Treatment of Sewage Effluent by using Advanced Oxidation Process

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Abstract

All advanced oxidation processes (AOP) are characterized by a common chemical feature: the capability of exploiting the high reactivity of HO radicals in driving oxidation processes. Photo catalytic oxidation is generally applied for treating waste water containing organic contaminants under mild conditions such as ambient temperature and pressure. In this study photo catalytic oxidation using TiO2 as photo catalyst was conducted in the apparatus setup made, for the study of basic physical parameters involved before and after treatment. Comparison of effective method and optimization of parameters involved in waste water is done. The BOD and COD reduction was effectively achieved well after photo catalytic oxidation. the effective degradation was well achieved by using the optimal conditions for temperature 40 degree Celsius ,Reaction time 45 minutes and Airflow rate 2.5l/min.

Keywords: BOD, COD, Effluent, OD, UV Rays

I. INTRODUCTION

All advanced oxidation processes (AOP) are characterized by a common chemical feature: the capability of exploiting the high reactivity of HO radicals in driving oxidation processes. Photo catalytic oxidation is generally applied for treating waste water containing organic contaminants under mild conditions such as ambient temperature and pressure. In this study photo catalytic oxidation using TiO_2 as photo catalyst was conducted in the apparatus setup made, for the study of basic physical parameters involved before and after treatment. Comparison of effective method and optimization of parameters involved in waste water is done. The BOD and COD reduction was effectively achieved well after photo catalytic oxidation

AOP involves formation of hydroxyl radicals; reaction of these radicals with Organic compounds in water produces biodegradable intermediates. Reaction of biodegradable with oxidant referred as mineralization. AOP involves various process like; FENTON PROCESS, ELECTRO FENTON PROCESS, SONO-ELECTRO-FENTON, PHOTO ELECTRO FENTON among which photo catalytic oxidation was selected for the treatment of sewage effluent, since it has good efficiency of degrading the contaminants present in water.

PCO is the acceleration of a photoreaction in the presence of a catalyst. In PCO, light is absorbed by an adsorbed substrate. It depends on the ability of the catalyst to create electron–hole pairs, which generate hydroxyl radicals (•OH). In this study, the PCO was chosen since it showed higher efficiency in degradation compared to all AOP process, the process is accelerated using UV365 on Tio_2 coated plate. Tio2 showed efficient photo catalytic activity since it has wider applications. The apparatus setup is shown in the figure

II. SCOPE OF THE PROJECT

The scope of the project is to find the applicability of new technology for sewage effluent treatment for the better quality of water. Since photo catalytically degraded waste water had less contaminant.

A. Apparatus Set Up for PCO

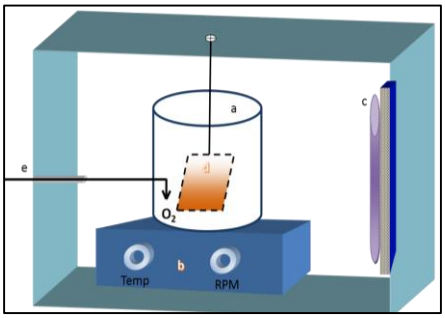

Fig. 1: Apparatus Set-up for PCO

The whole set up was kept inside the dark box in order to avoid direct sun light, since UV lamp was used as light source

III. MATERIALS AND METHODS

A. Chemicals and Reagents

Nano crystalline titanium di oxide (photo catalyst Nano powder) Aps: 7nm (TiO2 - Anatase) and molecular weight 79.87 was purchased from Sisco research laboratories Pvt. Ltd. Mumbai. Butanol and acetic acid purchased from Merck India laboratories

B. Specifications

1) Dimensions of Cylindrical Tank
- Height of the reactor- 30.480 cm
- Thickness of the reactor- 0.5 cm
- Diameter of the reactor- 10 cm

2) Dimensions of the Glass Plate
- Length of the plate-19.05 cm
- Breadth of the plate-11.43 cm
- Thickness of the plate-0.2 cm

3) UV Lamp & Oxygen Pump
- The maximum intensity of UV lamp used is 365nm and the maximum
- Outlet of oxygen pump was varied to get optimal value of DO

IV. EXPERIMENTAL STUDIES

The sample selected for this experiment is sewage effluent (thickener over flow) and was collected from perungudi waste water treatment plant. The water collected was refrigerated for further experiment purpose since it can avoid the increase in BOD and COD levels. Initially 2l of raw sewage sample collected was given for analysis of basic physical parameter like BOD, COD, DO, pH, oil and grease, chlorides, sulphides and total dissolved solids .The parameters obtained before treatment is tabulated below and test analysis was done in CVR labs

A. Parameters Obtained Before Treatment

Table – 1
Parameters Obtained Before Treatment

S. No.	*Parameter*	*Raw Water Mg/L*
1	*pH Value*	*7.04*
2	*Total suspended solids*	*404*
3	*BOD@ 5 days 20*	*250*
4	*COD*	*840*
5	*chlorides*	*110*
6	*sulphides*	*58*
7	*Oil & grease*	*14*

3l of water was taken into the cylindrical tank and TiO2 coated plate. The coated plate was supported from top of the dark box with the help of thread and it was adjusted so that the plate gets fully immersed in sample taken in flask. Oxygen Supply was continuously provided by using oxygen pump, the maximum outlet of the oxygen pump used initially was 3 l/m .The pump was kept inside the sample taken. The cylindrical tank was stirred continuously by using a magnetic stirrer, initial RPM was kept as 300 to obtain uniform supply of oxygen and mixing. The UV 365 lamb was used as light source and whole apparatus setup kept 7.5cm away from the light source. The whole experiment was done at room temperature and pressure initially.

B. Coating of Tio₂

- TiO_2 was immobilized on glass plate using spray coating technique.
- The process involves minimal equipment, operator training, and time and so this technique was selected.
- The glass plate was washed thoroughly 4 times using distilled water and cleaned using spirit.
- After which glass plate was sterilized under UV for 30 minutes, to avoid contamination.
- 1.597g of TiO_2, 7.316 ml n-butanol, and 4.575 ml acetic acid were mixed thoroughly at 80 °C for 4 h to become solution.
- The solution was then spray coated onto glass plates to form uniform thin films.
- Calcination was then conducted in atmosphere at 5 °C/min to 200 °C and set for 1 h before being heated again to 500 °C for another 3 h.
- In order to improve particle adhesion to the glass and particle-particle cohesion.
- Dense, uniform, and well-adhered TiO_2 thin films were obtained.

V. OBSERVATION

A. Effect of Temperature on Bod, Cod and Do

The effect of temperature on BOD, COD and DO was studied. BOD measures the amount of oxygen consumed by microorganisms in decomposing organic matter in water. COD is a measure of the capacity of water to consume oxygen during the decomposition. The temperature of the water is main factor affecting BOD and COD high levels. So optimizing the temperature is required to achieve an effective degradation of BOD and COD levels. By adjusting different temperature levels by using magnetic stirrer, BOD, COD and DO values was calculated by the procedure mentioned above and plotted.

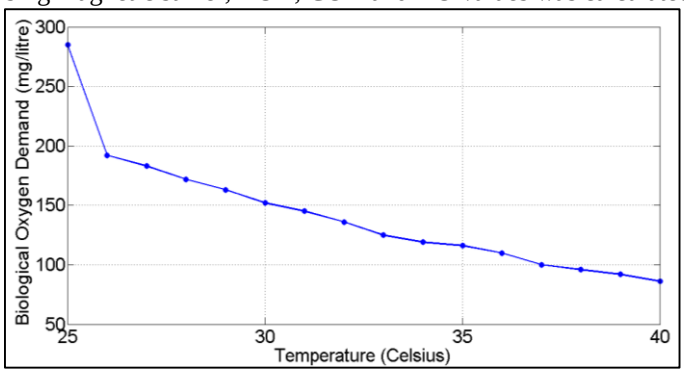

Fig. 2: Effect of temperature on BOD

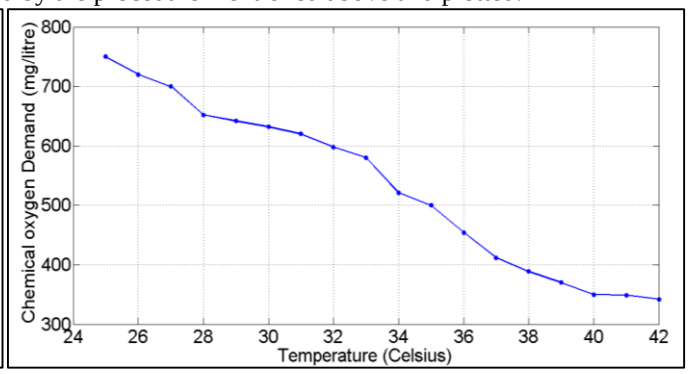

Fig. 3: Effect of temperature COD

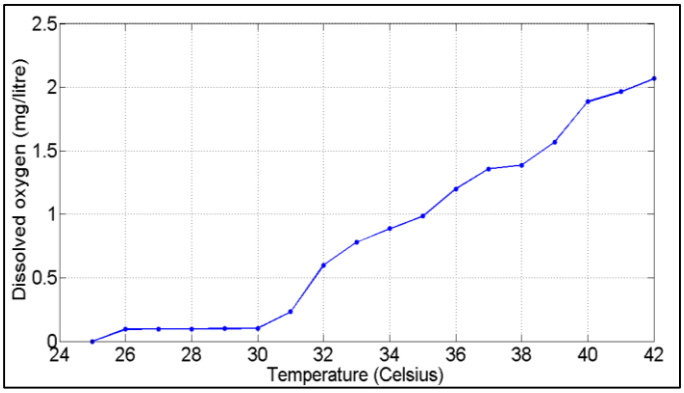

Fig. 4: Effect of temperature on DO

B. Effect of Air Flow Rate on Bod, Cod and Do

Air flow rate is again also an important factor that influences the BOD, COD and DOES levels. Optimization of air flow rate is essential since DO level must be from O1.5 – 2.5 mg/l. High amount of DO also affects the water by increased algal growth which can affect water quality. By varying maximum outlet of the oxygen pump the BOD, COD and DO values are measured and plotted.

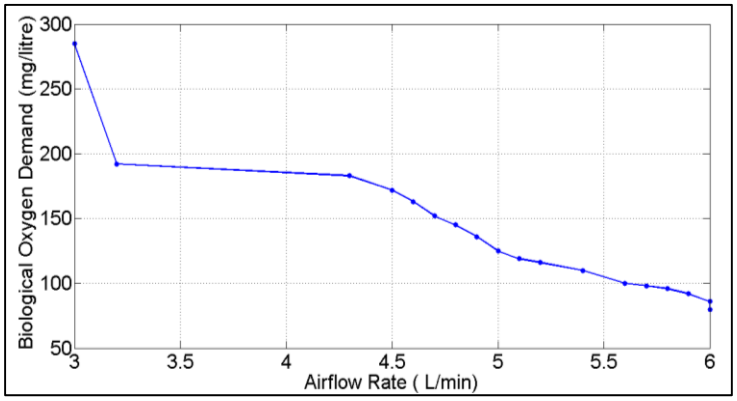

Fig. 5: Effect of airflow rate in BOD

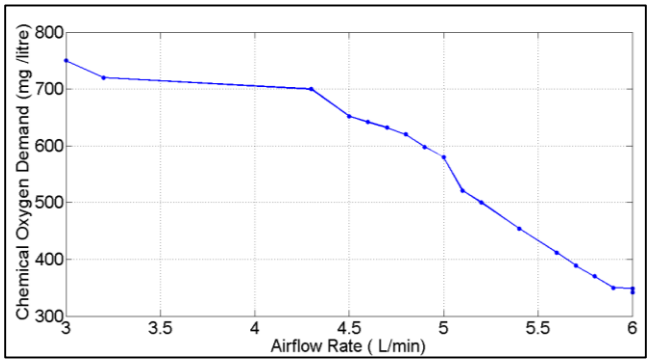

Fig. 6: Effect of airflow rate on COD

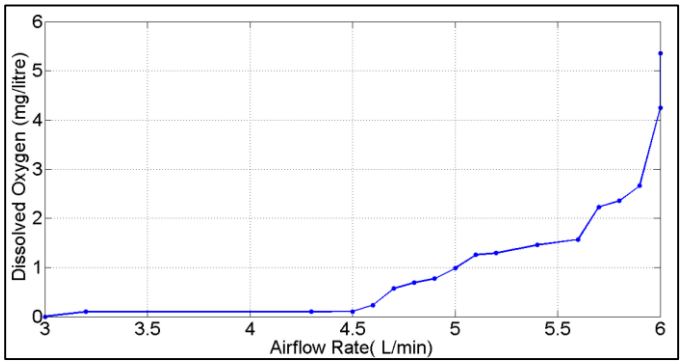

Fig. 7: Effect of airflow rate DO

C. Effect of Time on Bod, Cod and Do

In this PCO time is considered as important factor too, since OH radicals are produced it has the capacity to bring down the DO content low. So external supply of oxygen is given to improve the quality of water. So at different time intervals the BOD, COD and DO was calculated and plotted.

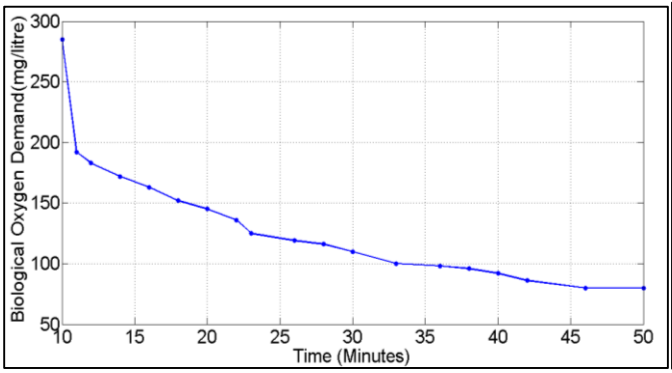

Fig. 8: Effect of time on BOD

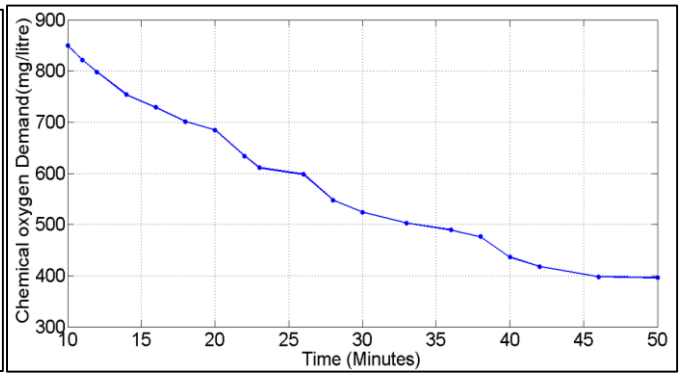

Fig. 9: Effect of time on COD

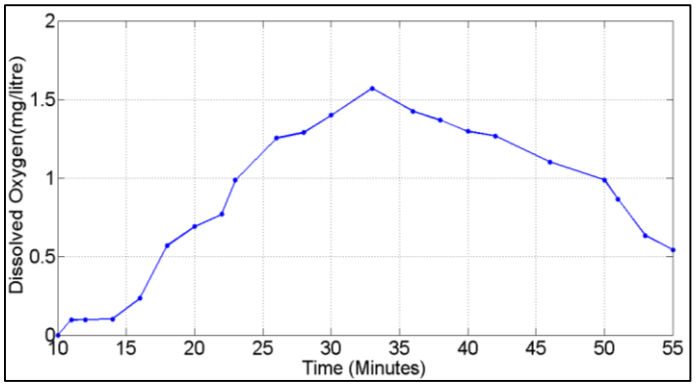

Fig. 10: Effect of time on DO

D. Physical Parameters after Treatment

Table – 2
Physical Parameters after Treatment

Sl. No.	*Parameter*	*Raw Water mg/l*
1	*pH Value*	*7*
2	*Total suspended solids*	*22*
3	*Oil & grease*	*8.9*
4	*BOD@ 5 days 20c*	*15*
5	*COD*	*258*
6	*Chlorides*	*14*
7	*Sulfides*	*11*

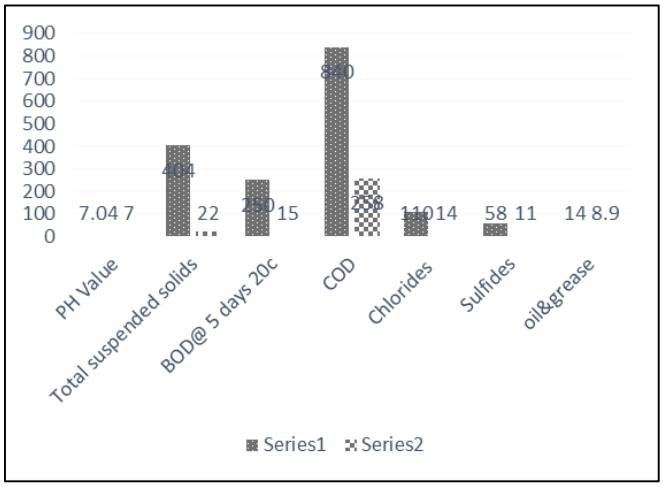

Fig. 11: Comparison between Before and After Treatment

VI. SUMMARY AND CONCLUSION

In this study, the selected sewage sample was treated successfully using photo catalytic oxidation and this method showed effective result on the degradation of basic physical parameter involved. This procedure was carried out by analyzing the BOD, COD, and DO for the treated sewage sample by varying the parameter like temperature, reaction time and airflow rate, since it must obey the tolerance limit of tamilnadu sewage board. Result showed that predicated and experimental values were not significantly different. The effective degradation was well achieved by using the optimal condition for temperature 40 degree celcius ,Reaction time 45 minutes and airflow rate 2.5 l/min.

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