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Analysis the Deficit of Dissolved Oxygen in Al_Hilla River According to Wastes Disposal and Velocity of Stream

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Abstract: *The dissolved oxygen levels and quality of water play an important role in supporting aquatic life. In this paper we collected number of samples from AL_Hilla River near AL-Hilla city center about 40 km from the beginning of the river to investigate the deficit of the DO concentration in the river and the pollution level in it.*
Keywords: *AL_Hilla River, DO concentration and pollution level.*

I. INTRODUCTION

Control of water pollution has reached primary importance in developed and a number of developing countries. The dissolved oxygen (DO) concentration is a primary measure of a stream's health, but the dissolved oxygen concentration responds to the biochemical oxygen demand (BOD) load [1]. The availability of dissolved oxygen in a flowing stream is highly variable due to several factors. Daily and seasonal variations in DO levels have been reported. The diurnal variations in DO are primarily induced by algal productivity. Seasonal variations are attributable to changes in temperature that affect DO saturation values. The ability of a stream to absorb or reabsorb oxygen from the atmosphere is affected by flow factors such as water depth and turbulence, and it is expressed in terms of the reaeration coefficient [2]. The DO in water has an important impact on aquatic animals and plants. Most aquatic animals, such as fish, require oxygen in the water to survive. The two major sources of oxygen in water are from diffusion from the atmosphere across the water Analysis the Deficit of Dissolved Oxygen in Al_Hilla River According to Wastes Disposal and Velocity of Stream surface and the photosynthetic oxygen production from aquatic plants such as algae and macrophysics. Important factors that affect DO in water [3].

Dissolved oxygen criteria apply to both continuous and cyclic low DO conditions. If the DO conditions are always above the chronic criterion for growth (4.8 mg/L), the aquatic life at that location should not be harmed. If the DO conditions at a site are below the juvenile/adult survival criterion (2.3 mg/L), there is not enough DO to protect aquatic life. When persistent DO conditions are between these two values, further evaluation of duration and intensity of low DO is needed to determine whether the level of oxygen can support a healthy aquatic life community

II. COLLECTION OF SAMPLES

The samples were collected by using bottles with one liter capacity, the mechanism of filling the bottles with water samples can be clear by knowing the tool that used (as shown in Figure 1).

The sticks inserted in the water until we reach the specific depth, then we drag the stick1 carefully until a simple gap found between the bottle opening and the stopper so the water started to flow inside the bottle, then we move stick down until the stopper back to its position to close the bottle well.

At any tested depth, when the bottle out from water body, we label it with the depth and the cross place (left, right or middle). Also we label the temperature and the time and the date.

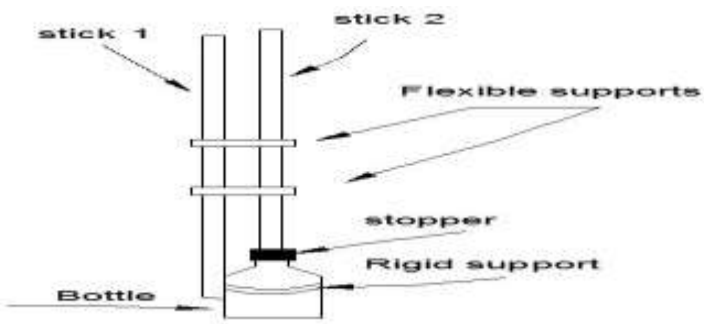

Figure 1 The sampling instrument.

III. DATA AND MEASUREMENT

The samples places and data can be shown in the following table:

Table 1 Sampling data

Sample No.	**Sample Place**	**Tested Depth (m)**	**Do mg/L**
1.	Middle	0.0	3.3
2.	Middle	0.0	3.4
3.	Middle	0.5	3.4
4.	Middle	0.5	3.2
5.	Middle	1.0	3.5
6.	Middle	1.0	3.2
7.	Middle	1.5	3.5
8.	Middle	2.0	3.4
9.	Middle	2.5	3.2
10.	Middle	2.5	3.4
11.	Shoulder	0.0	2.7
12.	Shoulder	0.0	2.7
13.	Shoulder	1.0	2.8
14.	Shoulder	1.0	3.0

We can note from the above table, the average concentration of dissolved oxygen in the middle of the river = 3.35 mg/L and for shoulders =2.8 mg/L.

The two concentrations < 4.5 mg/L.

This results reflect the real pollution that occur in AL-Hillariver , and the deficit of DOC could be increase by discharge or disposal more wastes into this water source.

For calculate the deficit of Oxygen in the shore we can use the Streeter- Phelps equation:

$$D = \left(\frac{k_d L_0}{(k_r - k_d)}\right)\left(e^{-k_d t} - e^{-k_r t}\right) + D_0 e^{-k_r t}$$

where L0 = ultimate BOD in the water at t = 0

D0 = deficit at t = 0.

Both L0 and D0 are the values in the stream after any external waste streams have been mixed in. This equation is known as the DO sag equation (for its distinctive shape) or the Streeter- Phelps equation, after the gentlemen who first published it in 1925.

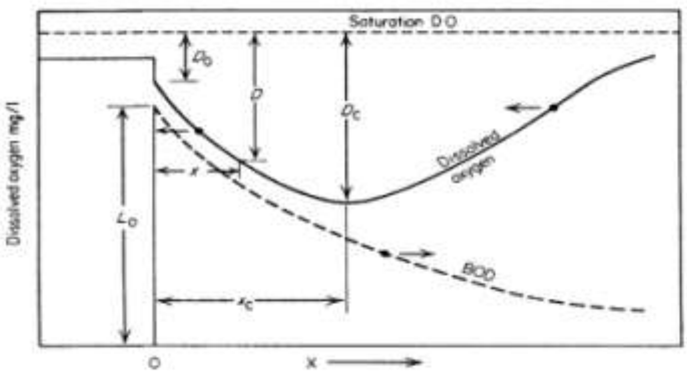

Figure 2 DO deficit in water stream

3.1. Dissolved Oxygen Saturation

DO saturation (DOsat) values for various water temperatures can be computed using the American Society of Civil Engineers' formula (American Society of Civil Engineering)
DOsat - 14.652 - 0.410227 + 0.0079910T2 - 0.000077774 J3 (2.4)

Where: DOsat = dissolved oxygen saturation concentration, mg/L T: water temperature, ^{o}C

For the sampling condition, the temperature was 28 ^{o}C, so the measured Do sat could be equal to 7.72 mg/L.

The section of the river can be shown in the following Figure (Source from the water resource office in Babylon province / 2015)

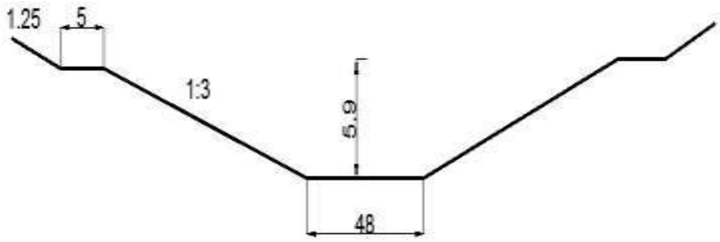

Figure 3 AL-Hilla river section

For calculated the Dox in Streeter- Phelps equation, we must find initial deficit in dissolved Oxygen Do, the value of kd and kr, The value of the velocity and the value of waste concentration Lo:
The average discharge of the river in the sampling section = 264.7 m^3/sec,

The area of the section can be calculated as following:
A=387.63 m²
Velocity (u)= q/A = 264.7/387.63=0.682 m/sec
U=0.682*60*60*24=58752 m/d

3.2. Calculation of kr
We can calculate the value of kr from one of the equations below:

Kr =	.	O' Connor- Dobbins (1958)
Kr =	.	Churchil et al (1962)
Kr =	.	Owens & Gibbs (1964)

The average depth of the river can be calculated by the following:

hav. =	. . . .	= 3.7 m

The Value Of Kr From The Above Equations Can Be As Follows:
Eq. (1)…….kr= 0.45 d^{-1}
Eq.(2) …… kr= 0.38
Eq.(3) …..…kr=0.36

We can take variable values of the disposal wastes (Lo) and kd for calculation the deficit in Do along the river stream.

Table 2 Do calculation.

T (day)	**X (m)**	**Dox(mg/L) (Lo= 8 mg/L)**				
		Kd = 0.1	**Kd = 0.15**	**Kd = 0.2**	**Kd = 0.25**	**Kd = 0.3**
0	0.00	3.20	3.20	3.20	3.20	3.20
0.1	5892.48	3.29	3.25	3.21	3.17	3.13
0.2	11784.96	3.36	3.29	3.21	3.14	3.07
0.3	17677.44	3.44	3.33	3.22	3.12	3.01
0.4	23569.92	3.52	3.38	3.24	3.10	2.97
0.5	29462.4	3.59	3.42	3.25	3.09	2.93
0.6	35354.88	3.66	3.46	3.27	3.08	2.90
0.7	41247.36	3.73	3.51	3.29	3.08	2.88
0.8	47139.84	3.80	3.55	3.31	3.08	2.86
0.9	53032.32	3.87	3.59	3.33	3.09	2.85
1	58924.8	3.93	3.64	3.36	3.09	2.84

1.1	64817.28	4.00	3.68	3.39	3.11	2.84
1.2	70709.76	4.06	3.73	3.41	3.12	2.85
1.3	76602.24	4.12	3.77	3.44	3.14	2.86
1.4	82494.72	4.18	3.81	3.48	3.16	2.88
1.5	88387.2	4.23	3.86	3.51	3.19	2.89
1.6	94279.68	4.29	3.90	3.54	3.22	2.92

$$Xc = \frac{U}{kr - k1} \ln \frac{kr}{k1}\left(1 - \frac{kr - k1}{k1\ Lo}(Do)\right)$$

$$Tc = \frac{Xc}{u}$$

Table 3 Calculation Xc, Tc and Doc

Kd d^{-1}	Xc(km)	Tc	Do mg/L at Tc
0.25	37.6	0.7	3.08
0.3	54.64	1	2.84

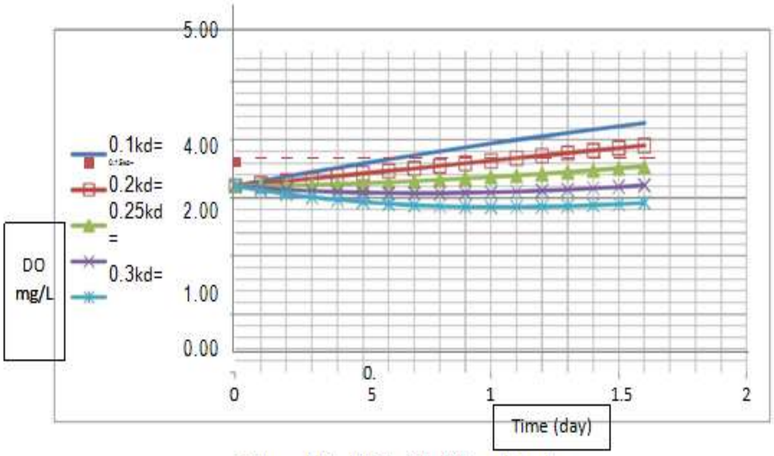

Figure 4 Do deficit with different kd values

Table 4 DO calculation

T (day)	X (m)	Dox (mg/L) (Lo= 12 mg/L)				
		Kd=0.1	Kd=0.15	Kd=0.2	Kd=0.25	Kd=0.3
0	0.00	3.20	3.20	3.20	3.20	3.20
0.1	5892.48	3.25	3.19	3.13	3.07	3.02
0.2	11784.96	3.29	3.18	3.06	2.95	2.84
0.3	17677.44	3.33	3.17	3.00	2.84	2.69
0.4	23569.92	3.37	3.16	2.95	2.75	2.55
0.5	29462.4	3.41	3.16	2.90	2.66	2.42
0.6	35354.88	3.45	3.15	2.86	2.58	2.31
0.7	41247.36	3.49	3.16	2.83	2.51	2.21
0.8	47139.84	3.53	3.16	2.80	2.45	2.12
0.9	53032.32	3.57	3.16	2.77	2.40	2.05
1	58924.8	3.61	3.17	2.75	2.36	1.98
1.1	64817.28	3.65	3.18	2.74	2.32	1.93
1.2	70709.76	3.69	3.19	2.73	2.29	1.88
1.3	76602.24	3.73	3.21	2.72	2.27	1.84
1.4	82494.72	3.77	3.22	2.72	2.25	1.82
1.5	88387.2	3.81	3.24	2.72	2.24	1.80
1.6	94279.68	3.84	3.26	2.72	2.23	1.78

Table 5 Calculation Xc, Tc and DOc

Kd^{d-1}	Xc(km)	Tc	Do (mg/L) at Tc
0.15	31.5	0.6	3.15
0.2	75.2	1.4	2.72
0.25	87.6	1.6	2.23
0.3	91.0	1.7	1.78

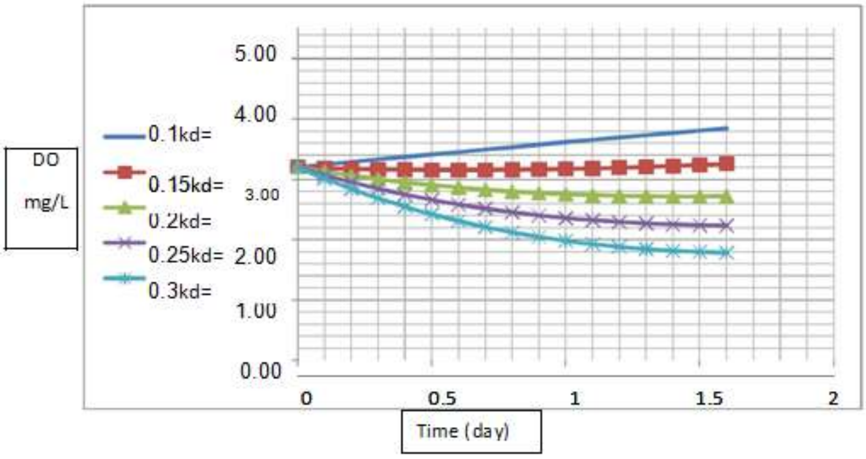

Figure 5 Do deficit with different k_d values (L=12 mg/L)

Table 6 Do calculation

T (day)	X (m)	Dox (mg/L) (Lo= 15 mg/L)				
		Kd=0.1	**Kd=0.15**	**Kd=0.2**	**Kd=0.25**	**Kd=0.3**
0	0.00	3.20	3.20	3.20	3.20	3.20
0.1	5892.48	3.22	3.14	3.07	3.00	2.93
0.2	11784.96	3.23	3.09	2.95	2.81	2.68
0.3	17677.44	3.25	3.04	2.84	2.64	2.44
0.4	23569.92	3.26	3.00	2.74	2.48	2.23
0.5	29462.4	3.28	2.96	2.64	2.34	2.04
0.6	35354.88	3.30	2.92	2.56	2.21	1.87
0.7	41247.36	3.32	2.89	2.48	2.09	1.71
0.8	47139.84	3.33	2.87	2.41	1.98	1.57
0.9	53032.32	3.35	2.84	2.35	1.89	1.44
1	58924.8	3.37	2.82	2.30	1.80	1.33
1.1	64817.28	3.40	2.81	2.25	1.73	1.24
1.2	70709.76	3.42	2.80	2.21	1.67	1.15
1.3	76602.24	3.44	2.79	2.18	1.61	1.08
1.4	82494.72	3.46	2.78	2.15	1.56	1.02
1.5	88387.2	3.49	2.78	2.13	1.53	0.97
1.6	94279.68	3.51	2.78	2.11	1.49	0.93

Table 7 Calculation Xc, Tc and DOc

$_{Kd}$d-1	Xc(km)	Tc	Do (mg/L) at Tc
0.15	81.9	1.5	2.78
0.2	102.4	1.9	2.09

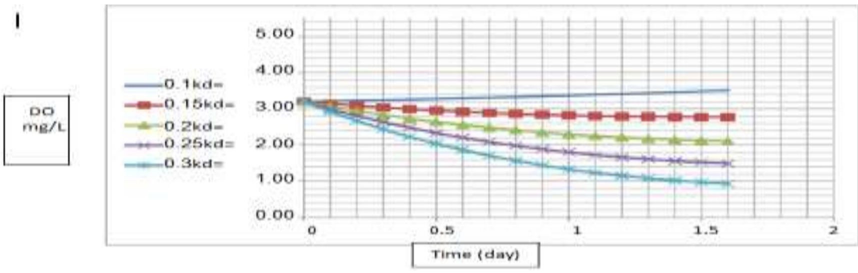

Figure 6 Do deficit with different kd values (L=15 mg/L)

As we notice from the analysis of the dissolved Oxygen concentration in AL-Hilla river, the concentration was unacceptable according to the standard specifications (<4.8 mg/L, according to EPA).

The effects of the stream velocity on the DO concentration can be clear by the following Figure, the increasing in velocity could make the critical distance along the stream more than the decreasing in it.

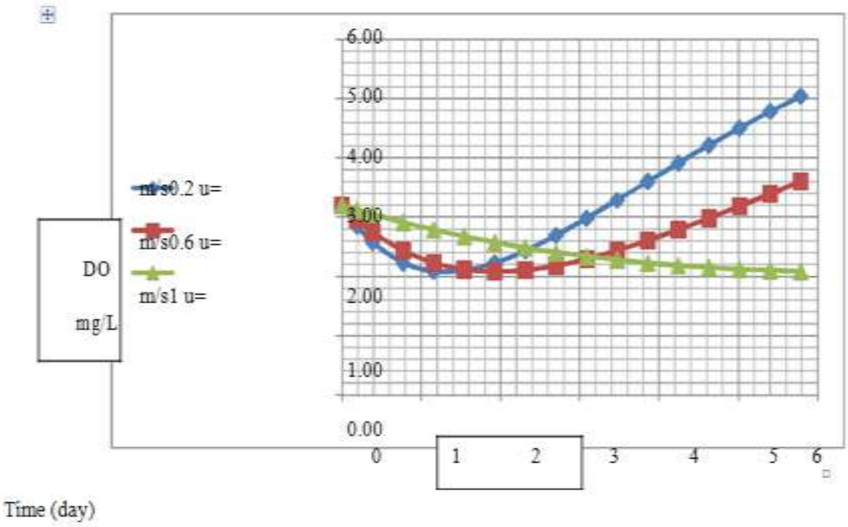

Figure 7 Relationship between time and Do deficit with different velocity along the stream

IV. CONCLUSION

The river is under pollution according to the analysis and results in this research.

The tables show that the disposal of wastes with (L> 8 mg/L) and(kd> 0.15 d^{-1}) into the river make the DO concentration decrease along the river stream because the sampling area was about 40 km from the beginning of the river and the remaining long is about (94.48 − 40=54.48 km), so the critical distance is more the remaining part of the river.

The high velocity of the stream could increase the critical distance below the re-back of DO concentration and could make the deficit of the DO along all the river because its limit long.

List Of Symbols

Do: Dissolved Oxygen (mg/L).
Kd: Reaction rate constant for wastes (day-1)
Kr: Reaeration constant of river (day-1)
Lo: Ultimate BOD in the water at t=0.
U: River velocity.
Xc: Distance with maximum deficit
Tc: Time from disposal to maximum deficit.
Doc: maximum deficit of DO

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