

e-ISSN : 2320-0847  
p-ISSN : 2320-0936



# American Journal of Engineering Research (AJER)

Volume 4 Issue 3 – March 2015

[www.ajer.org](http://www.ajer.org)

[ajer.research@gmail.com](mailto:ajer.research@gmail.com)

## Editorial Board

### American Journal of Engineering Research (AJER)

#### **Dr. Moinuddin Sarker,**

Qualification :PhD, MCIC, FICER,  
MInstP, MRSC (P), VP of R & D  
Affiliation : Head of Science / Technology  
Team, Corporate Officer (CO)  
Natural State Research, Inc.  
37 Brown House Road (2nd Floor)  
Stamford, CT-06902, USA.

#### **Dr. June II A. Kiblasan**

Qualification : Phd  
Specialization: Management, applied  
sciences  
Country: PHILIPPINES

#### **Dr. Jonathan Okeke Chimakonam**

Qualification: PHD  
Affiliation: University of Calabar  
Specialization: Logic, Philosophy of  
Maths and African Science,  
Country: Nigeria

#### **Dr. Narendra Kumar Sharma**

Qualification: PHD  
Affiliation: Defence Institute of Physiology  
and Allied Science, DRDO  
Specialization: Proteomics, Molecular  
biology, hypoxia  
Country: India

#### **Dr. ABDUL KAREEM**

Qualification: MBBS, DMRD, FCIP, FAGE  
Affiliation: UNIVERSITI SAINS Malaysia  
Country: Malaysia

#### **Prof. Dr. Shafique Ahmed Arain**

Qualification: Postdoc fellow, Phd  
Affiliation: Shah Abdul Latif University  
Khairpur (Mirs),  
Specialization: Polymer science  
Country: Pakistan

#### **Dr. sukhmander singh**

Qualification: Phd  
Affiliation: Indian Institute Of  
Technology, Delhi  
Specialization : PLASMA PHYSICS  
Country: India

#### **Dr. Alcides Chaux**

Qualification: MD  
Affiliation: Norte University, Paraguay,  
South America  
Specialization: Genitourinary Tumors  
Country: Paraguay, South America

#### **Dr. Nwachukwu Eugene Nnamdi**

Qualification: Phd  
Affiliation: Michael Okpara University of  
Agriculture, Umudike, Nigeria  
Specialization: Animal Genetics and  
Breeding  
Country: Nigeria

#### **Dr. Md. Nazrul Islam Mondal**

Qualification: Phd  
Affiliation: Rajshahi University,  
Bangladesh  
Specialization: Health and Epidemiology  
Country: Bangladesh

**CONTENTS**

**Volume-4 Issue-3**

<b>S.No.</b>	<b>Manuscript Title</b>	<b>Page No.</b>
<b>01.</b>	Evaluation of Formation Damage and Assessment of Well Productivity of Oredo Field, Edo State, Nigeria Omotara O. Oluwagbenga    Jeffrey O. Oseh    Ifeanyi A. Oguamah    Oluwaseun S. Ogungbemi    Abel A. Adeyi.	01-10
<b>02.</b>	Predicting Churners in Telecommunication Using Variants of Support Vector Machine Sindhu M E    Vijaya M S	11-18
<b>03.</b>	Appraisal of Construction Project Procurement Policies in Nigeria Bima Abubakar Muhammad    Tafida Adamu    Baba Dorothy Ladi	19-24
<b>04.</b>	Assessment of Cost Impact in Health and Safety on Construction Projects Bima Abubakar Muhammad    Ismaila Abdulateef    Baba Dorothy Ladi	25-30
<b>05.</b>	Design Method of Reinforced Concrete Shear Wall Using EBCS Dr. Suresh Borra    P.M.B.RajKiran Nanduri    Sk. Naga Raju	31-43
<b>06.</b>	Synthesis and Anticorrosion for Carbon Steel Of 4-Amino-3,5 Bis (4-Hydroxy-3-Methoxy )-1,2,4-Triazole in Hydrochloric Acid Solution H. El Attari    A. El Bribri    L. Mhaidra    F. Bentiss    M. Siniti	44-51
<b>07.</b>	Recuperation of data node: An alternative way to ensure the data recovery in Hadoop architecture. P.Sai Kiran	52-54
<b>08.</b>	Comparison of Different Classification Techniques Using WEKA for Hematological Data Md. Nurul Amin   Md. Ahsan Habib	55-61
<b>09.</b>	Field Study of Drilling Bits Performance Optimization Using a Computer Model Oriji, A. Boniface   Zakka Bala   Akintola Sarah. A	62-69
<b>10.</b>	Influence Of Thermal Radiation On Magnetohydrodynamic (Mhd) Boundary Layer Flow Of A Viscous Fluid Over An Exponentially Stretching Sheet A.S. Idowu    S. Usman	70-80
<b>11.</b>	Should Public Buildings Be Exclusive? A Study of Selected Institutional Buildings in Minna, Niger State Oyetola, S.A   Adedayo, O.F   Anunobi, A.I   Adebisi, G.O   Eri, P.O	81-87

<b>12.</b>	Analyzing and studying the role of Zabol city in regional development Gholam Ali Khammar   Alireza Miri Bonjar	88-94
<b>13.</b>	Evaluation and analysis of the role of urban planners and managers in sustainable urban development (Case study: The cities in Sistan region) Ahmad Mollashahi Zare   Hussein Bandani	95-103
<b>14.</b>	Instantaneous GSM Signal Strength Variation with Weather and Environmental Factors Abraham U. Usman   Okpo U. Okereke   Elijah E. Omizegba	104-115
<b>15.</b>	Impact of urban population on the environment of the city of Brazzaville Nzoussi Hilaire Kevin    Prof. Li Jiang Feng	116-125
<b>16.</b>	Measuring radioactivity level in various types of rice using NaI (TI) detector Laith A. Najam   Nada F. Tawfiq   Fouzey H. Kitha	126-132
<b>17.</b>	Design of a Chlorinator in a Water Treatment plant for Small Village Community in Borno State, Nigeria H. A. Abdulkareem    M A Abdullahi    S O Aliu	133-135
<b>18.</b>	Crystal structure and electrical characterization of mixed lithium ferrite ceramics. Suresh. S. Darokar	136-138
<b>19.</b>	Effect of different molarities of Sodium Hydroxide solution on the Strength of Geopolymer concrete Shivaji S. Bidwe    Ajay A. Hamane	139-145
<b>20.</b>	5083 type Al-Mg and 6082 type Al-Mg-Si alloys for ship building Burcu Ertuğ    Levent Cenk Kumruoğlu	146-150
<b>21.</b>	Inhibitive Effect of Hydrofluoric Acid Doped Poly Aniline (HF-PANI) on Corrosion of Iron in 1N Phosphoric Acid Solution. G.Maheswari    P.Madhu    M.Sivaraju	151-160

## Field Study of Drilling Bits Performance Optimization Using a Computer Model.

Oriji, A. Boniface<sup>1</sup>, Zakka Bala<sup>2</sup> & Akintola Sarah. A<sup>3</sup>

<sup>1</sup>Department of Petroleum Engineering University of Port-Harcourt Nigeria

<sup>2,3</sup>Department of Petroleum Engineering University of Ibadan Nigeria

**ABSTRACT:** One of the major problems facing drilling operations is the performance of the drilling Bits. The ability of the Bit to crush the rock and the removal of the crushed rock from the wellbore effectively. It is necessary to understand the fundamental difference in Bit design for different rock textures because many variables tend to affect Bit optimization, particularly the type of formations, economics and Bit selection. However, the cost of drilling a well has a considerable effect on the selection and the design of a particular Bit, therefore this paper focuses on the development of a model that will predict future Bit performance and optimization for actual well design and construction. The variables to optimize Bit performance provide means of handling cost estimation hence the model becomes more realistic and dynamic in its application. The input variables and control factors for this model are stretched to minimize cost and maximize performance. The cost per foot and the break even calculations were done using data from the reference well X14 and also the evaluation well X35 from a field-X in the Niger Delta region. A Visual Basic dot Net program model was developed, tested and validated with the real field data to know its accuracy. The model interface shows the detailed application of the Bits in validating the data to provide the equivalent results for the five different Bits. Each set of the Bit record was ran separately on the software and the results for each application developed for comparison. In the software, data application were grouped into two distinct methods namely; rentals method and historical method. Under the rentals method, data were uploaded into the software and ran to generate results while the historical method was basically used for model prediction. The breakeven analysis provided a technique for calculating the performance required for an alternative Bit type to match the cost per foot of the current Bit. Based on the model results, Hughes Tungsten Carbide (HTC) Bit and Security Bit (SEC) used to drill well X14 and X35 were well optimized and should be encouraged in drilling wells within the area.

### I. INTRODUCTION

The increasing demand for fossil fuel has intensified the search for hydrocarbon reservoirs. The world has to move on the daily energy derived from processing of the content of the reservoir. This search has led to high cost of drilling oil and gas wells. The drilling Bit performance optimization depends on the type of formation, drilling fluids, pore pressure and engineering variables but with a direct relationship with the drilling cost per footage. The drilling industry has seen tremendous improvements in drill Bit development and manufacturing and technological advancement is being made by Bit manufacturers in order to meet the continuously changing and more demanding needs of the operators. However, the evaluation of drilling Bit performance plays an important role in the oil and gas drilling operation.

### II. CASE STUDY DEVELOPMENT OF FIELD -X

A case study of the Bits was from the offset well X14 in field- X used to evaluate well X35 that was subsequently drilled. The offset well X14 and the evaluation well X35 were drilled 5 kilometers apart both with formation intervals of interest as basically alternating shale and sharp sand, sandstone and silt stone. The field-X Bit records are as shown in tables (1-5), which were ran on trials in the different intervals to see their performances. The cost per foot calculation were used to analyze the performance of the Bits for the wells while the breakeven method were used to analyze the Bits on trial in order to know the performance of each of

the Bit. In analyzing the Bits used to drill well X14. Four SEC Bits drilled from 6214-7789 ft for a footage of 1895ft in 65 hours with an average cost per foot drilled of \$ 49.43/ft. Three HTC Bits drilled well X14 from 3124ft to 5167ft for a footage of 3094ft in 48 hours with an average cost per foot of \$19.09/ft. The REED Bit made a footage of 99ft in 19 hours with an average cost per foot of \$42.32/ft. The SEC Bit drilled well X35 from 8607- 10057ft for a footage of 2050ft in 41 hours with an average cost per foot of \$32.98/ft. While the HTC Bit drilled well X35 from 5031-8007ft for a footage of 3716ft in 48 hours with an average cost per foot \$17.31/ft. From the analysis, the SEC Bit and the HTC Bit in well X35 drilled more footage with less time in the well than that of the HTC Bit and SEC bit in well X14.

**Table 1: SEC. Bits Record for the Interval in Well X14.**

BIT NO	TYPES/ MAKE	BIT COST (\$)	FOOTAGE DRILLED (FT)	ROTATION TIME (HOUR)	FOOT /HOUR (FT)	TRIP TIME (HOUR)	BIT SIZE (INCHES)
7	SEC	3560	335	12	27.9	6.2	12 ¼
8	SEC	3560	670	21	31.9	6.8	12 ¼
9.	SEC	3560	428	16.5	28.0	7.3	12 ¼
10.	SEC	3560	428	15.5	27.6	7.7	12 ¼
<b>AVERAGE</b>		<b>3560</b>	<b>465.25</b>	<b>16.25</b>	<b>28.85</b>	<b>7</b>	<b>12 ¼</b>

**Table 2: HTC. Bits Records for the Interval in Well X14**

BIT NO	TYPES/ MAKE	BIT COST (\$)	FOOTAGE DRILLED (FT)	ROTATION TIME (HOUR)	FOOT /HOUR (FT)	TRIP TIME (HOUR)	BIT SIZE (INCHES)
3	HTC	2803	1051	18.5	56.8	3.1	12 ¼
4	HTC	2803	1438	11.5	125	4.5	12 ¼
5	HTC	2803	605	18	33.8	5.1	12 ¼
3	HTC	2803	1051	18.5	56.8	3.1	12 ¼
<b>AVERAGE</b>		<b>2803</b>	<b>1031.3</b>	<b>16</b>	<b>71.8</b>	<b>4.2</b>	

**Table 3: REED Bit Record for the Interval in Well 14**

BIT NO	TYPES/ MAKE	BIT COST (\$)	FOOTAGE DRILLED (FT)	ROTATION TIME (HOUR)	FOOT /HOUR (FT)	TRIP TIME (HOUR)	BIT SIZE (INCHES)
14	REED	16,900	996	19	52.4	11.2	12 ¼
<b>AVERAGE</b>		<b>16,900</b>	<b>996</b>	<b>19</b>	<b>52.4</b>	<b>11.2</b>	<b>12 ¼</b>

Table 4: SEC BITS Record for the Interval in Well X35

BIT NO	TYPES/MAKE	BIT COST (\$)	FOOTAGE DRILLED (FT)	ROTATION TIME (HOUR)	FOOT /HOUR (FT)	TRIP TIME (HOUR)	BIT SIZE (INCHES)
7	SEC	3560	600	18.75	32	8.6	12 ¼
8	SEC	3560	505	11.75	43	9.1	12 ¼
9.	SEC	3560	945	10.5	90	10.0	12 ¼
<b>AVERAGE</b>		<b>3560</b>	<b>683.3</b>	<b>13.5</b>	<b>55</b>	<b>9.2</b>	

Table .5: HTC BITS Record for the Interval in Well X35.

BIT NO	TYPES/MAKE	BIT COST (\$)	FOOTAGE DRILLED (FT)	ROTATION TIME (HOUR)	FOOT /HOUR (FT)	TRIP TIME (HOUR)	BIT SIZE (INCHES)
4	HTC	2803	740	10	74	5.0	12 ¼
5	HTC	2803	956	9.75	98	5.9	12 ¼
6	HTC	2803	2020	28.25	52.8	8.0	12 ¼
<b>AVERAGE</b>		<b>2803</b>	<b>1238.6</b>	<b>16</b>	<b>74.93</b>	<b>6.3</b>	

## DISCUSSION

Predicting the behaviour of drill Bits in an unfamiliar environment is done using the drilling data acquired from the vicinity but if already known conditions and terms remain the same, then predicting well cost becomes very easy. However, it is customary to always use certain level of safety factors to account for downtime losses due to tool failures and other unforeseen hole problems rather than solely rely on the data obtained from the previous well.

### Well 14: (BIT TYPE SEC and HTC)

In table 8, Bit number 7 has the highest overall cost value of 27,136.24US Dollar while Bit number 8 has the least overall cost of 18,961.69US Dollar. Therefore, if all other factors are kept constant, Bit number 8 being the Bit with the lowest cost value may be recommended for this operation. From table 7, Bit number 5 has the highest overall cost value of 36,494.52US Dollar while Bit number 4 has the least overall cost of 11,607.23 US Dollar.

### Well 35: (BIT TYPE SEC and HTC)

In table 9, Bit number 9 has the highest overall cost value of 77,772.12US Dollar while Bit number 7 has the least overall cost of 13,015. 21US Dollar. Table.10 , Bit number 4 has the highest overall cost value of 41,632.69US Dollar while Bit number 5 has the least overall cost of 31,863.71US Dollar.

Generally from the results and the cost per foot analysis, a total saving of 114,622.12US Dollar was experienced in well X35 when compared with well X14 Bit records. The X14 Bit records showed a total of 14 Bits, in 220.25 hours while the X35 well Bit records showed a total of 9 Bits with a drilling time of 160.25 hours. Thus this is a cost and time saving for the evaluation well X35. Hence it can be deduced that Bit performance evaluation and optimization enhanced the minimum cost of the well and also lots of time saving.

## SOFTWARE DESIGN AND RESULTS

TABLE 6: Bit Input Data and optimization Results X14 (BIT TYPE SEC)

Formation Depth (ft) 465.25    Rig Cost (\$ / hr) 836    Trip Time (hr) 7    Choose Number of Bits to be analyzed 4    Database Length 4

DRILLING BITS RECORDS				
Bit Number	Bit Cost (\$)	Rotating Time (hr)	Connection Time (hrs)	Mean Penetration Rate (ft/hr)
7	3560	12	0.1	27.9
8	3560	21	0.4	31.9
9	3560	16.5	0.5	28
10	3560	15.5	0.3	27.6

BIT OPTIMIZATION RESULT

RESULT SUMMARY    Save As--- Pdf format\*.pd    Save    Print

Bit Number	Drill Cost Per Foot(\$)	Overall Drill Cost(\$)
7 =	58.326165	27136.24826625
8 =	40.755934	18961.6982935
9 =	51.134199	23790.18608475
10 =	52.877045	24601.04518625

TABLE 7: Bit Input Data and optimization Results X14 (BIT TYPE HTCC)

Formation Depth (ft) 1031.3    Rig Cost (\$ / hr) 836    Trip Time (hr) 4.2    Choose Number of Bits to be analyzed 4    Database Length 4

DRILLING BITS RECORDS				
Bit Number	Bit Cost (\$)	Rotating Time (hr)	Connection Time (hrs)	Mean Penetration Rate (ft/hr)
3	2803	18.5	0.5	56.8
4	2803	11.5	0.3	125
5	2803	18	0.2	33.8
3	2803	18.5	0.8	56.8



Bit Number	Drill Cost Per Foot(\$)	Overall Drill Cost(\$)
3 =	21.125048	21786.2620024
4 =	11.254957	11607.2371541
5 =	35.386917	36494.5275021
3 =	21.363723	22032.4075299

TABLE 8: Bit Input Data and optimization Results X14B (BIT TYPE HTC)

Formation Depth (ft): 996      Rig Cost (\$ / hr): 836      Trip Time (hr): 11.2

Choose Number of Bits to be analyzed: 2      Database Length: 1

### DRILLING BITS RECORDS

Bit Number	Bit Cost (\$)	Rotating Time (hr)	Connection Time (hrs)	Mean Penetration Rate (ft/hr)
3	2803	18.5	0.5	56.8
4	2803	11.5	0.3	125
5	2803	18	0.2	33.8
3	2803	18.5	0.8	56.8

Bit Number	Drill Cost Per Foot(\$)	Overall Drill Cost(\$)
3 =	26.694138	26587.361448
4 =	15.325913	15264.609348
5 =	45.005588	44825.565648
3 =	26.932813	26825.081748

TABLE 9: Bit Input Data and optimization Results X35 (BIT TYPE SEC)

Formation Depth (ft): 683.3    Rig Cost (\$ / hr): 836    Trip Time (hr): 113.5    Choose Number of Bits to be analyzed: 3    Database Length: 3

### DRILLING BITS RECORDS

Bit Number	Bit Cost (\$)	Rotating Time (hr)	Connection Time (hrs)	Mean Penetration Rate (ft/hr)
7	3560	18.75	0.2	32
8	3560	11.75	0.2	43
9	3560	10.5	0.4	90

**BIT OPTIMIZATION RESULT**

RESULT SUMMARY    Save As... Pdf format\*.pd    Save    Print

Bit Number	Drill Cost Per Foot(\$)	Overall Drill Cost(\$)
7 =	190.480333	130155.2115389
8 =	214.618902	146649.0957366
9 =	113.818413	77772.1216029

TABLE 10: Bit Input Data and optimization Results X35 (BIT TYPE HTC)

Formation Depth (ft): 1238.6    Rig Cost (\$ / hr): 836    Trip Time (hr): 16    Choose Number of Bits to be analyzed: 3    Database Length: 3

### DRILLING BITS RECORDS

Bit Number	Bit Cost (\$)	Rotating Time (hr)	Connection Time (hrs)	Mean Penetration Rate (ft/hr)
4	2803	10	0.4	74
5	2803	9.75	0.3	98
6	2803	28.25	0.5	52.8

Bit Number	Drill Cost Per Foot(\$)	Overall Drill Cost(\$)
4 =	33.612703	41632.6939358
5 =	25.725589	31863.7145354
6 =	26.960311	33393.0412046

**REFERENCES**

- [1]. Carl Gatlin (1960) : Petroleum Engineering (Drilling and Well Completion) Prentice Hall Inc: page 149-150.
- [2]. Chevalier, J.F, Quetier and Marshall(1986). :‘Technical Drilling Data Acquisition and Processing United Integration Computer System’. SPE JPT (April) page 4-7
- [3]. Mayeri-Gurr Alfred(1975). :Petroleum Engineering: Published by Pittmon .Page 152 – 215.
- [4]. Preston, L. Moore(1974) : Drilling Practice Manual “Petroleum Publishing Company, Tulsa (January) Page 140-150
- [5]. Rotary Drilling Manual(1960) : “The Bit” University of Texas, First Edition page 1-38.
- [6]. University of Texas : “Lesson in Rotary Drilling-“The Bit” lesson II Petroleum Extension Service.
- [7]. Young, F.S. (1969). Computerized Drilling Control SPT (April) pages 483.

**APPENDIX**

**TABLE 11: The Input And Output Variable Of The Sensitivity Analysis Of Well X14 Bit Type Reed**

	Bit Cost	Rig Cost	Rotation time	Trip Time	Depth
Distribution	Uniform	Uniform	Uniform	Uniform	Uniform
Min	16900	836	19	7	465.25
Max	16900	836	19	7	465.25
Name	16900	836	19	7	465.25
OUTPUT		VARIABLES			
Cost Per Foot	83.04352499				
<b>Overall Cost</b>	38636				

**TABLE 12: The Input And Output Variable Of The Sensitivity Analysis Of Well 35 Bit Type Sec**

	INPUT VARIABLES				
	Bit Cost	Rig Cost	Rotation time	Trip Time	Depth
Distribution	Normal	Uniform	Normal	Uniform	Uniform
Mean/Min	3560	836	13.66667	13.5	683.3
STD/Max	0	836	4.446441	13.5	683.3
Name	3560	836	13.66667	13.5	683.3
OUTPUT		VARIABLES			
Cost Per Foot	38.44772916				
<b>Overall Cost</b>	26271.33333				

TABLE 13: The Input And Output Variable Of The Sensitivity Analysis Of Well 35 Bit Type Htc

	INPUT VARIABLES				
	Bit Cost	Rig Cost	Rotation time	Trip Time	Depth
Distribution	Normal	Uniform	Normal	Uniform	Uniform
Mean/Min	2803	836	28.25	6.3	1017.55
STD/Max	0	836	10.60955	6.3	1017.55
Name	2803	836	28.25	6.3	1017.55
	OUTPUT VARIABLES				
Cost Per Foot	31.14028795				
Overall Cost	31686.8				

TABLE 14: The Input And Output Variable Of The Sensitivity Analysis Of Well 14 Bit Type Sec

	INPUT VARIABLES				
	Bit Cost	Rig Cost	Rotation time	Trip Time	Depth
Distribution	Normal	Uniform	Normal	Uniform	Uniform
Mean/Min	3560	836	16.25	16.25	465.25
STD/Max	0	836	3.708099244	16.25	465.25
Name	3560	836	16.25	16.25	465.25
	OUTPUT VARIABLES				
Cost Per Foot	66.05051048				
Overall Cost	30730				

TABLE 15: The Input And Output Variable Of The Sensitivity Analysis Of Well 14 Bit Type Htc

	INPUT VARIABLES				
	Bit Cost	Rig Cost	Rotation time	Trip Time	Depth
Distribution	Normal	Uniform	Normal	Uniform	Uniform
Mean/Min	2803	836	16.625	16	1031.1
STD/Max	0	836	3.424787	16	1031.1
Name	2803	836	16.625	16	1031.1
	OUTPUT VARIABLES				
Cost Per Foot	29.17030356				
Overall Cost	30077.5				