JOURNAL OF PETROLEUM GEOMECHANICS
(JPG)

Extended Abstract

Selection of drilling fluid weight based on rock mechanics criteria

Reza Jalakani [1], Seyyed Shahab Tabatabaee Moradi [1*]

1- Faculty of Petroleum and Natural Gas Engineering, Sahand University of Technology, Tabriz, Iran

Received: 24 September 2023; Accepted: 10 December 2023

DOI: 10.22107/JPG.2024. 417631.1211

Keywords

Drilling fluid density
Well stability
Fluid density window
Elastic coefficients
Induced stresses

Abstract

One of the most important tasks of the drilling fluid is to maintain and provide the stability of the well. The Objectives of this research is to determine the density of drilling fluid according to the concept of wellbore stability so that the radial and tangential stresses in the well wall are equal. For this purpose, first the required data were collected from one of the field wells in the southwest of Iran. Then, the induced stresses in the well wall were calculated using the existing relations. The results of this study showed that according to the safe window of drilling fluid density, the maximum and minimum optimal fluid density in which the stability of the well will be maintained at the desired depths will be 16.80 and 13.93 pounds per gallon, respectively.

1. Introduction

Drilling fluid in order to perform tasks such as cooling the drill bit, controlling the pressure of the subsurface formations, lubricating the movement of the drill string and providing Well stability [1]. Adenoy (2010) showed that the appropriate density of the drilling fluid from the perspective of the stability of the well should be selected in such a way that the induced stresses, including tangential and radial stresses, are equal to each other at each depth. According to Adenoy's theory, this density is the optimal density in terms of the stability of the well and prevents subsequent problems, such as collapse or failure of the well [2]. Ramiro et al. (2000) stated that well stability problems are one of the main sources of time and cost in drilling operations. Researchers showed that one of the key parameters in the well control process is fluid density [3]. According to Maliki et al.'s research (2014), well stability was reported to be one of the most important problems observed during drilling operations. According to the obtained results, it is very important to determine the appropriate window or density of the drilling fluid to avoid well instability problems [4]. In this research, Adenoy's theory was investigated in the field of choosing the density of drilling fluid for one of the fields in the southwest of Iran, and then the optimal values of the density of the drilling fluid were compared with the actual density of the fluid.

2. Methodology

After collecting and evaluating data, elastic coefficients pore pressure, in-situ stresses and induced stresses are calculated. Then, the density values of the drilling fluid at different depths are calculated and compared with the density value of the actual drilling fluid used. The data used are related to the Sarvak formation in one of the southwestern fields of Iran. These data include density and sonic logs, formation pressure and well geometry data. In different geomechanically models, the most important elastic coefficients affecting rock behavior are Young's modulus and Poisson's ratio. To estimate these two parameters, using shear wave velocity data, compression wave velocity and log density data are used [5]. In order to calculate the horizontal stresses in this research, Zobek's formula are used. To obtain formation pressure in the studied interval from Sarvak Formation, Eaton's relation has been used [6]: In

* **Corresponding Author:** s.sh.tabatabaee@gmail.com

order to calculate in-place stresses using Zobek's relations, it is necessary to characterize the value of Biot's coefficient. According to the type of formation in the studied, which is limestone, in this project, the value of Biot coefficient is 0.7 [7]. The formations in the basement are in equilibrium before the drilling operation. When the drilling operation starts, this balance in tensions is disturbed and causes changes in these tensions. After determining the induced stresses and based on Adenoy theory, the density of the drilling fluid and its equivalent pressure inside the well are determined in such a way that the tangential and radial stresses in the wall are equal. The basis of Adenoy's theory is shown in figure (1). Based on this figure, as the pressure inside the well increases, the radial stress increases and on the contrary, the tangential stress decreases. As the fluid density decreases, the pressure inside the well decreases, which, as shown in the figure, leads to a decrease in the radial stress and an increase in the tangential stress [2].

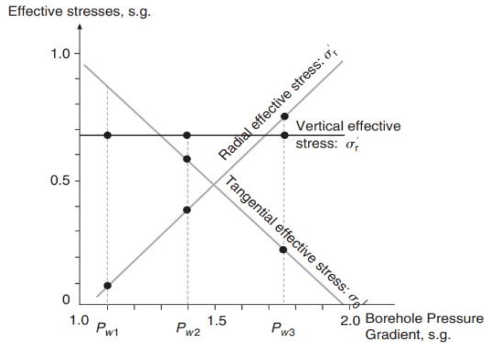

Fig. 1. Stresses around the well and different fluid density [2].

3. Results and Conclusions

According to the relationship between overburden stress, maximum horizontal stress and minimum horizontal stress, the stress regime of the region is normal based on Anderson's classification [8]. As mentioned, to calculate the optimal density of the drilling fluid, the tangential and radial stresses were equal to each other. the pressure inside the well is within the range of safe mud window (between formation pressure and fracture pressure).

The optimal drilling fluid density values obtained according to the well stability criterion have a higher value than the actual density of the drilling fluid used in this well. Examining the data related to the studied well shows that due to the fact that the actual density of the fluid is lower than the optimal density, problems of instability of the well have been observed at different depths.

4. References

[1] Marshall, W., H., Brandt, L., K. (1978). Solids control in a drilling fluid. Proceedings - SPE International Symposium on Formation Damage Control. SPE 7011, 109-112https://doi.org/10.2118/7011-MS

[2] Aadnoy, Bernt S. (2010). Modern Well Design: 2nd Edition. Petroleum Exploration and Development. 13:978-0-203-83613-2,6000 Broken Sound park way, NW

[3] Liz-Losada, Ramiro J., Alejano, Leandro R. (2000). New Safe Mud Weight Window Representations to Prevent Wellbore Instability, Proceedings of the IADC/SPE Asia Pacific Drilling Technology Conference, APDT, ADC/SPE 62800, 493-504. https://doi.org/10.2118/62800-MS

[4] Maleki, Sh., Gholami, R., Rasouli, V., Moradzadeh, A., Riabi, R., Ghavami, Sadaghzadeh, Farhad. (2014). Comparison of different failure criteria in prediction of safe mud weigh window in drilling practice, Earth-Science Reviews, 136, 36-58. https://doi.org/10.1016/j.earscirev.2014.05.010

[5] Dashtian, H., Jafari, G., Koohi Lai, Z. Masihi, M., Sahimi, M., (2011). Analysis of Cross Correlations Between Well Logs of Hydrocarbon Reservoirs. Transp Porous Med (2011) 90: 445–464. DOI 10.1007/s11242-011-9794-x.

[6] Azadpour, M., Shad Manaman, N., (2015), Determination of Pore Pressure from Sonic Log: a Case Study on One of Iran Carbonate Reservoir Rocks. Iranian Journal of Oil & Gas Science and Technology, Vol. 4, No. 3, pp. 37-50. https://doi.org/10.22050/ijogst.2015.10366

[7] Li, Q., Aguilera, R., (2019), A correlation for estimating the biot coefficient. SPE Drilling & Compeletion, 1–13. https://doi.org/10.2118/195359-PA

[8] Anderson, E.M., (1951), The dynamics of faulting and dyke formation with applications to Britain.: Hafner Pub. Co.