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$FMTL_xL_yL_z$ DIMENSIONAL EQUATION FOR SLUDGE DRYING BEDS

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ABSTRACT
An equation for sludge dewatering using $FMTL_xL_yL_z$ dimensional analysis approach has been presented. A pilot plant made of 12mm thick steel plate was used in designing a drying bed, 1.20m long, 0.75m wide, 0.80m deep with a total area of 0.90m² and was used in dewatering sewage sludge from the University of Nigeria, Nsukka, waste water treatment plant. Parameters affecting filtration processes were used to derive an equation using dimensional analysis approach. The derived equation based on the concept of specific resistance, was used to investigate the performance of the sand drying bed as a sludge dewatering option. On verification using the experimental data obtained from the sewage plant, the theoretical prediction of the derived equation gave a close relationship to the practical values with a correlation of 0.994. The specific resistance from the experimental data was found to increase as the hydrostatic pressure increases numerically. Also, when ferric chloride was used to verify the effect of chemical conditioner on the sludge, it was observed that the specific resistance decreases with increasing dosage of chemical with the following results: Dosage increase of 10g, 20g, 30g, 40g and 50g of ferric chloride gave specific resistance decrease of 1.2271x 10^8m/kg, 0.4998 x 10^8m/kg, 0.29803 x 10^8m/kg, 0.18124 x 10^8m/kg, 0.075466 x 10^8m/kg respectively. Equally, when the effect of dilution was investigated, the specific resistance showed a decrease in value with increasing initial solid content. The experimental results obtained were in accordance with earlier studies done by other researchers.

Keywords: *sludge dewatering, sand drying bed, dimensional analysis, specific resistance, chemical conditioner*

1. INTRODUCTION

Waste generation is a growing problem facing the world and this is as a result of rapid industrialization, urbanization and expansion in population growth. Emphasis on agriculture for more food production to take care of the astronomical increase in population has generated increased volume of domestic industrial as well as agricultural wastes.

Owing to health and other environmental hazards like water, air and soil pollution, posed by industrial, domestic and agricultural wastewaters to the existence of man and the entire ecosystem there is therefore every need to treat wastewater properly before discharging them to the receiving streams, water bodies or agricultural lands.

According to [1], sludge, a term used to designate the solid that settles when sewage is passed through a settling tank is a serious problem to all wastewater treatment plants worldwide in terms of disposal, transportation and handling. Wastewater processing plants in an effort to meet more stringent discharge measures and limitations led to increased volume of sludge production. Sludge dewatering is a wastewater treatment process that reduces the water content of the sludge so that it can be transported, handled and disposed with ease. In most dewatering process the ability of sludge to form and maintain a porous media that enhances its compressibility is a desired goal [2].

Dewatering and disposal of sludge is a major economical factor in the operation of wastewater treatment plant, [3] reported that 30- 50% of the annual operating costs of treatment plants are related to sludge dewatering alone.

So many techniques exist for dewatering sludge and these include mechanical method as well as natural method. Natural filtration methods include the drying bed, lagoons, oxidation ditch etc.

Sand drying bed is a natural dewatering technique that makes use of natural phenomenon such as losing water to the atmosphere by evaporation and also percolation through the filter medium via an under drain to achieve sludge volume reduction. It is more

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economical to operate and maintain when compared to mechanical means, though large area of land is required. Drying beds are mostly used in small industries as well as small communities with populations of over 100,000 people [4]. Dispersed particles in sludge has often been observed to have a negative effects on filtration rate and the increase in resistance experienced using drying bed is due to the blinding of the filter medium of sludge cake with small particles [5]. Drying time depends on weather or climatic conditions and equally on the thickness of the sludge applied. It may vary from 10 days to several weeks. For efficient performance during rainy season, drying beds may be provided with covers to avoid interference from weather and climatic conditions (rainfall, humidity etc.). The objective of this research work is to use dimensional analysis method Force, mass, time in three dimensions (FMTL$_x$L$_y$L$_z$) to develop sludge filtration equation without the compressibility attribute and also to examine the effect of conditioner on specific resistance using drying bed.

Dimensional analysis according to [6] is a mathematical technique which makes use of the study of the dimensions for solving engineering problem. It is an important tool for analyzing fluid flow problems.

Dewatering process helps to remove high water content such that the sludge can be handled and transported easily over a long distance for ultimate disposal and in effect reduces cost. The raw sludge has about 97.5% water content and 2.5% solid [7]. Dewatering process increases solid content between 20 to 35% [8].

Over the years researchers in this field have come up with many theories and derived equations based on experimental assumptions and conditions, [9] proposed an equation for sludge dewatering at constant vacuum pressure as;

$$V^2 = \frac{PA^2t}{\mu cr} \quad (1)$$

$$r = r^1P^s \quad (2)$$

In (1) and (2), V is the volume of filtration (m^3), c is the solid concentration (Kg/m^3), P is the filtration pressure (N/m^2), r is the specific resistance (m/Kg), A is the area of filtration (m^2), μ is the dynamic viscosity (N.s/m^2), t is the time of filtration (s) and s is the compressibility coefficient (m^2/N).

The work done by Carman on filtration was based on the idea of specific resistance and the velocity time plot at constant pressure and on ideal situation where the cake formed is considered rigid at constant pressure. He was of the idea that specific resistance is independent of solid concentration and opined that the total loss of pressure arises from, pressure drop across filter cake, pressure drop across initial resistance, and loss incurred in filtrate recovery. The cake formed during filtration process shows that the cake so formed does not change volume as pressure builds up and for non rigid cake the pressure across the cake increases faster than the cake build up [10]. Equally [11]showed that Carman's equation does not give room for low compressibility value to be evaluated with any degree of accuracy and for a rigid cake, the compressibility coefficient $S_c = 0$ and that low compressibility is equal to unity and proposed an equation of the form;

$$r = r_1\,(1 + r_2PS_c) \quad (3)$$

where r_1 and r_2 are constants, r is the specific resistance, P is the filtration pressure and S_c is the compressibility coefficient.

Carman's equation was later developed by [12] and showed that the rate of filtration is given by,

$$\frac{dV}{dt} = \frac{PA^2}{\mu(\alpha c + R_mA)} \quad (4)$$

where α and R_m are the specific resistance of cake and that of the filter medium respectively. After integrating, equation (4) turns out a straight line when t/V is plotted against V, with a slope $= \frac{\mu\alpha c}{2PA^2}$ and intercept $= \frac{R_m\mu}{PA}$.

Another researcher [13] also criticized the work done by [9] on the assumption he made that the cake formed during filtration process is rigid as compared with sand bed which he assumed as bundle of capillary tubes. He used dimensional analysis to formulate filtration equation based on force, mass, time in three dimensions, the variables that have significant effect on sludge filtration are reduced to the fundamental quantity of force, mass, time and length. Length is further divided into three, x, y, z representing the three mutual axis in space. He opined that the major factors that could affect filtration process include, pressure, Area of filtration, time, specific resistance, concentration of solids, dynamic viscosity and gave an equation of the form;

$$V^2 = \frac{PA^{5/2}t}{\mu c^{1/2}r^{1/2}} \quad (5)$$

But [14], objected to the use of FMTL$_x$L$_y$L$_z$ saying that mass and force can both be used as fundamentals only in the unusual situations when the physical proportionality between the two is not involved in any of the terms and suggested that, the partial equation developed by [13] be written thus,

$$V^2 = P\mu^{-1}A^{2b}t(cr)^{2b-3} \quad (6)$$

In (6), t is the time of filtration, r is the specific resistance, A is the area of filtration, v is the volume of filtration, p is the filtration pressure, c is the concentration of solid and μ is the dynamic viscosity

They finally agreed that the correct determination of the exponent b, based on theoretical or experimental consideration would guide the choice of filtration equation. Much later [7] worked relentlessly to determine experimentally the value of the exponent b, using Buchner funnel technique as described by [12], they stated that,

$$V^2 = \frac{PA_t^{1.82}t}{\mu(cr)^{1.18}} \quad (7)$$

And

$$V^2 = \frac{PA_{eff}^{2.76}t}{\mu(cr)^{0.24}} \quad (8)$$

where A_t and A_{eff} are total and effective area of the Buchner funnel respectively. Also in another development [13] proposed another filtration equation known as sludge dewaterability number SDN and discovered that sludge filtration parameter is dependent not only on the equipment design but also on pre- treatment before dewatering and other unquantifiable physical factors such as ageing, shear to the filter medium, etc and stated that,

$$SDN = \frac{\Delta H(c_0 - c_f)}{V_i c_c t} + \frac{H_0}{V_i t} \quad (9)$$

In (9) where C_0 is the initial concentration of sludge (Kg/m3), ΔH is the change in head loss (m), C_f is the filtration concentration (Kg/m^3), C_c is the cake concentration (Kg/m^3), H_0 is the initial head loss (m), V_i is the approach velocity (m/s).

2. EXPERIMENTAL SET-UP AND METHODS OF ANALYSIS.

The pilot plant as shown below is made of 12mm thick steel plate. Its dimension is 1.2m long, 0.75m wide, 0.80m deep and a total filtration area of 0.9m^2. At the top of the perforated base, is 200mm course of gravel followed by 200mm course of fine sand, 250mm thick sludge. The set up was used to dewater sewage sludge collected from the wastewater treatment plant (Imhoff tank) at the University of Nigeria, Nsukka. The experiment started by collecting and pouring sewage sludge into the drying bed to a height of 250mm.Filtrate from the sludge started percolating through the sand bed by gravitational movement of water downwards. Water was also lost by evaporation from the surface of the sludge, readings were taken and specific resistance was calculated using the derived equation. Thermometers were inserted at the four corners of the sand drying bed to measure the difference in sludge temperatures and the atmospheric temperatures. Measurements were taken at interval of two hours on the first day and 24 hours on the subsequent days. Effects of chemical conditioner and also dilution, on the specific resistance of the sludge were also investigated using the same set up.

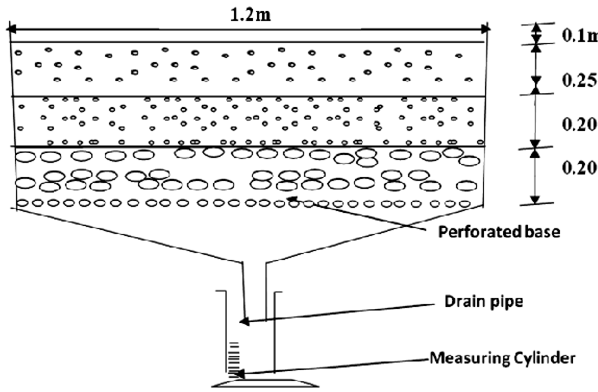

Figure 1: Schematic diagram of sand drying bed.

3. DERIVATION OF SLUDGE FILTRATION EQUATION USING FMTLxLyLz DIMENSIONAL ANALYSIS METHOD.

Since no chemical reaction is assumed to take place during sludge filtration, the process can be assumed to constitute a physical system and dimensional analysis can be used in deriving an equation to describe the system.

However, in deriving the equation only the effective terms are incorporated.

Table 1: FMTL Dimensions.

Physical variables	Symbols	Fundamental systems ($FMTL_xL_yL_z$)
Volume of filtration (m^3)	V	$L_xL_yL_z$
Filtration Area (m^2)	A	L_xL_y
Filtration Time (s)	T	T
Mass of dry cake per unit volume (Kg/m^3)	C	$ML_x^{-1}L_y^{-1}L_z^{-1}$
Net filtration pressure(N/m^2)	P	$FL_x^{-1}L_y^{-1}$
Viscosity of filtration(N.S/m^2)	μ	FTL_z^{-1}
Specific resistance(m/Kg)	R	L_zM^{-1}

$$V = P^aA^bC^c\mu^dR^et^f \quad (10)$$

Applying dimension;

$$L_xL_yL_z = (FL_x^{-1}L_y^{-1})^a \times (L_xL_y)^b \times (ML_x^{-1}L_y^{-1}L_z^{-1})^c \times (FTL_z^{-2})^d \times (M^{-1}L_z)^e \times (T)^f$$

Solving we obtain;

$$V = \left(\frac{Pt}{\mu}\right)^{1/2} A^{3/2}A^eC^eR^e \quad (11)$$

$$V = \left(\frac{Pt}{\mu}\right)^{1/2} A^{3/2}(ACR)^e \quad (12)$$

$$V = \left(\frac{PtA^2}{\mu}\right)^{\frac{1}{2}} (ACR)^e \quad (13)$$

$$V = t^{1/2}\left(\frac{PA^2}{\mu}\right)^{1/2} (ACR)^e \quad (14)$$

$$\frac{V}{t^{\frac{1}{2}}} = \left(\frac{PA^2}{\mu}\right)^{\frac{1}{2}} (ACR)^e \quad (15)$$

$$\frac{t^{1/2}}{V} = (\frac{PA^2}{\mu})^{1/2}(ACR)^e \quad (16)$$

Solving;

$$\frac{t}{V^2} = (\frac{PA^2}{\mu})^{-1}(ACR)^{-2e} \quad (17)$$

$$\frac{t}{V} = V\left(\frac{\mu}{PA^2}\right)(ACR)^{-2e} \quad (18)$$

If t/V is plotted against solid content C, it gives a straight line showing, that the volume of filtrate is proportional to the solid content.

Equating the powers we have,-2e = 1 or e = - ½.

Substituting e = - ½ in equation (18),

$$\frac{t}{V} = V = V\left(\frac{\mu}{PA^2}\right) (ACR)^{-2\,X-\frac{1}{2}} \quad (19)$$

$$\therefore \frac{t}{V} = V\left(\frac{\mu CR}{PA^2}\right) \quad (20)$$

But,

$$\frac{t}{V} = f\left(\frac{V\mu CR}{PA^2}\right) \quad (21)$$

By observing the experimental plot of t/V versus V, equation (21) should be re – written as,

$$\frac{t}{V} = V\left(\frac{\mu CR}{PA^2}\right) + \beta \quad (22)$$

where β is the intercept of the plot of $\frac{t}{V}$ against V. Since we are working on natural drying bed, the pressure P, under consideration is hydrostatic, i.e. P = ρgh. Applying P = ρgh in equation (20) we obtain,

$$\frac{t}{V} = V\left(\frac{\mu CR}{\rho ghA^2}\right) + \beta \quad (23)$$

Also

$$C = \frac{w_d}{v_s}, \qquad \therefore \frac{t}{V} = V\left(\frac{\mu Rw_d}{\rho ghA^2V_s}\right) + \beta \quad (24)$$

If $\frac{t}{V}$ is plotted against V, the slope say b of the straight line is given by:

$$b = \frac{\mu Rw_d}{\rho ghA^2V_s} \quad (25)$$

Specific resistance R, is calculated thus,

$$R = b\left(\frac{\rho ghA^2V_s}{\mu w_d}\right) \quad (26)$$

In (26), R is the specific resistance(m/kg), A is the area of filtration(m^2), b is the Slope(s/m^6) , C is the solid content(kg/m^3), μ is the dynamic viscosity (N.s/m^2), V_s is the volume of sludge(m^3), w_d is the weight of dry sludge(kg) and ρgh is the hydrostatic pressure(N/m^2).

4. RESULTS AND DISSCUSIONS

As the filtration process began, it was observed that the filtrate was high and clear on day one and this may be attributed to low resistance offered by the filter septum (the sand bed) alone. As the filtration proceeds, the thickness of the cake keeps building up and as a result there is a reduction in the volume of filtrate and this is due to the combined effect of the resistance offered by the filter septum and the cake formed. Before now, most of the dewatering process is by drainage through the sand bed. As the sludge height decreases, there is a corresponding increase in the hydrostatic pressure.

The plot of t/v against V gave a straight line and the specific resistance increases as the pressure increases. The efficiency of the drying bed was also investigated by plotting a graph of t/V against hydrostatic pressure versus time, this gave a straight line. Investigating the effect of dilution on the specific resistance, each sludge volume was diluted to varying concentration using different dosage of distilled water, dilution was done within comparable range and it shows that the resistance decreases as the dosage of the distilled water increases. As dilution increases more fines attain their 'disintegration energy' and therefore increase the filter medium blinding.

Effect of ferric chloride was investigated and each sludge volume was conditioned using different dosage of ferric chloride (Fecl$_3$) 10g, 20g, 30g, 40g, and 50g and their corresponding specific resistance are, 1.2271 x 10^{8}m/Kg, 0.4998 x 10^{8}m/Kg, 0.29803 x 10^{8}m/Kg, 0.18124 x 10^{8}m/Kg, 0.07545 x 10 m/Kg respectively. The result from the experimental data analysis shows that the specific resistance decreases with increasing dosage of ferric chloride. The effectiveness of ferric chloride conditioner in lowering the specific resistance of the sludge in this study was due to coagulation of fine particles in the sludge, larger particles are gathered together by the sludge and hence they become more porous. The result shows that the derived equation is valid and can be adopted for sludge dewatering.

The data and graph analysis are as shown;

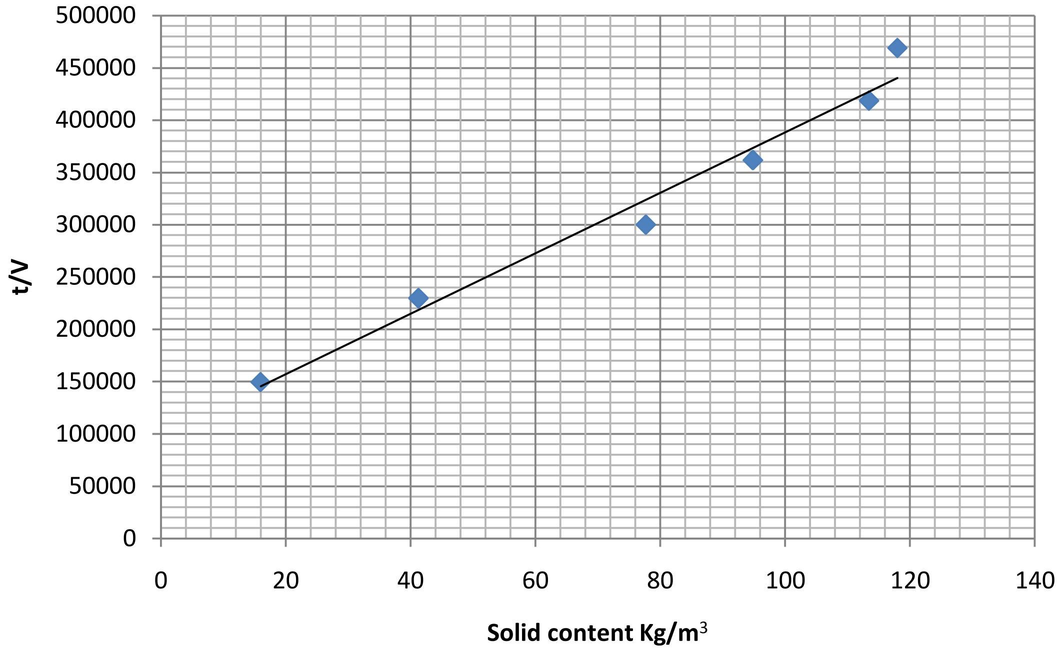

Figure 2 showing the graph of t/v against solid contents.

Table 2: Filtration of unconditioned sludge, on day one of the experiment.

Volume(m³)	Time(s)	Height of sludge(m)	Hydrostatic pressure(N/m²)	t/V	V²	V* t/V
0.054729	7200	0.058	566.84	131557.31	0.002995	7200
0.062659	14400	0.071	693.58	229815.35	0.003926	14400
0.071967	21600	0.079	771.62	300137.56	0.005179	21600
0.079592	28800	0.083	810.78	361845.41	0.006335	28800
0.085967	36000	0.087	850.13	418765.34	0.007390	36000
0.092097	43200	0.100	976.85	469070.65	0.008482	43200
0.447011			778.3	1911191.8	0.034306	151200.1

Initial height = 0.25m, Area = 0.9m², Hydrostatic pressure = 778.3N/m², Dynamic Viscosity = 0.8816N.s/m², Solid Content = 76.89kg/m³, R = 0.81716 x 10⁸, Slope b = 8.787 x 10⁶.

The slope was analyzed by regression,

$$b = \frac{n\sum V\left(\frac{t}{V}\right) - \sum V \sum(\frac{t}{V})}{n\sum(V)^2 - (\sum V)^2}$$

The specific resistance R is:

$$R = \frac{\rho g h A^2 V_s}{\mu w_d}$$

Table 3: Filtration of unconditioned sludge at 24 hours interval for 5 days.

Volume(m³)	Time(s)	Height of sludge(m)	Hydrostatic pressure(N/m²)	t/V	V²	V*t/V
0.12666	86400	0.162	1584.32	682141.2	0.01604	86400
0.13186	172800	0.204	1995.83	1310480.8	0.01739	172800
0.13361	259200	0.206	2014.62	1939974.6	0.01785	259200
0.13427	345600	0.207	2023.31	2573918.2	0.01803	345600
0.13516	432000	0.210	2054.53	3196211.9	0.01827	43200
0.66156			1934.52	9702726.7	0.08758	1296000

Area = 0.9m², Hydrostatic pressure = 1934.52N/m², Dynamic Viscosity = 0.9776N.s/m², Slope b = 3.053206x10⁸, Solid Content = 639.82kg/m³, R = 7.6488x10⁸m/kg.

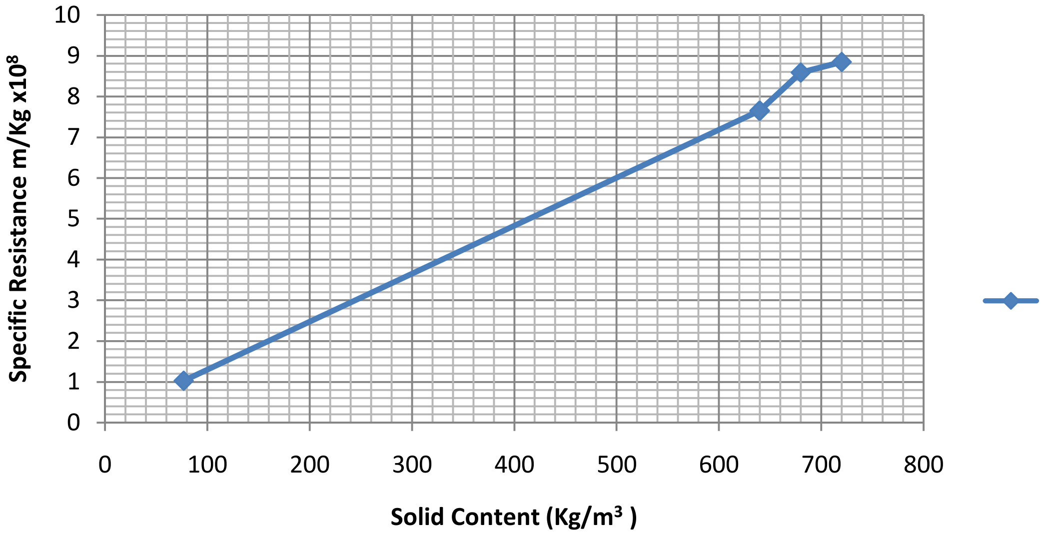

Figure 3: Plot of specific resistance against solid content.

The graphs in Figure 3 shows that the solid content increases as the specific resistance increases, this signifies that as more solid settles the pressure increases and the void ratio decreases and this reduces the volume of filtrate that passes through the cake per time.

Table 4: Effect of ferric chloride on specific resistance of sludge using 10g ($Fecl_3$) on 10 litres of sludge.

s/N	Time t (s)	Volume V (m^3)	t/V(s/m^3)	$V^2(m^6)$	V*t/V(s)	Sludge height (m)
1	1800	0.002025	888888.889	$4.100625x10^{-6}$	1800	0.020
2	3600	0.003893	924736.707	$1.515545x10^{-5}$	3600	0.020
3	5400	0.005603	963769.409	$3.139361x10^{-5}$	5400	0.020
4	7200	0.007133	1009392.962	$5.087969x10^{-5}$	7200	0.020
5	9000	0.008003	1124578.283	$6.404801x10^{-5}$	9000	0.020
		0.026657	3899266.250	$1.655774x10^{-4}$	27000	

Height of sludge = 0.02m, Area of filtration = $0.9m^2$, Temperature = 27.6°C, Density = $996.35Kg/m^3$, Dynamic viscosity = $0.9031N.s/m^2$, Hydrostatic pressure = $195.49N/m^2$, Slope b = $5.87828x10^7S/m^2$, R = $1.2271x10^8$ m/Kg.

Table 5: Effect of ferric chloride on specific resistance of sludge using 20g of ($Fecl_3$) on 10 litres of sludge.

s/N	Time t (s)	Volume V (m^3)	t/V(s/m^3)	$V^2(m^6)$	V* t/V(s)	Sludge height (m)
1	1800	0.002475	727272.72	$6.125625x10^{-6}$	1800	0.015
2	3600	0.004763	755826.16	$2.268617x10^{-5}$	3600	0.015
3	5400	0.006773	797283.33	$4.587353x10^{-5}$	5400	0.015
4	7200	0.008357	861553.19	$6.983945x10^{-5}$	7200	0.015
5	9000	0.009332	964423.49	$8.708623x10^{-5}$	9000	0.015
		0.0317	4106358.9	$2.316110x10^{-4}$	27000	0.015

Height of sludge = 0.015m, Area of filtration = $0.9m^2$, Temperature = 28°C, Dynamic viscosity = $0.8916N.s/m^2$, Density = $996.232Kg/m^3$, Solid content = $84.0Kg/m^3$, Hydrostatic pressure = $146.60N/m^2$, Slope b = $0.31524x10^8S/m^2$, R = $0.4998X10^8$m/Kg.

Table 6: Effect of ferric chloride on specific resistance of sludge using 30g 0f ($Fecl_3$) on 10 litres of sludge.

S/N	Time t (s)	Volume V (m^3)	t/V(s/m^3)	V^2(m^6)	V* t/V(s)	Sludge height (m)
1	1800	0.0099375	181132.08	9.875391x10^{-5}	1800	0.010
2	3600	0.0146715	245373.68	2.152529x10^{-4}	3600	0.010
3	5400	0.017034	317013.03	2.901572x10^{-4}	5400	0.010
4	7200	0.018534	388475.24	3.435092x10^{-4}	7200	0.010
5	9000	0.019602	459136.82	3.842384x10^{-4}	9000	0.010
		0.079779	1591130.85	1.331912x10^{-4}	27000	0.010

Height of sludge = 0.010m, Area of filtration = 0.9m^2, Temperature = 29^{o}C, Density = 995.944Kg/m^3 , Dynamic viscosity = 0.8642 N.s/m^2, Hydrostatic pressure = 97.70 N/m^2, Solid content = 84.0Kg/m^3, Slope b = 0.27338x10^8s/m^2, R = 0.29803X10^8 m/Kg

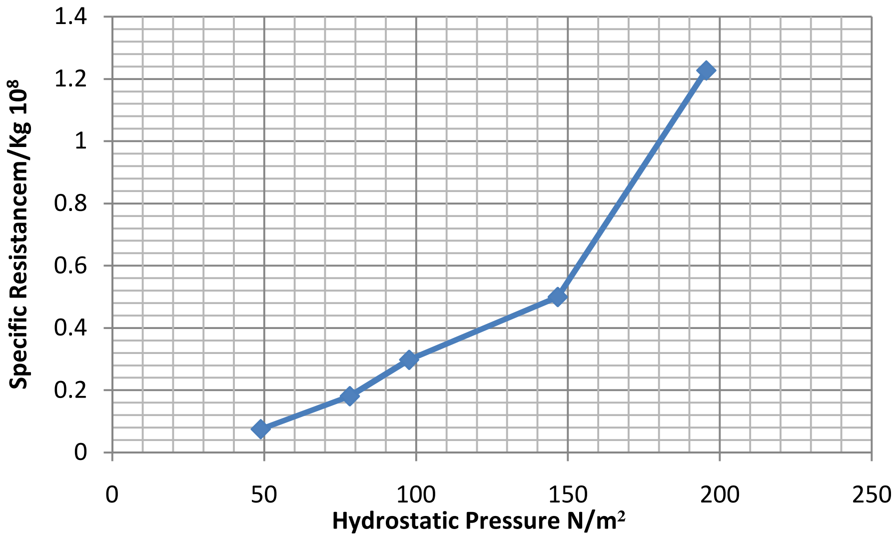

Figure 4, Plot of specific resistance against Hydrostatic pressure.

The derived equation was validated using experimental data from the sewage treatment plant and on verification the theoretical prediction of the derived equation agrees closely with the practical values.

By regression analysis,

Slope is:

$$b = \frac{n\sum V\left(\frac{t}{V}\right) - \sum V \sum(\frac{t}{V})}{n\sum(V)^2 - (\sum V)^2}$$

$$= \frac{6\,x\,151200 - 0.447011 \times 1911191.8}{6 \times 0.034306 - 0.447011^2}$$

$$= 8.787 \times 10^6\ s/m^6$$

Correlation = 0.994.

Applying,

$$\frac{t}{V} = a + bv = -3.285 \times 10^5 + V\left(\frac{\mu R w_d}{\rho g h A^2 V_s}\right) \quad (26)$$

From the plot of t/v against V,(experimental values from the sewage plant and the theoretical values) it shows that t/v increases as the numerical value of V increases. This is so, since the sludge height in the drying bed decreases as the filtrate volume increases with time.

Table 7: Experimental data from the sewage plant

Volume(m^3)	Time(s)	Area(m^2)	V^2
0.054729	7200	0.9	0.002994
0.062659	14400	0.9	0.003926
0.071967	21600	0.9	0.005179
0.079592	28800	0.9	0.006335
0.085967	36000	0.9	0.007390
0.092097	43200	0.9	0.008482

Table 8: Experimental and Theoretical data

t/V (Experimental values)	t/V (Theoretical values)	Time(s)
1.32x10^5	1.53x10^5	7200
2.30x10^5	2.22x10^5	14400
3.00x10^5	3.04x10^5	21600
3.63x10^5	3.71x10^5	28800
4.19x10^5	4.27x10^5	36000
4.69x10^5	4.81x10^5	43200

5. CONCLUSION

Natural filtration process that makes use of sand drying bed has been used to propose an equation using dimensional analysis approach. The major parameters that influence filtration processes were incorporated. It was observed from the analysis of experimental data that the derived equation was in accordance with theoretical predictions. The results obtained in investigating the effect of initial solid content, pressure and ferric chloride conditioning on specific resistance show that there was a general decrease in the specific resistance with increasing dilution of ferric chloride dosage. There was also corresponding increase in specific resistance with increased pressure. The ferric chloride dosage that was tested in the following order, 10g, 20g, 30g, 40g, and 50g gave specific resistance values of 1.2271 x 10^8m/Kg, 0.4998 x 10^8m/Kg, 0.29803 x 10^8m/Kg, 0.18124 x 10^8m/Kg, 0.075466 x 10^8m/Kg respectively. On verification using experimental data obtained from the sewage plant, the theoretical predictions of the derived equation gave a close relationship with the practical values.

When the results obtained using the derived equation was compared with Carman's equation it showed a similar trend among the parameters verified.

All these results are in agreement with previous work and as a result, specific resistance can be used to quantify sludge filterability. The derived equation can be accepted in sludge dewatering process since it is in agreement with previous research

6. RECOMENDATIONS

Sludge drying bed should be provided with cover like the one in use in 'green house effect' to make it functional throughout the year since its efficiency is dependent on weather and climate condition. Sludges should be pre- treated with conditioners to facilitate the filterability of the sludge.

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