CUTTER -TUBULAR GOODS CONTACT
EXPERIMENTAL RESEARCH

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SUMMARY
The paper presents the phenomenon of appearance and initiation of friction at cutter-tubular goodie contact with application for the tongs used to the drilling-production works. Drilling tongs are used for the screwing-unscrewing operation of the tubular goods: drilling piper, tubing's etc. The paper states the functioning criterion of the drilling tongs taking into consideration the influence factors: exterior factors (motive power, working medium), constructive factors (tubular goods diameter, shape and sizes the cutter) and superficial layer contact (cutter surface geometry, thermal treatment applied to the material etc.).

Keywords: friction - tongs - cutter - tubular element

1 INTRODUCTION
An important category of drilling tools, which, has as an important purpose, the handling of the tubular material, for the drilling-extraction works, realises their functional scope by the moving flux at the contact between jaw-tubular material.

The catching capacity of the tubular material and the transmission of a torsion moment able to realise the screw-up (unscrew) operation, in dry conditions of work on in a presence of some lubricants, by several rugosities of the contact surfaces, allow the assimilation of this work system of the drilling tools (drilling tongs) with a tribo-system of frictional sliding.

The screwing-unscrewing operations of the tubular material with in drilling-production activities are performed by means of break out tongs. Break out tongs as handling tools influence the quality of screwing-unscrewing of the tubular material (drilling pipers, pumping pipers, tubing, reductions etc.) and consequently the other activities in drilling.

2 THE TRIBOLOGICAL SYSTEM 
JAW-TUBULAR MATERIAL
The structure and form the tongs depends on the form and nature of the assembling material. For the development of the calculation will be considered the case of the multidimensional tong for drilling, the results obtained in this care can be extrapolated also for the others operating tools, in some specific conditions (particularly). The form and the structure of the average drilling tong is given in figure 1. Are made up by 3 … 6 elements (jaws) articulated between them by means of some joint bolts [1].

The contact jaw-tubular element is realised in three points settled on the circumference of the tubular element (fig. 2) considering a perpendicular plane on the geometrical axis of the tubular material; practically exists an area of contact (fig. 3) of (150 … 200) mm length and width settled as the distance between two teeth of the jaw (apr. 8 mm).

Starting from the above considerents and from the tests realised in exploitation, the tribological system can be described as follows:

a) The elements of the tribological system:
   a.1) the base element-tubular material;
   a.2) the helping element-working jaw;
   a.3) the intermediate element-working environment (salt water, crude oil, petrol, drilling flowed etc.);
   a.4) the environment-characterised by different working temperatures (-45…+40°C) depending the climatic zone.

b) The properties of the elements:
   b.1) the working properties of intermediate element;
   b.2) the mechanical characteristics of the elements being in contact.

c) The interaction of the elements.

Figure 1: Schematic representation-drilling multidimensional tong.
FM External motive force; F1, F2, F3 – tangential contact forces; R1, R2, R3 – radial contact forces; BC – jaw; ET – tubular element; Mt – developed torsion moment; 1, 2, 3 – contact points jaw-tubular element.

Figure 2: Multidimensional tong – the contact jaw-tubular element.

1-tubular element; 2-striated jaw; d-external diameter of the tubular element; y-elastic deformation.

Figure 3: The contact jaw-tubular element.

Through the application of an external motive force FM to the tongs arm, its elements are gathering (are operating) around the tubular element, tarring contact with the external surfaces of it, so in the final phase of operating it forms a rigid system with the tubular element, creating the screwing function of the tubular that has actioned over [2].

At the contact jaw-tubular element in the operating process should not be produced permanent deformations. In accordance with this restriction are to be taken into account three conditions that the morning jaw must satisfy:

- do not produce deformations to the tubular material;
- do not slide on the external surface of the tubular material;
- do not leave imprints on the tubular material surfaces.

In this context, the condition of good operating of the multidimensional tongs is the screwing (unscrew) without sliding of the tubular material with the torsion prescribed moment.

In accordance to the specifications of the multidimensional tongs the torsion moment is depending on the diameter of the tubular material over that actions.

Thus, the main technical characteristics of the multidimensional tongs are expressed in two parameters:

- Catching internal Ip, defined as the reunion of subintervals of catching, Ipi:

\[ I_p = \bigcup I_{pi}, \ i = 1, k \]  

in which: Ipi represents the multitude of the diameters of the tubular (di,j) corresponding to a range of type-dimensions:

\[ I_{pi} = \{ \ d_{i,1}, d_{i,2}, \ldots d_{i,j}, \ldots d_{i,n} \} \]

- the moment torsion, Mt, that can be applied (developed) with the help of the tongs. The size of the torsion moment that can be applied depends on the diameter (di,j) on the tubular material that is actioned over. On operational point of wives, the effective torsion moment Mt,e must satisfy the inequality:

\[ M_{t,e} \leq M_{t,max} \]

in which: M_{t,max} is the maximal torsion moment that may be applied to the tubular material (in accordance the product specifications).

Synthesising the above raid questions it can be raid that the good function of the tongs must settle a dependence which defines the criterion of operation (CF) as follows:

\[ CF = f(F_m, d, F, R, p, \Phi, y, \mu_0, \mu) \]

in which: $F_m$ represents the actuating force; d - the exterior diameter of the tubular element; F - the contact tangent forces; R - the contact radial forces; p - the breadth of the contact region; $\Phi$ - the angle in the centre of the characteristic contact points placed on the circumference of the tubular material; y - the elastic deformation; $\mu_0$ - the friction coefficient at adhesion slipping; $\mu$ - the minimal friction coefficient at the contact ram-tubular element (before the slipping starts).

To explain the relation (4) must be made Somme considerents regarding the building-up of the jaw and the disposal mode of their circumference of the tubular material – important conditions in settling the right operating activity of the tongs.

From the experimental researches results that the jaws used for the equipment of the multidimensional tongs, can be grouped, from the surface of contact geometrical point of view in two categories (fig. 4):

- smooth jaws;
- rough jaws.
In accordance to the experimental researches the contact points jaw-tubular material are distributed on the external surface of the tubular material reacting between them an angle at the centre of approx. 120°, in purpose to settle some option operating conditions.

Also, it is important for the operation of the tongs the forces system which appears at the contact jaw-tubular element (fig. 6).

The functioning condition is:

\[
M_a \leq \frac{\mu R_1 \cos \phi + R_2 \cos \beta + R_3 \cos(\theta + \beta)}{R_1 + R_2 + R_3} + E \cdot p \cdot \frac{y_1 + y_2 + y_3}{R_1 + R_2 + R_3} \leq \mu_0
\]  

Thus, the functioning of the tong is established by the value of the adhesion friction coefficient (\( \mu_0 \)) at the contact ram-tubular element which must be superior to the value of the friction slipping coefficient (\( \mu \)).

The checking of the geometric solutions are realised through checking the functioning condition on the sample stand.
The aspects presented above and their solving have as a definite purpose the improvement of the technique-functional characteristics of the multidimensional tongs as well as a more secure way of using this type of drilling tongs.

3 CONCLUSIONS

By tribological point of view, the study for approaching the surfaces and for the phenomena, which take place at the direct contact of these, is completely researched.

The existing theories are based, generally speaking, on the statistic results, obtained by the investigation of a great number of pairs of surfaces, characterised by different parameters, regarding the material, the shape of the surface, mechanical processing procedure, superficial thermal treatment, the size of the normal force, the compatibility of the materials of the surfaces which are contact, environmental conditions etc.

The validation of the geometrical solutions obtained by the geometrical dimensioning of the tongs can be made only in the functioning process, in the correct exploitation conditions.

4 REFERENCES

