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A Short term study of Dissolved Oxygen behavior in Adyar River, Chennai

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Abstract: This paper addresses the behavior of dissolved oxygen content (DO) in Adyar river during early hours of day in the summer season (March, 2016) – May 2016). The study showed that the Dissolved Oxygen in the stream is below 4mg/l in a stretch of 42km and therefore water is not potable. In addition to this the study assessed the physico-chemical parameter of full stretch of Adyar river and identified the high contamination zone of river and also applied the Streeter - phelp equation to find out the critical deficit and critical time of deficit across the river stretch

Key words: Dissolved Oxygen Adyar River, Deoxygenation, Oxygen Deficit

Introduction

Water pollution is a major environmental issue in India. The largest source of water pollution in India is untreated sewage. There is no sign of river pollution being stopped. It is increasing day by day. In most of the towns and cities, the municipal drains carry our wastes to rivers. In our everyday life we can easily see symptoms of river pollution. The floating dead fishes in our river, any colored water in the river, or a bad smell from the river point towards river pollution.

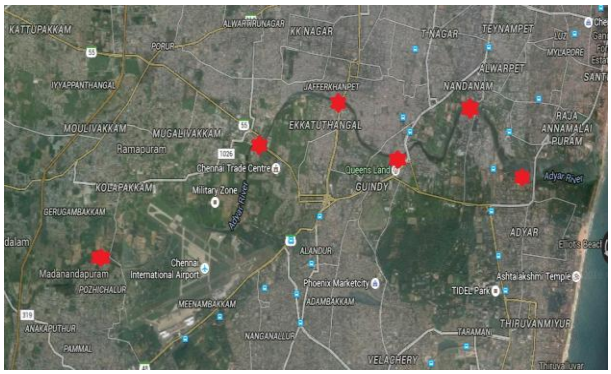
The discharged sewage, in due course of time, is purified by what is known as self-purification process of natural waters (S.K.Garg 2015) . In a running polluted stream exposed to the atmosphere, the de-oxygenation as well as the re-oxygenation go hand in hand. De-oxygenation is more rapid than the re-oxygenation, an oxygen deficit results.

The degree and amount of treatment given to raw sewage before disposing it off into the river-stream will definitely depend not only upon the quality of raw sewage but also upon the self-purification capacity of the river stream and the intended use of its water. The concentration of dissolved oxygen (DO) reflects equilibrium between De oxygenation and reoxygenation processes (e.g. aerobic respiration, nitrification, and chemical oxidation) and depends on many factors such as temperature, salinity, oxygen depletion, sources of oxygen and other water quality parameters [Masrur Ahmed 2014]. Therefore, it is essential to study the behavior of DO in full stretch of river.

Methodology

Study area

Adyar river origin from Malaipattu tank, Manimangalam Village, Kancheepuram, Tamil Nadu. It is located very near to Chembarambakkam Lake. It is one of the two rivers which flows through Chennai. The 42km long river contributes to the estuarine ecosystem of Chennai. Most of the waste from the city is drained into this river and the Cooum river. Despite heavy pollution, boating and fishing takes place in the river. It joins the Bay of Bengal at Adyar. The river has a varying depth of 0.75m at its upstream and 0.5m at its downstream. The river gets only 10% of the untreated sewage being let into the three principal waterways namely: The Buckingham Canal and the Cooum river taking the major share (60% and 30% respectively).



SAMPLING POINTS

Sampling Points

Samples of river water were taken at 6 locations in 1litre capacity plastic cans and used for tests on the chemical parameters of water and also in determining the variation of D.O along the river stream. Tharapakkam and Manapakkam were lies in upstream. Jafferkhanpet and Saidapet are the middle part of river. Kotturpuram and Adayar is at the downstream of the river. The DO was fixed at site and analysis was done with in half an hour in the laboratory. The sampling was repeated after 15 days and the present study is spread over a period of two months of summer season. The DO was determined following the Standard Methods (APHA 1992).

Results and Discussion

The results of the study conducted during January 2016- April 2016 on the Adyar River are presented in the above and below tables.

pH - pH values show relatively less variation along the length of the river among all the water samples analyzed, the maximum pH 7.70 was recorded at Kotturpuram and the minimum pH 6.99 at Saidapet in the post monsoon season. On the whole the pH of the water samples is under the considerable limit (range 5.5-9.0, according to general standards of Environmental (protection) rule,1986).

Turbidity – The observed samples have higher values of turbidity. High turbid nature of the water is due to suspended matter or microscopic organism making such water unfit for consumption or for other domestic purposes. The maximum turbid water was from the sample collected at Kotturpuram (104 NTU). This is due to increase in the rate of dumping wastes along the banks of the river at that point. The general standards for turbidity as prescribed by WHO is 5NTU. The observed values have higher turbidity values.

Fluoride – The maximum permissible limit of fluorides is 2mg/l as per the Environmental (protection) rule,1986. Higher fluoride concentration was observed in three of the sampling locations thereby indicating the infiltration of chemical fertilizers or soil-rock interaction in the particular area. The high concentration leads to occurrences of fluorosis. Sampling locations such as Jafferkhanpet, Kotturpuram and Adyar have higher levels of Fluoride content (3, 3, 5 mg/L respectively).

Chloride - Sample location Adyar has higher chloride content than rest of the sampling locations. The test results obtained for all locations exceed the maximum permissible limit. High Chloride concentration in water is the indicator of organic pollution (Hanipha, and Hussain, 2013). The concentration of chlorides for all groundwater samples ranged from 251.70-1102.50mg/l. So it should be treated for further usage and all other samples are safe regarding chloride content. High concentration of chloride imparts salty taste (Bishnoi, and Arora, 2007). This high concentration of chloride occurrence may be due to high rate of evaporation and invasion of solid waste dumped nearby areas.

Electrical conductivity - The maximum permissible limit is about 1.4mhos. The observed values for all the samples except Adyar (0.4 mho) have higher electrical conductivity than the permissible limit.

Total suspended solids – The standard limit according to EPR, 1986 is 100mg/L. The observed values are much greater than the limit which implies that the samples collected have higher suspended solids present in them.The concentration of TDS in water is due to presence of sodium, potassium, calcium, phosphate and other organic matter (Sharma, 2013).

Chemical oxygen demand – The maximum permissible limit for COD is 250mg/L. Three different volumes of samples are used to determine the COD values for each location. The COD values for sample collected from Tharapakkam, Manapakkam, Saidapet (2.5ml), Kotturpuram (2ml) have lower COD content than other locations.

Total Kjeldhal Nitrogen – The standard value specified by EPR, 1986 is 100mg/L. The Sample from Tharapakkam has lower Total Kjeldhal Nitrogen content when compared to other locations and permissible limit.

Chlorine – On the whole the chlorine content of the samples collected are within the limit 1mg/L as specified by the EPR, 1986.

Dissolved oxygen – The permissible limit, according to WHO standards, range in between (6.5-8.5) mg/L. The DO values obtained vary from (2 - 5.33) mg/L. DO levels rise from morning through the afternoon, reaching a peak in late afternoon and falls to a low point before dawn. As a result of which DO values fluctuate with increase and decrease of temperature.

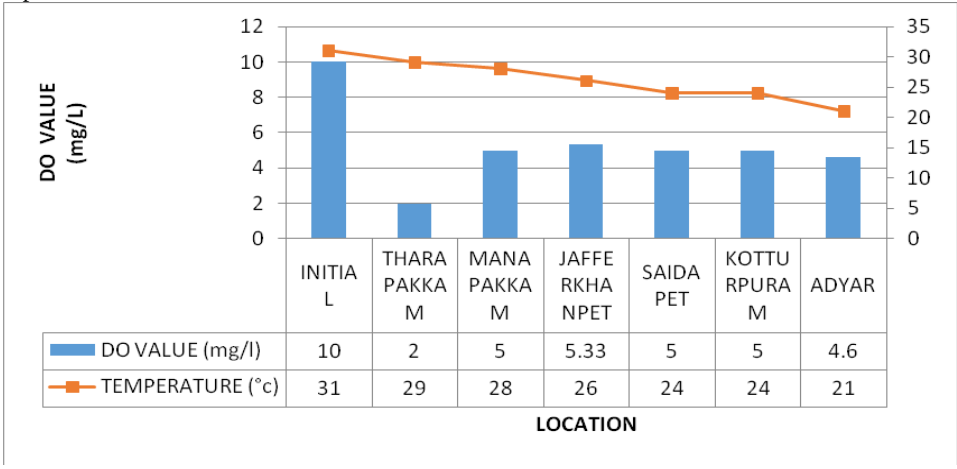
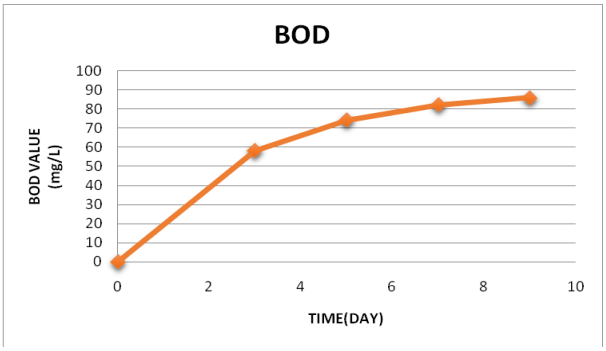


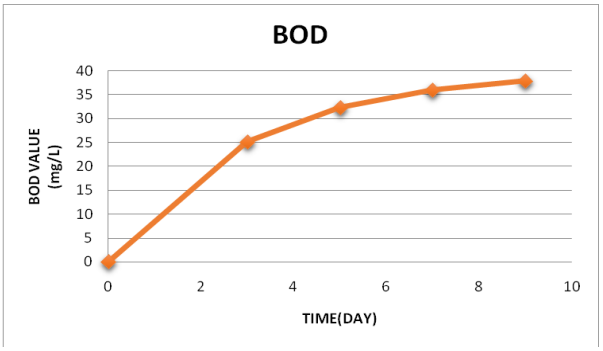
Figure 2 -Average Concentration of Do across the River

The above graph shows that the collected sample has Do value less than the standard limit provided by the WHO 96.5-8.5 mg/L) and is of poor quality due to inadequate dissolved oxygen.

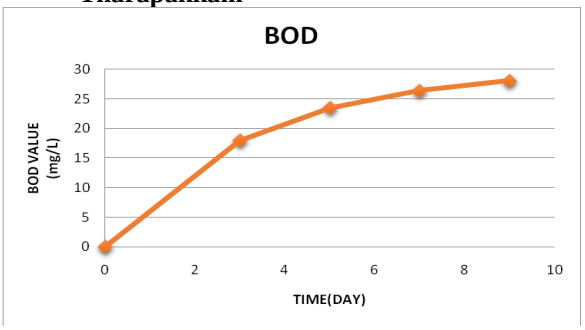
Biological oxygen demand – The total amount of oxygen used by microbes to
Breakdown the organic material in an aquatic ecosystem is called BOD. The values are obtained for 4 different days and vary from 5-59 mg/L for 3 days, 7-75mg/L for 5 days, 8-83 mg/L for 7 days and 9-87 mg/L for 9 days, for all the locations. Comparatively Tharapakkam has higher BOD values ranging from 58.287-86.062mg/L. These higher values of BOD are may be due to heavy civilization and increased inflow of organic matter as well as domestic sewage in the water body.

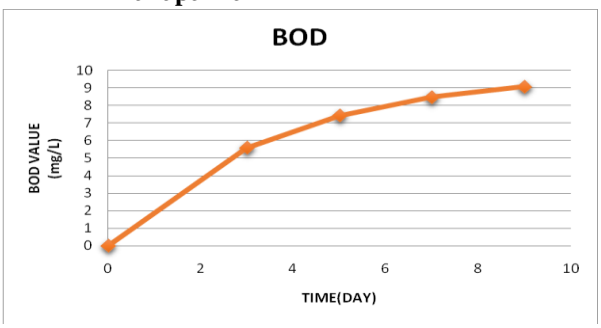
Figure 3 – Average Concentration of BOD at 6 Locations



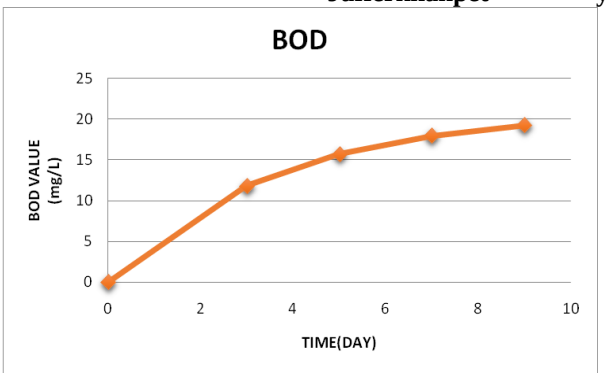


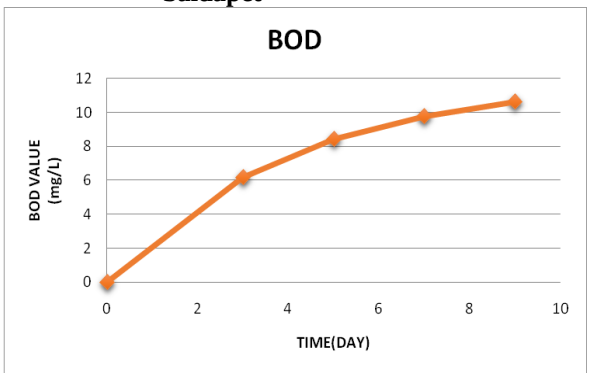
Tharapakkam **Manapakkam**





Jafferkhanpet **y** **Saidapet**





Kotturpuram **Adyar**

The figures 3 shows that the BOD curve is an increasing curve since the BOD values gradually increase with increase in duration. The highest value is at Tharapakkam and the lowest recorded value is Saidapet.

TABLE 1Average concentration of Physicochemical characteristics of Adyar river

LOCATION	Ph	TEMP (^{O}C)	TURBIDITY	FLUORIDE	CHLORIDE	EC	TS mg/l	TSS mg/l	TDS mg/l	COD 1ML	COD 2 ML	COD 2.5 ML	TKN mg/l	CHLORINE	NITRITE mg/l	DO mg/l
Tharapakkam	7.25	29	12	0.5	623.92	1.84	4400	595.65	3804347.00	68	68	54	70	0	0.5	2.00
Manapakkam	7.34	28	16	1.0	251.70	1.57	1700	366.67	1333.33	136	103	136	140	0.2	0.5	5.00
Jafferkhanpet	7.30	26	26	3.0	436.04	1.76	118400	7840.46	110919.54	816	816	816	210	0.2	0.2	5.33
Saidapet	6.99	24	36	1.5	779.90	1.59	20300	16777.27	3522.27	272	272	272	210	0.2	0.5	5.00
Kotturpuram	7.70	24	104	3.0	471.49	1.88	2200	1200.00	1000.00	272	234	274	420	0.5	0.2	5.00
Adyar	7.60	21	47	5.0	1102.50	0.45	3900	978.70	2921.30	340	340	326	210	0.5	0.1	4.60

TABLE 2 Oxygen Sag Curve Analysis

S.NO	LOCATION	D_T	D_{T3}	D_{T5}	D_{T7}	D_{T9}
1	THARAPAKKAM	78.92	51.12	65.05	72.01	75.47
2	MANAPAKKAM	30.09	18.97	24.36	27.14	28.57
3	JAFFERKHANPET	165.39	99.07	129.28	145.73	153.47
4	SAIDAPET	46.78	26.40	35.05	40.03	42.89
5	KOTTURPURAM	761.724	483.78	601.78	669.69	708.76
6	ADYAR	50.35	26.01	35.35	41.12	44.67

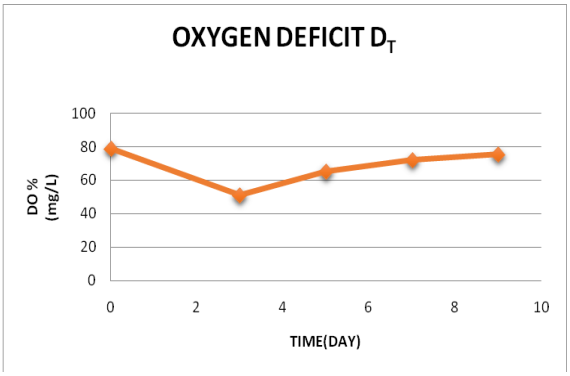


Figure 4 - Variation of D_T

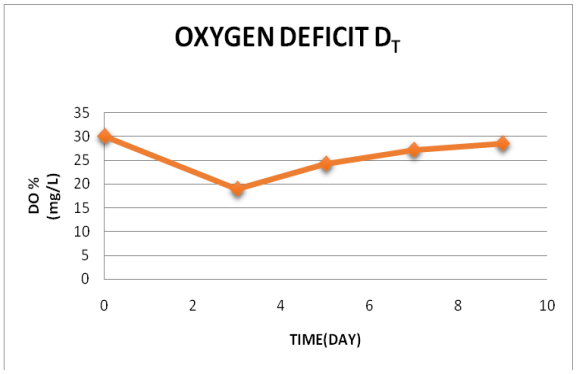


Figure 5 - Variation of D_T at Manapakkam at Tharapakkam

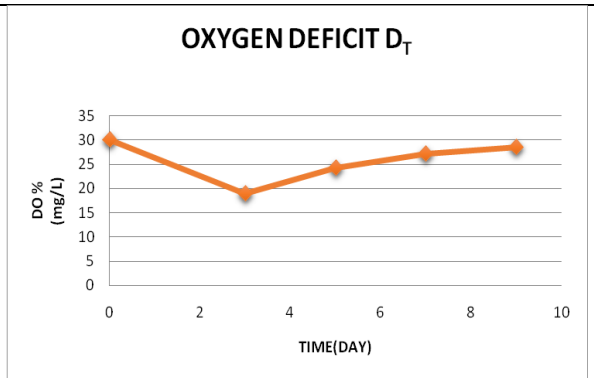


Figure 6 - Variation of D_t

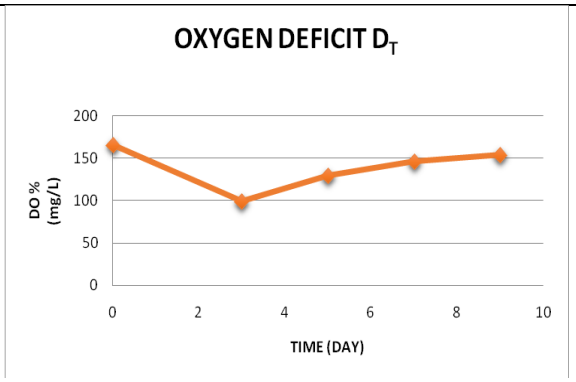


Figure 7 - Variation of D_t

AT JAFFERKHANPET

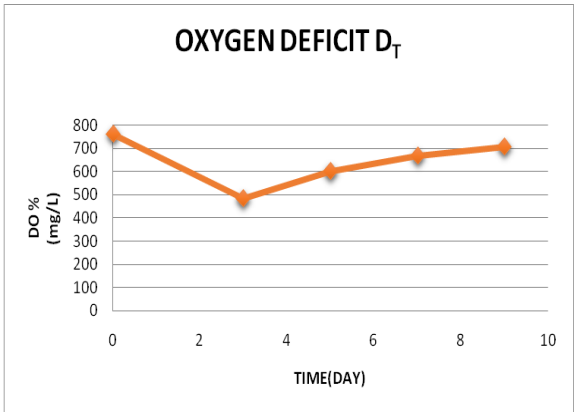


Figure 8 - Variation Of Dt at kotturpuram

AT SAIDAPET

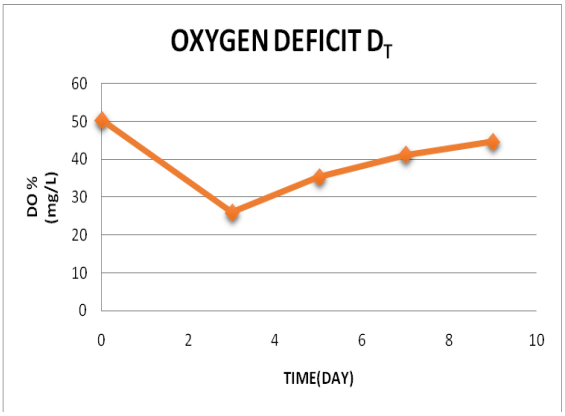


Figure 9 - Variation of Dt at Adyar

The figures 4 to 9 show the oxygen deficit curve at each location. The critical deficit is shown at 3rd day as the DO levels decreases drastically for all the locations and gradually increases.

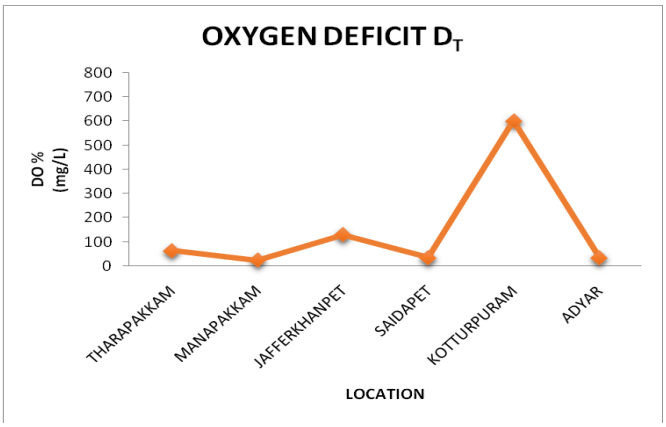


Figure 10 – Oxygen Deficit across the river

The graph shows the variation of oxygen deficit across the river. Across the river there is mild variation except at Kotturpuram which has a spiked deficit in the oxygen content- a result of constant dumping and disposal of waste along the river banks.

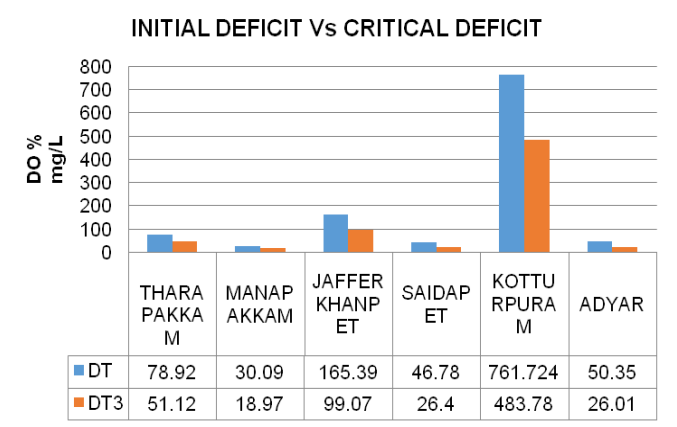


Figure 11 - Initial Deficit Vs Critical Deficit

The above graph shows the comparative study of initial and critical deficit. The Critical deficit value is lower than Initial deficit values for all the locations.

CONCLUSION AND RECOMENDATIONS

It is clear from the above test results and analysis that the Adyar River is indeed polluted heavily. However due to the recent flooding, the pollution levels have reduced. The DO of the river reveals that there is constant De-oxygenation process occurring along the stretch of the river from Tharapakkam (point in the upstream) to Adyar (near the mouth). Re-oxgenation rate is revealed to be zero (or very negligible). The oxygen deficit found out using the Streeter Phelps Equation shows that the critical point occurs at the third day for all the points. To increase the Re-oxygenation rate it seems that river needs some kind of purification to aid the naturally occurring "Self-Purification".

From the analysis of the various quality parameters, some portions of the river are still affected by the pollution (i.e. places such as Jafferkhanpet, Kotturpuram and Adyar) whereas other places seem to have a lesser effect of the pollution due to the recent flooding in December (i.e. Manapakkam, Tharapakkam, Saidapet).

The water quality of Adyar River has deteriorated seriously and would continue if urgent measures are not put in place to control the fast continuous rate of waste discharge into the river without breaking down some of these wastes. Existing enabling laws to restrict contaminants levels of effluent discharge to water bodies should be enforced as there is possibility that the rate DO reduction might be greater than the rate of self purification, which in this case may result in the death of aquatic lives as well as the abandonment of the river.

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