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Prediction of Void Ratio Pressure on Nitrogen Transport in Homogenous Silty Formation Patani, Delta State of Nigeria

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Abstract: These papers study the deposition of nitrogen transport under the influences of void ratio in the study area, the transport process were examined thoroughly thorough development of mathematical modelling compared with physiochemical investigation for model validation. This was carried out to find the rate of nitrogen concentration in the study environment, the alarming rate of microbial growth from the investigation is a seriously concern causing hundred of ill health in the study location. The application of this modelling techniques generated detailed sources of nitrogen deposition at different depth and time. The developed model from the graphical representation shows that nitrogen deposition are influenced by the variation of void ratio, some location experienced exponential and vacillation determined from the derived model simulation values, high growth rate sources from micronutrient has be examined thus stratum where high concentration are deposited has been observed. The study is imperative because it has express sources of nitrogen thoroughly. Finally, it has predicted the rate of nitrogen concentration under the influences of predominated void ratio in the study area.

Keywords: Prediction, Void Ratio, Pressure, Nitrogen Transport, Homogeneous Silty, Formation

1. Introduction

Soil and groundwater contamination by pesticides from agricultural activities is a worldwide environmental problem. These are serious environmental crisis generated from agricultural activities if it's not managed proper according its standard regulation More so it has been observed that pesticide and other contaminant concentrations are sources of major problem thus monitoring it has been not thoroughly managed in most part of developing nations, such monitoring is quite expensive and time consuming. The BPS [1, 2, 3 and 4] through several mathematical concepts have been developed at different dimensions thus some are recently developed, this includes simulating water movement and solute transport in soils. There has been a recent study in Czech Republic; this type of studied carried out was experimental approach that described BPS code [4, 6]. It is observed that the inconsistency between sorption isotherms determined from laboratory and field express experimental facts. While [7, 8] it applied linear and nonlinear one- and two-stage sorption models to fit the sorption and desorption isotherms [10, 11]. It has been expressed that pesticides migration are in small soil columns using non-equilibrium two-region/mobile-immobile model approach. [3, 4, 5, and 6]. Examined preferential flow in the field from his investigation herbicide was only partly sorbed by the soil matrix. A portion of substance compound was transported with or without slight adsorption along cracks or fissures. 14, 15, 16, and 17]. Examined chlorotoluron transport affected by preferential flow in five different types of soil. [8, 9, 10 11 and 12], it was observed from his experimental study, it express the behaviour of pesticides transport through preferential paths. [10, 11, 12, and 13] also simulated water and solute flow in fractured porous system. [15, 16, and 17] the developed concepts of applying the dual-permeability model that solves flow and transport equations in both matrix and fracture pore – systems has been evaluated, these were applied on one scenario in the EU risk assessment, the developed Macro model for simulation of water and solute transport in a dual-permeability system was developed [12, 13, 15]. Macro was applied concepts by for simulating water and isoproturon behavior in a heavy clay soil by [13, 14, and 15]. The Macro model was also program [7, 8]. Furthermore the behaviour of the contaminant through preferential flow on chlorotoluron transport in the soil profile. Experimental field data presented [3, 4, and 5] involved the chlorotoluron transport in the soil profile were simulated using the modified HYDRUS-1D software package [9, 11, 13 and 16]. Preferential flow was evaluated by comparing results of the single-porosity and dual-permeability models [13, 14, 16, 17 and 18].

2. Governing Equation

$$K\frac{d^2c}{dx^2} - \varphi\frac{dc}{dx} + V_t\frac{dc}{dx} = 0 \quad (1)$$

$$K\frac{d^2c}{dx^2} - (\varphi - V_t)\frac{dc}{dx} = 0 \quad (2)$$

Let $C = \sum_{n=0}^{\infty} a_n x^n$

$$C^1 = \sum_{n=1}^{\infty} n a_n x^{n-1}$$

$$C^{11} = \sum_{n=2}^{\infty} n(n-1) a_n x^{n-2}$$

$$K\sum_{n=2}^{\infty} n(n-1) a_n x^{n-2} - (\varphi - V_t)\sum_{n=1}^{\infty} n a_n x^{n-1} = 0 \quad (3)$$

Replace n in the 1st term by *n+2* and in the 2nd term by *n+1*, so that we have;

$$K\sum_{n=2}^{\infty} n(n+2)(n+1) a_{n+2} x^n - (\varphi - V_t)\sum_{n=0}^{\infty} (n+1) a_{n+1} x^n = 0 \quad (4)$$

$$\text{i.e. } K(n+2)(n+1)a_{n+2} = (\varphi - V_t)(n+1)a_{n+1} \quad (5)$$

$$a_{n+2} = \frac{(\varphi - V_t)(n+1)a_{n+1}}{K(n+2)(n+1)} \quad (6)$$

$$a_{n+2} = \frac{(\varphi - V_t)a_{n+1}}{K(n+2)} \quad (7)$$

$$\text{for } n = 0,\ a_2 = \frac{(\varphi - V_t)a_1}{2K} \quad (8)$$

$$\text{for } n = 1,\ a_3 = \frac{(\varphi - V_t)a_2}{3K} = \frac{(\varphi - V_t)^2 a_1}{2K \bullet 3K} \quad (9)$$

$$\text{for } n = 2;\ a_4 = \frac{(\varphi - V_t)a_3}{4K} = \frac{(\varphi - V_t)}{4K} \bullet \frac{(\varphi - V_t)a_1}{3K \bullet 2K} = \frac{(\varphi - V_t)^3 a_1}{4K \bullet 3K \bullet 2K} \quad (10)$$

$$\text{for } n = 3;\ a_5 = \frac{(\varphi - V_t)}{5K} = \frac{(\varphi - V_t)^4 a_1}{5K \bullet 4K \bullet 3K \bullet 2K} \quad (11)$$

$$\text{for } n;\ a_n - \frac{(\varphi - V_t)^{n-1} a_1}{K^{n-1} n!} \quad (12)$$

$$C(x) = a_0 + a_1 x + a_2 x^2 + a_3 x^3 + a_4 x^4 + a_5 x^5 + ...a_n x_n \quad (13)$$

$$= a_0 + a_1 x + \frac{(\varphi - V_t)a_1 x^2}{2!K} + \frac{(\varphi - V_t)a_1 x^3}{3!K^2} + \frac{(\varphi - V_t)x^4}{4!K^3} + \frac{(\varphi - V_t)^4}{5!K^4} \quad (14)$$

$$C(x) = a_0 + a_1\left[\frac{(\varphi - V_t)x}{2!K} + \frac{(\varphi - V_t)^2 x^3}{3!K^2} + \frac{(\varphi - V_t)^3}{4!K^3} + \frac{(\varphi - V_t)^4}{5!K^4}\right] \quad (15)$$

$$C(x) = a_0 + a_1\,\ell^{\frac{(\varphi - V_t)}{K}x} \quad (16)$$

Subject equation (16) to the following boundary condition

$$C(o) = 0 \; and \; C(o) = H$$

$$C(x) = a_0 + a_1 \ell^{\frac{(\varphi - V_t)}{K}x}$$

$$C(o) = a_0 + a_1 = 0$$

$$\text{i.e. } a_0 + a_1 = 0 \quad (17)$$

$$C^1(x) = \frac{(\varphi - V_t)}{2!K} a_1 \ell^{\frac{(\varphi - V_t)}{K}x}$$

$$C^1(o) = \frac{(\varphi - V_t)}{2!K} a_1 = H$$

$$a_1 = \frac{HK}{\varphi - V_t} \quad (18)$$

Substitute (18) into equation (17)

$$a_1 = a_0$$

$$\Rightarrow a_0 = \frac{-HK}{\varphi - V_t} \quad (19)$$

Hence the particular solution of equation (16) is of the form:

$$C(x) = -\frac{HK}{\varphi - V_t} + \frac{HK}{\varphi - V_t} \ell^{\frac{(\varphi - V_t)}{K}x}$$

$$\Rightarrow C(x) = \frac{HK}{\varphi - V_t}\left[\ell^{\frac{(\varphi - V_t)}{K}x} - 1\right] \quad (20)$$

If $x = V \bullet t$

$$\therefore C(x) = \frac{HK}{\varphi - V_t}\left[\ell^{\frac{(\varphi - V_t)}{K}V \bullet t} - 1\right] \quad (21)$$

If $T = \frac{d}{V}$

$$C(x) = \frac{HK}{\varphi - V_t}\left[\ell^{\frac{(\varphi - V_t)}{K}\frac{d}{V}} - 1\right] \quad (22)$$

3. Materials and Method

Standard laboratory experiment where performed to monitor nitrogen concentration 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 generated variation at different depth producing different migration of nitrogen concentration through pressure flow at different strata, the experimental result are applied to be compared with the theoretical values to determined the validation of the model.

4. Result and Discussion

Results and discussion are presented in tables including graphical representation of nitrogen concentration

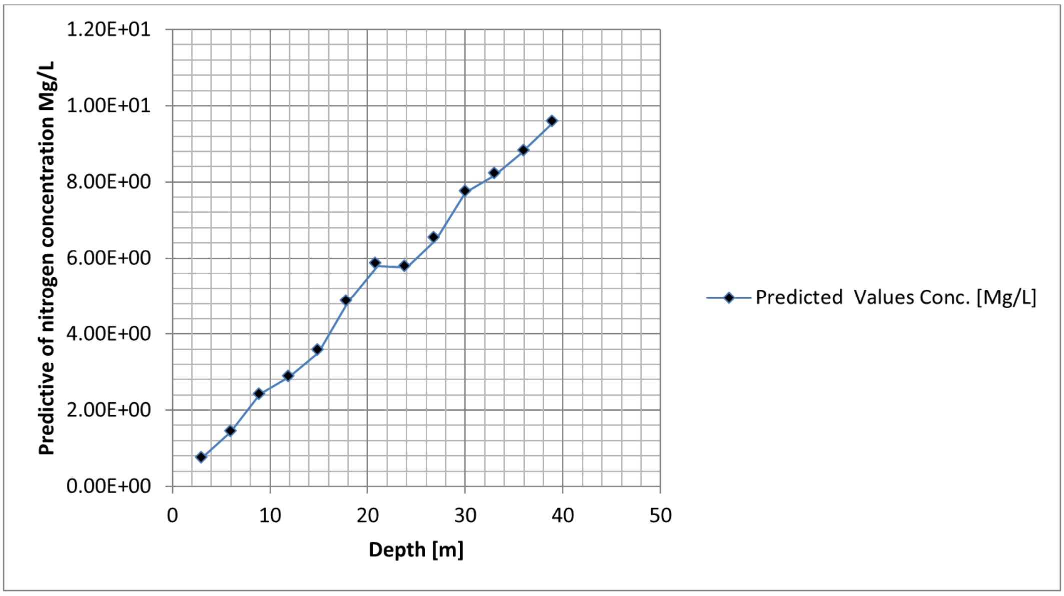

Figure 1. Concentration of Nitrogen Values at Different Depth.

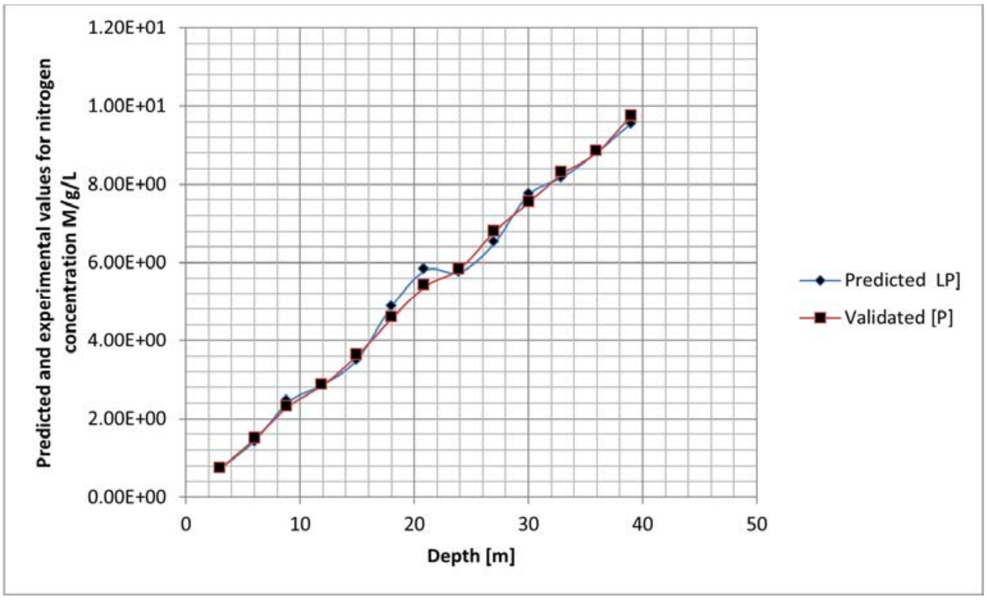

Figure 2. *Predicted and Experimental Values for Nitrogen Concentration at Different Depth.*

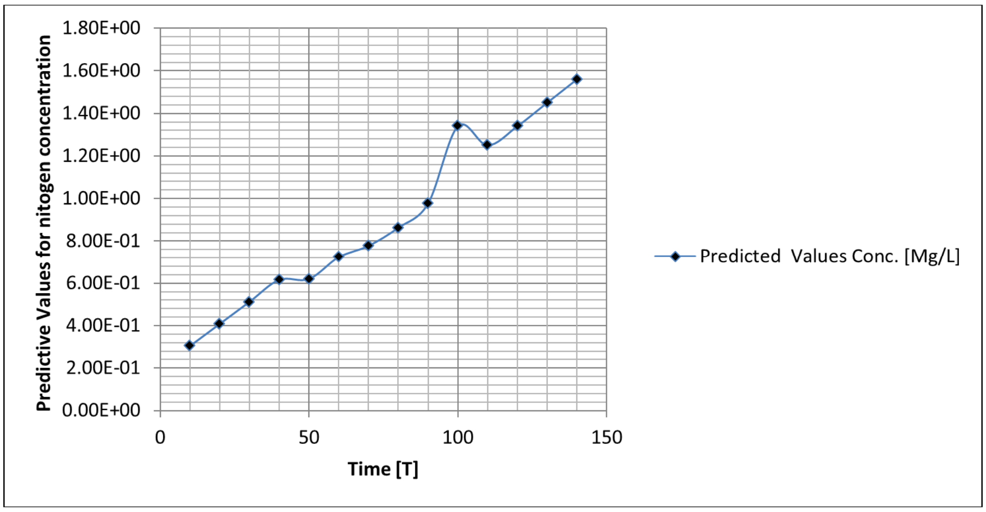

Figure 3. *Concentrations of Nitrogen Values at Different Depth.*

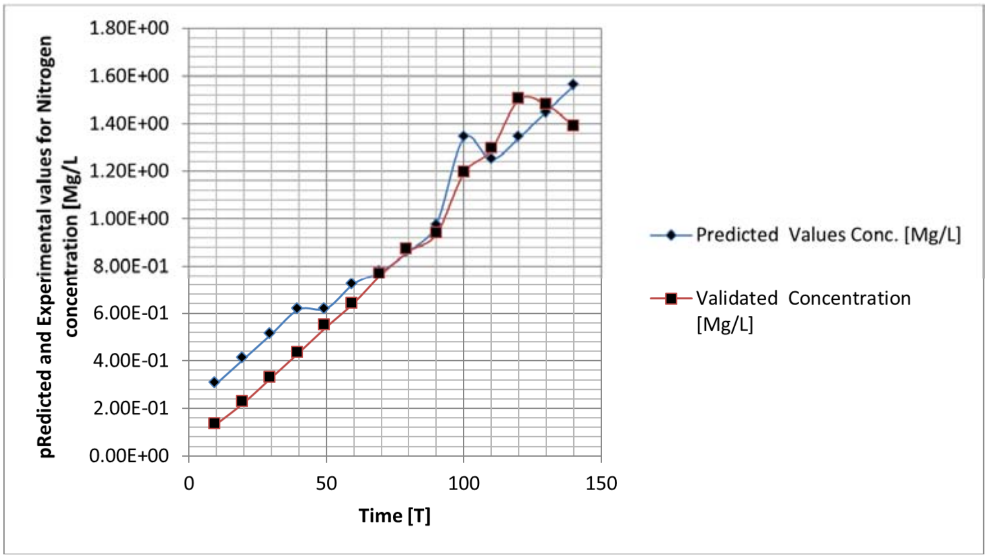

Figure 4. *Predicted and Experimental Values for Nitrogen Concentration at Different Depth.*

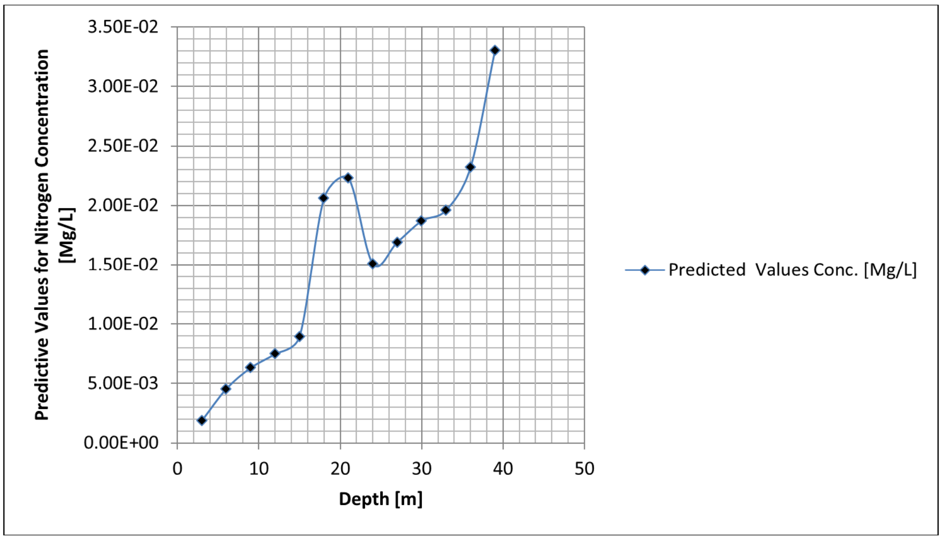

Figure 5. *Concentrations of Nitrogen Values at Different Depth.*

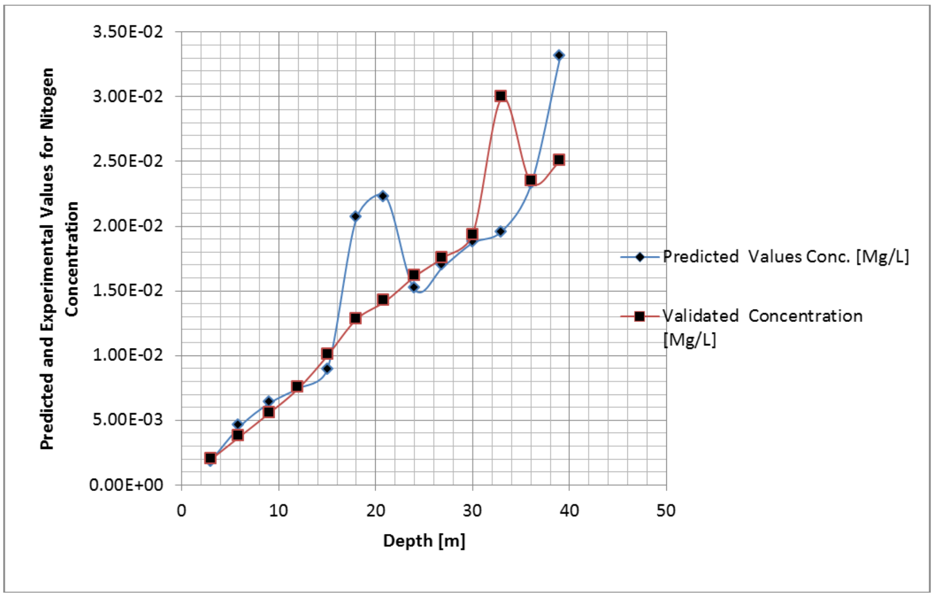

Figure 6. *Predicted and Experimental Values for Nitrogen Concentration at Different Depth.*

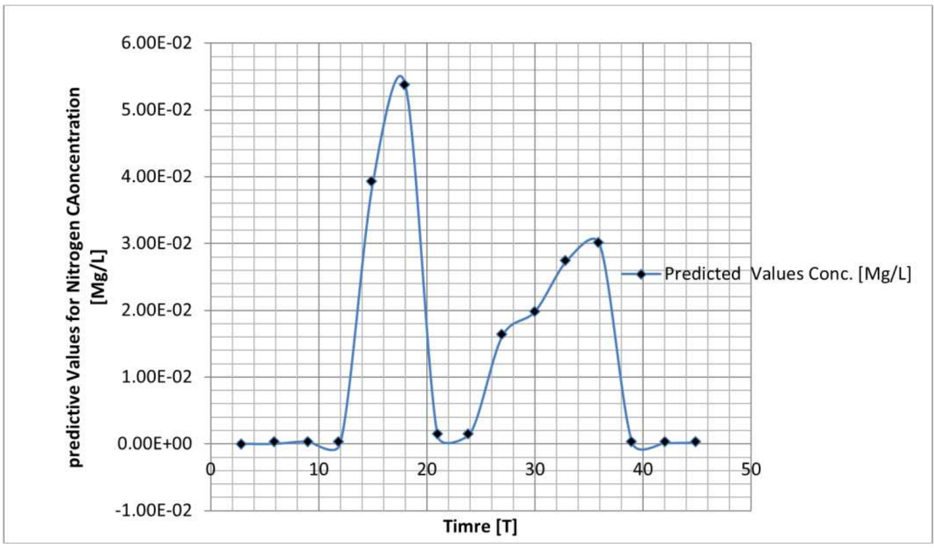

Figure 7. *Concentrations of Nitrogen Values at Different Depth.*

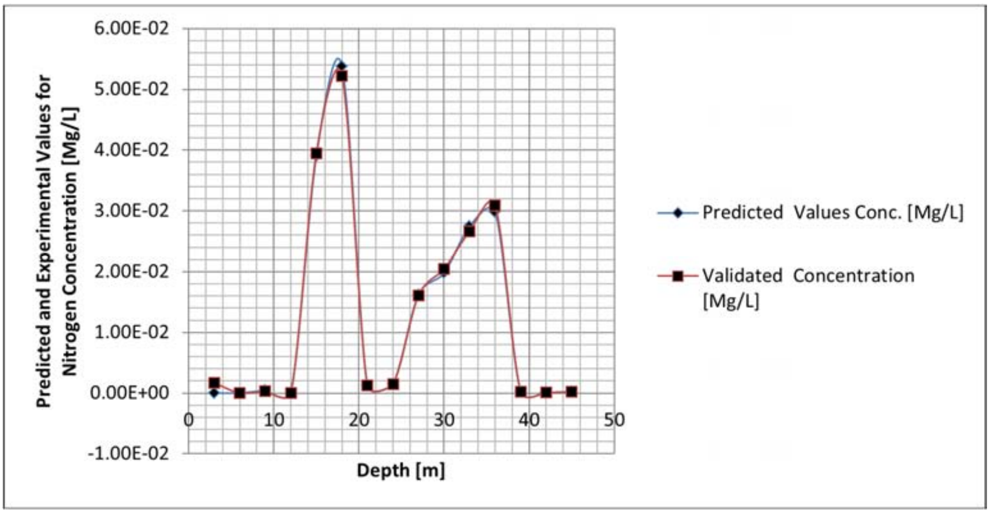

Figure 8. *Predicted and Experimental Values for Nitrogen Concentration at Different Depth.*

Table 1. *Concentration of Nitrogen at Different Depth.*

Depth [M]	Predicted Values Conc. [Mg/L]
3	7.30E-01
6	1.43E+00
9	2.43E+00
12	2.87E+00
15	3.51E+00
18	4.86E+00
21	5.80E+00
24	5.75E+00
27	6.49E+00
30	7.73E+00
33	8.18E+00
36	8.82E+00
39	9.56E+00

Table 2. *Predicted and Experimental Values for Nitrogen Concentration at Different Depth.*

Depth [M]	Predicted LP]	Validated [P]
3	7.30E-01	0.72
6	1.43E+00	1.48
9	2.43E+00	2.32
12	2.87E+00	2.86
15	3.51E+00	3.61
18	4.86E+00	4.55
21	5.80E+00	5.39
24	5.75E+00	5.84
27	6.49E+00	6.78
30	7.73E+00	7.53
33	8.18E+00	8.27
36	8.82E+00	8.81
39	9.56E+00	9.76

Table 3. *Concentration of Nitrogen at Different Depth.*

Time [T]	Predicted Values Conc. [Mg/L]
10	3.04E-01
20	4.08E-01
30	5.12E-01
40	6.16E-01
50	6.20E-01
60	7.24E-01
70	7.78E-01
80	8.63E-01
90	9.77E-01
100	1.34E+00
110	1.25E+00
120	1.34E+00
130	1.45E+00
140	1.56E+00

Table 4. *Predicted and Experimental Values for Nitrogen Concentration at Different Depth.*

Time [T]	Predicted Values Conc. [Mg/L]	Validated Concentration [Mg/L]
10	3.04E-01	0.134
20	4.08E-01	0.224
30	5.12E-01	0.329
40	6.16E-01	0.434
50	6.20E-01	0.542
60	7.24E-01	0.643
70	7.78E-01	0.764
80	8.63E-01	0.864
90	9.77E-01	0.935
100	1.34E+00	1.19
110	1.25E+00	1.29
120	1.34E+00	1.5
130	1.45E+00	1.48
140	1.56E+00	1.39

Table 5. *Concentration of Nitrogen at Different Depth.*

Depth [M]	Predicted Values Conc. [Mg/L]
3	1.87E-03
6	4.54E-03
9	6.31E-03
12	7.48E-03
15	8.95E-03
18	2.06E-02
21	2.23E-02
24	1.51E-02
27	1.69E-02
30	1.87E-02
33	1.96E-02
36	2.32E-02
39	3.30E-02

Table 6. *Predicted and Experimental Values for Nitrogen Concentration at Different Depth.*

Depth [M]	Predicted Values Conc. [Mg/L]	Validated Concentration [Mg/L]
3	1.87E-03	1.98E-03
6	4.54E-03	3.76E-03
9	6.31E-03	5.54E-03
12	7.48E-03	7.45E-03
15	8.95E-03	9.98E-03
18	2.06E-02	1.28E-02
21	2.23E-02	1.42E-02
24	1.51E-02	1.61E-02
27	1.69E-02	1.76E-02
30	1.87E-02	1.94E-02
33	1.96E-02	2.99E-02
36	2.32E-02	2.34E-02
39	3.30E-02	2.50E-02

Table 7. *Concentration of Nitrogen at Different Depth.*

Depth [M]	Predicted Values Conc. [Mg/L]
3	1.79E-05
6	3.01E-05
9	3.93E-04
12	5.60E-05
15	3.90E-02
18	5.38E-02
21	1.28E-03
24	1.51E-03
27	1.62E-02
30	1.98E-02
33	2.75E-02
36	2.99E-02
39	2.15E-04
42	1.29E-04
45	1.87E-04

Table 8. *Predicted and Experimental Values for Nitrogen Concentration at Different Depth.*

Depth [M]	Predicted Values Conc. [Mg/L]	Validated Concentration [Mg/L]
3	1.79E-05	1.70E-03
6	3.01E-05	2.22E-05
9	3.93E-04	3.04E-04
12	5.60E-05	5.57E-05
15	3.90E-02	3.95E-02
18	5.38E-02	5.22E-02
21	1.28E-03	1.24E-03
24	1.51E-03	1.48E-03
27	1.62E-02	1.61E-02
30	1.98E-02	2.05E-02
33	2.75E-02	2.66E-02
36	2.99E-02	3.09E-02
39	2.15E-04	2.15E-04
42	1.29E-04	1.23E-04
45	1.87E-04	1.94E-04

Figures one to four express disparities with respect to time and depth at different rate of nitrogen concentration. This has examined the rate of nitrogen deposition on heterogeneous setting at different time and depth, under its deposition in natural and manmade influences, the structures of the formation pressure the deposition of the transport system as it express in figure one to four. Exponential deposition were experienced on these figures at various time and depth, these situation can be attributed to the variation of deposited void ratio at different degrees of the formation, more so it can be attributed to structural disintegration of the porous rocks developing unconsolidated strata in the deltaic formation. The ability of penetrations within the macropoles at various intercedes of the strata generated the variations of deposited nitrogen content, these has developed variation of concentration thus exponential deposition in those figures. More so in a related developed, it was also observed in figure five and six maintaining exponential deposition base on the transport from manmade activities with respect to time and depth. But with more vacillation compared to other previous expressed figures, and it is observed that there are slight deposited heterogeneous formations that may have developed higher concentration. While figure seven and eight developed different deposition compared to other figures, fluctuation were observed in these figures, the lowest concentration were experienced between three and twelve, suddenly, rapid increase were observed between fifteen and twenty one thus another vacillation were observed, more so the same rapid increase were observed between twenty seven and thirty nine, thus homogeneous concentration were finally experienced between forty three and forty nine, these theoretical values were compared with experimental data, both parameters generated best fits validating the model.

5. Conclusion

The study of nitrogen has express its level of deposition including its transport system at different time and depth, these concentration were monitored to deposit at different concentration base on several factors, but there are principal pressure is the variations of void ratio at different time and depth, the influences from the strata void ratio predominantly pressured the variation of nitrogen concentration in exponential and fluctuation phase of the formation. The study observed some formation that its concentration are very high, this can be attributed to the impermeable formations that developed accumulation of nitrogen, while some strata that experience lower hydraulic conductivity implies that nitrogen accumulation are base on these factors observed in the system. the fluctuation are reflected on the these factors, while other figures that observed lower concentration are base on higher hydraulic conductivity in those formation, the developed model from the graphical representation shows that nitrogen deposition are influenced by the variation of void ratio, these condition were observed in various figures of the transport system in the study location, the study is essential because the deposition of nitrogen transport has been evaluated through modelling approach, validation of these model through experimental concept has express the authenticity of the model.

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