Treatment of Sewage by Partially Submerged Three Stage Rotating Biological Contactor (RBC)

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Abstract

Due to fading of natural water resources (Surface source), sewage treatment is becoming more critical. The disposal regulations of sewage discharge firmer have reduced levels of contaminants allowed in waste-streams (nallah). The sewage management extreme objective is the assurance of the earth in a way too equivalent the general well-being and financial concerns. Understanding the nature and characterization of the sewage is essential for the design of appropriate sewage treatment plant and sanitation technologies. This project is study to show the general sewage characteristics collected from the sewage treatment plant and also to treat the domestic sewage by attach growth process. The attach growth process considered for treating domestic sewage is Rotating Biological Contactor (RBC) model. Result showed removal efficiency for partially submerged Rotating Biological Contactor (RBC) for Biochemical Oxygen Demand was efficient for rotational speed of disc at 6rpm. It is also seen that after treatment the values are within desirable limits of effluent standards as per CPCB, New Delhi.

Keywords: Sewage Treatment Plant, Hydraulic Retention Time, Organic Loading Rate, Rotation per Minute

I. INTRODUCTION

The wastewater that streams in the wake of being utilized for local (domestic), industries, manufacturing and different purposes is called as sewage. It is no doubt understood that sewage from local point contains suspended solids, pathogens, natural and inorganic toxins. Keeping in mind the goal is to diminish the well-being dangers (health hazards) and for safe transfer of sewage these contaminants and impurities should be cut down as far as possible. Thus, removal of the contaminants and pathogens from sewage is of preeminent imperative for its reuse in distinctive activities.

Sewage comprises water as the main constituent, while other constituent includes organic waste and chemical [1]. To safeguard public health and the environment assessment of water and sewage is very crucial. The major source of water contamination is the discharge of sewage, which is adding to the interest of sewage and natural loading of the water bodies, algal blooms, advancing harmful and prompting destabilized sea-going biological system[2].The issue is intensified in areas where effluent treatment systems are simple and not temperate. The conventional wastewater treatment advances in received in industrialized countries are expectionally lavish to manufacture, keep up and work particularly for the de-centralized communities. Research efforts are in progress for the development of the treatment technologies related to the de-centralized communities [3].

The domestic sewage is the wastes from food preparation, garbage-grinding, dishwashing, showers, baths, sinks and toilets. However, the municipal sewage is a composite mixture of liquid wastes flushed down sewers from the sources of industrial, residential, commercial and institutional. Sewage comprises human wastes and bathroom tissues, which flow to the treatment facility in more quantity in the form of suspended fibrous material and dissolved organic matter, and these add to the loadings of nitrogen, phosphorous and pathogens. The wastes from these substances are chiefly designed and treated in the municipal sewage treatment plants (STPs) [4].The unstable organic matter ranging from 60 to 80% is present in the primary sedimentation tank of sewage treatment plant. Further by the biological treatment processes the colloidal and the dissolved organic matter, which passes from the primary clarifiers, without any settling has to be removed. The organic matter characteristics is changed and thus by oxidation and nitrification these substances are converted to stable forms like nitrates, sulphates etc and therefore biological treatment is carried out[4].

II. MATERIALS AND METHODOLOGY

A. Sample Collection:

Sewage was collected from the sewage treatment plant of KLS GIT campus, Belagavi for this study. The disposal of the sewage is used for gardening in the campus. The flow diagram of Sewage Treatment Plant (STP) for KLS GIT, Belagavi is shown in Fig 1.

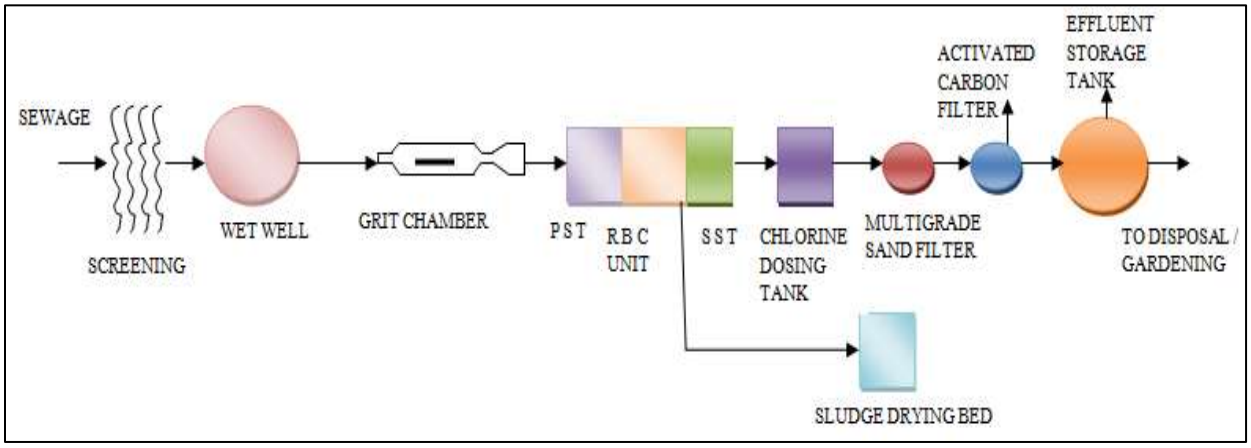


Fig. 1: Flow diagram of Sewage Treatment Plant (STP)

B. Initial Characeristics of Sewage:

Sewage sample was collected from the grit chamber of Sewage treatment plant (STP) of GIT campus, Belagavi and analyzed on various parameters in college laboratory. The characteristics of sewage used in the study are given in Table 1.

Table – 1
Initial Characteristics of Sewage

Sl. No	*Parameters*	*Unit*	*Values Obtained*
1	*pH*	*-*	*7.75*
2	*Electric Conductivity*	*Micro Siemens/cm (µS/cm)*	*1090*
3	*Total Dissolved Solids*	*mg/L*	*590*
7	*BOD*	*mg/L*	*132.99*

C. Fabrication of Rotating Biological Contactor (RBC):

A three stage lab scale RBC reactor was fabricated using Acrylic sheet (non-corrosive, non-reactive) of 3mm thickness and the inner dimension of individual tank is 20×20×21.5cm and outer dimension is 21×21×22.5cm. The reactor was provided with groove opening of 3×2cm and at a height of 20.5cm from the bottom of the reactor. The inlet and outlet of the reactor was provided at a height of 18cm from bottom and of 1cm diameter. A gap of 12.5cm was provided between two reactors and the frame size is 110×22cm was provided to support the disc over shaft. The size of shaft is 2.5cm diameter which was supported along the frame with bushing and bearings on either side. There are 6 discs mounted over the shaft for each reactor with the size of disc 18cm diameter and spacing between 2-discs is 1cm. To increase the surface area acrylic beads of size 0.5×0.5×0.5cm was provided on inner pair of the disc and other 4 discs are plain i.e. without the acrylic beads. As disc was constructed with acrylic sheet it had smooth surface area to make it rough surface and for the attachment and growth of microorganisms it was provided with polyester cloth on 4 discs i.e. 2 plain discs for Biofilm development and 2 discs modified with acrylic beads to increase surface area and 2 discs with door mat material for Biofilm development. Hence it was provided total 6discs for one reactor similarly in the same sequences the other two reactors was constructed and was operated in series. The cloth used is non-biodegradable material and a fan motor is provided for rotation of discs [5].

Fig. 2: Fabrication of partially submerged three stage Rotating Biological Contactor (RBC) reactor

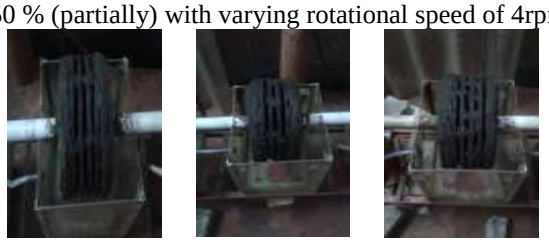
D. Experimental set up of the reactor

A three stage RBC reactor in which every reactor of total volume was 8.6L and 7.2L of working volume is constructed with acrylic sheet and reactor was set in arrangement. Sewage was discharged from the feed tank to the inlet of the reactor. In this

study, with a constant submergence of 50% and with a varying rotational speed of 4rpm and 6rpm was carried out. Biofilm formation on the surface of the discs helped in the better treatment of the sewage. With a temperature of 29°C - 32°C the reactor was kept for working. For initial BOD concentration of 100mg/L the HRTs were varied for 48hrs,24hrs,12hrs,6hrs,4hrs,2hrs,1hrs and the ideal HRT was determined. After recognizing the ideal HRT slowly the BOD loading rate was incremented up to 700mg/L at which the effectiveness was decreased subsequently. The BOD loading rate was incremented at interim of 20mg/L from 600mg/L (i.e. 620,640,660,680) and optimum BOD loading rate was determined.

E. Reactor operation

Acclimatization was needed for starting period. In this study, cow dung is used as a seeding material because it comprises of large measure of microorganisms which exist in aerobic condition. Acclimatization of the reactor took place until a thick bio-film media was developed on the discs. The reactor was inoculated with 25% of cow dung in each tank. After 15days of acclimatization period the sewage was fed to feed the tank with initial BOD concentration of 100mg/L. Later the reactor was operated for constant submergence of 50 % (partially) with varying rotational speed of 4rpm and 6rpm.



I-Stage II-Stage III-Stage

Fig. 3: Development of bio film on the surface of discs in different stages of RBC

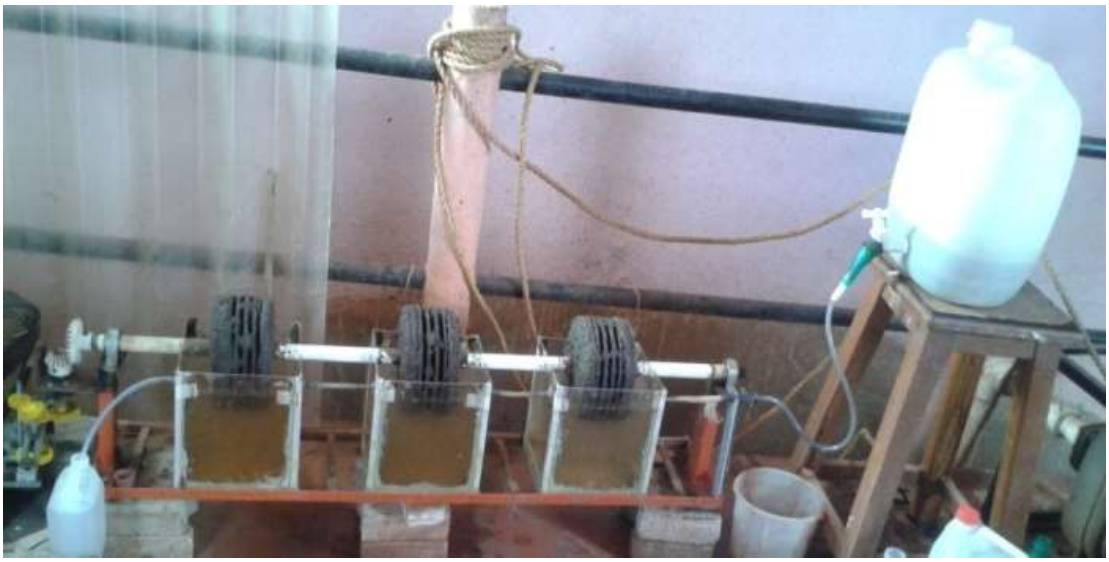


Fig. 4: Operation of RBC reactor

F. Analysis

Samples from rotating biological contactor were collected and tested for pH, temperature, BOD. The analysis of sewage was carried out according to standards prescribed by APHA and AWWA [6].

III. RESULTS AND DISCUSSIONS

A. Removal Efficiency (%) for Partial Submergence (50%) at a Rotational Speed of the disc at 4rpm:

During the study, the reduction in BOD was observed 97.5% of BOD reduction was observed at an optimum concentration of 620mg/L.

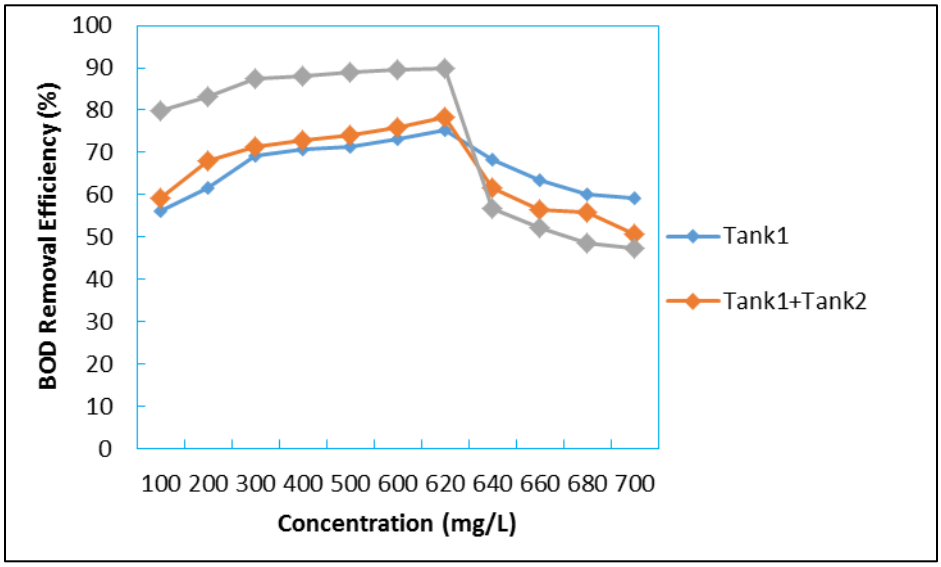


Fig. 5: Overall BOD removal efficiency (%) at different concentrations (mg/L)

B. Removal Efficiency (%) for Partial Submergence (50%) at a Rotational Speed of the disc at 6rpm

During the study, the reduction in BOD was observed 98.32% of BOD reduction was observed at an optimum concentration of 460mg/L.

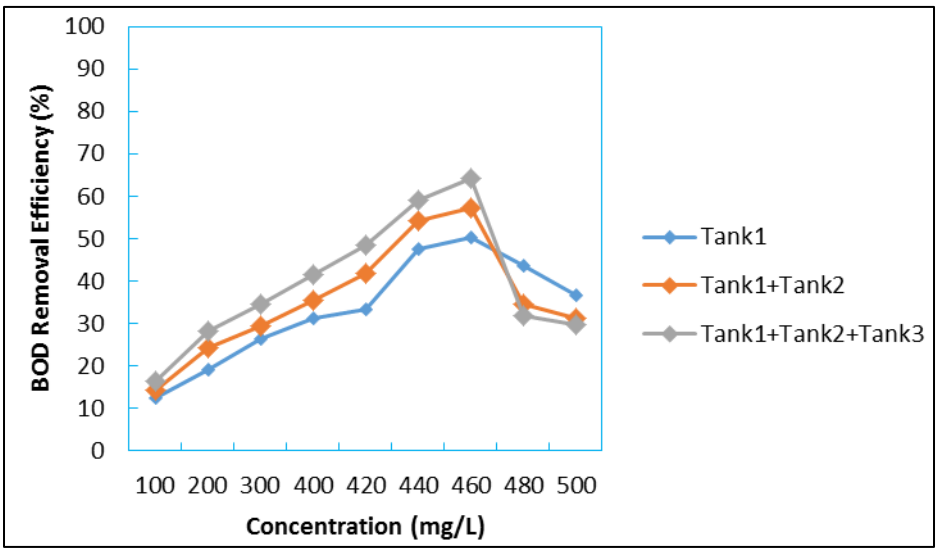


Fig. 6: Overall BOD removal efficiency (%) at different concentrations (mg/L)

IV. CONCLUSIONS

The following conclusions were obtained from the study carried out on treatment of sewage by partially submerged three stage Rotating Biological Reactor (RBC).

At a rotational speed of the disc at 4rpm with partial submergence (50%):

1) At optimum BOD concentration of 620mg/L at 2hrs HRT, the removal efficiency of BOD for the three stage RBC was 88.87%-Tank1,96.32%-Tank1+Tank2 and 97.5%-Tank1+Tank2+Tank3.

   At a rotational speed of the disc at 6rpm with partial submergence (50%)

2) At optimum BOD concentration of 460mg/L at 1hrs HRT, the removal efficiency of BOD for the three stage RBC was 89.78%-Tank1, 95.69-Tank1+Tank2 and 98.32%-Tank1+Tank2+Tank3.
3) By comparing both the rotational speed of the disc with 50% constant submergence, it concludes that treatment of sewage for physico-chemical parameters of 6rpm was efficient than 4rpm.
4) The usage of Polyvinyl chloride and polyethylene material resulted in a thick biofilm (Microorganism) growth for effective treatment of sewage.
5) Hence Rotating Biological contactor is efficient, economical and effective in treating organic and inorganic waste.

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