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Research article

MATHEMATICAL MODEL TO PREDICT VIRUS MIGRATION INFLUENCED BY CONSTANT PERMEABILITY AND POROSITY DISPERSION ON HOMOGENEOUS SILTY AND COARSE FORMATION IN COASTAL AREA OF ABONNEMA, RIVERS STATE OF NIGERIA.

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Abstract

Homogeneous deposition of porosity and permeability in silty and coarse formation were found to develop influence on the dispersions of virus in coastal area of Abonnema, This conditions were confirmed through various hydrological studies carried in previous years past in the study area, several concept has been applied to monitor dispersion rate of virus the biological point sources but proof abortive in the study area, this due to lack of in sufficient information in theory any practical about the geological formation in the study location, the dispersion influences were confirm through the rate hydraulic conductivity of the formation thus expressed through the rate of high yield rate. To monitor this condition, mathematical model were found suitable by application of the stated mathematical method, this is applied to monitor the dispersions rate of virus in the system; the derived mathematical model will definitely monitor the rate homogeneous porosity and permeability on dispersion level of virus in coastal area of Abonnema.

Keywords: mathematical model virus migration permeability and porosity dispersion silty and coarse formation

1. Introduction

In the previous two decades, a number of researches have been done with batch, flowing column, and field experiments on viral performance in the subsurface. Quite a lot of processes may affect viral fate and transport in ground water, irreparable attachment, reversible attachment, and inactivation only irreversible attachment can result in permanent removal of viruses from water. The viral behavior in ground water appears to be controlled by the properties of viruses (Dowd et al. 1998; Deborde et al. 1999; Schijven et al. 2001; Woessner et al. 2001; Huade et al 2003), the properties of the porous medium (Loveland et al. 1996; Pieper et al. 1997; Ryan et al. 1999), and the properties of water transporting the virus (Loveland et al. 1996; Bales et al. 1993, 1997; Redman et al. 1999 Huade et al 2003). An incomplete understanding of the processes governing virus fate and transport is achieved if the study does not consider all controlling factors from the three aspects listed. The electrostatic attraction and repulsion, van der Waals forces, and hydrophobic effects are three major forces responsible for interaction between the virus and the porous medium (Jin et al. 2000). In particular, viral attachment was observed to be a function of water pH (Bales et al. 1993, 1997), the isoelectric point (pHiep) of the porous medium (Loveland et al. 1996), and the isoelectric point of the virus (Deborde et al. 1999; Dowd et al. 1998; Woessner et al. 2001; Huade et al 2003). In another development in microbial deposition in soil and water environment, Metals play an integral role in the life processes of microorganisms. Some metals, such as calcium, cobalt, chromium, copper, iron, potassium, magnesium, manganese, sodium, nickel and zinc, are essential, serve as micronutrients and are used for redox-processes; to stabilize molecules through electrostatic interactions; as components of various enzymes; and for regulation of osmotic pressure (Bruins et al., 2000). Many other metals have no biological role (e.g. silver, aluminums, cadmium, gold, lead and mercury), and are nonessential (Bruins et al., 2000) and potentially toxic to microorganisms. Toxicity of nonessential metals occurs through the displacement of essential metals from their native binding sites or through ligand interactions (Nies, 1999; Bruins et al., 2000). For example, Hg2+, Cd2+ and Ag2+ tend to bind to SH groups, and thus inhibit the activity of sensitive enzymes (Nies, 1999). In addition, at high levels, both essential and nonessential metals can damage cell membranes; alter enzyme specificity; disrupt cellular functions; and damage the structure of DNA (Bruins et al., 2000). Even though microorganisms have specific uptake systems, high concentrations of nonessential metals may be transported into the cell by a constitutively expressed unspecific system. This “open gate” is the one reason why metal ions are toxic to microorganisms (Nies, 1999). As a consequence, microorganisms have been forced to develop metal-ion homeostasis factors and metal-resistance determinants (Nies and Silver, 1995; Nies, 1999; Bruins et al., 2000 Turpeinen, 2002).

1. Theoretical Background

The rate permeability in soil and water environment were monitor under the influences of homogeneous formation, such condition were express mathematically to descretize the behaviour of the virus in soil and water environment, Constant permeability in strata influence the transport of virus in the formation. Transport of virus has been investigated by several experts that it travel more than three hundred meter in soil, several condition are found to influence the transport system, but in some conditions the influences in most of them are insignificant on the transport process in soil and water environment, the study area deposited homogeneous silty and gravel formation, such deposition developed constant migration of virus in the transport process, the migration are influenced by constant permeability and porosity, the uniformity of the parameters influenced the rate of contaminant in ground water aquifers, the stratification of the formation determined the rate of permeability and porosity deposition, the study location are affected by the transport of virus in soil and water environment, this has developed several abortive well in the study location. To monitor the migration of virus in soil and water environment between silty and gravel formation, mathematical model were found suitable in to monitor the behaviour of the virus in homogeneous silty and coarse formation, silty stratum develop low permeability and porosity more than gravel were the hydraulic conductivity is very high, the concept were to monitor the rate of fast migration of virus in those formations, this will definitely develop concept of predicting the rate of concentration in those formations. Ground water aquifers that experience this contaminant will definitely developed ground water pollution from virus deposition in the study locations. The developed mathematical model will definitely monitor the rate of virus concentration in the study area of Abonnema. The governing equations are expressed bellow.

3. Governing Equation

$$V_L \frac{\partial^2 C}{\partial Z^2} - \Phi \overline{K} \frac{\partial C}{\partial Z} = \frac{\partial C}{\partial t} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \qquad (1)$$

The governing equation to monitor the rate of virus were express to monitor the rate of virus transport in constant permeability and porosity in coastal area of Abonnema, the rate of permeability and porosity were found to be homogeneous in the system, this conditions were found to influence the migration of the virus under the influences of uniformity of the strata, the conditions were expressed mathematically as a system developed to monitor the deposition of virus under constant permeability and porosity. The boundary values are base on the on the behaviour of the virus in the system as it is expressed bellow.

Boundary condition $C(o,t) = C_o \ for \ t > 0 \ (z,o)$ and $C(\infty,t) = 0 \ C_o \ for \ t \geq 0$

The Laplace transform for a function $f(t)$ which is defined for all values of $t \geq 0$ is given.

$$\rho f(t) = f(s) = \int_0^\infty e^{-st} f(t)\,dt \quad f(t) = \rho^{-1} f(s) \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \qquad (2)$$

$$\rho f^{1}(t) \;=\; s\rho f(t) \;-\; f(o) \; where \;\; f^{1}(t) = \frac{\partial f}{\partial t} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \qquad (3)$$

$$\rho f^{11}(t) \;=\; s\rho f^{1}(t) \;-\; f^{1}(o) = s\left[s\rho f(t) - f^{1}(o)\right] - f^{1}(o) = s^{2}\rho f(t) - sf(o) - f^{1}(o)$$

Taking the Laplace transform of the function *C* with respect to *t* in eqn (1)

$$V_L\, \rho\left[\frac{\partial C^2}{\partial Z^2}\right] \;=\; \Phi K \rho\left[\frac{\partial C}{\partial Z}\right] \;=\; \rho\frac{\partial C}{\partial t} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \qquad (4)$$

The expression from equation one to four were transform through the application of Laplace transformation, the application were introduce to ensure that the parameters in the system express their various function subject to the behaviour of the virus, the transformed parameter will be able express their influential behaviour in the transport system. The transformation of the parameters is to ensure that the system produce normal function so that the objective of this study can be achieved.

Where $\rho\left[\frac{\partial C}{\partial t}\right] \;=\; s\rho(c) - C\,(z, o)$

This implies [*C* is a function of *z* and *t* i.e., $C\,(z,t) = f(t) = \rho C(z,t) = \overline{C}$]

Let $\overline{C} \;=\; \rho(c) \; then \;\; \rho\left[\frac{\partial C}{\partial Z}\right] \;-\; \frac{\partial}{\partial Z}\rho(C) = \frac{\partial \overline{C}}{\partial Z} \;\; and \;\; \rho\left[\frac{\partial^2 C}{\partial Z^2}\right] \;=\; \frac{\partial^2}{\partial Z}\;\rho(c) \;=\; \frac{\partial^2 C}{\partial t}$

Where $\overline{C}(z) = \rho C(z,t)$, that is only *t* changes to s and *z* is unaffected, and *s* is the Laplace parameter.

The boundary condition changes to:

At $z = 0;\!: \overline{C}(z) \;=\; \int_0^{\infty} e^{-stt}\, C(z,t)\, dt = \int_0^{\infty} e^{-st}\, C_o\, dt = \Big|_0^{\infty} -\frac{1}{s} e^{-st} C_o \;=\; \frac{C_o}{s}$

At $z = \infty : \overline{C}(z) \;=\; \int_0^{\infty} e^{-st}\, C_o(z,t) \;=\; 0$

Therefore, at $z = 0,\; \overline{C}(z) = \frac{C_o}{s}$, and $z = \infty,\; \overline{C}(z) = 0$

The expression in this system shows that constant concentration were monitored in this stage of transport process, the concentration maintained constant concentration in some certain region of the formation, this is under the influences of homogeneous strata, such formation are assumed to maintained uniform flow net in the strata, this condition may not be applicable to every formation, but in some strata such experience are found to develop slight variation, but in most case it may be assumed insignificant in the system depending on the deposition soil stratification under the influence of geological setting in the study location.

[Since this is one dimensional flow equation, the partial derivative changes to the full derivative, *s* is a Laplace parameter, which disappears on taking the inverse].

From the substitution Eqn (4)

$$V_L = \left[\frac{d^2 c}{\partial z^2}\right] - \Phi \overline{K}\left[\frac{d\overline{c}}{dz}\right] = S\overline{C}$$

Substituting these values in Eqn (4) gives

$$V_L \ A\lambda^2 e^{\lambda^2} - \ \Phi\overline{K}A\lambda e^{\lambda^2} - SA\lambda e^{\lambda z} = 0 \ or \ \left[\lambda^2 \frac{\overline{\Phi K}}{V_L}\lambda - \frac{s}{V_L}\right]e^{\lambda z} = 0 \qquad \ldots\ldots\ldots\ldots \qquad (5)$$

This will be a solution if the auxiliary equation or the characteristic equation = 0, that is

$$\left[\lambda^2 \frac{\overline{\Phi K}}{V_L}\lambda - \frac{s}{V_L}\right] = 0 \qquad \ldots\ldots\ldots\ldots \qquad (6)$$

Introduced a standard quadratic equation and the solution is given as

$$\lambda = \frac{\frac{\overline{\Phi K}}{V_L} \pm \sqrt{\frac{\overline{\Phi K}}{V_L} + \frac{4s}{V_L}}}{2}$$

That is $\lambda_1 = \dfrac{\overline{\Phi K} + \sqrt{\overline{\Phi K}^2 + 4sV_L}}{2V_L}$ and $\lambda_2 = \dfrac{\overline{\Phi K} - \sqrt{\overline{\Phi K}^2 + 4sV_L}}{2V_L}$

Therefore, either $\overline{C} = Ae^{\lambda_1 t} \ or \ \overline{C} = Ae^{\lambda_2 t}$ is a condition. However, only the latter satisfies the boundary condition.

At $z = \infty, \ \overline{C} = \dfrac{C_o}{s} e^{-\infty} = 0$ {because λ_2 is -ve and λ_1 is +ve}

Therefore $\overline{C} = A\left[\dfrac{\overline{\Phi K} - \sqrt{\overline{\Phi K}^2 + 4sV_L}}{2V_L}\right]^z$ is the solution ………………………….. (7)

At $Z = 0, \ \overline{C} = \dfrac{C_o}{s}$ gives $A = \dfrac{C_o}{s}$

Therefore $\overline{C} = \frac{C_o}{s}\left[\exp\left[\frac{\overline{\Phi K} - \sqrt{\overline{\Phi K}^2 + 4sV_L}}{2V_L}\right]z\right]$ is the solution …… (8)

The terms from equation [5-8] showcase the function of the system, it show the interface with other variables under the pressure of first order differential expression. The concentrations were still measured to be under steady flow in the system. but now the parameters' were express by integration at various condition were they have various function in the system, the transformation of the parameters were in line with the rate of incorporation, so that the functions of every variable will be articulated, the rate of formation variables were considered in this trend, this is because it equally affect the entire system on the transport process, such condition were considered under the influences of variation of porosity and velocity of flow in the formation.

From Equation (7) $C(z,t)$ can be determined as $\rho^{-1}\overline{C}(z)$

Equation (7) can further be written as $\rho^{-1}\overline{C}(z) =$:

$$C_o \exp\left(\frac{\overline{\Phi K}z}{2V_L}\right)\frac{1}{s}\exp\left[\frac{-z}{\sqrt{V_L}}\left(\frac{\overline{\Phi K}^2}{4V_L} + s\right)^{\frac{1}{2}}\right]$$

Applying the inverse Laplace transform to the above equation gives

$$C(z,t) = \rho^{-1}\overline{C}(z) = \rho^{-1}\left[C_o \exp\left(\frac{\overline{\Phi K}z}{2V_L}\right) - \frac{1}{s}\exp\left[\frac{-z}{\sqrt{V_L}}\left(\frac{\overline{\Phi K}^2}{4V_L} + s\right)^{\frac{1}{2}}\right]\right] \quad \text{.......................(9)}$$

The appearance from this phase were integrated by applying quadratic function, this submission were to ensure the significant parameters express their function in terms showing relevant at different state on this is base on dispersion rate of the microbes in the study area. Such circumstance expressed in the transport system of microbes implies that the behaviour at uniformity coefficient of the soil formed should be evaluated, to assess such condition, the relevance of quadratic function were suitable establish in that stage. The appliances of quadratic equation were articulated thoroughly, it is suitable to monitor the variables expressed parameters in the system, under the influence of constant flow net in the dispersion of microbes. The variations may be insignificant at this phase of the system as

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expressed in equation [9]. This implies that the soil matrix of the formation was assumed to be in this condition, it showcase dispersion from one region to the other under the influences of plug flow application. Boundary values were found essential in this condition because there should be limit of migration under the influences of homogeneity of the formation some certain depths, the boundary condition developed were integrated in the derived solution to ensure that their limit are base on the behaviour of the microbes are expressed mathematical derivation in the study of the dispersions condition of virus in the study location.

Application of the inverse Laplace transform to the above equation gives

$$=C(z,t) = \rho^{-1}\overline{C}(z) = \rho^{-1}\left[C_o \exp\left(\frac{\overline{\Phi K}z}{2V_L}\right)\frac{1}{s}\exp\left[\left(\frac{-z}{\sqrt{4V_L}}+s\right)^{\frac{1}{2}}\right]\right]$$

$$= \left[C_o \exp\left(\frac{\overline{\Phi K}z}{2V_L}\right)\rho^{-1}\frac{1}{s}\exp\left[\left(\frac{-z}{\sqrt{4V_L}}+s\right)^{\frac{1}{2}}\right]\right] \quad \ldots\ldots\ldots \quad (10)$$

From the Laplace transform table

$$\rho^{-1}\left(\frac{1}{s}\exp\left(-\alpha\sqrt{\beta^2+s}\right)\right) = \int_0^t \frac{\alpha}{2\sqrt{\pi,\beta}}\exp\left[-\left(\frac{\alpha^2}{4u}+\beta^2 u\right)du\right] \quad \ldots\ldots \quad (11)$$

Here $\frac{Z}{\sqrt{V_L}}$ *and* $\beta = \frac{\overline{V}}{2\sqrt{V_L}}$

Therefore

$$C(z,t) = \rho^{-1}\overline{C}(z) = C_o \exp\left(\frac{\overline{V}z}{2V_L}\right)\left[e^{-\alpha\beta}\int_0^t \frac{\alpha}{2\sqrt{\pi,\beta}}\exp\left[-\frac{\alpha^2}{4u}-\beta^2 u+\alpha\beta du\right]\right] \ldots\ldots\ldots\ldots \quad (12)$$

The term in the bracket = $\left[e^{-\alpha\beta}\int_0^t \frac{\alpha}{2\sqrt{\pi,\beta}}\exp\left[\frac{(\alpha-2\beta u)^2}{4u}du\right]\right]$ …………… (13)

$$= e^{-\alpha\beta} \int_0^t \left[\frac{\alpha + 2\beta u}{4\sqrt{\pi u^3}} + \frac{\alpha - 2\beta u}{4\sqrt{\pi u^3}} \right] \exp\left[-\frac{(\alpha - 2\beta u)^2}{4u} du \right] \quad \ldots\ldots\ldots\ldots\ldots \quad (14)$$

$$= e^{-\alpha\beta} \left[\int_0^t \left[\frac{\alpha + 2\beta u}{4\sqrt{\pi u^3}} \exp\left[\frac{(\alpha - 2\beta u)^2}{4u} du \right] + e^{2\alpha\beta} \int_0^t \frac{\alpha - 2\beta u}{4\sqrt{\pi u^3}} \right] \exp\left[\frac{(\alpha + 2\beta u)^2}{4\sqrt{\pi u^3}} du \right] \right] \quad \ldots\ldots \quad (15)$$

Let $\frac{\alpha - 2\beta u}{\sqrt{4u}} = A \; and \; \frac{\alpha + 2\beta u}{\sqrt{4u}} = B$ ……………. (16)

Differentiating the term in Equation (16) give

$$\frac{dA}{du} = \frac{\sqrt{4u}(0 - 2\beta) - 2\frac{1}{2}\sqrt[\frac{1}{2}]{u}\,(\alpha - 2\beta u)}{4u} \quad and \quad \frac{\sqrt{4u}(0 + 2\beta) - 2\frac{1}{2}\sqrt[\frac{1}{2}]{u}\,(\alpha - 2\beta u)}{4u} \quad \ldots\ldots \quad (17)$$

Or $$\frac{dA}{du} = \frac{-4\beta\sqrt{u}\frac{-\alpha}{u} + 2\beta\sqrt{u}}{4u} = \frac{-2\beta u - d}{4\sqrt{u^3}} = \frac{-(\alpha + 2\beta u)}{4\sqrt{u^3}}$$

And $$\frac{dB}{du} = \frac{4\beta\sqrt{u}\frac{-\alpha}{u} - 2\beta\sqrt{u}}{4u} = \frac{2\beta u - d}{4\sqrt{u^3}} = \frac{-(\alpha - 2\beta u)}{4\sqrt{u^3}}$$

Or $dA = \frac{-(\alpha + 2\beta u)}{4\sqrt{u^3}} du \; and \; dB = \frac{-(\alpha - 2\beta u)}{4\sqrt{u^3}} du$ ……………. (18)

$$C(z,t) = C_o \exp\left(\frac{\overline{\Phi K z}}{2V_L} \right) \left[-\int_0^{\frac{\alpha - 2\beta t}{\sqrt{ut}}} \exp\left(-A^2\right) \frac{dA}{\sqrt{\pi}} - e^{2\alpha\beta} \int_\infty^{\frac{\alpha + 2\beta t}{\sqrt{4t}}} \exp\left(-\beta^2\right) \frac{dB}{\sqrt{\pi}} \right] \quad \ldots\ldots\ldots \quad (19)$$

For the limit when $u = 0$

$$A = \frac{\alpha - 2\beta.0}{0} = \infty B = \frac{\alpha + 2\beta.0}{0} = \infty, and \; when$$

$$u = t, A = \frac{\alpha - 2\beta t}{\sqrt{4t}} = and \;\; B = \frac{\alpha + 2\beta : t}{\sqrt{4t}} du$$

Changing the integral limits in Equation (19), it is given as

$$\frac{1}{2}\frac{2}{\sqrt{\pi}}e^{-\alpha\beta}\int_{\frac{\alpha-2\beta t}{\sqrt{4t}}}^{\infty}\exp\left(-A^2\right)dA+\frac{1}{2}\frac{2}{\sqrt{\pi}}e^{\alpha\beta}\int_{\frac{\alpha-2\beta t}{\sqrt{4t}}}^{\infty}\exp\left(-B^2\right)dB \qquad \ldots\ldots\ldots\ldots\ldots \qquad (20)$$

The expression at this stage of the system showcase lots of interaction of the variables expressing their fitness to each other in the system, this situation clarify the various comparison conformity of the variables under homogeneous condition. These expressions achieve the migration of microbes at different phase through the micropoles deposition in the soil and water environment. Such condition showcase the incorporation of variables to define the rate of soil deposition under the influence of formation characteristics in the formation, this state of microbes established expressed their behaviour in this direction of flow is always in accordance with the level of formation characteristics, such as porosity will definitely influence velocity of flow in the stratification of the soil. Furthermore microbial reactions were found to develop inverse condition on the transport system, whereby the microbes become inverse within themselves in some certain region of the soil, the deposition of microbes can found at different species, such condition develop inverse were some of the microbes becomes larger than the other in a certain region of the soil. The conditions of inverse are showcase in the transport system as expressed in the derived expression. The expressed accommodate the factor of this condition in the derived solution in other to showcase that condition in the system as expressed above

The complimentary error function is defined as $erfc\, x=\frac{2}{\sqrt{\pi}}\int_{\frac{\alpha-2\beta t}{\sqrt{4t}}}^{\infty}\exp\left(-t^2\right)dt$

For which Equation (20) changes to

$$\frac{e^{-\alpha\beta}}{2}erfc\frac{\alpha-2\beta t}{\sqrt{4t}}+\frac{e^{-\alpha\beta}}{2}erfc\frac{\alpha+2\beta t}{\sqrt{4t}} \qquad \ldots\ldots\ldots\ldots\ldots \qquad (21)$$

The various combinations of α and β can be simplified as follows:

$$\alpha\beta=\frac{Z}{V_L}\frac{\overline{V}}{2\sqrt{V_L}}=\frac{\overline{\Phi Kz}}{2\sqrt{V_L}};\ \frac{\alpha+2\beta t}{\sqrt{4t}}=\frac{\frac{Z}{\sqrt{V_L}}+\frac{\overline{\Phi Kt}}{\sqrt{V_L}}}{2\sqrt{t}}=\frac{Z+\overline{\Phi Kt}}{2\sqrt{V_L{}^{t}}}\ \text{and}$$

$$\frac{\alpha-2\beta t}{\sqrt{4t}}=\frac{\frac{Z}{\sqrt{V_L}}+\frac{\overline{\Phi Kt}}{\sqrt{V_L}}}{2\sqrt{t}}=\frac{Z-\overline{\Phi Kt}}{2\sqrt{V_L{}^{t}}}$$

Using these, equation (21) changes to

$$\frac{e\frac{\overline{KZ}}{2V_L}}{2}erfc\left[\frac{Z-\overline{\Phi Kt}}{2\sqrt{V_L{}^{t}}}\right]+\frac{e\frac{\overline{\Phi KZ}}{2V_L}}{2}erfc\left[\frac{Z+\overline{\Phi Kt}}{2\sqrt{V_L{}^{t}}}\right]$$

Therefore finally, Equation (11) with equation (14) changes to

$$C(z,t) = C_o \exp\left(\frac{\overline{\Phi K}z}{2V_L}\right)\frac{1}{2}\exp\left(-\frac{\overline{\Phi K}z}{2V_L}\right)erfc\left[\frac{Z-\overline{\Phi K}t}{2\sqrt{V_L{}^t}}\right]\frac{1}{2}\exp\left(\frac{\overline{\Phi K}z}{2V_L}\right)erfc\left[\frac{Z+\overline{\Phi K}}{2\sqrt{V_L{}^t}}\right]$$

Or $$C(z,t) = \frac{C_o}{2}\left[erfc\left[\frac{Z-\overline{\Phi K}t}{2\sqrt{V_L{}^t}}\right]+\exp\left(\frac{\overline{\Phi K}z}{V_L}\right)erfc\left[\frac{Z+\overline{\Phi K}t}{2\sqrt{V_L{}^t}}\right]\right] \quad \ldots\ldots\ldots\ldots\ldots \quad (22)$$

The explicit dispersion in virus under the influence of homogeneous level of permeability and porosity deposited in silty and coarse formations, this condition to express the variables were developed through various mathematical methods. This condition are influenced by the stratification deposition of the formation under the influences of geologic setting, the study of the formation has been found to developed slight heterogeneous which were assumed to be irrelevant in the system as expressed in the formation, this condition were confirmed through physical view of the lithology from the desk study carried out, these conditions were considered in the system at different factors expressed mathematically on the area of study. The behaviour virus in those regions found through the physical view to be homogeneous in porosity and permeability from the yield rate considered to influence the behaviour of the microbial deposition soil and water environments. These conditions showcased the application of errors functions due to slight variable in the deposition of the soil matrix in the study location. The behaviour of the microbes on this condition were slight variation of heterogeneous, but were assumed to be insignificant, base on this factors it is imperative to apply errors function to accommodated this variation in the system as expressed in the final model equation in [22]. The application of errors function monitor the concentration of the microbes under the behaviour homogeneous condition reflected from high to low concentration in the study location, it should be compared with laboratory results expressing the same direction.

4. Conclusion

The rate of dispersion of virus in the entire study locations were subject of concern due to fast dispersions of contaminants in to ground water aquifers. Such condition were assessed in terms of some influential parameters that be responsible for this pollutant in the study area, such state found in virus through formation characteristics was monitored through waters risk assessment to have spread entire area of Abonnema, the study location are predominant with alluvium deposition under coastal fresh and shallow water aquifers, this implies that formation characteristics like high degree of Permeability with high hydraulic conductivity were paramount in the study location developing fast dispersions of virus in the study location. this situation on the virus characteristic develop some variables considered to have pressure the rate virus dispersion in the entire location, this circumstance generated numerous ground water contaminant which lots of conceptual frame has been applied but proof unproductive, base on the failure mathematical model was proof appropriate to evaluated the problem and at the same time monitor the rate of spread under the influence of formation characteristics like porosity and flow through the coefficient of permeability of the soil in the study location. The expressed mathematical equation modified is to solve the problem considered in the system, several factors under the influence of formation characteristics and microbial behaviour were monitored under exponential condition in the system, the modified equation has definitely streamline the factors that will definitely monitor the rate of dispersion under homogeneous porosity and permeability in the study location.

Reference

[1] Bales, R.C., S. Li, K.M. Maguire, M.T. Yahya, and C.P. Gerba 1993. MS–2 and poliovirus transport in porous medium: Hydrophobic effects and chemical perturbations. *Water Resources Research* 29, no. 4: 957–963.

[2] Bales, R.C., S.Li, T.C.J. Yeh, M.E. Lenczewski, and C.P. Gerba. 1997. Bacteriophage and microsphere transport in saturated porous medium: Force-gradient experiment at Borden, Ontario. *Water Resource Research* 33, 639–648.

[3] Huade G Dirk S -Makuch, Steve S, and Suresh. P D The Effect of Critical pH on Virus Fate and Transport in Saturated Porous Medium Vol. 41, No. 5 ground water September–October 2003 (pages 701–708

[4] Deborde D.C., W.W. Woessner, Q.T. Kiley, and P. Ball. 1999. Rapid transport of viruses in a floodplain aquifer. *Water Research* 33, no. 10: 2229–2238. Dowd, S.E., S.D. Pillai, S.Wang, and M.Y.Corapcioglu. 1998.

[5] Delineating the specific influence of virus isoelectric point and size on virus adsorption and transport through sandy soils. *Applied and Environmental Microbiology* 64, no. 2: 405–410

[6] Loveland, J.P., J.N. Ryan, G.L. Amy, and R.W. Harvey. 1996. The reversibility of virus attachment to mineral surfaces *Colloids and Surfaces A: Physicochemical and Engineering Aspects* 107, 205–221.

[7] Pieper, A.P., J.N. Ryan, R.W. Harvey, G.L. Amy, T.H. Illangasekare, and D.W. Metge. 1997. Transport and recovery of bacteriophage PRD1 in a sand and gravel aquifer: Effect of sewage-derived organic matter. *Environmental Science & Technology* 31, no. 4: 1163–1170.

[8] Redman, J.A., S.B. Grant, T.M. Olson, J.M. Adkins, J.L. Jackson, M.S. Castillo, and W.A. Yanko. 1999. Physicochemical mechanisms responsible for the filtration and mobilization of a filamentous bacteriophage in quartz sand. *Water Research* 33, no. 1: 43–52.

[9] Jin, Y., Y. Chu, and Y. Li. 2000. Virus removal and transport in saturated and unsaturated sand columns. *Journal of Contaminant Hydrology* 43, 111–128.

[10] Ryan, J.N., and M. Elimelech. 1996. Colloid mobilization and transport in groundwater. *Colloids and Surfaces A: Physicochemical and Engineering Aspects* 107, 1–56.

[11] Ryan, J.N., M. Elimelech, R.A. Ard, R.W. Harvey, and P.R. Johnson. 1999. Bacteriophage PRD1 and silica colloid transport and recovery in an iron oxide-coated sand aquifer. *Environmental Science & Technology* 33, 63–73.

[12] Schijven, J.F., S.M. Hassanizadeh, S.E. Dowd, and S.D. Pillai 2001. Modeling virus adsorption in batch and column experiments. *Quantitative Microbiology* 2, 5–20.

[13] Woessner, W.W., P.N. Ball, D.C. Deborde, and T.L. Troy. 2001. Viral transport in a sand and gravel aquifer under field pumping conditions. *Ground Water* 39, no. 6: 886–894.

[14] Bruins, M.R., Kapil, S., Oehme, F.W. 2000. Microbial resistance to metals in the environment. Ecotoxicol and Environ Safety 45, 198-207.

[15] Nies, D.H. 1999. Microbial heavy-metal resistance. Appl Microbiol Biotechnology 51, 730-750.

[16] Turpeinen R 2002 Interactions between metals, microbes and plants – Bioremediation of arsenic and lead contaminated soils dissertation Department of Ecological and Environmental Sciences, University of Helsinki