Chapter V

ANALYSIS OF OBSERVATIONS

There are two ways to analyse the data observed in the experiments to determine the biological stabilization reaction rate constant (K) in aeration tank

1. by graphical method and
2. by mathematical method

with the graphical method the reaction rate constant (K) is computed as the slope of an experimental plot of (Ct 1 - Ct 2) against time of aeration in plotting

The biological or biochemical stabilization process is a first order reaction of the form (SAWYER & Mc CARTY, 1967)

$$-\frac{dC}{dt} = KC \quad \text{.....(1)}$$

where

C is the concentration of BOD, COD

t is the time in days

K is the reaction rate constant

Ct 1 = COD value at time t 1

Ct 2 = COD value at time t 2

The integrated equation may be rearranged in the following form in order to determine the reaction rate constant (K)

$$-\frac{dC}{C} = K\,dt$$

$$-\int_{C_1}^{C_2} \frac{dC}{C} = K \int_{t_1}^{t_2} dt$$

$$-\text{Ln}\,(C_2 - C_1) = K\,(t_2 - t_1)$$

$$\text{Ln } (C_1 - C_2) = K (t_2 - t_1)$$

$$K = \frac{\text{Ln } C_1/C_2}{t_2 - t_1} \quad \ldots\ldots\ldots\ldots\ldots(2)$$

A common term to express the rate of reaction is the half life which is the time to reduce the concentration of COD, BOD to one-half of it initial value

when $t_1 = 0$

$$K = \frac{\text{Ln } C_1/C_2}{t_2 - t_1}$$

$$C_2/C_1 = e^{-Kt}$$

$$C_2 = C_1 e^{-Kt} \quad \ldots\ldots\ldots\ldots\ldots(3)$$

when $C_2 = C_{1/2}$

at $t_{1/2}$

therefore

$$C_{1/2} = C_1 e^{-Kt_{1/2}}$$

$$e^{-Kt_{1/2}} = 2$$

$$Kt_{1/2} = \text{Ln}_2$$

$$t_{1/2} = \frac{0.693}{K} \quad \ldots\ldots\ldots\ldots\ldots(4)$$

where t ½ is the time to reduce the concentration to one-half of it initial value

Sample calculation for the reaction rate constant by graphical method and mathematical method

From graph in appendix A-3, from A to B is the stage which the bacteria are getting acclimatized with the environment and donot actively digest organic matters,

it is therefore not significant in the graphical and mathematical calculation. Instead, it begins from point B which to be regarded as initial point as bacteria already acclimatized with the environment and begins to digest actively until point C, totally from B to C organic matters were digested about one-half of initial quantity.

Sample calculation for K (from table II) by graphical method

B^1C^1 = $t\frac{1}{2}$

$t\frac{1}{2}$ = $1\frac{1}{3}$ days

From $t\frac{1}{2}$ = $\frac{0.693}{K}$

therefore

$1\frac{1}{3}$ = $\frac{0.693}{K}$

$K = \frac{0.693 \times 3}{4}$

$= 0.52$

The reaction rate constant = 0.52

Sample calculation for K (from table II) by mathematical method

From

$$K = \frac{\text{Ln } C_1/C_2}{t_2 - t_1}$$

where

C_1 = 4936

C_2 = 430

t_1 = 2 days

t_2 = 7 days

therefore

$$K = \frac{\text{Ln } 4936/\ 430}{7 - 2}$$

$$= \frac{\text{Ln } (4936 - 430)}{5}$$

$$= 0.533$$

The reaction rate constant = 0.533