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Development of Portable Grey Water Purification System for Urban Housing

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Abstract: Rapid urbanization and industrial development have led to a significant increase in wastewater generation, creating a need for efficient and sustainable treatment technologies. Conventional wastewater treatment systems require large land areas, multiple treatment units, and complex operation. The Sequencing Batch Reactor (SBR) technology is an advanced biological treatment process that overcomes many limitations of conventional activated sludge systems. In SBR technology, all treatment processes such as filling, aeration, reaction, settling, and decanting are carried out sequentially in a single reactor tank, eliminating the need for separate clarifiers and reducing space requirements.

This paper studies the application of SBR technology for wastewater treatment with respect to its working principle, process efficiency, and operational flexibility. The system effectively removes BOD, COD, suspended solids, and nutrients like nitrogen and phosphorus. Due to its batch operation and automated control, SBR can handle fluctuating influent flow and load conditions efficiently. The study concludes that SBR technology is a cost-effective, compact, and environmentally sustainable solution for modern wastewater treatment systems.

Keywords: Sequencing Batch Reactor (SBR), Wastewater Treatment, Activated Sludge Process, Biological Treatment, BOD Removal, COD Removal, Nutrient Removal, Sewage Treatment Plant (STP), Sustainable Treatment Technology

1. Introduction

Water is one of the most valuable natural resources on Earth and is essential for human survival, agriculture, industry, and ecosystem balance. However, with the rapid growth of

Population, urbanization, and industrialization, the demand for water has increased significantly. As a result, a large quantity of wastewater is generated every day from domestic, commercial, and

industrial activities. Wastewater contains harmful pollutants such as organic matter, suspended solids, nutrients, toxic chemicals, and disease- causing microorganisms. If this untreated wastewater is discharged directly into rivers, lakes, or land, it can cause serious environmental Pollution and health hazards.

Water pollution leads to the depletion of dissolved oxygen in water bodies, which harms aquatic life. It also contaminates drinking water sources, Spreading waterborne diseases such as cholera, typhoid, and dysentery.

Nutrients like nitrogen and phosphorus present in wastewater can cause eutrophication, leading to excessive growth of Algae in lakes and ponds. Therefore, proper treatment of wastewater before disposal or reuse is very important for environmental protection and public health.

Traditional wastewater treatment systems, such as the Conventional Activated Sludge Process (ASP), have been widely used for many years. These systems involve several separate units like primary clarifiers, aeration tanks, secondary clarifiers, and sludge handling units. Although effective, these systems require large land areas, higher construction costs, and continuous monitoring.

In developing regions and densely populated areas where land availability is limited, installing such large treatment plants becomes difficult. Moreover, variations in wastewater flow and pollution load can reduce the efficiency of conventional systems.

Technology of Waste Water Treatment: - Sequencing Batch Reactor

SBR is a type of activated sludge process in which all treatment steps take place in a single tank in a time-based sequence. Instead of continuous flow, the treatment occurs in batches. This makes the system more flexible and space-saving compared to conventional treatment plants.

In SBR technology, wastewater treatment is carried out through a series of stages including filling, aeration (reaction), and settling, decanting, and idle phase. During the aeration stage, microorganisms break down organic pollutants present in the wastewater. In the settling stage, the treated sludge settles at the bottom of the tank, and clear water is removed from the top during the decanting stage. by timers and automated systems, it can easily adjust the duration of each treatment phase according to wastewater characteristics.

In today's world, where sustainable development and environmental protection are major priorities, SBR technology offers a reliable and eco-friendly solution for wastewater management. Proper treatment not only prevents pollution but also makes it possible to reuse treated water for purposes like gardening, flushing, and industrial cooling, there by conserving fresh water resources.

This paper focuses on the study of Sequencing Batch Reactor (SBR) technology, including its working principle, components, treatment performance, advantages, and applications. The aim is to understand how SBR systems contribute to efficient and sustainable wastewater treatment in modern infrastructure

2. Components Used in SBR Process

Main components of SBR technology include:

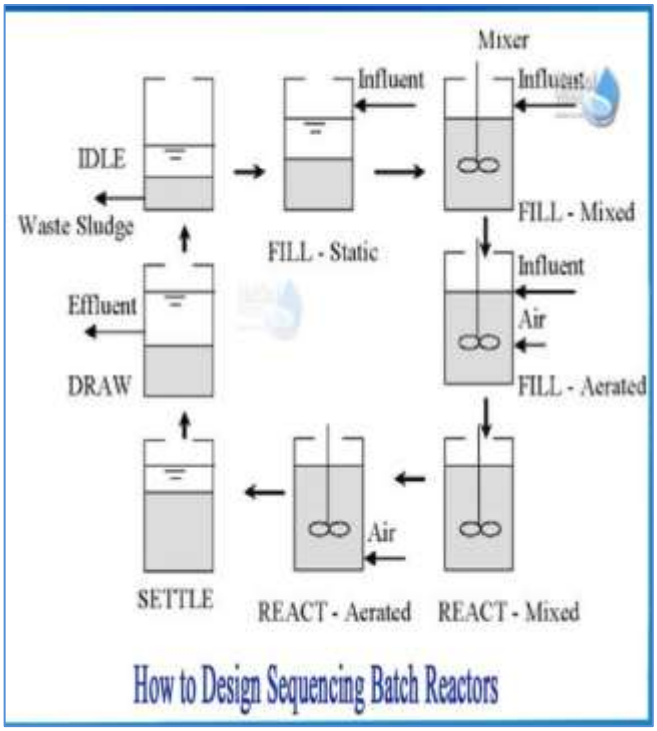
- SBR Tank
- Aeration system (blowers & diffusers)
- Decanter mechanism
- Sludge pump
- Control panel (PLC/Timer)
- Inlet and outlet pipes
- All treatment processes occur within a single reactor

3. Procedure of SBR Technology

The SBR process operates in five main steps in a single tank:

- Fill – Wastewater is introduced into the reactor.
- React (Aeration) – Air is supplied to promote biological treatment.
- Settle – Aeration is stopped and solids settle at the bottom.
- Decant – Treated clear water is removed from the top.

- Idle – Preparation for the next cycle.
- Each cycle is repeated automatically as per design requirements.



4. Need of SBR Technology

The need for SBR technology arises due to the following reasons:

- Increasing population and wastewater generation
- Limited land availability
- Requirement of high treatment efficiency
- Strict environmental discharge standards
- Need for flexible and economical treatment systems

3 . Advantages of Sequencing Batch Reactor (SBR) Technology

- Requires less space (single tank system)
- High BOD, COD & TSS removal efficiency
- Flexible and easy to operate Control panel
- No separate clarifier needed
- Handles variable flow and load well
- Low construction and maintenance cost

4. Conclusion

- All treatment stages occur in a single tank
- It provides high removal of BOD, COD, and suspended solids
- Requires less land compared to conventional systems
- Flexible operation helps handle variable flow and load
- Easy automation reduces manpower requirement
- Cost-effective for small and medium-scale plants
- Suitable for decentralized and urban wastewater treatment

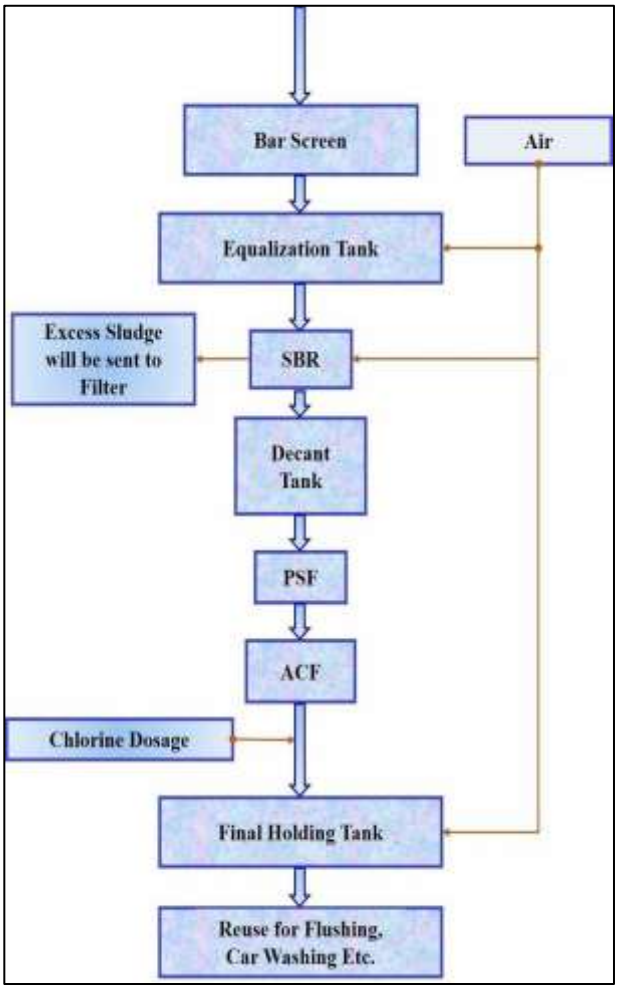


Fig. Flow Chart of SBR technology

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