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"Treatment of VIJAYAPUR City Domestic Wastewater byMoving Bed Sequential Batch Reactor."

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Abstract
Moving bed sequencing batch reactor (MBSBR) incorporates benefits provided by both Moving bed biofilm reactor (MBBR) and Sequencing batch reactor (SBR). MBSBR is modification of MBBR process which is operated in sequencing batch mode. It is an advanced wastewater treatment technology which involves high treatment efficiency with low capital, operational, maintenance and replacement cost. It is a cost-effective way of upgrading existing wastewater treatment system as it is efficient, compact and easy to operate. MBSBR can be
provided for designing new wastewater treatment plants and also for retrofitting existing wastewater treatment plants where higher removal efficiency is required with low cost. The performance of MBSBR depends on the carrier fill percent, specific surface area of carriers and organic loading. Kinetic models used for optimization of MBSBR are also discussed in this paper.
Key Words: *MBSBR, Advanced Wastewater Treatment, Domestic Wastewater*

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I. Introduction

Around 85 % of the world population lives in the driest half of the planet. There are about 783 million people who don't have access to clean water and nearly about 2.5 billion do not have access to adequate sanitation [4]. It is expected that 60 % of the world population will live with water scarcity if water consumptions remain at the same current level, by the year 2025 [1]. It is expected that the need for fresh water will keep increasing with further development of human society. In the next 15 years, more than 90 % of available fresh water resources will be consumed [2]. Therefore, water reclamation and its reuse are inevitable in the years to come. Wastewater treatment technologies like trickling filters (TFs), rotating biological contactors (RBCs), activated sludge processes (ASPs) which have been in use for wastewater treatment processes for over a century requires advancement and/or replacement with new and more advanced treatment technology that can provide high quality treated water, which can be used for domestic, industrial and agricultural purposes and also for future sustainable practices.

Considering environmental, economic and social limitations of conventional centralized wastewater treatment systems, it is necessary to consider low cost and flexible decentralized wastewater treatments and having community benefits. A new generation of highly efficient, compact, user friendly and low-cost treatment system is to be developed in order to serve the needs of developing countries. "A novel approach in designing, fabricating, and operating decentralized package plants is necessary. Mass production using modern industrial methods will provide best chances to serve the public with reliable, effective, robust and reasonably priced treatment plants.

Suspended growth and attached growth biofilm systems such as different activated sludge and bio-filterconfigurations have a number of inherent limitations even if they are widely used as successful biological treatment schemes for domestic and industrial wastewater. The operational difficulties experienced with these traditional systems stimulated considerable research effort for the development of novel biological processes. In the past few years, studies focusing on hybrid systems combining the advantages of suspended growth and attached growth biofilm systems have increased.

Under these circumstances, moving bed biofilm reactors (MBBR) have been developed as one of the most attractive hybrid systems [3]. Since the last decade, significant research has been conducted on pilot and full-scale MBBR systems for the removal of organic matter and nutrients from domestic as well as industrial wastewater [31]. MBBR is encouraged mainly as more biomass in the reactor can be sustained in the reactor and thus, more stable treatment efficiency can be achieved, through the use of the carrier elements of various nature and type [5].

In the last two decades, Sequencing Batch Reactor (SBR) is another highly successful biological treatment alternative widely studied and used for domestic as well as industrial wastewater treatment [6]. SBR offers number of significant advantages, such as, smaller footprint since various processes can take place in a single reactor, ease in adjusting operational conditions, and flexibility of operation.

Recently, it was suggested that MBBRs could be operated in a sequencing batch mode, in order to get benefit from the advantages of both processes. [7], carried out research on biological phosphorus removal in a moving bed sequencing batch biofilm reactor (MBSBBR). Where a phosphorus removal efficiency of 98% was reported operating a biological treatment system with MBSBBR. After that, Moving Bed Sequencing Batch Reactor (MBSBR) has attracted a great deal of attention due to its ability to take advantages of both a biofilm reactor and a Sequencing Batch Reactor (SBR). Specifically, MBSBR show improved biomass concentration in reactors with corresponding higher specific removal efficiencies, greater volumetric loads, and increased process stability towards shock loading. As suspended active sludge with a short generation time can afford space to nitrifies, meanwhile the biofilms developed on carriers can support Phosphorus Accumulating Organisms (PAOs) [8]. MBSBR can remove nitrogen and phosphorus from wastewater. It is one of the advanced aerobic wastewater treatment processes, which is based on the plastic carriers on which biomass attaches and grows [5]. It is continuously operating, non-cloggable biofilm process with no need for backwashing, low head-loss and a high specific biofilm surface area [10].

MBSBR is modification of MBBR process which is operated in batch mode. Attached biofilm grows on small carrier elements suspended in constant motion throughout the entire volume of the reactor [9]. Contrary to the Activated sludge process (ASP), it does not need any sludge recycle, as is the case in other biofilm reactors. Since no sludge recirculation takes place, only the surplus biomass has to be separated, which is a considerable advantage over ASP [11]. Moreover, nitrification and de-nitrification can also be successfully achieved in biofilm-based processes since nitrifies, which are slow growing micro-organisms, are retained by the biofilm [12]. MBSBR has some advantages in which the treatment facilities can be improved to produce the economic benefits by reducing the solid load of existing secondary clarifier [13]. The basic purpose of this review is to study various factors affecting performance of MBSBR, its applications and performance.

Advantages ofMBSBR

- Simple in operation and flexible.
- Reactor volume reduction, as all the phases are carried out in a single reactor.
- Increased treatment capacity as it has advantage of both attached as well as suspended growth processes.
- Reduction in sludge production.
- Improvement in sludge settling characteristics.
- Sludge returns not required.

Disadvantages of MBSBR

- Low pathogen removal
- Requires skilled persons

Flow chart
Working principle of Moving Bed Sequential Batch Reactor

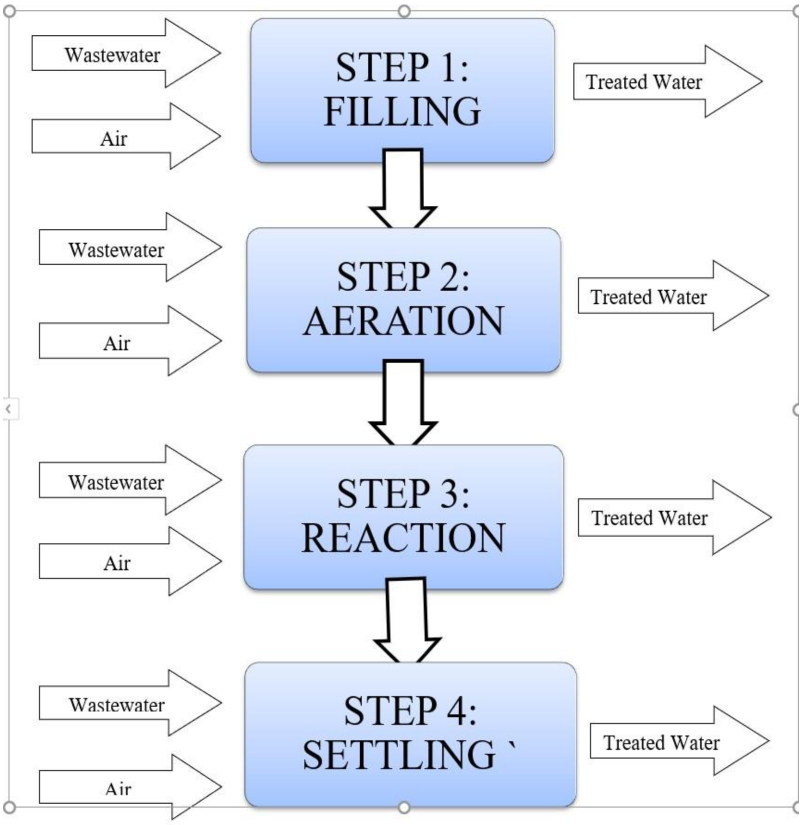

Fig. 1 Flow chart of Moving Bed Sequential Batch Reactor

II. Material and Methodology

Source of Wastewater
The present study is conduct for decentralized wastewater treatment applicable to individual house/apartment/small colony. Hence, a location in a residential area Vijayapur city Karnataka.

Experimental Set-up
A laboratory scale experimental setup was developed for MBSBR. The schematic and photographic view of the system is shown in Figs. 1 and 2 respectively. It was made up of 5mm thick acrylic glass reactor 300mm high, 300mm wide and 300mm long with a total working volume of 27 L. Multiple outlets were provided for decanting and sludge wasting at different levels. The size of these outlets was chosen so that carrier elements will not escape from the reactor. Aeration system consisted of two aerators injecting at 8 lpm/aerator through diffuser stones placed at the bottom. The carrier used is shown in Fig. 3. The specific surface area of these carriers was specified to be 430 m2/m3 and each carrier element was 20 mm in diameter and 10 mm high.

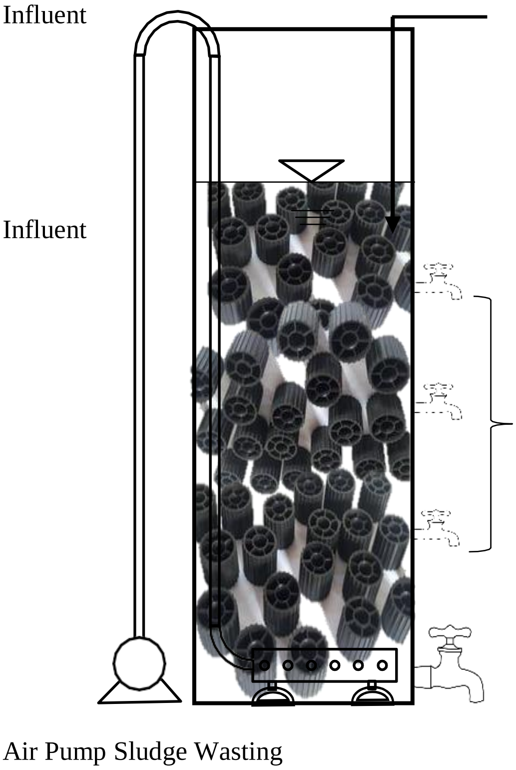

Fig. 2 Schematic diagram of reactor for MBSBR **Fig. 3** Photographic view of reactor

Fig. 4 Photo of biofilm carrier use.

III. RESULTS AND DISCUSSION

Wastewater from identified source was analysed for 6 days to assess the variation in characteristics daily and during the course of the day. Analysis of settled wastewater which was fed to MBSBR system was also carried out. The results are as summarized in table 1.

Wastewater collected in peak hours was used in the study as it was convenient to collect the samples in the peak hour and there was no much variation observed in the characteristics at other times in a day. Further, collection of the sample in the morning enabled to conduct the required number of cycles of MBSBR for that day. Fresh wastewater was used as a feed for MBSBR operation.

Figure 5 shows the COD removal efficiency for various fill percent of carriers and aeration time from 1 h to 6.0 h with 0.25 h interval. The COD removal efficiency was observed between 36.66 % and 55.53 % for 2 h aeration for different carrier fills. Increase in aeration time has increased COD removal efficiency for all the cycles and all the fills. COD removal efficiencies were more than 91.48 % at all the carrier fill percent after 6 h aeration. This shows consistency in the performance of MBSBR process. This may be interpreted as slowly biodegradable organic matter is hydrolyzed in long residence time. Average influent COD concentration is 235±20Mg/Lit. The COD removal efficiency was 91.48±2%.

Similarly Fig.6 show the Total Dissolved Solids (TDS) removal efficiency for various carries and time intervals from 1 h to 6.0 h with 0.25 h interval. The TDS removal efficiency observed between 15.60 % to 64 % for 4 h intervals and after 6 h the total removal efficiency of TDS is 90.66 %.

And Fig.7 shows the Total Suspended Solids (TSS) removal efficiency was observed at different time intervals and carries from 1 h to 4 h with 0.25 h intervals. The TSS removal efficiency was observed between 30 % to 75% for 4 hours and after 6 h process the total removal efficiency of TSS is 91.05 %

Chloride parameters Fig.8 shows the removal efficiency for various carries and time intervals from 1 h to 6 h with 0.25 h intervals. The chloride removal efficiency observed between 29 % to 79% for 4 h and the 6 h complete process the chloride removal efficiency is 92.73 %.

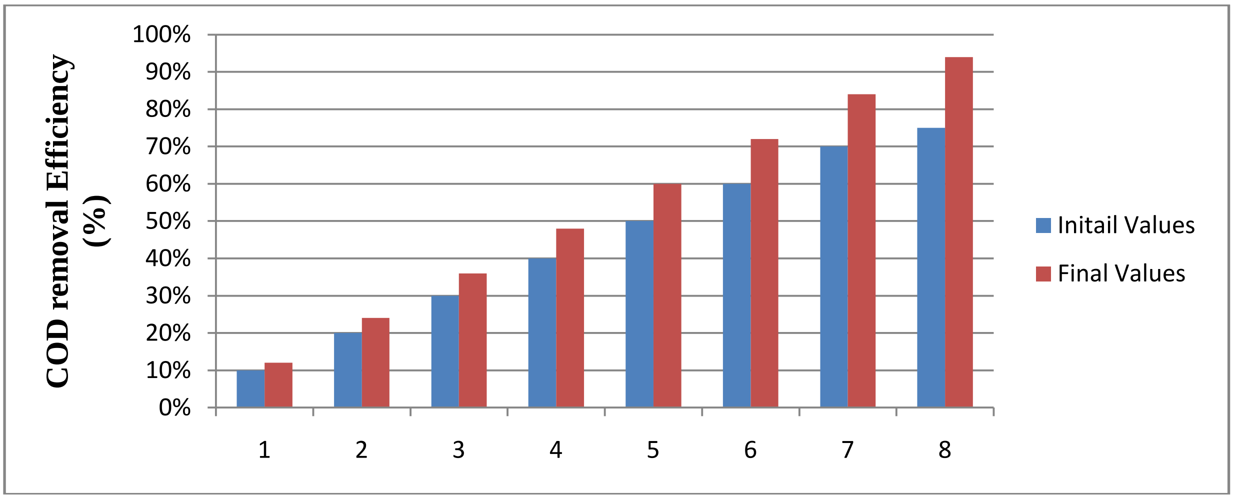

Fig.5 COD

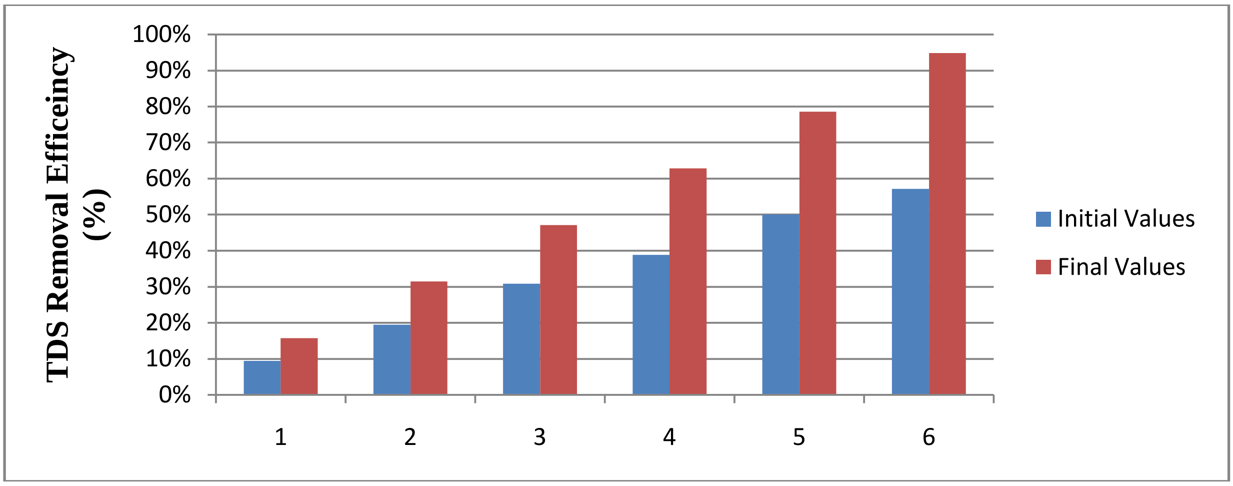

Fig.6 Total Dissolved Solids

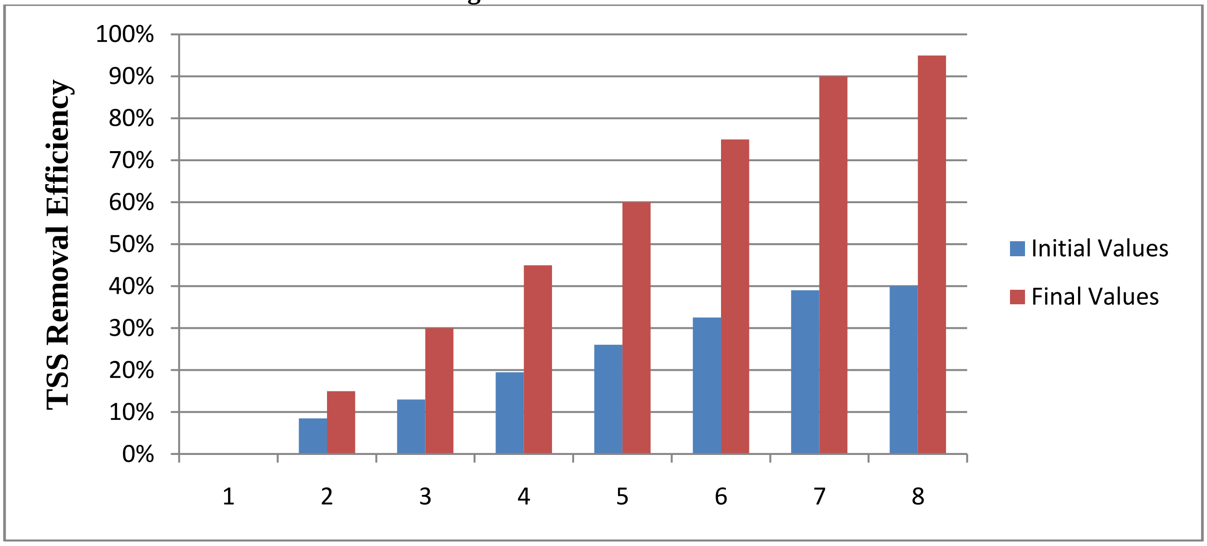

Fig.7 Total Suspended Solids

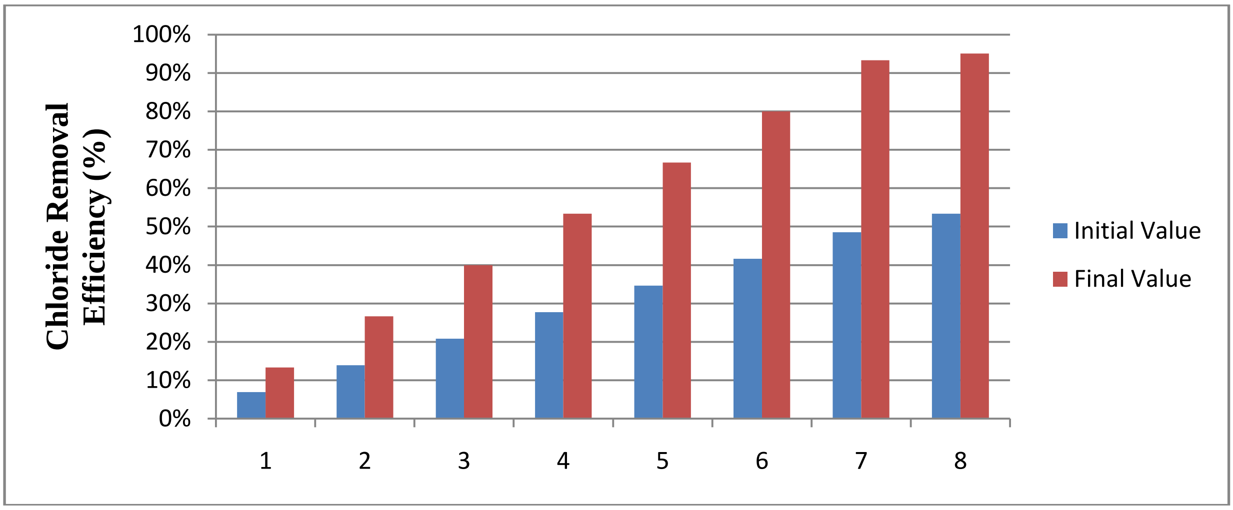

Fig.8 Chloride

Table:1 Raw water characteristics of domestic waste water

Parameters	Values(average)
Chemical Oxygen Demand	235Mg/Lit
Total Dissolved Solids	332Mg/Lit
Total Suspended Solids	190Mg/Lit
Chloride	731.2Mg/Lit

IV. Conclusion

- It can be concluded that, MBSBR can be used for secondary wastewater treatment for organic carbon andnutrient removal from domestic as well as industrial wastewater.
- MBSBR can work efficiently with varying organic and inorganic loading and under various operatingconditions.
- MBSBR maintains higher biomass in reactor as compared to suspended growth systems such as ASP; thiscan make the reactor small footprint thus reducing the overall cost.
- The COD removal efficiency achieved is higher in MBSBR is 91.48 %, TDS is 90.60% , TSS is 91.05 % and Chloride is 92.73 %.
- The accumulation of biofilm depends most strongly on carrier surface properties, such as surface roughnessand specific surface area.
- Furthermore, one can choose any shape for reactor and different operating loads in a given reactor volume, simply by choice of carrier filling. Such results clearly demonstrated the big potential of this technology for different wastewater treatment processes.
- Also, for small scale domestic and industrial wastewater treatment systems, this technology can be proved efficient.
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