



Modelling and Simulation of Bacteroides Transport in Heterogeneous Silty Formation in Deltaic Environment



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Abstract

This paper monitor the migration of Bacteroides in silty depositions, the soil formation experiences low degree of porosity, this implies that the depositions of Bacteroides were affected by the formations through their heterogeneous depositions in porous medium, the study observed that in some location that exhibited inhibitors and micronutrients pressure on the behaviour of the contaminant, these were reflected from its level of migration in heterogeneous silty formation. The study has express the litho structures of the formation that were observed to play serious role in the transport system of Bacteroides in silty formation, the derived solution generated parameters that were subjected to model validation, and both parameters maintained favourable fits, the study is imperative because it has explain the variation of Bacteroides in silty deposition through the influences from inhibitors and micronutrients in silty formation.

Keywords: Modeling bacteroides; Transport heterogeneous silty; Environment

Introduction

The behaviour of the system is a way that the migration of the contaminant transport to silty deposition, the deposition of silty formation in deltaic environment are observed to experiences heterogeneity in the study location, the study expresses the reflection of the geological setting [1-7]. Subsurface formations typically exhibit heterogeneities over a wide range of length scales. Because only limited amounts of data are generally available, formation properties are often described using some type of geostatistical approach. Flow and transport results for such descriptions reflect the uncertainty associated with the geological model. Using the first approach, formation properties are represented in the flow equations as random variables. The resulting flow quantities are then also random variables, that is, described in terms of expected values and higher statistical moments [8-13]. However, this approach also has some limitations. Specifically, the set of equations that must be solved is, in general, considerably more complex than the underlying deterministic equations [14-20]. Further, it is often difficult to include additional physics (e.g., three-phase flow) or other complications, such as different geostatistical models in different regions of the formation, without extensive reformulation. A variety of such approaches exists, and there are advantages and disadvantages associated with the different methodologies (for recent reviews, see [21,22]). he approaches described in this paper also differs considerably from previous methods for upscaling. Most such methods either attempt

to minimize, and then neglect, sub-grid effects [8] or require the a priori estimate of the global flow field from which up scaled (or pseudo) flux functions are computed [23-26].

Theoretical Background

$$\frac{dc}{dy} + A_{(y)}C_{(d)} = B_{(y)}C_d^n; n \geq 2 \quad (1)$$

Where $A_{(y)}$ and $B_{(y)}$ are function of y

$$\frac{dc}{dy} + A_{(y)}C_{(d)} = B_{(y)}C_d^n \quad (2a)$$

Divided by (1) through by C_d^{-n} we have obtain

$$C_d^{-n} \frac{dc}{dy} + A_{(y)}C_d^{1-n} = B_{(y)} \quad (2b)$$

Let $\beta = C_d^{1-n}$

$$\frac{d\beta}{dy} = (1-n)C_d^{-n} \frac{dc}{dy}$$

This implies that;

$$C_d^{-n} \frac{dc}{dy} = \frac{1}{1-n} \frac{d\beta}{dy}$$

Multiplying Equation (2a) through by (1-n)

$$(1-n)C_d^{1-n} \frac{dc}{dy} + (1-n)A_{(y)}C_d^{1-n} = (1-n)B_{(y)} \quad (3)$$

If recall that, $\beta = C_d^{1-n}; \frac{d\beta}{dy} = (1-n)C_d^{-n} \frac{dc}{dy}$

Therefore equation (3) can be written as:

$$\frac{d\beta}{dy} + (1-n)A(y)\beta = (1-n)B(y) \quad (4)$$

If we say A=B/2

$$\frac{d\beta}{dy} + (1-n)\frac{B}{2}(y)\beta = (1-n)B(y) \quad (5)$$

$$\frac{2d\beta}{dy} + (1-n)B(y)\beta = 2(1-n)B(y) \quad (6)$$

$$\frac{2d\beta}{dy} + \beta(1-n)B(y) = 2(1-n)B(y) \quad (7)$$

$$\frac{2d\beta}{dy} = (1-n)B(y)[2 - \beta] \quad (8)$$

$$\frac{2d\beta}{2 - \beta} = (1-n)B(y)dy \quad (9)$$

$$\frac{2}{2 - \beta} \frac{d\beta}{dy} = (1-n)B(y) \quad (10)$$

$$\text{Let } \frac{2}{2 - \beta} = \phi^2$$

$$\phi^2 \frac{d\beta}{dy} = (1-n)B(y) \quad (11)$$

$$\frac{d\beta}{dy} = \left(\frac{(1-n)B(y)}{\phi^2} \right) \quad (12)$$

$$d\beta = \frac{(1-n)B(y)dy}{\phi^2} \quad (13)$$

$$\beta = \int \frac{(1-n)B(y)dy}{\phi^2} \quad (14)$$

$$\left[\beta = \frac{1}{\phi^2} \int (1-n)B(y)dy \right] \quad (15)$$

$$\beta = \frac{1}{\phi^2} \int (1-n)B(y)dy \quad (16)$$

$$\beta = \frac{1}{\phi^2} \int (1-n)B(y)dy = \frac{1}{\phi^2} (1-n)B(y)Y + K_1 \quad (17)$$

$$\left[\beta = \frac{(1-n)}{\phi^2} B(y)Y \right] \quad (18)$$

Materials and Methods

Standard laboratory experiments were performed to monitor the rate of Bacteroides transport at different formation. The soil depositions of the strata were collected in sequences based on the structural deposition at different study areas. The samples collected at different locations generated variation of concentration at different depths through its pressure flow at the lower end of the column. The experimental result was applied and compared with theoretical values for model validation.

Results and Discussion

Table 1: Predictive and experimental values for Bacteroides concentration at different depths.

Depth [M]	Predictive Concentration [Mg/L]	Experimental Values for void Ratio [Mg/L]
3	2.53E-01	0.27327
6	3.51E-01	0.34008
9	3.54E-01	0.38943
12	3.57E-01	0.42132
15	3.49E-01	0.43575
18	3.48E-01	0.43272
21	3.47E-01	0.41223
24	3.42E-01	0.37428
27	3.31E-01	0.31887
30	3.28E-01	0.246

Table 2: Predictive and experimental values for Bacteroides concentration at different depths.

Depth [M]	Predictive Concentration [Mg/L]	Experimental Values for void Ratio [Mg/L]
3	2.64E-03	0.00572
6	2.28E-03	0.00188
9	2.92E-03	-0.00052
12	1.06E-03	-0.00148
15	1.32E-03	-0.001
18	1.58E-03	0.00092
21	1.84E-03	0.00428
24	2.11E-03	0.00908
27	2.38E-02	0.01532
30	2.64E-02	0.023

Table 3: Predictive and experimental values for Bacteroides concentration at different depths.

Depth [M]	Predictive Concentration [Mg/L]	Experimental Values for void Ratio [Mg/L]
3	5.10E-05	0.00005772
6	5.81E-05	0.00005688
9	5.72E-05	0.00005748
12	4.62E-05	0.00005952
15	5.53E-05	0.000063
18	5.44E-05	0.00006792
21	6.34E-05	0.00007428
24	7.24E-05	0.00008208
27	8.15E-05	0.00009132
30	9.10E-05	0.000102
33	9.97E-05	0.00006
36	1.10E-04	0.00006

Table 4: Predictive and experimental values for Bacteroides concentration at different depths.

Depth [M]	Predictive Concentration [Mg/L]	Experimental Values for void Ratio [Mg/L/]
3	5.33E-06	5.5586E-06
6	5.42E-06	6.0128E-06
9	5.53E-06	6.3302E-06
12	5.67E-06	6.4784E-06
15	5.69E-06	0.000006425
18	5.96E-06	6.1376E-06
21	4.22E-06	5.5838E-06
24	2.54E-06	4.7312E-06
27	2.85E-06	3.5474E-06
30	3.18E-07	0.000002

Table 5: Predictive and experimental values for Bacteroides concentration at different depths.

Depth [M]	Predictive Concentration [Mg/L]	Experimental Values for void Ratio [Mg/L]
3	1.26E-06	2.2511E-06
6	1.26E-06	2.9288E-06
9	1.24E-06	3.9197E-06
12	1.28E-06	5.1104E-06
15	2.33E-06	6.3875E-06
18	3.37E-06	7.6376E-06
21	3.42E-06	8.7473E-06
24	4.27E-06	9.6032E-06
27	4.31E-06	1.00919E-05
30	4.46E-06	0.0000101

Results and discussion are presented in Table 1-5 including graphical representation of heterogeneous depositions on Bacteroides concentration at different depths. The Figure 1-4 shows how the deposition of Bacteroides behave in silty formation, there was a gradual migration of Bacteroides from three metres

to the optimum rate recorded at eighteen metres, but sudden decrease were experience from twenty one metres to the lowest concentration recorded at thirty metres, while the experimental values gradually observed migration within three and twelve metres and maintained linear condition under constant migration

influenced by velocity of flow. Figure 2 observed fluctuation in gradual process and suddenly express rapid increase to the optimum values recorded at thirty metres, while the experimental values for model validation maintained the same vein, but with slight variation in concentration, thus with exponential state to the optimum values recorded at thirty metres. Figure 3 maintained fluctuation between three and fifteen metres, but suddenly experienced decrease in concentration to lowest level recorded at thirty-six metres, while the experimental values experienced vacillation and rapidly developed exponential state to the optimum

values recorded at thirty-six metres. Figure 4 express rapid increase between ten and eighteen metres and suddenly observed decrease in concentration to the lowest rate recorded at thirty metres, while that of the experimental parameters obtained gradual increase between three and fifteen metres and experienced deterioration to the lowest rate recorded at thirty metres. Figure five observed fluctuation from three and twenty-one metres in exponential state and finally observed constant migration between twenty-four and thirty metres.

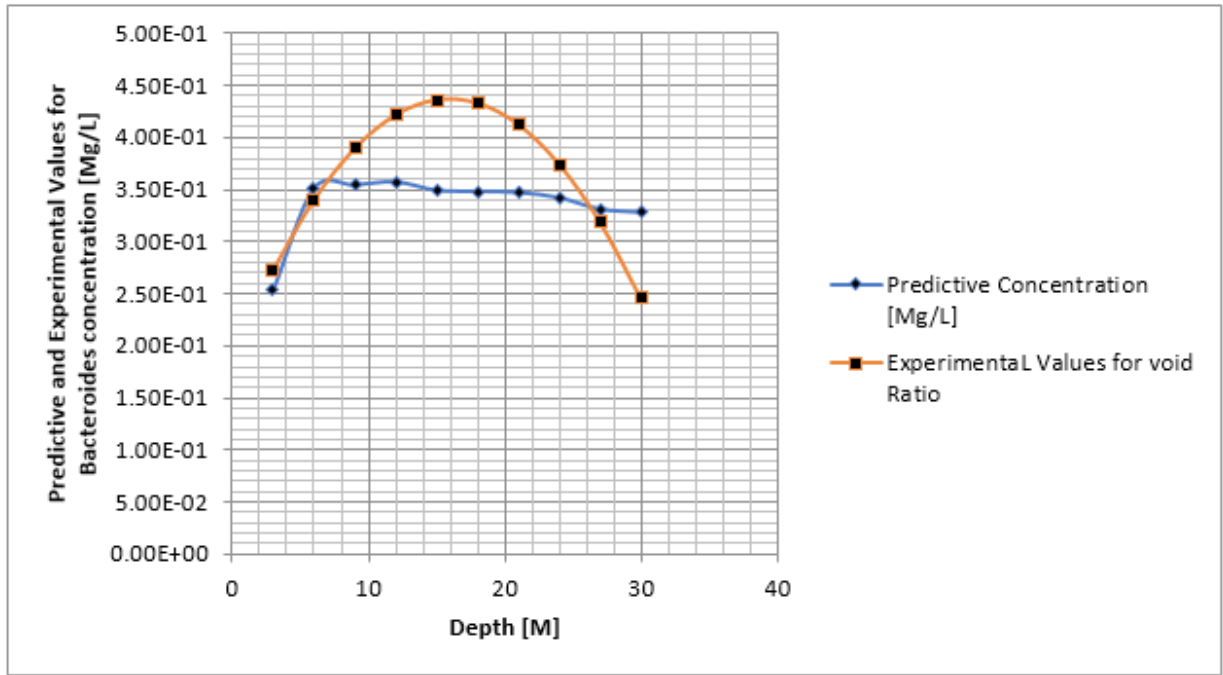


Figure 1: Predictive and experimental values for Bacteroides concentration at different depths.

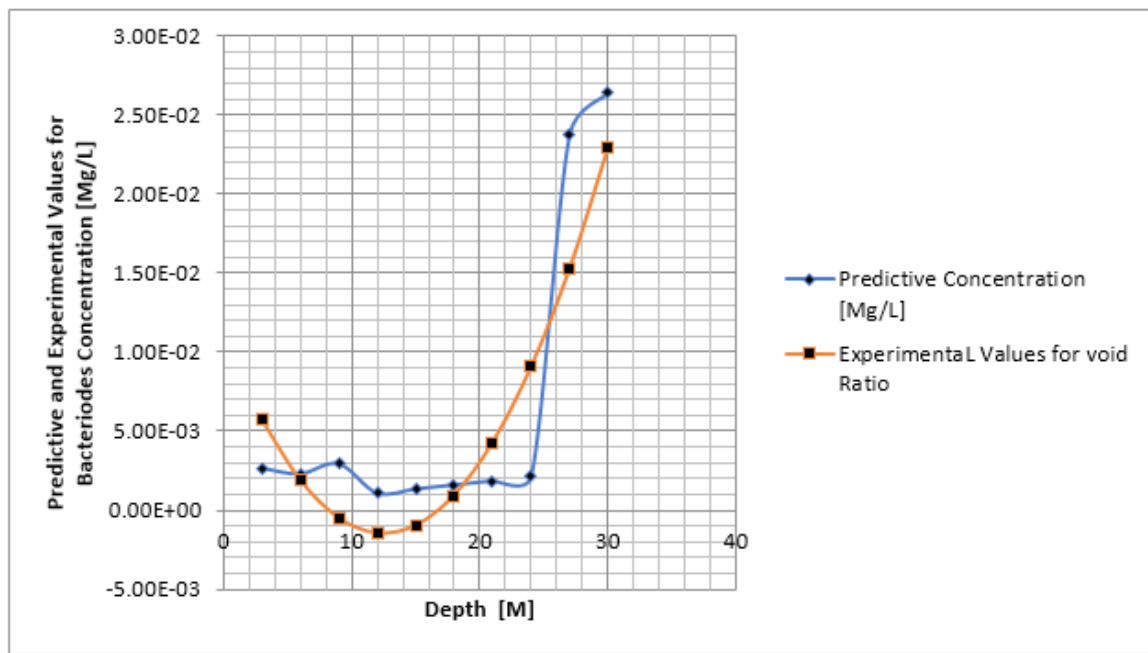


Figure 2: Predictive and experimental values for Bacteroides concentration at different depths.

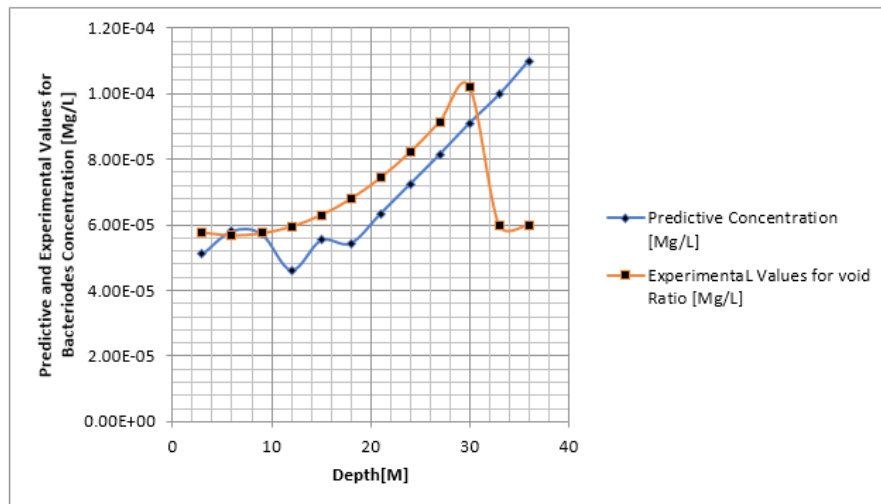


Figure 3: Predictive and experimental values for Bacteroides concentration at different depths.

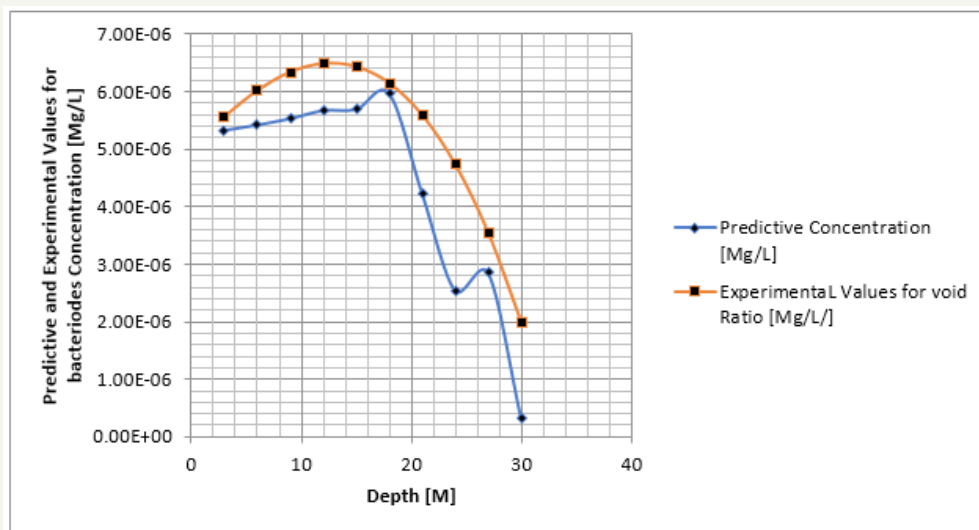


Figure 4: Predictive and experimental values for Bacteroides concentration at different depths.

Conclusion

The study from the graphical representation has shown that the system express fluctuation base on the heterogeneity deposition from silty strata in deltaic environment. The study explain the behaviour of Bacteroides concentration in heterogeneous silty deposition, such condition were observed to determine the migration rates in silty formation, lots of works has been done on other microbes, but the behaviour of their migration are not always the same, the behaviour of Bacteroides were capture from the predictive model simulation parameters, it has also express the heterogeneity in other substances that may have inhibit the migration rate of Bacteroides in silty depositions, porosities variation experiences heterogeneity and this affected the system in terms of its migration in silty depositions, although the rate of porosity experienced lower degree level, but it still reflect its influences on the migration rates in the study environment, the derived solution were able to monitor the behaviour of the contamination in silty depositions, experimental values were applied to validate the derived model, and both parameters developed favourable fits.

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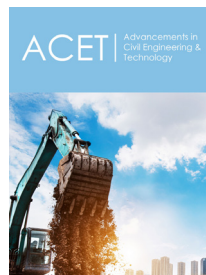
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