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Comparative Study of Utilization of Pre-aerated Sludge in Activated Sludge Process

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Abstract - The research was 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 is to be 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) was supplied for regular intervals of 30, 60, 90, 120 minutes respectively and samples were 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.

Keywords: Activated Sludge Process, BOD, COD, Phosphate, Nitrate, MLVSS

INTRODUCTION

The primary goal of this research was to investigate utilization of Pre-aerated sludge in Activated Sludge Process. Activated Sludge Process is now used routinely for biological treatment of municipal and industrial wastewater. A number of activated-sludge processes and design configurations have evolved since its early conception as a result of (1) engineering innovation in response to the need for higher-quality effluents from wastewater treatment plants; (2) technological advances in equipment, electronics, and process control; (3) increased understanding of microbial processes and fundamentals; and (4) continual need to reduce capital and operating costs for municipalities and industries. [2] The role of microorganisms of mixed culture in wastewater treatment is very complex as their metabolic activities, growth rate and substrate assimilation are interrelated and helping each other. Therefore, to maintain proper balance of mixed culture in the biological treatment system, it is very essential to have basic knowledge about the significant microorganisms normally present in wastewater, types of their metabolism and how major environmental factors like temperature, pH, mixing, nutrient requirement, trace elements, oxygen etc. affect their growth and decay rates. Utilization of activated sludge in the biological treatment of wastewater have received little research attention compared to utilization of different mediums such as PVC spirals, low cost adsorbents, commercial lime ,granular activated carbon in the biological treatment of domestic and industrial wastewater. In this study, specific effect of pre- aeration of sludge in activated sludge process for effective removal of pollutants from dairy wastewater, comparison between removals of concentrations of pollutants by utilization of non-pre-aerated sludge and pre-aerated sludge, investigation of optimum pre-aeration duration as well as inter-relationship between different parameters by regression analysis is done. The generalized equations for co-relation between different parameters are obtained.

DEVELOPMENT OF LAB-SCALE MODEL

A lab scale model of activated sludge reactor was prepared for the research. The aeration tank was simple locally manufactured from glass. 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 plastic 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 fish tank aerator with constant and continuous supply of air. The air flow rate was observed to be 1.5 liters per second. The sludge was not recycled for wastewater treatment.

Fig No.1) Image showing Dairy Wastewater Sample mixed with Sludge after Aeration

METHODOLOGY

Sample Collection

Fresh dairy effluent sample was obtained from the Katraj Dairy located in Pune of Maharashtra. The sample was collected in a 5 L plastic container. The container used for sample collection was pre-treated by washing with alcohol and later rinsed for three times with distilled water. It was dried in an oven for 1 hour at 30 0C and allowed to cool to room temperature. At the collection point, container was rinsed with the sample thrice and then filled, corked tightly and taken to the laboratory for further analysis. It was stored at a temperature below 40C to avoid any physico-chemical changes in the effluent.

Preparation of sludge

- The fresh dairy /domestic waste water or sludge from similar ETP in aeration tank
- (1-2% of tank volume) was taken.
- Remaining tank was filled with fresh water
- Aerator blade immersion in the tank in case of surface aeration was checked.
- Aerator / Blower were started.
- It was aerated for a week with aerator.
- The development of micro-organisms was checked on microscope.
- Formation of biological flocks can be observed on the microscope.
- Various nutrients like Urea, Superphosphate , sugar are added if required to maintain BOD:N:P ratio as 100:5:1
- The colour of bacteria produced should be golden brown & musty odour.
- The settled sludge was used for the experimental work

Experimental Procedure

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Fresh dairy effluent sample was obtained from the Katraj Dairy located in Pune of Maharashtra. The study was conducted by following two methods:

1) By utilization of non-pre-aerated sludge

In the first method the fresh dairy effluent measuring 5 liters was added in laboratory scale activated sludge reactor. The activated sludge was cultured in the laboratory. 400 ml of activated sludge cultured in the laboratory was mixed with the sample water in the reactor and run in continuous mode. The air or oxygen was supplied continuously and with constant rate by aerator. The sample was aerated at regular intervals of 30 minutes, 60 minutes, and 90 minute and 120 minutes. The samples were collected before aeration and after aeration at regular time intervals. These samples were characterized for determination of pollutant concentration.

2) By utilization of pre-aerated sludge.

In the second method the fresh dairy effluent measuring 5 liters was added in laboratory scale activated sludge reactor. The activated sludge was cultured in the laboratory. Activated sludge cultured in the laboratory was taken in the container; it was pre-aerated for 20 minutes duration. This pre-aerated sludge for 20 minutes duration was mixed with the sample water in the reactor and run in continuous mode. The air or oxygen was supplied continuously and with constant rate by aerator. The sample was aerated at regular intervals of 30 minutes, 60 minutes, and 90 minute and 120 minutes. The samples were collected before aeration and after aeration at regular time intervals. These samples were characterized for determination of pollutant concentration.

Similarly, the fresh dairy effluent measuring 5 liters was added in laboratory scale activated sludge reactor. The activated sludge was cultured in the laboratory. Activated sludge cultured in the laboratory was taken in the container; it was pre-aerated for 40 minutes duration. This pre-aerated sludge for 40 minutes duration was mixed with the sample water in the reactor and run in continuous mode. The air or oxygen was supplied continuously and with constant rate by aerator. The sample was aerated at regular intervals of 30 minutes, 60 minutes, and 90 minute and 120 minutes. The samples were collected before aeration and after aeration at regular time intervals. These samples were characterized for determination of pollutant concentration.

Similarly, the fresh dairy effluent measuring 5 liters was added in laboratory scale activated sludge reactor. The activated sludge was cultured in the laboratory. Activated sludge cultured in the laboratory was taken in the container; it was pre-aerated for 60 minutes duration. This pre-aerated sludge for 60 minutes duration was mixed with the sample water in the reactor and run in continuous mode. The air or oxygen was supplied continuously and with constant rate by aerator. The sample was aerated at regular intervals of 30 minutes, 60 minutes, and 90 minute and 120 minutes. The samples were collected before aeration and after aeration at regular time intervals. These samples were characterized for determination of pollutant concentration.

Analytical Methods

Wastewater samples were characterized for determination of pollutant concentrations. Different parameters like Biological oxygen demand (BOD), Chemical Oxygen Demand (COD), Phosphate, Nitrate and Mixed liquor volatile suspended solids (MLVSS) were analyzed in the laboratory.

Biological oxygen demand (BOD) was estimated by preparing required volume of dilution water with the addition of nutrients and incubation period of 5 days at 20^0C.

Chemical oxygen demand (COD) determination was based on rapid dichromate oxidation method.

Nitrate determination was done by preparing required volume of dilution by adding 1 ml of Hydrochloric acid (1:1) to the diluted sample. Then it was analyzed by ultraviolet spectrophotometer.

Phosphate determination was done by preparing required volume of dilution by adding 2 ml of Ammonium Molybate and 2 ml of Stannous Chloride in the diluted sample. Then it was analyzed by microprocessor spectrophotometer.

Mixed Liquor Volatile Suspended Solids (MLVSS) was determined filtration of the wastewater sample and by loss in weight by ignition method. .

RESULTS AND DISCUSSION

Concentration of Pollutants before and after aeration of 5 Liters of Dairy Effluent mixed with Non-pre –aerated Sludge

Table No. 1) Concentration of Pollutants before and after aeration of Dairy Effluent mixed with Non-pre-aerated Sludge

Sr.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
2	Tank 1/1(30 min)	1290	2100	0.638	0.170	3600
3	Tank 1/2 (60 min)	1280	2080	0.639	0.169	3600
4	Tank 1/3 (90 min)	1279	2075	0.630	0.269	3610
5	Tank 1/4 (120 min)	1275	2070	0.630	0.258	3620

Concentration of Pollutants before and after aeration of 5 Liters of Dairy Effluent mixed with 20 minutes Pre-aerated Sludge

Table No. 2) Concentration of Pollutants before and after aeration of Dairy Effluent mixed with 20 minutes of Pre-aerated Sludge

Sr.No.	Sample Name	BOD5 (mg/lit)	COD (mg/lit)	Phosphate (mg/lit)	Nitrate (mg/lit)	MLVSS (mg/lit)
1.	Tank 2 Inlet	1300	2140	0.640	0.281	3500
2	Tank 2/1 (30 min)	1289	2100	0.642	0.242	3580
3	Tank 2/2 (60 min)	1278	2078	0.630	0.179	3600
4	Tank 2/3 (90 min)	1274	2069	0.628	0.178	3620
5	Tank 2/4 (120min)	1270	2065	0.628	0.172	3628

Concentration of Pollutants before and after aeration of 5 Liters of Dairy Effluent mixed with 40 minutes Pre-aerated Sludge

Table No. 3) Concentration of Pollutants before and after aeration of Dairy Effluent mixed with 40 minutes of Pre-aerated Sludge

Sr.No.	Sample Name	BOD5 (mg/lit)	COD (mg/lit)	Phosphate (mg/lit)	Nitrate (mg/lit)	MLVSS (mg/lit)
1.	Tank 3 Inlet	1320	2180	0.681	0.182	3520
2	Tank 3/1 (30 min)	1280	2140	0.673	0.144	3525
3	Tank 3/2 (60 min)	1272	2130	0.670	0.142	3530
4	Tank 3/3 (90 min)	1265	2120	0.671	0.142	3532
5	Tank 3/4 (120min)	1260	2120	0.668	0.140	3534

Concentration of Pollutants before and after aeration of 5 Liters of Dairy Effluent mixed with 60 minutes Pre-aerated Sludge

Table No. 4) Concentration of Pollutants before and after aeration of Dairy Effluent mixed with 60 minutes of Pre-aerated sludge

Sr.No.	Sample Name	BOD5 (mg/lit)	COD (mg/lit)	Phosphate (mg/lit)	Nitrate (mg/lit)	MLVSS (mg/lit)
1.	Tank 4 Inlet	1330	2190	0.672	0.190	3540
2	Tank 4/1 (30 min)	1310	2182	0.672	0.148	3542
3	Tank 4/2 (60 min)	1308	2179	0.671	0.144	3546
4	Tank 4/3 (90 min)	1300	2170	0.670	0.142	3548
5	Tank 4/4 (120 min)	1280	2162	0.662	0.142	3550

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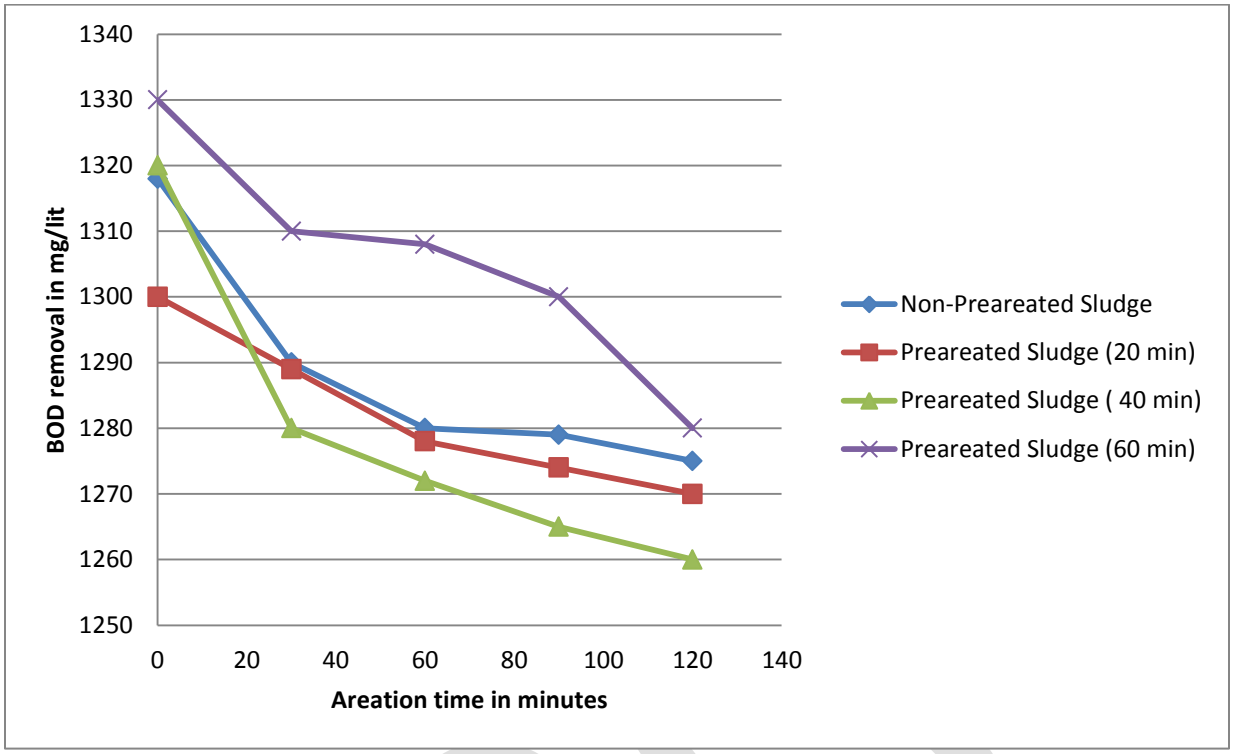

Fig No.1) Graph between Aeration Time and BOD Removal

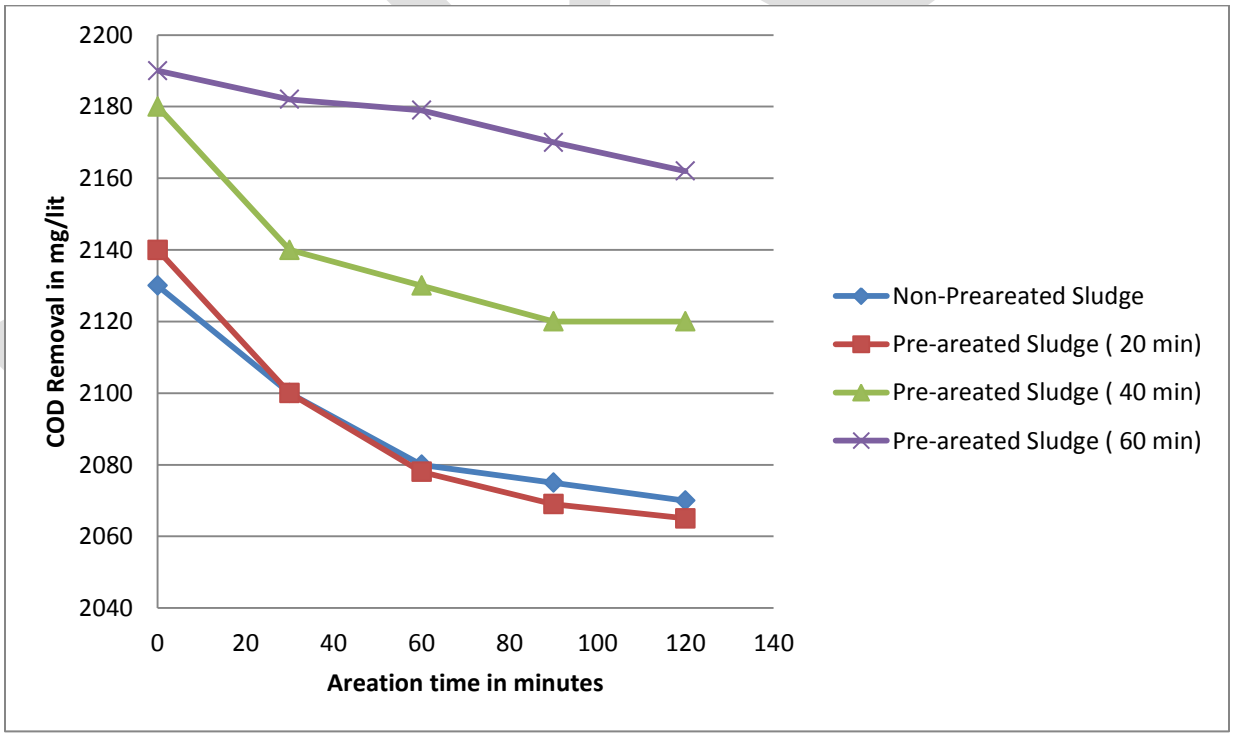

Fig No.2) Graph between Aeration Time and COD Removal

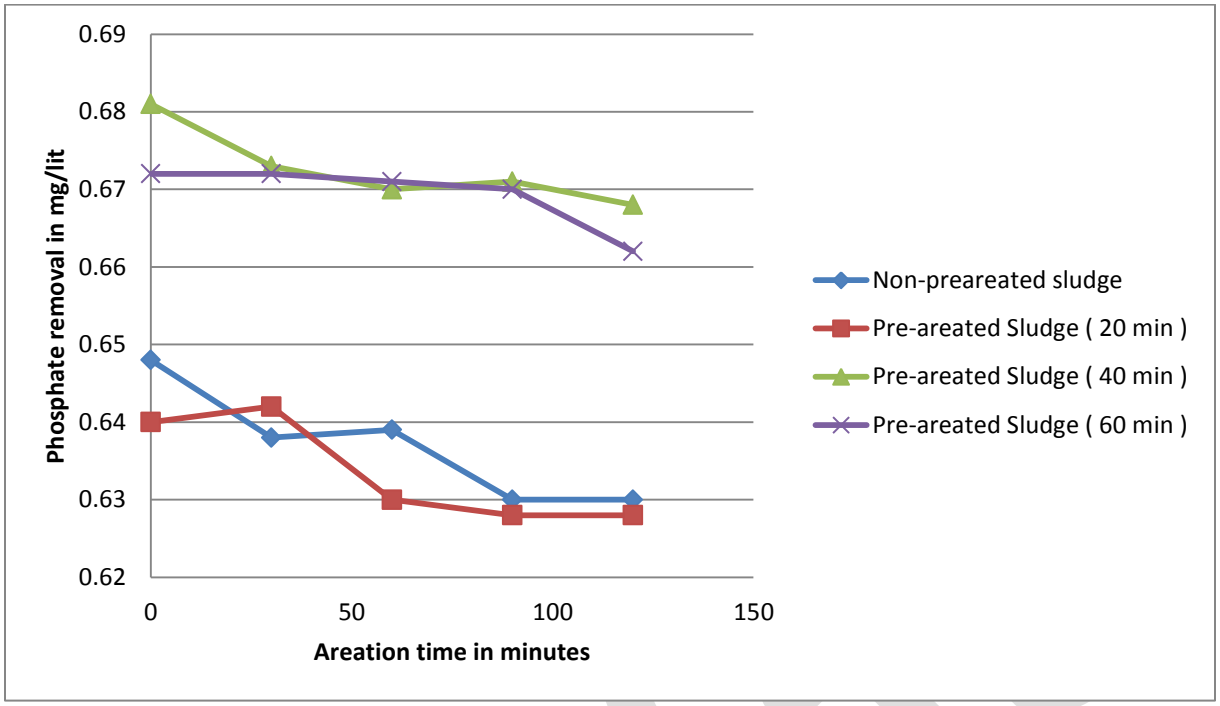

Fig No.3) Graph between Aeration Time and Phosphate Removal

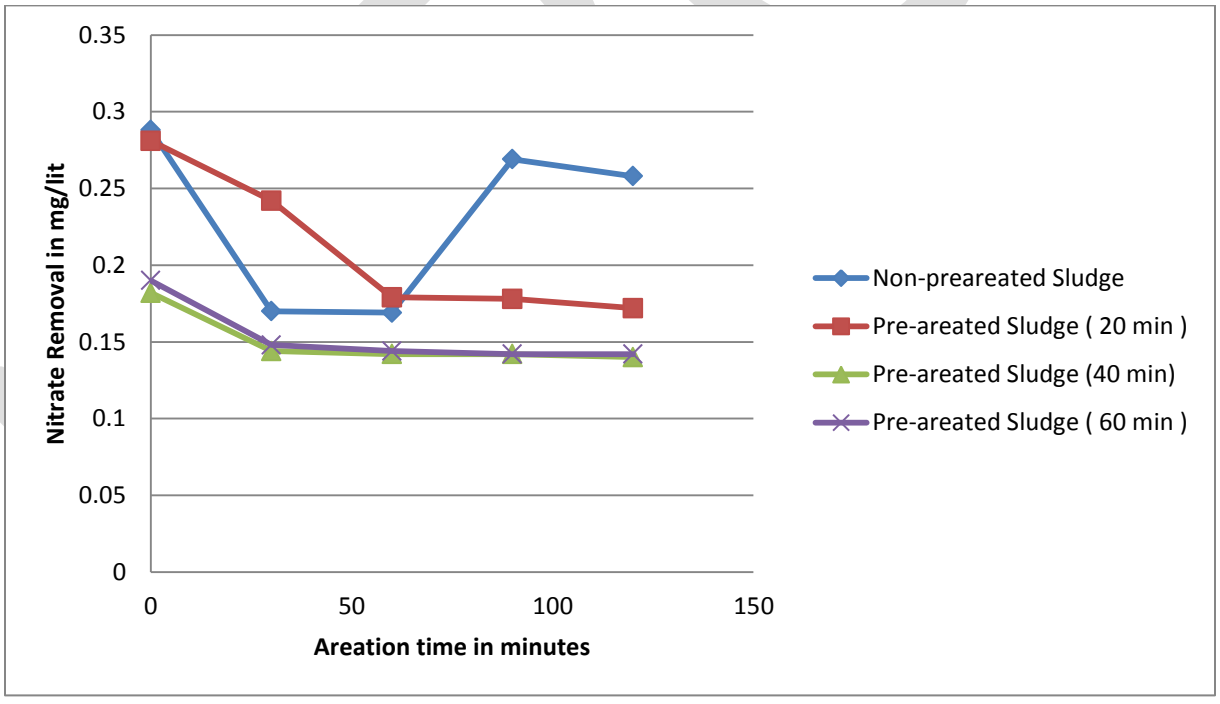

Fig No.4) Graph between Aeration Time and Nitrate Removal

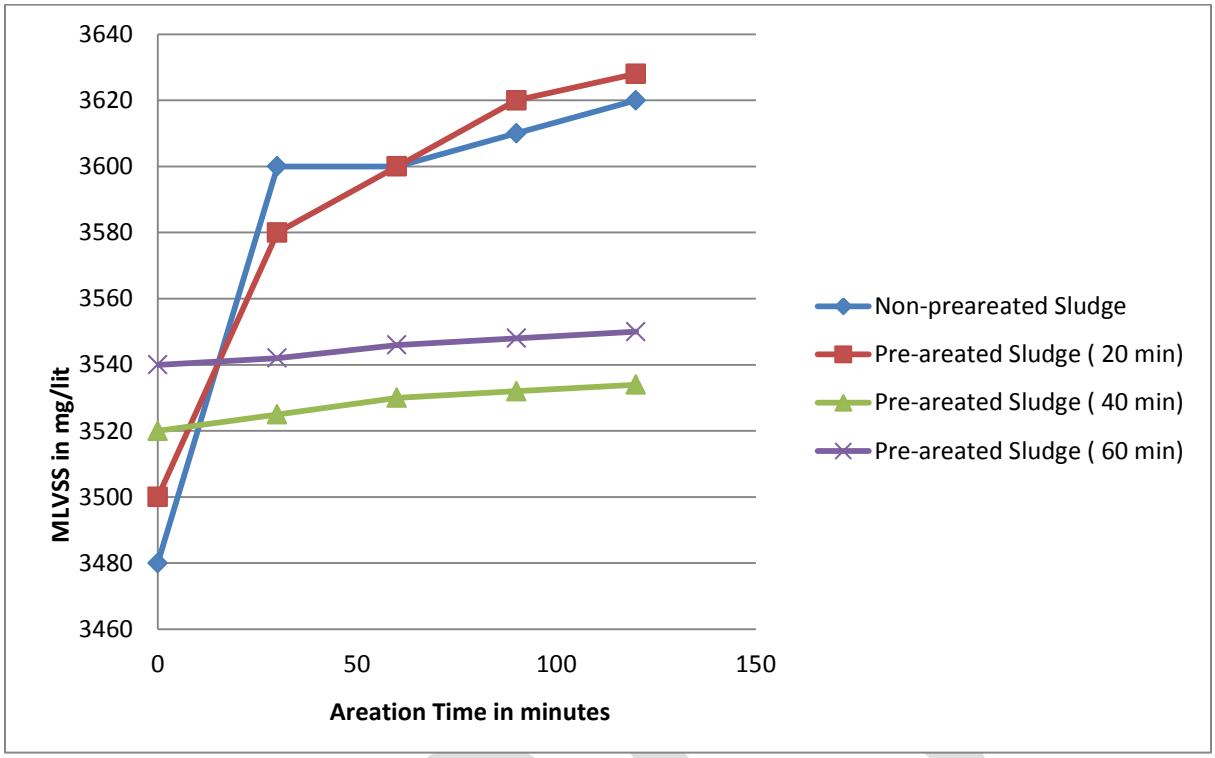

Fig No.24) Graph between Aeration Time and MLVSS

Comparison of removal of different pollutants

From the results tabulated in Table No.1, Table No.2 and Table No. 3, Table No. 4 , we can plot the graphs between aeration time (in minutes) on X axis and Pollutant removal (in mg/lit) on Y axis . From the Fig No 1, 2 .3 and 4, we can see that by utilization of non-pre-aerated sludge in activated sludge process, concentration of pollutants such as BOD, COD, Phosphate, Nitrate and MLVSS, decreases with increase in the aeration time from 30 minutes to 120 minutes.

Further, removal of these pollutants can be enhanced by utilization of pre-aerated sludge in activated sludge in activated sludge process and increasing the aeration time from 30 minutes to 120 minutes. But removal of these pollutants is effective only up to optimum duration of pre -aeration.

Optimum Duration for Pre aeration for various samples.

Optimum duration for pre aeration is the duration up to which removal of pollutants such as BOD, COD, Phosphate, Nitrate, MLVSS decreases with increase in the pre-aeration duration but beyond this duration if sludge is pre-aerated and utilized in activated sludge process ; removal of concentration of different pollutants are not effective . The graphs can be plotted by plotting pre-aeration duration on X axis and plotting pollutants removal on Y axis for each cycle of aeration. `

CONCLUSION

The research study presented is based on the literature review on removal of different pollutants from domestic and industrial wastewater by using activated sludge process. The microorganisms present in wastewater play an important role in removal of different pollutants from wastewater. From microbiological study it was investigated that carbon degrading organisms- helps in fast degradation of BOD from waste water and decomposition of organic matter from waste. A lipolytic organism helps in degradation of Wax, Fats, and Oil & Grease from waste water. Proteolytic, Nitrogen fixing, nitrifying and ammonifying organisms helps in degradation of protein material from waste, fixing nitrogen and maintaining C/N ratio for effective degradation. P-Solubilizing Organisms - helps in converting phosphates from waste in to available form and utilizing it for better fast degradation. Actinomycetes help in degradation of more complex organic matter from effluent. Other organism includes enzyme, amino acid and growth factor producing organisms**,** spores of protozoa, fungi and activated sludge/ Anaerobic/ Facultative organisms. Many of these microorganisms are present in sludge.

In this research work, we are utilizing non-pre-aerated sludge in activated sludge process. We are also pre-aerating the sludge and utilizing this pre-aerated sludge in activated sludge process. From results, we can conclude that due to pre-aeration of sludge and by mixing it in wastewater and again aerating it, the growth rate of microorganisms increases. It leads to the increase in the consumption rate which consequently led to the decrease of content levels of pollutants present in the wastewater respectively.

The concentration of pollutants such as BOD, COD, Phosphate, Nitrate, MLVSS decreases with increase in aeration time from 30 minutes to 120 minutes by utilizing pre-aerated sludge. Further it can be enhanced by utilization of -pre-aerated sludge, mixing it in dairy wastewater and aerating the wastewater from 30 minutes to 120 minutes.

It can be concluded that removal of different pollutants is effective only up to the optimum duration of pre-aeration. Beyond this optimum pre-aeration duration, if sludge is pre-aerated used in activated sludge process, the removal of different pollutants is not effective i.e. there is no reduction in concentration of pollutants such as BOD , COD, Phosphate, Nitrate, MLVSS. This happens due to decrease in growth rate of microorganisms beyond optimum pre-aeration duration. For effective removal of BOD, 40 minutes is the optimum pre-aeration duration. For effective removal of COD, 20 minutes is the optimum pre-aeration duration. For effective removal of Nitrate, 40 minutes is the optimum pre-aeration duration. For effective removal of phosphate, 20 minutes is the optimum pre-aeration duration. The mixed liquor volatile suspended solids (MLVSS) i.e. for less sludge generation the optimum pre-aeration duration is 40 minutes. Therefore, if we are utilizing the sludge with 20 minutes or 40 minutes of pre-aeration in activated sludge process, pollutants can be removed effectively.

REFERENCES:

[1] Wastewater Treatment, Concepts and Design Approach by G.L. Karia and R.A. Christian, Second Edition, June 2013.
[2] Wastewater Engineering, Treatment and Reuse , Fourth Edition , Metcalf & Eddy , Inc ,Tata McGraw Hill Education Private Limited.
[3] S. Haydar, J. A. Aziz, M.S.Ahmad (July 2007) “Biological Treatment of Tannery Wastewater Using Activated Sludge Process” in Pak. J. Engg. & Appl.Sci.Vol.1 July 2007.
[4] Muhammad Khalid Iqbal , Tahira Shafiq , Amana Nadeem (2007) “ Biological Treatment of Textile Wastewater by Activated Sludge Process.” In Jour. Chem. Soc. Pak .Vol. 29, No. 5 , 2007
[5] Saad A. Al-Jlil (2009) “ COD and BOD Reduction of Domestic Wastewater using Activated Sludge, Sand Filters and Activated Carbon in Saudi Arabia.”
[6] Saritha. B, Veda .M, Silari Venkatesh (May 2011) “Study of Activated Sludge Process using Medium in Treatment of Wastewater ” in International Journal of Engineering Trends and Technology (IJETT) – Volume 1, Issue 2 – May 2011.
[7] T. Subramani, Professor & Dean and K. Arulalan, (August 2012) “Study of efficiency of surface aerator in ASP for treatment of food processing effluent.” in International Journal of Modern Engineering Research (IJMR), Volume 2, Issue 4, July-Aug 2012 pp- 1518-1528, ISSN: 2249-6645
[8] Ambreen Lateef, Muhammad Nawaz Chaudhry,Shazia Ilyas (January 2013) “Biological Treatment of Dairy Wastewater using activated sludge”
[9] Pooja Rajendra Nagwekar, (May 2014) “Removal of Organic matter from wastewater by Activated sludge process, International Journal of Science, Engineering and Technology Research (IJSETR) , Volume 3,Issue 5, May 2014
[10] Jianjun Chen , Xueli Wang , Xiuyan Liu , Jinggang Huang and Zhengmiao Xie “Removal of Dye Wastewater COD by Sludge based Activated Carbon”, Journal of Costal Research, 73 (spl) : 1-3