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# INCREASING OF MAGNETIC DEVICES LIFTING CAPACITY AND ITS EFFICIENCE IN SHUT DOWN WELLS

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# УПРАВЛЕНИЕ ГРУЗОПОДЪЕМНЫМИ ХАРАКТЕРИСТИКАМИ МАГНИТНЫХ ЛОВИТЕЛЕЙ ДЛЯ ПОВЫШЕНИЯ ЭФФЕКТИВНОСТИ ИЗВЛЕЧЕНИЯ ПОСТРОЕННЫХ ПРЕДМЕТОВ ИЗ АВАРИЙНЫХ СКВАЖИН

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*Abstract.* The effectiveness of the point of application of force for lifting the objects from the bottom of oil and gas wells has been investigated. It the proven, that if the force to lift the deposited objects is applied not at the center of gravity of the object but at one end, then the force required is four times less than the force applied to the center of gravity of the object.

*Аннотация.* Исследована эффективность точки приложения силы для поднятия построенных предметов со дна нефтяных и газовых скважин. Доказано, что если силы для поднятия посторонних предметов приложена не в центре тяжести предмета, а на одном конце, то потребуется сила в четыре раза меньше, чем сила приложенная в центра тяжести предмета.

*Keywords:* drilling, breakdown object, complications, energetic potential, technology.

*Ключевые слова:* бурение, разрушение объекта, осложнения, энергетический потенциал, технология.

## *Introduction*

It is known in realization of various technological operations in oil and gas wells, and also in the process of liquidation of happened shut downs metallic matters fall into the well buttom and prevent the development of well operations. One of the effective liquidation ways of shut downs is the use of (fishing tools) picking up instruments with magnet acquisition mechanisms. Metallic objects stick into the well bottom and column of heavy flushing fluid influences them: all these

make difficult picking up shut down matters in the well bottom. Besides it existing magnet acquisition mechanisms of picking instruments use and allow to create traction characteristic in the direction of well axis. Created traction characteristic in the boundary of hoisting force of magnet acquisition in many cases isn't enough for taking off shut down matter out of well bottom in such environment. It isn't explained by the efficiency of energetic interaction of shut down matter and magnetic system in the condition of such well bottom. That's why there is necessity of supplying effective force interaction of shut down matter and magnet acquisition mechanism. It is, undo subtly, will allow the use of energetic opportunities of acquisition mechanism and considerably will increase traction characteristic of picking instrument. Such decision can be achieved at the expense of creating of "dynamo" in well bottom that is by the displacement of application point of traction force and creating its moment. But joint influence of two forces factors considerably will increase hoisting force of the acquisition at the expense of use its energetic potential. For bringing this idea to construction realization analytical investigation of force interaction of shut dawn matter and magnet acquisition is necessary. For solving of this task it is supposed that shut down matter with $\sigma_n$ diametrical sizes of "$a$" and "b" is in the well bottom. For taking off this fall matter out of well bottom it is required to apply force equate to

$$F_1 = ab \cdot \sigma_n \qquad (1)$$

Where $s=a \cdot b$ square of metallic matter section, $\sigma_n$–limit of mixture strength of shut down matter stick with the ground from well bottom. Magnet force is usually distributed equally and creates force determined by formula (1).

Let us suppose, that picking elements are placed disaxially to well axis and influence at one end of the matter (Figure 1).

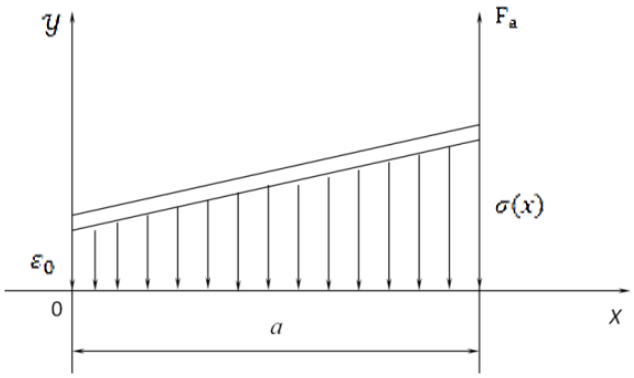


Figure 1. Supposed distribution of stresses along the length of foreign object under the influence of the link on the one end of the object

Shut down matters fallen into the well bottom and being under the flushing fluid column influence are in sluch environment.

*Setting up the task*

The task consists of creating of necessary take off effort on shutdown matter in the well bottom sluch environment. Consequently, mechanical model of formulated task is presented by the extended body take off and holding it in the well bottom. In this model picked up matter is modeled

absolutely hard, but holding environment is modeled by deformed bodies (fig.1). Then distribution longitudinal eformation is linear, that is:

$$\epsilon(x)=\varepsilon(0) + K_1 x \tag{2}$$

From Guk's law distribution of longitudinal tension will also be linear function from x; that is

$$\sigma(x) = E \cdot \epsilon(x) = E\varepsilon(0) + EK_1 x = \sigma(0) + Kx \tag{3}$$

where $\sigma(0) = E \cdot \varepsilon(0)$; $K = E \cdot K_1$,

In order to determine unknown constants $\sigma(0)$ and $K$ let's consider balance of shutdown matter. From the equality to zero of projection sum of all functioning forces along the axis $y$ we get:

$$F_2 = s\left[\sigma(0) + \frac{ka}{2}\right] \tag{4}$$

From the equality to zero of the sum of all functioning forces moments relatively the beginning of the coordinates we have:

$$F_2 \cdot a = a^2 b[\frac{\sigma(0)}{2} + \frac{ka}{3}] \tag{5}$$

For picking up shut down matter out of the well bottom it is necessary to carry out below mentioned condition [2]

$$\sigma(a) = \sigma_n \tag{6}$$

Then from (3)

$$\sigma_n = \sigma(0) + ka \tag{7}$$

from (7)

$$\sigma(0) = \sigma_n - ka \tag{8}$$

Considering several transformations in the equalities (3), (4), (5) and (8). For $\sigma(x)$ we have

$$\sigma(x) = -\frac{1}{2}\sigma_n + \frac{3}{2a} \cdot \sigma_n \cdot x = \frac{\sigma_n}{2}\left(\frac{3x}{a} - 1\right) \tag{9}$$

As it is seen from equalities (9) in $x = {}^{a}/_{3}$ $\sigma(x)$=0. It means that diagram of loading of shut down matter differing from initial modeling according to fig.1 must be presented by the diagram in fig. 2.

Considering this suggestion from (4) for $F_2$ we get:

$$F_2 = a \cdot b\left[-\frac{1}{2}\sigma_n + \frac{3}{4}\sigma_n\right] = \frac{\sigma_n}{4} \cdot S \tag{10}$$

Comparison of the equalities (1) and (10) shows, when increasing force is applied on one end of the taken off shut down matter, for its lifting the force 4 times less force than in balancing the force applied along the center of the matter gravity. Proceeding from above mentioned the following is suggested. Constant magnet field in longitudinal section of well bottom mustn't be distributed equally but must be concentrated at the definite part of the well, that's from the edge, so that the force of a magnet application was not less $\frac{1}{4}$ of the part of application force of equally distributed magnet.

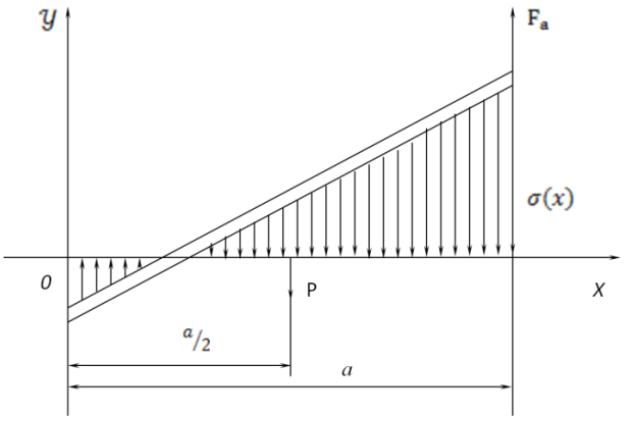


Figure 2. Supposed distribution of stresses along the length of foreign object under the influence of the link on the one end

Lets consider the case when gravity force of the matter, column of flushing liquid with height $h_1$, and density $\rho_1$ influence on the matter.

In this case in order to pick up the matter in the well bottom with equally distributed magnet field we should apply on it the force equal to,

$$F_1 = a - b \cdot (\sigma_n + \rho_1 g h_1 + \rho_2 g h_2) \tag{11}$$

where $\rho_2$ , $h_2$- is density of the matter material and its height, $g$ – is acceleration of free fall.

It to apply traction force on the one end of the matter, then the scheme of influencing forces will be shown by the diagram in fig. 3.

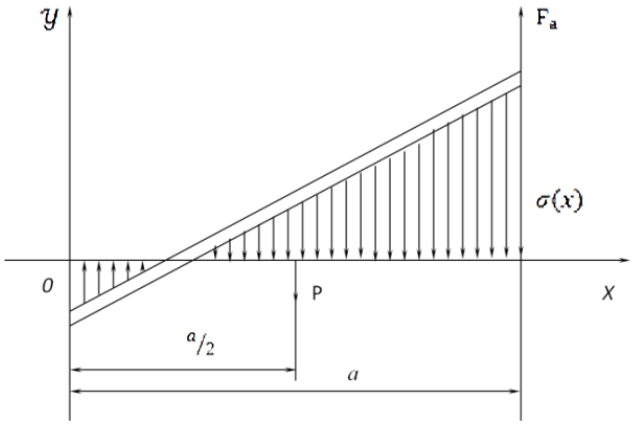


Fig. 3 Supposed distribution of stresses along the length of foreign object under the influence of the link on the one end of the pivot considering the influence of pressure column of washing fluid

Equally influencing force of flushing liquid gravity and the matter is applied in the middle of the matter along the well axis [3] in fig.3 is indicated through P, that is.

$$p = a \cdot bg(\rho_1 h_1 + \rho_2 h_2) \tag{12}$$

From the equality zero of the sum of all forces projection influencing along the axis y we get

$$F_2 = p + s\left[\sigma(0) + \frac{ka}{2}\right] \tag{13}$$

From the equality to zero of the sum of moments of all forces influencing relatively to the beginning of coordinates we have:

$$F_2 \cdot a = p\frac{a}{2} + a^2 b\left[\frac{\sigma(0)}{2} + \frac{ka}{3}\right] \quad (14)$$

After a number of transformations from (8) we have

$$K\frac{a^2 b}{6} = -\frac{1}{2}[\rho + s\sigma_n - ska]$$
$$ska = -3[\rho + s\sigma_n - ska]$$

Where

$$k = \frac{3}{2}\cdot\frac{p+s\sigma_n}{s\cdot a} \quad (15)$$

Putting (15) into (8) we get,

$$\sigma(0) = \sigma_n - \frac{3}{2}\cdot\frac{p+s\sigma_n}{s} = \sigma_n - \frac{3}{2}\sigma_n - \frac{3p}{2s} = -\frac{\sigma_n}{2} - \frac{3p}{2s} = -\frac{\sigma_n}{2} - \frac{3p}{2s} \quad (16)$$

Putting (15) and (16) into (3) and (13) for σ(x) and $F_2$ we get below mentioned expressions:

$$\sigma(x) = -\frac{\sigma_n}{2} - \frac{3p}{2s} + \frac{3}{2}\cdot\frac{p+s\sigma_n}{s\cdot a}\cdot x \quad (17)$$

$$F_2 = \frac{1}{4}\cdot b(\sigma_n + \rho_1 g h_1 + \rho_2 g h_2) \quad (18)$$

Comprising (18) and (11) between forces $F_1$ and $F_2$ we get correlation:

$$F_2 = \frac{1}{4}F_1 \quad (19)$$

As it is shown from (19) for taking off shut down matter out of such well bottom more effective is the application of take-off effort to its outlying part. In this case in equal 4 time less effort is required in comparison with the variant of effort application along the well axis. For supplying of such interaction of shut down matter with pick up instrument development of corresponding magnet acquisition mechanism is necessary. It requires carrying out additional studies for determination of disposition scheme of magnet elements and magnet drives of pick up acquisition mechanism [6, 7].

*Conclusion*

In the work it has been proved that when the force for lifting of metallic matters out of well bottom is applied on one end of metallic matter then the force four times less applied in the gravity center of the matter will be required in order to take off the matter out of the well.

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