic Diagram of SBR**

### 2.2- Rotating Biological Contractor (RBC):

The rotating biological contactor is an attached growth biological treatment used in removal of biodegradable matter present in wastewater. Microorganisms which break down wastewater is attached to media as a part of slime colony. The process is simpler to operate than activated sludge since recycling of effluent or sludge is not required. Special consideration is to be given to returning supernatant from the sludge. The biological growth in an RBC secondary treatment process more closely resembles the zoological slime from a trickling filter than the mixed liquor from an activated sludge process, but there is one major difference. While the trickling filter growth is layered with aerobic organisms living into the outer layers and anaerobic organisms living next to the media, the RBC growth is intentionally kept thin to discourage anaerobic organisms. RBC is a proved and prudent technology and is known widely used throughout the world particularly for addressing the need of small communities.

**Operation:**

A rotating biological contactor is an attached growth biological process that consists of one or more basins in which large closely-spaced circular disks mounted on horizontal shafts rotate slowly through waste water. It contains a number of discs which are arranged along the shaft axis of the contractor. The disks, which are made of high density polystyrene or polyvinyl chloride. The wastewater is fed in the contactor at a certain flow rate. All the discs are partially submerged into the wastewater. When the discs are continuously rotated by a shaft, the lower portion of the discs submerged in the wastewater would then be turned to the upper atmosphere phase. The microbial film on the disc that is initially in contact with the nutrients of the wastewater phase and the oxygen in the atmosphere would then perform its metabolism. The organic compounds in the wastewater would serve as the nutrients for the microbes to digest and grow. By such periodical operation, the microbes would grow, and a certain thickness of the sludge film would be obtained. The rotary movement also allows excess bacteria to be removed from the surfaces of disks and maintains a suspension of sloughed biological solids. A final clarifier is needed to remove sloughed solids.

RBCs are commonly used as secondary treatment process, but are also used in advance wastewater treatment processes. When temperatures are high enough and carbonaceous BOD is low enough, a shaft media identical to that used in secondary treatment will develop a biomass consisting of primarily nitrifying bacteria which will convert remaining ammonium-nitrogen to nitrate-nitrogen. If denitrification is required following nitrification, totally submerged RBC shafts in anoxic tanks are used to grow a denitrifying bacteria population. The denitrifiers convert the nitrate to nitrogen gas which bubbles to the surface and escapes to the atmosphere.

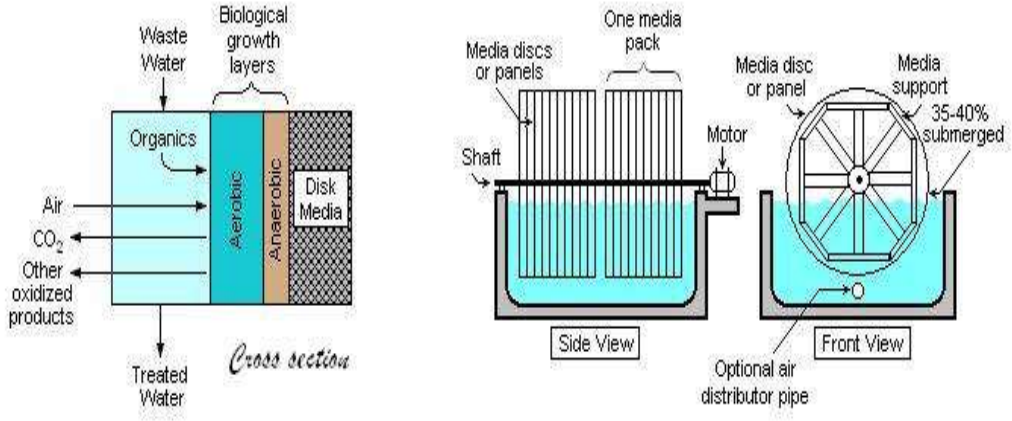


**Figure 3: Both aerobic and anaerobic microorganisms can live in the bio-film and contribute to the removal of pollutant from the water.**

**2.3- Soil Bio Technology:**

Soil Bio- technology is a terrestrial system for wastewater treatment which is based on the principle of trickling filter. In this system, combination of physical process like sedimentation, infiltration and biochemical process are carried out to remove the suspended solids, organic and inorganic contents of the wastewater. Suitable mineral constitution, culture containing native micro-flora and bio-indicator plants are the key components of the system. It is also known as Constructed Soil Filter (CSF). SBT system constructs from RCC, stone-masonry and/or soil bunds. It consists of raw water tank, bioreactor containment, treated water tank, piping and pumps. Soil Biotechnology (SBT) is an environment friendly waste processing technology that offers systems for processing of both solid organic waste and wastewater treatment using bacteria, earthworms and mineral additives in a garden-like setup. SBT reinforces the carbon and nitrogen cycle in nature, the quality of the treated water exceeds state pollution control board standards reducing Chemical Oxygen Demand (COD). The SBT system is an engineered ecology of soil plant system configured as a packed bed reactor with multi grade media consisting of different sizes of stone, gravel and formulated soil enriched along with micro flora and geophagous earthworm culture. Chemistry, Biology and Ecology in SBT facilitates both aerobic & anaerobic respiration, and reactions like nitrification, denitrification, acidogenesis, etc depending on the types of waste load. Organics get removed by adsorption & filtration and are biologically converted to $CO_2$ with help of indigenous soil microflora. Suspended Solids are removed in Primary Settling Unit. Dissolved Solids are removed by adsorption followed by biodegradation and uptake by green plants. Media and additives provide sites for biological transformation. Earthworm culture regulates microbial ecology. Health of green plants bio-indicate the process.

**Procedure**:

Soil Biotechnology harnesses the bioenergy in organic matter by integrating the elements of a productive soil ecosystem viz. soil bacteria, select earthworm and plant species and mineral nutrients. Litter pests indicate over loaded process and warrant corrective measures. Biocarbon energy contained in the waste is tapped to unlock plant nutrients from minerals, fix atmospheric nitrogen and produce metabolite to be assimilated by plant and thus prevent wasteful dissipation of the carbon energy. Presence of select aerobic bacteria and mineral additives prevent foul odor in the process. Two grades of bio-fertilizer can be harvested from Life Link's Soil Biotechnology process, namely, Fertilizer Grade and Culture Grade, depending on the end use application desired. The SBT waste processing area is thus developed into a green belt or garden, which easily integrates into any existing landscape.

**Major Elements of SBT**:

1. Media which supports the micro & macro organisms of soil ecology for aerobic respiration which include nitrogen fixation and active oxygen production.

2. Culture which includes geophagous worms serves as the top carnivore to regulate soil population.

3. Additives: A natural mineral mixture which regulates pH.

4. Green plants to serve as bio indicator of the health of process. In view of the ecology of soil & engineered natural oxygen supply highly aerobic environment exists in the bioreactor.

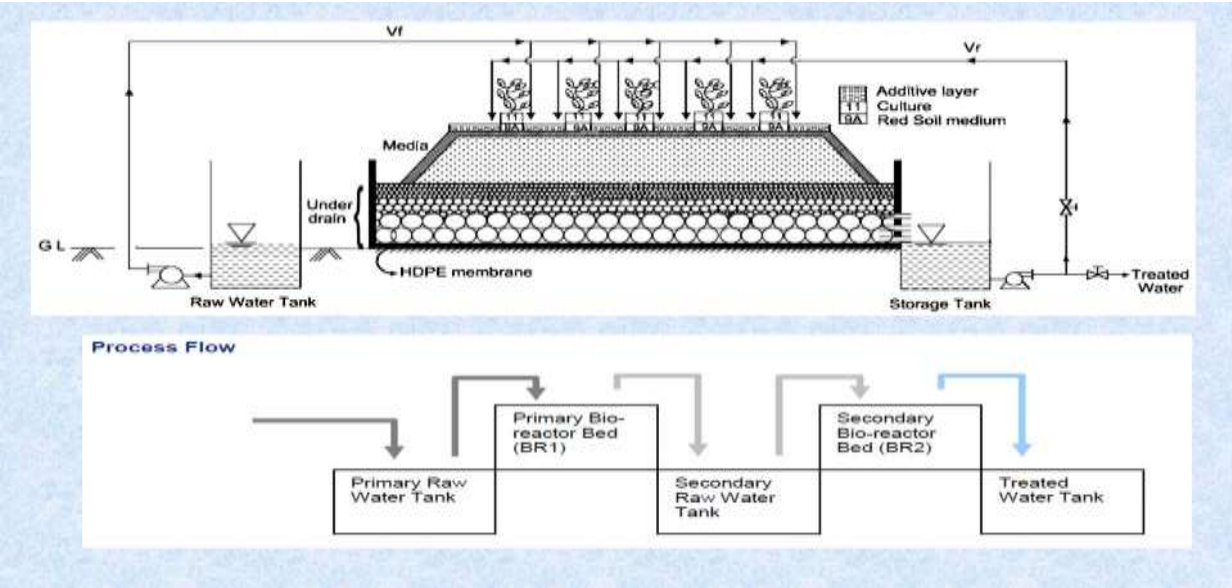


**Figure 4: Typical Layout of Soil Biological Technology Plant**

## III. RESULT:

| S. No. | Factors of Comparison | Sequencing Batch Reactor (SBR) | Rotating Biological Contractor (RBC) | Soil Biological Technology (SBT) |
|---|---|---|---|---|
| **1.** | **Process** | BOD reduction takes place aerobically. Suspended growth process. Improvised Activated Sludge Process. The organic matter is brought in contact with bacteria in suspension. | Attached growth process with circular disk on horizontal shaft. | BOD reduction takes place. Aerobically, no excess sludge is generated in the process. |

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| **2.** | **Media** | No media. | A biological slime or 'zoogleal film' grows on the media which contain the bacteria and microorganism which supply treatment of the wastewater. | It is formulated from soil with primary minerals of suitable size and composition. |
| **3.** | **Sludge** | Sludge is active. Hence, anaerobic (or aerobic) digester is must, for complete destruction of biomass. This increases plant cost and operator attention. | Low production of sludge than SBR. | No sludge is produced in the process. |
| **4.** | **Power Required** | Power required is more than SBT. | Power required is more than SBT, and almost similar to SBR. | Less power is consumed in the process. Only power is used for operating the pump. |
| **5.** | **Area Required** | Area required is higher than RBC as well as SBT. | Area required is higher than SBT, but lesser than SBR. | Very less area is required. |
| **6.** | **Maintenance** | The entire plant operation is cyclic in nature and controlled by PLC only. The process requires very high level of instrumentation and sequencing operation. | Disk can be taken out or relocated. | No operation and maintenance is required. Once the process is started it continues and the performance of the plant increases as the time progresses. |
| **7.** | **Operational Cost** | Low. | Low. | No operational cost is required. |

| | | | | |
|---|---|---|---|---|
| **8.** | **Expandability** | Very low as higher loads cannot be accepted. However, Modular construction is possible. | Higher than SBR as well as SBT. | Higher loads not accepted. |

## IV. CONCLUSION:

In this study, a review of various biological treatment technologies has been done. Various modern technologies include Rotating Biological Contactor (RBC), Sequential Batch Reactor (SBR) and Soil Bio Technology (SBT). RBC is an attached growth process with one or more basins with circular disk mounted on horizontal shaft. SBR is area suspended growth process. The power requirement is low in the case of SBT. From the above, it can be observed that every technique has its advantages and disadvantages. When we consider space requirement, less space is required for all the process. When the cost of operation is considered, RBC and SBR are more costly than SBT. When we consider about load acceptability SBT is a very bad option, while SBR and RBC both are good for higher load also. In SBR, media is not required, while in other technologies media is a very important part of process. A comparison of these techniques will surely be helpful to choose the suitable technique.

Based on the study, it can be concluded that Soil Biotechnology is the technology for the future. It has an edge over other treatment techniques. The advantages of SBT as compared to other technologies are listed below:

• Cost effective.

• High efficiency in removing BOD and COD.

• Efficient pathogen removal.

• Odorless operation of the plant.

• Environment friendly technology.

• Maintains good aesthetic quality-green gardens.

• Skilled manpower is not required.

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