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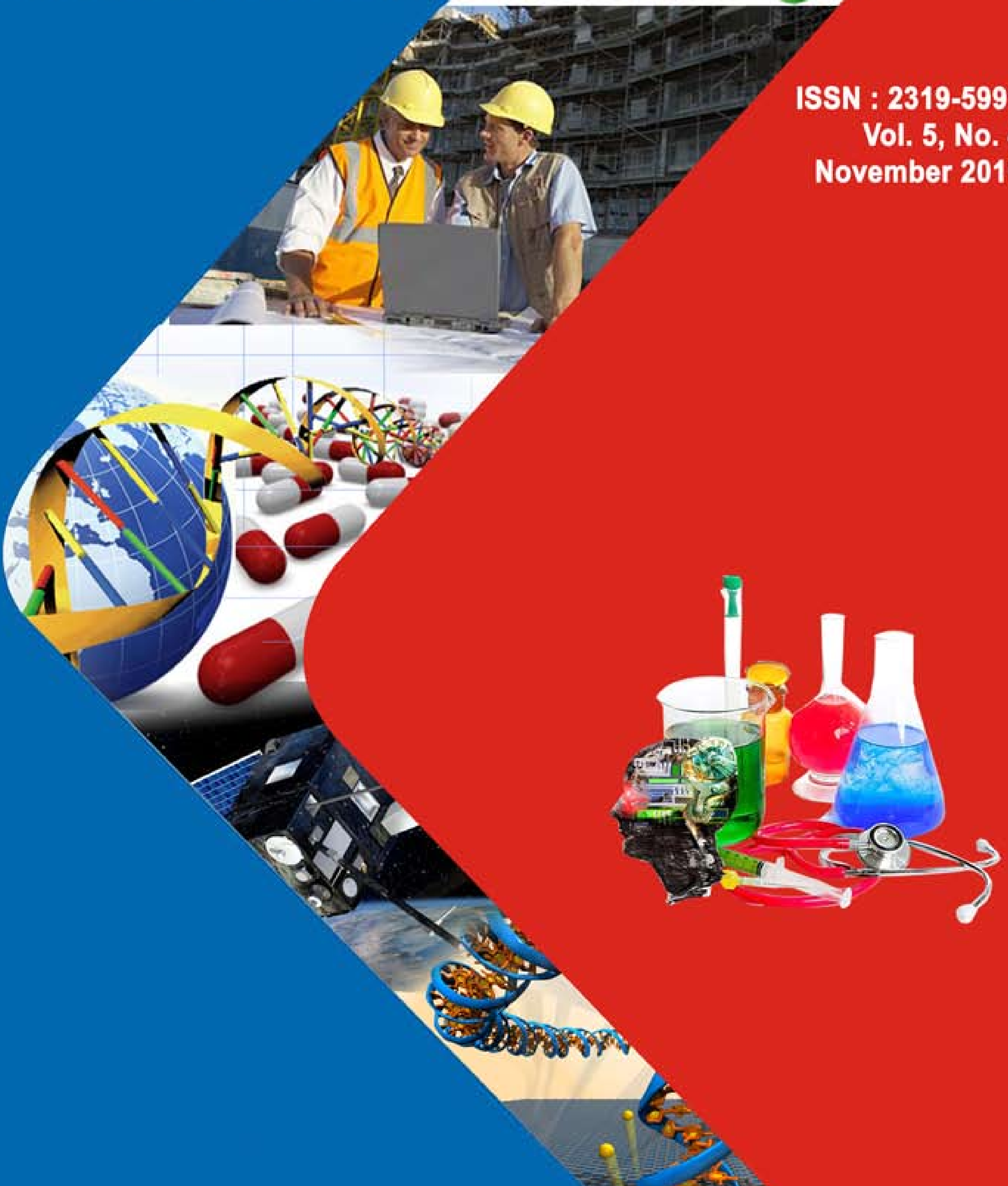

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Research Paper

A COMPARISON OF TWO DIFFERENT TECHNOLOGIES OF SEWAGE TREATMENT PLANTS WORKING IN SRINAGAR, KASHMIR

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In Srinagar, there are mainly two types of sewage plant treatment technologies namely Sequential Batch Reactor and Fluidised Aerobic Bed (Moving Bed Biological Reactor). The study aims at comparing the removal efficiencies of the two technologies stated above. Two treatment plants were selected, one from each technology at BRARI-NUMBAL (SBR) and LAAM (FAB) respectively. The samples were collected from the month of June 2015 to August 2015 and four parameters were analyzed namely ammonia, ortho-phosphate, total-phosphate and COD. The plant run by the SBR technology showed the highest removal percentage of COD, orthophosphate, total phosphate and ammonia having an average removal value of three months as 77.51%, 72.75%, 54.47% and 69.94% respectively. This is quite sufficient to say that SBR is a superior technology.

Keywords: Brari-nambal, Laam, SBR, FAB, COD

INTRODUCTION

The main purpose of waste water treatment is to treat the waste water with higher levels of contaminants so that the water can be discharged in the water bodies with minimal effect on the ecosystem. Biological processes are used to convert the finely divided and dissolved organic matter in wastewater into flocculent settleable inorganic solids that can be removed in final sedimentation tanks. These processes are called “secondary treatment”, are employed in conjunction with physical and chemical processes that are used for the preliminary and primary treatment of wastewater (Metcalf and Eddy).

Sequencing Batch Reactor (SBR) is a fill-and-draw activated sludge treatment system. Although the processes involved in SBR are identical to the conventional activated sludge process, SBR is compact and time oriented system, and all the processes are carried out sequentially in the same tank. SBR system is the upgraded version of the conventional activated sludge process, and is

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capable of removing nutrients from the wastewater.

FAB is a waste water treatment technology which acts as a better alternative to the conventional waste water treatment plants. The conventional treatment plants are large sized and require a lot of monitoring. Scarcity of open space geographical network of piping, high power and land cost have made conventional systems obsolete and FAB serves as a great space saving and efficient treatment operation.

The FAB consists of a tank filled with specially developed media. These media are made of special material of suitable density that can be fluidized using an aeration device through diffusers. A bio-film develops on the media, which move along the effluent in the reactor. The movement within the reactor is generated by providing aeration with help of diffusers placed at the bottom of the reactor. This thin film on the media enables the bacteria to act upon the bio-degradable matter in the effluent and reduce BOD/COD content in presence of oxygen from the air used for fluidization.

In the Srinagar city of Jammu and Kashmir, three types of treatment systems are currently in place namely Activated sludge, FAB and SBR. By 2015 the number of plants operating on FAB technology were three at LAAM, HABAK and HAZRATBAL and that on Sequential Batch Reactor (SBR) were two, one at Brari Nambal and Nallah Amer Khan respectively and only one sewage plant was working on the principle of activated sludge system at Brarinumbal. Two plants were studied in this study, one based on SBR and the other based on FAB and a comparison between these technologies was made. The details of these two STP's as taken in this study are as under in Tables 1 and 2:

Table 1: Salient Features of 16.10 MLD Sewage Treatment Plant (STP) at BRARI NUMBAL

S. No.	Particular	Remarks	
1	Capacity	16.10 MLD	
2	Technology	Sequential Batch Reactor (SBR)	
3	Design population (year 2017)	1, 15, 331 Souls	
4	Population by year 2015	1, 11, 148 souls	
5	House connection	Target	Achievement
		16717 houses	10850 (65%)
6	Catchment area	Rainawari, Muma Khan Khudpora, Khoja Yarbal, Saidakadal Naidyar, Jogilanker Miskeen Bagh, Moghal Mohallah, Motiyar, Dulatabad, Nowpora Bridge. Main Dalgate, Buchwara, Gagribal, Khonakhan and Adjacent Areas.	

Table 2: Salient Features of 4.50 MLD Sewage Treatment Plant (STP) at LAAM, NISHAT

S. No.	Particular	Remarks	
1	Capacity	4.50 MLD	
2	Technology	Fluidized aerobic bed (MBBR)	
3	Design population (2017)	24036 souls	
4	Present population (2015)	23146 souls	
5	House connection	Target	Achievement
		4696 houses	4555 (97%)
6	Catchment area	Karpora, Kraal Sangria, Brane, Kraal Pora, Pahloo, Manzgam, Meebagh, Danpora, Zeethyar, Old Nishat, Nishat Garden, Ishber, Laam, Dar Mohallah, Wani Mohallah	

TREATMENT PLANTS DESCRIPTION

Sequential Batch Reactor (Brari Numba Wastewater Treatment Plant)

The BRARI-NUMBAL treatment plant consists of an inlet chamber, coarse screens, raw sewage receiving sump, stilling chamber, fine screen, grit chamber, LUCAS III (sequential batch reactor), disinfection tank, chlorination system, sludge thickener and sludge dewatering facility. The plant has been designed for an average flow of 16.1 m^3/day and a peak flow of 40250 m^3/day.

The inlet chamber is 3.5 m length, 2.0 m width and 2.0 m depth. The coarse screen is designed for a maximum flow of 0.466 m^3/s and has a screen width of 650 mm.

The raw sewage receiving pump is designed to receive peak flows up to 1677 m^3/hr. To protect all further equipments and to reduce the total BOD load, fine particles bigger than 6 mm are retained by high quality self cleaning fine screens. To deal with the flow, two screens have been installed in parallel out of which one is kept as standby.

Sand particles are mostly eliminated into grit chamber and the total peak flow is divided into two parallel chambers, sharing the same travelling bridge. The width of the grit chambers is 6.5 m, length is 6.5 m and the water depth is 1.0 m. The total surface overflow rate is 960 m^3/ m^2/ day.

The wastewater is then treated by aerobic LUCAS III reactor which has a maximum capacity of 1677 m^3/hr. Automatic penstocks are provided to feed the influent three biological treatment tanks. The tanks are designed for a maximum load of 4347 kg BOD/day. The sludge concentration is 4 kg MLSS/ m^3 and the F/M ratio is kept at 0.16-0.20 kg BOD/ kg MLVSS/day. The outer tank dimensions are 26.0 m length x 26.0 m width x 6.0 m depth. The middle tank dimensions are 52.0 m length x 13.0 m width x 6.0 m depth and the free board is kept at 0.5 m. The aeration time for the main phase is 4 hours, intermediate phase is 1 hour and the total phase duration is 5.0 hours. For the process of aeration four blowers of the positive displacement type are provided. Blowers are running in parallel and their capacity at full speed is 3500 m^3/hour and the differential pressure is 700 mbar. Twin lobe blowers are installed for oxygenation and three root blowers are frequency controlled for air supply. The input of the necessary oxygen into the aeration tanks is done by means of special air diffusers (bubbling system), distributed all over the bottom surface, while the compressed air is delivered by blowers. The air flow per tank is 5000 m^3/hr. Length of the diffusers is 2 m, their membrane diameter is 63 mm and area is 0.395 m^2. The active area is 0.395 x 0.8 = 0.316 m^2.

The excess sludge is extracted from the outer tanks of the biological treatment system by using submersible pumps. The excess sludge is directly discharged to the sludge thickener. The sludge production per lane is 6944 kg MLSS/day and the excess sludge concentration is 10kg MLSS/ m^3. Two submersible pumps are installed per lane and the capacity of each pump of 43.4 m^3/hr. A rinsing pit is provided for the recirculation of dirty water coming out from the biological system during the aeration phase from the gutters of LUCAS. The pit has a volume of 140 m^3 with the dimensions as 11 m x 5 m x 2.5 m.

The sludge is then thickened in sludge thickener having a sludge inflow of 694.4 m^3/day and having 16 hours of operation. The tank has a diameter of 17 m and the depth is 3.5 m with a free board of 0.5 m. The solid loading rate is 30 kg/m^2/day.

The sludge is then dewatered using a solid bowl centrifuge having a capacity of 12 m^3/hr. Finally the disinfection of the effluents takes place in the disinfection tank. The tank has dimensions 26 m x 5.0 m x 2.5 m. the flow diagram for the plant has been shown in Figure 1 as under:

Fluidised Aerobic Reactor (LAAM, Nishat)

The FAB technology consists of a receiving sumo, sewage transfer pumps, stilling chamber, bar screen channel, grit chamber, FAB reactor, flash mixer, secondary clarisettler, chlorine contact tank, sludge sump, sludge thickener and centrifuge.

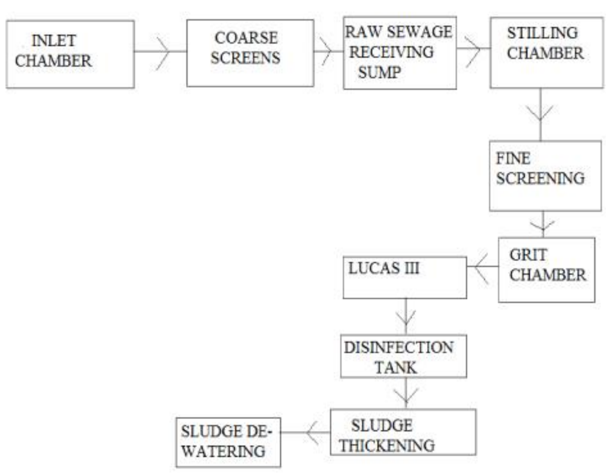
The receiving sump is circular has a volume of 279.5 m^3 and a sump depth of 3. 0 m.

The raw sewage is transferred by pumps and are 06 in number having a total capacity of 419.3 m^3/hr.

To reduce the incoming velocity of the effluent so as to be stable for the downstream processes, a stilling chamber is provided with a volume of 7.95 m^3.

The bar screen channels are provided with the velocity of flow in the bar screens as 0.6-1.2 m/s and a cross sectional area of 0.582 m^2.

Figure 1: Flow Diagram of Brari Nambal STP



A square type grit chamber is provided having length 6.2 m and basin depth of 1.0 m and width 6.2 m.

The FAB reactor is designed to take a design BOD load of 4347 kg/day and the total volume of the tank is 1227.5 m^3. The numbers of reactors installed in the plant are two in number.

A claritube-settler for removal of sloughed biomass has a plan area of 1610 m^2 and the actual plan area is 243.94 m^2. It is circular having a diameter of 20.2 m and the depth is 3.75 m. The hydraulic loading is 10 m^3/m^2/day. The treatment process is as under:

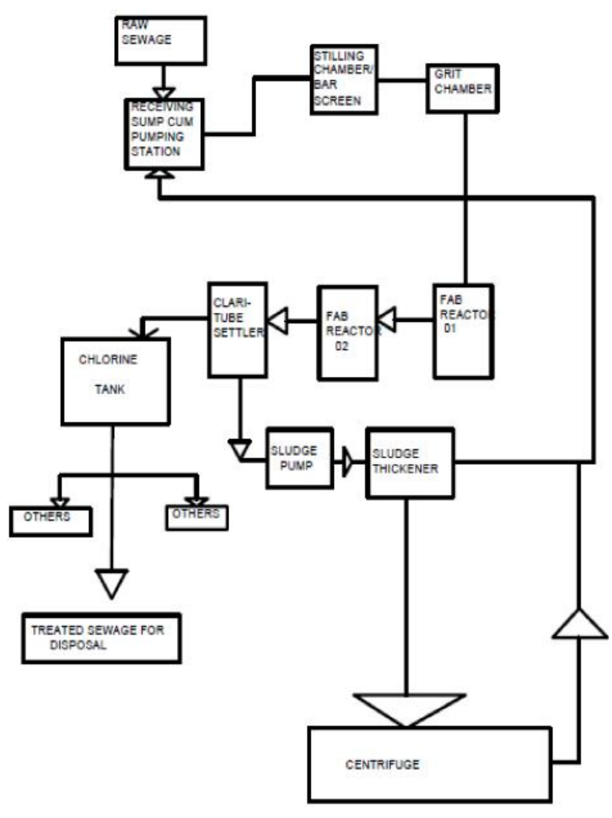
Primary Treatment: The raw sewage is pumped to the screens in the receiving pump and then pumped to the STP, into the stilling chamber followed by bar screen chamber for removal of floating matter. Removal of such floating matter is important because it can choke pipelines and pumps hindering the normal operation of the plant. The screens are placed at equal intervals. The raw sewage is made to pass through the screens, wherein the floating matter, any large particles are trapped in the bars. The inclination of bars is kept such that manual raking becomes easy. The screened sewage is now made to pass through grit chamber for the removal of smaller particles. The grit present in the raw sewage represents sand or dirt collected in the sewerage system. This must be removed, in order to keep the channels clean. Grit has high settling velocity and can be easily removed in the grit chamber. The grit removal provided in the plant is a gravity type removal system. As the sewage is made to pass through this system, the grit settles on the floor of grit channel. The grit is manually raked. The screening and grit is removed manually up to the suitable loading point from where it can be transported by using truck/trolley by client.

Biological Treatment: The main pollutants in the sewage are represented in the form of bio chemical oxygen demand and chemical oxygen demand the ammonical nitrogen, nitrate nitrogen and phosphorus present also represent as polluting substances. The bacterial ability to utilize the harmful products and turn them into carbon dioxide and water molecules is utilized to treat the raw sewage.

The bio reactions are carried out in controlled environment in the bio reactor. The bio reactor comprises of a tank, filled with aeration grid. The bacterial activity needs dissolved oxygen, to synthesize the organic matter. This is supplied by passing air in form of small bubbles. The air is passed at the bottom of the tank, so that complete volume of tank is utilized. Oxygen dissolved in the liquid, which can now be used by the bacteria. The bacterial population is present on the media, which forms an integral part of the reactor system. The media is made of small plastic elements. Millions of such pieces are present in the reactor and a very large surface area is available for the bacterial population to grow. The bacteria grow on plastic media, by using the organic content in the raw sewage, and the dissolved oxygen available. Due to continuous aeration, the media is set in whirling motion so that continuous mixing takes place. The bacterial layer growth on a media surface increase to a certain extent, and then gets sloughed off after a specific period. This phenomenon is called sloughing. Sloughing takes place only after complete growth and subsequent dying- off of the bacterial layer and hence sloughed off material is completely digested. Ammonical nitrogen is converted into nitrate nitrogen, in the bacterial synthesis. Phosphates are also assimilated in the organic synthesis. The bacterial activity is carried out in two stages, for maximizing the BOD removal efficiency. Hence two such reactors are provided in series. Within the reactors, arrangements are made to hold the plastic media in place. Air supply is done through perforated stainless steel pipes. Use of stainless steel pipes ensures that no maintenance is required. The plastic media is approximately of 20 mm diameter and 15 mm height.

Tertiary Treatment: The sloughed biomass must be removed before the treated sewage can be disposed off. Hence a claritubesettler has been provided. The secondary claritubesettler is equipment in which the biomass removed and suspended solids are settled and scraped mechanically. PAC will be dosed prior to the claritube settler. The treated sewage is then added with chlorine to kill the pathogens/E-coli, so that it becomes fit for the disposal in the lake.

Figure 2: Flow Diagram of LAAM STP



The treated sewage, now substantially free from the organic contamination, free coli form, and low in nutrients like phosphates, can be safely disposed off in the river, or in other water bodies. This water can also be re used for watering the gardens, flushing the toilets, etc. The sludge formed in the process of bio degradation is fed to a thickener, to increase the consistency. It is then pumped on to the centrifuge for further dewatering. The thickeners overflow and concentrate flows by gravity back to receiving station. For enhanced phosphate removal the effluent is dosed with Poly Aluminium Chloride (PAC) and routed to flocculator unit. The settled sludge from tube settler is routed to sludge thickener followed by centrifuge for dewatering. The process diagram for the FAB reactor is given as under:

Table 3: Removal Efficiencies of Both Plants in the Month of June

Sampling Month-June 2015			LAAM STP		
S. No.	Parameters	Unit	Raw	Final	Efficiency (%)
1	COD	mg/l	133	22	83.45
2	Ortho-phosphate	mg/l	1.1	0.4	63.63
3	Total – phosphate	mg/l	1.9	0.6	68.42
4	Ammonia nitrogen	mg/l	21.5	6.9	67.9
Sampling Month-June 2015			**BRARI-NUMBAL STP**		
S. No.	**Parameter**	**Unit**	**Raw**	**Final**	**Efficiency (%)**
1	COD	mg/l	265	42	84.15
2	Ortho-phosphate	mg/l	1.5	0.5	66.66
3	Total – phosphate	mg/l	2.9	0.6	79.31
4	Ammonia nitrogen	mg/l	28.5	11.3	60.35

Table 4: Removal Efficiencies of Both Plants in the Month of July

Sampling Month-July 2015			LAAM STP		
S. No.	Parameters	Unit	Raw	Final	Efficiency (%)
1	COD	mg/l	112	53	54.4
2	Ortho-phosphate	mg/l	1.6	1.2	25
3	Total – phosphate	mg/l	1.9	1.4	26.31
4	Ammonia nitrogen	mg/l	11.5	10.1	12.1
Sampling Month-July 2015			**BRARI-NUMBAL STP**		
S. No.	**Parameter**	**Unit**	**Raw**	**Final**	**Efficiency (%)**
1	COD	mg/l	157	51	67.51
2	Ortho-phosphate	mg/l	1.4	0.6	57.14
3	Total – phosphate	mg/l	1.8	0.8	55.55
4	Ammonia nitrogen	mg/l	13.2	5.5	58.33

Table 5: Removal Efficiencies of Both Plants in the Month of August

Sampling Month-August 2015			LAAM STP		
S. No.	Parameters	Unit	Raw	Final	Efficiency (%)
1	COD	mg/l	63.2	30.76	51.38
2	Ortho-phosphate	mg/l	1.4	0.5	64.28
3	Total – phosphate	mg/l	2.1	1.8	14.28
4	Ammonia nitrogen	mg/l	15	12.41	17.3
Sampling Month-August 2015			**BRARI-NUMBAL STP**		
S. No.	**Parameter**	**Unit**	**Raw**	**Final**	**Efficiency (%)**
1	COD	mg/l	90.3	16.57	81.6
2	Ortho-phosphate	mg/l	1.8	0.1	94.45
3	Total – phosphate	mg/l	2.8	2	28.57
4	Ammonia nitrogen	mg/l	25.7	2.27	91.16

MATERIALS AND METHODS

The chemical parameters such as Chemical Oxygen Demand (COD), Ortho-Phosphate, Total Phosphate and Ammonia Nitrogen were studied for a period of three months from June 2015 to August 2015 during the experimental work. The experimental work was done in accordance with Standards methods for examination of water and wastewater.

RESULTS AND DISCUSSION

A comparison has been made between the two systems and the results obtained for the months of June, July and August have been shown in Tables 3-5.

A graphical representation has been shown depicting the results for the removal efficiency of parameters like COD and Total Phosphate in Figures 3 and 4 below. The removal efficiency

Figure 3: Removal Efficiency of Total Phosphate

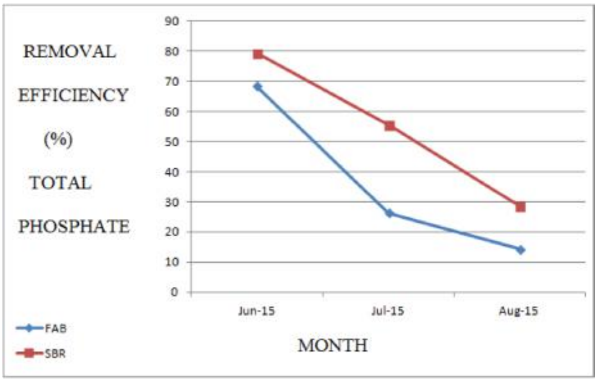
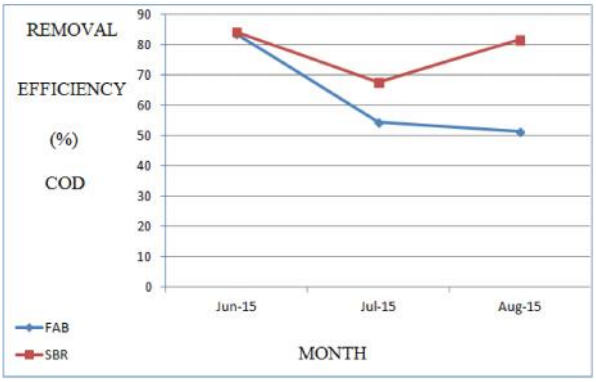


Figure 4: Removal Efficiency of COD in the Sampling Months



for COD at SBR operated BRARI NUMBAL plant has an average value of 77.51% while as total phosphate has an average of 54.47% in the three sampling months respectively. On the other hand FAB operated plant at LAAM has an average removal efficiency of 63.10% in the three months in terms of COD. The average removal efficiency for total phosphate is 36.33%. The results are the same for the other two parameters with SBR proving to be a better technology than FAB.

As per the report by lakes and waterways department, the removal efficiencies in the year 2013 and 2014 at LAAM STP for ammonia nitrogen is 26% and 14% respectively and total phosphorus removal efficiency rate is 51 and 56% respectively. However for total phosphorus, the results for the three months show an average value of just 33% in the summer months in 2015. This might show that the summer months may have low removal efficiency as compared to the overall results of the year. The ammonia nitrogen removal efficiency rates in the year 2013 and 2014 show a removal rate of 26 and 14% respectively while in the year 2015 the average value for the three months was calculated to be approximately 32%. These results however show a different trend for the removal efficiency in terms of ammonia nitrogen. It can therefore be said that the removal efficiency for different parameters is different and cannot be attributed to a single or same trend over a season or the whole year. It can also vary on different factors like the operating conditions of the plant and the incoming sewage concentration and influx which may differ in different seasons and hence are very dynamic.

CONCLUSION

The SBR technology gave the highest values of percentage removal for COD, total phosphate, ammonia nitrogen and ortho-phosphate proving to be a better technology than FAB.

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