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MODELING IONC CONTENT INFLUENCED BY HYDRAULIC CONDUCTIVITY AND VELOCITY IN HOMOGENEOUS COARSE SAND IN COASTAL AREA OF KAIAMA,

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

Abstract

Ionic content were found to deposit in Kaiama one of the location in deltaic environment, the substances were investigated to predominantly deposit at a very high concentration in the aquiferous zone. The study is to evaluate various stages of the intrusion in the study location; parameters that are predominant were expressed relating to its major roles in the system, thus through the derived solution. This generated the governing equation for the study, the derived solution developed several models base on different examined conditions that pressured the depositions of ionic content in groundwater aquifers. The study will definitely become a useful tool in monitoring and assessment of quality ground water exploration in the study location.

Keywords: modeling, ionic content, hydraulic conductivity and velocity

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1. Introduction

Uniformity of stratum is base on geologic history and geomorphology, including the geochemistry that influences the constituent of the formation, the characteristics determines the rate of microbial migration to ground water aquifers. Rivers State treasure base of the nation' is situated about 60 km from the open sea lies between longitude 6o55'E to 7o10'E of the Greenwich meridian and latitude 4o38'N to 4o54'N of the Equator, covering a total distance of about 804 km2 (Akpokodje 2001). In terms of drainage, the area is situated on the top of Bonny River and is entirely lowland with an average elevation of about 15m above sea level (Nwankwoala, 2005). The topography is under persuading of tides which a consequence is flooding especially during rainy season (Nwankwoala and Mmom, 2007). Climatically, the city is situated within the sub-equatorial region with the tropical monsoon weather characterized by high temperatures, low pressure and high relative dampness all the year round. The mean annual temperature, rainfall and relative dampness are 30oC, 2,300 mm and 90% correspondingly (Ashton-Jones, 1998). The soil in the area is mainly silty-clay with interaction of sand and gravel while the vegetation is an amalgamation of mangrove swamp forest and rainforest (Teme, 2002). Rivers state falls within the Niger Delta Basin of Southern Nigeria which is defined geologically by three sub-surface sedimentary facies: Akata, Agbada and Benin formations (Whiteman, 1982). The Benin Formation (Oligocene to Recent) is the aquiferous formation in the study area with an average thickness of about 2100m at the centre of the basin and consists of coarse to medium grained sandstone, gravels and clay with an average thickness of about 2100m at the centre of the basin and consists of coarse to medium grained sandstone, gravels and clay (Etu-Efeotor and Akpokodje, 1990). The Agbada Formation consists of alternating deltaic (fluvial coastal, fluviomarine) and shale, while Akata Formation is the basal sedimentary unit of the entire Niger Delta, consisting of low density, high pressure shallow marine to deep water shale (Schield, 1978).The quantity and quality of ground water resources of any region are restricted by the climate and geology of the area. The climate through rainfall and surface water resources ensure steady supply or recharge to groundwater resources of an area in a complex hydrological cycle. The geology of the region determines the aquiferous zones where exploitable groundwater may occur and influences the geochemical Characteristics of the groundwater, amongst other factors such as human activities (Domenico, 1972). The geochemical characteristics of the groundwater in turn influence the quality of the groundwater resources. Earlier works by Demenico, and Schwartz (1998), Ahiarakwem and Ejimadu (2002), Downey (1984), Aniya and, Schoenekeck K (1992), Idowu et al. (1999) and Awalla and Ezeigbo (2002) have confirmed the influence of local geology on the aquifer characteristics and quality of groundwater resources of any area. Human activities may also influence the quality of groundwater in the region (Alagbe, 2006). Groundwater has been described as the main source of potable water supply for domestic, industrial and agricultural uses in the southern part of Nigeria especially the Niger Delta, due to long retention time and natural filtration capacity of aquifers (Odukoya et al., 2002; Agbalagba et al., 2011; Ehirim and Ofor, 2011). Water that is safe for drinking, pleasant in taste, and suitable for domestic purposes is designated as potable water and must not contain any chemical or biological impurity (Horsfall and Spiff, 1998). Pollution of groundwater has gradually been on the increase especially in our cities with lots of industrial activities, population growth, poor sanitation, land use for commercial agriculture and other factors responsible for environmental degradation (Egila and Terhemen, 2004). The concentration of contaminants in the groundwater also depends on the level and type of elements introduced to it naturally or by human activities and distributed through the geological stratification of the area. It has been reported that petroleum refining contributes solid, liquid, and gaseous wastes in the environment (Ogbuagu, et al., 2011). Some of these wastes could contain toxic components such as the polynuclear aromatic hydrocarbons (PAHs), which have been reported to be the real contaminants of oil and most abundant of the main hydrocarbons found in the crude oil mixture (El-Deeb and Emara, 2005). Once introduced in the environment, PAHs could be stable for as short as 48 hours (e.g. naphthalene) or as long as 400 days (e.g. fluoranthene) in soils (Martens and Frankenberger, 1995). They thus, resist degradation and, remain persistent in sediments and when in organisms, could accumulate in adipose tissues and further transferred up the trophic chain or web (Decker, 1981; Schwartz, 2003 Boehm et al., 1981).

2. Theoretical background

The deposition of ionic content in Kaiama has been of serious concern in the study location; the study area has express high rate of water pollution. Deposition of ionic content are through high degree of void percentage were porosity playing similar role in the structural stratification of the formation, such deposition are also from the natural geomorphology and geochemistry as it is expressed from the study location, the deposition of these substances has also cause other natural challenges in the formation, high deposition of these substances in the formation will definitely cause more harm than good, the phreatic deposition in the study area produces high yield rate containing ion thus cannot be useful in any purpose unless it is treated, the demand for quality ground water is very high, designing treatment plant with standard water well is difficulty due to capital intensive of the project, the demand for equality water are not available due to this challenges. The study has express concern on the rate of pollution in the study area, unavailability of quality ground water has cause lots of health challenges in the study area, the deposition of ionic content has not been thorough evaluate by experts in the deltaic environment, the migration rate has also not been thoroughly monitored, these challenges has definitely worsen the situation thus developed serious economic dilapidation, the study will definitely look at area were the deposition has the highest degree as well evaluate the deltaic influences that has pressure the deposition of ionic content in the study location. The study of ionic content in Kaiama has developed serious concern on environmental health. The developed mathematical approach will definitely provide a platform for thorough evaluation and monitor the concentration rate of other formation characteristics that may have pressure the migration rate of the substance to the highest degree found in aquiferous zone.

3. Developed governing equation

$$\frac{Vv}{Vs}\frac{\partial e}{\partial t} = K_e \frac{\partial e}{\partial t} + V_t \frac{\partial e}{\partial L} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (1a)$$

The developed mathematical model were generated from the system formulated through the variables known to pressure the deposition of ionic content in Kaiama, the rate concentration are determined by this variables, the development of the governing equation are through the stated variable, these expression were derived looking at various way the parameters pressure the deposition or the contraptions of ion in various strata.

Nomenclature

K_e	=	$[LT^{-1}]$
Vt	=	$[LT^{-1}]$
τ	=	$[LT^{-1}]$
e	=	[-]
L	=	[L]
T	=	[T]

For simplicity let $\frac{Vv}{Vs}$ denote τ, so that equation (1) can be written as:Type equation here.

$$\tau \frac{\partial e}{\partial t} = K_e \frac{\partial e}{\partial t} + V_t \frac{\partial e}{\partial L} \qquad \text{(1b)}$$

$$\tau \frac{\partial e}{\partial L} - \frac{\partial e}{\partial t} = \frac{\partial e}{\partial t} + K_e + V_t \qquad \text{(2)}$$

$$(\tau - 1) \frac{\partial e}{\partial L} = \frac{\partial e}{\partial t} + K_e + V_t \qquad \text{(3)}$$

$$(\tau - 1) \frac{\partial e}{\partial L} = \frac{\partial e}{\partial t} \qquad \text{(4)}$$

$$0 = \frac{\partial e}{\partial L} = + K_e + V_t \qquad \text{(5)}$$

i.e. $\frac{\partial e}{\partial L} = - K_e - V_t$ .... (6)

From (5), integrate directly

$$e = (- K_e - V_t)t + e_1 \qquad \text{(7)}$$

From (6) $(\tau - 1) \frac{\partial e}{\partial L} = \frac{\partial e}{\partial t}$

Let $e = LT$ .... (8)

$$\frac{\partial e}{\partial L} = Z^1 T \qquad \text{(9)}$$

$$\frac{\partial e}{\partial t} = ZT^1 \qquad \text{(10)}$$

Substitute (9) and (10) into (8), we have

$$\tau - 1Z^1 T = (K_e + V_t) ZT^1 \qquad \text{(11)}$$

$$\tau - 1\frac{Z^1}{Z} = (K_e + V_t)\frac{T^1}{T} = \lambda \qquad \text{(12)}$$

$$\tau - 1\frac{Z}{Z} = \lambda \qquad \text{(13)}$$

$$\left(n_e + V_t\right)\frac{T^1}{T} = \lambda \qquad \text{..............................} \qquad (14)$$

From (13) $$\frac{Z^1}{Z} = \frac{\lambda}{\tau - 1} z \qquad \text{..............................} \qquad (15)$$

$$Ln z = \frac{\lambda}{\tau - 1} z + e_3 \qquad \text{..............................} \qquad (16)$$

$$z = A\ell^{\frac{\lambda}{\tau - 1} z} \qquad \text{..............................} \qquad (17)$$

The expressed model at [17] looks at the behaviour of void ratio on the deposition of the formation, the expressed model are monitoring the derived solution with respect to depth, the deposition of void varies, therefore it rate of concentration will definitely vary under the influences of variation percentage of pore space deposition in the formation, the exponential condition of void space in the formation will definitely influences the concentration of ionic content in the study location.

From (14) $$\left(n_e + V_t\right)\frac{T}{T} = \lambda$$

$$T = \frac{\lambda}{n_e + V_t} \qquad \text{..............................} \qquad (18)$$

$$LnT = \frac{\lambda}{K_e + V_t} t + e_3 \qquad \text{..............................} \qquad (19)$$

$$T = B\ell^{\frac{\lambda}{K_e + V_t} t} \qquad \text{..............................} \qquad (20)$$

Similar condition has been observed in the expressed derived model at twenty, these condition are looking periodic conditions of intrusion through the deposition of ionic content in the formation, the derived model were able to relate permeability and velocity of fluid flow in the formation with time, these expression create enabling environment for the variable to express various functions and ways they related to each under the influences of time.

Put (17) and (20) into (8) yield

$$e_2 = A\ell^{\frac{\lambda}{\tau - 1} z} \bullet B\ell^{\frac{\lambda}{K_e + V_t} t} \qquad \text{..............................} \qquad (21)$$

$$e_2 = AB\ell^{\left(\frac{z}{\tau - 1} + \frac{t}{K_e + V_t}\right)\lambda} \qquad \text{..............................} \qquad (22)$$

Hence general solution becomes

$$e = [LT] = e_1 + e_2$$

$$e[LT] = AB\ell\left(\frac{z}{\tau - 1} + \frac{t}{K_e + V_t}\right)\lambda \qquad \text{...............................} \qquad (23)$$

The expression at twenty three is coupled to be the final model that will be applied to monitor the deposition of ionic content in Kaiama, the study has definitely evaluate the intrusion rate of ion base on geological setting to develop the governing equation. The derived model establish the behaviour of several conditions base on the stratification of the system, these condition monitor the intrusion of ionic content in the system, the expression from these direction explain the rate of concentration at different structural deposition of the formation, the predominant parameters were observed to pressure the intrusion at a very high degree, therefore the deposition of the substances are base on the rate of these predominant formation characteristics, there is no doubt that the deposition of ionic content has destroyed water quality to the maximum level, the derived solution generating this model has produced several stages that were integrated to developed final model for the study.

4. Conclusion

Ionic content in Kaiama has been the subject of serious concern on ground water quality in the study location, the development of the model were to critically evaluate several ways that the deposition of the substances intrude into ground water aquifers in the study area. The settlers in the area are trapped by these sources of pollution and these have resulted to lots of several groundwater challenges in the study location. The difficulties in ground pollution can only be solved through thorough investigations from other dimensions; base on this method, the development of mathematical model that will monitor the intrusion rate of ionic content including the behaviour of the other parameters were found imperative to applied in such study. The evaluation of these substances has definitely caused several ill health and has to be addressed to prevent high death rate from these sources of these pollution in Kaiama.

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