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A study on the efficiency of aerated lagoon process to treat wastewater

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Abstract

With increasing urbanization and industrial development there is an increase in the production of wastes. These wastes, if not properly managed can have detrimental effect on the environmental quality. Under the growing demand of water in Dhaka city for daily needs and considering the constraints in disposal of wastewater, wastewater can be recycled and can be used as a major source of water supply for the growing population of Dhaka, the capital city of Bangladesh, if it can be properly treated. The study area includes a huge amount of wastewater both industrial and domestic wastewater from Tejgaon industrial area and its surrounding areas which are disposed to Hatirjheel canal. Hence an extensive study was carried out to evaluate the effectiveness of aerated lagoon process to treat the sewage diverted from Tejgaon industrial area to hatirjheel canal. Lagoon-based wastewater treatment is popular because of their simplicity and cost effectiveness. The study involved collection of extensive water samples for test, analysis of the sample for selected water quality parameters that include Color, NH_3-N, Chemical Oxygen Demand (COD), Biochemical Oxygen Demand (BOD). The study finds final reduction of 15% in Color, 93% in BOD_5, 71% in COD, 29% in NH_3-N.The study result shows that the aerated lagoon is effective in reduction of COD and BOD_5 in a significant percentage.

Keyword: Wastewater, aerated lagoon, recycle, industrial area, water quality.

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Introduction

Though water deserves the epithet “Life” but when contaminated, instead of being considered equivalent to life it may turn into a death trap. In terms of quality, the surface water of the country is unprotected from untreated industrial effluents and municipal wastewater, runoff pollution from chemical fertilizers and pesticides. . In the capital city Dhaka, the water demand is increasing everyday with its population and the two dimensional expansion, vertically through high rise building and horizontally through growth of new building estates. Moreover increasing poverty, decreasing working opportunities in rural areas, anticipation of better standard of living is causing a high migration rate towards this city. The fact results in decreasing per capita resource availability. Hence there is a tremendous pressure on scarce resources of which potable water is a significant one. The surface and ground water is too limited to meet the potable water demand of the huge population of Dhaka city as the ground water table is going downward rapidly. So to meet the increasing demand of water, dependence on ground and surface water must be decreased and a conventional method to recycle the already used water must be introduced. In this regard the treatment of sewage disposed to hatirjheel can play an invaluable role in mitigating the potable water scarcity of Dhaka city to a remarkable extent. The source of the sewage in the study area is generated from Tejgaon industrial area and its surrounding areas. The pollution due to dumping of untreated industrial and domestic wastes into the study area has already imposed a great threat to the surrounding environment. And the sewage quality is deteriorating at an alarming rate every day. So this sewage treatment is of paramount importance.

Study Area

Hatirjheel-Begunbari project is a mega project , in the nucleus of the Dhaka city. The sample has been collected from the point at which the domestic and industrial sewage from the Tejgaon industrial area is disposed to the project area.

Sample Collection

Everyday a huge amount of waste is generated and disposed to the project area. A number of representative sampling point were previously selected based on the treatment type to be operated, the location of the project area, the disposal frequency of sewage and other sewage quality parameter .The sample was manually collected on 25.04.2012 .The sample was selected so that it can represent the representative required parameter.

Fig: Study Area (Photo Taken from Google Map)

Methodology

Aerated lagoons are activated sludge units operated without sludge return where mechanical aeration is used to supplement the algal oxygen supply. Floating aerators are used to supply the necessary oxygen and mixing power. In a cone, sample water is taken and with an aerator it is kept for 6 days (as the retention time is 2-6 days). After aeration for 4 days, 5 days and 6 days the required parameters such as Color, BOD5, COD, NH_3-N are measured to assess the performance of the process.

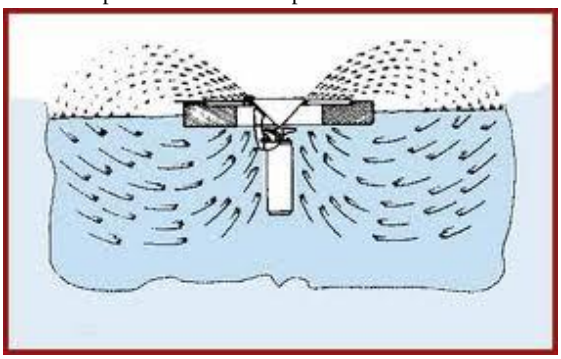

Fig: Floating Aerator (Taken from Google)

To measure Color value certain amount of sample was filtered and then in a 10 ml cell 10 ml sample was taken and the color value was found over range. So the sample was needed to be diluted. And finally 1 ml of sample was diluted to 10 ml and the color value was read. The Color was measured by Portable Datalogging Spectrophotometer (Model: HACH, DR/2010), a kind of multi-meter by which a wide range of parameters can be measured.

COD was measured using high range COD vial. 2 ml of the unfiltered sample was taken in a vial and then shaked for some time. After complete mixing the vial with sample was kept in the COD reactor for 2 hours .Then the sample was cooled down and COD value was measured by the portable datalogging spectrophotometer.

To determine BOD_5 12.5 ml of sample was converted to 1000 ml by adding seeded water. Then two BOD bottles were filled with diluted sample. The BOD bottles were completely filled. Initial DO was measured in one bottle immediately after filling with sample. Other bottle was kept in dark at 20^0c for particular (5) days. Then final DO was measured and BOD_5 was calculated by the equation $BOD_5 = [DO_i - DO_f] \times D.F.$

NH_3-N was measured using Nesslar solution and then using Portable Datalogging Spectrophotometer.

(a)

Fig: (a) Portable Datalogging Spectrophotometer (Model: HACH, DR/2010), (b) COD Reactor

Results and Discussions

The main objective of the study was to find the effectiveness of the treatment process in removal of several pollutants from the raw sewage. The water quality data obtained from the sample collected on 25.04.2012 were analyzed for the parameter Color, NH_3-N, COD, BOD_5. The performance of the treatment process regarding the limiting or removal of these parameters were assessed based on the parameter concentration in raw and treated water. All the results were plotted as curves to show the effect of the treatment processes on the sewage sample.

Analysis of raw sample:

Parameter	Value
Color (Pt-co unit)	1140
COD (mg/L)	562
BOD_5 (mg/L)	224
NH_3-N (mg/L)	2.05

The color value of the sample was extensively large (1140 pt-co unit) while drinking water standard was only 15 unit (ECR, 1997 & WHO guideline). So various dissolved and colloidal form of impurities discharged from various industries and also suspended materials were responsible for high value of color of the sample.
Ammonical nitrogen (as elementary N) standards for sewage from industrial or project wastes range from 50 mg/l to 75 mg/l (ECR, 1997). Hence the removal of nitrogen was of least concern.

During determination of COD organic matter is converted to carbon dioxide and water regardless of the biological assimilabality of the substances. And for the sample high value of COD indicates large amount of oxygen required for oxidation which means large amount of waste present in the sample. According to Bangladesh environment conservation rules, 1997 drinking water standard for COD is 4 mg/L where the sample shows a value of 562 mg/l which indicates it is highly polluted.
The total amount of oxygen that will be required for bio-degradation is an important measure of the impact that a given waste stream would have on the receiving water body. If DO goes below 4 mg/l due to decomposition of organic wastes, forms of life that can survive begin to be reduced .according to Bangladesh environment conservation rules,1997 for drinking water BOD_5 at 20^oc is 0.2mg/l. And from the sample BOD_5 is 224mg/l. This high value indicates higher amount of oxygen consumed by micro-organisms during the first 5 days of biodegradation. And it also indicates higher amount of organic wastes.

Effect of Aerated Lagoon on Sewage Properties:

Parameter	Raw sample	Aeration for		
		4 days	5 days	6 days
COD (HR)(mg/l)	562	178	166	159
BOD_5(mg/l)	224	65	35	15
Color (Pt-Co)	1140	1045	990	965
NH_3-N (mg/l)	2.75	2.05	2.0	1.95

The treatability of an industrial waste may be assessed by observing BOD/COD ratio. If the ratio>0.6, the wastes are biologically treatable without acclimatization. If the ratio is between 0.3 to 0.6, the wastes need acclimatization for biological treatment and if the ratio is less than 0.3 other methods are suggested for treatment.
BOD/COD=224/562=0.4 (range 0.3 to 0.6). So the wastes need acclimatization for biological treatment. The acclimatization involves the gradual exposure of the waste in increasing concentration to the seed or initial microbiological population, under a controlled condition.

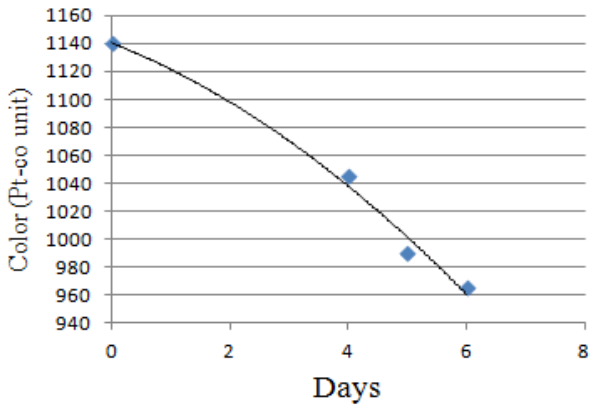

Fig: Change of color with aeration time

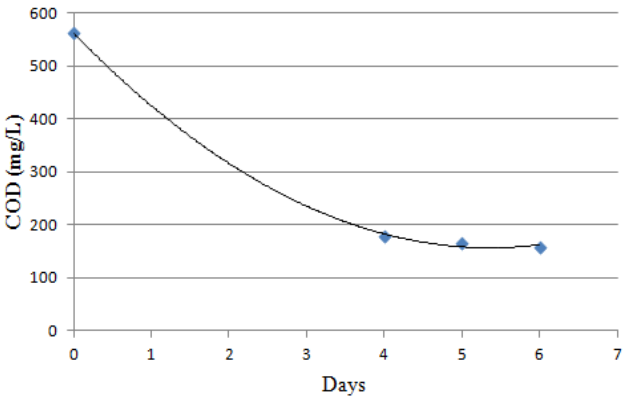

Fig: Change of COD with aeration time

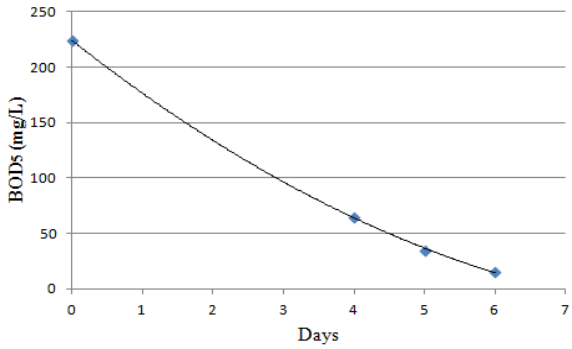

Fig: Change of BOD_5 with aeration time

BOD_5 standard for sewage discharge is 40 mg/l (ECR, 1997).This limit shall be applicable to discharges into surface and inland waters bodies. Performance of aerated lagoon in removing BOD_5:
BOD_5 removal=(224-15)/224 x100=93.3%

From literature, aerated lagoons achieve BOD_5 removals> 90%. So from this point of view aerated lagoon is satisfactory.

Aerated lagoon process reduced Color and COD by 15.35% and 71.71% respectively.

Conclusion

The target of the research was to evaluate the performance of the Aerated lagoon process in the removal of some selected parameters like Color, BOD_5, COD. Initially the abnormally high value of Color, BOD_5, COD indicated the presence of pollutants having origins in the domestic and industrial sewage. Aerated lagoon could not remove the high color value of the sample. But it brought the BOD_5 and COD value in a range which is sufficient for sewage discharge though not enough for drinking and other household usages. It can be summarized that the removal efficiency can be increased adopting other treatment process like activated sludge process, activated carbon process etc.

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