Journal of Advanced Science and Engineering Research Vol 2, No 4 December (2012) 323-329

Drilling Optimization Using Software Algorizms and Mathmatical model Simulating Block 8 – Dindir – Sudan Drilling Operation

Article Info

Received: 24/3/2012
Accepted:2/9/ 2012
Published online: 1/12/2012

[1, 2]Ahmed Abdelaziz Ibrahim,[1]Tagwa Ahmed Musa, [1]Fatima Ahmed Eltigani Mohamed, [1]Areej Eltaj Eltieb Ginheer

[1]Sudan U. of Science and Technology – Petroleum Engineering Department – Sudan
[2]Universiti Tecknologi PETRONAS – Petrolrum Engineering Department - Malaysia

ISSN 2231-8844

Abstract

The overall health of oil industry depend on reducing the cost of the drilling operation and enhance its performance. For attaining this, more experiences and awareness is needed. The target of this study is to optimize drilling operation and enhance its performance in one of the Sudanese field - Dindir area that suffer of very low rate of penetration by using three tools (land Mark Well Plan soft ware, Z. Aswad Model and Drilling Optimization Simulator soft ware). The study starts by collecting and evaluating the data for three explortion wells in dindir area. These data were introduced in to land mark well plan to achieve optimum hydraulics and flow properties then the output of land mark plus some parameters (like differential pressure, bit dullness, …) were applied in Z. Aswad drilling rate equation to achieve the optimum weight on bit and rotary speed. Pay zone simulator used to simulate actual drilling operation (history matching) then using the optimum parameters that was imported from Land mark and Z. Aswad model as a new scenario (optimum scenario). By Visualizing and comparing between the two field/modified scenarios the results showed the reduction in time/cost was in an average of 30%. That can be consider as the basic for drilling operations in this area

Key Word

Hydraulic Parameter Optimization Penteration Rate Simulation Performance

Introduction

Drilling is one of the most expensive project in oil exploration and development. When a drilling project is commenced, two goals are governing all aspects of it. The first is to realize the well in a safe manner (personal injuries-technical problems) and according to its purpose, the second one is to complete it with minimum cost (Harold et. Al., 1982 and Fatima, 2009). Appropriate or better planning of development drilling operations and by execution optimum techniques will increase safety on the drilling rigs and will save money that reduce the overall cost of drilling operations.

Drilling optimization system is the logical process of analyzing effects and interactions of drilling variables (such as weight on bit, rotary speed, drilling properties, bit type and size) through mathematical modeling in order to achieve optimum drilling performance, maximum drilling efficiency and the minimum ecnomical well cost. There are three tools used in this study land mark Well Plan soft ware, theoretical (Z. Aswad) model and pay zone simulator soft ware (Millheim, 1983; Cooper, 2006 and Fatima, 2009).

There are many wells drilled in Block 8-Blue Nile Basin (Dinder area) inwhich the reduction in drilling rate was the main problem facing the engineers specially in DindirII and DindirIII formations (Drilling Department, White Nile Petroleum Operation Company, 2005-2009). In this study data were collected from three well Hosan-1, Jauhara-1 and Tawakul-1, Fig. 1. Data were subjected to concentrated evaluation. Some of it introduced into land mark well plan (Land Mark@Development center, 1996); then the outputs plus optimum drilling fluid properties values (density, viscosity, ...) were used as basic inputs to Z. Aswad rate of penetration model. These Z. Aswad outputs plus the well logging information's defined to pay zone simulating (Cooper, 2006) the best drilling operation senario.

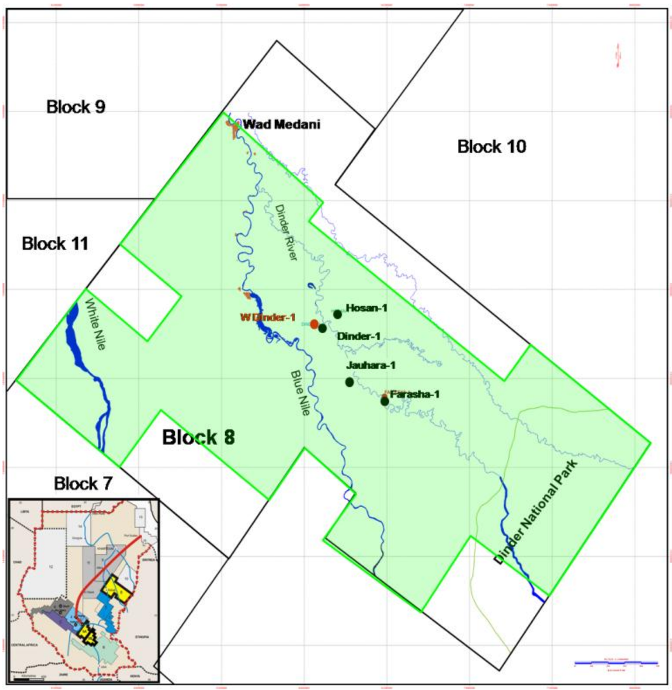

Figure (1): Well Location Map in Block 8 (Drilling and Geology Departments, White Nile Petroleum Operation Company, 2005-2009).

Hosan-1 well: Hosan-1 well is Vertical Onshore Exploration Oil Well; historically, the well drilling operation started normally to the depth 1735m, the 12¼in section logged, cased by 95/8in. Then by starting the 8½in section the penetration rate severly dropped facing hard formations (dinder III formation) from 1735m to 2911m (TD), (Drilling and Geology Departments, White Nile Petroleum Operation Company, 2005-2009).

Jauhara-1 well: Jauhara-1 well is Deviated Onshore Exploration Oil Well; Historacally, the well start normally to the measured depth (MD) 2042m, the 12¼in section logged, cased by 95/8in and cemented. Then by start drilling the 8½in section the penetration rate severly dropped facing hard formations (dinderIII formation) from 2042m MD to total depth 2978m MD (Drilling and Geology Departments, White Nile Petroleum Operation Company, 2005-2009).

Tawakul-1 well: Tawakul-1 well is Deviated Onshore Exploration Oil Well; Historacally, the well start normally to the depth 2009m MD, the 12¼in section logged, cased by 95/8in and cemented. Then by start drilling the 8½in section the penetration rate severly dropped for facing hard formations (dinderII and dindirIII formations) from 2011m MD to total depth 3430m MD (Drilling and Geology Departments, White Nile Petroleum Operation Company, 2005-2009).

Land Mark Application

The data of well bore, drill string, survey and fluid properties for Hosan-1, Jauhara-1, and Tawakul-1 wells were introduced to land mark format editors . The hydraulic optimization allows the user to inspect the effectbit hydraulic analysis of changing flow rate and the total flow area on a number of hydraulcs parameters required to achieve optimal bit horse power (HP), table (1).

Table (1): Bit Hydraulic Optimization

Well	Hosan-1	Jauhara-1	Tawakul-1
Optimum Flow Rate (gpm)	400 to 500	450 to 650	500 to 570
Optimum Total Flow Area(in^2)	0.45 to 0.7	0.33to 0.4	0.65 to 0.719

Z. Aswad Model Application

Z. Aswad drilling rate model used to analyze the drilling parameters (Weight on bit and rotary speed) for the three wells by applying and substitute the optimum values of fluid properties and the optimum hydraulics (land Mark outputs). For any well to Apply Z. Aswad Drilling rate model one bit has to be choosen, table (2). For different values of weight on bit, rotary speed many values of optimum drilling rate was obtained; table (3).

Table (2): Z. Aswad Model parameters:

Well	Hosan-1	Jauhara-1	Tawakul-1
Formation	DindirIII	DindirIII	DindirII
section depth(m)	1735-1780	2042-2347	2011-2361
Bit teeth dullness (D)	0.875	0.875	0.875
Drill ability factor (C_f)	0.068	0.072	0.045
Differential pressure (ΔP)psi	812	511	784
X (constant)	0.75	0.75	0.75
Z (constant)	0.85	0.85	0.85

C_2(constant) for hard formation	1.23	2.65	1.07
y (constant)	1.65	2.00	1.9

Table (3): Penetration rate at different Weight On Bit (WOB) and RPM (N).

WOB	N = 60			N = 80			N = 100			N = 120			N = 140			N = 160		
	H	**J**	**T**	**H**	**J**	**T**	**H**	**J**	**T**	**H**	**J**	**T**	**H**	**J**	**T**	**H**	**J**	**T**
10	**1.35**	**3.02**	**1.63**	**1.72**	**3.86**	**2.08**	**2.08**	**4.66**	**2.52**	**2.43**	**5.44**	**2.94**	**2.77**	**6.20**	**3.35**	**3.1**	**6.95**	**3.75**
20	**4.23**	**12.08**	**4.91**	**5.41**	**15.42**	**6.26**	**6.53**	**18.64**	**7.57**	**7.63**	**21.77**	**8.84**	**8.7**	**24.82**	**10.08**	**9.74**	**27.80**	**11.29**
30	**8.26**	**27.17**	**9.35**	**10.55**	**34.70**	**11.94**	**12.76**	**41.95**	**14.43**	**14.89**	**48.98**	**16.85**	**16.98**	**55.84**	**19.21**	**19.02**	**62.55**	**21.51**
40	**13.28**	**48.31**	**14.77**	**16.96**	**61.69**	**18.86**	**20.51**	**74.58**	**22.80**	**23.94**	**87.08**	**26.62**	**27.30**	**99.27**	**30.34**	**30.58**	**111.20**	**33.99**
50	**19.20**	**75.48**	**21.06**	**24.51**	**96.39**	**26.89**	**29.63**	**116.53**	**32.51**	**34.6**	**136.06**	**37.95**	**39.45**	**155.11**	**43.27**	**44.19**	**173.75**	**48.47**
60	**25.93**	**108.70**	**28.14**	**33.12**	**138.81**	**35.93**	**40.03**	**167.80**	**43.44**	**46.75**	**195.92**	**50.72**	**53.29**	**223.35**	**57.82**	**59.69**	**250.20**	**64.77**

Well	**(H) Hosan-1**	**(J) Jauhara-1**	**(T) Tawakul-1**
Optimum weigh on bit (1000Ib)	40 to 50	20 to 40	40 to 50
Optimum rotary speed (rpm)	120 to 140	100 to130	100 to 120

Dindir Area Drilling Simulation

The optimum hydraulic parameter that were obtained from land Mark Algorizm and the optimum Drilling Parameters obtained from Z. aswad model plus the logging informations were introduced to the pay zone simulator. Historical data match was done to simulate the real company scenario. Then introducing the optimum fluid properties, optimum hydraulic parameters, weight on bit and rotray speed simulating optimum operation scenario to be implemented in Block-8. Then a comparative simulation between old and new scenario had to be done; figure (2).

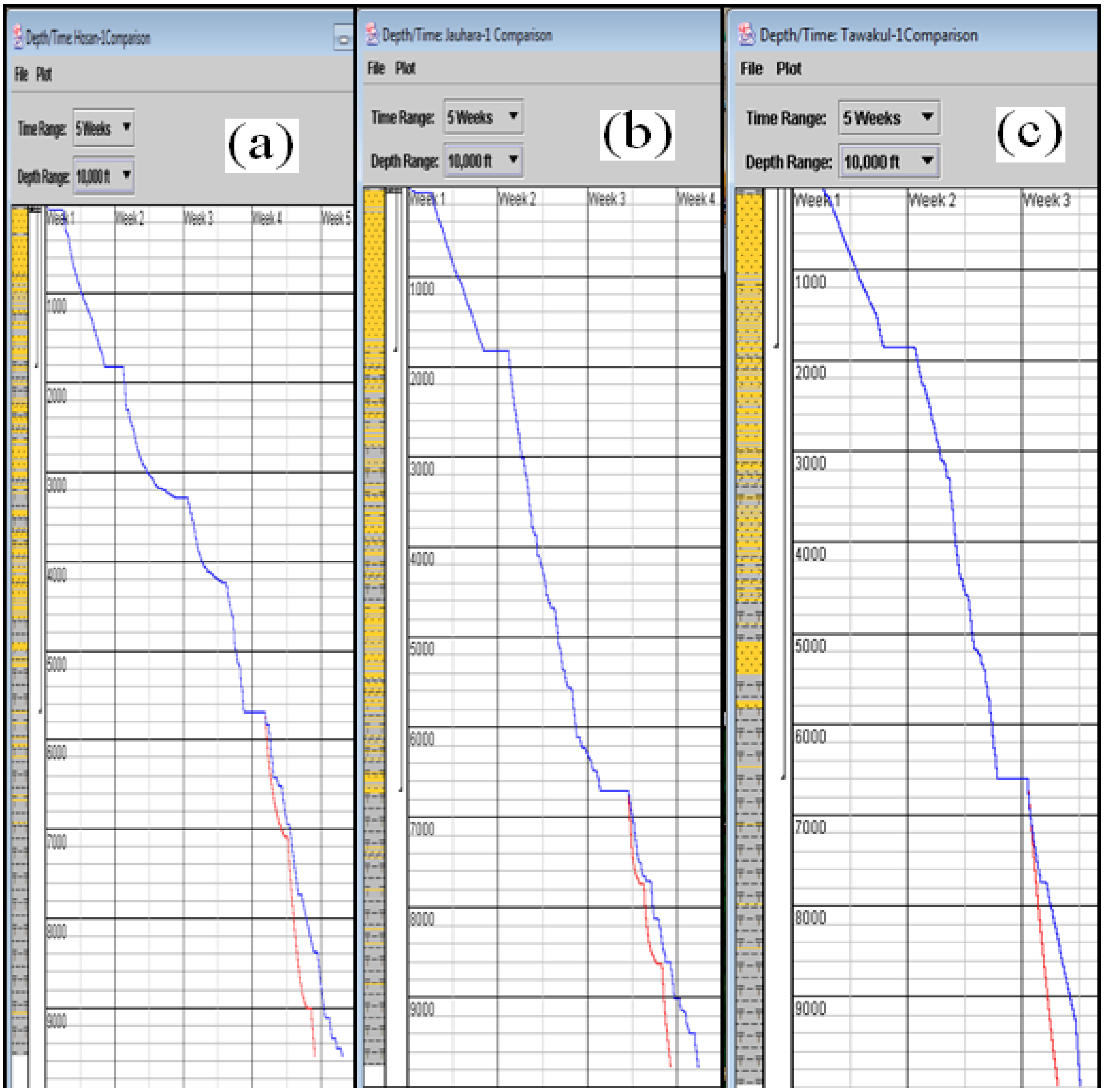

Figure (2): field/optimum Comparison simulation for three wells

(Real operation – Blue; Simulated operation – Red)

Hosan–1 well: The 8.5in section drilled in 8 days using 10 different bits, the rate of penetration was 7 to 15ft/hr and the total cost of drilling operation was 178395USD, Using the optimum scenario, the same section drilled in 5days using only 3 bits, the rate of penetration was 25 to 35ft/hr and the overall cost of drilling 126750USD, fig. 2a. **Jauhara–1 well:** The 8.5 section drilled in 6 days using 6 diferent bits, the rate of penetration was 5 to 16ft/hr and the total cost of drilling this section was 234052USD,. This section drilled in 3 days by using only 3 bits, the rate of penetration was 25 to 70ft/hr and the overall cost of drilling this section 126760USD, fig. 2b. **Tawakul–1:** The 8.5 section drilled in 3 days using 2 bits, the rate of penetration was 8 to 20ft/hr and the total cost of drilling this section was 86291USD. This section drilled in 2 days using only 1 bit, the rate of penetration was 23 to 40ft/hr and the overall cost of drilling this section 40761USD, fig. 2c.

Conclousions and Recommendations

From the drilling, mud and the final reports there were an increase in cutting generation, shaker plugs, cutting falling down and bit balling indicators. The pressure drops very sever and the losses within the pump were greater than the well circulation system (pipe, bit and annulus). Surface pump rate should be in the range of (400 ~ 570gpm) as the operation optimum running flow and for the effective.

The data and the resulted figures have been subjected to analytical processes, overall, and according to the correlation: The low values of weight on bit (W) and rotary speed (N) give low penetration rate and the high values of W&N increase the overall cost and causes increasing in bit wear. Therefore By using Z. Aswad model, the optimum values of weight on bit and rotary speed were estimated.

The basic problem observed was the narrowness of the well bore, which gives an indication of high abrasive formation. The rate of penetration must exceed the critical 15m/h (1ft/mint) and must be controlled under the 75m/h (5ft/mint) as compatible with hard formations.

From the new well category the reduction of the drilling cost by using half of the bits number and reducing the tripping time. Meanwhile; total time for the simulated actual well have decreased approximately by the half drilling the optimized drilling parameters. In the samemaner; final cost of the optimized simulated well decreased by approximately 18% correlated to the actual simulated well.

The oil industry is one of the more important sudanese economical depend on. The reduction of this industry expenses cost is an important factor (Study aim). The companies are incorage for importing such Mathmatical Models and soft ware programs for developing the industry. Meanwhile, empliyee trainning is very important. Finally, it is highly recommended to use the estaplished teqnique in this study which proved its qualitative assurance to manage the ongoing field operation.

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