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Research article

DISPERSION INFLUENCES TO MONITOR VIRUS TRANSPORT IN COASTAL AREA OF DEGEMA, NIGER DELTA OF NIGERIA

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Abstract

Dispersion of virus in coastal environment was observed from the rate of deposition in some observation well in the study location. The concentration of the virus were very high as it is observed from thorough investigation in the study area, base on these factors the sources of these pollution was discovered in details, the rate of spread were paramount, such investigation made mathematical modeling technique more advantage to monitor the sources and cause of spread in the study location. The developed system generated the governing equation for the study, the behaviour of the virus was thoroughly observed, these were integrated on the developed governing equation, the derived solution generated model for simulation, base on the behaviour of the virus in saline environment, the developed model for the study will definitely become a useful tools in monitoring the deposition and transport of virus in coastal phreatic bed. **Copyright ©WJECE, all rights reserved.**

Keywords: dispersion influences, virus transport and coastal area

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1. Introduction

The presence of pathogenic viruses in drinking water wells has been well documented [*Gerba and Rose*, 1990]. Viruses from sewage sludges, wastewater, septic tanks, and other sources can be transported with groundwater to drinking water wells. During this transport, viruses can be either irreversibly or reversibly sorbed onto surfaces of subsurface materials, or inactivated by various mechanisms. The U.S. Environmental Protection Agency (EPA) has proposed the Ground Water Rule, which requires groundwater systems to conduct a hydrogeologic sensitivity assessment to determine groundwater vulnerability to contamination by viruses and other fecal microorganisms (U.S. EPA, National primary drinking water regulations: Ground Water Rule, proposed rule, Federal Register 65, pp. 30,194 –30,274, Washington, D. C., 2000). Soil water content is an important factor that affects virus sorption and inactivation during transport in the subsurface environment. However, the mechanisms by which this effect occurs are unclear at present, although speculations have been made in the literature. Studies have clearly shown that viruses are usually removed more extensively during unsaturated transport than during saturated transport [Yeager and O'Brien, 1979; Hurst et al., 1980; Lance and Gerba, 1984; Bitton et al., 1984; Jorgensen, 1985; Powelson et al., 1990; Powelson and Gerba, 1994; Poletika et al., 1995]. Water content has also been observed to influence the retention and transport of various bacteria and other types of colloidal particles [Wan et al., 1994;Scha¨fer et al., 1998; Jewett et al., 1999]. Several mechanisms have been suggested in the literature to explain the increased virus sorption/inactivation observed in unsaturated systems, and a detailed discussion is given by Jin et al. [2000]. A brief summary of the discussion is given below. Bitton et al. [1984] and Jorgensen [1985] postulated that the limited virus movement under unsaturated conditions was due to increased sorption promoted by the closer proximity of the viruses to the solid surfaces. Electrostatic and hydrophobic interactions as well as van der Waals' forces are believed to be responsible for virus sorption to the solid-water interface [Preston and Farrah, 1988]. However, Powelson et al. [1990] dismissed this possibility on the basis of their calculations of the sizes of water-filled pores that apparently were much larger than the sizes of viruses. Ever since the sorption of colloids (including hydrophobic and hydrophilic particles of clay and polystyrene latex as well as bacteria) to the surface of air bubbles was directly visualized using fluorescent microscopy [Wan and Wilson, 1992, 1994], the presence of AWI has been suggested by more and more researchers as the dominant mechanism responsible for the increased removal of colloidal particles, including viruses and bacteria, in unsaturated systems [Powelson and Mills, 1996; Scha¨fer et al., 1998; Jewett et al.,1999; Jin et al., 2000].

2. Theoretical background

The study of virus has been carried out by several researchers in various dimensions, the dispersion of virus in coastal area were predominant in saline interfaces with fresh water aquifers which has not been evaluated, several occurrences of these different water will definitely generate influences in some organism like virus in coastal formations, there flow dynamics between the micropores of the strata in coastal fresh and saline interface is the subject matter of the study.

Base on these factors the study from these dimensions should of serious concern in the transport system of the virus. the deposition of virus in fresh water phreatic bed will no doubt develop different concentration and velocity in migration process in various strata. The saline environment in study location are predominantly deposited in the area, there will always been the tendency of brackish water in transition zone, the structural stratification sequentially between the formation down to the phreatic bed developed the interface between the saline and fresh water aquifers, these conditions express the dynamic of flows whereby the concentration will develop reactions with other deposited substances in the formations. During this transport, viruses can be either irreversibly or reversibly sorbed onto surfaces of subsurface materials, or inactivated by various mechanisms of Soil water content, it is an important factor that affects virus sorption and inactivation during transport in the subsurface environment. However, the mechanisms by which this effect occurs are unclear at present, although speculations have been made in the literature. Studies have clearly shown that viruses are usually removed more extensively during unsaturated transport than during saturated transport. These develop postulation that limited virus movement under unsaturated conditions; it has been observed that it is due to increased sorption promoted by the closer proximity of the viruses to the solid surfaces. More so Electrostatic and hydrophobic interactions as well as van der Waals' forces are believed to be responsible for virus sorption to the solid-water interface,

3. Governing equation

$$D\frac{\partial^2 c}{\partial t^2} = K_V \frac{\partial c}{\partial Z} - \lambda_U \frac{\partial c}{\partial Z} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \qquad (1)$$

The developed governing equation expresses the system behaviour on the deposition in terms of dispersion of the virus in coastal location where there is interface of saline and fresh water phreatic bed, the developed model equation were generated through this fundamental depositional soil characteristics, this parameters has been found to Influences the flow net direction that the virus pass through the formation micropores of the strata in costal coastal phreatic bed.

Nomenclature

C = Virus concentration
λ = Saline concentration
K = Permeability
U = Velocity
T = Time
Z = Depth
V = Void Ratio

Let $C = T, Z$

$$DT^{11}Z = K_V TZ^1 - \lambda_U TZ^1 \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \qquad (2)$$

$$D\frac{T^{11}}{T} = K_V \frac{Z^1}{Z} - \lambda_U \frac{Z^1}{Z} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \qquad (3)$$

$$D\frac{T^{11}}{T} = \theta^2 \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \qquad (4)$$

$$K_V \frac{Z^1}{Z} = \theta^2 \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \qquad (5)$$

$$-\lambda_U \frac{Z^1}{Z} = \theta^2 \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \qquad (6)$$

$$\left[K_V - \lambda_U\right]\frac{Z^1}{Z} = \theta^2 \tag{7}$$

$$D\frac{dc}{dt} = \theta^2 \tag{8}$$

$$D\frac{dc^2}{dt^2} = \theta^2 \tag{9}$$

$$D\frac{dc}{dZ} = \theta^2 \tag{10}$$

$$-\lambda_U\frac{dc}{dZ} = \theta^2 \tag{11}$$

$$d^2Z = \left[\frac{\theta^2}{D}\right] = dZ \tag{12}$$

$$\int d^2 = \int\frac{\theta^2}{D}dZ \tag{13}$$

$$dZ = \frac{\theta^2}{D}Z + C_1 \tag{14}$$

$$\int dZ - \int\frac{\theta^2}{D}Z\ dZ + C_1\int dZ \tag{15}$$

$$Z = \frac{\theta^2}{D}\frac{Z^2}{2} + C_1 + C_2 \tag{16}$$

$$Z = \frac{\theta^2}{D}\frac{Z^2}{2} + C_{1^2} + C_2 \tag{17}$$

$$\boxed{Z = \frac{\theta^2}{D}Z^2 + C_{1^2} + C_2} \tag{18}$$

The dispersion rate of the virus from surface of the soil in coastal area were precisely determined at this stage of derived solution, the rate of spread were monitored at this stage of the study, because dispersion implies that it will definitely contaminate most part of the environment. The periods of migration were monitor, but the areas of spread were paramount in the derived model at this phase of the transport system.

$$\Rightarrow \frac{\theta^2}{2D} Z^2 + C_{1^2} + C_2 = 0 \quad \dots\dots\dots\dots \tag{19}$$

Auxiliary equation becomes

$$\frac{\theta^2}{2D} M_2 + C_2 M + C_2 = 0 \quad \dots\dots\dots\dots \tag{20}$$

Applying quadratic expression, we have

$$M_{1^2} = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \quad \dots\dots\dots\dots \tag{21}$$

$$M = \frac{-C_1 \sqrt{C^2 - 4 \frac{\left(\theta^2\right)}{2D} C_2}}{2 \frac{\theta^2}{D}} \quad \dots\dots\dots\dots \tag{22}$$

$$M_1 = \frac{-+C_1 \sqrt{C^2 - 2C_2 \frac{\theta^2}{D}}}{2 \frac{\theta^2}{D}} \quad \dots\dots\dots\dots \tag{23}$$

$$M_2 = \frac{-C - \sqrt{C_1^{\,2} - 2C_2 \frac{\theta^2}{D}}}{2 \frac{\theta^2}{D}} \quad \dots\dots\dots\dots \tag{24}$$

Assuming this discriminant is complex, therefore equation (23) and (24) can be written as:

$$C[T, Z] = F1\, Cos\, M_1 t + F2\, Sin\, M_2 Z \quad \dots\dots\dots\dots \tag{25}$$

But if But if $t = \frac{d}{v}$ and $Z = v \cdot t$

The expressed model can be written as

$$C[T, Z] = F1\, Cos\, M_1 \frac{d}{v} + F2\, Sin\, M_2 V \cdot t \quad \dots\dots\dots\dots \tag{26}$$

The expressed derived model has been developed to monitor the dispersion impact of on virus transport process in coastal location, the derived model were developed base on the soil characteristics of the formation in terms of velocity of flow through porosity and permeability rate of deposition in the formations. The migration of virus were considered base on its behaviour in interface of fresh and saline environment, these expressed model were generated from every positive impact of these parameters.

4. Conclusion

The behaviour of virus migration in coastal environment has been thoroughly assessed in the system, these were through the parameters that has serious impact on the behaviour of virus, dispersion influences were precisely monitor on this study to determined the rate of dispersion impact in the system, these were considered in coastal environment base on the rate of spread in the study location. Velocities of flow through high degree of permeability were through evaluated through pressures of flow in the study location. The system monitored the transport of virus by determining the period of migration in coastal formations, the rate of migration under dispersion impact were found to increase base on the permeability rate of the formation, the study location are in coastal environment were environmental factors are seriously involved in every deposition of the formation and the virus migrations in the study area. The fresh water and saline interface were also considered to monitor the impact on the mixed reaction from the concentration of virus in various phreatic bed. The study is imperative because it will definitely predict migration rate of virus in coastal environment.

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