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MATHEMATICAL MODEL TO PREDICT BLOCKING EFFECT ON RANDOM SEQUENTIAL ADSORPTION ON THERMOTOLERANT TRANSPORT IN HOMOGENEOUS UNCONFINED AQUIFER IN AHOADA DELTAIC ENVIRONMENT, RIVERS STATE OF NIGERIA

Eluozo, S. N.

Subaka Nigeria Limited Port Harcourt Rivers State of Nigeria
Director and principal consultant Civil and Environmental Engineering, Research and Development
E-mail: Soloeluozo2013@hotmail.com
E-mail: solomoneluozo2000@yahoo.com

ABSTRACT

The continued existence of Thermotolerant affected by numerous ecological factors such as sunlight, rainfall, soil moisture and holding capacity, temperature and soil composition, pH, the presence of oxygen and nutrients and the easy use of organic matter and rivalry are from soil micro flora. These environmental factors are one of the most influences on 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. Water contains 70% of the body system, therefore, water quality for human consumption and utilization determine health status of human. Based on this public health concern, it becomes imperative to monitor the rate of water quality consumed by human to maintain standard health status. Significantly, mathematical model was developed to monitor the blocking effect on random sequential adsorption of Thermotolerant transport in homogeneous unconfined aquifer. High rate of pollution were found in groundwater aquifer in the study location, whereby Thermotolerant 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 to groundwater aquifers.

Keywords: Mathematical modeling, random sequential adsorption, Thermotolerant transport, and homogeneous unconfined aquifer

1. Introduction

Most developing nations in Asia, South America and Africa for an predictable 1,300 million cities dwellers the major source of drinking water is groundwater (Foster, 2000). This groundwater may be polluted by infiltrated wastewater, since extremely frequently a sewer system is not present and households dispose of their solid and liquid waste on-site. For example, in Africa around 80% of the inhabitants in the largest cities (in Asia: around 55%) have on-site sanitation, such as septic tanks, pour-flush, VIP latrines or simple pits (World Health Organization, 2000-2003). In adding together to leakage from on-site sanitation or from sewerage, the sources of fecal pollution could be manure wastewater or sewage sludge multiply by farmers on fields, waste from animal feedlots, waste from healthcare facilities, and leakage from waste disposal sites and landfills (Pedley et al., 2005).

To forecast the presence of pathogens in water, a dispersing group of bacteria is usually used, generally known as fecal indicator organisms (Pedley et al., 2005). Many microorganisms have been recommended as microbial indicators of fecal pollution (like enterococci, coliphages and sulphite reducing clostridial spores; Medema et al., 2003), but two of the most significant indicators applied worldwide are *Escherichia coli* and Thermotolerant coliform bacteria. Thermotolerant coliforms are a less reliable index of fecal pollution than *E. coli*, although under most conditions their concentrations are directly associated to *E. coli* concentrations (Payment et al., 2003). Viruses may be considered as the most critical or restrictive microorganism. Because of their small size, their mostly negative exterior charge, and their high doggedness in the surroundings, they may travel long distances in the subsurface. In addition, they can be highly infectious (Schijven, 2001), in the study by Karim et al. (2004a) Although *E. coli* and Thermotolerant coliforms as representatives of the group of fecal indicator organisms have frequently been establish in groundwater systems, to date there has been no complete report evaluating and discussing their transport characteristics. Several researchers have reviewed the transport and survival of pathogenic and/or non-pathogenic micro-organisms originating from wastewater.

Some of the researchers focus on the movement of bacteria and viruses in aquifers in a qualitative way, without attempting to predict their migration (e.g. Romero, 1970; Lewis et al., 1980; Hagedorn et al., 1981; Crane and Moore, 1984; Bitton and Harvey, 1992; Stevik et al., 2004). Others mainly focus on first-order die-off rates, thereby neglecting the transport component including attachment and detachment processes (e.g. Reddy et al., 1981; Barcina et al., 1997). Murphy and Ginn (2000) mainly summarize the mathematical descriptions of the various physico-chemical and biological processes involved in the transport of bacteria and viruses, without indicating the relative importance of these processes and their occurrence in the natural environment. Merkli (1975) and Althaus et al. (1982) have presented a comprehensive bacteria transport model based on the colloid filtration theory (Herzig et al., 1970; Yao et al., 1971), including the effects of dispersion, diffusion, sedimentation, and filtration.

2. Theoretical Background

Groundwater has been a considerable excellent quality for human utilization; this comes from soil barriers that provide effective isolation to generate quality water free from any type of pollutant. The truth about ground water resource is that it is deposited in a soil formation known to be aquiferous zone but in most cases, groundwater quality do not possess its status due to the activities of man that generate pollution. The groundwater aquifers are being polluted through this source of pollution by leaching form the surface in the organic soil down to the aquiferous zone that deposit either gravel, fine sand or coarse. Homogenous formation is being found in deltaic environment and in most cases, the deposition of aquifers are in shallow depth, 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 determined by the geological setting confirmed from the hydrogeological studies. Deltaic environments are prone to deposit solute within a short period of time. Subject to this relation, random sequential of adsorption on Thermotolerant become at ease due to this influential formation characteristics that deposit in the study location. Thermotolerant is from a fecal family which has a strong relationship with E.coli, they deposit within the intercides of the soil particle grains from biological waste dumped indiscriminately by man. 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.

High tension in the degradation of public health has been observed from environmental experts due to high percentage of poor sanitation and poor management of biological waste in the study location. These have been confirmed to increase high percentage of illness from water-related diseases in the study area. To generate lasting solution that will solve this menace, 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.

$$V\frac{\partial c}{\partial t} = D\frac{\partial^2 c}{\partial X^2} - VP\frac{\partial c}{\partial X} - \frac{f}{\pi \partial c^2}\frac{\varepsilon \theta c}{\partial t} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

3. Governing Equation

Equation on is the governing equation that were modified to monitor the transport of Thermotolerant through random sequential of adsorption in homogenous unconfined beds. This expression modified considered several parameters that influenced the behaviour of Thermotolerant in the system. The developed equation will express the condition in phases under the influence of several formation characteristics that determine the transport of the microbes at different strata to groundwater aquifers. Moreso, variety of microorganisms in natural water vary greatly in different places under different conditions. Bacteria are washed into the water from the air, soil and from almost every conceivable object. Significant numbers of bacteria move through media even when the percentage retained is very high. Subject to this relation, the migration of Thermotolerant 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) we have

$$V\frac{\partial^2 c_1}{\partial X^2} = D\frac{\partial^2 c_1}{\partial X} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

$$\left.\begin{aligned} x &= 0 \\ C_{(o)} &= 0 \end{aligned}\right\} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3)$$

$$\left.\frac{\partial c}{\partial X}\right|_{x=0} = 0$$

$$V\frac{\partial c_2}{\partial t} = -VP\frac{\partial c}{\partial X} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. \quad (4)$$

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

$$V\frac{\partial c_3}{\partial t} = -\frac{f}{\pi\partial c^2}\frac{\varepsilon\partial c}{\partial t} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. \quad (6)$$

$$\left.\begin{aligned} t &= 0 \\ x &= 0 \\ C_{(o)} &= 0 \\ \left.\frac{\partial c_3}{\partial t}\right|_{t=0} &= 0 \end{aligned}\right\} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. \quad (7)$$

$$VP\frac{\partial c_4}{\partial X} = -\frac{f}{\pi\partial c^2}\frac{\varepsilon\partial c}{\partial t} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. \quad (8)$$

$$\left.\begin{aligned} x &= 0 \\ t &= 0 \\ C_{(o)} &= 0 \\ \left.\frac{\partial c_4}{\partial X}\right|_{x=0} &= 0 \end{aligned}\right\} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. \quad (9)$$

The expression from equation (2) to (9) are splitted to be derived in phases, this application is to monitor the transport system at different phases based on the structural deposition of the soil, under the influence of formation characteristics. Based on these factors, mathematical expressions from the governing equation were splitted to monitor the transport and behaviour of the microbes at different conditions.

Applying direct integration on (2)

$$\frac{V\partial c_1}{\partial t} = Dc + K_1 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. \quad (10)$$

Again, integrate equation (10) directly, yield

$$VC = DCt + K_1 t \quad K_2 \qquad \text{.....................................} \qquad (11)$$

$$VC = K_2 \qquad \text{.....................................} \qquad (12)$$

And subjecting equation (10) to (3), we have

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

Yield

$$0 = DC_o + K_2$$

$$\Rightarrow K_2 = DC_o \qquad \text{.....................................} \qquad (13)$$

So that we put (11) and (12) into (13), we have

$$VC_1 = DCt - VC_o t + \phi\theta C_o \qquad \text{.....................................} \qquad (14)$$

$$VC_1 - DC_1 t = VC_o - VC_o t \qquad \text{.....................................} \qquad (15)$$

$$\Rightarrow C_1 (Vc - Dct) = C_o (Vc - Vct)$$

$$\Rightarrow C_1 = C_o \qquad \text{.....................................} \qquad (16)$$

Hence equation (16), entails that at any given distance x, we have constant concentration of the contaminant in the system.

The source of pollution to a very high rate has been confirmed to be as a result 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 hydrogeological 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.

Now, we consider equation (4) which is the progressive phase of the system

$$V\frac{\partial c_2}{\partial t} = -VP\frac{\partial c}{\partial X} \qquad \text{.....................} \qquad (4)$$

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

$$i.e. \quad C_2 = XT \qquad \text{.....................................} \qquad (17)$$

i.e. $$\frac{\partial c_2}{\partial t} = XT^1 \qquad \text{.....................................} \qquad (18)$$

$$\frac{\partial c_2}{\partial x} = X^1 T \qquad \text{.....................................} \qquad (19)$$

Put (18) and (19) into (17), so that we have

$$VcXT^{1} = VPX^{1}T \qquad \text{.................................} \qquad (20)$$

i.e.
$$\frac{VCT^{1}}{T} = \frac{VPX^{1}}{Z} - \lambda^{2} \qquad \text{.................................} \qquad (21)$$

Hence
$$\frac{VcT^{1}}{T} + \lambda^{2} = 0 \qquad \text{.................................} \qquad (22)$$

$$X^{1} + \frac{\lambda^{2}}{Vc}X = 0 \qquad \text{.................................} \qquad (23)$$

$$And\ VPX^{1} + \lambda^{2}T = 0 \qquad \text{.................................} \qquad (24)$$

From (23)
$$T = ACos\frac{\lambda}{Vc}t + BSin\frac{\lambda}{Vc}X \qquad \text{..................} \qquad (25)$$

And (19) gives:

$$\boxed{T = C\ell^{\frac{-\lambda^{2}}{Vc}t}} \qquad \text{.................................} \qquad (26)$$

The transport system of the microbes were found in this condition to be in exponential phase, such progressive condition implies that the microbes are progressively transporting under the influence of constant deposition, through the source of regeneration from constant indiscriminate dumping of biological waste in the study location. This supports the homogenous deposition of the strata 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 transport system with respect to time factor, under the influence of exponential condition found on the migration of Thermotolerant., Subject to this relations, the established model has definitely expressed the migration of Thermotolerant in line with the influence of the formation of the soil. The degrees of the micropores determine the fluid flow path that generates the transport of the microbes in the system.

By substituting (24) and (25) into (17) we have

$$\boxed{C_{2} = \left[ACos\frac{\lambda}{\sqrt{Vc}}t + BSin\frac{\lambda}{\sqrt{Vc}}x\right]C\ell^{\frac{-\lambda^{2}}{Vc}t}} \qquad \text{.....................} \qquad (27)$$

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 (27).

Subject equation (27) to condition in (5), so that we have

$$C_{o} = AC \qquad \text{.................................} \qquad (28)$$

Equation (28) becomes:

$$C_2 = C_o \ell^{\frac{-\lambda^2}{VP}t} \; Cos \frac{\lambda}{\sqrt{Vc}} X \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (29)$$

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

Equation (29) becomes:

$$\frac{\partial c}{\partial t} = \frac{\lambda}{\sqrt{Vc}} C_o \ell^{\frac{-\lambda^2}{VP}t} \; Sin \frac{\lambda}{Vc} x \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (30)$$

i.e. $0 = -C_o \frac{\lambda}{\sqrt{Vc}} \; Sin \frac{\lambda}{\sqrt{Vc}} 0$

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

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

$$0 = -C_o \frac{\lambda}{\sqrt{Vc}} \; Sin \frac{\lambda}{\sqrt{Vc}} B \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (31)$$

$$\Rightarrow \frac{\lambda}{\sqrt{Vc}} = \frac{n\pi}{2}, \; n, 1, 2, 3 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (32)$$

$$\Rightarrow \lambda = \frac{n\pi\sqrt{Vc}}{2} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (33)$$

So that equation (29) becomes

$$C_2 = C_o \ell^{\frac{-n^2\pi^2 Vc}{2VP}t} \; Cos \frac{n\pi\sqrt{Vc}}{2\sqrt{Vc}} x \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (34)$$

$$\Rightarrow C_2 = C_o \ell^{\frac{-n^2\pi^2 Vc}{2VP}t} \; Cos \frac{n\pi}{2} x \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (35)$$

The progression of Thermotolerant transport are cause by the deposition of substrate in soil, the substrate gives more energy to the microbes, it increase microbial population, the expression in this condition were considered in the system were by a model were developed stated in (35), this model expressed other conditions including the substrate deposition in the soil, the expressed model in (35) were able to monitor the microbes with this expression.

We consider equation (6)

$$V \frac{\partial c_3}{\partial t} = -\frac{f}{\pi \partial c^2} \frac{\varepsilon \partial c}{\partial t} \quad \ldots\ldots\ldots \quad (6)$$

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

$$C_3 = XT \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (36)$$

$$\frac{\partial c_3}{\partial t} = XT^1 \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (37)$$

$$\frac{\partial c_3}{\partial Z} = XT^1 \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (38)$$

Again, we put (37) and (38) into (36), so that we have

$$VcXT^1 = \frac{f}{\pi\partial c^2}\varepsilon XT^1 \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (39)$$

i.e. $\frac{VcT^1}{T} = \frac{f}{\pi\partial c^2}\frac{\varepsilon T^1}{Z} = -\lambda^2$ ……………………………… (40)

Hence $\frac{VcT^1}{T} + \lambda^2 = 0$ ……………………………… (41)

i.e. $T^1 + \frac{\lambda^2}{Vc}T = 0$ ……………………………… (42)

And $VcT^1 + \lambda^2 T = 0$ ……………………………… (43)

From (43) $Z = ACos\frac{\lambda}{\sqrt{Vc}}T + BSin\frac{\lambda}{\sqrt{Vc}}T$ ……………………………… (44)

$$T = C\ell^{\frac{-\lambda^2}{Vc}t} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (45)$$

By substituting (44) and (45) into (36), we get

$$C_3 = \left(ACos\frac{\lambda}{\sqrt{Vc}}T + BSin\frac{\lambda}{\sqrt{Vc}}T\right)C\ell^{\frac{-\lambda}{Vc}t} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (46)$$

Subject (46) to conditions in (9), so that we have

$$C_o = AC \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (47)$$

∴ Equation (47) becomes:

$$C_3 = C_o\ell^{\frac{-\lambda^2}{Vc}t}Cos\frac{\lambda}{\sqrt{Vc}}t \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (48)$$

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

$$t = 0, B$$

Equation (48) becomes:

$$\frac{\partial c_3}{\partial t} = \frac{\lambda}{\sqrt{Vc}} C_o \ell^{\frac{-\lambda^2}{Vc}t} \ Sin \frac{\lambda}{Vc} t \quad \ldots\ldots\ldots\ldots\ldots \quad (49)$$

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

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

$$0 = -C_o \frac{\lambda}{\sqrt{Vc}} \ Sin \frac{\lambda}{\sqrt{Vc}} B \quad \ldots\ldots\ldots\ldots\ldots \quad (50)$$

$$\Rightarrow \frac{\lambda}{\sqrt{Vc}} = \frac{n\pi}{2} \quad \ldots\ldots\ldots\ldots\ldots \quad (51)$$

$$\Rightarrow \lambda = \frac{n\pi\sqrt{Vc}}{2} \quad \ldots\ldots\ldots\ldots\ldots \quad (52)$$

So that equation (48) becomes

$$C_3 = C_o \ell^{\frac{-n^2\pi^2 Vc}{2Vc}t} \ Cos \frac{n\pi\sqrt{Vc}}{2\sqrt{Vc}} t \quad \ldots\ldots\ldots\ldots\ldots \quad (53)$$

$$\Rightarrow C_3 = C_o \ell^{\frac{-n^2\pi^2 Vc}{2Vc}t} \ Cos \frac{n\pi}{2} t \quad \ldots\ldots\ldots\ldots\ldots \quad (54)$$

The deposition of Thermotolerant in system continues to express these from (35) to (54) were another model continue to monitor the microbes under the influence of substrate and other parameters in another situation, this is to ensure that at this phase of the microbial migration, there the tendency of increase of microbial population 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 steady flow rate of the system

$$VP \frac{\partial c_4}{\partial X} = -\frac{f}{\pi \partial c^2} \frac{\varepsilon \partial c}{\partial t} \quad \ldots\ldots\ldots\ldots \quad (8)$$

Using Bernoulli's method, we have

$$C_4 = XT \quad \ldots\ldots\ldots\ldots\ldots \quad (55)$$

$$\frac{\partial c_4}{\partial X} = X^1 T \quad \ldots\ldots\ldots\ldots\ldots \quad (56)$$

$$\frac{\partial c_4}{\partial t} = XT^1 \quad \ldots\ldots\ldots\ldots\ldots \quad (57)$$

Put (56) and (57) into (8), so that we have

$$VPX^1 T = -\frac{f}{\pi \partial c^2} \varepsilon XT^1 \quad \ldots\ldots\ldots\ldots\ldots \quad (58)$$

i.e. $$\frac{VPX^1}{X} = \frac{f}{\pi\partial c^2}\frac{\varepsilon T^1}{Z} = \varphi \qquad \text{(59)}$$

$$\frac{VPX^1}{X} = \varphi \qquad \text{(60)}$$

$$-\frac{f}{\pi\partial c^2}\frac{T^1}{T} = \varphi \qquad \text{(61)}$$

$$X = \frac{A\varphi}{\frac{f}{\pi\partial c^2}\varepsilon}X \qquad \text{(62)}$$

And $$T = B\ell\frac{-\varphi}{\frac{f}{\pi\partial c^2}\varepsilon}t \qquad \text{(63)}$$

Put (62) and (63) into (55), gives

$$C_4 = A\ell^{\frac{A\varphi}{\frac{f}{\pi\partial c^2}\varepsilon}x} B\ell^{\frac{-\varphi}{\frac{f}{\pi\partial c^2}\varepsilon}x} \qquad \text{(64)}$$

$$C_4 = AB\ell^{(z-z)}\,{}^{\frac{A\varphi}{\frac{f}{\pi\partial c^2}\varepsilon}} \qquad \text{(65)}$$

Subject equation (66) and (67) yield

$$C_{(4)} = (o) = C_o \qquad \text{(66)}$$

So that, equation (66) becomes

$$C_4 = C_o\ell^{(z-z)}\frac{\varphi}{\frac{f}{\pi\partial c^2}\varepsilon} \qquad \text{(67)}$$

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

$$C_4 = 0 \qquad \text{(68)}$$

The migration of Thermotolerant process were considered to migrate to some extent, this is were the substrate were not deposited, the microbe may be found to experience degradation, thus on the process if the microbial migration, if it can not adapt at a particular region, they may experience death or it may also migrate to the next formation that may found faviourable to them, the condition were expressed in equation 68 were the concentration at that condition is assumed to be zero

Therefore solution of the system is of the form

$$C = C_1 + C_2 + C_3 + C_4 \qquad \text{(69)}$$

Now, we substitute (16), (35), (54) and (69) into (70), so that we have the model of the form

$$C = C_o + C_o \ell^{\frac{-n^2\pi^2 VP}{4\frac{\varphi}{\frac{f}{\pi\partial c^2}\varepsilon}} x} \bullet {}^{\frac{n^2\pi^2 Vc}{4VP} t} Cos \frac{n^2\pi^2}{4} X \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (70)$$

The final equation becomes

$$C = C_o \left[1 + \ell^{\frac{-n^2\pi^2 VP}{4\frac{\varphi}{\frac{f}{\pi\partial c^2}\varepsilon}} t} \bullet {}^{\frac{n^2\pi^2 Vc}{4VP}} + Cos \frac{n^2\pi^2}{4} X \right] \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (71)$$

The expression in (71) is the final developed model equation that expressed the blocking effect on sequential adsorption of Thermotolerant in unconfined aquifers, the model were developed considering the behaviour of the microbes in phases, the expressed developed model considered the parameters that influence the transport system in homogeneous unconfined aquifers. The expressed mathematical model will definitely predict the blocking effect in Radom sequential effect on Thermotolerant in unconfined aquifers

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 transport of Thermotolerant under the influence of block effects and sequential adsorption in unconfined aquifer. The model has streamlined the relationship of different formation characteristics considered in the system to have influenced the behaviour of Thermotolerant transport process in homogenous unconfined aquifer in the study area.

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