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Research article

MODELLING AND SIMULATION OF LACTOBACILLUS INFLUENCED BY DISPERSION AND VELOCITY IN HOMOGENEOUS COARSE FORMATION IN COASTAL AREA OF AHOADA EAST, NIGER DELTA OF NIGERIA

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Abstract

The deposition of lactobacillus in homogeneous formation has been through examined. This is to monitor the transport and deposition of the bacterial and also determine their various rates of influences, dispersions and velocity of fluid pressure in homogeneous coarse formation were focused in other to determine their level of concentrations in lateritic and silty formations. Application of mathematical modelling and simulation techniques were applied, these method provided the platform of examining their migration process through various degrees of velocity and dispersion pressure in the formation, theoretical values generated from the developed model were compared with experimental results for validation, both parameters express best fits validating the developed model for the study, experts in ground water engineering will definitely applied these model as a useful tools in determining the rate of concentration of lactobacillus in homogeneous coarse formation.

Keywords: modelling lactobacillus, dispersion, velocity, and coarse formation.

Introduction

advancement various modeling in microbial transport processes in porous media is important to improving our understanding various concepts of physical, chemical, and biological processes are attached in groundwater and their various impact on groundwater like chemistry evolution, bioremediation, including reactive migrations of contaminants and microorganisms. Lost it contrast perspective direction, biological processes of growth/decay, chemotaxis, predation, physiological adaptation (survival), and adhesion or active detachment definitely depend on their respective characteristics of the bacterial inhabitants , such assessment have received slight awareness in field-scale hydrogeologic migrations models. Though numerous researchers willingly admit the significance of growth processes in transport (Harvey et al. 1984; Hornberger et al. 1992; Tan et al. 1994), increase is frequently eradicated in column or field test of biocolloids migrations (Champ and Schroeter 1988; Harvey et al. 1989, 1993; Bales et al.1995). Numerous in bulk representations of microbial progressions in saturated porous media are several; however, the combination of these processes in dynamic pollutant systems is not well comprehended. Beneath oligotrophic (carbon-limiting) situations in aquifers, microbial increase is restricted and most of the biomass is connected by means of solid phase (Harvey et al. 1984; Hirsch and Rades-Rohkohl 1988; Kölbel-Boelke et al. 1988; Godsy et al. 1992; Albrechtsen 1994). Field explanation constantly indicates a advanced level of biomass in the aqueous phase. In a polluted segment of the Cape Cod aquifer in developed nations,like USA, Harvey et al. (1984) information has show that aqueous biomass increased by an order of magnitude, Godsy et al. (1992) note that 90% of total biomass in a creosote contaminated aquifer was attached, but 49% of (creosote-degrading) methanogens were in the aqueous phase. These observations are consistent with specific recognition of growth-induced partitioning to the aqueous phase (Jenneman et al. 1985, 1986; Reynolds et al. 1989; Sharma et al. 1993).

2. Governing equation

$$K\phi\frac{\partial c_{(x)}}{\partial t} = \Delta V_{(x)}\frac{\partial C}{\partial x} + V_{(x)}\frac{\partial c}{\partial x} - K_d\frac{\partial c}{\partial x} \qquad \text{...............................} \qquad (1)$$

Nomenclature

V	=	Void Ratio	[-]
K	=	Permeability	[LT^{-1}]
ϕ	=	Porosity [-]	
D	=	Dispersion in number	[-]
V(x)	=	Velocity	[LT^{-1}]
K_d	=	Decay	[-]
C	=	Concentration	[ML^{-3}]
T	=	Time [T]	
X	=	Depth [L]	

Let $C = X\,T$ from equation (2), we have

$$K\phi\, T^1 Z = D_v TX^1 + V_{(x)} TX^1 - K_d TX^1 \qquad \text{...............................} \qquad (2)$$

$$K\phi \frac{T^1}{T} = D_v \frac{X^1}{X} + V_{(x)} \frac{X^1}{X} - K_d \frac{X^1}{X} = \tau^2 \quad .... \quad (3)$$

$$K\phi \frac{T^1}{T} = \tau^2 \quad .... \quad (4)$$

$$D_v \frac{X^1}{X} = \tau^2 \quad .... \quad (5)$$

$$V_{(x)} \frac{X^1}{X} = \tau^2 \quad .... \quad (6)$$

$$K_d \frac{X^1}{X} = \tau^2 \quad .... \quad (7)$$

This implies that equations (4), (5), (6) and (7) can be written as:

$$\left[D_v + V_{(x)} - K_d\right]\frac{X^1}{X} = \tau^2 \quad .... \quad (8)$$

From (4) $K\phi \frac{T^1}{T} = \tau^2$

i.e. $K\phi \frac{\partial T}{dT} = \tau^2$ .... (9)

$$\int \frac{dT}{T} = \frac{\tau^2}{K\phi}\int dt \quad .... \quad (10)$$

$$Ln\, T = \frac{\tau^2}{K\phi} t + c_1 \quad .... \quad (11)$$

$$\frac{\tau^2}{K\phi} + c_1 \quad .... \quad (12)$$

$$\boxed{T = A\ell^{\frac{\tau^2}{K\phi}}} \quad .... \quad (13)$$

From (8)

$$\left[D_v + V_{(x)} + K_d\right]\frac{X^1}{X} = \tau^2\, dx \quad \text{..............................} \quad (14)$$

$$\int \frac{dx}{dx} = \frac{\tau^2}{D_v + V_{(x)} - K_d}\int dx \quad \text{..............................} \quad (15)$$

$$Ln\ x = \frac{\tau^2}{D_v + V_{(x)} - K_d} + c_1 \quad \text{..............................} \quad (16)$$

$$Z = \exp\left[\frac{\tau^2}{D_v + V_{(x)} - K_d} + c_1\right] \quad \text{..............................} \quad (17)$$

$$X = B\exp\frac{\tau^2}{D_v + V_{(x)} - K_d}x \quad \text{..............................} \quad (18)$$

Combining (17) and (18), we have

$$C, TX = TX$$

$$A\ell^{K\phi} B\left[\exp\frac{\tau^2}{D_v + V_{(x)} - K_d}\right] \quad \text{..............................} \quad (19)$$

$$C\ X, T = AB\exp\left[\frac{t}{K\phi} + \frac{X}{D_v + V_{(x)} - K_d}\right]\tau^2 \quad \text{..............................} \quad (20)$$

3. Materials and Method

Standard laboratory experiment where performed to monitor lactobacillus concentration using the standard method for the experiment at different formation, the soil deposition of the strata were collected in sequences base on the structural deposition at different locations, this samples collected at different location, it generated variations at different depths producing different lactobacillus concentration through pressure flow at different strata, the experimental result were to compared with the theoretical values for the validation of the model.

4. Results and Discussion

Results and discussion are presented in tables including graphical representation void ratios in lateritic and peat soil formations.

Table: 1 Concentration of Lactobacillus at Different Depth

Depth [M]	Concentration [Mg/L
3	0.0466
6	0.0472
9	0.0478
12	0.0485
15	0.0492
18	0.0498
21	0.0504
24	0.0511
27	0.0518
30	0.0525
33	0.0532
36	0.0539

Table: 2 Concentration of Lactobacillus at Different Time

Time Per Day	Concentration [Mg/L
10	0.0466
20	0.0472
30	0.0478
40	0.0485
50	0.0492
60	0.0498
70	0.0504
80	0.0511
90	0.0518
100	0.0525
110	0.0532
120	0.0539

Table: 3 Comparison of Predictive and Experimental of Lactobacillus at Different Depth

Time Per Day	Predicted values Conc. [Mg/L	Experimental values Conc.[Mg/L]
10	0.0466	0.0457
20	0.0472	0.0464
30	0.0478	0.0471
40	0.0485	0.0478
50	0.0492	0.0485
60	0.0498	0.0492
70	0.0504	0.0499
80	0.0511	0.0506
90	0.0518	0.0513
100	0.0525	0.052
110	0.0532	0.0527
120	0.0539	0.0534

Table: 4 Comparison of Predictive and Experimental of Lactobacillus at Different Time

Depth [M]	Predictive Values Conc. [Mg/L	Experimental values Conc.[Mg/L]
3	0.0466	0.0469
6	0.0472	0.0475
9	0.0478	0.0482
12	0.0485	0.0489
15	0.0492	0.0494
18	0.0498	0.0503
21	0.0504	0.0508
24	0.0511	0.0517
27	0.0518	0.0524
30	0.0525	0.0534
33	0.0532	0.0545
36	0.0539	0.0548

Table: 5 Concentration of Lactobacillus at Different Time

Depth [M]	Concentration [Mg/l]
3	4.61E-03
6	4.62E-03
9	4.62E-03
12	4.62E-03
15	4.63E-03
18	4.64E-03
21	4.64E-03
24	4.65E-03
27	4.66E-03
30	4.66E-03
33	4.67E-03
36	4.67E-03

Table: 6 Concentration of Lactobacillus at Different Time

Time Per Day	Concentration [Mg/l]
10	4.61E-03
20	4.62E-03
30	4.62E-03
40	4.62E-03
50	4.63E-03
60	4.64E-03
70	4.64E-03
80	4.65E-03
90	4.66E-03
100	4.66E-03
110	4.67E-03
120	4.67E-03

Table: 7 Comparison of Predictive and Experimental of Lactobacillus at Different Time

Depth [M]	Predicted values Conc.[Mg/l]	Experimental values [Mg/l]
3	4.61E-03	4.61E-03
6	4.62E-03	4.61E-03
9	4.62E-03	4.62E-03
12	4.62E-03	4.62E-03
15	4.63E-03	4.63E-03
18	4.64E-03	4.63E-03
21	4.64E-03	4.64E-03
24	4.65E-03	4.64E-03
27	4.66E-03	4.65E-03
30	4.66E-03	4.66E-03
33	4.67E-03	4.66E-03
36	4.67E-03	4.67E-03

Table: 8 Comparison of Predictive and Experimental of Lactobacillus at Different Time

Time Per Day	Predicted values Conc.[Mg/l]	Experimental values [Mg/l]
10	4.61E-03	4.61E-03
20	4.62E-03	4.61E-03
30	4.62E-03	4.62E-03
40	4.62E-03	4.62E-03
50	4.63E-03	4.63E-03
60	4.64E-03	4.63E-03
70	4.64E-03	4.64E-03
80	4.65E-03	4.64E-03
90	4.66E-03	4.65E-03
100	4.66E-03	4.66E-03
110	4.67E-03	4.66E-03
120	4.67E-03	4.67E-03

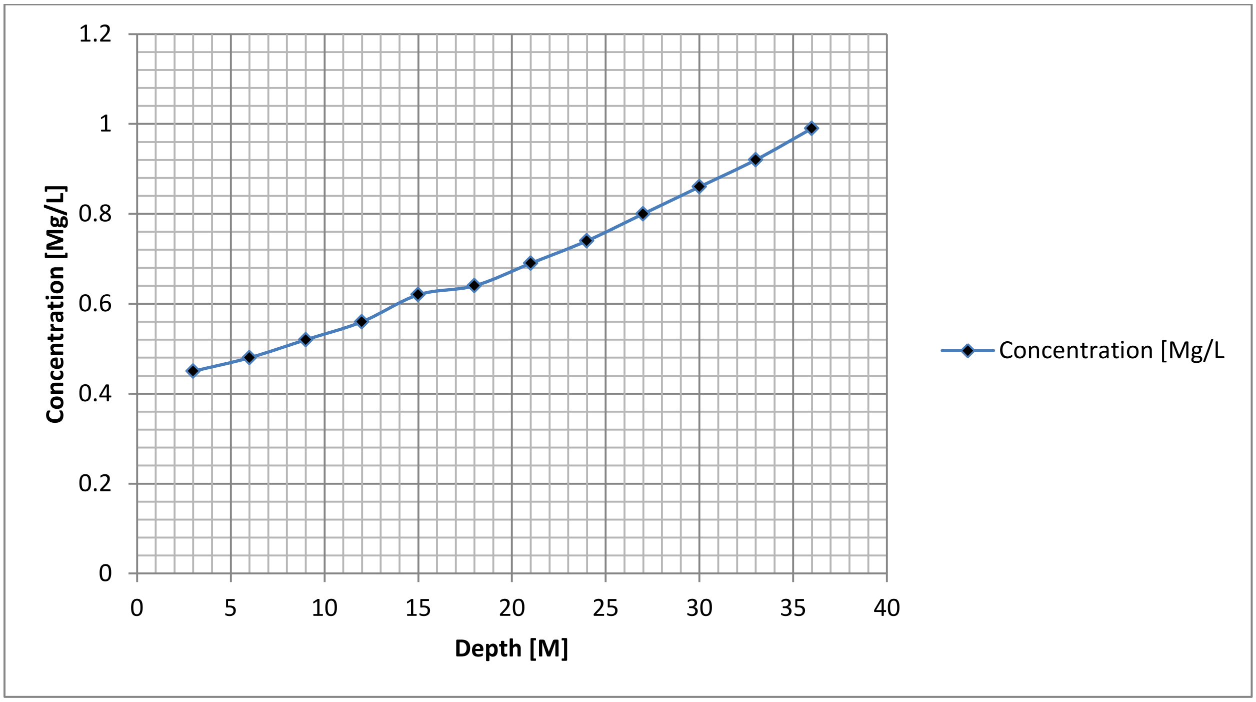

Figure: 1 Concentration of Lactobacillus at Different Depth

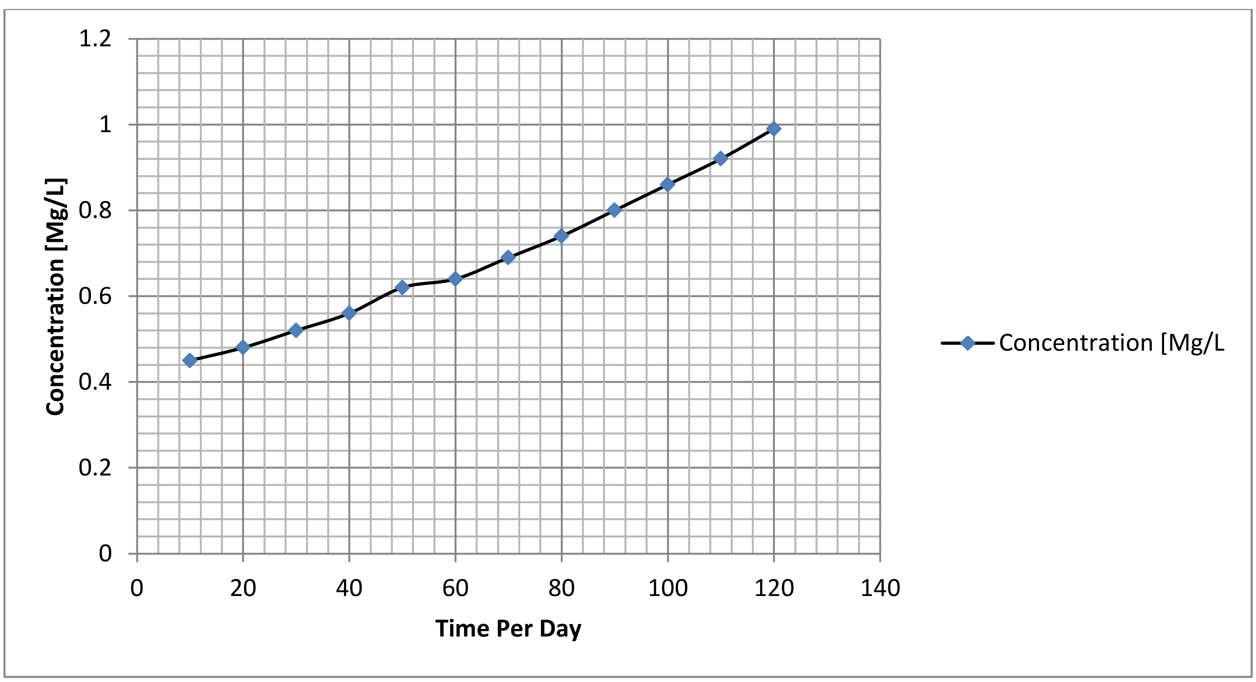

Figure: 2 Concentration of Lactobacillus at Different Depth

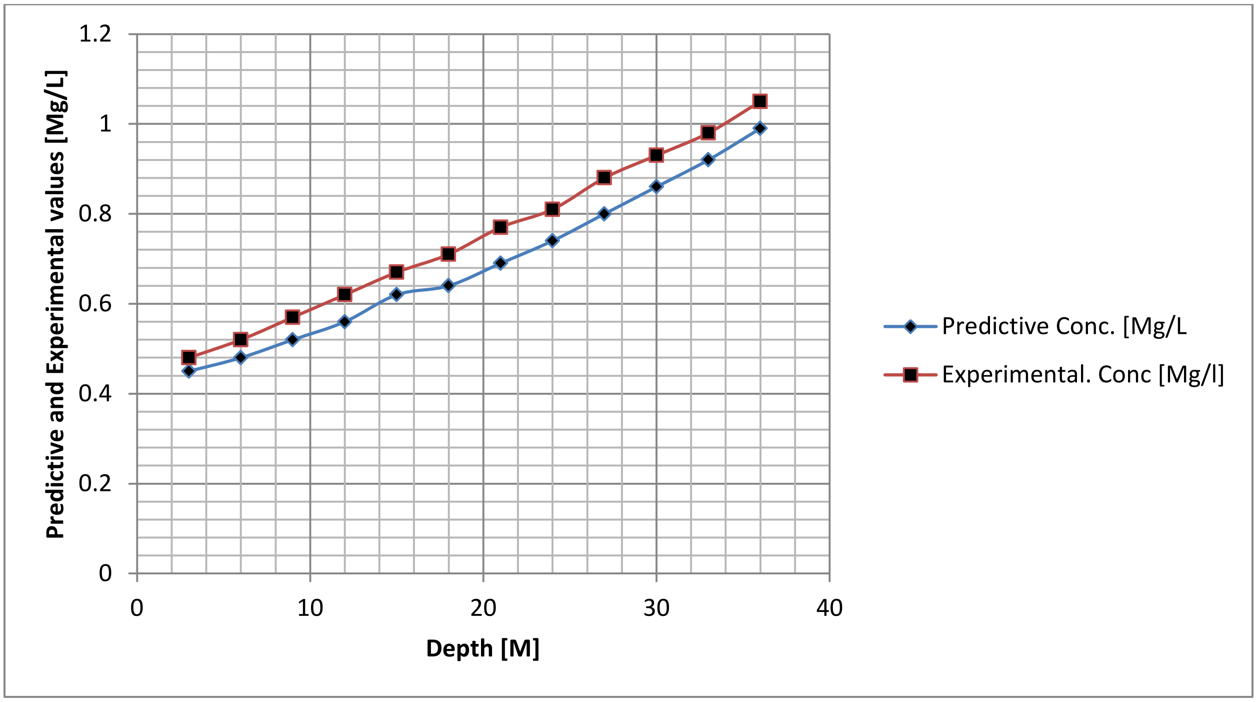

Figure: 3 Comparison of Predictive and Experimental of Lactobacillus at Different Depth

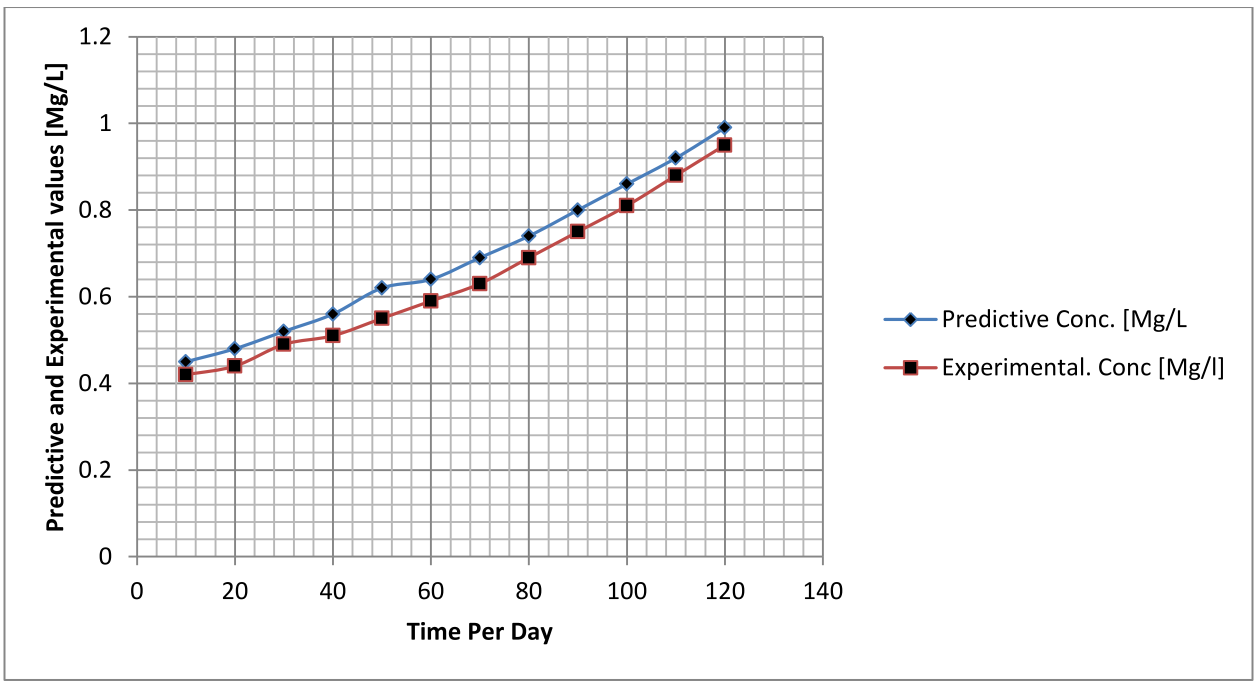

Figure: 4 Comparison of Predictive and Experimental of Lactobacillus at Different Depth

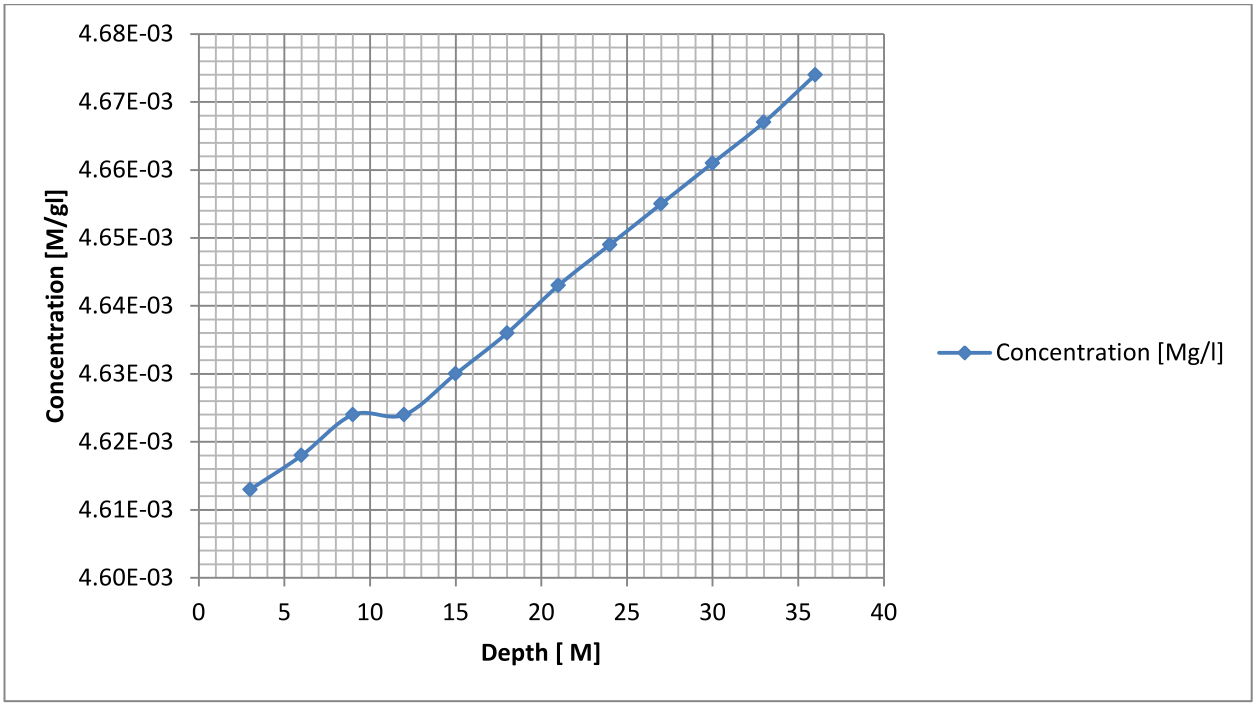

Figure: 5 Concentration of Lactobacillus at Different Depth

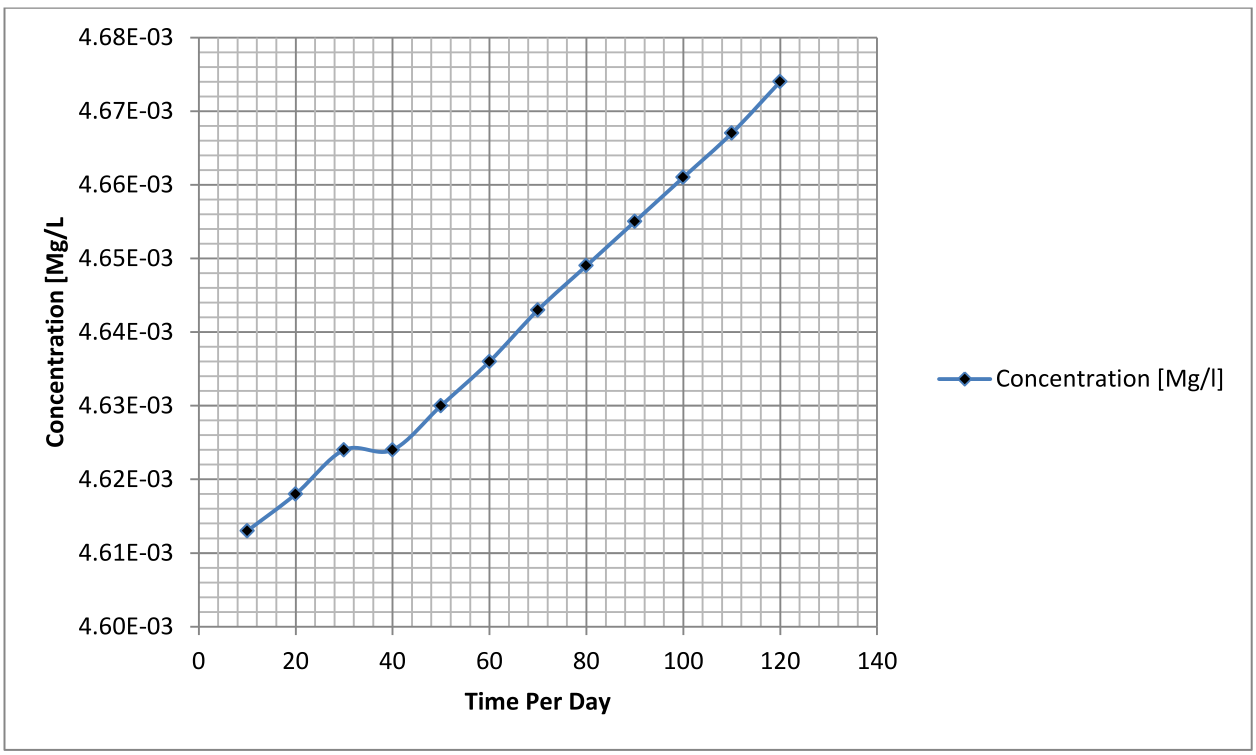

Figure: 6 Concentration of Lactobacillus at Different Depth

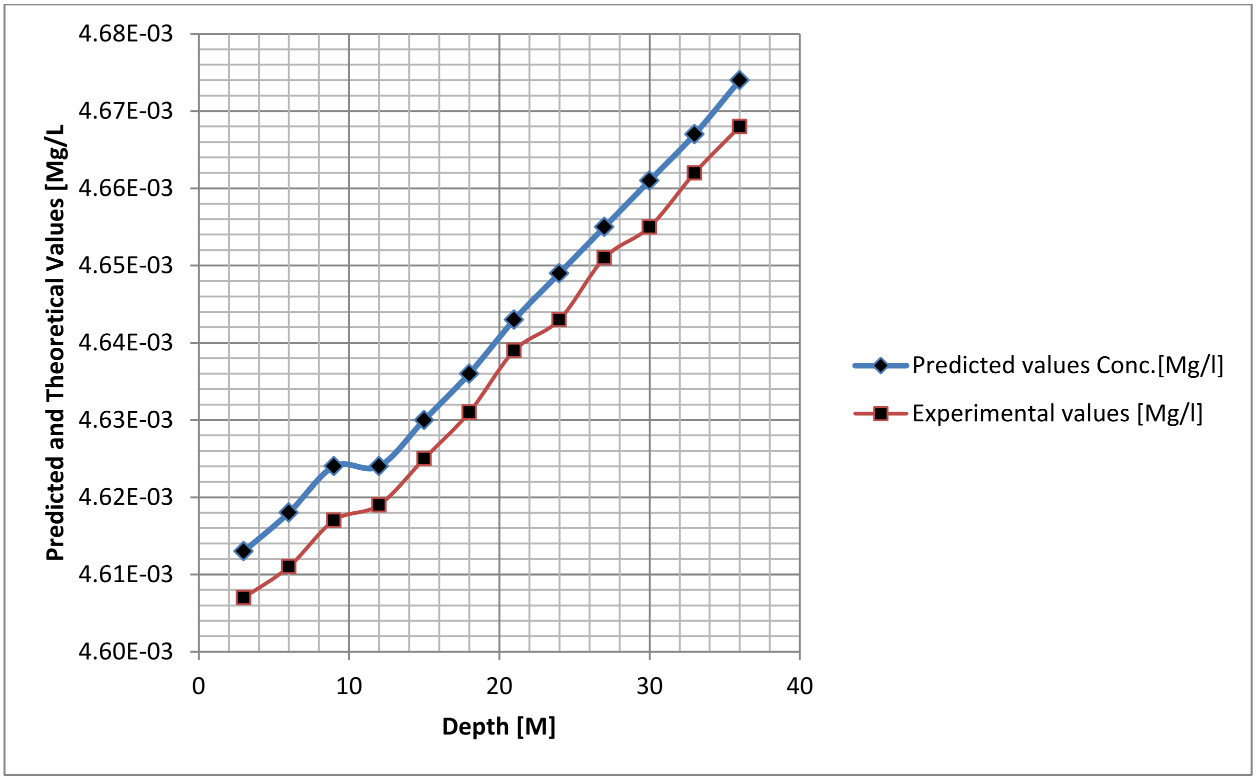

Figure: 7 Comparison of Predictive and Experimental of Lactobacillus at Different Depth

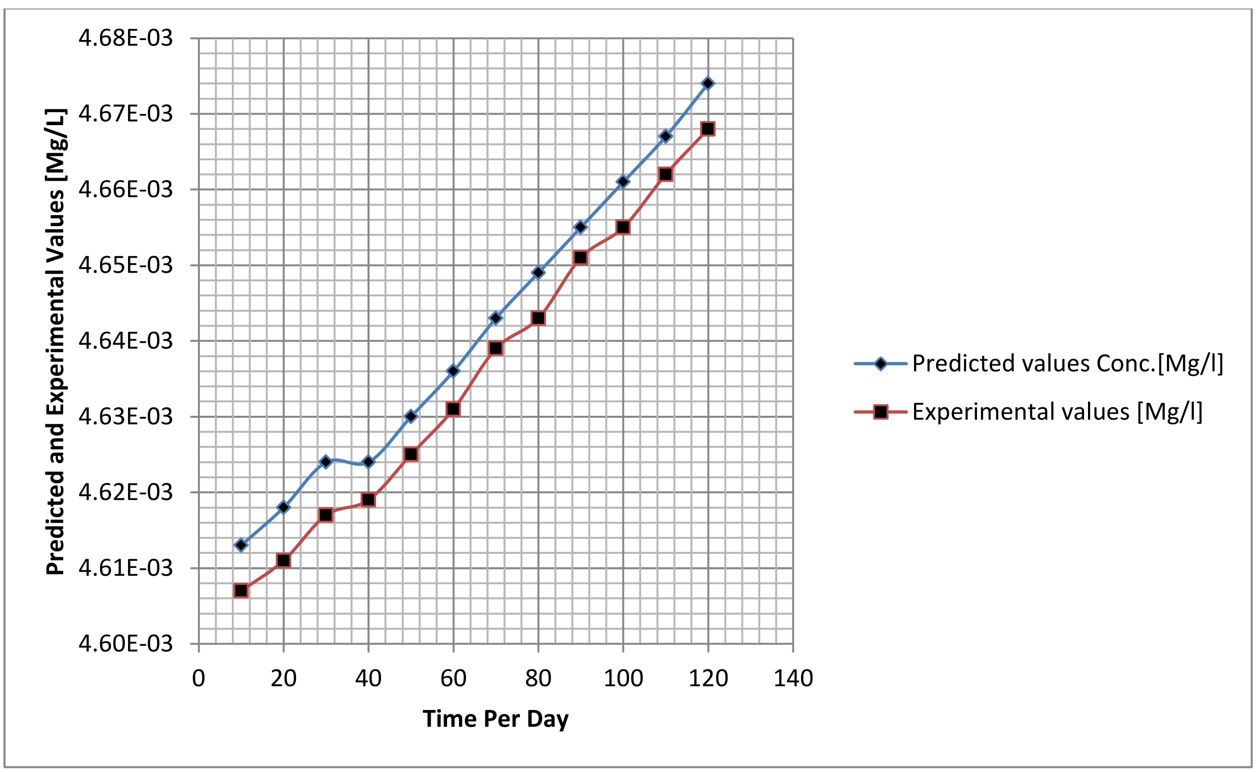

Figure: 8 Comparison of Predictive and Experimental of Lactobacillus at Different Time

The study expresses various deposition and behaviour of lactobacillus in the study area. The bacterial were found from figure one to four to have migrated linearly through gradual process to the optimum level at thirty six meters at the period of one hundred and twenty days. The rate of concentration were observed to have obey the structural stratification of the formation which may have influence the migration process of the bacterial to ground water deposition in unconfined bed. Compared parameters that are applied to validate the expressed model at these location developed similar condition, base on these emerging best fit with the theoretical values, there was no doubt about the structural influences of the formation expressing linear migration. While figure five to eight express similar transport conditions but experiences slight fluctuation between some certain depth and predominantly influenced by linear and gradual migration. Base on theses phase, the lowest concentration were deposited at three metres and the optimum rate concentration at thirty six metre between the period of ten to hundred and thirty six days, comparison between the predictive and experimental values developed best fits but with slight fluctuation from the lowest to the highest concentration.

4. Conclusion

The deposition of lactobacillus in the study has been thorough examined, the deposition of these bacterial from biological waste were found predominantly deposited in the study location, the application of engineering depend on investigation about the rate of deposition including its behaviour in transport process, such conditions were considered in the developed system that produced the governing equation, the deposition of lactobacillus were monitored through development of mathematical model, from the theoretical results it has been found that the deposition were on gradual process in most predominant homogeneous deposition, while few formation experiences slight variation in depositions, the behaviour of the bacterial has show how the concentration were able to migrate between the period of hundred and twenty day to unconfined beds, the study is imperative because experts in ground water engineering will definitely applied these concept to determine the deposition and migration process of lactobacillus in homogeneous coarse formation.

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