Research Open Journal of Water
Vol. 1, No. 6, November 2013, PP: 35 - 49
Available online at http://scitecpub.com/Journals.php

Research article

MODELING PLUG FLOW APPLICATION OF FLUID ON VIRUS MIGRATION INFLUENCED BY VOID RATIO AND TEMPERATURE IN HOMOGENEOUS FINE SAND IN RUMUOLUMENI, RIVERS STATE OF NIGERIA

Eluozo, S. N[1] and Afiibor, B.B[2]

[1]Subaka Nigeria Limited, Port Harcourt, Rivers State of Nigeria
Director & Principal Consultant, Civil & Environmental Engineering,
Research & Development
E-mail: Soloeluozo2013@hotmail.com
E-mail: solomoneluozo2000@yahoo.com

[2]Department of Mathematics and Computer Science
Rivers State University of Science and Technology, Nkpolu Port Harcourt
E-mail: afiibor4bony@yahoo.com

Abstract

Modeling migration of virus on the application of plug flow system was to express the behaviour of the microbes in soil structural setting of the formation. The soil develop several deposition in structure and colure, it is influenced by the geological structure of the formation in the study area, several variation are found to deposit formation characteristics, this condition are reflected in the behaviou on its migration process from one formation to another, the express mathematical governing equation was formulated base on the principle of plug flow system, the strata were confirmed to developed homogenous fine sand in the study area, the expressed derived equation developed a model that will monitor the transport of virus under the principles of plug flow. The fluid deposition are found to behave in accordance with the principles of plug flow system these conditions shows how it established relationship with the migration of virus at different strata in the study area, experts will applied the model to monitor the behaviour of virus in this direction.

Keywords: modeling plug flow, fluid, virus migration and homogeneous find sand

1. Introduction

Severe destructive microorganisms may enter ground water via poor well production, ground water refresh/infiltration from the exterior, faulty septic tanks and/or sewer lines, land techniques of sewage Sludge, and percolation of landfill migration (Sobsey 1979; Pedley and Howard 1997 David, 2003, Eluozo, 2013). The fates of bacteria in the subsurface are base on two fundamental procedure, survival and transport/retention (Gerba and Bitton 1984). Study of the transport of microorganisms to and through ground water is an entire field onto itself. substantial work has been done to define factors upsetting microbial transport in ground water, generally with two motivating reasons: public health implications from contamination by potential pathogens, and migrates of biodegrading bacteria to aquifer regions contaminated with chemical constituents. Transport studies often involve the use of columns to model movement through a soil matrix or *in-situ* studies of microbial transport which employ monitoring wells to detect the organisms of interest, often a tracer organism, as they are transported with ground water across a study site Column studies are useful for isolating and/or defining specific impacts controlling transport as they offer a controlled environment, while *in-situ* studies allow for evaluating the impact of other factors in the natural environment that are difficult or impossible to model with column studies. Such factors could include predation and antagonism by other organisms, alterations in adsorption and survival in response to natural geochemical constituents and pore size or transmissivity effects of the undisturbed aquifer material, and interrelation of these and other variables (Harvey 1997 David,2003). By and large, microbial cells/particles have a negative surface charge in near-neutral water (Gerba 1984; Klein and Ziehr 1990; Krekeler 1991). But the overall charge on an organism is highly variable. Such rapid transport to surface water in Key Largo sites was largely attributed to tidal pumping, while sites where tidal pumping was not as significant demonstrated slower transport rates of 0.12 – 2 m/h (Paul 1997). The presence of human enteroviruses in surface water of the Florida Keys was also demonstrated (Griffin 1999). There are also indications that coral mucus may concentrate microorganisms of fecal origin, including human enteroviruses, leading to unknown but possibly deleterious effects on these organisms and the associated stressed marine ecosystem of coral reefs (Lipp 2002). Besides the Florida Keys, tracer studies have implicated septic tanks in contamination of surface water at estuarine (Rose and Zhou 1995; Lipp 2001) and freshwater sites in Florida, including demonstration of virus migration from a seeded septic tank to adjacent river waters (Callahan 2001). The potential of SF6 as a ground water tracer has also been reported, including its use in karst limestone and shallow, sandy aquifers (Wilson and Mackay 1993; Dillon 1999; Corbett 2000 Eluozo, 2013).

2. Theoretical background

Plug is tools that are applied to monitor any particular substance or object moving from region to another,, the process are applied in tracing of any substances can migrate from another region, the application of the concept in soil are flow of fluid from on formation to another formation, the migration of virus under the influences of plug flow application as system were established in these conceptual frame work, the system using such methods were to model the flow of fluid in the system influences some of the formation characteristic, this methods are designed to monitor several traced mineral either manmade or natural origin through the designed system, the behaviour of plug flow system depends on the structural setting of the variable in the soil, there are lots of variable known to be formation characteristics, the most influential should considered in formulating the system denoted through mathematical tools, the deposition of virus in soil were found through thorough investigation on the strata in the study location, modeling the system considering the application of plug flow system were imperative, because its conditions are in line with the principle of plug flow reactor, such condition express the behaviour of the microbes under the influences of the structural geomorphology and geochemistry deposition that react with other mineral deposited in the formation of the soil to generate output base on the level of reaction ,inhibition temperature influences including other formation setting condition in the formations , the study express the behaviour of virus to react with other formation deposited influences or its structural geological setting, this condition implies that the concentration in any formation of the soil are determined by the reactions of any deposited minerals including the formation characteristics influences such as void ratio and temperature of the formation at different strata , the study will definitely establish the a mathematical model that will express plug flow application on the transport of virus at different formation in the study area.

3. Governing Equation

$$K\frac{\partial v}{\partial x} - \phi\frac{\partial^2 v}{\partial x^2} - Q\frac{\partial v}{\partial x} = \rho\frac{\partial v}{\partial t} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \qquad (1)$$

The expressed equation is modified to monitor the application of plug flow on the transport of virus in homogeneous fine sand, the study through this governing equation will express various parameters relation in the system , the behaviour of the microbes will be expressed as various boundary values will establish on the derived process , such condition implies that the expression will consider several conditions that are known to influences the behaviour of virus on the transport process in the formation, these parameters stated in the system formulated the principle equation ,these condition were definitely considered in the system as it is presented mathematically above.

Nomenclature

V = Volumetric concentration of Transport $[ML^{-1}]$

K = Permeability $[LT^{-1}]$

ϕ = porosity [-]

T = Time [T]

X = Distance [L]

ρ = bulk density [-]

$$K\frac{\partial^2 v}{\partial t} = \phi\frac{\partial\ v}{\partial x} \qquad \text{..................................} \qquad (2)$$

$$\left.\begin{array}{l} t = 0 \\ x = 0 \\ C_{(o)} = 0 \\ \left.\dfrac{\partial v}{\partial t}\right|_{t = 0, B} = 0 \end{array}\right\} \qquad \text{..................................} \qquad (3)$$

$$K\frac{\partial v}{\partial t} = Q\frac{\partial v^2}{\partial x^2} \qquad \text{..................................} \qquad (4)$$

$$\left.\begin{array}{l} t = 0 \\ x = 0 \\ q_{(o)} = 0 \\ \left.\dfrac{\partial q}{\partial t}\right|_{t = 0,\ B} \end{array}\right\} \qquad \text{......................................} \qquad (5)$$

$$K\frac{\partial v_3}{\partial t} - = \rho\frac{\partial v_3}{\partial t} \qquad \text{......................................} \qquad (6)$$

$$\left.\begin{array}{l} t = 0 \\ C_{(o)} = 0 \\ \left.\dfrac{\partial v_3}{\partial t}\right|_{t = 0,\ B} = 0 \end{array}\right\} \qquad \text{......................................} \qquad (7)$$

$$Q\frac{\partial v_4}{\partial x} - = \rho\frac{\partial v_4}{\partial t} \qquad \text{......................................} \qquad (8)$$

$$\begin{array}{l} x = 0 \\ t = 0 \\ C_{(o)} = 0 \\ \left.\dfrac{\partial v_4}{\partial x}\right|_{x = 0,\ B} = 0 \end{array} \qquad \text{......................................} \qquad (9)$$

Research Open Journal of Water
Vol. 1, No. 6, November 2013, PP: 35 - 49
Available online at http://scitecpub.com/Journals.php

$$\phi\frac{\partial^2 v_5}{\partial x^2} - Q\frac{\partial v_5}{\partial x} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (10)$$

$x = 0$

$$q_{(o)} = 0 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (11)$$

$$\left.\frac{\partial v_5}{\partial x}\right|_{x = 0,\ B}$$

Applying direct integration on (2)

$$K\frac{\partial v_1}{\partial t} = \phi v + K_1 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (12)$$

Again, integrate equation (12) directly yield

$$Kv = \phi vt + Kt + K_2 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (13)$$

Subject to equation (3), we have

$$Vv_o = K_2 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (14)$$

And subjecting equation (12) to (3) we have

$$\text{At } \left.\frac{\partial v_1}{\partial x}\right|_{t = 0} = 0 \quad v(o) = vo$$

Yield

$$0 = \phi v + K_2$$

$$\Rightarrow V_1 = \phi v_o = K_2 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (15)$$

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

$$Kv_1 = \phi v_{1t} - \phi vox\, Kvo \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (16)$$

$$Kv_1 - \phi v_{1x} = Kv_o - \phi vox \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (17)$$

$$v_1 = v_o \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (18)$$

Hence equation (18) entails that at any given distance x, we have constant concentration of the contaminant in the system. This condition implies in transport system there some region of the soil that the migration will develop constant deposition of concentration, this condition depends on the deposition of the strata, and such expression implies that deposition of the formation may have deposition homogeneous void ratio may pressure the concentration to reduces it concentrations and maintain constant, at most it may also implies that they reaction with other deposited minerals has reduce or inhibit the concentrations of the microbes .

$$K\frac{\partial v_2}{\partial v} = -Q\frac{\partial v}{\partial x} \quad \ldots\ldots\ldots\ldots \quad (4)$$

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

$$v_2 = XT \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (19)$$

i.e. $$K\frac{\partial v_2}{\partial x} = X^1 T \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (20)$$

$$K\frac{\partial_2}{\partial x} = X^1 T \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (21)$$

Put (20) and (21) into (19), so that we have

$$KXT^1 = -QX^1 T \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (22)$$

i.e. $$K\frac{X^1}{X} = Q\frac{X^1}{X} = -\lambda^2 \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (23)$$

Hence $$K\frac{T^1}{T} + \lambda^2 = 0 \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (24)$$

i.e. $$X^1 + \frac{\lambda}{K}x = 0 \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (25)$$

$$KX^1 + \lambda^2 X = 0 \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (26)$$

From (25), $$X = A\,Cos\frac{\lambda}{K}X + B\,Sin\frac{\lambda}{\sqrt{K}}X \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (27)$$

And (20) gives

$$T = C\ell^{\frac{-\lambda^2}{V}t} \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (28)$$

And (20) gives

$$\boxed{C_2 = \left(A\,Cos\frac{\lambda}{K}x + B\,Sin\frac{\lambda}{\sqrt{K}}x\right)C\ell^{\frac{-\lambda^2}{V}x}} \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (29)$$

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

$$V_o = AC \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (30)$$

Equation (30) becomes

$$v_2 = v_o \ell^{\frac{-\lambda^2}{K}x} \; Cos \frac{\lambda}{\sqrt{K}} x \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \qquad (31)$$

Again, at

$$\left.\frac{\partial v_2}{\partial x}\right|_{x = 0,\ B} = 0,\ x = 0$$

Equation (31) becomes

$$\frac{\partial v_2}{\partial x} = \frac{\lambda}{\sqrt{K}} v_o \ell^{\frac{-\lambda}{V}x} \; Sin \frac{\lambda}{\sqrt{K}} x \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \qquad (32)$$

i.e. $0 = -\dfrac{vo\lambda}{K} \; Sin \dfrac{\lambda}{KV} 0$

$vo\dfrac{\lambda}{K} \neq 0$ Considering NKP

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

$$0 = vo\frac{\lambda}{\sqrt{K}} \; Sin \frac{\lambda}{\sqrt{K}} B \qquad \ldots\ldots\ldots\ldots\ldots..\ldots\ldots\ldots \qquad (33)$$

$$\Rightarrow \frac{\lambda}{K} = \frac{n\pi}{2} n, 1, 2, 3 \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. \qquad (34)$$

$$\Rightarrow \lambda = \frac{\lambda}{K} = \frac{n\pi\sqrt{R}}{2} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. \qquad (35)$$

So that equation (31) becomes

$$\Rightarrow v_2 = vo\ell \frac{-n^2\pi^2 R}{2} t \; Cos \frac{n\pi\sqrt{K}}{2\sqrt{K}} x \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. \qquad (36)$$

$$\Rightarrow v_2 = vo\ell \frac{-n^2\pi^2 R}{2} x \; Cos \frac{n\pi}{2} x \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. \qquad (37)$$

Now, we consider equation (7), we have the same similar condition with respect to the behaviour

$$v\frac{\partial q_3}{\partial x} = -\rho\frac{\partial v}{\partial t} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \qquad (6)$$

$$v_3 = XT^1 \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. \qquad (38)$$

$$\frac{\partial v_3}{\partial x} = X^1T \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. \qquad (39)$$

i.e. $K\frac{\partial v_3}{\partial t} = XT^1$ ………………………….. (40)

Put (20) and (21) into (19), so that we have

$$KX^1T = -XT^1 \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. \qquad (41)$$

i.e. $K\frac{x^1}{x} \; - = \rho\frac{T^1}{T}$ ………………………….. (42)

$$K\frac{T^1}{T} + \lambda^2 = 0 \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. \qquad (43)$$

$$X^1 + -\frac{\lambda}{K}t = 0 \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. \qquad (44)$$

And $KT^1 + \lambda^2 t = 0$ ………………………….. (45)

From (44), $x = A\,Cos\,\frac{\lambda}{K}x + B\,Sin\,\frac{\lambda}{\sqrt{K}}t$ ………………….. (46)

and (39) give

$$\boxed{T = C\,\ell\,\frac{-\lambda^2}{\rho}t}$$

………………………….. (47)

By substituting (46) and (47) into (38), we get

$$\boxed{v_3 = \left(A\,Cos\,\frac{\lambda}{K}tx + B\,Sin\frac{\lambda}{\sqrt{K}}t \right) C\,\ell\,\frac{-\lambda^2}{\rho}t}$$ ……………… (48)

Subject equation (48) to conditions in (7), so that we have

$$vo = AC \qquad \text{…………………………..} \qquad (49)$$

Equation (49) becomes

$$v_3 = vo\,\ell\,\frac{-\lambda^2}{\rho}t\;Cos\,\frac{\lambda}{K}t \qquad \text{…………………………..} \qquad (49)$$

Again, at $\left.\frac{\partial v_3}{\partial x}\right|_{t\,=\,0,B} = 0 \quad t = 0$

Equation (50) becomes

$$\frac{\partial q_3}{\partial x} = \frac{\lambda}{K}\,Co\,\ell\,\frac{-\lambda}{\rho}t\;Sin\,\frac{\lambda}{K}t \qquad \text{……………………} \qquad (51)$$

i.e. $0 = vo\frac{\lambda}{K}\;Sin\,\frac{\lambda}{K}0$

$vo\frac{\lambda}{K} \neq 0$ Considering NKP again

The considerations of substrate utilization is imperative, several depositions in the soil has been expressed, this condition implies that the deposition of micro elements are deposited in most region of the strata, base on these conditions it is imperative to monitor the microbes at when such depositions are confirmed to deposition in some region of the soil, therefore the expressions were found suitable to consider the rates of concentration at various deposited region of the soil.

Due to the rate of growth, which is known to be the substrate utilization of the microbes we have

$$0 = -vo\frac{\lambda}{\sqrt{K}} \; Sin \, \frac{\lambda}{\sqrt{K}} B \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. \qquad (52)$$

$$\Rightarrow \frac{\lambda}{K} = \frac{n\pi}{2} n, 1, 2, 3 \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. \qquad (53)$$

$$\Rightarrow \lambda = \frac{n\pi\sqrt{V}}{2} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. \qquad (54)$$

So that equation (50) becomes

$$v_3 = vo\ell \, \frac{-n^2\pi^2 R}{2\rho} x \; Cos \frac{n\pi}{2} t \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. \qquad (55)$$

Now, we consider equation (8), we have

$$K \frac{\partial v_4}{\partial x} - \rho \frac{\partial v_4}{\partial x} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \qquad (8)$$

Using Bernoulli's method, we have

$$v_4 = XT \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. \qquad (56)$$

$$\frac{\partial v_4}{\partial x} = X^1 T \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. \qquad (57)$$

$$\frac{\partial v_4}{\partial t} = X \; T^1 \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. \qquad (58)$$

Put (57) and (58) into (56), so that we have

$$KX^1T = -X \; T^1 \rho X^1 T \qquad \text{……………………} \qquad (59)$$

i.e. $$K\frac{X^1}{X} \quad - = \rho\frac{T^1}{T} \qquad \text{……………………} \qquad (60)$$

$$K\frac{X^1}{X} = \varphi \qquad \text{…………………………..} \qquad (61)$$

$$\rho v\frac{T^1}{T} = \varphi \qquad \text{………………………….} \qquad (62)$$

$$X = A\,\ell\,\frac{\varphi}{\rho}x \qquad \text{…………………………..} \qquad (63)$$

Put (62) and (63) into (56), gives

$$v_4 = A\,\ell\,\frac{\varphi}{\rho} \bullet B\,\ell\,\frac{-\varphi}{\rho}t \qquad \text{…………………………..} \qquad (64)$$

$$v_4 = AB\,\ell^{(t-x)}\frac{\varphi}{\rho} \qquad \text{…………………………..} \qquad (65)$$

Subject equation (66) to (8)

$$V_4 \;(o) = Vo \qquad \text{…………………………..} \qquad (66)$$

So that equation (67) becomes

$$\boxed{v_4 = Ko\,\ell^{(t-x)}\frac{\varphi}{\rho v}} \qquad \text{…………………………..} \qquad (67)$$

Considering equation (10), we have

$$\phi \frac{\partial\ v_5}{\partial x} - Q\frac{\partial v^2{}_5}{\partial x^2} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ (10)$$

$$q_5 = X^{11}T \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (68)$$

$$\frac{\partial\ v_5}{\partial x} + X\ T^1 \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (69)$$

$$\frac{\partial v_5}{\partial t} + X\ T^1 \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (70)$$

Put (69) and (70), so that we have

$$\phi X^1T - TX\ T^1 \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (71)$$

$$\phi\frac{X^{11}}{X}T - Q\frac{T^1}{T} \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (72)$$

$$\phi\frac{X}{X} = \varphi \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (73)$$

$$Q\frac{T^1}{T} = \varphi \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (74)$$

$$X^1 = A\ell\ \frac{\varphi}{Q}t \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (75)$$

Put (74) and (75) into (68), gives

$$v_5 = A\ell\ \frac{\varphi}{Q} \bullet B\ell\ \frac{-\varphi}{Q}x \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (76)$$

$$v_5 = AB\ell^{(x-t)}\frac{\varphi}{Q} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. \qquad (77)$$

Subject (76) to (10)

$$v_5 \ (o) = vo \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. \qquad (78)$$

So that equation (78) becomes

$$v_5 = vo\ell^{(x-x)}\frac{\varphi}{Q} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. \qquad (79)$$

Several region of the soil may not experiences the same concentration, lots of variations may be experienced in the formations , this is due to variation of stratum deposition including its structural deposition within the intercedes, such conditions are found in soil formation, the study geological setting are influenced such conditions in the study locations , there lots of deposited pressures in the formation that may develop steady state flow and on the process the deposition of substrate may be not found in the system .therefore the study consider steady state of the formation as it is expressed below.

Now, assuming that at the steady flow, there is no NKP for substrate utilization, our concentration here is zero, so that equation (79) becomes

$$v_5 = 0 \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. \qquad (80)$$

Therefore, $v_1 + v_2 + v_3 + v_4 + v_5$ ………………….. (81)

We now substitute (18), (37), (55), (67) into (81) so that we have the model of the form

$$v = vo + vo\ell\frac{-n^2\pi^2 Q}{2Q}x\ Cos\frac{n\pi Q}{2}t \bullet vo\ell\frac{-n^2\pi^2 Q}{2T}t\ Cos\frac{n\pi}{2}t +$$

$$vo\ell^{(t-x)}\frac{\varphi}{Q} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. \qquad (82)$$

$$\Rightarrow v = vo + 1 + \ell \frac{n^2\pi^2 Q}{2Q} x \; Cos \frac{n\pi}{2} \bullet vo\ell \frac{-n^2\pi^2 Q}{2T} t \; Cos \frac{n\pi}{2} t +$$

$$vo\ell^{(t-x)} \frac{\varphi}{T} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. \qquad (83)$$

The expression in 83 from the derived governing equation is the final developed model that will monitor the deposition and migration of virus under plug flow application, several mathematical concept has been developed by experts in the field but there was no effective concept that genera rated results that be applied as a bench mark for breakthrough of success in this condition of these type of transport system in soil, the formation are found to deposits lost of pressured, but the expressed model will definitely develop effective results on the deposition and migration of virus.

4. Conclusion

The deposition of virus were found to predominant in some part of Rumuolumine, the study is to establish the base line on the plug flow application on the deposition of virus in the study area, the structural deposition of the formation influenced the deposition and migration of the formation, the structural deposition of the soil determine the behaviour of the virus in some condition, while in some instance other deposition in the soil determine the deposition of the microbes theses are some minerals deposited by manmade of natural origin .the rate temperatures in various formation were found to influences in various formations in the study location, the study is imperative because the structural setting of the formation has been designed mathematically using this principles of plug flow in the designed of the mathematical modeling in the soil the developed model will definitely monitor the system through the applied conceptual setting of plug flow in the formations of homogeneous fine sand .

References

[1] Corbett, D. R., Dillon, K. and Burnett, W. (2000). "Tracing groundwater flow on a barrier island in the north-east Gulf of Mexico." Estuarine Coastal and Shelf Science **51**(2): 227-242.

[2] Callahan, M. R., Rose, J. B. and Paul, J. H. (2001). Bacteriological and pathogenic water quality assessment of the upper reaches of the Chisago Witczak river. Citrus County, FL, Citrus County Department of Public Works Utility Division.

[3] Dillon, K. S., Corbett, D. R., Chanton, J. P., Burnett, W. C. and Furbish, D. J. (1999). "The use of sulfur hexafluoride (SF6) as a tracer of septic tank effluent in the Florida Keys." J Hydrol **220**(3-4): 129- 140.

[4] Gerba, C. P. and Bitton, G. (1984). Microbial pollutants: their survival and transport pattern to groundwater. Groundwater Pollution Microbiology. Bitton, G. and Gerba, C. P. New York, NY, John Wiley and Sons**:** 65-88.

[5] Gerba, C. P. (1984). "Applied and Theoretical Aspects of Virus Adsorption to Surfaces." Advances in Applied Microbiology **30**: 133-168.

[6] Griffin, D. W., Gibson, C. J., Lipp, E. K., Riley, K., Paul, J. H. and Rose, J. B. (1999). "Detection of viral pathogens by reverse transcriptase PCR and of microbial indicators by standard methods in the canals of the Florida Keys." Appl Environ Microbiol **65**(9): 4118-4125

[7] Harvey, R. W. (1997). In Situ and laboratory methods to study subsurface microbial transport. Manual of Environmental Microbiology. McInerney, M. J. and Hurst, C. J. Washington, D.C., ASM Press**:** 586-599

[8] Klein, J. and Ziehr, H. (1990). "Immobilization of Microbial-Cells by Adsorption." Journal of Biotechnology **16**(1-2): 1-16.

[9] Krekeler, C., Ziehr, H. and Klein, J. (1991). "Influence of Physicochemical Bacterial Surface-Properties on Adsorption to Inorganic Porous Supports." Applied Microbiology and Biotechnology **35**(4): 484-490.

[10] Lipp, E. K., Farrah, S. A. and Rose, J. B. (2001). "Assessment and impact of microbial fecal pollution and human enteric pathogens in a coastal community." Mar Pollut Bull **42**(4): 286-293.

[11] Lipp, E. K., Jarrell, J. L., Griffin, D. W., Lukasik, J., Jacukiewicz, J. and Rose, J. B. (2002). "Preliminary evidence for human fecal contamination in corals of the Florida Keys, USA." Mar Pollut Bull **44**(7): 666-670

[12] Kersters, I., Huys, G., VanDuffel, H., Vancanneyt, M., Kersters, K. and Verstraete, W. (1996). "Survival potential of Aeromonas hydrophila in freshwaters and nutrient-poor waters in comparison with other bacteria." J Appl Bacteriol **80**(3): 266-276.

[13] Paul, J. H., Rose, J. B., Jiang, S. C., Zhou, X. T., Cochran, P., Kellogg, C., Kang, J. B., Griffin, D., Farrah, S. and Lukasik, J. (1997). "Evidence for groundwater and surface marine water contamination by waste disposal wells in the Florida Keys." Water Res **31**(6): 1448-1454.

[14] Sobsey, M. D. (1979). "Detection of Enteric Viruses in Solid-Waste Landfill Leachates - Response." American Journal of Public Health **69**(4): 390-390.

[15] Wilson, R. D. and Mackay, D. M. (1993). "The Use of Sulfur-Hexafluoride as a Conservative Tracer in Saturated Sandy Media." Ground Water **31**(5): 719-724.

[16] Pedley, S. and Howard, G. (1997). "The public health implications of microbiological contamination of groundwater." Q J Eng Geol **30**: 179-188

[17] David E. John 2003 Transport and Survival of Water Quality Indicator Microorganisms in the Ground Water environment of Florida: Implications for Aquifer Storage and Waste Disposal Ph.d Dissertation University of South Florida

[18] Eluozo S.N modeling dispersion of bacterial transport influenced by inhibitors and variation of ammonia deposition in unconfined aquifer s in Bayelsa Niger delta of Nigeria American Journal of Environment, Energy and Power Research Vol. 1, No. 3, May 2013, PP: 45 - 61