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Research article

PREDICTING THE DEPOSITION OF NITROGEN INFLUENCES ON VIRUS TRANSPORT IN ALLUVIUM DEPOSITING SEMI CONFINED BED IN COASTAL AREA OF OKRIKA, NIGER DELTA OF NIGERIA

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Abstract

Semi-confined bed were confirmed to deposit in coastal region of Okrika through partially-depositing overburden pressure through a sand stone transiting from unconfined to semi-confined bed. Such structural strata developed an influence from formation characteristics depositing various variations expressed in the deltaic formation. The deposition of virus and nitrogen were found to predominantly degrade groundwater quality in some parts of the semi-confined formation. Subject to this condition, the significance of groundwater quality degradation becomes a serious concern to environmental health. Dispersion influences noticed within the region where degradation is found are pressured by high degree of porosity which was found predominant in some parts of the region. Based on this heterogeneity setting, the evaluation and monitoring of these two stated parameters become imperative to study. Mathematical model were applied to monitor the behaviour of the two parameters and also to express their exponential phase influenced by substrate deposition from nitrogen. Several parameters from the system were considered at various conditions where they expressed predominant influence that reflects the behaviour of the virus and the substrates. Experts will definitely find this application a necessary tool in monitoring and evaluation of nitrogen and virus in coastal area of Okrika.

Keywords: predicting nitrogen, virus transport, alluvium and semiconfined bed

1. Introduction

The intention of coastal aquifer management is the same as for other aquifer systems – to achieve a sustainable use of groundwater, coordinated with the use of other water resources, to meet part of the demand for water by supplying water of adequate quality, in the place at the right time, respecting environmental and habitat restrictions [1]. The main additional items to be considered are the risk of salinization and water quality degradation in relation with possible accumulation of manmade contaminants in areas of low hydraulic gradient and flow pattern forming a closed area due to groundwater abstraction conditions [2]. Often these risks do not result in immediate threats, but the results may be delayed for a long time. This means that coastal aquifer management should rely on conservation and protection measures [3 6, 15, 16]. Coastal groundwater resources are increasingly a critical component of available freshwater in Nigeria, in a national setting of rising population density in coastal margins. The enhanced dependency on coastal groundwater has resulted in symptoms of over-extraction, namely seawater intrusion (i.e., the landward encroachment of saline groundwater). The seawater intrusion threat to freshwater supplies has already led to groundwater management response in some regions of Nigeria, with extensive investigation and the construction of monitoring boreholes. Coastal aquifer management in Nigeria needs to account not only for existing threats to freshwater resources and groundwater-dependent ecosystems but also for the influences of climate change which is expected to produce modified groundwater recharge and rising ocean levels. Effective coastal management must be based on a solid scientific foundation, taking into account the limitations of natural systems, while balancing and integrating the demands of the various sectors which depend on these systems for their livelihood The coastline of Nigeria is about 1000km long on the Gulf of Guinea, bordering eight states of Lagos, Ogun, Ondo, Delta, Bayelsa, Rivers, Akwa Ibom and Cross River. While the first four states are west of the River Niger, the last three states are east of the Niger with the last, Bayelsa State, straddling the river. Geologically, Coastal Nigeria is covered by two sedimentary basins, the Keta basin and Niger Delta basin. The Keta basin (also called the Benin- or Dahomey basin in Nigerian literature) is a transboundary basin that extends from Ghana through Togo and Benin to Nigeria. The Niger Delta basin is separated by the Okitipupa Ridge [8,11,12]. The Keta Basin constitutes part of a system of West African margin developed during a brief period of rifting in the late Jurassic to Early Cretaceous, associated with the Benin Trough Complex. It was accompanied by an extended period of thermally induced basin subsidence through the Middle to Upper Cretaceous to Tertiary times as the South American and African plate entered a drift phase. The onshore portion of the basin covers a broad arc-shaped profile approximately 600km2, attaining a maximum width of 65km at the basin axis along the Nigerian border with the Republic of Benin. It narrows to about 25km west and eastwards. It is along its north eastern fringe (the Okitipupa Structure) that a band of tar sand (oil sand) and bitumen seepage occurs [9 10]. A quantity of text materials exist on diverse processes of proper sitting of monitoring wells based on the character of groundwater flow, and dimensions of the polluted field. [6,7a,7b 15] Devised a graphical heuristic for locating up gradient groundwater monitoring wells near landfills, and observed that it can be adapted to no homogeneous flow fields, heterogeneous transport limitations, and irregularly shaped landfills oriented at various angles to the direction of groundwater flow. [10,13,14] observed that the need for satisfactory characterization of spatial and temporal variations of groundwater flow are for suitable position and construction of monitoring wells, timing of ground water monitoring, and evaluation of exposure risk and contaminant flux in support of remedial decision-making.

2. Theoretical background

The groundwater deposition in some part of the study location were found to developed semi confined deposition, the geological setting of the formation are the major influences that generated the deposition of semi confined bed in the study area. Such condition has also affected lots of water pollution in the study area. the development of ground water from deposition of semi confined bed provide a platform for the deposition of contaminant as the movement of ground water determine the depositional rate of contaminant. The study involved two different contaminated parameters that were found to deposit in the region of semi confined bed in the deltaic area. Such condition were consider to monitor the rate of reaction of these two parameters in various strata, the deposition of virus from biological waste and micronutrient nitrogen were found to be the subject of concern in the deltaic area, this study are to examined the behaviour of virus on the migration process reflecting the increase in concentration of the virus in semi confined zone, partially penetrating confined aquifer are known to be semi confined bed in these direction, theses has definitely express it influences on the migration process and increase of the microbes from the deposition on nitrogen in the formation. Such condition investigated in the study confound these two parameters as predominant contaminants in the formation which has been the subject of serious concern, the tendency of permeability as predominant depositional influences were no doubt expressed on the study location, these condition implies that formation characteristics to a large extent influences the depositional rate of the contaminants. The development of the system expressing the governing equation will definitely determined other formation parameters that may be found dormant in the system, these has express their level of pressure on the migration and concentration of the contaminants in semi confined bed in the study area.

$$\phi \frac{\partial Cs}{\partial t} = \frac{\partial Cs}{\partial z} K + Ds \frac{\partial Cs}{\partial z} - \overline{V}t \frac{\partial Cs}{\partial z} + \frac{\partial Cs}{\partial t} \theta + \frac{\partial Cs}{\partial z} \gamma \quad \ldots\ldots\ldots \tag{1}$$

The deposition of nitrogen and virus in semi confined bed in deltaic formation are subject of concern that need to be monitored, there is need for thorough examination, because lots of deltaic depositional influences in the study location are defined through the pressure from the geological setting. Partially penetrating semi confined bed was found to deposition in the coastal area of Okrika, the rates of permeability in the study location are refection from the aquifer depositional level in such deltaic area. Subject to this circumstance, the behaviour of virus and nitrogen were expressed in the system including other parameters that generated the governing equation.

$$\phi \frac{\partial Cs_1}{\partial t} = \frac{\partial Cs_1}{\partial z} K \tag{2}$$

$$\left.\begin{array}{l} x = 0 \\ Cs_{(o)} = 0 \\ \dfrac{\partial Cs_1}{\partial t} \Big| t = 0,\ B \end{array}\right\} \tag{3}$$

$$\phi \frac{\partial Cs_2}{\partial t} = D_s \frac{\partial Cs_2}{\partial z} \tag{4}$$

$$\left.\begin{array}{l} x = 0 \\ t = 0 \\ Cs_{(o)} = 0 \\ \frac{\partial Cs_2}{\partial t} \big| t = 0,\ B \end{array}\right\} \quad (5)$$

$$\phi \frac{\partial Cs_3}{\partial t} = \frac{\partial Cs_3}{\partial t} Vt \quad (6)$$

$$\left.\begin{array}{l} t = 0 \\ Cs_{(o)} = 0 \\ \frac{\partial Cs_3}{\partial t} \big| t = 0,\ B \end{array}\right\} \quad (7)$$

$$\phi \frac{\partial Cs_4}{\partial t} = \theta \frac{\partial Cs_4}{\partial z} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (8)$$

$$\left.\begin{array}{l} t = 0 \\ x = 0 \\ Cs_{(o)} = 0 \end{array}\right\} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (9)$$

$$\frac{\partial Cs_4}{\partial t} \big| t = 0,\ B$$

$$\phi \frac{\partial Cs_5}{\partial t} + \frac{\partial Cs_5}{\partial z} \gamma \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (10)$$

$$\left.\begin{array}{l} t = 0 \\ x = 0 \\ Cs_{(o)} = 0 \\ \frac{\partial Cs_5}{\partial t} \big| t = 0,\ B \end{array}\right\} \quad \ldots\ldots\ldots\ldots\ldots \quad (11)$$

$$Vt \frac{\partial Cs_6}{\partial z} = \frac{\partial Cs_6}{\partial t} \theta \quad - \; = 0 \quad \ldots\ldots\ldots\ldots\ldots \quad (12)$$

$$\left.\begin{array}{l} x = 0 \\ Cs_{(o)} = 0 \\ \frac{\partial Cs}{\partial t} \big| t = 0,\ B \end{array}\right\} \quad \ldots\ldots\ldots\ldots \quad (13)$$

Applying direct integration on (2)

$$\frac{\partial Cs_1}{\partial t} = K_1 + A_1 \qquad \ldots\ldots\ldots\ldots \quad (14)$$

Again, integrate equation (14) directly yield

$$\phi Cs = K + A_1 + A_2 \qquad \ldots\ldots\ldots\ldots \quad (15)$$

Subject to equation (3) we have

$$Cs_{(o)} = A_2 \qquad \ldots\ldots\ldots \quad (16)$$

Subjecting equation (15) to (3)

$$\text{At } \left.\frac{\partial Cs_1}{\partial t}\right|_{t=0} = 0 \quad Cs_{(o)} = Cs_o$$

Yield

$$O = \phi Cs_o = A_2$$

$$A_2 = VC_o \qquad (17)$$

So that we put (16) and (17) into (15), we have

$$Cs_1 = \phi Cs_1 t - K\,Cst + Cs_o \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (18)$$

$$Cs_1 = \phi = Cs_o - K\,Cst \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (19)$$

$$\Rightarrow Cs_1\left[Cs_1 - \phi t\right] = Cs_o\left[Cs_1 - K\right] \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (20)$$

$$\Rightarrow Cst = Cs_o \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (21)$$

$$\phi\frac{\partial Cs_2}{\partial t} = \frac{\partial Cs_2}{\partial z}Ds \qquad \ldots\ldots\ldots \quad (4)$$

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

i.e. $Cs_2 = ZT$ ……………… (22)

$$\frac{\partial Cs_2}{\partial t} = ZT^1 \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (23)$$

$$\frac{\partial Cs_2}{\partial z} = Z^1T \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (24)$$

Put (23) and (24) into (25), so that we have

$$VZT^1 = Ds\,Z^1T \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (25)$$

$$\phi ZT^1\frac{\phi T^1}{T} = Ds\frac{Z^1}{Z} = -\lambda^2 \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (26)$$

Hence $\dfrac{\phi T^1}{T} = -\lambda^2$ ……………… (27)

$$Ds\,Z^1 + \lambda^2 Z = 0 \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (28)$$

From (27)

$$T = ACos\frac{\lambda}{\phi}t + B\,Sin\frac{\lambda}{\phi}z \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (29)$$

And (28) gives

$$T = Cs\ell^{\frac{-\lambda^2}{\phi}t} \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (30)$$

By substituting (28) and (29) into (22) we get

$$Cs_2\left[ACos\frac{\lambda}{\sqrt{\phi}}t + B\,Sin\frac{\lambda}{\sqrt{\phi}}z\right]Cs\ell^{\frac{-\lambda^2}{\sqrt{\phi}}t} \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (31)$$

$$Cs_o = Ac \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (36)$$

Equation (31) becomes

$$Cs_2 = Cs_o\ell^{\frac{-\lambda^2}{\phi}t}\;Cos\frac{\lambda}{\phi}z \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (33)$$

Again at $\left.\frac{\partial Cs_2}{\partial t}\right|\begin{matrix} = 0, z = 0 \\ t = 0, B\end{matrix}$

Equation (33) becomes

$$\frac{\partial Cs_2}{\partial t} = \frac{\lambda}{\phi}Cs_o\ell^{\frac{-\lambda^2}{\phi}t}\;Sin\frac{\lambda}{\phi}z \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (34)$$

i.e. $0 = Cs_o\frac{\lambda}{\sqrt{\phi}}\,Sin\frac{\lambda}{\phi}0 \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (35)$

$Cs_o\frac{\lambda}{\sqrt{\phi}} \neq 0$ Considering NKP

The existence of nitrogen as micronutrient in the formation has been found to be a regular predominant microbial growth in semi-confined beds. Such pressures are one of the high increase rates of the microbes, the expression in (35) is a consideration of this microelement under vertical transport conditions depositing in lateritic and silty formations where high accumulations may be experienced. Subject to this condition, there is no doubt that dispersion influence might also be experienced under the influence of accumulative depositional formation in penetrating aquitard. Therefore, the expression from (35) considered the substrate deposition under continuity condition whereby formation influence expressed their functions from such aquitard zone.

$$0 = -Cs_o\frac{\lambda}{\phi}\,Sin\frac{\lambda}{\phi}B \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (36)$$

$$\Rightarrow \lambda = \frac{n\pi\sqrt{\phi}}{2} \qquad \text{.....................} (37)$$

So that equation (33) becomes

$$Cs_2 = Cs_o \, \ell^{\frac{-n^2\pi^2 V}{\phi}} \, Cos \frac{n\pi\sqrt{\phi}}{2\sqrt{\phi}} z \qquad \text{.....................} (38)$$

$$Cs_2 = Cs_o \, \ell^{\frac{-n^2\pi^2 Ds}{\phi}} \, Cos \frac{n\pi}{2} z \qquad \text{.....................} (39)$$

We consider equation (6)

$$\phi \frac{\partial Cs_3}{\partial t} = \frac{\partial Cs_3}{\partial z} Vt \qquad \text{...........} \qquad (6)$$

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

$$Cs_3 = ZT \qquad \text{.....................} (40)$$

$$\frac{\partial Cs_3}{\partial t} = ZT^1 \qquad \text{.....................} (41)$$

$$\frac{\partial Cs_3}{\partial z} = Z^1 T \qquad \text{.....................} (42)$$

Again, we put (41) and (42) into (40), so that we have

$$\phi Z T^1 = Vt\, Z^1 T \qquad \text{.....................} \qquad (43)$$

$$\text{i.e. } \frac{\phi T^1}{T} = Vt \frac{Z^1}{Z} - \lambda^2 \qquad \text{.....................} \qquad (44)$$

$$\text{Hence } \frac{\phi T^1}{T} = -\lambda^2 \qquad \text{.....................} (45)$$

$$\text{i.e. } Vt\, Z^1 + \lambda^2 z = 0 \qquad \text{.....................} (46)$$

$$\text{From (46) } T = ACos \frac{\lambda t}{\phi} Z + BSin \frac{\lambda z}{\phi} \qquad \text{.....................} \qquad (47)$$

And (46) gives

$$T = Cs_o \ell^{\frac{-\lambda^2}{Vt} t} \qquad \text{.....................} \qquad (48)$$

Concentration with respect to time has a reflection on the transport system through the exponential phase expressed in (48). Such conditions are reflected on the velocity of flow influencing the exponential phase of the microbes including the deposition of micronutrient where it gains energy and increase growth. The expression in (48) is a developed model with respect to time of transport through velocity of flow. This expressed model detail the condition of microbes under homogeneous velocity reflecting homogeneous stratification within some certain region in the formation.

By substituting (47) and (48) into (40), we get

$$Cs_3 = \left[A\,Cos\frac{\lambda}{\phi}z + B\,Sin\frac{\lambda}{\sqrt{V\phi}}z \right] Cs\ell^{\frac{-\lambda^2}{\phi}t} \qquad \dots\dots\dots\dots\dots\dots\dots \quad (49)$$

Subject (54) to condition in (6) so that we have

$$Cs_o = Ac \qquad \dots\dots\dots\dots\dots\dots\dots \quad (50)$$

$$Cs_3 = Cs_o\ell\frac{-\lambda^2}{\phi}t \;\; Cos\frac{\lambda}{\sqrt{\phi}}Z \qquad \dots\dots\dots\dots\dots\dots\dots \quad (51)$$

Again at $\frac{\partial Cs_3}{\partial t}\Big| \quad t = 0,\; B$

Equation (51) becomes

$$\frac{\partial Cs_2}{\partial t} = \frac{\lambda}{\sqrt{\phi}}Cs_o\ell^{\frac{-\lambda^2}{Vt}} \;\; Sin\frac{\lambda}{\phi}z \qquad \dots\dots\dots\dots\dots\dots\dots$$

(52)

i.e. $0 = -Cs_o\frac{\lambda}{\sqrt{\phi}}\;Sin\frac{\lambda}{\phi}0 \qquad \dots\dots\dots\dots\dots\dots\dots \quad (53)$

$Cs_o\frac{\lambda}{\sqrt{\phi}} \neq 0$ Considering NKP

The continuity of substrate deposition is a predominant influence of microbial growth in the study area. Definitely the deposition of nitrogen known as micro nutrient deposited heterogeneous condition in the strata, such influential stratification under heterogeneous setting pressure the behaviour and growth of the microbes in the formation. Monitoring the migration and deposition of nitrogen and the predominant microbes in the study location are examined under the reflection of the heterogeneous influential condition from the geological setting as it is expressed in coastal area of Okrika.

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

$$0 = -Cs_o\frac{\lambda}{\phi}\;Sin\frac{\lambda}{\phi}B \qquad \dots\dots\dots\dots\dots \quad (54)$$

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$$\Rightarrow \frac{\lambda}{\sqrt{V}} = \frac{n\pi}{2} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (55)$$

$$\Rightarrow \lambda = \frac{n\pi\sqrt{\phi}}{2} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (56)$$

So that equation (57)

$$Cs_3 = Cs_o\, \ell^{\frac{-n^2\pi^2 V}{2Vt}}\, Cos \frac{n\pi\sqrt{\phi}}{2\sqrt{\phi}} z \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (57)$$

$$\Rightarrow Cs_3 = Cs_o\, \ell^{\frac{-n^2\pi^2 Vt}{2\phi}t}\, Cos \frac{n\pi}{2} z \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (58)$$

Now we consider equation (8)

$$\phi \frac{\partial Cs_4}{\partial t} = \theta \frac{\partial Cs_4}{\partial z} \qquad \ldots\ldots\ldots\ldots \quad (8)$$

Using Bernoulli's method of separation of variables, we have

$$Cs_4 = ZT \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (59)$$

$$\frac{\partial Cs_4}{\partial t} = ZT^1 \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (60)$$

$$\frac{\partial Cs_4}{\partial Z} = Z^1 T \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (61)$$

Put (60) and (61) into (8), so that we have

$$\phi Z T^1 = -\theta Z^1 T \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (62)$$

i.e. $$\frac{\phi T^1}{T} = \theta \frac{Z^1}{Z} = \varphi \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (63)$$

$$\phi \frac{Z^1}{Z} = \varphi \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (64)$$

$$T = A \frac{\varphi}{\phi} z \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (65)$$

$$Z = B\ell^{\frac{-\varphi}{\phi}z} \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (66)$$

And

The exponential phase of the system express the pressure of microbes under predominant deposition of porosity in some certain region, the expression in [66] shows the model under the predominant state of high degree of porosity in the transport system of the microbes, these expression considered the migration with respect to depth in the study location, since Phreatic zone deposited at shallow depth the expression of the model considering the influences from shallow deposition become significant in the study through the model in [66].

Put (65) and (60) into (59), gives

$$Cs_4 = A\ell^{\frac{\varphi}{\theta}z} \bullet B\ell^{\frac{-\varphi}{\theta}z} \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (67)$$

$$Cs_4 = AB\ell^{(x-t)}\frac{\varphi}{\theta} \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (68)$$

Subject equation (67) to (8) yield

$$Cs_4 = (o) = C_o \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (69)$$

So that equation (69) becomes

$$Cs_4 = Cs_o\ell^{(x-t)}\frac{\varphi}{\theta} \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (70)$$

Now, we consider equation (9)

$$\phi\frac{\partial Cs_5}{\partial t} = \frac{\partial Cs_5}{\partial z}\gamma \qquad \ldots\ldots\ldots\ldots \qquad (9)$$

Apply Bernoulli's method, we have

$$Cs_5 = ZT \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (71)$$

$$\frac{\partial Cs_5}{\partial t} = ZT^1 \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (72)$$

$$\frac{\partial Cs_5}{\partial Z} = Z^1T \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (73)$$

Put (72) and (73) into (9), so that we get

$$\phi XT^1 = -Z^1T\gamma \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (74)$$

i.e. $\frac{\phi T^1}{T} = \frac{Z^1}{Z}\gamma = \beta$ $\qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (75)$

$$\frac{VT^1}{T} = \beta \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (76)$$

$$\frac{Z^1}{Z} = \beta \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (77)$$

$$T = \frac{A\beta}{\phi}T \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (78)$$

And $Z = B\ell\frac{-\beta}{\phi}Z$ $\qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (79)$

Put (78) and (79) into (71), gives

$$Cs_5 = A\ell^{\frac{\beta}{\phi}t} \bullet B\ell^{\frac{-\beta}{\phi}t} \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (80)$$

$$Cs_5 = AB\ell^{(x-t)}\frac{\beta}{\phi} \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (81)$$

Subject equation (83) and (84) into (74) yield

$$Cs_5 = (o) = Cs_o \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (82)$$

So that equation (81) and (82) becomes

$$Cs_5 = (o) = Cs_o \; \ell^{(t-x)} \frac{\beta}{\phi} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (83)$$

The deposition of nitrogen and virus in coastal formation of this nature needs to be thoroughly expressed in the study area. This implies that the reflections from the geologic setting where shallow aquifer are experienced in the coastal formation are pressured by man-made activities of different sort. These are found from the regeneration of biological waste and other substances from different sort of man-made activities resulting from indiscriminate dumping and unregulated waste management. Such conditions in our environment experience high degradation of soil and water quality. The predominant deposition of nitrogen and virus are experienced from these developments, pressuring the rate of migration to aquiferous zone due to its shallow depositional nature.

Now, we consider equation (11) which is the steady flow rate of the system

$$Vt \frac{\partial Cs_6}{\partial z} = \frac{\partial Cs_6}{\partial z} \gamma \quad \ldots\ldots. \; (11)$$

Applying Bernoulli's method of separation of variables, we have

$$Cs_6 = ZT \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (84)$$

$$\frac{\partial Cs_6}{\partial t} = ZT^1 \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (85)$$

$$\frac{\partial Cs_6}{\partial Z} = Z^1 T \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (86)$$

Put (85) and (86) into (11), so that we have

$$Vt\, Z^1 T = -\, \gamma Z^1 T \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (87)$$

i.e. $Vt \frac{Z^1}{Z} = \gamma \frac{Z^1}{Z} = \alpha$ ……………… (88)

$$Vt \frac{Z^1}{Z} = \alpha \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (89)$$

$$\gamma \frac{Z^1}{Z} = \alpha \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (90)$$

$$Z = A \frac{\alpha}{Vt} Z \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (91)$$

And $Z = B\ell^{\frac{\alpha}{\gamma} Z}$ ……………… (92)

Put (91) and (92) into (84) gives

$$Cs_6 = A\ell^{\frac{\alpha}{Vt}} B\ell^{\frac{\alpha}{Vt}} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (93)$$

$$Cs_6 = AB\ell^{(x-x)} \frac{\alpha}{Vt} x \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (94)$$

The behaviour of the system at this phase of the transport system express the influences from high homogeneous rate of velocity in some region of the formation, such condition are express detail degree of homogenous velocity setting at this particular region were homogeneity are predominant, the expressed model established these condition to thoroughly monitored the behaviour of virus and nitrogen. The development of this model at this phase of the study is to express linear velocity of flow in the transport system.

Subject equation (93) and (94) into (94) yield

$$Cs_6 = (o) = C_o \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (95)$$

So that equation (96) becomes

$$Cs_6 = Cs_o \, \ell^{(x-x)\frac{\alpha}{Vt}} \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (96)$$

Now, assuming that at the steady flow there is no NKP for substrate utilization, our concentration is zero so that equation (96) becomes

$$Cs_6 = 0 \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (97)$$

Therefore, solution of the system is of the form

$$Cs = Cs_1 + Cs_2 + Cs_3 + Cs_4 + Cs_5 + Cs_6 \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (98)$$

We now substitute (20), (39), (58), (70), (83) and (96) into (98), so that the model is of the form

$$C = Cs_o + Cs_o \, \ell \frac{-n^2\pi^2 Ds}{2\phi} Cos \frac{n\pi}{2} Z + Cs_o \, \ell \frac{-n^2\pi^2 Vt}{2\phi} Cos \frac{\sqrt{V}}{2} Z +$$

$$Cs_o \, \ell^{(x-t)} \frac{\phi}{Ds} + Cs_o \, \ell^{(t-x)} \frac{\phi}{q_z C_s} + Cs_o \, \ell^{(t-x)} \frac{\alpha}{M_b \frac{\mu_o}{\gamma_o}} \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (99)$$

$$\Rightarrow Cs = Cs_o \; 1 + \ell \frac{-n^2\pi^2 V}{2\frac{C_A}{K_A + C_A}} Cos \frac{n\pi}{2} + \ell \frac{-n^2\pi^2 V}{2V} + Cos \frac{n\pi}{2} +$$

$$\ell^{(t-z)} \frac{\phi}{q_z C_s} + \ell^{(t-x)} \frac{\phi}{M_b \frac{\mu_o}{\gamma_o}} \qquad \ldots\ldots\ldots\ldots\ldots \qquad (100)$$

The deposition of virus and nitrogen has a lot of heterogeneous setting in behaviour; this implies that formation influence at different regions expressed lots of variation on predominant deposition at different stratification. In line with this condition, structural intercedes of the soil has a significant impact on the depositional condition of virus and nitrogen. Such expressions are reflected on general coastal evaluation in its geological setting. The expressed model evaluates these conditions through the developed system that generated the governing equation, producing the final model equation from the derived solution. Experts should take note of this conceptual framework ensuring that the mathematical tools are applied based on the study carried out in the coastal formation, this will enable them to thoroughly in detail notice the variation of the two parameters behaviour in their migration at every strata in the study location.

4. Conclusion

The behaviour of nitrogen as a micronutrient to microbes has been thoroughly evaluated; such heterogeneous deposition of the substrates with the virus has been expressed through developed mathematical equation that monitors their transport condition in coastal area of Okrika. Depositing semi-confined bed in Okrika pressured the deposition and migration of the virus and the micronutrient within the semi-confined bed. Dispersion influence should also be part of predominant deposition of virus within the semi-confined beds, such dispersion deposition may have been taking place from penetrating the semi-confined under predominant of permeability of the formation. Subject to this condition, the heterogeneity of the formation in some certain regions reflects the behaviour of the transport system for the two parameters through the exponential phase of virus. The study is in line with the nature of the coastal deposition of its geologic setting reflecting the deltaic nature of the study location. Experts should thoroughly establish their concept of monitoring and evaluation of this virus through the application of noticing the rate of heterogeneity in behaviour and in some regions of the formation, to ensure that migration and deposition of nitrogen and virus are thoroughly monitored.

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