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RESEARCH ARTICLE

EVALUATION OF COMPLETION FLUID TURBIDITY AND TOTAL SUSPENDED SOLIDS TRENDS IN SOUTHERN NIGERIA

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A B S T R A C T

The evaluation of turbidity and total suspended solids of completion fluid is a necessary operation. The completion of wells without consuming a lot of time, damaging the zone and controlling the formation pressure gave rise to the evaluation and correlation of NTU and TSS in the selected area. Selecting a properly designed, compatible fluid with evaluation and correlation of NTU and TSS in the selected area is a means of mitigating these effects of hydration of formation clays, wettability changes, pressure differential, water blocking, emulsion blocking, paraffinic or asphaltic plugging, formation of precipitates, and migration/dispersion of formation clays and prolonged displacement period. In this work the borehole water and seawater samples collected from selected operations areas in Southern Nigeria at specific depth were used. Mix borehole water and seawater samples were collected from selected operations areas in Southern Nigeria at specific depth and laboratory analysis/measurements were carried out. The densities of water and brine samples were measured. The density of Owaza water (8.31ppg) and CaCl brine sample was the highest with 10.91ppg specific gravity and Obagi water (8.30ppg) and KCl brine was lowest with 9.44ppg. The brine NTU and TSS data extracted from was used to develop a correlation of $R^2 = 0.765$ which is good for the determination of NTU of brine with its TSS. Also, software has been developed for determining each variable that is needed.

INTRODUCTION

A correlation between turbidity and TSS that was established in one location may not be valid at other locations, even for the same sample site while establishing correlations between turbidity and TSS may prove expeditious for certain types of sampling.

There are parameters and primary ways in which sediment in the water column is measured: turbidity, total suspended solids, water density and water clarity.

Turbidity is an optical property of water where suspended and dissolved materials such as silt, clay, finely divided organic and inorganic matter, chemicals, plankton, and other microscopic organisms cause light to be scattered rather than transmitted in straight lines. Measurements of turbidity have been developed to quickly estimate the amount of sediment within a sample of water and to describe the effect of suspended solids blocking the transmission of light through a body of water (Lloyd, 1987).

Turbidity is usually measured by nephelometry-the relative measurement of light scattering through a restricted range of angles to the incident light beam. Typically, nephelometers detect light scattered by a water sample usually at 90 degree to the incident beam. Nephelometric turbidity units (NTUs) are used as a rough index of the fine suspended sediment content of the water (Davies-Colley and Smith, 2000). In the past, turbidity was measured using Jackson Turbidity Units (JTUs). The Jackson Candle Turbidimeter was limited in that it could not measure turbidities lower than 25 JTU and was dependent on human judgment. At high turbidities, JTUs and NTUs are roughly equivalent (Lloyd, 1987). Please note that JTUs are only used in this report in tables culled from previous literature reviews.

Total Suspended Solids (TSS) represents the actual measure of mineral and organic particles transported in the water column. TSS is an important measure of erosion, and is linked to transport of nutrients, metals, and industrial and agricultural chemicals through river systems. Suspended sediment consists primarily of silt and clay size particles that may be rapidly transported downstream and locally deposited on floodplains and overbank storage locations or may infiltrate into gravel interstices of the bed (Everest *et al*, 1987). Note that in older literature, TSS may also be referred to as suspended sediment concentration (SSC). This term will be used in the literature review where appropriate. Fluctuating TSS levels always affects rig time. Fine particles may carry substances that are harmful or toxic to aquatic life.TSS is determined by measuring the residue in a well-mixed sample of water which will not pass a standard (glass fiber) filter. The residue trapped on the filter is dried (103-105 °C) and reported in units of weight per volume - typically mg/l (Sorenson *et al*, 1977). Total Solids is the term applied to material residue left in a vessel after evaporation of a water sample and subsequent drying of the residue. Total Solids includes Total Suspended Solids (TSS), the portion of total solids in a sample that can be retained by a filter, and Total Dissolved Solids (TDS), the portion that passes through a filter. We are sometimes asked if turbidity readings can be converted to TSS values. The short answer to this is “no”. Turbidity is the measure of a sample’s tendency to scatter light. While the scattering is produced by the presence of suspended particles in the sample, turbidity is purely an optical property. The pattern and intensity of scatter changes with the size and shape of the suspended particles as well as with the material of which they are made.

A sample containing 1,000 mg/L of fine talcum powder will give a different turbidity reading than a sample containing 1,000 mg/L of coarsely ground talc. Both of these samples will also have a different turbidity reading than a sample containing 1,000 mg/L ground pepper. Yet, all three samples contain the same quantity of TSS. A user who wishes to convert turbidity readings to TSS measurements is obligated to first establish a correlation between the two for a specific sample site. The resulting correlation coefficient will give an estimate of how strong the relationship is. Conversion of turbidity readings to TSS values should be approached with caution even after a correlation is established, though. The composition of suspended material with respect to particle size and composition is likely to change both spatially and temporally. Imagine a river along which multiple sample sites.

Water clarity, a direct measure of visible distance through water is another important measure related to the presence of sediment in the water column. Visual water clarity describes the distance that an organism can see underwater. Water clarity is affected by suspended and dissolved materials (Davies-Colley and Smith 2000). Correlations between visual water clarity and turbidity (NTU) or TSS may vary dramatically between watersheds.

Changes in water clarity alter the balance between predators and prey and may have a strong effect on individual behaviors (A. Steel, pers. commun.). Historically, water clarity has been measured with a Secchi disk, a black and white disk submerged vertically into the water until it can no longer be seen (Davies-Colley and Smith 2000).

‘‘The relationship of TSS and transparency to turbidity across many streams indicates that 25 NTU is approximately equal to 58 mg/L for TSS and 20 centimeters of visibility through a T-tube. However, the relationship between turbidity and TSS can vary greatly in individual streams or even locations within a stream’’ according to Water Quality/Impaired Waters #3.21 • March 2008

Completion and workover fluids are those placed against the formation while killing well, cleaning out, plugging back, stimulating, or perforating, hardware replacement, gravel packing, etc.

Their primary functions are:

- To transfer treating fluid to a particular zone in the borehole,
- To protect the producing formation from damage,
- To control the well pressure during servicing operations,
- To clean the well,
- To displace other fluids or cement.

It follows, then, that a wide variety of equipment designs and procedures have been developed to provide safe, efficient conduits from subsurface reservoirs to the surface in different situations. In each case, the ideal completion design minimizes initial completion and operating costs, while providing for the most profitable operation of an oil or gas well over its entire life. After the cement has set, the inside of the casing must be drilled out and flushed clean of cement and other debris to a depth below that of the proposed completion. It is important that the inside diameter of the production casing be clean and smooth.

Table 1 Brine Types and Respective Density Ranges

Density Range(lb/gal)	Salt Solutions
8.3 - 9.7	Potassium Chloride
8.3 - 9.9+	Sodium Chloride
8.33-8.9	Amonium Chloride
10.1 - 11.1	Sodium Chloride/Calcium Chloride
8.33-11.1	Sodium BiCarbonate(NaHCO2)
8.3 - 11.7	Calcium Chloride
12.0 - 16.0	Zinc Chloride/Calcium Chloride
9.8 - 10.9	Potassium Bromide/Potassium Chloride
10.0 - 12.4	Sodium Bromide/Sodium Chloride
11.7 - 15.1	Calcium Bromide/Calcium Chloride
15.0 - 19.2	Zinc Bromide/Calcium Bromide/Calcium

World Oil, Modern Sand Face Completion (2003)

Hydrocarbon production in a general sense is governed by reservoir conditions, well-bore status, and network of flow lines, surface storage and handling facilities or a combination of any of these factors.

The goal of sustaining production in a mature field can be achieved by maximizing production rates or by minimizing production cost. However there is a limit to which the latter can be achieved. Hence, it may not be a viable option when the limit has been reached and a certain base cost must be maintained. This study aims at developing optimized model techniques for evaluation of completion fluid turbidity and total suspended solids (TSS) trends in Southern Nigeria to mitigate natural time consuming tendencies. Variables and constraints that can affect completion fluid placement are considered. These constraints/variables may differ from field to field but the underlying concept remains the same and as such will be captured in the course of this study. The study will also consider identification of different water samples, screening of possible candidates, and building of individual base models for selected candidates and evaluation for each candidate water sample.

MATERIALS AND METHODS

This study was carried out in southern Nigeria in 2014 to 2015 According to ‘‘Api Recommended Practice In Testing Of Heavy Brines’’ The density of brine is determined by its salt type and concentration. Moreover, the brine density decreases as the temperature increases. The amount of decrease depends on the brine composition.

Conversely, the brine density increases as the pressure on the brine increases. Therefore, the brine density at ambient atmospheric conditions is not a reliable indicator of brine density downhole because the brine density changes with temperature, hydrostatic pressure and applied pressure.

Set of glass hydrometers, that cover the density or specific gravity range encountered in brine applications with graduations not great than 0.002 in density units expressed in grams per cubic centimeter (or grams per milliliter) or in specific gravity units (dimensionless).

Specific gravity hydrometers (relative density) - The depth to which the hydrometer sinks in a fluid is determined by the density of the fluid and temperature (Archimedes' Law), and therefore, the brine temperature should be recorded to apply temperature correction if required.

NTU meter, available from a number of manufacturers. The manufacturer's recommendations for use and maintenance were followed.

Water samples were collected from water boreholes and sea/rivers within the following states in Southern Nigeria.

1. Aguleri -Anambra state
2. AyetoroUgbonla- IlajeOndo state
3. Okolobiri and Yenegoa – Bayelsa state
4. Warri and Kwale- Delta state
5. Ologbo – Edo state
6. Eket -AkwaIbom
7. Etche and Iriebe- Rivers state
8. Owaza- Ukwa west Abia State
9. Izombe – Oguta Imo state

Specific gravity (relative density) hydrometer

Specific gravity (relative density) hydrometers are widely used, for which the sample-reference temperature and the reference material reference temperature are typically 15.56°C (60 °F). Specific gravity hydrometers are similar to density hydrometers and have a graduated stem with dimensionless graduations in specific gravity units not greater than 0.002. At the same time, brine temperature should be recorded to apply temperature correction and/or conversion factors if needed.

Since the hydrometer is constructed of glass, a correction factor due to the thermal volumetric expansion (or contraction) of glass is applied first to the measurement whenever the measurement is made at a temperature different from the sample reference temperature.

The measurement is the specific gravity (relative density) of a brine at the measurement temperature relative to the density of the reference material at its reference temperature. Then, the density of a brine at the measured temperature is calculated by multiplying the specific gravity at the measured temperature by the density of the reference material at the reference material reference temperature. The density of the reference material for the most popular specific gravity hydrometer (60°F/60°F) used for oilfield brine measurements is 0.9990 g/ml (8.337 lb/gal).

When converting the measured specific gravity of brine into density ata temperature different from the measured temperature, a conversion factor shall be applied based on the thermal volume expansion (or contraction) of the specific brine composition.

The density of each brine sample was measured with hydrometer and recorded. The density of each water sample was taken and recorded before the brine formulation. Temperature in degrees Fahrenheit or Centigrade. Funnel viscosity of the brine. NTU's of the brine. True crystallization temperatures. Reported in degrees Fahrenheit. The brine solution was formed or prepared from each water sample with three different salt samples visa-visNaCl, KCl, CaCl. These additives were added in the right proportion or according to the recipes which includes

Corrosion Inhibitor (sodium silicate)

Corrosion is the damaging of a metallic object by chemical or electrochemical reaction within its surroundings.

The electrochemical cell is made up of the metallic hardware and the brine that acts as electrolyte. Any metal surface is a composite of electrodes electrically connected through the body of the metal itself. Where brines are used, dissolved gases such as oxygen, carbon dioxide and hydrogen sulfide are the primary causes of most corrosion problems. The following electrochemical reactions are of considerable importance and concern.

$Fe + H_2S \rightarrow FeS\downarrow + H_2\uparrow$ Sour corrosion
$Fe + H_2O + CO_2 \rightarrow FeCO_3\downarrow + H_2\uparrow$ Sweet corrosion
$4Fe + 3O_2 \rightarrow 2Fe_2O_3\downarrow$ Oxygen corrosion

Biocides (hypochlorite)

Microbiologically Induced Corrosion (MIC) may be treated with biocides that control bacteria (aerobic and anaerobic), fungi, algae, etc.

Microorganisms can produce biofilms that coat metal surfaces and anaerobic bacteria can reduce sulfate to hydrogen sulfide. This not only increases the corrosivity of the fluid, but also causes the formation of tubercles that accelerate corrosion through the formation of concentration cells.Bacteria also produce organic acids that initiate or accelerate corrosion on the metal surface beneath the colonies.Enzymes are produced that can increase the corrosion rate by direct participation in the electrochemical process

Oxygen scavenger (ascorbate)

Additives that mitigate or remove corrosive constituents from the fluid are available to treat for small amounts of dissolved oxygen, carbon dioxide or hydrogen sulfide.

These additives include sulfites, bisulfites, erythorbates, phosphates/alkyl phosphates, salts, amine compounds, etc. The compatibility of the materials and chemicals is important. For instance, sulfite- and bisulfite-oxygen scavengers should be limited to use in monovalent brines as they will precipitate in divalent brines. NOTE Careful formulation and dosing of treatment packages is essential for avoiding increased risk of corrosion. The density of each brine sample and additives was measured with hydrometer and recorded.

Filtration

Using vacuum, filter the volume of fluid in the graduated cylinder through the prepared filter paper, and then wash the graduated cylinder, filter, residue and filter funnel wall with three portions of distilled water, allowing complete drainage between washings. Remove all traces of water by continuing to apply vacuum to the glass filter.

The brines samples were filtered with Watson filter paper of 110mm and funnel. The NTU of brine sample was measured with turbidity meter and recorded after filtration. The NTU of each brine sample and additives was measured with turbidity and recorded after filtration. The TSS of each brine sample and additives was measured with turbidity and recorded after filtration. Photo spectrometer was used for measurement of TSS. Tables 3.1 to 3.5 shows the concentrations of the brines formed, the additives added and the specimen used in the lab studies.

Table 2 Calcium Chloride Brine: 11.6 ppg

Name of Product	Concentration	
	CaCl2 ppb	Water bbls
Calcium Chloride	195.99 ppb	0.839 bbls
Corrosion Inhibitor	0.55 gal/bbl	
Biocide (Glyceraldehyde)	0.05 gal/bbl	
Oxygen Scavenger	0.15 ppb	

Table 3 Potassium Chloride Brine: 9.7 ppg

Name of Product	Concentration	
	KCl ppb	Water bbls
Potassium Chloride	97.7 ppb	0.883 bbls
Corrosion Inhibitor	0.55 gal/bbl	
Biocide (Glyceraldehyde)	0.05 gal/bbl	
Oxygen Scavenger	0.15 ppb	

Table 4 Sodium chloride Brine: 10.0 ppg

Name of Product	Concentration	
	NaCl ppb	Water bbls
Sodium Chloride	109.3 ppb	0.887 bbls
Corrosion Inhibitor	0.55 gal/bbl	
Biocide (Glyceraldehyde)	0.05 gal/bbl	
Oxygen Scavenger	0.15 ppb	

Table 5 Brines and Additives Concentrations

Cacl	55.5g/100ml or 138.7g/250ml
Corrosion Inhibitor(Sodium silicate, morpholine or hydrazine)	0.055l/100ml*3=165ml
Biocide (Glyceraldehyde) hypochlorite solutions	2ml/100ml*3=6ml =10ml
Oxygen Scavenger(ascorbate)	0.042g/100ml
KCl	27.65g/100ml
NaCl	30.85g/100ml

RESULTS AND DISCUSSION

Presentation Of Experimental Data

The experiments were conducted for the evaluation of completion fluids using the samples of water got from the seventeen sites across the Southern Nigeria. The completion fluids were formed from the addition of salts and some other additives as shown in the chapter three to the water samples.

Table 6 NTU and TSS of Samples of Mixture of Brine and Additives

Base Water	Salt samples	Base water Turbidity (NTU)	Brine Turbidity (NTU)	Brine Total Suspended solids(TSS)Mg/l	Base water Total Suspended solids (TSS)Mg/l
A) OWAZA Man power		0.30			0
	CaCl2		12.07	40	
	NaCl		4.72	228	
	KCl		4.89	58	
B) Yenegoa water		147			160
	CaCl2		5.24	5	
	NaCl		21.13	49	
	KCl		4.87	1568	
C)NDUTH Okolobiri		40.29			174
	CaCl2		0.58	42	
	NaCl		1.18	20	
	KCl		8.59	39	
D) Kwale		0.00			0.27
	CaCl2		6.15	52	
	NaCl		4.68	42	
	KCl		6.90	143	
E) Ibewa Sea		0.00			0
	CaCl2		5.27	66	
	NaCl		11.10	700	
	KCl		5.08	12	
F) Aguleri 1		11.85			87
	CaCl2		11.57	71	
	NaCl		84	127	
	KCl		2.83	90	
G) Etche water		0.00			0.09
	CaCl2		8.38	25	
	NaCl		7.88	49	
	KCl		39.47	189	
H)Ologbo water		0.00			0.9
	CaCl2		9.33	38	
	NaCl		4.46	9	
	KCl		0.00	12	
I)UgbonlaIlaje		1.47			0.54
	CaCl2		1.67	6	
	NaCl		11.32	33	
	KCl		7.51	33	
J) Obagi sea		0.00			0.81
	CaCl2		4.22	69	
	NaCl		11.13	2600	
	KCl		0.16	22	
K) Izombe		0.33			0.63
	CaCl2		9.88	455	
	NaCl		3.37	38	
	KCl		30.84	97	
L) EKET					0.9
	CaCl2		1.85	89	
	NaCl		2.74	58	
	KCl		0.77	83	
M) Iriebe		0.00			0.45
	CaCl2		2.88	37	
	NaCl		4.14	41	
	KCl		22.69	243	
N)Owaza borehole		0.03			0.45
	CaCl2		2.78	51	
	NaCl		3.84	81	
	KCl		12.27	100	
O)Ayetoro River		3.4			0.9
	CaCl2		11.37	446	
	NaCl		8.86	79	
	KCl		12.05	31	
P)Warri		0.1			0.45
	CaCl2		1.24	4	
	NaCl		20.30	157	
	KCl		57.00	1436	
Q)Aguleri 2		9.06			0.81
	CaCl2		21.31	181	
	NaCl		0.89	20	
	KCl		3.27	400	

The turbidity (NTU), total suspended solids (TSS) and densities of the base water, brines and samples of mixture of brine and the additives were determined for the whole samples. The data got from these experiments are presented in Tables 2 to 5 as shown.

Table 7 NTU and TSS of Brine Samples

Base Water	Salt samples	Brine Turbidity (NTU)	Brine Total Suspended solids (TSS)Mg/l
A) OWAZA Man power			
	CaCl2	0	10
	NaCl	3	16
	KCl	2	16
B) Yenegoa water			
	CaCl2	2	0
	NaCl	3	18
	KCl	7	7
C)NDUTH Okolobiri			
	CaCl2	4	15
	NaCl	0	2
	KCl	2	13
D) Kwale			
	CaCl2	9	19
	NaCl	3	14
	KCl	4	17
E) Ibewa Sea			
	CaCl2	0	13
	NaCl	0	12
	KCl	0	16
F) Aguleri 1			
	CaCl2	2	6
	NaCl	5	5
	KCl	9	17
G) Etche water			
	CaCl2	0	6
	NaCl	6	20
	KCl	5	14
H)Ologbo water			
	CaCl2	0	13
	NaCl	9	16
	KCl	4	4
I)UgbonlaIlaje			
	CaCl2	2	17
	NaCl	6	5
	KCl	6	12
J) Obagi sea			
	CaCl2	0	4
	NaCl	0	11
	KCl	0	13
K) Izombe			
	CaCl2	4	14
	NaCl	0	20
	KCl	0	14
L) EKET			
	CaCl2	5	4
	NaCl	3	9
	KCl	1	9
M) Iriebe			
	CaCl2	7	8
	NaCl	2	17
	KCl	8	9
N)Owaza borehole			
	CaCl2	3	7
	NaCl	4	11
	KCl	1	9
O)Ayetoro River			
	CaCl2	9	18
	NaCl	6	10
	KCl	9	7
P)Warri			
	CaCl2	0	9
	NaCl	36.44	16
	KCl	0	9
Q)Aguleri 2			
	CaCl2	7	4
	NaCl	2	7
	KCl	5	18

Table 6 shows the salt sample concentrations and densities of brines and samples of the mixture of brine and the additives. The NTU and TSS of the mixtures of brines and additives are as shown in Table 6, while Table 7 represent the NTU and TSS of the brines.

Note that the densities were not converted to pounds (lb) but 8.33ppg *specific gravity was considered Also the pressure gradient of 0.433psi/ft was considered.

Regression Analyses

The data shown in Tables 6 were used to perform regression analyses of the parameters got determined in the experiments for the base water, brines and mixtures of brines and additives. These analyses were performed to determine the dependence of some parameters on the others. These analyses were conducted using Microsoft Excel Tool. (visual basic).

Regression of Base Water NTU with Base Water TSS

The base water NTU and TSS data extracted from Table 6 was used to develop a correlation that can be used to estimate the NTU of water given its TSS. The plot of NTU of base water against the TSS of base water is as shown in Fig 1.

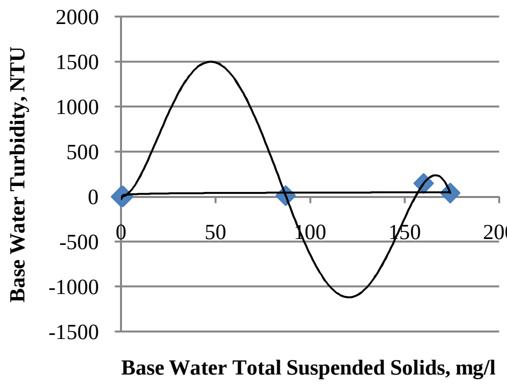

Figure 1 Plot of NTU of Base Water against TSS of Base Water

The correlation developed for determination of NTU of base water with its TSS is given in Equation 4.1 as shown:

$$NTU = -1E\text{-}06TSS^5 - 0.068TSS^3 + 2.877TSS^2 + 0.133TSS - 0.052 \quad \ldots\ldots(4.1)$$

The regression coefficient of the correlation expressed in Equation 4.1 is gotten as $R^2 = 0.996$

This regression coefficient of 0.996 which is very close to 1 shows that the correlation is very accurate for the determination of NTU of base water with its TSS.

However, it shows that the base water NTU and TSS are less than that of brine and additives.

Regression of Brine NTU with Brine TSS

The brine NTU and TSS data extracted from Table 7 was used to develop a correlation that can be used to estimate the NTU of brine given its TSS. The plot of NTU of brine against the TSS of brine is as shown in Fig 2.

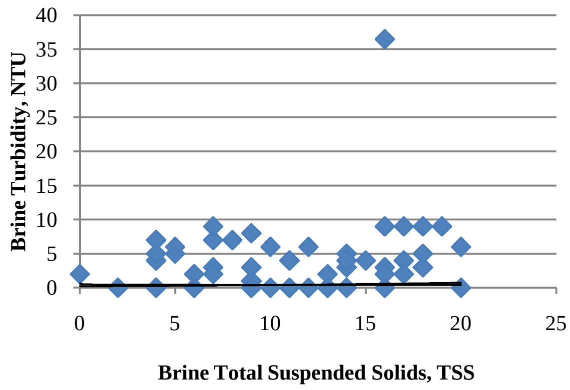

Figure 2 Plot of NTU of Brine against TSS of Brine

The correlation developed for determination of NTU of brine with its TSS is given in Equation 4.2 as shown:

$$NTU = 0.209e^{0.062TSS} \quad \text{……..(4.2)}$$

The regression coefficient of the correlation expressed in Equation 4.2 is gotten as $R^2 = 0.765$

This regression coefficient of 0.765 which is not close to 1 shows that the correlation is not very accurate for the determination of NTU of brine with its TSS.

Regression of Mixture of Brine and Additive NTU with TSS

The brine and additive mixture NTU and TSS data extracted from Table 4.2 was used to develop a correlation that can be used to estimate the NTU of brine and additive mixture given its TSS. The plot of NTU of brine and additive mixture against the TSS is as shown in Fig 3.

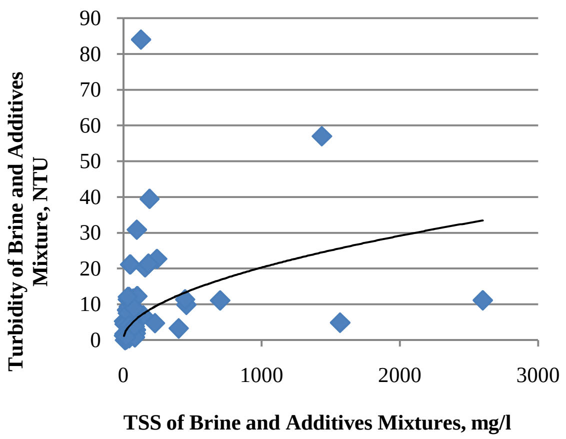

Figure 3 Plot of NTU of Brine and Additives Mixture against the TSS

The correlation developed for determination of NTU of brine and additives mixture with its TSS is given in Equation 4.3 as shown:

$$NTU = 0.538TSS^{0.524} \quad \text{….(4.3)}$$

The regression coefficient of the correlation expressed in Equation 4.3 is gotten as $R^2 = 0.186$ ……(4.4)

This regression coefficient of 0.186 which is not close to 1 shows that the correlation is not very accurate for the determination of NTU of brine and additives mixtures with its TSS.

Software Development

After the regression analyses were performed to develop equations 4.1 to 4.4, a software was written with the use of Microsoft Visual Basic Program for the determination of the parameters. This software was used to estimate values of NTU at given TSS for the base water, brine and mixture of brine and additives and also to estimate density of brine and additives mixture at given density of additive-free brine as shown in Figs 4 to 6

Determination of NTU of Base Water at given TSS using the Software

At TSS of 4.5, the NTU was determined as shown in Fig 4.

Figure 4 Software Determination of NTU of Base Water at given TSS

Determination of NTU of Brine at given TSS using the Software

At TSS of 6.2, the NTU was determined as shown in Fig 5.

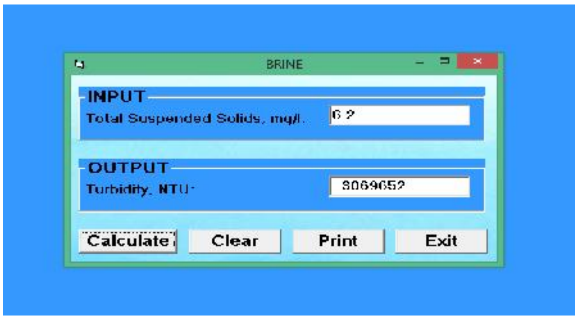

Figure 5 Software Determination of NTU of Brine at given TSS

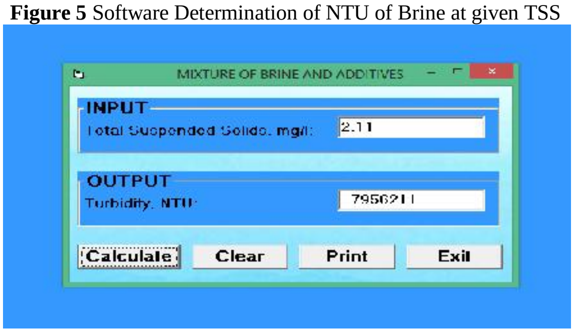

Figure 6 Software Determination of NTU of Brine and Additive Mixture at given TSS

Determination of NTU of Brine and Additive Mixture at given TSS using the Software

At TSS of 2.11, the NTU was determined as shown in Fig 6.

CONCLUSIONS

After a careful empirical and analysis of this study, any other reader would have observed the following conclusions

- The TSS and NTU of various locations in the Southern Nigeria have been determined as shown in the experiments. Therefore, service companies can use the data provided in the text to carry out completion operation more efficiently in any operation area.
- The usual time wasted on the completions operation will be reduced with the model developed in this study.
- The water samples influenced the NTU and TSS of the brine before filtrations.
- The software model developed can be used to determine the corresponding values of each variable.
- A linear model showed strong positive correlation between density of brine and additives mixture (R^2= 0. 781)
- This model can be applied for the prediction of NTU AND TSS in real time.

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