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AN APPROACH TO WELL BORE WALL STABILITY ANALYSIS BY MATLAB AND FLAC3D SOFTWARE FOR SALMAN OIL FIELD

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To My Lovely father and mother ……

Abstract

Instability in wellbore wall is one of the most serious difficulties in drilling, because this problem can ultimately delay the drilling operations, increase cost of drilling and in some cases lead to the wellbore becoming abandoned. Now a day, with consideration of physical and chemical characteristics of mud we can apply the necessary changes to the composition of mud and make the wellbore wall more stable. With the help of the science of rock mechanics and the full knowledge of the characteristics of formation, the optimum path to drilling wellbore and the mud window can be calculated. In this research, first stability of the shale layer in wellbore **2SK5** in Salman oil field using analytical method (MATLAB software) and numerical method (FALC3D software) with the use of three criteria of failure of Mohr Coulomb, Mogi Coulomb and Drucker Prager will be studied and at the same time comparisons of applications of above criteria in stability of wellbore and comparisons of occurred difficulties in drilling this wellbore will be studied, and recommendations concerning drilling wellbore in the mentioned oil field will be presented, also at the same time some research work will be carried out in assessing drilling deviational wellbores in oil fields and effect of different stress regimes for calculating optimum direction and angle of deviation. Therefore, we conclude that stability of the wellbore with the increase in angle of deviation of wellbore does not necessarily decrease from that of its right angled one (90 degrees) , unless in a case when stress is normal or the principal horizontal stresses are equal. Also, when stress regime is normal, drilling in the direction of minimum horizontal stress and decrease in angle of deviation of the wellbore from that of right angled one will be most stabilizing for the wellbore, but drilling in this direction in the other two stress regimes will result maximum instability.

Abstrak

Ketidakstabilan di dalam lubang telaga dinding adalah salah satu masalah yang paling serius dalam penggerudian, kerana masalah ini akhirnya boleh melambatkan operasi penggerudian, meningkatkan kos penggerudian dan dalam beberapa kes membawa kepada lubang telaga menjadi terbengkalai, Sekarang sehari, dengan mengambil kira ciri-ciri fizikal dan kimia lumpur. kita boleh memohon perubahan yang perlu untuk komposisi lumpur dan membuat dinding lubang telaga yang lebih stabil. Dengan bantuan sains mekanik batu dan pengetahuan yang penuh dengan ciri-ciri pembentukan, jalan yang optimum untuk penggerudian telaga dan tingkap lumpur boleh dikira. Kaedah analisis kerana simplicities mereka dan keperluan yang tidak perlu mereka untuk banyak ciri-ciri yang berkaitan dengan persekitaran lubang telaga yang boleh diketahui pada awal projek adalah agak berkenaan. Dalam kajian ini, kestabilan pertama lapisan syal dalam lubang telaga 2SK5 dalam bidang minyak Salman menggunakan kaedah analisis (MATLAB perisian) dan kaedah berangka (FALC3D software) dengan menggunakan tiga kriteria kegagalan Mohr Coulomb, Mogi Coulomb dan Drucker Prager akan dikaji dan pada masa yang sama perbandingan masa permohonan kriteria di atas dalam kestabilan lubang telaga dan perbandingan kesukaran berlaku dalam penggerudian telaga ini akan dikaji, dan pada masa yang sama perbandingan masa permohonan kriteria di atas dalam kestabilan lubang telaga dan perbandingan kesukaran berlaku dalam penggerudian telaga ini akan dikaji, dan cadangan mengenai telaga penggerudian di medan minyak tersebut akan dibentangkan, juga pada masa yang sama kerja-kerja penyelidikan yang akan dijalankan dalam menilai penggerudian wellbores deviational dalam bidang minyak dan kesan rejim tekanan yang berbeza untuk mengira arah optimum dan sudut sisihan.

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LIST OF SYMBOLS

ϑ = Poisson coefficient

α = Biot coefficient

E = Young's coefficient

P_P = Pore pressure

K_{fr} = Module of rock bulk in dried state

K_S = Module of solid particles

V = Change in rock volume

V_P = change in rock pores

$_r$ = Radial stress

= Tangential stress

$_z$ = Axial stress

A = Radius of wellbore

P_w = Pressure inside the wellbore

v = Poisson ratio

θ = Angle clockwise in relation to x axis

r = Radial stress

σ_t = Tangential stress

σ_a = Axial stress

σ_H = Maximum horizontal stress

σ_h = Minimum horizontal stress

σ_v = Vertical stress

σ_w = Wellbore radius

r = Distance from center of wellbore

P_w = Fluid pressure of wellbore wall

Θ = Angle between one point of wellbore and the maximum horizontal stress

R_W = Radius of wellbore

R_f = Radius of the plastic region

R_P = Radius of the plastic region

R_e = Radius of the elastic region

r = Distance from the center of wellbore

ψ = Angle of expansion

σ_h = Homogeneous horizontal stress

P_i = Mud pressure

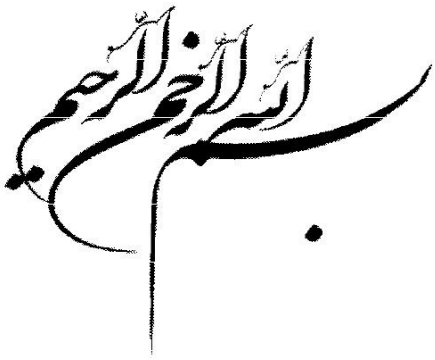
c_0 = pressurized strength of single axis (Mpa)

T_0 = tensile strength of single axis (Mpa)

= porosity in percentage

= Slope of line related to $^{1}{}'{}^{3}$, figure

C_0 = Uniaxial strength which is dependent on cohesion and angle of internal friction



In the name of God

the companionate and the merciful

CHAPTER 1

INTRODUCTION

1.1 Research background

Instability in wellbore wall is one the most serious difficulties in drilling, because this can ultimately create delay in drilling operations, increase costs of drilling and in some cases can lead to abandonment of the wellbore. It is estimated that the costs related to difficulties in drilling wellbores around the world is two billion dollars a year.

Now a day, with consideration of physical and chemical characteristics of drilling we can apply necessary changes to mud composition and make the wellbore wall more stable. With assistance of the science of rock mechanics and full knowledge of characteristics of formation, optimum path to drilling wellbore and the window of mud can be calculated.

1.2 Statement of the problem

There are number of factors involved in designing wellbore when passing through different formations such as, regional in situ stress, depth of drilling, geometry of the wellbore, amount of opening pressure and existing fractures in the region and other characteristics of rock mechanics which we will deal with later. Full knowledge of these characteristics can be very effective in designing correctly. Analytical methods due to their simplicities and not requiring features related to the drilling wellbore environment that may be unknown at the beginning of project are quite applicable.

In assessing the stability of wellbore we can mention the new numerical methods which with advancement of computer software and increase in number of related parameters they are able to provide substantial assistance in assessing the stability of the wellbore and as a result reducing costs and time and at the same time increasing safety.

1.3 Objective

In this research, first of all, the stability of the wellbore **2SK5** in the salman oil field is studied in its scorpion shale layer, using analytical method (MATLAB

software) and numerical method (FLAC3D software) with the use of the three criteria of failure of Mohr Coulomb, Mogi Coulomb and Drucker Prager.

At the same time comparisons of applications of the above criteria in relation to the wellbore stability and resultant difficulties in the process of drilling are made and ultimately recommendations to drill wellbore in the shale layer of wellbore 2SK5 in Salman oil field are presented. Also, effect of different stress regimes in specifying optimum direction and angle of deviation of the wellbore will be studied.

1.4 Scope

This research is presented in five chapters. In second chapter summary of similar activities are presented in relation to analyzing stability of wellbore and factors creating instability and summary of our solution for instability in deviational wellbores is also presented in this research.

Also, different criteria of failure are presented in second chapter. In third chapter details of algorithms of modeling and used software (MATLAB and FLAC3D) are presented.

At the beginning of fourth chapter there are some general information regarding the Salman oil field and features of lithology formations that the concerned wellbore cuts through, and properties and location of shale layer in 2SK5 wellbore is presented and then the mud window is calculated, ultimately with the use of related software study of stability of the wellbore in this shale layer takes place.