Predicting the Effect from Fluid Flow Dynamics on Lacustrine Deposition in Siltyand Gravel Formation at Ahoada Niger Delta of Nigeria

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Abstract— *This study were carried out to monitor the behaviour of fluid dynamics from the deposition of silty and gravel formation found to predominantly deposit in some location of Ahoada Niger delta of Nigeria, the study were to monitor fluid flow dynamics in a heterogeneous stratification in the study area. The behaviour of the fluid flow under these condition were monitored though the deposition of fluid dynamics at the study area, these parameters were observed to influences fluid flow deposition in the formation, the study observed the structural setting of the soil macropoles in such deltaic deposition, the heterogeneity of the macropoles in the geological setting developed heterogeneity flows dynamics, the structural setting of these strata developed such heterogeneous influences expressing flow dynamics in heterogeneous deposition in Ahoada, the model express various formation characteristic conditions in soil, simulation of the model generated different dynamics flow that determine the rate of fluid flow in heterogeneous silty and gravel formation, the study has express the rate of fluid dynamics by expressing the effect from Lacustrine deposition that should definitely determine the heterogeneity yield coefficient from silty and gravel formation, this implies that the deposition of silty and gravel formation in deltaic location should be a penetrating unconfined bed formation, the deltaic effect from fluid dynamics express the rate of influences in every part of the study location, the study has also observed low yield rate deposition in some part of the location . This is an expression from the simulation data that shows the rate of dynamics fluid flow in silty and gravel formation, this deposition should be penetrating unconfined bed in the study area, the study has shows that phreatic bed yields cannot not produce enough quantity for industrial purpose. Experts will use this model to determine the rate of fluid flow dynamics for penetrating unconfined bed.*

Keywords— void ratio fluid flow, velocity Lacustrine and coarse formation.

I. INTRODUCTION

Water is an elixir of life. It governs the evolution and function of the universe on the earth hence water is 'mother of all living world'. Majority of water available on the earth is saline in nature; only small quantity is fresh water. Fresh water has become a scare commodity due to over exploitation and pollution (Ghose and Basu, 1968; Gupta and Shukle, 2006; Patil and Tijare, 2001; Singh and Mathur, 2005). Pollution is caused when a change in the physical, chemical or biological condition in the environment harmfully affect quality of human life including other animals' life and plant (Lowel and Thompson, 1992; Okoye *et al*., 2002). Industrial, sewage, municipal wastes are been continuously added to water bodies hence affect the physiochemical quality of water making them unfit for use of livestock and other organisms (Dwivedi and Pandey, 2002). Uncontrolled domestic waste water discharge into pond resulted in eutrophication of ponds as evidence by substantial algal bloom, dissolve oxygen depletion in the subsurface water leads to large fish kill and other oxygen requiring organism (Pandey, 2003) Effluent is discharge into environment with enhanced concentration of nutrient, sediment and toxic substances may have a serious negative impact on the quality and life forms of the receiving water body when discharge untreated or partially treated (Forenshell, 2001; Miller and Siemens, 2003; Schulz and Howe, 2003). Water pollution by effluent has become a question of considerable public and scientific concern in the light of evidence of their extreme toxicity to human health and to biological ecosystems (Katsuro *et al.*, 2004).

The occurrence of heavy metals in industrial and municipal sewage effluents constitute a major source of the heavy metals entering aquatic media. Hence there should be regular assessment of these sewage effluents to ensure that adequate measures are taken to reduce pollution level to the minimum. Worldwide water bodies are primary means for disposal of waste, especially the effluents from industrial, municipal sewage and agricultural practices that are near them. This effluent can alter the physical, chemical, and biological nature of receiving water body (Sandoyin, 1991). The initial effect of waste is to degrade physical quality of the water. Later biological degradation becomes evident in terms of number, variety and organization of the living organism in the water (Gray, 1989). Often the water bodies readily assimilate waste materials they receive without significant deterioration of some quality criteria; the extent of this is referred to as its assimilative capacity (Fair, 1971). However, the water quality is deteriorating day by day due to anthropogenic input of dissolved nutrient and organic matter and industrial effluent, which is built up on its bank. So it is of vital importance to monitor and simulate the water quality parameters to ascertain whether the water is still suitable for various uses. Water contaminated by effluent from various sources is associated with heavy disease burden (Okoh, 2007) and this could influence the current shorter life expectancy in the developing countries compared with developed nation (WHO, 2002). There is a wide variety of methods available for testing the microbial quality of drinking water through indicator organisms. The two most common methods that are studied in detail in this thesis are the Presence/Absence (P/A) test and Membrane Filtration (MF) test. The P/A test is a simple method to identify the presence or absence of the indicator organism and is often indicated by a color change. While the P/A test may be adequate for detecting the presence of indicator organisms, it is unable to assess the extent of contamination in the water sample. The ability to enumerate indicator organisms is particularly important when assessing the performance of a water treatment device such as a water filter. It allows the researcher to calculate microbial removal efficiency by finding out how much of the indicator organisms are removed by the filter. However, the MF test is more elaborate in terms of its equipment and incubation requirements compared to the P/A test. There are also many kinds of culture media to choose from for the MF test. In this thesis, the most appropriate indicator test for monitoring the microbial quality of drinking water and assessment of filter efficiency will be proposed (Chian, 2002). Fresh water resources are most precious to earth: they are the basic ingredient to life. Increased demands on the resources have impacted heavily on natural aquatic ecosystems. Fresh and pure water is limited in quantity indicates the need for comprehensive water management (WHO, 1992). So researches on the impacts of anthrop genial and techno-genial factors on fresh water resources are imperative. Such studies provide us with information of our limits in nature (Ray, 1992). We have several examples of civilizations, which have suffered by going into eclipse or extinction due, in great part, to a lack of stewardship and or knowledge of their water resources. The living communities of waters, their functional relationships, productivity, physical, chemical environment are all dealt in aquatic ecology. Study of all inland aquatic environments like; streams, rivers, lakes, reservoirs, and wetlands are called Limnology. The history of the discipline of Limnology dates back to Lake Geneva, the best known and one of the beautiful lakes in the world, since the 17th century. Bertola (1998), observed that between 1892 and 1904, Francois-Alphonse Forel, a Swiss naturalist carried out a major research work in this Lake and, laid the basis of Limnology. As the supply of fresh water around the world continues to dwindle because of increased use and pollution, lakes of the world will undoubtedly be viewed as potential water reservoirs of convenience for human use (Odada *et al.*, 004). The author emphasized that basic research on the lakes of the world lags far behind similar researches on the oceans. Lakes have a more complex and fragile ecosystem and they easily accumulate pollutants (Bhatt *et al*., 1999). according to him several characteristics of lakes make them ideal study sites to advance our basic understanding of ecosystem dynamics. Therefore, lakes in the world are in dire need of major new research initiatives. Bronmark and Hansson (2002) found that biodiversity of lakes and pond ecosystems are currently threatened by a number of human disturbances. The growing concern for environmental problems, implementation of new environmental strategies and administrations, international agreements, are positive signs of changes that should improve the ability to manage old as well as new, yet undiscovered threats in these systems. Lewis (1987) noted that in the absence of protective management, tropical lakes would decline greatly in their utility for water supply, production of commercially useful species, and recreation, because tropical lakes are more sensitive than temperate lakes to pollution. So management programs for tropical lakes will focus on interception of nutrients, protection of aquatic habitats from invasive species, and minimization of hydrological changes in rivers to which lakes are connected. The awareness of the scientific community and the public for fresh water systems will definitely serve as a function through collective opinions that is important to the determination of public policy, and consequent management of these systems. All these authors have thus emphasized the significance of ecological investigations of freshwater, especially that in the tropics.

II. GOVERNING EQUATION

$$K\frac{\partial V}{\partial t} = \phi\frac{\partial^2 V}{\partial X^2} - q\frac{\partial V}{\partial X} - Q\frac{\partial V}{\partial X} \ldots\ldots \quad (1)$$

Nomenclature

V = velocity
K = Permeability
Q = Fluid flow
ϕ = Porosity
q = Void Ratio
X = Distance (depths)
T = Time

Let $V = ZT$

$$KZT^1 = \phi Z^1T - qZ^1T - QZ^1T \ldots\ldots\ldots\ldots \quad (2)$$

$$K\frac{T^1}{T} = \phi\frac{Z^1}{Z} - q\frac{Z^1}{Z} - Q\frac{Z^1}{Z} = \beta^2 \ldots\ldots\ldots\ldots \quad (3)$$

$$K\frac{T^1}{T} = -\beta^2 \ldots\ldots\ldots\ldots\ldots\ldots \quad (4)$$

$$\phi\frac{Z^1}{Z} = \beta^2 \ldots\ldots\ldots\ldots\ldots\ldots \quad (5)$$

$$Q\frac{Z^1}{Z} = \beta^2 \ldots\ldots\ldots\ldots\ldots\ldots \quad (6)$$

$$\phi\frac{Z^1}{Z} + q\frac{Z^1}{Z} + Q\frac{Z^1}{Z} = \beta^2 \ldots\ldots\ldots\ldots \quad (7)$$

$$\phi q Q\frac{Z^1}{Z} = \frac{dy}{dz} = \beta^2 \ldots\ldots\ldots\ldots\ldots\ldots \quad (8)$$

$$K\frac{dy}{dz} = \beta^2 \ldots\ldots\ldots\ldots\ldots\ldots \quad (9)$$

$$\frac{dy}{dz} = \frac{\beta^2}{K} \ldots\ldots\ldots\ldots\ldots\ldots \quad (10)$$

$$dy = \left[\frac{\beta^2}{K}\right]dz \ldots\ldots\ldots\ldots\ldots\ldots \quad (11)$$

$$\int dy = \int\frac{\beta^2}{K}dz \ldots\ldots\ldots\ldots\ldots\ldots \quad (12)$$

$$dy = \frac{\beta^2}{K}dz \ldots\ldots\ldots\ldots\ldots\ldots \quad (13)$$

$$\frac{dy}{dz} = \frac{\beta^2}{K} \ldots\ldots\ldots\ldots\ldots\ldots \quad (14)$$

$$dy = \frac{\beta^2}{K}dz \ldots\ldots\ldots\ldots\ldots\ldots \quad (15)$$

$$\int dy = \int\frac{\beta^2}{K}dz + C_1 \ldots\ldots\ldots\ldots\ldots \quad (16)$$

$$\frac{\beta^2}{K}z + C_1 \ldots\ldots\ldots\ldots\ldots\ldots \quad (17)$$

$$y = \frac{\beta^2}{K}\int dz + C_1 \ldots\ldots\ldots\ldots\ldots\ldots \quad (18)$$

Applying quadratic expression we have

$$Z = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \ldots\ldots\ldots\ldots\ldots \quad (19)$$

Where $a = \frac{\beta^2}{K}$, $b = \beta^2$, $c = C_1$

$$Z = \frac{-(\beta^2 C) \pm \sqrt{(\beta C)^2 - 4\left(\frac{\beta^2}{K}\right)}}{2\beta C} \ldots\ldots\ldots \quad (20)$$

$$Z = \frac{-\beta^2 C + \sqrt{\beta^2 C^2 - 4\left(\frac{\beta^2}{K}\right)}}{2\beta C} \ldots\ldots\ldots \quad (21)$$

$$Z = \frac{-\beta^2 C + \sqrt{\beta^2 C^2 - 4\frac{\beta^2}{K}}}{2\beta C} \ldots\ldots\ldots \quad (22)$$

$$Z = \frac{-\beta^2 C_1 - \sqrt{\beta^2 C^2 - 4\frac{\beta^2}{K}}}{2\beta C} \ldots\ldots\ldots\ldots \quad (23)$$

Substituting equation (23) in the following boundary condition and initial values condition

$$t = 0 \quad V = 0 \ldots\ldots\ldots\ldots\ldots \quad (24)$$

Therefore,

$$Z_{(z)} = V_1 \ell^{-M_1 Z} + {}^{M_2 Z} \ldots\ldots\ldots\ldots\ldots \quad (25)$$

$$V_1 Cos M_1 Z + Sin M_2 Z \ldots\ldots\ldots\ldots\ldots \quad (26)$$

$$V(t,z) = \left(V_1 Cos M_1 z\, Sin M_2 z\right) \ldots\ldots \quad (27)$$

But if $t = \frac{d}{V}$

Therefore, equation (27) will be expressed as the form:

$$V(t,z) = \left(V_1 Cos\, M_1 \frac{d}{V} + Sin M_2 \frac{d}{V} \right) \quad \ldots\ldots\ldots \quad (28)$$

Also If Z=V.T,
Therefore the equation can be express as:

$$V(t,z) = \left(V_1 Cos\, M_1 V.T + Sin M_2 V.T \right) \ldots\ldots\ldots \quad (29)$$

III. MATERIALS AND METHOD

Standard laboratory experiment where performed to monitor the velocity of flow at different formation, the soil deposition of the strata were collected in sequences base on the structural deposition at different locations, this samples collected at different location thus generate variation at different depth producing different migration of fluid flow velocity at different strata, the experimental result are applied to be compared with the theoretical values that determined the validation of the model.

IV. RESULTS AND DISCUSSION

Results and discussion are presented in tables and figures including graphical representation for velocity of flow are stated below.

Table.1: Velocity of Flow at Different Depth

Depth [M]	Velocity of Flow
3	9.87E-05
6	5.96E-05
9	7.78E-05
12	3.93E-04
15	1.29E-04
18	1.56E-04
21	1.82E-04
24	2.07E-04
27	2.34E-04
30	2.58E-04

Table.2: Velocity of Flow at Different Time

Time Per Day	Velocity of Flow
10	9.87E-05
20	5.96E-05
30	7.78E-05
40	3.93E-04
50	1.29E-04
60	1.56E-04
70	1.82E-04
80	2.07E-04
90	2.34E-04
100	2.58E-04

Table.3: Predicted and Measured Values at Different Depth

Depth [M]	Predicted Velocity of Flow	Measured Velocity of Flow
3	9.87E-05	9.53E-05
6	5.96E-05	5.78E-05
9	7.78E-05	7.46E-05
12	3.93E-04	3.87E-04
15	1.29E-04	1.34E-04
18	1.56E-04	1.67E-04
21	1.82E-04	1.86E-04
24	2.07E-04	2.24E-04
27	2.34E-04	2.46E-04
30	2.58E-04	2.46E-04

Table.4: Predicted and Measured Values at Different Time

Time Per Day	Predicted Velocity of Flow	Measured Velocity of Flow
10	9.86E-05	9.53E-05
20	5.95E-05	5.78E-05
30	7.73E-05	7.46E-05
40	3.94E-04	3.87E-04
50	1.28E-04	1.34E-04
60	1.54E-04	1.67E-04
70	1.80E-04	1.86E-04
80	2.06E-04	2.24E-04
90	2.32E-04	2.46E-04
100	2.57E-04	2.46E-04

Table.5: Velocity of Flow at Different Depth

Depth [M]	Velocity of Flow
3	7.62E-07
6	1.53E-06
9	1.51E-06
12	3.06E-06
15	3.83E-06
18	4.57E-06
21	5.36E-06
24	6.13E-06
27	6.89E-06
30	7.67E-06

Table.6: Velocity of Flow at Different Depth

Time Per Day	Velocity of Flow
10	7.62E-07
20	1.53E-06
30	1.51E-06
40	3.06E-06
50	3.83E-06

60	4.57E-06
70	5.36E-06
80	6.13E-06
90	6.89E-06
100	7.67E-06

Table.7: Predicted and Measured Values at Different Depth

Depth [M]	Predicted Velocity of Flow	Measured Velocity of Flow
3	7.62E-07	7.45E-07
6	1.53E-06	1.68E-06
9	1.51E-06	1.59E-06
12	3.06E-06	3.15E-06
15	3.83E-06	3.78E-06
18	4.57E-06	4.67E-06
21	5.36E-06	5.58E-06
24	6.13E-06	6.24E-06
27	6.89E-06	6.68E-06
30	7.67E-06	7.89E-06

Table.8: Predicted and Measured Values at Different Depth

Time Per Day	Predicted Velocity of Flow	Measured Velocity of Flow
10	7.60E-07	7.45E-07
20	1.52E-06	1.68E-06
30	1.50E-06	1.59E-06
40	3.05E-06	3.15E-06
50	3.82E-06	3.78E-06
60	4.58E-06	4.67E-06
70	5.35E-06	5.58E-06
80	6.11E-06	6.24E-06
90	6.88E-06	6.68E-06
100	7.64E-06	7.89E-06

Table.9: Velocity of Flow at Different Depth

Depth [M]	Velocity of Flow
3	1.95E-05
6	3.89E-05
9	5.84E-05
12	7.77E-05
15	9.69E-05
18	4.29E-04
21	1.37E-04
24	1.57E-04
27	1.76E-04
30	1.95E-04
33	2.16E-04
36	2.35E-04

Table.10: Velocity of Flow at Different Time

Time Per Day	Velocity of Flow
10	1.95E-05
20	3.89E-05
30	5.84E-05
40	7.77E-05
50	9.69E-05
60	4.29E-04
70	1.37E-04
80	1.57E-04
90	1.76E-04
100	1.95E-04
110	2.16E-04
120	2.35E-04

Table.11: Predicted and Measured Values at Different Depth

Depth [M]	Predicted Velocity of Flow	Measured Velocity of Flow
3	1.95E-05	1.89E-05
6	3.89E-05	3.79E-05
9	5.84E-05	5.77E-05
12	7.77E-05	7.69E-05
15	9.69E-05	9.58E-05
18	4.29E-04	4.35E-04
21	1.37E-04	1.46E-04
24	1.57E-04	1.67E-04
27	1.76E-04	1.89E-04
30	1.95E-04	1.89E-04
33	2.16E-04	2.26E-04
36	2.35E-04	2.47E-04

Table.12: Predicted and Measured Values at Different Depth

Time Per Day	Predicted Velocity of Flow	Measured Velocity of Flow
10	1.93E-05	1.89E-05
20	3.87E-05	3.79E-05
30	5.81E-05	5.77E-05
40	7.75E-05	7.69E-05
50	9.68E-05	9.58E-05
60	4.28E-04	4.35E-04
70	1.35E-04	1.46E-04
80	1.55E-04	1.67E-04
90	1.74E-04	1.89E-04
100	1.93E-04	1.89E-04
110	2.13E-04	2.26E-04
120	2.32E-04	2.47E-04

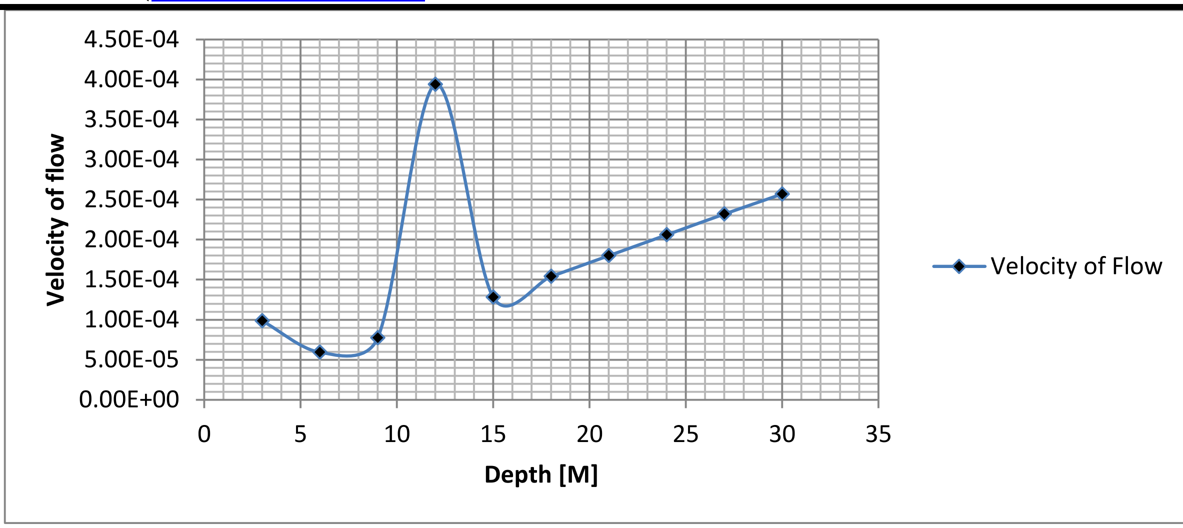

Fig.1: Velocity of Flow at Different Depth

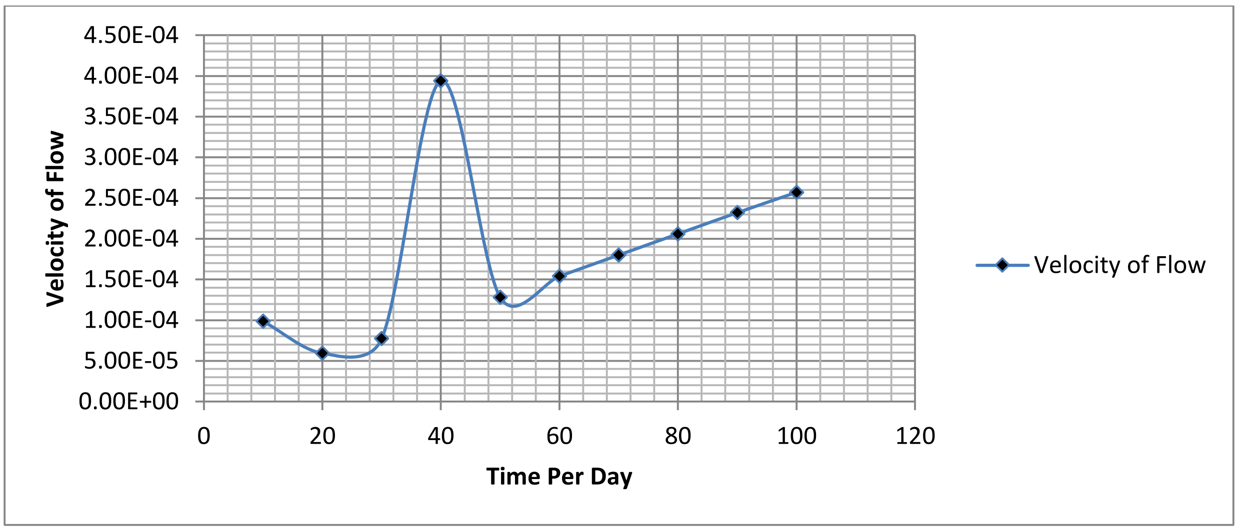

Fig.2: Velocity of Flow at Different Time

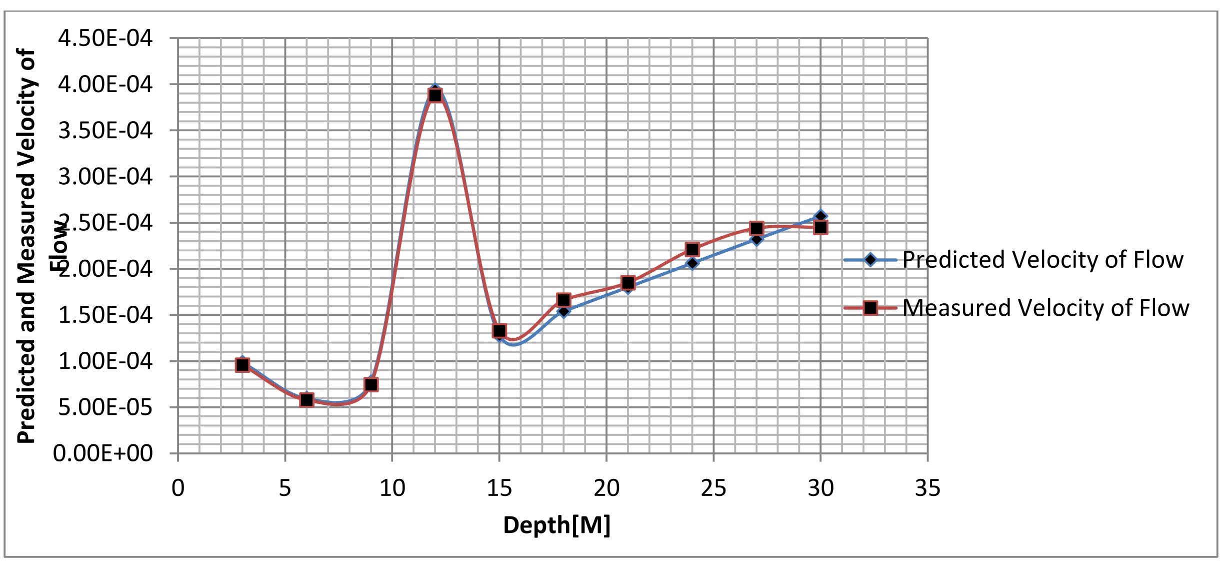

Fig.3: Predicted and Measured Values at Different Depth

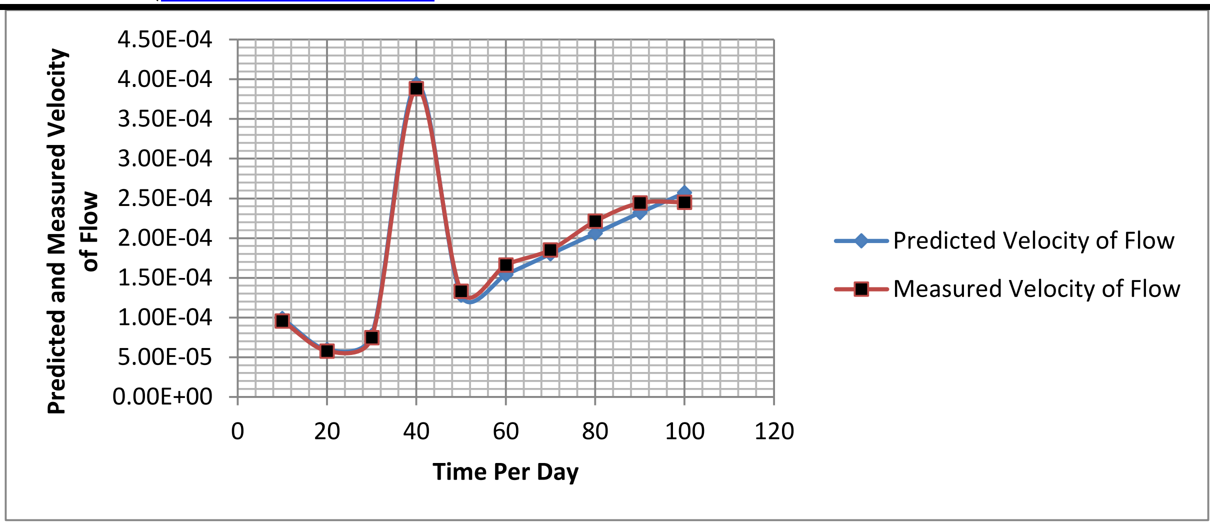

Fig.4: Predicted and Measured Values at Different Depth

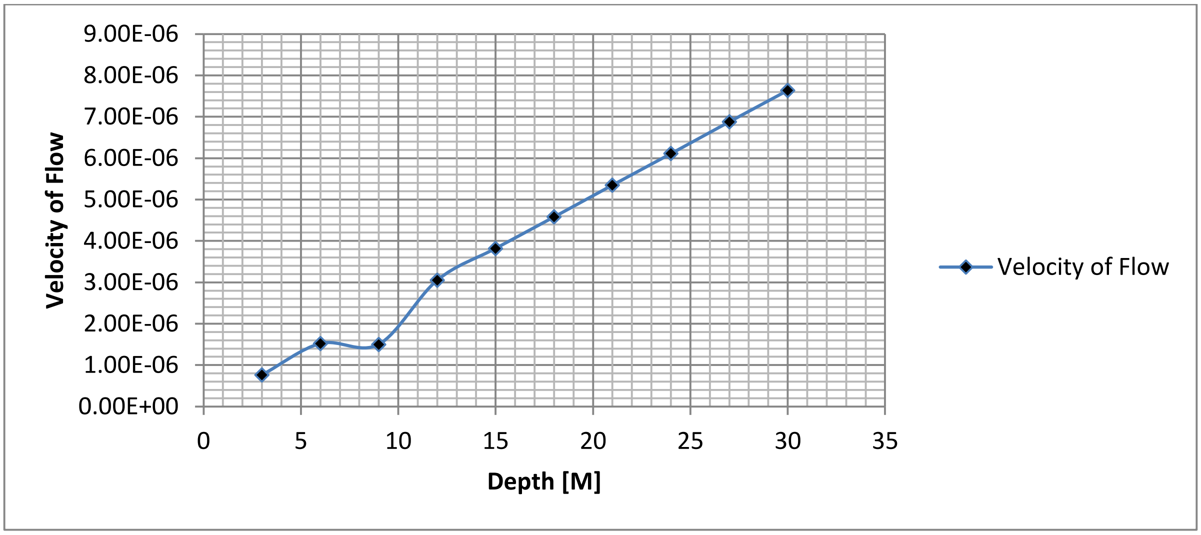

Fig.5: Velocity of Flow at Different Depth

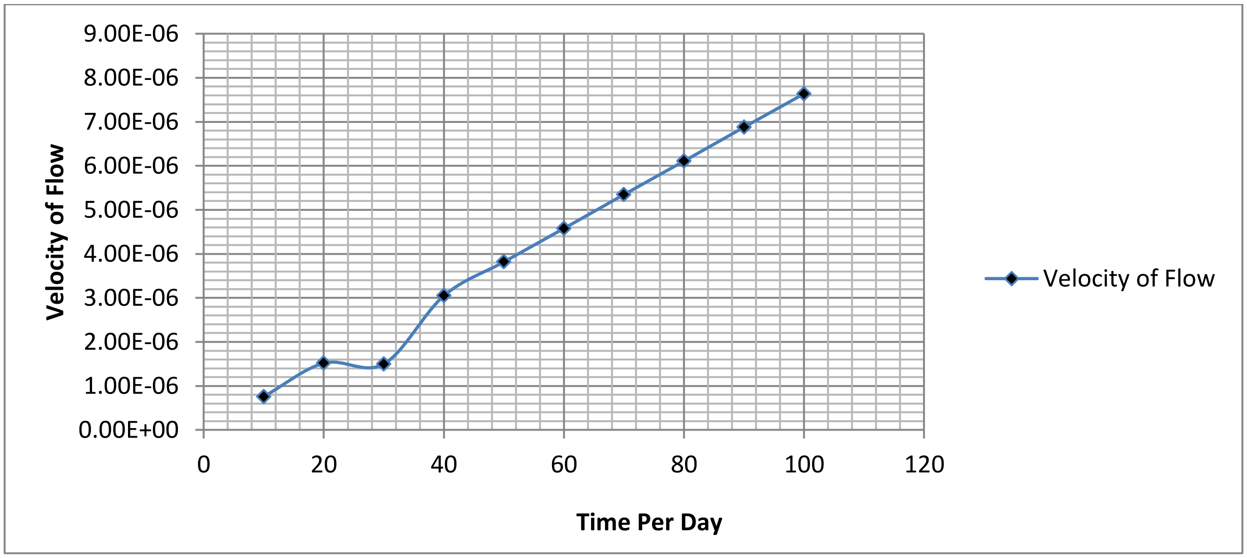

Fig.6: Velocity of Flow at Different Depth

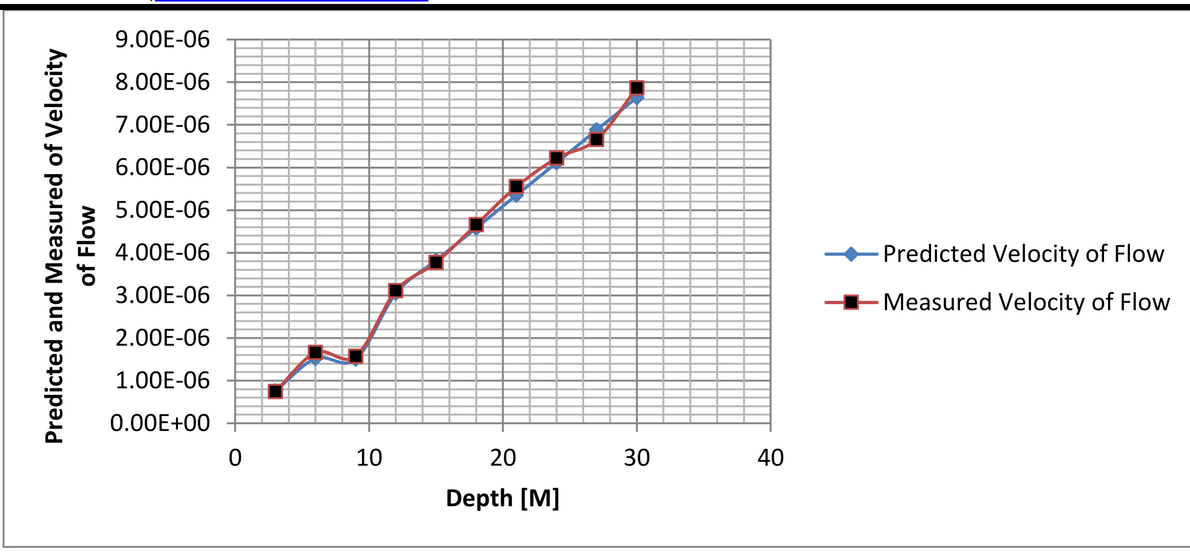

Fig.7: Predicted and Measured Values at Different Depth

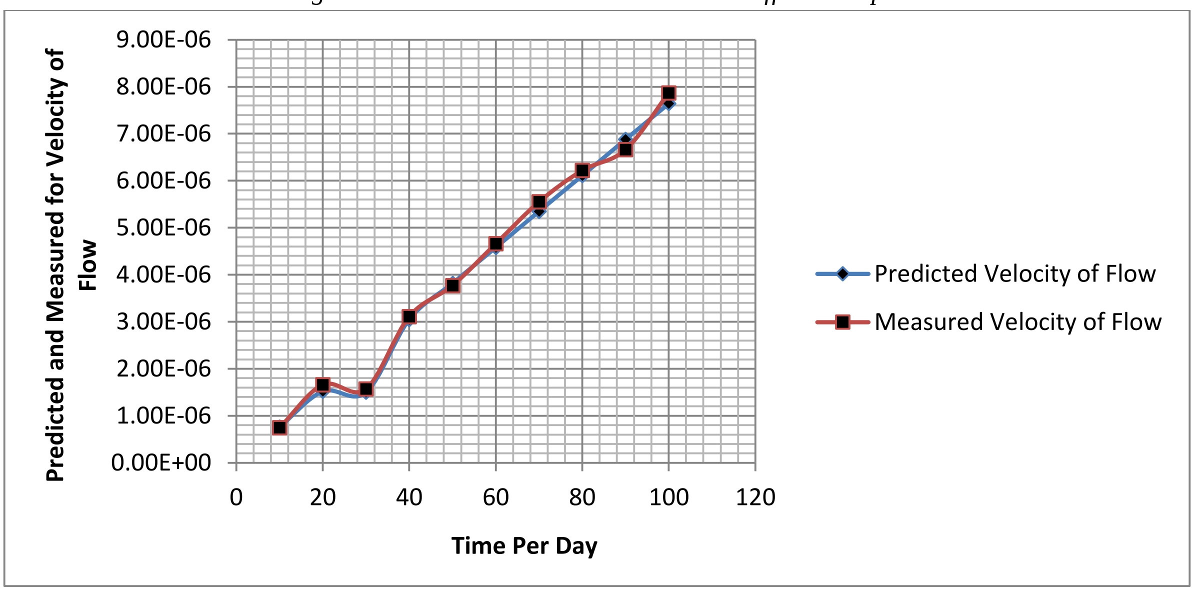

Fig.8: Predicted and Measured Values at Different Time

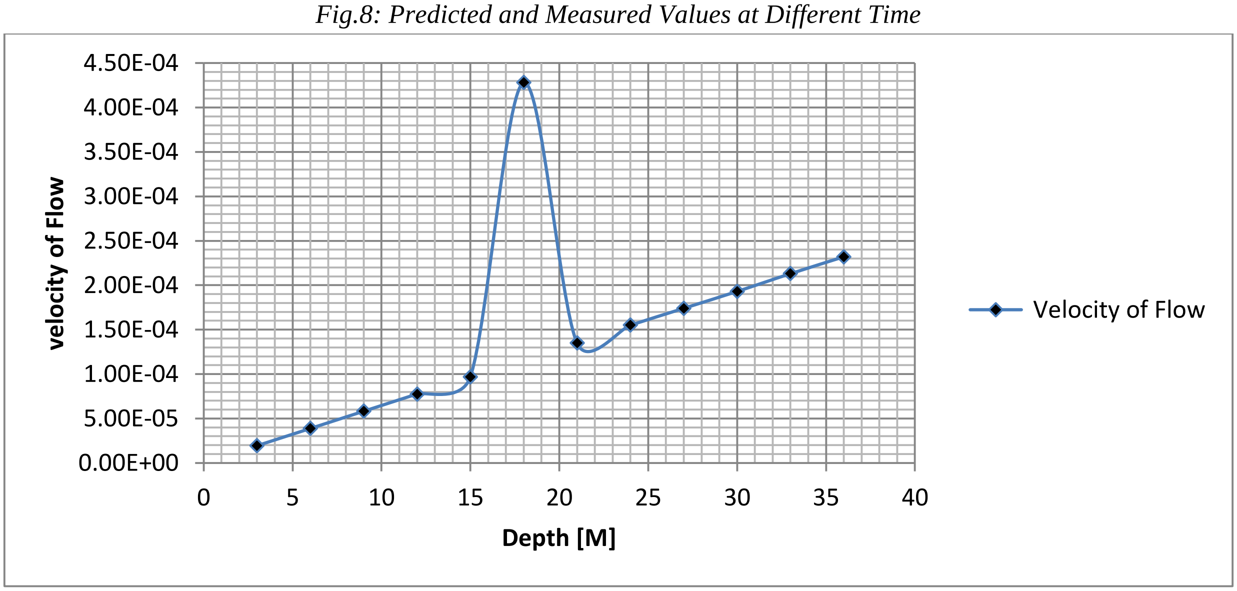

Fig.9: Velocity of Flow at Different Depth

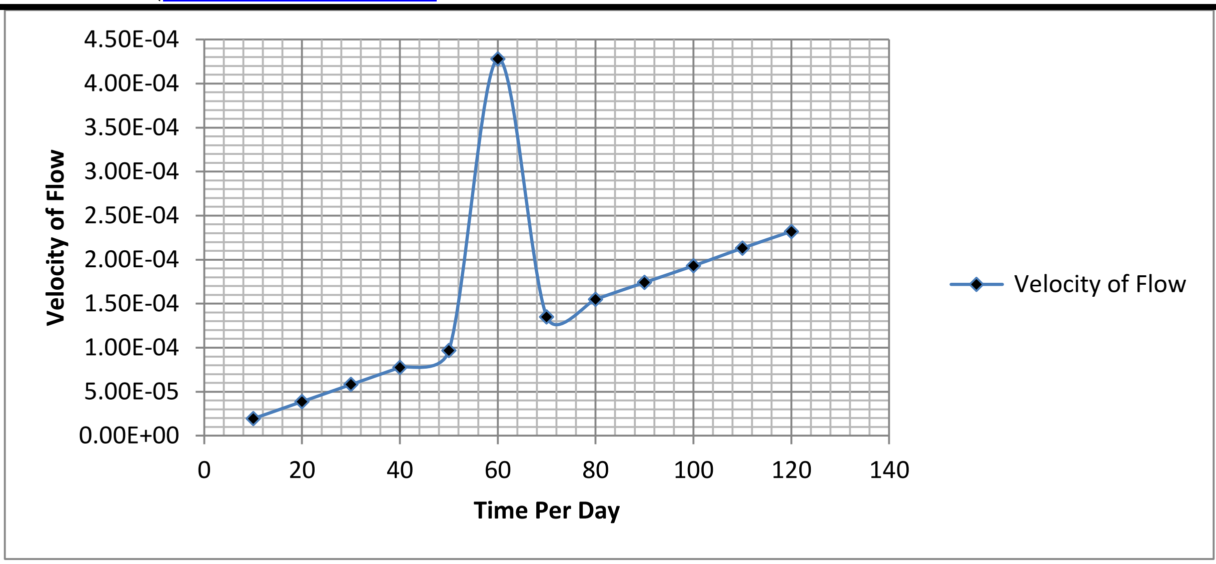

Fig.10: Velocity of Flow at Different Time

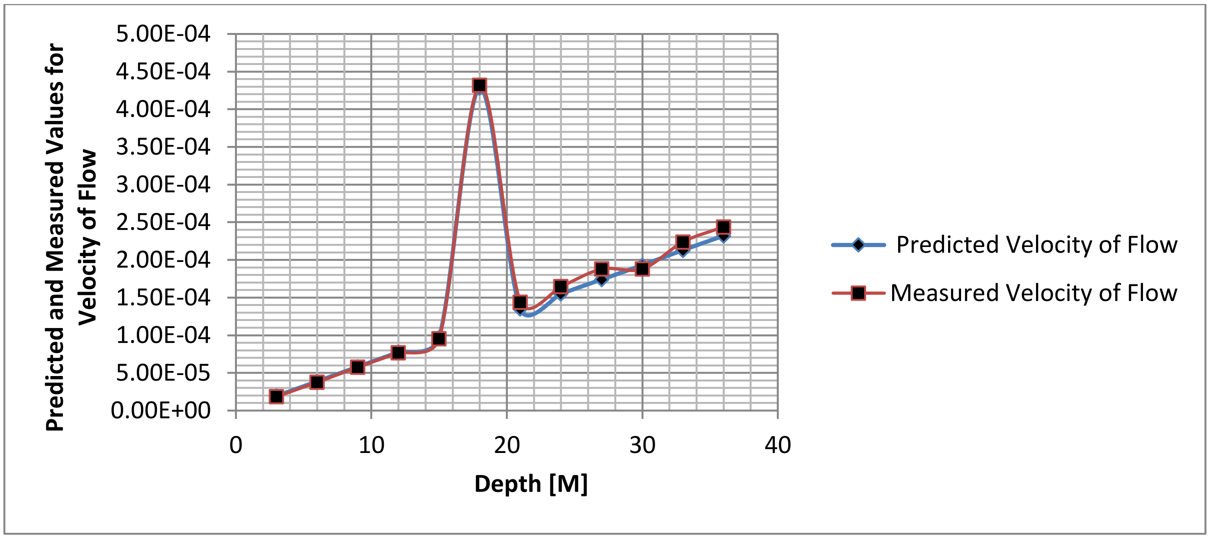

Fig.11: Predicted and Measured Values at Different Depth

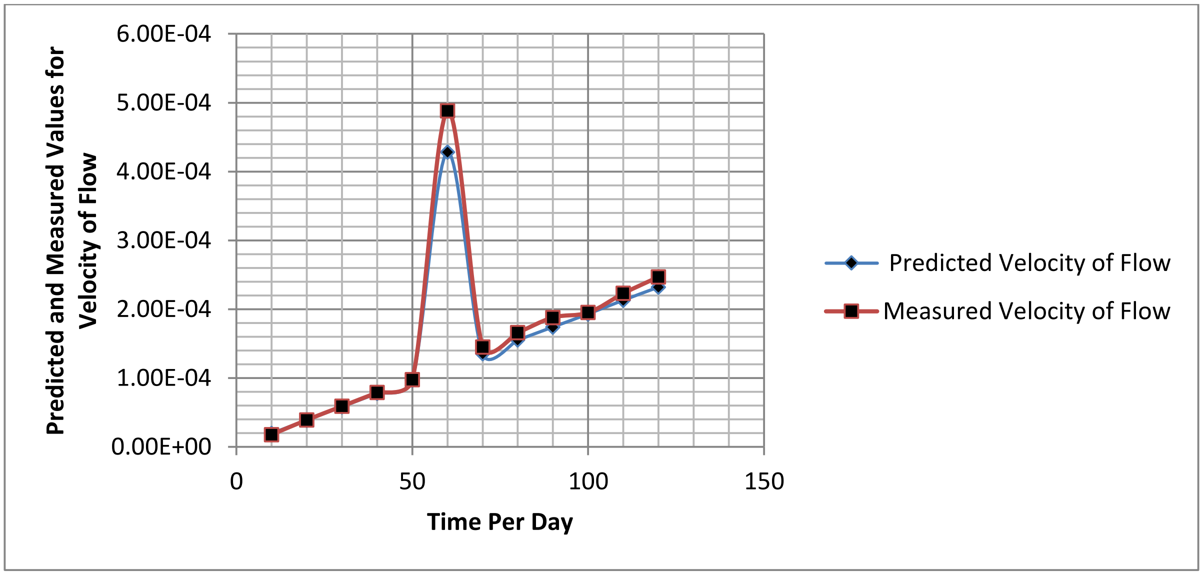

Fig.12: Predicted and Measured Values at Different Time

The figures presented shows dynamic level of flows at different structured strata deposited in various formations, the theoretical values through graphical representation shows the variation of flow base on various predominant deposited formation influences in the strata. Figure one in the study express the lowest flow between three and nine metres, while the highest velocities were observed from twelve and thirty metres. Similar conditions were experiences on the considered time of flow from the theoretical values, the lowest were observed between ten to forty days, while the highest were recorded from fifty to hundred days. The formation experienced the optimum velocity of flow at twelve metre, the same for time of flow where the highest were recorded at forty days; figure three and four experienced best fit as comparison between the theoretical and measure values for validation, figure five and six developed exponential phase with slight fluctuation observed between six and twelve, twenty and forty days, while figure seven and eight express comparison of both theoretical and measured value, these generated best fit, figure nine and ten observed linear exponential condition, but suddenly development rapid state developing the optimum value recorded at twelve metres at period of forty days, linear decrease at steady state were observed from fifteen to thirty metres at the period between fifty to hundred days, figure eleven and twelve observed comparison where predicted and measured recorded express best fit validation for the developed model, the velocity of flow observed at various condition express dynamic deposition in the strata at various predominant formations, but the geological setting express homogeneous velocity of flow through deposited lithostratification from their various disintegration of the sediments, these conditions has definitely generate homogeneous setting in deltaic formations through alluvia deposition

V. CONCLUSION

The study has definitely generate several level of flow dynamics at various deposition in the study location, the lithology of the formation are influenced by formation characteristics , this condition affect the fluid flow in the study area, such condition has also generate several level of yield heterogeneous coefficient as presented in the tables and figures. It has been observed from the study that aquifers from such deltaic formation are found to produces fluctuated yield flow dynamics under the influence of formation variables in most location, it has been also observed that other disposition that shear with another location outside the deltaic area experienced similar condition . The developed governing equation considers these conditions in expressing the rate of dynamic yield influences in the study location. The expressed model should be applied to determine the level of fluid flow yield condition in Ahoada .

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