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Self-remediation Characteristics Of Ekulu River Enugu, Enugu State, Nigeria, As, Effluents Sink

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ABSTRACT

The self purification process at Ekulu river was studied. The oxygen balance was monitored over a distance of and the sag point located. Deoxygenating rate, physical characteristics and the reaeration rate of the river, were determined. Results of the analysis yielded an f-value or purification coefficient which classified the river portion as one with high self recovery characteristics. © 2007 Trade Science Inc. - INDIA

KEYWORDS

Remediation;
Deoxygenation;
Self purification;
Ekulu river;
Industrial effluent sink;
Reaeration.

INTRODUCTION

The phenomenon of self-purification of surface waters is well known and has been a subject of intensive study[1,9]. Such studies may be because self-purification provides a unique set of advantages of clean up polluted water streams. Some of such advantages include rapidity of operation, inexpensiveness, instantaneousness, continuity and efficiency[1,3].

Natural forces rid polluted water of corruption when given chance to exert themselves. These natural forces which can be physical, chemical or biological are many and varied. When pollutants are discharged into surface water, a succession of changes in water quality take place. The oxygen resources of the river are largely drawn upon and in overloaded stream, the supply of the dissolved oxygen (DO) may be exhausted.

The depletion of dissolved oxygen as a result of metabolization of wastes by bacteria is opposed by reaeration, a process which replaces oxygen through solubilization at the surface. The rate of reaeration is proportional to the rate of depletion of oxygen through microbial activity below the surface. In streams, the interplay between deoxygenating and reaeration produces a dissolved oxygen profile called oxygen sag[17].

Industrial activities are major sources of many of the wastes which pollute surface waters. Dust, wastes waters, waste chemicals, and defective products are such industrial wastes. Ekulu river has its origin from Udi Hills, Enugu, Nigeria and runs hthrough Emene, the industrial center of Enugu town. Large industrial plants like asbestos, Nigeria steel mills, air port, flour mills, motor manufacturing company etc. are located in Emene. These industries are known to discharge their effluents into Ekulu river.

MATERIALS AND METHODS

Sample collection

Various water samples from the Ekulu river were collected in 250 ml plastic bottles and two drops of dilute HCl was added in each of them.

Dissolved oxygen profile

Several sample points were mapped out along the stretch of the river in order to locate the bottom of the sag below the entry points of the industrial wastes. The azide modification method[10] of determining DO was used in this study. Ekulu river contain high iron concentration and to eliminate the effect of the iron, the samples collected for DO determinations were treated immediately after collection by adding 1ml of potassium fluoride solution. Samples from selected stations were acidifies with 90% phosphoric and instead of sulphuric acid to eliminate the interference caused by ferric ions.

The DO content of the water samples was determined on site immediately after collection. A digital oxygen probe machine supplied by Halch chemical Co. USA was used. The procedure consisted of using powdered pillows of reagents outlined in the azide modification method[10]. Further determinations on water samples were performed in the laboratory. For these determinations, samples were fixed by appropriate methods[18]. DO values thus obtained wee comparable to those obtained on site.

Deoxygenation rate (K_1) determination

The rate of biochemical oxygen demand (BOD) degradation (K_1) of the river was estimated from a 10-days BOD measurements of the water samples from the bottom of the sag-corresponding to 50m from the entry of the pollution sources. K_1 was estimated using the method devised by Nemerow[11] and used by Guandy[12].

Water samples collected in a 300ml BOD bottles were fixed on the spot by introducing in quick succession 1ml KF solution; 2ml $MnSO_4$solution and 2 ml alkali iodide reagent/. The bottles filed to the brim were corked to prevent air entrainment and mixed by inversion, Finally 2ml of conc. H_2SO_4(or H_3PO_4) was run don the neck of the bottle and the precipitate dissolved by inverting the bottle. With this treatment on the site, the samples were transferred to the laboratory, refrigerated and kept

In the dark[13,14] the reagents and procedure for determination was carried out as in cited literature.

Reaeration coefficient (K_2) determination

The reaeration coefficient (K_2) was determined using Isaac's modification of Streeter-Phelps model [15]. The original Streeter-Phelps equation is

$$K_2 = CV^n/H^2 \quad (1)$$

Where

K_2 = reaeration coefficient per day

V = mean velocity

H = Mean depth of the water above extremes low flow

C, n = Constants for a particular river stretch depending on Channel, slope and roughness.

The modified model equation by Isaac is

$$K_2 = 2.833\, V/H^{3/2} \quad (2)$$

The constant 2.833 represent an average of all roughness in the river.

Stream discharge measurements

Stream flows were computed by measurements of the cross sectional area of the river and the average velocity of the water flowing past the section using the equation[12].

$$Q = AV \quad (3)$$

Where Q = stream discharge or volumetric flow rate depth

A = Cross section area given by average depth

Multiplied river width

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V = velocity of the river given by Distance traveled by surface boat (m)
Time taken (s)

RESULTS AND DISCUSSION

The 10-day BOD (BOD10) measurement data are shown in TABLE 1 below and figures 1 and 2 below. The values of K_1 and first stage ultimate BOD were estimated graphically from a plot of the data in TABLE 1. From the table and the plots, BOD5 is 5.20mg/I, BOD10 is 6.40 mg/I while the first stage ultimate BOD (BOD) is 7.40mg/l. With the estimated, first stage ultimate BOD, L, the deoxygenation rate (K_1) was determined using monomolecular law. (ref) The decomposition of the wastes satisfies the first order reaction.

$$dL/dt = -K_1 (L-y) \quad (4)$$

where (L-y) = organic matter to e oxidized
t = time
K_1 = rate constant
Therefore

$$In(L-y) = -K_1 t + c \quad (5)$$

Or

$$Log(l-y) = -K_1 t = c$$

A graph of the BOD remaining on a log scale against time of oxidation plotted arithmetically (figure 1) yielded a straight line of whose slope is the K_1 and intercept © on the log axis is the predicted value of L.

The value of K_1 is 0.104 while L is 7.40mg/l
The river discharge measurements yielded:
Average velocity = 0.15m/sec
Average dept = 1.27m
Substituting these values in equation (ii yielded

$$K_2 = 2.833 \times 0.15/1.27^{1.5} = 0.297 \text{ day}^{-1}$$

Result of the calculation showed that the rate at which oxygen of the air is renewed in the flowing Ekulu river studied is 0.297 per day and this is the rate at which the oxygen deficit in the river is being paid back.

Stream purification coefficient

The ration of K2 to K1 is known as the purification coefficient off-ration of any receiving water. Streams are considered to behave as their f-ratio.[16]

$$F = K_2 \quad (6)$$

For Ekulu River
$K_1 = 0.104; K_2 = 0.297$
Therefore, f = 2.86

When the f-value obtained for Ekulu river under study was compared with the table off-values (TABLE 3) the river falls into large stream of normal velocity. The f-value is an index of river recovery or self purification because the higher the f-value, the faster the river recovers from the effect of pollution. The classification confirms the finding of this study considering the stream discharge measurements carried out in this study.

TABLE 1 : BOD10 analysis of water samples a sag point (ERS 005)

Day	BOD10(mg/l) Rainy season	BOD10(mg/l) Dry season
0	0.00	0.00
1	0.80	1.25
2	1.30	1.92
3	2.00	2.45
4	3.00	3.33
5	4.00	5.20
6	4.30	5.50
7	4.60	5.80
8	4.90	6.10
9	5.20	6.20
10	5.22	6.40

Data are means of four determination.

TABLE 2 : Data for determination of K_1 by general laboratory method

T (Day)	BOD exerted 'y' (mg/l)	BOD remaining L – y (mg/l)	Log (L – y)
0	0.00	7.40	0.87
1	1.25	6.15	0.79
2	1.92	6.48	0.74
3	2.45	4.95	0.69
4	3.33	4.07	0.61
5	5.20	2.20	0.34
6	5.50	1.90	0.28
7	5.80	1.60	0.21
8	6.10	1.30	0.11
9	6.20	1.20	0.08
10	6.40	1.00	0.00

Data are means of four determination.

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