International Journal of Environmental Engineering Science and Technology Research
Vol. 1, No. 9, September 2013, PP:217-228, ISSN: 2326-3113 (Online)
Available online at www.ijestr.org

Research article

MATHEMATICAL MODEL TO PREDICT THE DISPERSION OF E.COLI INFLUENCED BY HOMOGENOUS POROSITY AND VELOCITY IN DEPOSITED GRAVEL FORMATION IN DEGEMA, 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

Mathematical model to predict the dispersion of E.coli influenced by homogenous porosity and velocity in deposited gravel formation in Degema has been developed. The expressed model were developed base on some factors considered to be the fundamental variables in the transport process, formation characteristics were assumed to be in homogeneous deposition which also reflected on the velocity of flow, this variables express the rate of dispersion in the study area, the behaviour of E.coli in this direction were considered in the derived expressions, such microbial behaviour were considered in the system, the derived mathematical expression showcase all the behaviour of the microbes in the derived model, this expression will monitor dispersion level of E.coli influenced by homogeneous porosity and velocity in deposited gravel formation in coastal area of Degema, the study is imperative because it will assist practicing water engineers and hydrologist to monitor the rate dispersion of E.coli in this direction.

Keywords: mathematical model dispersion of E.coli, homogenous porosity and velocity

---

1. Introduction

Intermittent infiltration through permeable soils or sand filters has been increasingly used for the treatment of primary or secondary wastewater effluents [Brissaud and Lesavre, 1993; Stevik et al., 2004] because of its low energy and maintenance requirements. The use of these systems represents a simple and low-cost solution to wastewater treatment in developing countries and even in developed ones. These systems can also increase the recharge of groundwater aquifers, but there is concern about the impacts on water quality. In a typical intermittent filter, the surface is sequentially dosed with partially treated sewage effluent that percolates in a single pass through the unsaturated porous medium [U.S. Environmental Protection Agency (USEPA), 1999]. Research and field experiments have shown that intermittent filtration can provide high removal efficiency of bacteria if properly designed and operated [Brissaud et al., 1991; Gold et al., 1992; Guessab et al., 1993; Castillo et al., 2001; Ausland et al., 2002]. Therefore filtered secondary treatment effluents can be used for unrestricted agricultural irrigation [Salgot et al., 1996; Shelef and Azov, 1996], irrigation of public parks, lawns and golf courses [Faby et al., 1999] and groundwater recharge [Bouwer, 1996]. Intermittent filtration can also occur naturally as water is sprayed in an infiltration basin [Mottier et al., 2000] or in other processes to replenish the aquifer with reclaimed water [World Health Organization, 2003], but the pathogen removal capability needs to be understood. Intermittent flushing might also be relevant for colloid transport in unsaturated media, whether intentional or due to a leak from a container [Pang et al., 2003]. The removal of microorganisms during infiltration can be attributed to the combination of straining, adsorption and inactivation. Straining is influenced by filter media grain size, amount of filter clogging and water content [Yao et al., 1971; McDowell-Boyer et al., 1986]. Adsorption is mainly controlled by surface characteristics of the porous medium, water flow velocity, wastewater ionic strength, pH, moisture content and cell surface characteristics [Ryan and Elimelech, 1996]. Microbial die-off depends on temperature, pH, presence of other microorganisms in the porous media [Matthess and Pekdeger, 1981; Schijven and Hassanizadeh, 2000] and operating parameters such as hydraulic load, number of flooding-drainage cycles per day and existence of preferential flow paths [Stevik et al., 1999] Several authors have estimated fecal coliform removal in intermittent filters based on water retention time using conservative tracer experiments [Brissaud et al., 1999; Van Cuyk et al., 2001; Ausland et al., 2002]. Powelson and Mills [2001] were one of the first investigators to track the movement of bacteria by labeling the cells in a simulated septic system under variable unsaturated flow. Some other studies examined the removal of Escherichia coli by deep well injection into a sandy aquifer [Schijven et al., 2000; Maria and Arturo 2005].

2. Theoretical background

Dispersion of E.coli were monitored in a uniform soil porosity and velocity of the soil deposition, this deposition E.coli formation monitored is known to be gravel stratum, the behaviuor of the microbes E.coli are assumed, to be under homogeneous stratum expressed to be a plug flow reactor, this present condition of the formation implies that the stratification of the formation are monitored at the aquiferous zone under the influence of aquifer thickness, this conceptual framework presented the reality of uniformity flow condition influenced by the homogeneity of gravel formation in aquiferous zone. Such expression should present different behaviuor if the dispersion is not influenced by the homogeneous deposition of porosity and velocity of flow, but under normal condition, the rate of velocity and porosity are reflected on the formation in the study location thus affect the dispersion rate of the microbes in the stratum. Velocity of flow are influenced by the degree of porosity under the rate of homogeneous deposition of gravel formation in the aquiferous zone, such reflection from porosity develop the rate of dispersion of E.coli as it is generated in the transport process in aquiferous zones, the study predict the rate of dispersion under the influence of uniform flow through homogeneous deposition of gravel formation in aquiferous strata. The study geological histories are in accordance with rate of stratification of formation as expressed in the system. The system are formulated base on this frame work, this is to ensure that the system express the transport behaviour under the influence of the stated variable expressed in the study, the study determined the rate of dispersion in the study location, this condition shows how the express mathematical equation are design to monitor the rate of E.coli spread in the entire environment, there may be variation in some location base on the stated formation characteristics in the study location, the expression of this conditions stated determined the rate of E.coli dispersion in the system, the velocity of the flow net within the stratification will also display the rate of E.coli migration under the influences of dispersion of solute in study location, the expression from this dimension are imperative because it express the rate of dispersion of E.coli at different stratification under the influence of formation characteristic variation in soil and water environment. Development of this expressed mathematical equation will definitely monitor various variations of stratifications of the soil formation in the study area.

3. Governing Equation

$$D_L \frac{\partial C}{\partial t} = \bar{V} \frac{\partial^2 C}{\partial Z^2} - \Phi \frac{\partial C}{\partial Z} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

The expression in equation one is the governing equation is to monitor the rate of dispersion of E.coli, in the study location, such expression were developed through mathematical symbol that formulated the governing equation, such system were developed from the study [Rastogi, 2007]. The modified equation was developed through variables that were found essential on the study as expressed above.

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

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

$$\rho f(z) = f(s) = \int_0^\infty e^{-sz} f(z) dz \;\; f(z) = \rho^{-1} f(s) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots.. \quad (2)$$

$$\rho f(z) = s\rho = s\rho f(z) - f(o) \; where \; \rho^1(z) = \frac{\partial f}{\partial Z} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots.. \quad (3)$$

Taking the Laplace transform of the function *c* with respect to *t* eqn. (1) changes to

$$D_L\,\rho\left[\frac{\partial C}{\partial t}\right] = \overline{V}\left[\frac{\partial^2 C}{\partial Z}\right] - \Phi\rho\frac{\partial C}{\partial Z} \quad \text{..........................} \quad (4)$$

Developing the expression in other to displayed their various roles of action in the system, the condition were developed through the Laplace transformation applied in the system, it is to streamline the various roles of the variables, this includes some established boundary values state on the derived expressed solution that are influential to the dispersion of the microbes in the study location, such transformation develop this expression in equation [4] stated above.

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

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

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

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 derived mathematical expression assumed in the condition to be under the influences of concentration changing with respect to time and distance, this expression show case the direction of flow through the rate of constant change of distance and time, the function time were expressed to showcase the function of time. The reflections of constant concentration of the microbes are influenced by the behaviour of the transport migration at different region. The applications of Laplace transformation were able transform the parameters into the applied mathematical method as expressed above.

At $z = 0 : \overline{C}(z) = \int_0^\infty e^{-st}\,C(z,t)\,dt = \int_0^\infty e^{-st}\,C_o\,dt = \left.\begin{matrix}\infty\\0\end{matrix}\right| -\frac{1}{s}e^{-st}C_o = \frac{C_o}{s}$

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

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

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

From the substitution Eqn.

$$D_L\, s\bar{C} \;=\; \overline{\Phi V}\left[\frac{dc}{\alpha z}\right] - \left[\frac{d\bar{c}}{dz}\right] \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (5)$$

Let $\bar{C} \;=\; Ae^{\lambda z}$ be the solution of the above linear ordinary differential equation. [This is a standard way of solving this class of equations].

The $\frac{d\bar{c}}{dz} \;=\; A\lambda e^{\lambda^2}$ *and* $\frac{d^2\bar{c}}{dz^2} \;=\; A\lambda^2 e^{\lambda^2}$ ………………… (6)

Solution of these values in Eqn. (5) gives

$$D_L\;A\lambda^2 e^{\lambda^2} = \;\overline{\Phi V}A\lambda e^{\lambda^2} - \phi\lambda e^{\lambda^2}\;\; or \left[e^{\lambda^2} \;=\lambda^2\frac{\overline{\Phi V}}{D_L}\,\lambda - \frac{s}{D_L}\;\right] \quad \ldots\ldots\ldots\ldots\ldots \quad (7)$$

This will be a solution of the auxiliary equation or the characteristics Equation = 0, this implies that

$$\left[\lambda^2 - \frac{\overline{\Phi V}}{D_L}\,\lambda - \frac{s}{D_L}\;\right] = \;0 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (8)$$

The expressions from equation [5-8] express the function of the system show the interaction with other variables under the influence of derivation application of first order differential expression. The concentrations were still considered to be under constant 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 integration so that the functions of every variable will be expressed, the rate of formation variables were considered in this direction, this 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.

Equation (8) is the standard quadratic equation and the solution is expressed in this form.

$$\lambda \;=\; \frac{\dfrac{\overline{\Phi V}}{D_L} \;\pm\; \sqrt{\dfrac{\overline{\Phi V}^2}{{D_L}^2} + \dfrac{4s}{D_L}}}{2}$$

That is $\lambda_1 \;=\; \frac{\overline{\Phi V} \;+\; \sqrt{\overline{\Phi V}^2 \;+\; 4sD_L}}{2D_L}$ *and* $\lambda_2 \;=\; \frac{\bar{V} \;-\; \sqrt{\overline{\Phi V}^2 \;+\; 4sD_L}}{2D_L}$

Therefore, either $\bar{C} = Ae^{\lambda,z}$ *or* $\bar{C} = Ae^{\lambda^2 z}$ is a solution. However, only the latter satisfies the boundary condition.

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

Therefore $\overline{C} = A\left[e^{\frac{\overline{\Phi V} - \sqrt{\overline{\Phi V}^2 + 4sD_L}}{2D_L}}\right]^{z}$ is the solution

At $Z = 0\ \overline{C} = \frac{C_o}{s}$ give $A = \frac{C_o}{s}$

Therefore $\overline{C} = \frac{C_o}{s}\left[\exp\left[\exp^{\frac{\overline{\Phi V} - \sqrt{\overline{\Phi V}^2 + 4sD_L}}{2D_L}}\right]\right]$ is the solution ………………… (9)

From Equation (9) $C(z,t)$ can be determined as $\rho^{-1}\overline{C}(z)$

Equation (9) can further be expressed as:

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

The expression from this stage were integrated by applying quadratic equation, this application were to ensure the influential parameters express their function in terms showing function at different condition on the rate of dispersion of the microbes in the study area. Such condition recorded in the transport system of the microbes implies that the behaviour at homogeneity of the soil formed assumed should be evaluated, to assess such condition, the application of quadratic function were found suitable in that stage. The application of quadratic equation were expressed to monitor the quadratic functions expressed by the variable in the system under the influence of constant flow net in the dispersion of the microbes, the variations may insignificant at this stage of the system as expressed in equation [9]. This implies that the stratification of the formation was assumed to be in this condition on the process of dispersion from one region to the other under the influences of plug flow application. Boundary values were found imperative in this condition because there should be limit of migration under the influences of homogeneity of the formation to some certain depths, the boundary condition developed were integrated in the derived solution to ensure that their limited base on the behaviour of the microbes are expressed mathematical in the study of the dispersions condition of E.coli in the study location.

Application of the inverse Laplace transform to the above equation gives

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

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

From the Laplace transform table

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

Here $\frac{Z}{\sqrt{D_L}}$ $and\ \beta = \frac{\phi\overline{V}}{2\sqrt{D_L}}$

Therefore

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

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)

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

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

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) gives

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

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)

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

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

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

The expression at this stage of the system show how the variable fit to each other in the system, this condition explain the various similarity agreement of the variables under uniform condition in terms of their function, this is to achieve the migration of microbes at different stage through the micropoles deposition in the soil and water environment. Such condition showcase the integration of variables to define the rate of stratification under the influence of formation characteristics in the formation, this condition of microbes are found in this direction to always behave in accordance with the rate of formation characteristics deposition such deposited porosity will definitely influence velocity of flow in the stratification of the soil. Furthermore microbial behaviour from E.coli 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 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:

$$\alpha\beta = \frac{Z}{D_L} \frac{\overline{\Phi V}}{2\sqrt{D_L}} = \frac{\overline{\Phi V z}}{2\sqrt{D_L}};\ \frac{\alpha + 2\beta t}{\sqrt{4t}} = \frac{\frac{Z}{\sqrt{D_L}} + \frac{\overline{\Phi V t}}{\sqrt{D_L}}}{2\sqrt{t}} = \frac{Z + \overline{\Phi V t}}{2\sqrt{D_L{}^{t}}}$$

And

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

Using these, equation (21) changes to

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

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

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

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

The expression from dispersion of E.coli under the influence of homogeneous porosity and velocity deposited in gravel were developed through various mathematical expressed condition influenced by the geologic history of the formation, from the study of the formation it has been found that the soil developed slight heterogeneous which were assumed to insignificant in the system as expressed in the formation, these conditions were considered in the system as different conditions are expressed mathematically on the study. The behaviour of microbial depositions E.coli in those regions that expressed homogeneous porosity and velocity were 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 stratification of the soil in the study location. The behaviour of the microbes on this condition are base on slight variation through heterogeneous deposited assumed to be insignificant were imperative to apply errors function to accommodated this variation in the system as expressed in the final model equation in [22].

4. Conclusion

The rate of dispersion of E.coli in the entire study area was a subject of concern due to fast spread of the contaminant in to ground water aquifers in the study location. Such condition were evaluated in terms of assessment of some influential parameters that must be responsible for this contaminant transport in the study area, such condition found in the study area were E.coli through formation characteristics monitored through waters risk assessment, it was found in some part to have spread entire area of Degema, the study location are predominant with alluvium deposition under coastal fresh and shallow water aquifers, this implies that formation characteristics like high degree of porosity were paramount in the study location developing fast dispersions of E.coli in the study location, this expressed condition on the microbial characteristic develop some variables considered to have influence the rate microbial dispersion to the entire location, this condition generated several ground water contaminant which lots of conceptual frame has been applied but proof abortive, 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 velocity of flow through the coefficient of permeability of the soil in the study location the expressed mathematical equation modified to solve the problem considering several factor under the influence of formation characteristics and microbial behaviour 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 velocity in the study location.

References

[1] Ausland, G., T. K. Stevik, J. F. Hanssen, J. C. Køhler, and P. D. Jenssen (2002), Intermittent filtration of wastewater—Removal of fecal coliforms and fecal streptococci, Water Res., 36, 3507– 3516.

[2] Bales, R. C., S. Li, K. M. Maguire, M. T. Yahya, C. P. Gerba, and R. W. Harvey (1995), Virus and bacteria transport in a sandy aquifer, Cape Cod, MA, Ground Water, 33, 653– 661.

[3] Bouwer, H. (1996), Issues in artificial recharge, Water Sci. Technol, 33, 381– 390.

[4] Brissaud, F., and J. Lesavre (1993), Infiltration percolation in France: 10 years experience, Water Sci. Technol., 28, 73–81.

[5] Brissaud, F., M. Restrepobardon, M. Soulie, and C. Joseph (1991), Infiltration percolation for reclaiming stabilization pond effluents, Water Sci. Technol., 24, 185– 193.

[6] Brissaud, F., M. Salgot, A. Bancole, C. Campos, and M. Folch (1999), Residence time distribution and disinfection of secondary effluents by infiltration percolation, Water Sci. Technol., 40, 215– 222.

[7] Faby, J. A., F. Brissaud, and J. Bontoux (1999), Wastewater reuse in France: Water quality standards and wastewater treatment technologies, Water Sci. Technol., 40, 37–42.

[8] Castillo, G., M. P. Mena, F. Dibarrart, and G. Honeyman (2001), Water quality improvement of treated wastewater by intermittent soil ercolation, Water Sci. Technol., 43, 187–190.

[9] Gold, A. J., B. E. Lamb, G. W. Loomis, J. R. Boyd, V. J. Cabelli, and C. G. McKiel (1992), Wastewater renovation in buried filters and recirculating sand filters, J. Environ. Qual., 21, 720– 725

[10] Matthess, G., and A. Pekdeger (1981), Concepts of a survival and transport model of pathogenic bacteria and viruses in groundwater, Sci. Total Environ., 21, 149– 159.

[11] McDowell-Boyer, L. M., J. R. Hunt, and N. Sitar (1986), Particle-transport through porous media, Water Resour. Res., 22, 1901–1921.

[12] Mottier, V., F. Brissaud, P. Nieto, and Z. Alamy (2000), Wastewater treatment by infiltration percolation: A case study, Water Sci. Technol., 41,
77– 84.

[13] Pang, L. P., M. Close, M. Goltz, L. Sinton, H. Davies, C. Hall, and G. Stanton (2003), stimation of septic tank setback distances based on transport of E. coli and F-RNA phages, Environ. Int., 29, 907– 921.

[14] Powelson, D. K., and A. L. Mills (2001), Transport of Escherichia coli in sand columns with constant and changing water contents, J. Environ. Qual., 30, 238– 245

[15] Saiers, J. E., and J. J. Lenhart (2003), Colloid mobilization and transport within unsaturated porous media under transient-flow conditions, Water Resour. Res., 39(1), 1019, doi:10.1029/2002WR001370.

[16] Salgot, M., F. Brissaud, and C. Campos (1996), Disinfection of secondary effluents by infiltration-percolation, Water Sci. Technol., 33, 271– 276.

[17] Schijven, J. F., and S. M. Hassanizadeh (2000), Removal of viruses by soil passage: Overview of modeling, processes and parameters, Crit. Rev. Environ. Sci. Technol., 30, 49– 12

[18] Schijven, J. F., G. Medema, A. J. Vogelaar, and S. M. Hassanizadeh (2000), Removal of microorganisms by deep well injection, J. Contam. Hydrol., 44, 301– 327

[19] Stevik, T. K., G. Ausland, P. D. Jenssen, and R. L. Siegrist (1999), Removal of E. coli during intermittent filtration of wastewater effluent as affected by dosing rate and media type, Water Res., 33, 2088– 2098.

[20] Stevik, T. K., A. Keller, G. Ausland, and J. K. Hanssen (2004), Retention and removal of pathogenic bacteria in wastewater percolating through porous media: A review, Water Res., 38, 1355–1367.

[21] U.S. Environmental Protection Agency (USEPA) (1999), Wastewater technology fact sheet, intermittent sand filters, Rep. EPA 832-F-99-067, Off. of Water, Washington, D. C.

[22] Van Cuyk, S., R. Siegrist, A. Logan, S. Masson, E. Fischer, and L. Figueroa (2001), Hydraulic and purification behaviors and their interactions during wastewater treatment in soil infiltration systems, Water Res., 35, 953– 964.

[23] Yao, K. M., M. T. Habibian, and C. R. O'Melia (1971), Water and waste water filtration Concepts and applications, Environ. Sci. Technol., 5, 1105– 1112

[24] World Health Organization (2003), Health risks in aquifer recharge using reclaimed water: State of the art report, Rep. SDE/WSH/03.08, Water, Sanitation and Health, Prot. of the Human Health, Geneva, Switzerland

[25] Maria A and Arturo A. 2000 Keller intermittent filtration of bacteria and colloids in porous media water resources research, vol. 41, w09408, doi:10.1029/2004wr003611

[26] Rastogi, A.K 2007 Numerical Ground Water hydrology Penram international publishing Pvt Ltd