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Research article

MATHEMATICAL MODEL OF BIOCHEMICAL DEPOSITIONS INFLUENCING ENTEROCOCCUS IN HOMOGENEOUS SILTY AND FINE SAND FORMATION APPLYING COLLOID FILTRATION METHOD IN COASTAL AREA OF WARRI, DELTA STATE OF NIGERIA.

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Abstract

Biochemical deposition from the biological waste depositing Enterococcus are affected by numerous environmental factors such as rainfall, soil moisture and holding capacity, temperature and soil composition, pH, the presence of oxygen and micronutrients including easy use of organic matter and rivalry are from soil micro flora. These environmental factors are one of the most influences that express the survival of microbes in general concept. This study focuses on these stated factors. Public health concern is a serious issue on the life span of man, the survival of human life depends on the quality of what we takes into the body system. High percentage of fluid are made of human body system, therefore, water quality for human consumption and use decide health status of human. Based on this municipal healthiness concern, it becomes vital to monitor the rate of water quality consumed by human to maintain standard health status. considerably, mathematical model was developed to monitor biochemical deposition influencing Enterococcus in silty and fine sand formation. High rate of contamination were found in groundwater aquifer in the study location, whereby Enterococcus concentration were found to be predominant. To solve this menace, the model developed if applied, will predict the rate of concentration under the influence of the stated parameters that aid the transport of Enterococcus in soil and water environment.

Keywords: mathematical model, biochemical deposition, Enterococcus, and fine colloid filtration method.

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1. Introduction

Historically, pollution control measures have been focused more on point source pollution than on non-point sources, using control standards, regulatory enforcement, capital investment and management in industrial and municipal infrastructures (Justus, 2007). For example in Europe and North America, point source pollution has been greatly reduced (Daniel et al., 1998). This is because point pollution sources are easily identified, measured, collected and treated at the source. However, all over the world a large percentage of water pollution has been recognized as originating from non-point sources (Luzio et al., 2004). Unlike point sources, non-point sources are more difficult to measure and regulate, because they arise from various activities (i.e. agricultural production) dispersed over wide areas of land and variable in time and space due to effects of weather and the hydrologic cycle (Carpenter et al., 1998; Daniel et al., 1998). Managing non-point sources of pollution in addition to being politically, economically, and socially difficult, is technically complex (Young et al., 1989 Justus, 2007). Pollution sources often are located over large geographic areas and are not readily identifiable. Therefore, assessment and quantification of pollution sources especially from non-point sources and their contribution to chemical loads to surface waters is an important aspect of remediation, monitoring, and control of water quality, especially for the lakes (Scheren et al., 2000). In order to determine whether non-point source pollution from agricultural fields is a problem in a given area one must estimate the extent of pollution at present and predict the effects of alternative agricultural practices to counteract pollution in the future (Wauchope and Leonard, 1980). Methods as unit area yields or loads, experimental relationships (regression models), and watershed simulation models linked with GIS, have been used to estimate pollutant loads originating from nonpoint sources in a drainage basin (Newell et al., 1992; Scheren, 2000;Luzio et al., 2004 Liu and Smedt 2004a). Simulation models linked with GIS prove to be more useful in predicting runoff, sediment and nutrient transport from agricultural watersheds and assist in field management practices, because these models can identify the most vulnerable erosion-prone areas as reported by Liu et al, 2002; Liu et al. (2005b). Simulation models provide more detailed simulation in time and space of pollutant transport and transformation mechanism. Comprehensive distributed hydrological models linked with GIS have been developed to estimate contaminant loads and transport to surface waters (DHI 1999; Neitsch et al., 2002). However, these require very extensive and detailed input data that cannot be easily measured or obtained due to limited resources (Liu et al, 2003; Liu et al., 2005a Justus, 2007).

2. Theoretical background

Utilization of groundwater has been a considerable excellent quality for human in most part of the world; pollution in so many several conditions through manmade activities, while some comes from soil barriers that provide effective isolation to generate quality water free from any type of contaminants. The fact about ground water reserve is that the deposition come from soil structure identified to be aquiferous zone, but in most conditions, groundwater quality do not hold its grade due to the actions of man that generate contamination. Groundwater aquifers are being contaminated through this foundation of contamination by leaching form the exterior part of the soil in the organic soil down to the ground water aquifers that deposit either gravel, fine sand or coarse. Alluvium deposited formation is being found in deltaic environment producing homogeneous stratification, shallow aquifers are deposited in shallow, formation characteristics that deposit in deltaic environment have been confirmed through hydrological studies to contain high degree of porosity, permeability and void ratio. Structural depositions of the strata are expressed through geological setting confirmed from the hydro geological studies. Deltaic environments reflect through deposit solute within a short period of time under the influences of high degree of porosity in the study location. Biological waste generates lots of different biochemical substances. Constant deposition of these wastes generates constant regeneration of these microbial depositions migrating under the influence of plug flow systems as confirmed from groundwater laboratory results. Environmental experts have experiences increment in the degradation of public health; this has been observed from due to high percentage of poor sanitation and poor management of biological waste in the study location. Biological dumped indiscriminately under biodegradation generate. These have been confirmed to increase high percentage of sickness from water-related diseases in the study area. To create permanent resolution that will solve this threat, mathematical model to monitor the rate of this microbial transport in unconfined were found imperative to develop. The establishment of this conceptual framework will definitely reduce the transportation of these types of microbial species to unconfined aquifer that deposit in the study location. The expressed mathematical equation is stated below. The chemical structure shows their similarities, chemical constitution, physico-chemical properties and hence can be used to predict their environmental and public health fate as suggested by Akhabuhaya and Lodenius (1988) and Nowell et al. (1999). Most organ chlorine pesticides are moderately toxic to mammals, but their low biodegradability and high persistence in the environment has raised much concern on their effects to the environment. Organ phosphorous insecticides vary tremendously in chemical structure and hence chemical properties. Hydrolysis is the major degradation route. The acute toxicity of organophosphate insecticides tends to be much greater than that of the organochlorine insecticides (Nowell et al., 1999). They are less persistent and more effective at lower doses than organochlorines (Ware, 1994). They degrade fairly rapidly, hydrolysis being the principal degradation mechanism (Burnside, 1974; Nowell et al., 1999). Synthetic pyrethroids are widely used in agricultural, households, and veterinary insecticide applications. They are structural analogues of natural pyrethrins of botanical origin. In general they are more stable (to photochemical, chemical and microbial degradation),

Nomenclature

C - Concentration
P_b - Bulk density
θ - Porosity
S - Biochemical
D - Dispersion
V Velocity
X - Distance
T - Time

$$V\frac{\partial c}{\partial t} + \frac{P_b}{\theta} S \frac{\partial c}{\partial t} = D\frac{\partial^2 c}{\partial X^2} - V\frac{\partial c}{\partial X} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \qquad (1)$$

Modified equation express the deposition of biological influence from biological waste that influences Enterococcus is the governing equation. The express derived equations were to monitor the migration of Enterococcus influenced by biological deposition in homogenous unconfined beds. This expression modified considered several variables are influenced by the behaviour of Enterococcus in the system. The developed equation will express the condition in phases under the influence of several formation characteristics that determine the migration of the microbes at different strata to groundwater aquifers. More so, varieties of microbes in natural water vary greatly in different places under different conditions. Enterococcus is washed into the water from the air, soil and from almost every conceivable object. Important statistics of microbes move through porous media even when the percentage retained is very high. Subject to this relation, the migration of Enterococcus are influenced by the deposition of soil formation at different structural setting, this determine the microbial migration at different strata.

Applying physical splitting techniques on equation (1)

$$\frac{P_b}{\theta} S \frac{\partial c_1}{\partial t} = P_b \frac{\partial c_1}{\partial t} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \qquad (2)$$

$$\left.\begin{array}{l} t = 0, \quad x = 0 \\ C_{(o)} = 0 \\ \left.\frac{\partial c_1}{\partial t}\right| t = 0 \end{array}\right\} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \qquad (3)$$

$$V\frac{\partial c_2}{\partial t} = D\frac{\partial^2 c_2}{\partial X^2} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \qquad (4)$$

$$\left.\begin{array}{l} t = 0, \quad x = 0 \\ C_{(o)} = 0 \\ \left.\frac{\partial c_2}{\partial t}\right|_{t = 0} = 0 \end{array}\right\} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \qquad (5)$$

$$V\frac{\partial^2 c_3}{\partial t} = -\frac{V\partial c_3}{\partial X} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \qquad (6)$$

$$\left.\begin{array}{l} t = 0 \\ C_{(o)} = 0 \end{array}\right| \left. t = 0 \right\} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \qquad (7)$$

$$V\frac{\partial^2 c_4}{\partial X^2} = -V\frac{\partial c_4}{\partial X} \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (8)$$

$$\left.\begin{aligned} x &= 0 \\ t &= 0 \\ C_{(o)} &= 0 \end{aligned}\right\} \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (9)$$

Subject to this expressed equation from (2) to (9) showcase the derived expression through the derived solution in phases; this appliance were to ensure the migration of the microbes are expressed in the system at different phases, based on the structural deposition of the soil. This is under the influence of formation characteristics. Based on these factors, mathematical expressions from the governing equation were spitted to monitor the migration t and behaviour of the microbes at different conditions.

$$\left.\frac{\partial c_4}{\partial X}\right| \quad x = 0 \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (10)$$

Applying direct integration on (2)

$$V\frac{\partial c}{\partial t} = \frac{P_b}{\theta}C + K_1 \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (11)$$

Again, integrate equation (11) directly, yield

$$VC = \frac{P_b}{\theta}Ct + K_1 t \quad K_2 \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (12)$$

Subject to equation (3), we have

$$VC_o = \quad K_2 \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (13)$$

And subjecting equation (11) to (3)

$$at \left.\frac{\partial c_1}{\partial t}\right|_{t\,=\,0} = 0 \quad C_{(o)} = C_o$$

Yield

$$0 = \frac{P_b}{\theta}C_o + K_2$$

$$\Rightarrow K_2 = -\frac{P_b}{\theta}C_o \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (14)$$

So that, put (13) and (14) into (13), we have

$$VC_1 = \frac{P_b}{\theta}C_1 t - \frac{P_b}{\theta}C_o t + VC_o \quad \dots\dots\dots\dots\dots\dots \quad (15)$$

$$VC_1 - \frac{P_b}{\theta}C_1 t = VC_o - \frac{P_b}{\theta}C_o t \quad \dots\dots\dots\dots\dots\dots \quad (16)$$

$$\Rightarrow \quad C_1\left(V - \frac{P_b}{\theta}t\right) = C_o\left(V - \frac{P_b}{\theta}t\right) \quad \dots\dots\dots\dots\dots\dots \quad (16)$$

The foundation of this contamination is through high rate of biological waste dumped indiscriminately generating biochemical substances, it was confirmed from the consequences of indiscriminate dumping of biological wastes. This implies that there is a tendency of constant regeneration of the microbial deposition from organic soil leaching down to groundwater aquifers, predominantly from the hydro geological point of view, the study location has been expressed to deposit homogenous soil under the influence of its geological setting. Considering this condition, the expression in equation (16) shows that there is constant concentration based on frequent regeneration of the contaminant in the formation.

$$\Rightarrow \quad C_1 = C_o \quad \dots\dots\dots\dots\dots\dots \quad (17)$$

Hence equation (16) entails that at any given distance, *x*, we have constant concentration of the contaminant in the system. Now we consider equation (4) which is the progressive phase of the system.

$$V\frac{\partial c_2}{\partial t} = D\frac{\partial^2 c_2}{\partial X^2} \quad \dots\dots\dots \quad (4)$$

Approach this system using the Bernoulli's method of separation of variables

i.e. $C_2 = XT$ $\quad \dots\dots\dots\dots\dots\dots \quad$ (18)

i.e. $V\frac{\partial c_2}{\partial t} = XT^1$ $\quad \dots\dots\dots\dots\dots\dots \quad$ (19)

$$\frac{\partial^2 c_2}{\partial X^2} = X^{11}T \quad \dots\dots\dots\dots\dots\dots \quad (20)$$

Put (19) and (20) into (18), so that we have

$$VXT^1 = DX^{11}T \quad \dots\dots\dots\dots\dots\dots \quad (21)$$

i.e. $\frac{VT^1}{T} = \frac{DX^{11}}{X} = -\lambda^2$ $\quad \dots\dots\dots\dots\dots\dots \quad$ (22)

Hence $$\frac{VT^{1}}{T} + \lambda^{2} = 0 \tag{23}$$

$$X^{11} + \frac{\lambda^{2}}{V} = 0 \tag{24}$$

And

$$DX^{11} + \lambda^{2}T = 0 \tag{25}$$

From (24) $$T = ACos\,\frac{\lambda}{V}t + B\,Sin\,\frac{\lambda}{V}x \tag{26}$$

And (19) gives:

$$T = C\ell^{\frac{-\lambda^{2}}{V}t} \tag{27}$$

The migration process of the microbes were found in this condition to be in progressive phase, such exponential condition implies that the microbes are progressively migrate under the influence of constant deposition, through the source of regeneration from constant indiscriminate dumping of biological waste thus developing biochemical substances in the study location. This supports the alluvium deposition of the formations under the influence of the structural deposition, through the influence of deltaic environment. The expressed model in equation (26) were developed subjecting the condition of the migration system with respect to time factor, under the influence of exponential condition found on the migration of Enterococcus. Subject to these relations, the established model has definitely expressed the migration of Enterococcus in line with the influence of the formation of the soil. The degrees of the micropores determine the fluid flow path that generates the sources of pollutions.

By substituting (25) and (26) into (18) we get:

$$C_{2} = \left[ACos\,\frac{\lambda}{\sqrt{V}}t + B\,Sin\,\frac{\lambda}{\sqrt{V}}x \right] C\ell^{\frac{-\lambda^{2}}{V}t} \tag{28}$$

the behaviour of the microbes in equation (16) and (26) were couple together to generate the established model in (27), the condition implies that both condition are found in some phase on the transport system, the Behaviuor of the microbes are influence by the level deposition, these condition were considered that develop the model which accommodate the condition in (28).

Subject equation (29) to condition in (5), so that we have

$$C_{o} = AC \tag{29}$$

Equation (29) becomes:

$$C_2 = C_o \ell^{\frac{-\lambda^2}{D}t} \, Cos \frac{\lambda}{\sqrt{V}} x \qquad \ldots\ldots\ldots\ldots\ldots\ldots \tag{30}$$

Again at $\left.\frac{\partial c_2}{\partial t}\right|_{t \,=\, 0, B} = 0, \quad x = 0$

Equation (30), becomes:

$$\frac{\partial c_2}{\partial t} = \frac{\lambda}{\sqrt{V}} C_o \ell^{\frac{-\lambda^2}{D}t} \, Sin \frac{\lambda}{V} x \qquad \ldots\ldots\ldots\ldots\ldots\ldots \tag{31}$$

i.e. $0 = -C_o \frac{\lambda}{\sqrt{V}} \, Sin \frac{\lambda}{\sqrt{V}} 0$ ……………………………….. (31)

$C_o \frac{\lambda}{\sqrt{V}} \neq 0$ Considering NKP

Which is the substrate utilization for microbial growth (population), so that

$$0 = -C_o \frac{\lambda}{\sqrt{V}} \, Sin \frac{\lambda}{\sqrt{V}} B \qquad \ldots\ldots\ldots\ldots\ldots\ldots \tag{32}$$

$$\Rightarrow \frac{\lambda}{\sqrt{V}} = \frac{n\pi}{2}, \; n, 1, 2, 3 \qquad \ldots\ldots\ldots\ldots\ldots\ldots \tag{33}$$

$$\Rightarrow \lambda = \frac{n\pi\sqrt{V}}{2} \qquad \ldots\ldots\ldots\ldots\ldots\ldots \tag{34}$$

So that equation (30) becomes

$$C_2 = C_o \ell^{\frac{-n^2\pi^2 V}{2D}t} \, Cos \frac{n\pi\sqrt{V}}{2\sqrt{V}} x \qquad \ldots\ldots\ldots\ldots\ldots\ldots \tag{35}$$

$$C_2 = C_o \ell^{\frac{-n^2\pi^2 V}{2D}t} \, Cos \frac{n\pi}{2} x \qquad \ldots\ldots\ldots\ldots\ldots\ldots \tag{36}$$

The progression of Enterococcus migration are caused by the deposition of substrate in soil, the substrate gives more energy to the microorganisms Enterococcus, it increase microbial population, the appearance of this microbes in this phase were considered in the system, this through a model developed stated in (36), this model expressed other conditions including the substrate deposition in the soil, the expressed model in (36) were able to monitor the microbes with this expression.

We consider equation (6)

$$V\frac{\partial c_3}{\partial t} = -V\frac{\partial c_3}{\partial X} \tag{6}$$

We approach the system by using the Bernoulli's method of separation of variables

$$C_3 = X^1T \tag{37}$$

$$\frac{\partial c_3}{\partial t} = XT^1 \tag{38}$$

$$\frac{\partial c_3}{\partial X} = X^1T \tag{39}$$

Again, we put (38) and (39) into (37), so that we have

$$VXT^1 = VX^1T \tag{40}$$

i.e. $$\frac{VT^1}{T} = \frac{VX^1}{X} = -\lambda^2 \tag{41}$$

Hence $$\frac{VT^1}{T} + \lambda^2 = 0 \tag{42}$$

i.e. $$X^1 + \frac{\lambda^2}{V}X = 0 \tag{43}$$

And $$VT^1 + \lambda^2T = 0 \tag{44}$$

From (44) $$X = ACos\frac{\lambda}{\sqrt{V}}X + BSin\frac{\lambda}{\sqrt{V}}X \tag{45}$$

And (38) give

$$T = C\ell^{\frac{-\lambda^2}{V}t} \tag{46}$$

By substituting (45) and (46) into (37), we get

$$C_3 = \left(ACos\frac{\lambda}{\sqrt{V}}x + BSin\frac{\lambda}{\sqrt{V}}x\right)C\ell^{\frac{-\lambda}{V}t} \tag{47}$$

Subject (47) to conditions in (9), so that we have

$$C_o \quad = \quad AC \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \qquad (48)$$

$\therefore$ Equation (48) becomes:

$$C_3 = C_o \ell^{\frac{-\lambda^2}{V}t} Cos \frac{\lambda}{\sqrt{V}} x \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \qquad (49)$$

Again, at $\left.\frac{\partial c_3}{\partial t}\right| \quad = \quad 0, \quad t \; = \; 0$

$$t \; = \; 0, B$$

Equation (49), becomes:

$$\frac{\partial c_3}{\partial t} = \frac{\lambda}{\sqrt{V}} C_o \ell^{\frac{-\lambda^2}{D}t} \; Sin \frac{\lambda}{V} x \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \qquad (50)$$

i.e. $0 \; = \; \frac{-C_o \lambda}{\sqrt{V}} \; Sin \frac{\lambda}{V} 0 \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \qquad (51)$

$C_o \frac{\lambda}{\sqrt{V}} \quad \neq \quad 0$ Considering NKP

Which is the substrate utilization for microbial growth (population), so that

$$0 \; = \; -C_o \frac{\lambda}{\sqrt{V}} \; Sin \frac{\lambda}{\sqrt{V}} B \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \qquad (51)$$

$$\Rightarrow \; \frac{\lambda}{\sqrt{V}} \; = \; \frac{n\pi}{2} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \qquad (52)$$

$$\Rightarrow \; \lambda \; = \; \frac{n\pi\sqrt{V}}{2} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \qquad (53)$$

So that equation (30) becomes

$$C_3 \; = \; C_o \ell^{\frac{-n^2\pi^2 V}{4D}t} \; Cos \; \frac{n\pi\sqrt{V}}{2\sqrt{V}} x \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \qquad (54)$$

$$\Rightarrow C_3 \; = C_o \ell^{\frac{-n^2\pi^2 V}{4V}t} \; Cos \; \frac{n\pi}{2} x \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \qquad (55)$$

The deposition of Enterococcus in system continues to express these from (36) to (54) were another model continue to monitor the microbes under the influence of substrate and other variables in another circumstances, this is to ensure that at this phase of the microbial migration, there the tendency of enhance of microbial inhabitants through the substrate thus the degrees of porosity and constant regeneration biological waste in the study location.

Now, we consider equation (8), which is the stable flow rate of the system

$$\frac{D\partial^2 c_4}{\partial X^2} = -V\frac{\partial c_4}{\partial X} \qquad \ldots\ldots\ldots\ldots\ldots \qquad (8)$$

Using Bernoulli's method, we have

$$C_4 = XT \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \qquad (56)$$

$$\frac{\partial c_4}{\partial X^2} = X^{11}T \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \qquad (57)$$

$$\frac{\partial c_4}{\partial X} = X^1T \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \qquad (58)$$

Put (57) and (58) into (8), so that we have

$$DX^{11}T = -VX^1T \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \qquad (59)$$

i.e. $$\frac{DX^{11}}{X} = \frac{VX^1}{X} = \varphi \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \qquad (60)$$

$$\frac{DX^{11}}{X} = \varphi \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \qquad (61)$$

$$\frac{-VX^1}{X} = \varphi \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \qquad (62)$$

$$X = A\frac{\varphi}{D}X \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \qquad (63)$$

And $$X = B\ell\frac{-\varphi}{V}X \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \qquad (64)$$

Put (63) and (64) into (56), gives

$$C_4 = A\ell^{\frac{\varphi}{V}x} \quad B\ell^{\frac{-\varphi}{V}x} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \qquad (65)$$

$$C_4 = AB\ell^{(x-x)}\frac{\varphi}{V} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \qquad (66)$$

Subject equation (66) and (67) yield

$$C_{(4)} = (o) = C_o \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \qquad (67)$$

So that, equation (68) becomes

$$C_4 = C_o \ell^{(x-x)} \frac{\varphi}{V} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \qquad (68)$$

The migration of Enterococcus t process were considered to transport to some degree, this is where the substrate were not deposited, the microbe may be found to experience degradation, through microbial migration, if it cannot adapt at a particular region, they may experience death or it may also migrate to the next formation that may found faviourably to them, the condition were expressed in equation 68 were the concentration at that condition is assumed to be zero

Now assuming that, at the steady flow, there is no NKP for substrate utilization, our concentration here is zero, so that equation (68) becomes

$$C_4 = 0 \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \qquad (69)$$

Therefore solution of the system is of the form

$$C = C_1 + C_2 + C_3 + C_4 \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \qquad (70)$$

We now substitute (17), (36), (55) and (69) into (70), so that we have the model of the form

$$C = C_o + C_o \ell^{\frac{-n^2\pi^2V}{2D}t} \bullet {}^{\frac{n^2\pi^2V}{4D}x} Cos \frac{n^2\pi^2}{4} x \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \qquad (71)$$

$$\boxed{\Rightarrow C = C_o \left[1 + \ell^{\frac{-n^2\pi^2V}{2D}t} \bullet {}^{\frac{n^2\pi^2V}{4D}x} Cos \frac{n^2\pi^2}{4} x\right]} \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (72)$$

The expression in (72) is the final developed model equation that expressed the biochemical deposition influencing Enterococcus in silty and fine sand formation, the model were developed bearing in mind the behaviour of the microbes in phases, the expressed generated model considering the variables that influence the transport system in homogeneous silty and fine sand formation aquifers. The expressed mathematical model will definitely predict the rate of biochemical deposition influencing Enterococcus in silty and fine sand in Warri delta state of Nigeria.

4. Conclusion

Microbial are derived mostly from human and animal activities known as biological waste unsewered, on-site sanitation, cemeteries, waste disposal, and waste disposal feed lots, etc. Microorganism certainly will be the dormant forms of life and in most cases; they will be the only form of life present in aquifers. The principle of physical process for microbial movement through porous media is convection or advection and hydrodynamics dispersion. In advection microorganisms are carried out bulk water flow and their movement is governed by velocity of water. Advection is equal to the average velocity of groundwater as determined from the product of hydraulic conductivity and hydraulic gradient all divided by porosity. Hydrodynamic dispersion is the spreading of microorganism as they move along the water path as a result of both microscopic and macroscopic effect. The transports of Thermotolerant on homogenous unconfined aquifer through the random sequential absorption on blocking effect were expressed mathematically to predict the rate of the microbe’s disposition based on the stated parameters.

The studies focused on the stated parameters above but understand that hydrodynamics dispersion and advection are also the governing principles that influence microbial transport system in deltaic environment. The modified equations were expressed in a splitting method whereby they were derived to generate a model in phases, based on several considered conditions and behaviour of the microbes on transport process. Environmental experts will find this expressed model a conceptual framework that will be applied to monitor the deposition of biochemical substances influencing Enterococcus in silty and fine sand formation in the study area. The model has streamlined the relationship of different formation characteristics considered in the system to have influenced the behaviour of Enterococcus transport process in homogenous silty and fine sand formation in the study area.

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