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A Review paper on the Performance evaluation of STPs based on different technologies ASP, SBR &MBBR

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Abstract : This review paper provides an overview of the performance evaluation of sewage treatment plants (STPs) based on different technologies, including the activated sludge process (ASP), the sequencing batch reactor (SBR), and the moving bed biofilm reactor (MBBR). The paper highlights the importance of STPs in wastewater treatment and the need for sustainable and efficient treatment technologies. This paper examines various literature reviews in which many studies were done previously to examine various aspects of each technology, such as the removal efficiency of pollutants, operating costs, energy consumption, and so on. Based on these key findings from previous research, SBR and MBBR are more energy-efficient and have a higher removal efficiency for some contaminants than ASP, with MBBR appearing to be the more promising technology than SBR for wastewater removal. The paper also emphasis the requirement for persistent observation and evaluation of STP performance to ensure that they meet the required standards for effluent discharge, focusing on improving each technology's performance and sustainability with certain advancements and comparing their long-term costs and benefits.

Keywords: Activated sludge process (ASP), Sequencing batch reactor (SBR), Moving bed biofilm reactor (MBBR), Wastewater treatment, Sewage treatment plants (STPs).

INTRODUCTION

Wastewater or sewage consists of 99.9% water and 0.1% solids, and these solids cause a nuisance to the surrounding environment. Human excreta, food scraps, oil, soaps, chemicals, etc. are the major substances in the wastewater (Babitha M. 2018). According to the CPCB's website for 2021, India generates 72,368 MLD of wastewater every day, and with this, 78% of the sewage generated goes untreated and ends up in rivers, groundwater, lakes, etc. This results in the depletion of freshwater sources.

The volume of wastewater in India is rising at an alarming rate, with increase in both the country's population and industrial landscape. (Ruhela *et al*. 2020) To address these issues, domestic and industrial wastewater must be treated by low-cost wastewater treatment technologies that can produce effective output to meet the regulatory standard for domestic, agricultural, and industrial purposes etc., so its reuse for domestic and agricultural purposes can become an eco-friendly solution for water conservation.
Wastewater treatment plants are the backbone of a sustainable environment. It plays a significant role in managing sewage and treating wastewater before releasing it into the environment. Various technologies are available on the market to make this process effective, efficient, and economical. The performance evaluation of sewage treatment plants (STPs) based on different technologies like the activated sludge process (ASP), sequencing batch reactor (SBR), and moving bed biofilm reactor (MBBR) is vital for identifying the best technology for specific needs.

Activated Sludge Process (ASP)

ASP is one of the most popular and widely used technologies for wastewater treatment. The process is based on the concept of mixing the wastewater with a microbial culture in a reactor (aeration tank). The microbial culture is an assemblage of microorganisms that helps in breaking down the organic matter in the wastewater and converting it into carbon dioxide, water, and biomass. The performance evaluation of ASP is based on the removal efficiency of pollutants, such as Biological Oxygen Demand (BOD) and Total Suspended Solids (TSS), and the quality of the effluent discharged (B. Ahansazan *et al*. 2014).

The process typically consists of several stages, including Aeration, Settling, and Recycling.

From PST (primary sedimentation tank) the sewage is supplied to the Treatment tank from where it is supplied to SST (secondary sedimentation tank) due to the settling of Suspended solids resulting in the formation of Sludge (containing active microbes). This Sludge with living microbes is recycled back to the Aeration tank where the decomposition of O.M takes place by these active microbes, and as the decomposition is carried out by active suspension microbes therefore this process is called an Activated Sludge process

The activated sludge process is a highly efficient and cost-effective method for treating municipal and industrial wastewater. It can remove up to 95% of the organic matter and other pollutants from the wastewater, making it safe for discharge into water bodies or reuse in various applications. However, the process requires careful monitoring and management to ensure optimal performance and avoid problems such as sludge bulking, foaming, and odours.

Sequencing Batch Reactors (SBR)

A sequencing batch reactor (SBR) is a progressive suspended growth system for the treatment of wastewater. It operates on a batch basis, meaning that all the treatment stages occur in the same tank, but at different times.

The SBR system typically consists of one or more tanks where the wastewater undergoes a sequence of treatment steps, including filling, aeration, settling, decanting, and idling. In each cycle, the reactor is filled with wastewater, aerated to promote the growth of microorganisms that break down organic matter, and then left to settle. Once settled, the clear water is decanted from the top, leaving the sludge at the bottom of the tank. The tank is then left idle before the process is repeated **(**Mohini Singh and R. K. Srivastava 2020).
SBRs are efficient at removing organic matter, nitrogen, and phosphorus from wastewater, and they can be used for both municipal and industrial wastewater treatment **(**Ayushi Mandloi *et al.* 2018). SBR systems are often used in small to medium-sized wastewater treatment plants, and they offer several advantages over other treatment technologies, such as their flexibility in treating variable flow and load conditions, low capital costs, and the ability to operate at high sludge concentrations. SBRs are also relatively easy to operate and maintain and can achieve high levels of wastewater treatment.

Moving Bed Biofilm Reactor (MBBR)

MBBR (Moving Bed Biofilm Reactor) technology is a biological wastewater treatment process that utilizes plastic carriers that are continuously moving in a reactor tank. (Caroline Dale *et al.* 2019).The carriers provide a large surface area for biofilm to grow and perform the decomposition of organic matter in the wastewater. MBBR is a hybrid technology that combines the advantages of both fixed-film and suspended-growth systems. In MBBR technology, the wastewater is introduced into the reactor tank, and the plastic carriers provide a surface for the growth of microorganisms. As the carriers move, they create turbulence in the wastewater, promoting the exchange of oxygen and nutrients between the wastewater and the biofilm. This results in the decomposition of organic matter and the removal of pollutants.

MBBR technology is known for its compact design, high treatment efficiency, and low maintenance requirements. It is suitable for a wide range of wastewater applications, including municipal wastewater treatment, industrial wastewater treatment, and food and beverage processing wastewater.

In recent years, (Prerna Sharma *et al.* 2013) MBBR technology has become increasingly popular due to its high treatment performance and operational efficiency, compared to traditional wastewater treatment technologies like ASP (Activated Sludge Process). MBBR is also a cost-effective solution, particularly for smaller-scale treatment plants, as it requires a smaller footprint and lower energy consumption.

Literature reviews

Before this study, Numerous research has already been conducted in which a large number of laboratory tests have been done to examine the performance steps based on different technologies to determine the optimum technique and its applicability for reducing several physicochemical parameters that control the quality of the treated water.

Jain and Dhupper (2021) undertook a study to evaluate the performance of four plants that were located in Haryana and Delhi and had different treatment technologies, which included UASB, EA, ASP, OP, and BIOFOR technologies. In their investigation, they studied water samples to track different parameters, including pH, BOD, COD, TSS, TN, TP, and feces-borne bacteria (FC). UASB+EA have the highest BOD reduction efficiency, at 97.72% followed by BIOFOR with a reduction of 96.5%, ASP with a reduction of 94.4%, and UASB OP with a reduction of 94.2%. The highest COD reduction efficiency was measured in BIOFOR at 97.09%, followed by UASB, OP with a reduction of 94.53%, UASB EA with a reduction of 89.85%, and least among these, ASP with a reduction of 86.9%. All of these factors are evaluated, and after that, they are all checked for compliance with the MOEF's acceptable limitations.

Mohini Singh and R. K. Srivastava (2020) carried out their study on Sequencing batch reactor technology for biological wastewater treatment: a review. They talk about SBR's technical description and operational adaptability for treating a variety of wastewater under various operational conditions, as well as modifications that may increase the effectiveness of SBR systems in the future, and they describe the process modifications of SBR such as ASBR, SBBR, and GAC-SBR.

Mukesh Ruhela *et al.* (2020) undertook a study to evaluate the Efficiency of a Sequential Batch Reactor (SBR) based sewage treatment plant and its discharge impact on Dal Lake, Jammu & Kashmir, India. The researcher analyzes the physicochemical properties at the inlet and outlet of the plant for five months different parameters like TSS, TDS, BOD, COD, conductivity, nitrate nitrogen, sulphur, temperature, etc. are found and on the basis of these parameters, the researcher conclude that efficiency of the plant was in moderate condition.

Subramanyam (2020) conducted a study to evaluate the efficiency of different steps of the Sewage Treatment Plant located at Jaypee University of Engineering & Technology (JUET), Guan. The efficiency of the inlet, effluents of aeration, equalization, pressure filter, and outlet were all evaluated in this study. COD, BOD, TDS, and TSS removal efficiency was 68%, 57%, 12%, and 40.43%, respectively. All treated effluent values observed were below the specified tolerance limits for sewage effluent discharge to bodies of water.

Bhave *et al.* (2020) settles their 17-week learns at a home-grown sewage treatment plant situated at area 8 charkop, Mumbai Maharashtra. This plant is in view of turning media bio-reactor (RMBR) for the treatment of wastewater. In this study execution assessment of this plant was finished, by working out the rate decrease in physicochemical boundary, for example, BOD, COD, TSS, and biodegradability. BOD, COD, and TSS evacuation proficiency were seen as 94.87%, 92.65%, and 93.27 % respectively.

Florence *et al.* (2020) undertook a study to evaluate the overall performance of STPs that helped in the identification and rectification of different operational and maintenance problems and also explored the scope of future expansion to meet increasing sewage load. This study was completed at the Annarao Cabin region in Tirumala having a limit of 0.5 MLD. On assessing the proficiency of physio-synthetic boundary decrease, we observed that TSS was diminished from 700 mg/l to 150 mg/l, TDS diminished from 2200 mg/l to 1000 mg/l, BOD diminished from 200 mg/l to 30mg/l having evacuation productivity of 85%. COD was diminished from 340mg/l to 96mg/l, Nitrates decreased from 1.38 mg/l to 0.7 mg/l. This study maintained their concentration to limit inadequately treated wastewater with stacked poisons that came about because of awful activities, plans, and upkeep by assessing STPs execution in view of various quality boundaries and purposing required alterations and corrections.

Ayushi Mandloi *et al.* (2018) undertook a study on Comparative Study of Different Technologies Involved in Small Sewage Treatment Plants. The researcher compares the various technology like EA, MBR, SBR, ASP, MBBR, etc, and conclude that BOD removal efficiency varies in the order of MBR > SBR > UASB > EA > MBBR, TSS removal efficiency followed the order USAB > MBR > MBBR > SBR >EA, for economical point of view the order is as follow MBR < USAB < EA < SBR < MBBR.

Babitha M (2018) performs their study on the Performance Evaluation of STPs for The Treatment of Hospital Wastewater at RRMCH. The researcher estimated the psycho-chemical parameters like pH, Turbidity, TSS, COD, RC and MLSS/MLVSS, Dissolved oxygen and Residual Chlorine, etc. on the weekly samples taken from various treatment plant units and examined in the RRCE laboratory to determine the effectiveness. The researcher concludes that the COD in the effluent is higher than that in the influent indicating the absence of microbes and the same is also indicated by MLVSS values that are 0. Since no microorganisms are living in the plant, the oxygen supply in the aeration tank is essentially wasted which leads to a waste of electric power.

Jayanthi Ganesan *et al.* (2015) perform their study on the Performance Evaluation of Sewage Treatment Plants (STPs) in Multistoried Buildings. The researcher study different STPs installed in multistoried buildings and analyze the performance of each technology, its design concept, and life cycle as per the study they conclude that O & M cost of treating one KLD wastewater is: E A (Rs. 0.034 lakes), MBR (Rs. 0.074 lakes), SBR (Rs. 0.124 lakes), FBBR (Rs. 0.257 lakhs).

B. Ahansazan *et al.* (2014) carried out their study Activated Sludge Process Overview The author describes the overall working and the process of ASP Researcher concluded that the effectiveness of microorganisms in the treatment process is considered the most complete, environmentally acceptable, and cost-effective treatment options. The effectiveness of the solids/fluids division is primarily impacted by the properties of the Sludge. For effective working in getting good efficiency the proper BOD: N:P ratio should be maintained.

Prerna Sharma *et al.* (2013) undertook a study on Comparative Study of Sewerage Treatment Plants With Different Technologies in The Vicinity Of Chandigarh City, The researchers studied various physicochemical and biological parameters of wastewater from 3 STP plants named Raipur Kalan STP (UASB Technology), Raipur Khurd STP (ASP Technology), and Mohali STP (FAB/MBBR Technology) and evaluated and compared them to the Central Pollution Control Board (CPCB) General Standards for the Discharge of Environmental Pollutants, Part-A: Effluents, into Inland Surface Water, as prescribed by the Environment Agency. Because the effluent from these STPs enters the river Ghaggar, the Protection Rules of 1986, Schedule VI, apply. The researcher concludes that the plant-based MBBR technology is ahead of UASB and ASP technology in the treatment of sewage in terms of the removal of TDS, TSS, BOD, and COD.

K. SUNDARA KUMAR *et al.* (2010) carried out their study on the performance evaluation of wastewater treatment plants based on ASP. The researchers estimate the basic psycho-chemical parameters including total suspended solids (TSS), biological oxygen demand (BOD), chemical oxygen demand (COD), and total dissolved solids (TDS), etc of the wastewater samples that were collected at various phases of treatment units, and on these parameters evaluate the performance of Treatment plant.

Nobuyuki Sato *et al.* (2007) perform their study on the Economic Evaluation of STP in India. The researchers in their study evaluate the total annual cost for the up-flow anaerobic sludge blanket (UASB) and waste stabilization pond (WSP), activated sludge process (ASP), and systems in India, including capital and operation and maintenance (O&M) costs and conclude that Among the 3 technologies – UASB, WSP & ASP, the UASB is efficient and economical where the land cost is high and WSP is found to be more applicable in areas of low land costs.

Amit Sonune and Rupali Ghate (2004) undertook a study on Developments in wastewater treatment methods. The researcher in their study explains the treatment units like Preliminary treatment, Primary and secondary treatment and provide information regarding advancements in tertiary treatment, physicochemical treatment, combined biological-physical treatment with membrane treatment technology along with Desalination technologies like distillation, reverses osmosis (RO), electro dialysis (ED), ion exchange (IX), and freeze desalination.

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