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RESEARCH ARTICLE

UTILIZATION OF PRE-AERATED SLUDGE IN ACTIVATED SLUDGE PROCESS

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ABSTRACT

The project is to be carried out with Pre aerated Sludge in Activated Sludge Process to observe the effect of Pre-aerated Sludge on BOD, COD , Phosphate, Nitrate, Mlvss mainly in treatment of dairy wastewater. The experimental process involves the conventional Activated Sludge Process (ASP) in which microorganisms are kept in suspension by mixing and aerating the wastewater. The study was conducted by following two methods: 1) utilizing non pre-aerated sludge and 2) utilizing pre-aerated sludge. In the first method the dairy wastewater measuring five liters and 400 ml of non-pre-aerated sludge is filled in the aeration tank and was aerated in the aeration tank where air (or oxygen) is supplied for regular intervals of 30, 60, 90, 120 minutes respectively and samples are collected before aeration and at regular intervals. In the second method the dairy wastewater measuring five liters and 400 ml of pre aerated sludge (with 20, 40 and 60 minutes pre-aeration) are filled in aeration tank. This tank was aerated for regular intervals of 30, 60, 90, 120 minutes respectively and samples were collected before aeration and at regular intervals. The sludge was not recycled to the aeration tank. Testing of different parameters like BOD, COD, Phosphate, Nitrate and Mixed liquor volatile suspended solids were carried out on the samples aerated with different aeration time, with and without pre-aerated sludge and consequent results are to be found. By utilization of pre-aerated sludge, the concentrations of various parameters to be considered for study are to be found decreased when compared with the values of concentration without using pre-aerated sludge. It was be observed that removal of various parameters from wastewater is effective up to the optimum period for pre-aeration beyond this period removal of various parameters from wastewater will not be effective.

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INTRODUCTION

An activated sludge process (ASP) is a most versatile biological process available to the designer for the treatment of almost any type of wastewater. Aerobic biological treatment basically involves stabilization of biodegradable organic content of wastewater by the mixed population of microorganisms. The process that essentially requires the presence of molecular oxygen for metabolic activity of microorganisms is called an aerobic process. The process can be designed to supply required oxygen either naturally (as in a trickling filter, aerobic stabilization ponds) or by artificial /mechanical means (as in activated sludge process, aerated lagoons) in the reactor. The process normally fails in the absence of oxygen. (Karia and Christian, 2013) In aerobic biological treatment basically involves stabilization of biodegradable organic content of wastewater by the mixed population of microorganisms. In simplest term during the stabilization of organic content, biodegradable organic matter is oxidized or synthesized by microorganisms in aerobic conditions to produce new cells, inert solids and other simple end products. (Karia and Christian, 2013)

During the stabilization of organic content of wastewater, new cells (microorganisms) are also synthesized or produced. These generated new cells themselves are mainly organic in their composition and therefore increase BOD load on the system both as living cells and on their death by contributing as organic matter to wastewater. (Karia and Christian, 2013)

Thus, on other hand we take help of a variety of microorganisms to remove the organic matter from wastewater during biological treatment and on the other hand, during treatment, we add organic solids to the wastewater in the form of new cells (also known as surplus microorganisms or surplus sludge). Such conditions therefore, demand the maintenance of proper balance of biomass in wastewater during the treatment. This is usually accomplished by controlling the growth of new

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cells in the biological system. For effective growth control and proper balance of biomass in the system, it is essential to have a clear concept or understanding about the kinetics of

- Microbial growth rate
- Substrate (organic matter or food) utilization rate
- Limiting substrate or nutrients that affect the growth of cells
- Endogenous decay or death rate of microorganisms in the system. (Karia and Christian, 2013)

The proportionality constants obtained from kinetic equations derived for the above rates are called bio-kinetic coefficients or growth constants. (Karia and Christian, 2013)

The bio-kinetic constants depend on the type of microbial species and environmental conditions like pH, temperature; DO concentration, nutrients, inhibitory substances and degradability of organic substrate, etc. in wastewater. (Karia and Christian, 2013)

The treatment of wastewater, in general, means the partial reduction or complete removal of excessive impurities in the wastewater. The excessive impurities imply to the constituents concentrations that is more than the acceptable levels for final disposal or suitable reuse and recycling of treated wastewater. (Karia and Christian, 2013)

1.1 Objectives of the Research

The objectives of the Research are

a) To study the concentration of various parameters such as BOD, COD, Phosphate, Nitrate, Mixed liquor volatile suspended solids in the dairy wastewater.
b) To compare the removal efficiency of parameters of the effluent after treatment in conventional activated sludge process by using non pre-aerated sludge and by using pre-aerated sludge.
c) To find out the optimum duration for pre-aeration for efficient removal of these contaminants.
d) To develop inter-relationship between various parameters by regression analysis.

1.2 Limitations of the study

The limitations of the study are:

a) By utilization of pre-aerated sludge in conventional activated sludge process the parameters of the effluent can be removed effectively up to optimum duration of pre-aeration.
b) Beyond this optimum duration if sludge is aerated the efficiency of removal of these parameters decreases.
c) The efficiency of removal of pollutants depends upon various other parameters like temperature, dissolved oxygen concentration, nutrients, inhibitory substances and degradability of organic substrate, etc. in wastewater.

LITERATURE REVIEW

As this project topic is innovative no literature which is directly related with this topic is available. But we referred the literature related with the activated sludge process and removal of organic matter from wastewater.

In July 2007, S. Haydar, Associate Professor, J. A. Aziz, Professor, Institute of Environment Engineering and Research, UET Lahore and M. S. Ahmad, Individual Consultant were conducted study on Biological Treatment of Tannery Wastewater Using Activated Sludge Process. They prepared a bench scale model for ASP operated continuously for 267 days. The settled tannery wastewater used as influent to the aeration tank. They concluded that if the ASP is operated at an MLVSS concentration of 3500 mg/L keeping an aeration time of 12 hours, an efficiency of above 90% and 80% for BOD_5 and COD, respectively could be obtained.

In May 2011, Saritha. B, Veda .M, Assistant Professor Silari Venkatesh from Department of Civil Engineering Bharath University, 173, Agharam Road, Selaiyur, Chennai had done study on ASP using PVC spirals as medium for treatment of tannery effluent. They concluded that the concentration of BOD, COD, Total solids and Turbidity has been found decreased by increasing the aeration time from four hours to eight hours. Further removal efficiency can be enhanced by introducing PVC spirals.

In August 2012, T. Subramani, Professor & Dean and K. Arulalan, PG Student of Environmental Engineering, Department of Civil Engineering, VMKV Engg. College, Vinayaka Missions University, Salem, India had done study of efficiency of surface aerator in ASP for treatment of food processing effluent. They observed the reduction in the values of BOD and COD observed due to the process of aeration. The reduction of BOD level is significant for 45 minutes aeration process at 96 RPM of impeller rotation. The reduction in BOD level is more at the immersible depth of 10 cm. The oxygen transfer in the aeration tank by the surface aerators may be increased by changing the suitable design of impeller.

In May 2014, Pooja Rajendra Nagwekar, Datta Meghe College of Engineering prepared lab scale model for ASP for removal of organic matter from wastewater. She concluded that Activated sludge process was found to be effective method with scope for further research in terms of cost effectiveness, good quality effluent, efficient removal of BOD and COD.

METHODOLOGY

Preparation of Sludge

For this experimental study sludge was prepared in laboratory. For culture development in aeration basin following procedure was adopted.

1. Take fresh dairy /domestic waste water or sludge from similar ETP in aeration tank (1-2% of tank volume)
2. Fill remaining tank with fresh water
3. Check aerator blade immersion in the tank in case of surface aeration
4. Start aerator/Blowers

5. Aerate for a week. Check developed organisms microscopically.
6. Observe formation of biological flocks.
7. Add nutrients like Urea, Superphosphate if required to maintain BOD:N:P ratio as 100:5:1
8. The colour of bacteria produced must be golden brown & musty odour.
9. The settled sludge is used for the experiment.

Experimental setup

A lab scale model of activated sludge reactor was prepared for the project. The dimensions of the aeration tank are 0.45 x 0.23 x 0.30 meters in length, width and height respectively where the total volumetric capacity of the tank is 31.05 liters. The strip of 0.30 m length is kept diagonally at the bottom of the aeration tank having perforations closed at both ends. The aeration was done with aerator with constant and continuous supply of air.

Experimental Procedure

For the experimentation, the samples of the dairy wastewater were collected from Katraj Dairy at Pune. The study was conducted by following two methods:

1) Utilizing non pre-aerated sludge
2) Utilizing pre-aerated sludge.

In the first method the dairy wastewater measuring five liters and 400 ml of non-pre-aerated sludge is filled in the aeration tank and is to be aerated in the aeration tank where air (or oxygen) is supplied for regular intervals of 30, 60, 90, 120 minutes respectively and samples are collected before aeration and at regular intervals.

In the second method the dairy wastewater measuring five liters and 400 ml of pre-aerated sludge (with 20, 40 and 60 minutes pre- aeration) were filled in the aeration tanks. These tanks were aerated for regular time intervals of 30, 60, 90, 120 minutes respectively and samples are collected before aeration and at regular intervals.

Laboratory Analysis

Testing of different parameters like Biochemical oxygen demand (BOD), Chemical Oxygen Demand (COD), Phosphate, Nitrate and Mixed liquor volatile suspended solids were carried out on the samples aerated with different aeration time, with and without pre-aerated sludge and consequent results are to be found. Sample names are given accordingly. Tank 1 contains non pre aerated sludge and wastewater, tank 2 contains pre-aerated sludge (20 min) and wastewater, tank 3 contains pre-aerated sludge (40 min) and wastewater, tank 4 contains pre-aerated sludge (60 min) and wastewater.

RESULTS AND DISCUSSION

The concentrations of various parameters such as BOD, COD, Phosphate, Nitrate, and MLVSS are tabulated as below in Table 1.

From tabulated results for various samples, we can see that the concentration of BOD, COD, Phosphate, and Nitrate varies with the aeration time 30, 60, 90, 120 minutes respectively. By increasing the aeration time from 30 min to 120 min, it was observed that these pollutant content levels decrease effectively by non preareated sludge.

In case of with preareated sludge, it is seen that the BOD, COD, Phosphate, Nitrate content levels further decreases with the increase in the aeration time. It is observed that the concentration of pollutant removal was higher when preareated sludge is utilized as a medium into the conventional activated sludge process. But this is effective up to optimum duration of preareation. Since there was an increase in the growth rate of microorganisms, it leads to the increase in the consumption rate which consequently led to the decrease of content levels respectively. It was effective up to optimum duration of preareation.

Table 1.

S.No.	Sample Name	BOD5(mg/lit)	COD(mg/lit)	Phosphate(mg/lit)	Nitrate(mg/lit)	Mlvss(mg/lit)
1.	Tank 1 Inlet	1318	2130	0.648	0.288	3480
i)	Tank 1/1 (30 min)	1290	2100	0.638	0.170	3600
ii)	Tank 1/2(60 min)	1280	2080	0.639	0.169	3600
iii)	Tank 1/3 (90 min)	1279	2075	0.630	0.269	3610
iv)	Tank 1/4 (120 min)	1275	2070	0.630	0.258	3620
2.	Tank 2 Inlet	1300	2140	0.640	0.281	3500
i)	Tank 2/1 (30 min)	1289	2100	0.642	0.242	3580
ii)	Tank 2/2 (60 min)	1278	2078	0.630	0.179	3600
iii)	Tank 2/3 (90 min)	1274	2069	0.628	0.178	3620
iv)	Tank 2/4 (120min)	1270	2065	0.628	0.172	3628
3.	Tank 3 Inlet	1320	2180	0.681	0.182	3520
i)	Tank 3/1 (30 min)	1280	2140	0.673	0.144	3525
ii)	Tank 3/2 (60 min)	1272	2130	0.670	0.142	3530
iii)	Tank 3/3 (90 min)	1265	2120	0.671	0.142	3532
iv)	Tank 3/4 (120min)	1260	2120	0.668	0.140	3534
4.	Tank 4 Inlet	1330	2190	0.672	0.190	3540
i)	Tank 4/1 (30 min)	1310	2182	0.672	0.148	3542
ii)	Tank 4/2 (60 min)	1308	2179	0.671	0.144	3546
iii)	Tank 4/3 (90 min)	1300	2170	0.670	0.142	3548
iv)	Tank 4/4 (120 min)	1280	2162	0.662	0.142	3550

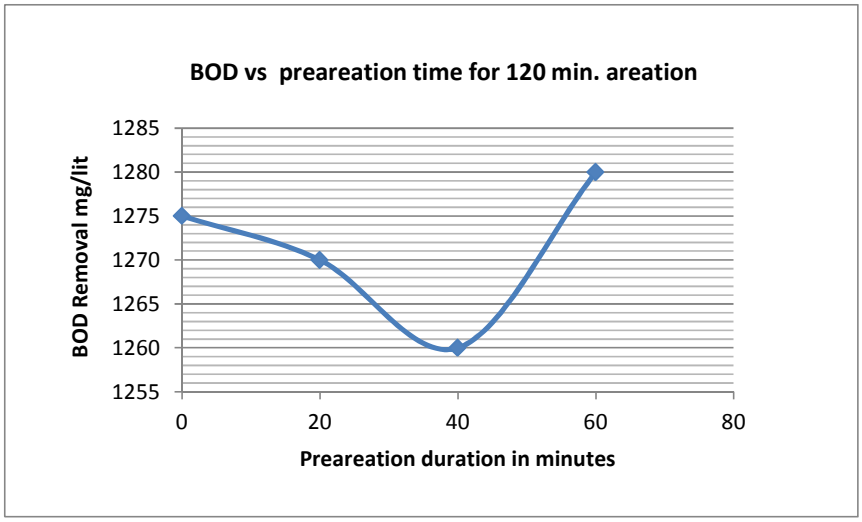
Optimum Duration for Pre aeration for various samples

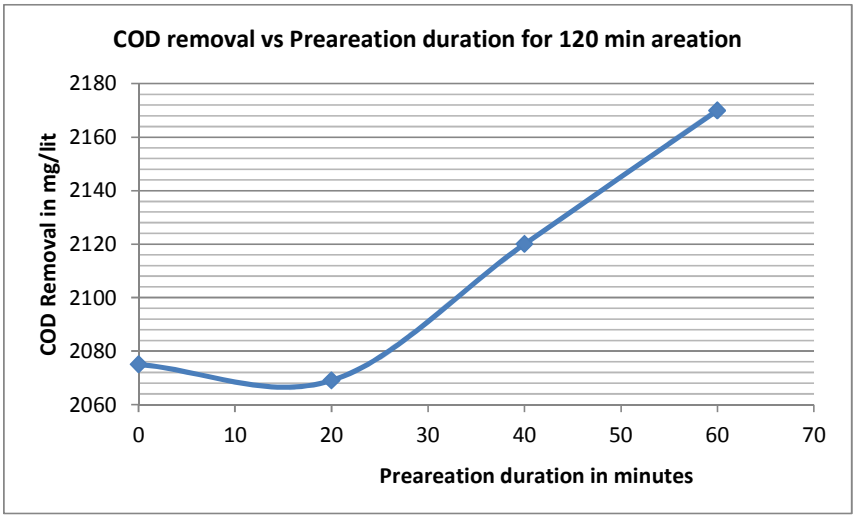
Optimum duration for pre aeration is the duration up to which removal of pollutants BOD, COD, Phosphate, Nitrate, MLVSS are effective but beyond this duration if pre aeration is done removal efficiency of pollutants decreases. The graphs can be plotted for pollutants removal verses preaeration duration for 30 minutes, 60 minutes, 90 minutes and 120 minutes of aeration.

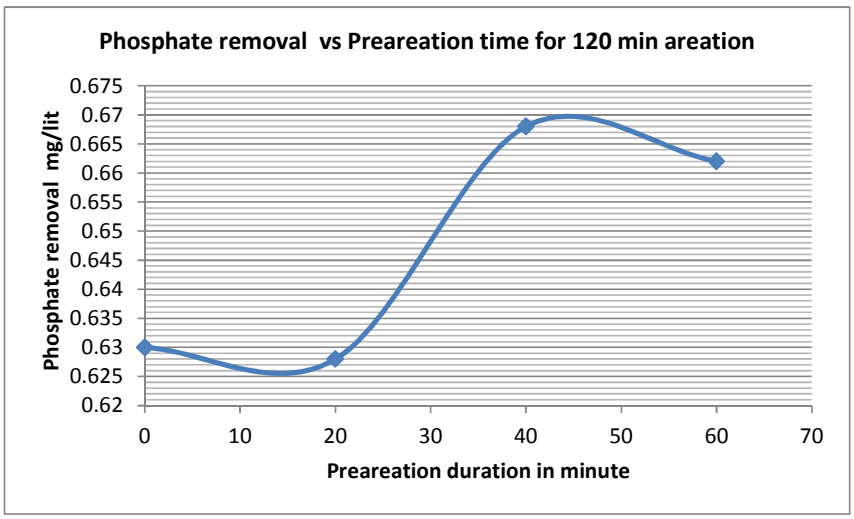
From the graphs shown, we can understand about optimum duration of preareation. For utilizing preareated sludge in activated sludge process 20 minutes of preareation is optimum preareation duration for effective removal of pollutants.

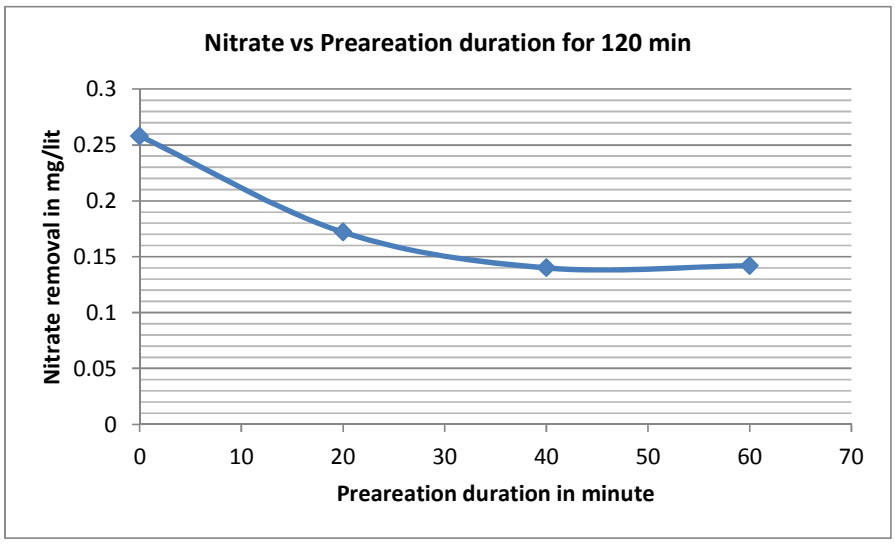
Inter-relationship between various parameters

The graphs can be plotted between various parameters BOD vs COD, BOD vs Phosphate, BOD vs Nitrate, BOD vs MLVSS linear relationship can be obtained. The equations can be obtained with regression coefficients nearly equal to 0.80.

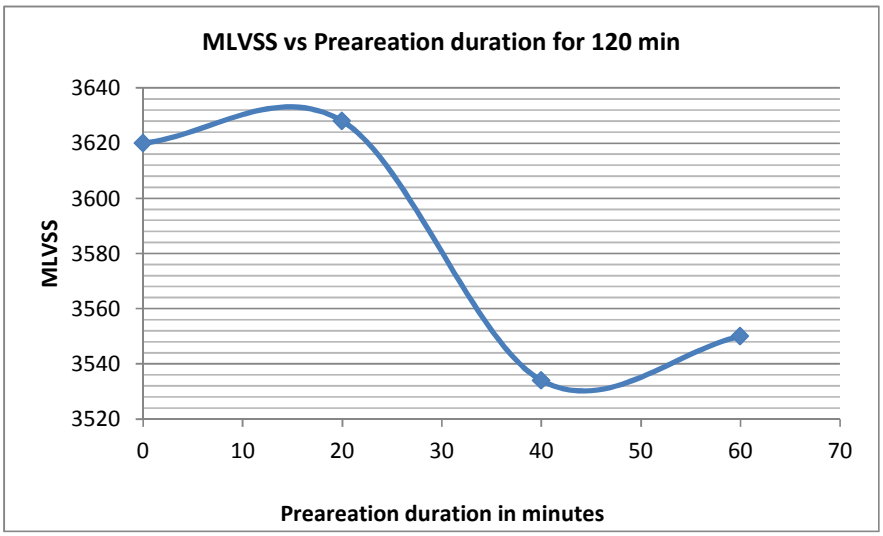


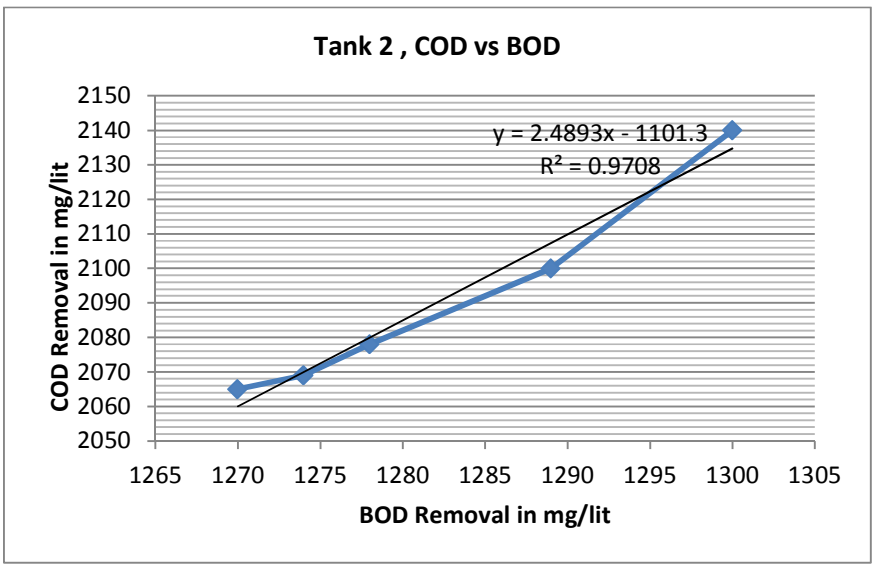


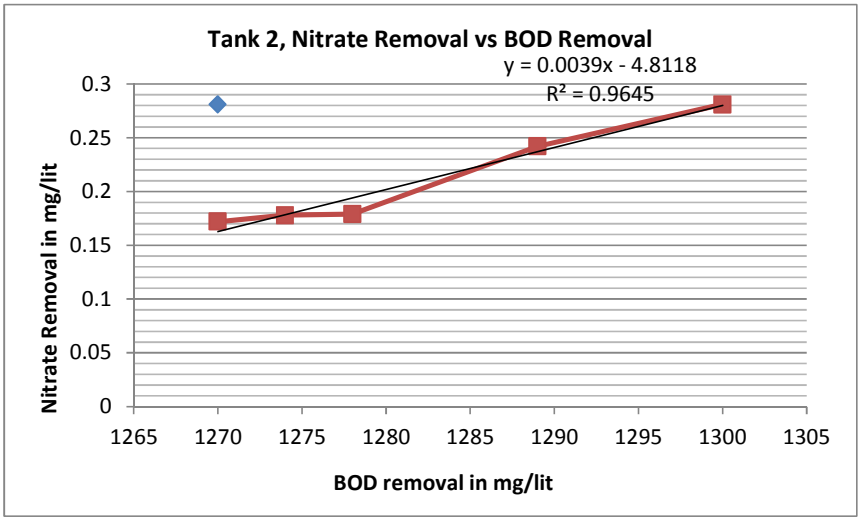


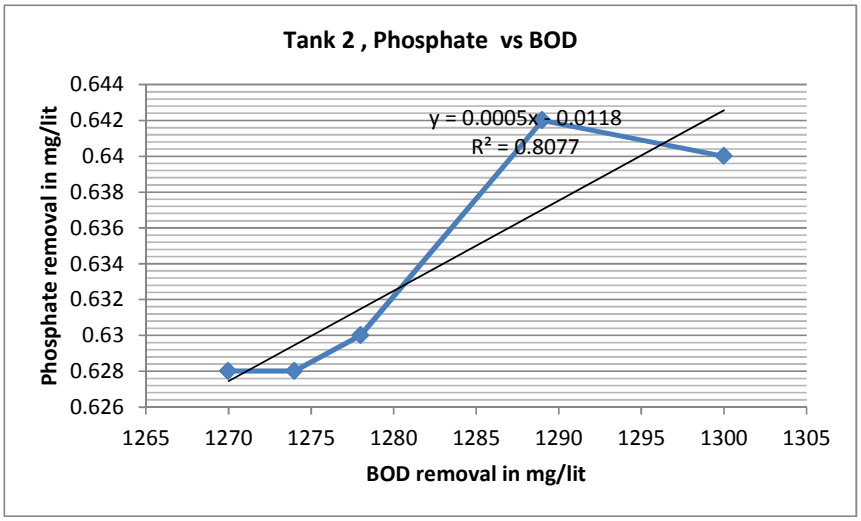


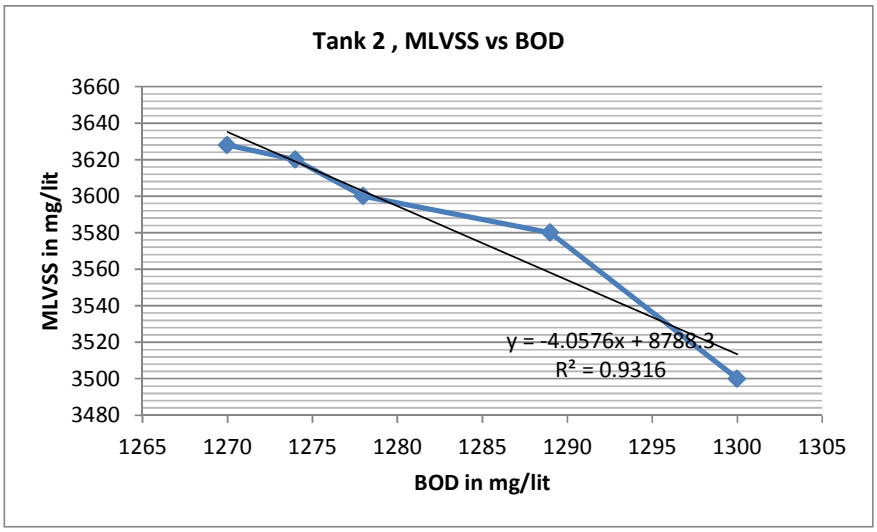
Graphs showing relationship between various parameters











Graphs showing relationship between various parameters

Conclusion

From this research with non preareated sludge work, it is observed that by using activated sludge process, the concentration of BOD, COD, Phosphate, Nitrate and MLVSS from dairy effluent has been found to be decreased by increasing the aeration time from 30 minutes to 120 minutes. Further it can be enhanced by utilization of preareated sludge up to optimum duration of pre aeration.

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