# Scheduling and time optimizing in directional biting using Ant Algorithm

Written by : Alirezahamed

(oil engineer drilling contact)

Email:engalirezahamed2@gmail.com

## Abstract

The process of biting operations is significantly important in upstream oil industry and can be considered as the most costly upstream activity. Speed optimizing and reducing the costs of biting has ever been one of the basic challenges of big biting companies all around the world and various methods with different computations have been done during the last decades. Many factors may extremely affect the biting rig including technical, economical and political factors. Permeability rate of rock is considered the main factor in the directional wells, so that the more permeability rate of rock indicates the higher speed of biting and the lower time of biting. This paper intends to investigate the basic parameters in the biting rig performance. To achieve this objective, the optimum in biting can be obtained through programming and considering the data from the drilled wells directionally in Southern areas of Iran. Using Ant Algorithm, this study determines the relation between these variables. Also, using Matlab software to compute, Ant Algorithm is applied to time optimizing of directional biting. According to the obtained results, Ant Algorithm can predicate the affecting parameters in the permeability rate of rock.

**Key words:** optimization, directional biting, Ant Algorithm

## Introduction

For the first time, directional biting was used to bit an onshore well in 1919. The biting aimed to exploit and produce the reserve. In this horizontal biting, the well deviation was out of control for biting group in some extent. Afterwards, this method was used to cap a well in Texas, USA. This well was drilled successfully by the Americans in 1929. Of course, due to low price of oil in the world and frequent discoveries of huge oil reserves, this kind of biting was not economical for oil production and was stopped for many years. The controlled directional biting using precise measuring tools and to produce oil from the reserves was prevalent in the oil industry of the world from the mid of 21$^{st}$ century.

The start of the directional biting in Iran backs to less than two decades and according to the confirmation of the informed sources in the oil industry, in Iran the first well was drilled in 1994. It seems that the first directional and horizontal drilled well in Iran is the well No. 18 of Ahvaz fields which has been drilled and completed under the airport of Sanat-e-Nafte hospital of Ahvaz (Naeimi and Arjmand Nasimi, 2009). Following are some instances of projects implemented on directional biting.

Kateb Saber, Shahbazi and Akhlaghi Olaghi (2012) conducted a study on "optimizing permeability rate of rock in directional well using artificial neural network" investigating the basic parameters of the biting rig performance. To this purpose, by programmimg and considering the data obtained from the drilled wells directionally in the oil field of Ahvaz, some optimum for biting in this field can be obtained. Simulating well`s condition and biting parameters with respect to the existing wells in the region, a similar, applicable and reliable model will be resulted. Many factors affect the permeability rate of rock. It is necessary to model the neural network to draw association between these variables which are very useful in optimizing process. This paper determine the relation between the variables using Burgin and Young`s equation. The first stage in applying neural network is to build the model in the pilot hole of the well. The neural network divides the data into three parts. 70% of data is dedicated to network training. 15% of data is dedicated to the network validation and 15% is dedicated to analyzing the network sensitivity. We should obtain a low percentage of error in computations, since the investigations should be optimized to reduce the risk and increase the speed of biting trend. The cycle of this process includes almost 2-4 million computations for each analysis. All of these processes are repeated to draw association between the variables and the diagrams (Kateb Saber et al., 2012).

**Main body**

**Statement of the problem**

Time is one of the most important issues which should be considered in managing each project. Considering the importance of time and costs management in the projects, increasing the speed of biting and it`s optimization is one of the basic factors to achieve the project objectives. Since the speed of biting rate is a main factor in compensating the occurred delay in the program or reduction in biting time and completing oil and gas wells, it can be useful to increase the biting rate and providing appropriate approaches in this case. Speed optimizing and reducing biting costs has been one of the basic challenges of big biting companies all around the world and various methods with different computations have been used to determine them over the last decades (Hasimi and Radaii, 2012).

Despite using directional and horizontal biting tools such as well stream engines, the directional biting speed is less than the vertical biting speed. The time sequence of biting in sliding mode, rotary biting, as well as stopping biting in different depth intervals is the main reason of removing the parameters of the well deviation. In reviewing the piece differences in the directional biting, it is necessary to point that repairing and regulating tools of well stream parts with wire line cables for the wells with the vertical angel less than 40degrees can enter the well and taking necessary action; but in the wells with the angel more than 40 degrees, a specific and expensive tool is needed to drive the mentioned equipments into the well. Permeability rate of rock is considered the main factor in the directional wells, so that the more permeability rate of rock indicates the higher speed of biting and the lower time of biting. Comparing and evaluating

affective factors, we can achieve the best rate of permeability of rock caused by increasing the speed of biting through soft computational methods.

**Research objectives**

To solve the problem of scheduling using Ant Algorithm to optimize the parameters of biting, we will need to the maximum permeability rate of rock in biting operations.

During the last decades, many dynamic and serious studies have been conducted regarding the theory and performance of the meta-heuristic methods as well as their applications to solve the complicated problems of optimizing. The meta-heuristic methods` success to find optimum ways for the practical problems is real and absorbs high attention to these kinds of methods (Krishnan and Cheraghi, 2005). The society and population of insects shows that there is an efficient way to adjust with environmental changes. In fact, it allows designing a router algorithm according to the basic factors of simple living based on Ant Algorithm (Claudia and Patrizia, 2008). This research tends to do time optimizing of the directional biting using Ant Algorithm.

Since the process of biting operations is significantly important in upstream oil industry and can be considered as the most costly upstream activity, the efficiency and speed of biting is highly regarded. Undoubtedly, many factors including technical, economical and political factors highly affect the performance of the biting rig. The permeability rate of rock is regarded as a main factor in the directional wells. Usually, the permeability rate of rock is computed from a relation regarding biting areas based on time and its value affected by many factors.

Considering the affecting factors in the permeability rate of rock, appropriate choice of these factors in biting program is inevitable and may increase the permeability rate of bit in the rock. More permeability rate of rock indicates the higher speed of biting and the lower time of biting leading to reducing the costs of total operations. Therefore, optimizing the operation ultimately will need to optimize the permeability rate. The material and characteristics of the components and the depth of reserves` layers are of affective factors in the permeability rate of rock. Increasing the depth makes the components stronger and reduces their permeability rate. Considering the fact that the wells of Iran are of the deepest wells; thus, optimizing and estimating the permeability rate in biting wells of Iran is regarded very important (Shahbazi, et, al., 2012).

Today, in exploiting oil from the reserves which due to different reasons are not justifiable technically and economically, the alternative but costly methods are used to increase the optimum production and better management of oil and gas reserves. Directional biting is one of these methods which are highly considered in current biting industry. The directional biting is a

science in which the well`s direction (non vertical) in a predicated course is conducted into a target deserve.

## Methodology

The present study, considering the available data from the wells of Southern regions of Iran drilled directionally; optimize the permeability rate of rock. There are many mathematical models to determine the relation between the variable parameters and the permeability rate of rock. The equation of Bourgain and young is the most common model to modeling such relation. The related computations of the algorithm are performed using Matlab software. In this section, the relations of the applied equation are discussed. The model was introduced to draw associations between the permeability rate of rock and the variable factors such as the sedimentation, the fraction pressure, the weight over the bit, the rotational speed, the hydraulic of the bit, the erosion of bit`s tooth, etc. the model is as follow (Bataee and Mohseni, 2011):

$$(1)\ \text{ROP} = F_1.F_2.F_3.F_4.F_5.F_6.F_7F_8.$$

Consequently, the permeability rate of rock will be obtained through substituting each related function in the equation.

$$(2)\ ROP = 6^{a_1}.6^{a_2(10000-TVD)}.6^{a_3 D^{0.69}(MW-67.41)}.\left[\frac{W}{d_h}\right]^{a_5}.\left[\frac{N}{60}\right]^{a_6}.6^{-a_7 h}$$

Finally, the evaluations should aim at reducing the risk and increasing the speed of biting trend with the optimum values.

## Ant Algorithm

The meta-heuristic algorithms are those that search to find the absolute optimum answer in the answer space of the problems in a non-deterministically manner. The algorithms are highly efficient in solving hard and complicated problems (Nejad Moghaddam, 2010). The meta-heuristic optimizing Ant algorithm based on the behavior of the ants was introduced in 1990s. The algorithm derived from the ants' natural behavior in finding food is applied highly in solving compositional optimizing problems. Each of the ants has simple and sometimes irregular movements. But their overall movements lead to the regular and sometimes complex movements. The positive feedback, the distributed computation and the constructive greedy heuristic can be considered as the significant merits of the algorithm. The positive feedback leads to discover the well-defined answers quickly. The distributed computations prevent the early and ill-timed convergence and the constructive greedy heuristic also helps to find the acceptable

answers in early stages of the search. This specific characteristic in ACSA (ant colony system algorithm) has caused a versatile, robust and controllable algorithm (Dorigo, 2004).
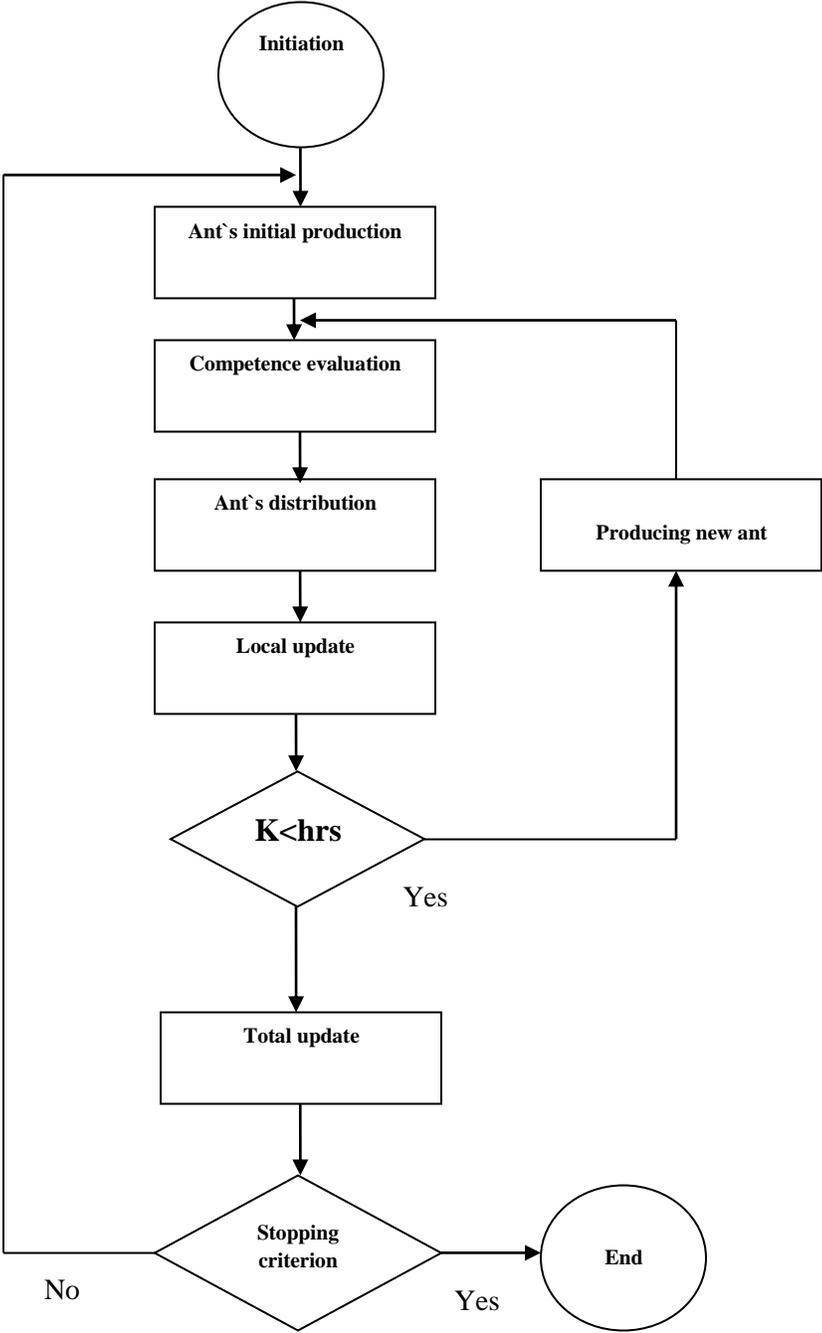


Diagram 1-total diagram of Ant Algorithm cycle (Asadi and Ranjbar, 2011)

**Discussion and results**

Today, DM technology due to the very high induced torque on bit and the high tension of biting string in the sliding mode is regarded as an ineffective method (although currently, this technology is used widely in Iran). In fact, guided engines impose an unacceptable curvature to the well in sliding mode of drilling. High curvature makes the slide drilling difficult. This phenomenon disturbs the survey operations as well as driving the casings into the well. The low quality of the logs in such wells is an evidence for this case.

Generally, there are two types of the directional drilling motors with circulation. The first type includes the turbine motors in which an axial centrifugal pump is its main component and the second type includes the PDM motors. The schematic of the motors` internal components and their function is shown in figure 1 (Schlumberger company, 2010).
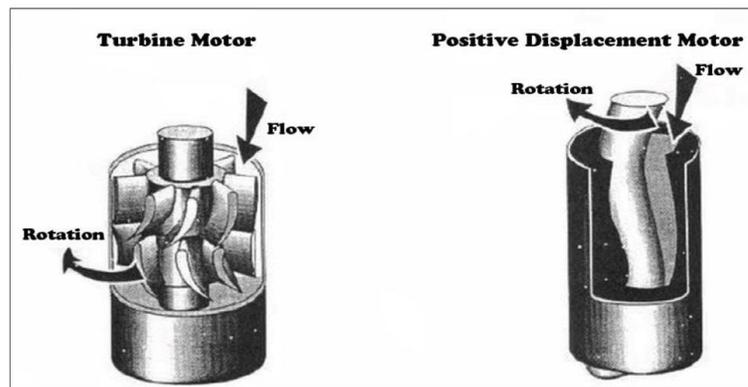


Figure1-the directional drilling motors with circulation

**The controllable and environmental factors in optimizing the permeability rate of rock**

Table 1- the affective factors in the permeability rate of rock

| Environmental factors | Controllable factors |
|---|---|
| Type of formation | Decay condition of bit |
| Characteristics of formation | Weight on bit |
| Type of drilling fluid | Design of bit |
| Density of drilling fluid | Rotary speed of bit |
| Other characteristics of drilling fluid | Flow debi |

| Bottom-hole pressure of drilling fluid | Hydraulic power of bit |
|---:|:---:|
| Size of bit | power of drilling engine |
| | Order of bit`s nozzles |

The permeability rate of rock influences the costs of each foot of drilling. Many studies have been conducted on the affective factors in the permeability rate of rock. The following diagrams show the relation between the permeability rate of rock and the rotary speed of the equipments and the weight on the bit (Bataee and Mohseni, 2011).
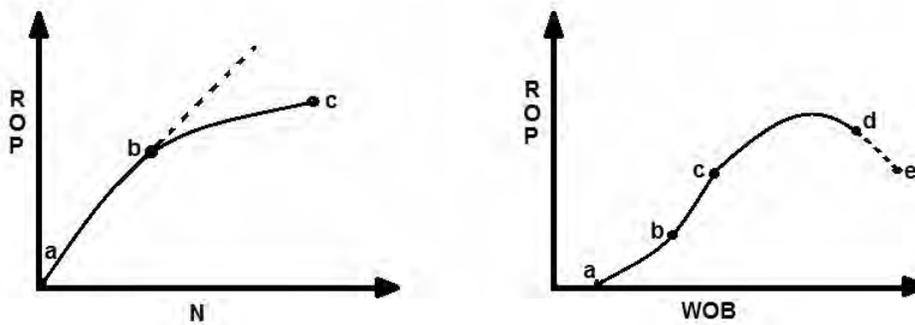


Figure2-the relation between the permeability rate of rock and the rotary speed of the equipments and the weight on the bit

 The normal log ends in C point. Increasing the rotary speed of the equipments to improve the permeability rate of rock may cause some problems in the well cleanup. The permeability rate of rock in the soft formations increases with increasing the rotary speed but it is reverse in case of rough formations.

**Conclusion**

Following are the results obtained from this paper:

- Ant Algorithm can forecast the affective parameters in the permeability rate of rock.
- Using this method reduces the human error and the best parameters of biting during the oil wells biting can be applied.
- Estimating the permeability rate through the algorithm, the best applied weight for the bit and the speed of rotary biting in biting string can be obtained.

**Reference**

1.Ashiani Abdi, H., (2010), "the directional and vertical drilling, its history, evolution, challenges and approaches", exploration and production publication, no. 71, 2010.

2.Ebrahimzade, K., Zamani, A., (2012), "drilling engineering principles", Ava publication, 1$^{st}$ edition, 2012.

3.Arjmand, R., Naeimi, Taqi, (2009), "the applications of the directional drilling techniques in the oil and gas fields", news.imidro.org   .

4.Asadi, H., Ranjbar, S., (2012), "the regional festival of new researches in mathematics"

5.Hasimi, A., Radaii, A., (2012), "optimizing the speed of drilling using the energy index", the first festival of Reservoir Engineering, related Science and industries.

6.Ghasemnejhad Moghadam,N., (2010),"Ant Algorithm a meta-heuristic technique in optimization", QC publication, No.39

7.Momeni, Gh. And Naviri, E., (2008), "evaluating the problems of directional drilling and solving them through conductable directed drilling using DS-NAS system", 12$^{th}$ chemical engineering national congress of Iran.

8- Claudia Lorenz, Patrizia Mottl,(2008). "Ant Algorithm", Semester Thesis, Distributed Computing Group.

9- Krishnaiyer, Krishnan and Cheraghi, S. Hossein,(2005). "Minimizing Tota Completion Time on a Single Machine with Tool Changes: An Ant Algorithms Approach", Wichita State University Wichita, Department of Industrial and Manufacturing Engineering.

10- Power-dive Rotary Steerable Systems, Schlumberger Company, 2010.

11- Dorigo Marco, and Stutzle Thomas, (2004) . "Ant Colony Optimization", IRIDIA lab at the Université Libre de Bruxelles .

12- Directional Drilling &Deviation Control Prepared by:Dr.khalil Shahbazi - omidieh university of technology, 2007.

13- M.Bataee, S.Mohseni, (2011), "Application Of Artificial Intelligent System In ROP Optimization : A Case Study" , SPE 140029.

14- David moran, Hani Ibrahim, (2010), "Sophisticated ROP Prediction Technologies Based On Neural Network Accurate Drill Time Results", IADC/SPE 132010.