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MATHEMATICAL ANALYSIS OF AMMONIA TRANSPORT IN LATERITIC SOIL

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Abstract: **Lateritic soil formation was monitored to examined the rate of ammonia deposition. The study was developed through the investigation, monitoring and modeling at various phases. Terminal velocity was observed from the variables to be a predominant parameter that influences the system. Formation characteristic such as porosity and permeability including void ratio were examined to be very low. These investigations were from the lithology of the formation from other evaluations carried out in the analysis which reveals the cause of concentration in lateritic soil formation. The derived solution from the governing equation express various conditions that these variables affect the depositions of ammonia in the study area and it has the potential to monitor the behaviour of substances in subsurface flows**

Keywords: **Modelling, migration, ammonia deposition and lateritic soil formation.**

1. INTRODUCTION

The lateritic soil is used for several engineering construction jobs, this is due to its mineral content in some deposited environment, but in other areas where it's plasticity is very high, it is observed to pose treat to some construction activities. But for this study we are evaluating the behaviour of this soil when ammonia is being transported. Ammonia migration base on the rate of fluid flow and it's relation to formation characteristics are subject of concern in lateritic soil formation. Lateritic soil environment can be changed base on the application of construction project which can be affected through physical properties of the soil structure (Anh et al 2011). Experts have observed that changes in mechanical strength, including water and gas transports affect the root and shoot growth. They also further observed that it changes the soil nitrogen and carbon cycles which results to increase in soil erosion due to water flow and are determined by the level of lateritic soil deposition base on the rate of formation characteristics. (Soane and van Ouwerkerk; 1994). The evaluation of the soil compaction develop influences on soil physical properties, these are normally based on the considerable changes in soil mechanical strength, including aeration and hydraulic properties (Horn et al., 1995; Kozlowski, 1999; Lipiec and Hatano, 2003; Schäfer- Landefeld et al., 2004; Hemmat and Adamchuk, 2008; Anh et al 2011). Diverse approaches have been projected to assess soil degradation due to compaction applying the relation between soil compaction parameters and soil capacity parameters such the deposition of air-filled porosity, degree of saturation, water content. Håkansson (1990). This implies that there should be thorough narrative about soil compactness and express soil porosity variations. Koolen and Kuipers (1989) monitored lateritic soil compaction and projected various compaction criterion in terms of deviation of soil strength parameters such as the pre-compression pressure. Also, Horn et al. (2007) and Mosaddeghi et al. (2007) examined the interaction between applied stress and soil air permeability while Håkansson and Lipiec (2000) investigated soil compaction using relations between soil capacity parameters and air permeability and observed proportional corolation. Horn and Kutilek (2009) in their research, expressed the parameters that define a general status of compactness and permeability and thus define intensity and compactness parameters which include dynamic aspects over time and space.

While Goss and Ehlers (2010) presented their disagreement concerning definitions thus arguing that both intensity and capacity properties can vary in both space and time. Examine the present study, it has been observed that the term "capacity parameter" is adopted and it defines a general position, this implies that the composition is of a given volume (as proposed by Horn and Kutilek, 2009); in the same vein, it is admitted that the capability parameters do vary with time (following Goss and Ehlers, 2010). Laboratory studies on air permeability have shown its reliance on different soil parameters related to the capacity parameters, such as the degree of saturation (Seyfried and Murdock, 1997; Juca and Maciel, 2006), the water content (Sanchez-Giron et al., 1998) and the air-filled porosity (Olson et al., 2001; Moldrup et al., 2003). In general, the air permeability is lower at a higher degree of saturation with a lower air-filled porosity. Based on the experimental data of compacted silty soil, Delage et al. (1998) state that air filled porosity is the unique parameter influencing air permeability. Moon et al. (2008) found that the air permeability of compacted soils depends on the compaction energy as well as the moisture content at moulding; the lowest value of air permeability being at the optimum moisture content (maximum dry unit weight). Studies on undisturbed and repacked soils have shown significant effects of the soil structure and pore-space characteristics on the air permeability (O'Sullivan et al., 1999; Moldrup et al., 2001; Tuli et al. 2005; Dörner and Horn, 2006).

2. THEORETICAL BACKGROUND

The system monitored the terminal velocity of flow in two dimensional ways, the systems were developed to investigate the rate of terminal velocity at different dimensions, and soil in diversified ways is one of the most significant engineering materials. The deposition of terminal velocity within the intercedes of soil were investigated to determined the rate terminal velocity in horizontal and vertical directions, this expression implies that velocity of flow in different strata are basically through the geological setting in the study area, it has been observed that the structure of the formation are not always homogeneous, therefore the study observed the rate of terminal velocity base on the depositions of lateritic soil formation, the formation even though with low void ratio, porosity and permeability, it has different minerals and classification for other engineering applications, the flow of fluid were examined to determined the deposition of ammonia influenced by terminal velocity of flow. The effects of soil structure are express in derived solution to determine the effect from terminal velocity on deposition of ammonia in lateritic soil deposition.

3. GOVERNING EQUATION

The governing equation that captures the phenomena of ammonia deposition in lateritic soil is given by

$$\phi K \frac{\partial C}{\partial t} = D_{v(x)} \frac{\partial C}{\partial x} + V_{(x)} \frac{\partial C}{\partial x} \tag{1}$$

Nomenclature

C = Ammonia concentration $[ML^{-3}]$

K = Permeability $[LT^{-1}]$

ϕ = Porosity [-]

D = Dispersion in number [-]

$V(x)$ = Velocity $[LT^{-1}]$

T = Time [T]

X = Depth [L]

Let $C(x,t) = X(x)T(t)$ from equation (1), we have

$$\phi K T'X = D_v TX' + V_{(x)} TX' \tag{2}$$

$$\phi K \frac{T'}{T} = D_v \frac{X'}{X} + V_{(x)} \frac{X'}{X} \tag{3}$$

$$\phi K \frac{T'}{T} = \tau^2 \qquad (4)$$

$$D_v \frac{X'}{X} = \tau^2 \qquad (5)$$

$$V_{(x)} \frac{X'}{X} = \tau^2 \qquad (6)$$

This implies that equations (5) and (6) can be written as:

$$\left[D_v + V_{(x)}\right]\frac{X'}{X} = \tau^2 \qquad (8)$$

Now, from (4) $\phi K \frac{T'}{T} = \tau^2$ (7)

$$\int \frac{dT}{T} = \frac{\tau^2}{\phi K}\int dt \qquad (9)$$

$$ln\, T = \frac{\tau^2}{\phi K} t + c_1 \qquad (10)$$

$$T = Ae^{\frac{\tau^2}{\phi K} t} \qquad (11)$$

Equation (11) has the potential to monitor most condition that results to the disintegration of the grain size at various particle in different condition. It is based on the deposition of deltaic formation in the study area and thus our model at this phase express time in the system base on fluid flow velocity as a result of permeability of the soil. It also shows that the period of permeation that is observed from the litho unit is very low (Zuonaki *et.al* 2024).

Now, from (7)

$$\left[D_v + V_{(x)}\right]\frac{X'}{X} = \tau^2\, dX \qquad (12)$$

$$\int \frac{dX}{X} = \frac{\tau^2}{D_v + V_{(x)}}\int dx \qquad (13)$$

$$lnX = \frac{\tau^2}{D_v + V_{(x)}} x + c_1 \qquad (14)$$

$$X = \exp\left[\frac{\tau^2}{D_v + V_{(x)}} x + c_1\right] \qquad (15)$$

$$X = B\exp\frac{\tau^2}{D_v + V_{(x)}} x \qquad (16)$$

Combining (11) and (16), and using

$$C(x,t) = TX$$

$$Ae^{\frac{\tau^2}{\phi}t} B\left[\exp\frac{\tau^2}{D_v + V_{(x)}}\right] \tag{17}$$

$$C\ (x,t) = AB\exp\left[\frac{t}{\phi K} + \frac{x}{D_v + V_{(x)}}\right]\tau^2 \tag{18}$$

The deposition of ammonia is influenced by terminal velocity in soil at various depositions, which are caused by variations from numerous parameters that influence the formation characteristics. In this study, we are able to monitor the deposition of ammonia pressured by terminal velocity. Our model is able to capture the rate of lateritic deposition influenced by terminal velocity in the deposition of ammonia in the study area.

4. CONCLUSION

The deposition of ammonia in lateritic formation was expressed through the developed system, the developed system generated variables that were found imperative in the system that influence the deposition of ammonia in lateritic soil. terminal velocity was a predominant parameter that was observed to affect the concentration of ammonia in lateritic soil, low degree of permeability, porosity and void ratio developed terminal velocity in the formation. The derived solution express various variables at different phase under various conditions that were examined in the study, various phase were generated for different conditions, considering the migration process, time of deposition and transport at different depth within lateritic soil were observed. The study is imperative because the developed model can be applied to monitor the rate ammonia at different phases in the study area.

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