BALKANTRIB'O5
5th INTERNATIONAL CONFERENCE ON TRIBOLOGY
JUNE.15-18. 2005
Kragujevac, Serbia and Montenegro

SOME CONSIDERATION CONCERNING THE FRICTION MOMENT OF THE THREE-CONE BITS SEALING RINGS

Ion ZIDARU[*], Adrian Catalin DRUMEANU[**], Ioan TUDOR[**]
[*]UPETROM S.A. Ploiesti, Romania, [**]Petroleum-Gas University, Ploiesti, Romania

Abstract

The bits are tools that are used at the drilling works. During their operating, these kinds of tools are subjected to: abrasive, erosive and corrosive working mediums; high temperatures values; high level of the mechanical stresses. There are many types of drilling bits, which are used in drilling operations. One of the most used types is the three-cone bit that has a specific construction configuration. This type of bit carries out the rock splintering using three profiled cones, which are fixed at the bit body through three journal bearings. These kinds of bearings are protected against the drilling mud penetration through sealing rings that are made from rubber. The sealing rings have a major role during the bit function, their behavior influencing the three-cone bit durability.

The paper presents the experimental determination concerning the sealing rings behavior during their utilization. There are shoved the results of experiments regarding the friction moment, which appears for three rubber types used for the sealing rings construction. The experimental results are done considering the influence of the bearing temperature, rings rubber composition and also, the behavior of the sealing rings in the presence of the lubricant grease that is used for these kinds of bearings. The paper conclusions can be used both at the three-cone bit designing and exploitation.

Key words: *three-cone bit, sealing "O" ring, friction moment, rubber*

1. INTRODUCTION

The bits are tools that are used at the drilling works. During their operating, these kinds of tools are subjected to: abrasive, erosive and corrosive working mediums; high temperatures values; high level of the mechanical stresses.

There are many types of drilling bits, which are used in drilling operations. One of the most used types is the three-cone bit that has a specific construction configuration. This type of bit carries out the rock splintering using three profiled cones, which are fixed at the bit body through three journal bearings. These kinds of bearings are protected against the drilling mud penetration through sealing rings that are made from rubber [1, 2]. The sealing rings have a major role during the bit function, their behavior influencing the three-cone bit durability [3].

2. EXPERIMENTAL CONDITIONS

The friction moment of the three-cone bits sealing rings was determined on a testing stand specially built for this kind of determinations.

The general scheme of this testing stand is presented in Figure 1. In this scheme, the bits bearing is represented by positions 4 and 5, corresponding to its fixed and moving components. The rotative motion of the moving is done by electric motor 1 through the speed-change 2 and the spindle 3. The fixed part of the bearing 5 is fasted on the supported table of the stand 7, and it contains the resistive transducer, which is connected through the joint wires 8 at the measuring bridge 6.

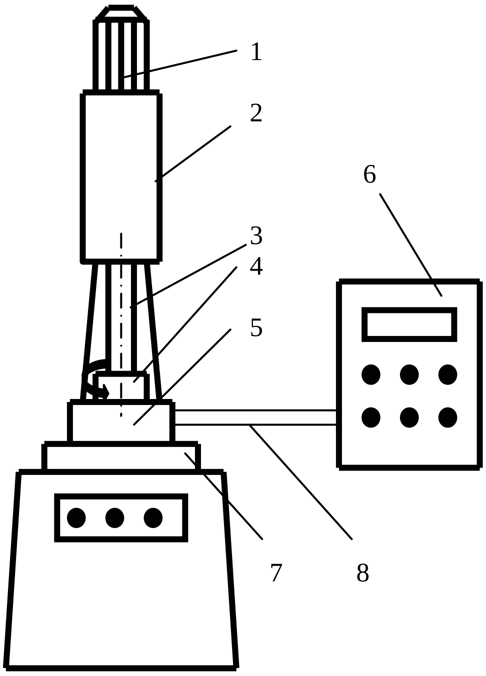

Figure 1: *General scheme of the testing stand: 1 – electric motor; 2 – speed-change box: 3 – spindle; 4 – moving half bearing; 5 – fixed half-bearing subassembly; 6 – measuring bridge; 7 – supporting table; 8 – junction wires.*

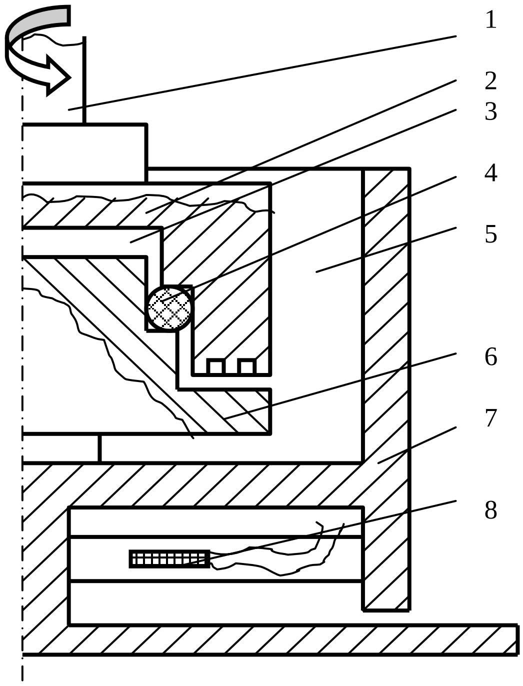

Figure 2: *Three-cone bits assembly: 1 – spindle; 2 – superior half-bearing; 3 – lubricant grease; 4 – „O" ring; 5 – drilling mud; 6 – inferior half-bearing; 7 - transducer subassembly; 8 – resistive transducer.*

In Figure 2 it is represented the assembly of the bit bearing, and its sealing which use an "O" ring made from rubber, 4. The sealing ring 4 works in a medium 3, which consists in lubricant grease usually used for the bits bearing lubrication. The fixed part of the bearing 6 is interlocking with the subassembly 7, which contains the resistive transducer 8 and is fastened on the supported table of the stand.

During the tests the both parts of the bearing were dipped in a medium 5, which it is formed of drilling mud. It has to be mentioned that the frontal part of the moving half bearing is equipped with an especially profile which consists in a plain screw fillet with reverse direction of the one which characterize the bearing movement. The purpose of this profiled surface is to not permit the drilling mud penetration inside the bearing.

On the above presented testing stand there were tested "O" rings made from rubber, which have the dimensions: the internal diameter 59.2 mm, the diameter of the ring – 5.7 mm.

The tested "O" rings were made from three types of rubber, which have the main mechanical characteristics presented in Table 1.

Table 1: Mechanical characteristics of the "O" rings rubber

Mechanical character-ristics	The type of the rubber		
	Fluorinated	Nitrile	Nitrile hydrogen-nated
	The commercial name		
	VITON	NBR	HNBR
Breaking strain [MPa]	12	18	20
Elongation [%]	180	250	250
Modulus of elasticity [MPa]	5	4.5	4.5
Hardness [^{o}ShA]	80	80	80
Compression overstrain [%]	70h x 200^{o}C max 20	70h x 100^{o}C max25	70h x 150^{o}C max 30

The others testing conditions were: lubricant grease with calcium type CaEP2M; the rotative movement of the bearing 130 rot/min; sliding speed on the internal "O" ring surface 0.403 m/s.

3. RESULTS AND DISSCUSIONS

During the test there were determined the following parameters values: the moment of rotation due to the friction between the “O” ring sealing and the bit bearing (friction moment); the temperature of the bearing; the “O” ring wear; the time.

In Figures 3, 4 and 5 there are represented the dependence between the friction moment and time for each type of rubber used for the “O” rings construction.

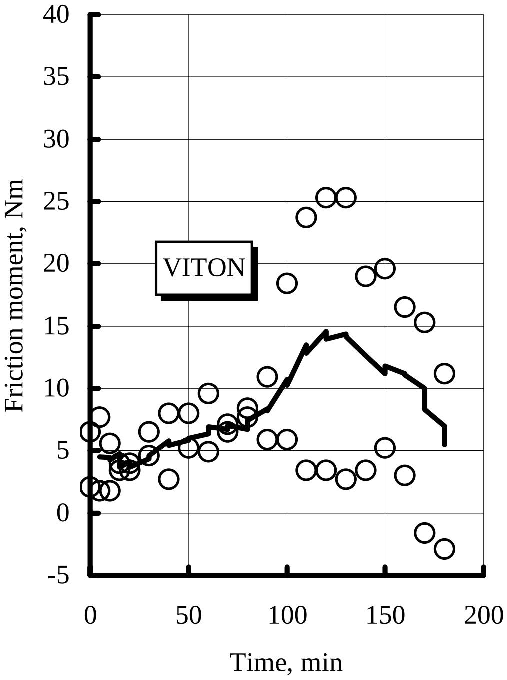

Figure 3: *The friction moment vs. time for the „O” rings made from rubber type VITON*

It can be observed that the small variations and values of the friction moment appear in the case of the HNBR rubber (Figure 5). Also, it can be remarked for all the tested rubber types that the friction moment has an increasing evolution during the first 120 minutes. After this time the registered values decrease (for the rubber type VITON and NBR) or they are maintained approximately constants (for the rubber type HNBR). For the rubber type VITON they were registered “negative” values of the friction moment (Figure 3). This fact appears due to the adhesion tendency of the ring with its contact bearing zones. The highest values of the friction moment were appeared for the rubber type NBR (Figure 4).

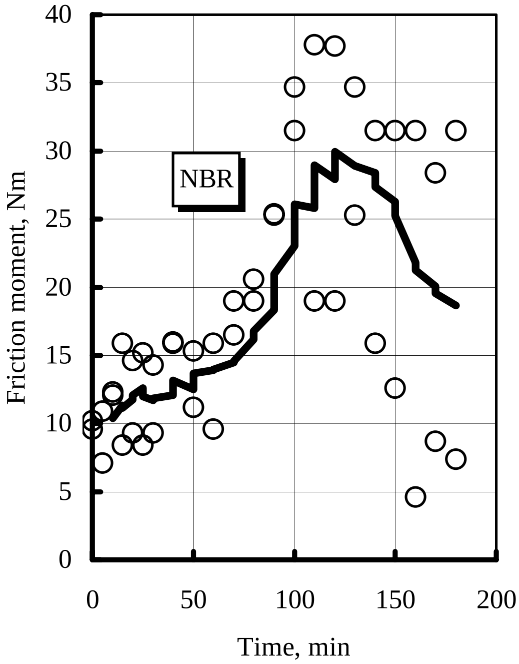

Figure 4: *The friction moment vs. time for the „O” rings made from rubber type NBR*

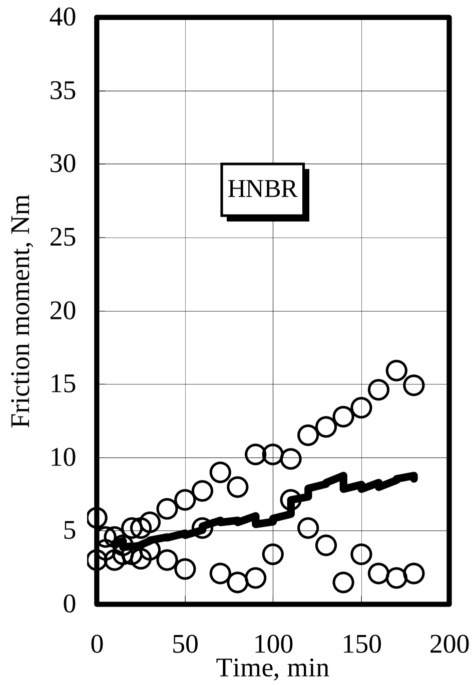

Figure 5: *The friction moment vs. time for the „O” rings made from rubber type HNBR*

Regarding the bit bearing temperature during the tests the maximum reached values were in the range of 60 … 76 ^{o}C (Figure 6). The low temperature values were registered for the rubber type HNBR, and the highest values for the rubber type NBR. Also, it can be observed that for the rubber type VITON the difference between the equilibrium temperature and the initial temperature is minimum by comparison with the others rubber types.

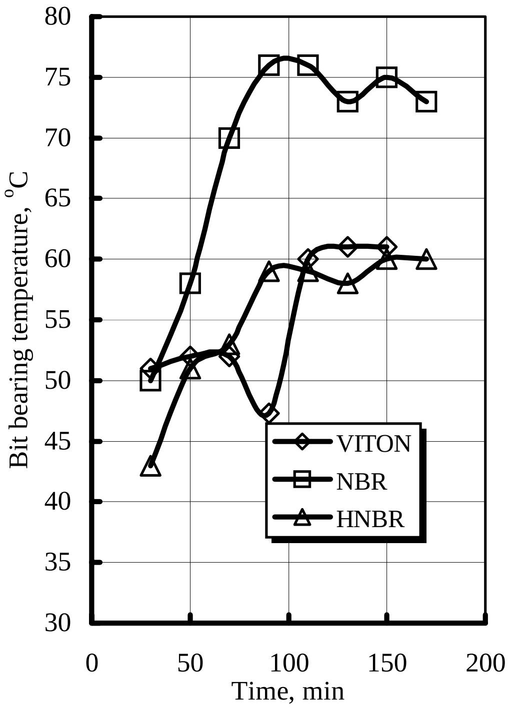

Figure 6: *Bit bearing temperature vs. time for different tested rubber types*

In Figure 7 it is represented the dependence between the weight wear and the breaking strain of the rubber. From this figure it can be observed that for the rubber type HNBR, which has the high value of the breaking strain the weight wear registered the lowest values. Also, on the diagram it is represented the regression line. The regression relation who corresponds of this line is:

$$W = -6.7237 \cdot BS + 155.17 \qquad (1)$$

where: W is the weight wear, g x 10^{-3}; BS is the breaking strain, MPa. The determination coefficient of the regression relation (1) is R^2=0.8923. This value shows a good correlation between the variables taken into account.

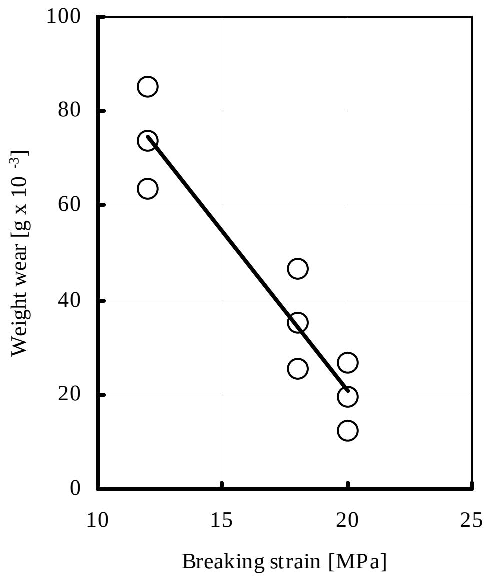

Figure 7: *Weight wear vs. breaking strain*

4. CONCLUSIONS

The testing methodology above presented permits the effectuation of the researches concerning the exploitation behavior of the three-cone bits sealing rings. Also, on the described testing stand it can be done determinations regarding the thermal regime of the bits bearing and the weight wear of the sealing “O” rings.

Analyzing the results presented in this paper it can be concluded that the nitrile-hydrogenated rubber HNBR has the best behavior in exploitation and can be recommended for the construction of the “O” rings used for the sealing of the bits.

REFERENCES

[1] Cristea, V., Gradisteanu, I., Peligrad, N., Instalatii si utilaje pentru forarea sondelor, Editura Tehnica, Bucuresti, 1985

[2] Radulescu, Al., Carnet tehnic. Utilaj petrolier-foraj, Editura Tehnica, Bucuresti, 1975

[3] Pavelescu, D., Tribotehnica, Editura Tehnica, Bucuresti, 1983