International Journal of Waste Management and Technology
Vol. 1, No. 6, September 2013, PP: 95 - 102, ISSN: 2327-8757 (Online)
Available online at www.ijwmt.com

Research article

MODELING THE TRANSPORT OF DISSOLVED AMMONIA IN LACUSTRINE DEPOSITION INFLUENCED BY POROSITY AND SEEPAGE VELOCITY IN SILTY AND GRAVEL FORMATION IN AHOADA, RIVERS STATE OF NIGERIA

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Abstract

Ammonia deposition were found to deposit in some part of the study location ,the deposition of the trace mineral has generated several water pollution through constant generation of waste, the speed of deposition has not been noted in the study area, ammonia deposition has been expressed from hydrogeological and desk studies carried out, it was confirmed from that sources including risk assessment to deposited high content in some part of the town, such situation mean that the generation of quality water through well construction and design will face lots of challenges in the study location, the deposition of ammonia also implies that it will increase the substrate deposition if found in the study location thus increase ground water pollution as well. The settlers will absolutely face quality water problem due to the ugly incident. The situation of water quality in Ahoada may be more challenging if not addressed, because it will be a serious threat to human settler in the area as most of them has been serious affected by water related disease from the contamination sources. The condition of ammonia deposition is at high degree and its concentration has a serious threat to water engineers due to lack of thorough information in the design and construction of water well in the study area. This demanding circumstance can be solved if there is a lay down theoretical outline that can be principles which must be applied in ensuring that such contamination are prohibited in the design and construction of water well. Base on this factors, mathematical model to monitor and predict the rates of ammonia deposition dissolving from organic to aquiferous zone were find suitable in the study this is to ensure that solution to this problem are solved in the study area, the expressed derived solution will definitely be a guild to water well engineers and scientists in the construction of water well in Ahoada.

Keywords: modeling dissolved ammonia, porosity and seepage velocity

1. Introduction

Worldwide 30 to 50 % of the earth's exterior is assumed to be unfavorably affected by non-point source contaminants (Duda 1993). Agriculture is measured to play a main role in non-point source contamination since agricultural actions results in the migration of fertilizer residues, agrochemicals and soil particles from the soil exterior into rivers and streams via runoff and erosion, and into subsurface soil and groundwater via leaching (Corwin, Loague and Ellsworth 1999). Nitrate, which is a major movable plant nutrient, continues to pollute surface and groundwater bodies throughout Europe. despite the ecological fortification policies adopted since the early 1990s, and in particular the implementation of the EU nitrate directive, nitrate concentrations in European rivers remained stable throughout the 1990s and there is no evidence of changes in trends of nitrate concentrations in European groundwater (Nixon and Kristensen 2003). Similar problems have been reported elsewhere in the world such as in the United States (EPA 1996; Kolpin, Burkart and Goolsby 1999). Another issue is the contamination of water bodies by residues of plant-protection products (PPPs), generally referred to as pesticides. In contrast to the crop nutrients, PPPs are designed to have effects on plants, insects or fungi and may have toxic effects on humans. Their presence in water bodies is therefore a major concern. Residues of some PPPs in surface, groundwater and drinking water occur also at levels of concern throughout Europe (Nixon and Kristensen 2003). The transport of reactive chemicals in porous media undergoes various chemical changes through advection, diffusion and dispersion. In addition, it involves other mechanisms like rate-limited sorption and desorption, biodegradation, and chemical reaction. To understand the process of transport of chemicals through soil layers and porous media, several mathematical models have been developed (Valocchi 1985; Evans and Stagnitti 1996; Srivastava and Brusseau 1996; Xu and Brusseau 1996; Stagnitti and Li 1999, 2001; De Rooij and Stagnitti 2000; Rajmohan and Elango 2001).

2. Theoretical background

The deposition of dissolved ammonia in the study area has been found to deposit at it highest concentration in the study area. Ahoada the study area was confirmed through hydrological and desk studies carried out, the result shows the rate of ammonia content precisely is influenced by porosity of the soil formation. Such condition can be attributed to deposition of the formation through geologic history in the study area. The stratification of the formation was also expressed in the system which deposits homogeneous and heterogeneous formation under the influence of parameters variables. The deposition of ammonia are found from surface to aquiferous formations, seepage velocity has been found to have pressured the transport of ammonia through regeneration of the contaminant from biological waste generation migrating from organic soil to aquiferous zone. The study also expressed some location or formation where the hydraulic conductivity is found to deposit low percentage. Precisely, these formations are known as lateritic and clay formations. Such formations within those two regions of the soil develop high accumulation of ammonia deposition under the influence of predominance of montmorillonite in the study are. Ahoada deposits heterogeneous and slight homogeneous formation including a shallow aquiferous zone with high rate of permeability expressing constant seepage velocity thus the deposition of other minerals in the strata. The deposition of ammonia in heterogeneous formation were confirm to generate from some industrialization of man-made activities, these are from the exploitation of other minerals that are found to create wealth or generate revenue in the country. The rate of ammonia concentration express in these sources are under the influences of hydrological studies that carried out in details, but the explanation to these dilemma in terms of developing quality ground water in such complicated formation were not done, such condition has made the abstraction of ground of quality become complex in the study location. The situations call for improved solution that will develop conceptual frame work for the construction of quality water borehole in the study location. The solution for this ugly plague can only be prevented pollution better through appropriate design and construction method, this will be done through the establishment of mathematical model that will monitor and predict the deposition of Ammonia content in the study location.

2. Governing equation

$$V_I \frac{\partial C}{\partial xi} = K_I \frac{qi}{\varepsilon} = -\phi_i \frac{h}{\varepsilon} \frac{\partial C}{\partial xi} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \qquad (1)$$

The governing equation generate the deposition of ammonias concentration in aquiferious zone influenced by porosity and seepage velocity in River State, the developed governing equation were expressed base on the parameters considered to be influential to the system in other to resolve the deposition of ammonia in the Ahoada, the governing equation are modified to determine the level of ammonia content in the stratification of the formation

$$\frac{\partial C}{\partial x} = SC_{(x)} - C_{(0)} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \qquad (2)$$

$$\frac{\partial C}{\partial xi} = SC_{(x)} - C_0 \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \qquad (3)$$

$$C = C_o \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \qquad (4)$$

The express equation displayed variables that are found as the paramount parameters in the system, this is done by relating themselves to each other through the application of Laplace transformation, and the appliance of this type of

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mathematical method was applied. This is to streamline the principal parameters in the systems that express its function including the achievement of ensuring the level of deposition in soil and water environment

Substituting equations (2), (3) and (4) into equation (1) yield

$$Vi\left[SC_{(x)} - SC_{(x)} - C_{(0)}\right] - \frac{qi}{\varepsilon} - K_I\frac{h}{\varepsilon}\left[SC_{(x)} - C_{(x)}\right] - C_{(0)} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

$$Vi\ SC_{(t)} - ViSC^1{}_{(t)} - C_{(0)} - \frac{qi}{\varepsilon}K_I\frac{h}{\varepsilon}SC_{(0)} + \frac{qi}{\varepsilon}\phi_I\frac{h}{\varepsilon}C_{(0)} - C_{(0)} \quad \ldots\ldots\ldots\ldots \quad (6)$$

Considering the following boundary condition at $t = 0,\ C^1{}_{(0)} = C_0 = 0$ .... (7)

We have

$$C_{(x)}\left(ViS - Vs - \frac{qi}{\varepsilon}\phi_I\frac{h}{\varepsilon}S\right) = 0 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (8)$$

$$C_{(t)} \neq 0 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (9)$$

But considering the boundary condition

At $t > 0,\ C^1{}_{(0)} = C_{(0)} = C_o$ .... (10)

The expressed equation [10] is the boundary values in the system; the condition measured boundary condition that shows how the time will be greater than zero and concentration from the initial level of deposition remain in constant level as initial concentration under the influences of constant regeneration of biological waste developed low porosity in some deposited formations.

$$SC_{(x)} - \frac{qi}{\varepsilon}\frac{Kih}{\varepsilon}S_{(x)} - Vi\,Sc_o + Vi\,C_o + \frac{qi}{\varepsilon}\phi_i\frac{h}{\varepsilon}C_o \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (11)$$

$$\left[ViS - \frac{qi}{\varepsilon}K_I\frac{h}{\varepsilon}S\right]C_{(x)} = \left[Vi\,S + Vi + \frac{qi}{\varepsilon}\phi_i\frac{h}{\varepsilon}\right]C_o \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (12)$$

$$\frac{C_{(x)} = Vi\,S + Vi\,\frac{qi}{\varepsilon}\phi_i\frac{h}{\varepsilon}}{ViS - \frac{qi}{\varepsilon}\phi_i\frac{h}{\varepsilon}S}C_o \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (13)$$

quadratic function were find suitable to detailed the system , Subject to this relation, quadratic function were find suitable to ensure that all variables are expressed their function in terms integration from one formation to the other, this will express several behaviour of dissolved ammonia under the influences of formation variations in the

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system, application of this concept is to monitor the deposition of ammonia base in the experienced variation through porosity of soil structural stratification in the study location. This is base on the formation characteristics that may be found in the study location, such condition call for the application of quadratic expression so that it can monitor the level of ammonia deposition in quadratic expressed condition, further more the expression of seepage velocity in the formation may develop several change in concentration in some condition, but application of this method will ensure that the system integrates every condition that may be found to developed the regeneration of ammonia deposition under the influences of seepage velocity in the study area.

Applying quadratic expression, we have

$$\frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (14)$$

$$\frac{-\frac{qi}{\varepsilon} \pm \sqrt{\frac{qi}{\varepsilon}^2 + 4Vi\phi_i \frac{h}{\varepsilon}}}{2Vi} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (15)$$

$$C_{(x)} = A\exp \frac{\left[-\frac{qi}{\varepsilon} + \sqrt{\frac{-qi^2}{\varepsilon} + 4Vi\phi_i \frac{h}{\varepsilon}} \right]^x}{2Vi} x - \exp \frac{\left[-\frac{qi}{\varepsilon} + \sqrt{\frac{-U^2}{\varepsilon} + 4Vi\phi_{iI} \frac{h}{\varepsilon}} \right]^x}{2Vi} \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (16)$$

Subjecting equation (16) to the following boundary condition and initial values condition

$$x = 0, \; C_{(0)} = 0 \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (17)$$

We have $B = -1$ and $A = 1$ ………………………… (18)

So that our particular solution, will be in this form

$$C_{(x)} = \exp^{\left[-\frac{qi}{\varepsilon} + \left(\frac{qi}{\varepsilon} - 4Vi\phi_i \frac{h}{\varepsilon} \right)^{1/2} \right]} x = \exp^{\left[-\frac{qi}{\varepsilon} + \left(\frac{qi^2}{\varepsilon} + 4Vi\phi_{iI} \frac{h}{\varepsilon} \right)^{1/2} \right]} \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (19)$$

inverse Laplace application were found necessary because the concentration may not be consistent in terms of variation, more so, the depositions of heterogeneous are predominant, this implies that every deposition in soil structure will be influences by this expressed conditions. The deposition of ammonia concentration should also deposit homogeneous due some stratification that disintegration from the porous rock, it may develop uniform grain size thus uniform micropores within the intercedes of the soil, such condition expressed in structural depositions base on disintegrations of the porous rock generating a structure strata at different grain size. The rate of heterogeneous deposition in the study area are predominant, several aquiferious depths to ground water aquifers will definitely be pressured by the solute deposition. Such concentration will definitely vary, but in some region of the formation at some deposition of the solute ammonia experience one been greater in concentration in another strum. Application of inverse Laplace transformation is very necessary to predict the rate of inverse at some depositions which may be reflected in the system simulation

But $e^{x} - e^{-x} = 2\,Sin\,x$

submission of sunsidal expression were considered because the depositions that reflected inverse transformation of the system, the expressed suncidal appliance is to ensure there a motivation through inverse application to streamline the system since the deposition of ammonia deposition vary reflecting seepage velocity, this implies that at this stage it may vary in concentration at high deposition in the formation, base on the structural strategraphic of the formation under the influences of geologic history..

Therefore, the expression of (19) can be written in this form

$$C_{(x)} = 2\,Sin\left[\frac{qi}{\varepsilon} + \left[\frac{qi^{2}}{\varepsilon} + 4ViK\phi_{i}\frac{h}{\varepsilon}\right]^{1/2}\right]x \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (20)$$

But if $x = \dfrac{v}{t}$

Therefore, the model can be expressed as:

$$C_{(t)} = 2\,Sin\left[\frac{qi}{\varepsilon} + \left(\frac{qi^{2}}{\varepsilon} + 4Vi\phi_{i}\frac{h}{\varepsilon}\right)^{1/2}\right]\frac{v}{t} \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (21)$$

Again if $\dfrac{v}{t} = x,$ we have

$$C_{(t)} = 2\,Sin\left[\frac{qi}{\varepsilon} + \left(\frac{qi^{2}}{\varepsilon} + 4Vi\phi_{i}\frac{h}{\varepsilon}\right)^{1/2}\right]x \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (22)$$

Considering (21) and (22) yield

$$C_{(x,\,t)} = 2\,Sin\left[\frac{qi}{\varepsilon} + \left(\frac{qi^{2}}{\varepsilon} + 4Vi\phi_{i}\frac{h}{\varepsilon}\right)^{1/2}\right]t + 2\,Sin\left[\frac{qi}{\varepsilon} + \left(\frac{qi^{2}}{\varepsilon} + 4Vi\phi_{i}\frac{h}{\varepsilon}\right)^{1/2}\right]x \quad \ldots \quad (23)$$

The generated model through the derived equation has developed a model that will monitor the deposition of ammonia in the Ahoada. The expressed model articulated different conditions that cause the deposition of ammonia concentration in the study location as expressed in the system. The depositions of dissolved ammonia have a lot that causes this deposition in different dimension; therefore it is imperative that the system ensure that those conditions are thoroughly expressed in the system. therefore the development of the derived solution were articulated considering all the pressured develop to deposit dissolved ammonia in the formation, the final expressed model that will definitely predict the rate deposition of dissolved ammonia in the study area.

4. Conclusion

Mathematical Modeling of ammonia deposition under dissolved solution in the formation to aquiferous has been evaluated. The depositions of the substances from organic to aquiferious zone are influenced by porosity and seepage velocity. The depositions of ammonia concentration are base on variety of soil depositions including the activities of man in the study area. But the most influential is the stratigarphy deposition of the formation, these are the pressure from formation characteristics, this influences are through variations from void ratio including porosity of the formation, the application of mathematical model were find suitable to ensure that various condition of the formation including the influences from manmade activities are through expressed in the derived solution, these are from developed model through derived mathematical method. Expressing these concepts was to ensure the rates of ammonia deposition of ground water aquifer degradation are thoroughly predicted through the developed model. The developed model in the study will definitely predict the deposition of ammonia concentration in the study location.

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