International Journal of Applied Engineering Research ISSN 0973-4562 Volume 12, Number 15 (2017) pp. 5214-5217
© Research India Publications. http://www.ripublication.com

Influence of Mud Filtrate on the Stress Distribution in the Row Zone of the Well

Pavel Aleksandrovich Blinov[1], Mikhail Vladimirovich Dvoynikov[2], Kulemin Maksim Sergeevich[3], Arslanova Elza Rustamovna[4]

[1,2,3,4] Department of Borehole Drilling, Oil and Gas Faculty, Saint-Petersburg Mining University, 21-st line V.O., 2, 199106, Saint Petersburg, Russia.

Abstract

During drilling, the problem of stability of the borehole walls, causing their effects to complications and increase the cost of the well. In this work the dependence of the parameters of the stability of the wellbore from the drilling mud filtrate.

Keywords: drilling fluid, drilling mud, loose rocks, unfixed rock.

When drilling directional and horizontal wells for oil and gas in friable rocks, fractured rocks and clay is increased, development, contraction and collapse of the wellbore. This leads to sticking of the drilling tool, redrilling passed intervals and requires the installation of additional casing, which increases the cost of well construction. It mostly happens in intervals of a set curvature, tangential and horizontal sections [1].

The stability of the wellbore is solved by the creation of technical means and technologies for drilling with simultaneous casing of the well casing, or through the development of special drilling fluid composition that is capable due to its properties to keep the wellbore in the steady state. The second decision in economic and technological parameters more advantageous and is an integral part of the first [2].

Practice shows that for a number of fields when it reaches the angle of inclination of the borehole a certain value, the stop of the excavation and removal of large amount of sludge, which indicates the destruction and sloughing of the walls of the wellbore. What is the reason of loss stability of inclined shafts wells compared to vertical wells?

To prevent collapses of the walls of the well are taking the following measures:

- the drilling mud must have a minimum filtration performance;
- the maximum possible density of drilling mud;
- to maintain the rate of upward flow in the annulus of at least 1.5 m/s;
- to avoid significant fluctuations in the density of the drilling mud.

In this work a different approach for the prevention of landslides and collapses of the walls of the wells. He is to change parameters of the rock, namely the angle of internal friction and cohesion, which subsequently redistribute the stresses on the borehole wall.

When drilling wells in the rocks redistribution of stresses associated with a decrease in pressure in the well. While there are shear, shear stresses, responsible for the destruction. The value of the larger, the greater the difference between the maximum and minimum compressive stresses, i.e. radial stresses σ_r and ring-type stresses σ_φ. [3].

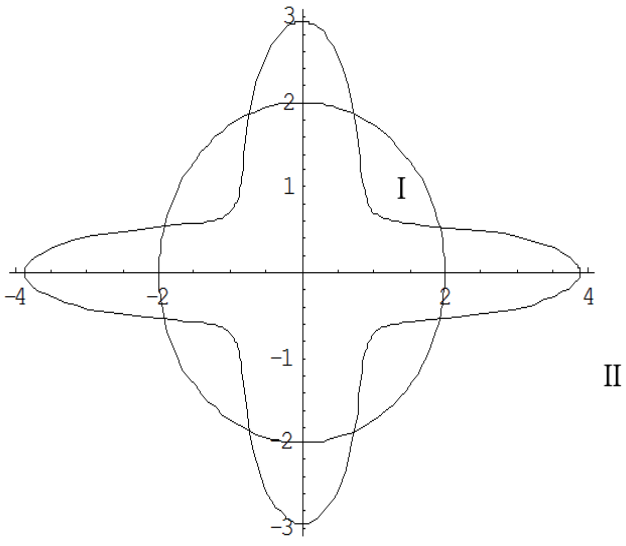

Figure 1: The distribution of ring-type stresses on the contour of the horizontal cylindrical hole in isotropic - I and anisotropic media - II.

Bearing capacity of rocks [3] caused mainly by the shear strength and separation. A critical value of shear resistance in the environment, which on average considered homogeneous in all directions, the focused area, i.e. the criterion of local fracture, are usually in the form $\tau \le [\tau]$ where $[\tau]$ is the tensile strength

$$[\tau] = k - \sigma_n \operatorname{tg} \varphi \qquad (1)$$

where σ_n – the normal stress on the area, k – coefficient of kohering and φ - angle of friction by strength characteristics of the rock.

If in breed there are grounds attenuation (bedding plane), then the destruction will begin in the first place for them, since the tensile strength $[\tau]$ is much lower than in other directions. In this case, k and φ should be understood the coefficient of kohering and friction angle on the bedding planes [4].

This means that the destruction will start in the first place at those points on its contour, where the shear stress in the plane of the layers reaches the value of $[\tau]$. The calculations show that increasing the angle of inclination of the borehole limit the shear stresses will occur around a larger number of points on the contour. With further increase of the angle of inclination comes a time when the rock near the well does not withstand stresses and destroyed. This extreme state of equilibrium corresponding to the tension and the angle of inclination of the borehole will be called ultimate. Thus, the loss of stability of the borehole walls and not enough to the destruction of the breed began in one or more points on the contour of the well. It is necessary that the destruction of seized quite a large area [3].

We consider the rock mass as a continuum, which under deformation behaves as isotropic, but the destruction which may occur on areas of weakening coincident with the bedding. Then the stress state on the contour of the well will not depend on the position of the considered point on the contour of the well. However, the presence of sites of attenuation in the rock leads to the fact that the points of the contour of the wells cease to be equal, in terms of potential destruction. A problem of choosing the most dangerous point (or region) on the contour of the borehole, i.e. the point at which in the plane of the strata previously only achieved the state of limit equilibrium.

Figure 2 shows the distribution of the combination of stress depending on the polar angle, for different angles of inclination of the borehole. The calculations were performed for angle of internal friction φ is equal to 20^0 and 30^0, the clutch rocks 30 kPa and 20 kPa. But, as shown by the calculations, changing the grip slightly affect the final result.

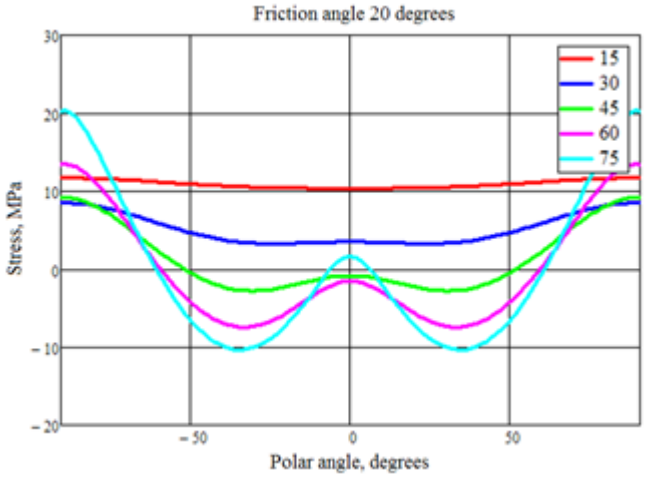

Figure 2: Distribution of combinations of stress (6) in MPa, depending on the polar angle φ in degrees, for different angles of inclination of the borehole θ (friction angle 20 degrees)

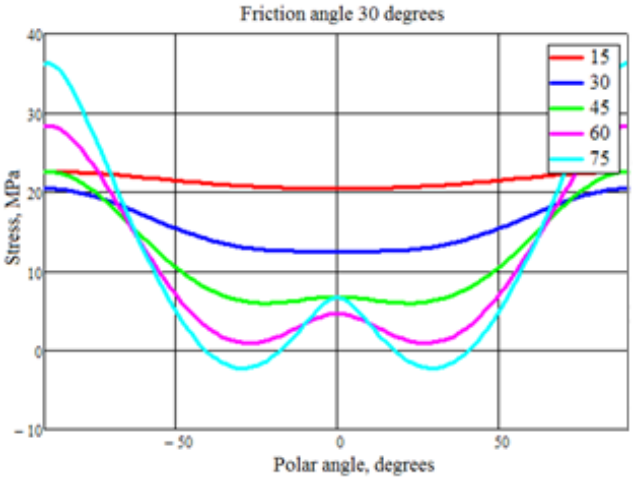

Figure 3: Distribution of combinations of stress (6) in MPa, depending on the polar angle φ in degrees, for different angles of inclination of the borehole θ friction angle 30 degrees)

From figure 2 and 3 it follows that with increasing inclination of the borehole increases and the value of maximum stress.

It can be concluded that the most dangerous from the point of view of loss of stability of the wells are the inclination angles of $40^0 \div 60^0$ depending on the module of kohering and angle of internal friction of rock.

It was originally designed and made the ring for sand packed tube (sand with d= 0.25÷0.5 mm, humidity 20 %). The ring is filled with sand, compacted rock. Then the sand in the ring is placed in a filter-press [5].

For research was used the following composition of drilling fluids.

1st solution: offered based on the experience of previously drilled wells. Potassium chloride mud with a density of 1.28 g/cm^3: KCl 12 %; $CaCO_3$ 12%; Duovis 0.35 %; Gravel 10 %; Pac HV 0,4 %; Pac LV 0,2 %.

2nd solution: Potassium chloride mud with a density of 1.28 g/cm^3: KCl 15%; $CaCO_3$ 20%; Duovis 0.25%; Pac HV 0,45 %; Pac LV 0,45%.

3rd solution: Potassium chloride mud with a density of 1.28 g/cm^3: KCl 12%; $CaCO_3$ 8%; Bentonite 1 %; Gravel 15 %; Pac HV 0,4 %; Pac LV 0,2 %.

Each of the solutions is poured into the cylindrical container of the filter-press, container sealed, the solution was filtered under pressure through the ring with the rock. Measures the volume of filtrate over a certain period of time. According to the obtained results graph of velocity for each solution for 3 experiment (Fig. 4).

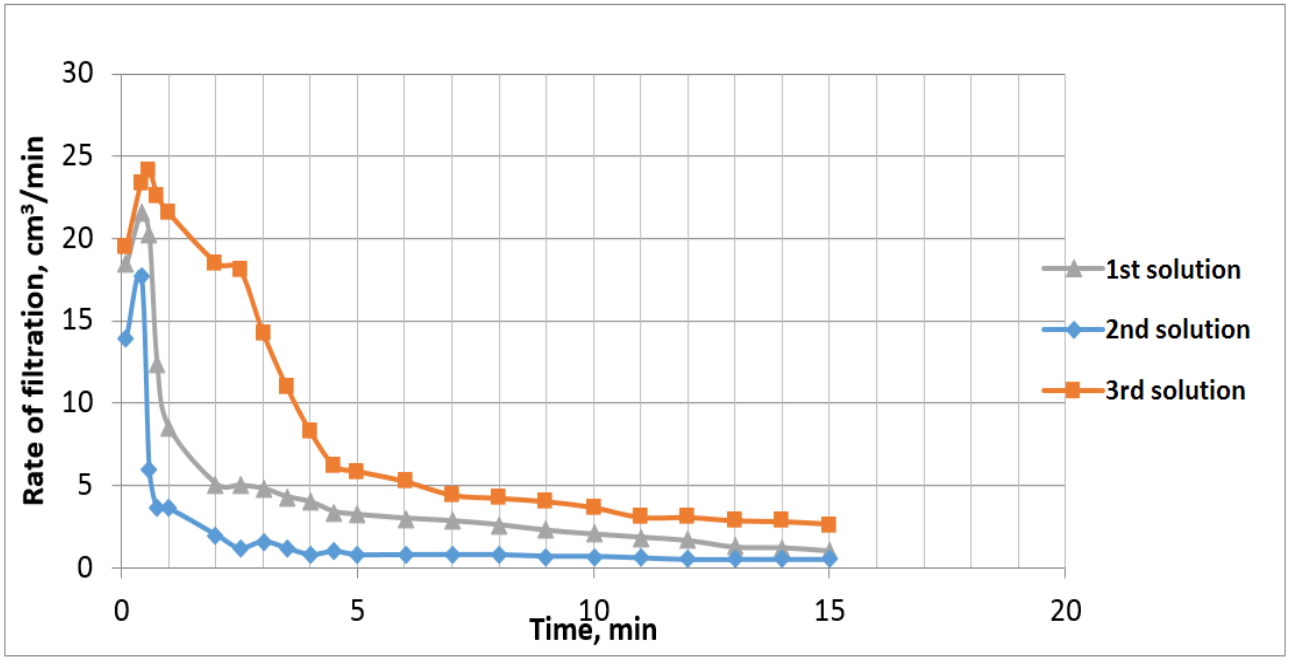

Figure 4: The graf of rate of filtration of solutions through a model of rock under pressure 100psi

Then rock out of the ring placed in the device of single-surface cut, where the rock sample pressure and shear load. On the measured values of the tangential and normal loads calculates shear and normal stresses τ and σ, kPa, according to the formulas:

$$\tau = \frac{Q}{A}; \quad (2)$$

$$\sigma = \frac{F}{A}, \quad (3)$$

where Q and F – respectively the tangential and the normal force to the plane of shear, кН; A - area of the cut.

The determination τ must be conducted no less than three different values σ. With the help of filter-press and mud to prepare two samples of the breed. The angle of internal friction φ and the specific kohering k, kPa, is calculated by the formula:

$$tg\ \varphi = \frac{n\sum \tau_i \sigma_i - \sum \tau_i \sum \sigma_i}{n\sum (\sigma_i)^2 - (\sum \sigma_i)^2}; \quad (4)$$

$$k = \frac{\sum \tau_i \sum \sigma_i^2 - \sum \sigma_i \sum \tau_i \sigma_i}{n\sum (\sigma_i)^2 - (\sum \sigma_i)^2}; \quad (5)$$

where τ_i - experimental values of the resistance of the slice (n = 3); n - the number of trials [4]. For estimation of the scatter of experimental data and errors detection tests before the calculation of tg φ and k the graph of dependence $\tau = f(\sigma)$ (Fig. 5).

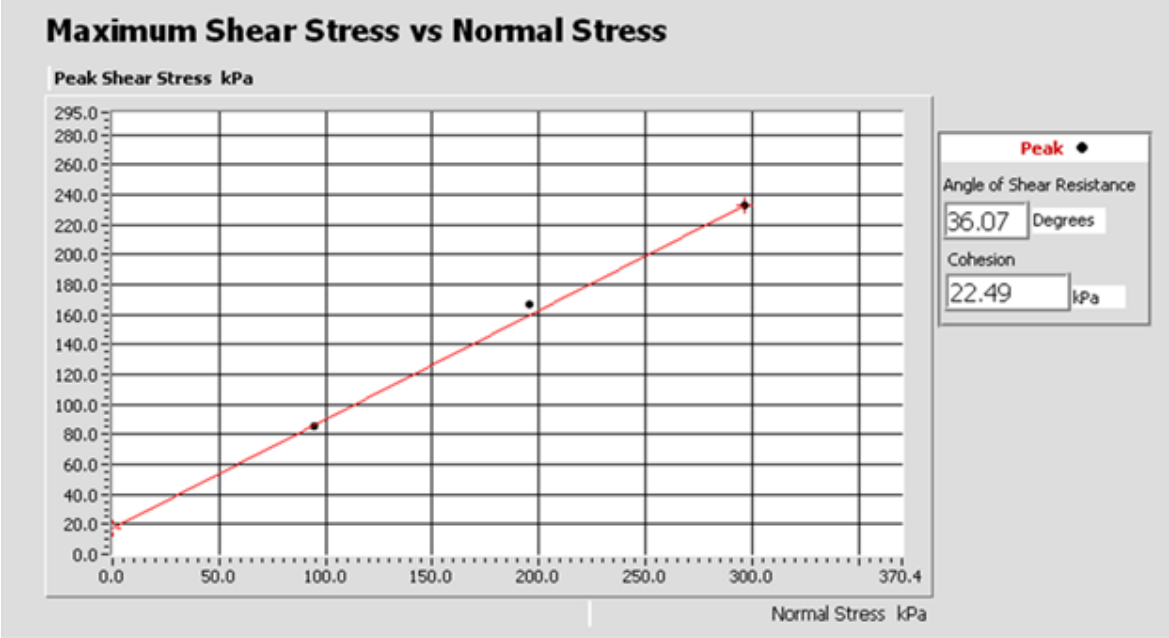

Figure 5: Graph of shear stress from normal for the three samples of sand through which was filtered 2nd mud

For each sample, tested with different types of drilling mud are determined by the values of angle of internal friction φ and the specific clutch k. All values of angle of internal friction and specific adhesion are listed in table 1.

Table 1:

Solution composition	Internal friction angle φ	Specific cohesion *k*, kPa
Without filtering	26.40	17.68
Mud №1	40.34	19.24
Mud №2	36.07	22.49
Mud №3	32.57	18.41

Results of the experiments were made the following conclusions:

1. The dependence of the stability of the trunk inclined directional wells from the strength characteristics of rocks taking into account the zenith angle.
2. Determined the position of the critical points (maximum stress concentration of the rock) depending on zenith angle.
3. The possibility of regulating the strength properties of rocks by drilling mud filtrate, which may allow to redistribute stresses in tree trunks the well area to ensure sustainability.

REFERENCES

[1] Avetisyan N.G. Vybor tipa burovogo rastvora dlya bureniya v neustojchivyh porodah. – Obzor. inform. Ser. Burenie. – M.: VNIIOEHNG, 1983.

[2] Blinov P.A., Dvoynikov M.V. The Process Of Hardening Loose Rock By Mud Filtrat. - International Journal of Applied Engineering Research. - Volume 11, Number 9 (2016) pp 6630-6632

[3] Karev V.I., Kovalenko YU.F., Kulinich YU.V., Ustinov K.B. Matematicheskoe i fizicheskoe modelirovanie razrusheniya gornyh porod pri prohodke naklonno napravlennyh skvazhin. Institut problem mekhaniki Rossijskoj akademii nauk (IPMekh RAN), OOO «PerfoLink».

[4] Bochko EH.A. Uprochnenie neustojchivyh gornyh porod pri burenii skvazhin. M., Nedra, 1979.

[5] Blinov P.A., . Podoliak A.V. The Method Of Determining The Effects Of Drilling Fluid On The Stability Of Loose Rocks. - International Journal of Applied Engineering Research. - Volume 11, Number 9 (2016) pp 6627-6629