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Research article

MATHEMATICAL MODEL ON ALLUVIA INFLUENCES TO PREDICT ENTEROMOBACTER TRANSPORT IN HOMOGENEOUS COARSE FORMATION IN COASTAL AREA OF PATANI,

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Abstract

The study monitor the behaviour of microbial transport in porous media, these study determine various dimension facilitated by flowing water, other condition in the deposition of Enteromobacter may be pressured by retention due to adsorption to phase interfaces. Water flow in porous media depends greatly on water content and pore size distribution. Considering microbial adsorption of air-water interfaces which is imperative mostly in unsaturated porous media. Bacterial transport in unsaturated soils is much less well understood than in saturated conditions, especially for intact soils. Since the study focus on saturate formation The express model from the governing equation was designed to investigate the fate and transport of microbes in intact gravel formation with different water saturations, and particularly the effect of deltaic influences, the behaviour of the contaminant at different depth on homogeneous gravel formation has expressed the fluid flow and formation pressure through the deltaic influences in the study area.

Keywords: mathematical model, alluvia influences, Enteromobacter, and coarse formation.

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1. Introduction

To recapitulate, *E. coli* microorganisms have often been establish in focally polluted soil and water , are easy to count, and are hydrophilic and powerfully unconstructively charged. These properties make this bacterium a useful indicator of fecal pollution of soil and water, especially in developing countries lacking adequate laboratory capital. In calculation, some *E. coli* strains are enteropathogenic. Viruses may be considered more critical to soil and water quality than *E. coli*. Because of their lesser size, stability, and unconstructive charge, they may be migrated even Further through the soil and because of their infectiousness they symbolize a major threat to public health. However, the discovery and enumeration of viruses, including Bacteriophages requires more technical skills than needed for *E. coli*. The migration of E.coli and deposition of potassium in accumulation in porous media may be normally described by the advection dispersion sorption (ADS) equation (De Marsily, 1986). Several expressions of the ADS equation have been applied for the transport of colloids in general [1, 3, 4, 7, 8.9,] and, more particularly, for the transport of *E. coli* and Thermotolerant coliforms [8, 9, 10, 11, 12, 13, 14]. To suitably explain the dynamic effects of colloid deposition and possible blocking effects, the colloid transport equation is expressed in terms of particle number concentration rather than mass concentration [5, 6] along with terms for attachment, detachment, straining, and inactivation or die-off [5]. Straining is defined as the trapping of bacteria in pore throats that are too small to allow passage, and it results from pore geometry. [11] Where N is the coordination number or the number of contact points between grains [2], determined the pore volume available for straining from modeling high concentration *E. coli* breakthrough curves, from geometrical considerations based on [1]. From a pore size density function, and concluded that pore volumes determined with those methods were in reasonable agreement. [15] The developed geometrically derived contact efficiency due to straining based on [1].

2. Theoretical background

The continuous movement of water between oceans, atmosphere and land is known as the hydrological cycle. Considering the freshwater component of the system, which is the part of greatest significance for this monograph, inflow is from precipitation in the form of rainfall and from melting snow and ice. Outflow occurs primarily as stream flow or runoff and as evapotranspiration, a combination of evaporation from water surfaces and the soil and transpiration from soil moisture by plants. Precipitation reaches streams and rivers both on the land surface as overland flow to tributary channels, and also by subsurface routes as interflow and base flow following infiltration to the soil. Part of the precipitation that infiltrates deeply into the ground may accumulate above an impermeable bed and saturate the available pore spaces to form an underground body of water, called an aquifer. The water contained in aquifers contributes to the groundwater component of the cycle, from which natural discharge reaches streams and rivers, wetlands and the oceans. Similar sources control the migration of contaminant to ground water aquifers, the behaviour of alluvia deposition in coastal area of patani, these coastal environment are predominantly alluvia deposit, generated influences from these predominant are the focus of these study, the behaviour of these system are expressed in developed mathematical expression to monitor the behaviour of enteromobacter transport in homogeneous coarse formation, the system applied these conceptual frame work to determine the rate of deposition

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and the level of alluvial pressure on the transport of enteromobacter in patani delta of Nigeria. The study will definitely define the structure of alluvia deposition on enteromobacter in such coastal formation. The structure of the coastal area were applied to develop the formation of the system, this include all the influential parameters that are predominant in the coastal environment.

3. Governing equation

$$K\frac{hA}{L}\frac{\partial c}{\partial t} = \Delta V\frac{\partial^2 c}{\partial z^2} + h_{(x)}\frac{\partial c}{\partial z} + \Delta\phi\frac{\partial^2 c}{\partial z^2} \quad \text{..............................} \quad (1)$$

Nomenclature

h	=	Fluid flow at vertical level
K	=	Permeability
A	=	Cross sectional area
L	=	Length
T	=	Time
Q	=	Porosity
c	=	Concentration
V	=	Velocity
z	=	Depth
$h_{(x)}$	=	Fluid at short distance

The governing equation are developed through the deposition of alluvia influences in coastal environment, such condition were applied to determine other variable that should pressure the transport of enteromobacter in the study location. The behaviour of the system should focus on the pressure from alluvia, these expression establish the functional parameters that should evaluates there influential function in the system.

$$K\frac{hA}{L}\frac{\partial c}{\partial t} = [\Delta V + \Delta\phi]\frac{\partial^2 c}{\partial z^2} + h\frac{\partial c}{\partial z} \quad \text{..............................} \quad (2)$$

$$K\frac{hA}{L}\frac{\partial c}{\partial t} = [\Delta V + \Delta\phi]\frac{\partial^2 c}{\partial z} \quad \text{..............................} \quad (3)$$

$$K\frac{hA}{L}\frac{\partial c_1}{\partial t} = h\frac{\partial c}{\partial z} \quad \text{..............................} \quad (4)$$

$$[\Delta V + \Delta\phi]\frac{\partial^2 c_3}{\partial z^2} = -h\frac{\partial c_3}{\partial z} \quad \text{..............................} \quad (5)$$

The solution is of the form $c = (t, z) = c_1(t, z) + c_2(t, z) + c_3(t, z)$

Let $c = T, Z \quad \text{..............................} \quad (6)$

$$\frac{\partial c_1}{\partial t} = T^1 Z \quad \text{..............................} \quad (7)$$

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$$\frac{\partial c}{\partial z} = TZ^1 \qquad \text{..............................} \qquad (8)$$

$$\frac{\partial^2 c}{\partial z^2} = TZ^{11} \qquad \text{..............................} \qquad (9)$$

Consider (3)

$$K\frac{hA}{L}T^1 Z = [\Delta V + \Delta\phi]TZ^{11} = \beta^2 \qquad \text{..............................} \qquad (10)$$

$$K\frac{hA}{L} = \beta^2 \qquad \text{..............................} \qquad (11)$$

$$\int\frac{dT}{T} = \int\frac{\beta^2}{K\frac{hA}{L}}dt \qquad \text{..............................} \qquad (12)$$

$$Ln\ T = \frac{\beta^2}{K\frac{hA}{L}} + c \qquad \text{..............................} \qquad (13)$$

$$\boxed{T = A\ell^{\frac{\beta}{K\frac{hA}{L}}t}} \qquad (14)$$

The expression here from the derived solution consider the behaviour of the system in terms of time, such condition are essential in the sense that the behaviour of the system should be influences by time under the pressure of fluid velocity, the migration of fluid within shallow depth are observed in the some strata that may exhibit uniformity of fluid flow in the coastal environment, the expressed model considering these condition thus note the level pressure from permeability in the strata, these condition will thoroughly determine the rate of migration at various formations.

Considering this expression again $[\Delta V + \Delta\phi] = \beta^2$

$$[\Delta V + \Delta\phi]Z^{11} = \beta^2 \qquad \text{..............................} \qquad (15)$$

$$c = B\ell^{\frac{\beta^2}{\Delta V + \Delta\phi}Z} + D\ell^{\frac{\beta^2}{\Delta V + \Delta\phi}Z} \qquad \text{..............................} \qquad (16)$$

Combine (14) and (16) gives

$$c_1(t,z) = \left(B\ell^{\frac{\beta}{\Delta V + \Delta \phi} Z} + D\ell^{\frac{\beta}{\Delta V + \Delta \phi} Z} \right) A\ell^{\frac{\beta^2}{K\frac{hA}{L}} t} \qquad \text{..............................} \qquad (17)$$

There is no doubt that migration of enteromobacter developed change in deposition, these are in accordance with the behaviour of transport process in alluvia depositions, such development express the migration system that permeability and other formation characteristics may have an influences in the study area. The conditions of the system at these levels evaluate the rate of change in enteromobacter at different condition under the influences of predominant deposited formation characteristics. The express model from the derived solution considered these conditions to evaluate the level of behaviour at various phase of the transport system in the coastal formation.

Consider equation (4)

$$K\frac{hA}{L}\frac{\partial c_2}{\partial t} = h\frac{\partial c_2}{\partial z}$$

$$K\frac{hA}{L} T^1 Z = hZ^1 T$$

$$K\frac{hA}{L}\frac{T^1}{T} = h\frac{Z^1}{Z} = \gamma \qquad \text{..............................} \qquad (18)$$

$$h\frac{Z^1}{Z} = \gamma \qquad \text{..............................} \qquad (19)$$

$$\int \frac{dT}{T} = \frac{\gamma}{K\frac{hA}{L}} \int dt \qquad \text{..............................} \qquad (20)$$

$$Ln\, T = \frac{\gamma}{K\frac{hA}{L}} + \varphi \qquad \text{..............................} \qquad (21)$$

$$T = C\ell^{\frac{\gamma}{K\frac{hA}{L}} t} \qquad \text{..............................} \qquad (22)$$

Considering $h\frac{Z^1}{Z} = \gamma$

$$\int \frac{dz}{z} = \int \gamma v dz \qquad \text{..............................} \qquad (23)$$

$$Ln\ z = \gamma hz + b \quad \text{.............................} \quad (24)$$

$$z = \Delta \ell^{\gamma h} \quad \text{.............................} \quad (25)$$

Combine (22) and (25), gives;

$$c_2 = (t, z) = ab\ell^{\left(\frac{1}{K\frac{hA}{L}} + h\right)t} \quad \text{.............................} \quad (26)$$

The structure of the system were observed base on the level of stratification in the study location, permeability were found to be the most influential parameter in the coastal area, look at these situation were these fluid behaviour change under the pressure of predominant deposition of permeability in the coastal environment, the study at these phase on the derived solution express the behaviour of the fluid flow on the transport of Enteromobacter in deltaic environment.

Consider equation (5)

$$[\Delta V + \Delta \phi] Z^{11} T = -hZ^{1} T$$

$$[\Delta V + \Delta \phi] \frac{Z^{11}}{Z} = -h\frac{dz}{dz} = \theta^2 \quad \text{.............................} \quad (27)$$

$$[\Delta V + \Delta \phi] \frac{d^2 z}{dz^2} = \theta^2 \quad \text{.............................} \quad (28)$$

$$Z = E\,Cos\frac{\theta}{\sqrt{\Delta V + \Delta \phi}} z + F\,Sin\frac{\theta}{\sqrt{\Delta V + \Delta \phi}} z \quad \text{.............................} \quad (29)$$

Also $h\frac{dz}{dz} = +\theta^2$

$$\int \frac{dz}{dz} = h\theta^2 \int dz \quad \text{.............................} \quad (30)$$

$$Ln\,z = h\theta^2 z + d \quad \text{.............................} \quad (31)$$

$$z = D\ell^{h\theta^2} \quad \text{.............................} \quad (32)$$

Similar condition were consider in these phase of the system, the behaviour of fluid flow with respect to migration of the contaminant in the formation where assessed, there is no doubt that the behaviour of the contaminant may be influenced by the condition of the flow between the intercedes of the formation, the deltaic pressure of the formation varies, therefore, it is of interest that such situation need to be considered in the system, the derived solution express the equation to generate the developed model at this phase of the study state in [32].

Combining (29) and (30) yield

$$c_3 = (t, z) = \left(E\,Cos \frac{\theta}{\sqrt{\Delta V + \Delta\phi}} z \; + \; F\,Sin \frac{\theta}{\sqrt{\Delta V + \Delta\phi}} z \right) G\ell^{h\theta^2} \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (33)$$

Therefore, combined equations (17), (26) and (33) give

$$c(t, z) = c_1(t, z) + c_2(t, z) + c_3(t, z)$$

$$c_1(t, z) = \left(B\ell^{\frac{\beta}{\Delta V + \Delta\phi} Z} + D\ell^{-\frac{\beta}{\Delta V + \Delta\phi} Z} \right) A\ell^{\frac{\theta^2}{K\frac{hA}{L}} t} \; +$$

$$ab\ell^{\left(\frac{1}{K\frac{hA}{L}} + h\right)} \gamma + \left(E\,Cos \frac{\theta}{\sqrt{\Delta V + \Delta\phi}} z \; + \; F\,Sin \frac{\theta}{\sqrt{\Delta V + \Delta\phi}} z \right) G\ell^{h\theta^2} z \qquad \ldots\ldots\ldots\ldots\ldots\ldots \qquad (34)$$

Several concepts has been developed to monitor the behaviour of Enteromobacter transport, but not much has been done in deltaic predominant formation, the developed model at these phase monitor the migration process in coarse formation to see the migration behaviour in predominant coarse strata, such condition also express the predominant deposited formation characteristics that should influences the deposited gravel formation to pressure the transport process of Enteromobacter in such coastal environment. The derived solution from the system consider these conditions to developed the governing equation, this were derived to produced the model in different phase, further expression were possible to determine several variables functions in the system, these has definitely detail every parameters that will monitor Enteromobacter in coastal area of patani.

4. Conclusion

The coastal environments are pressured by several environmental influences in the study area; such condition should be thoroughly evaluated to determine the behaviour of such type of microbial species in the study location. The migration process of Enteromobacter in homogeneous gravel formation can only be determined if the study precisely monitor the process in these phase in other to determine the variation of the microbial behaviour at various formation, permeability has been confound to deposit high percent in most region of the strata, the study from the derived solution has look at several condition in the system base of the stratification of the formation. The predominant permeability has pressure the migration process of the contaminant. The rates of fluid flow with respect to the transport in different formation were expressed, the study considering the various phase of the system, it has definitely evaluate the rate of deposition and migration in coastal area of patani.

References

[1] Hirtzel, C.S. and R. Rajagopalan, 1985. Colloidal phenomena – advanced topics. Noyes Publications, Park Ridge, N.J., USA.

[2] Foppen, J.W.A., A. Mporokoso and J.F. Schijven, 2005. Determining straining of *Escherichia coli*from breakthrough curves. J. Contam. Hydrol., Vol. 76, p. 191-210.
[3] Corapcioglu, M. Y. and A. Haridas, 1984. Transport and fate of microorganisms in porous media: a theoretical investigation. J. Hydrol. 72, 149-169.

[4] Corapcioglu, M. Y. and A. Haridas, 1985. Microbial transport in soils and groundwater: a numerical model. Adv. Water Resour. 8, 188-200.

[5] Bhattacharjee, S., J.N. Ryan and M. Elimelech, 2002. Virus transport in physically and geochemically heterogeneously subsurface porous media. J. Cont. Hydrol. 57 (2002), p. 161-187.

[6] 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), p. 238-245.

[7] Schijven, J.F. 2001. Virus removal from groundwater by soil passage. Modelling field and laboratory experiments. PhD Thesis. ISBN 90-646-4046-7. Posen and Looijen, Wageningen, The Netherlands.

[8] Hall, W.A., 1957. An analysis of sand filtration. J. Sanitary Engineering Division: Proceedings of the Am. Soc. Civ. Eng. (83) SA 3, p. 1276/1-1276/9.

[9] Matthess, G. and A. Pekdeger, 1981. Concepts of a survival and transport model of pathogenic bacteria and viruses in groundwater. In: Quality of Groundwater, Proceedings of an international symposium, edited by VanDuijvenbooden, W., P. Glasbergen and H. van Lelyveld, p. 427-437.

[10] Matthess, G. and A.Pekdeger, 1988. Survival and transport of pathogenic bacteria and viruses in groundwater. In Groundwater Quality, edited by C.H. Ward, W. Giger, and P.L. McCarty, pp. 472 -482, John Wiley, New York, 1985.

[11]Matthess, G., 1982. The properties of groundwater. ISBN 0-471-08513-8, John Wiley & Sons, Inc. New York.

[12] Matthess, G., A. Pekdeger and J. Schroeter, 1988. Persistence and transport of bacteria and viruses in groundwater – a conceptual evaluation. J. Cont. Hydrol. (2) 1988, p. 171-188.

[13] Matthess, G., E. Bedbur, K.O. Gundermann, M. Loof and D. Peters, 1991a. ergleichende Untersuchung zum Filtrationsverhalten von Bakterien und organischen Partikeln in Porengrundwasserleitern I. Grundlagen und Methoden. Zentralblatt für Hygiene und Umweltmedizin 191, p. 53-97 (1991). Gustav Fischer Verlag Stuttgart/New York.

[14] Matthess,, G., E. Bedbur, K.O. Gundermann, M. Loof and D. Peters, 1991b. ergleichende Untersuchung zum Filtrationsverhalten von Bakterien und organischen Partikeln in Porengrundwasserleitern II. Hydraulische, hydrochemische unde sedimentologische Systemeigenschaften, die den Filterfaktor steuern. Zentralblatt für Hygiene und Umweltmedizin 191, p. 347-395 (1991). Gustav Fischer Verlag Stuttgart/New York.

[15] Neumann, B., 1983. Untersuchungen zur Elekrophorese als Transportmechanismus bei der Tiefinfiltration. Diss. Universität Fridericana Karlsruhe, Fakultät fürChemieingenieurwesen.

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

[15] Murphy, E.M. and T.R. Ginn, 2000. Modelling microbial processes in porous media. Hydrogeol. J. 8, no. 1, 142-158.

[16] Sun, N., M Elimelech, N-Z Sun and J.N. Ryan, 2001. A novel two-dimensional model for colloid transport in physically and geochemically heterogeneous porous media. J. Contam. Hydrol. 49, 173-199.

[17] Yao, K-M, M.T. Habibian and C.R. O'Melia, 1971. Water and wastewater filtration: Concepts and Applications. Environmental Science and Technology Vol. 5, Number 11, p. 1105-1112

[18] Jan W. A. F 2007 Transport of *Escherichia coli* in saturated porous media Copyright © 2007 Taylor & Francis Group plc, London, UK.

[19] Eluozo, S.N. 2013; modeling the deposition of potassium in lateritic soil on batch system application influencing e. coli transport International Journal of Waste Management and Technology Vol. 1, No. 3, June 2013, PP: 49 – 56,