BOTTOM HOLE SHOCK ABSORBER APPLICATION IMPROVES DRILL CORE BIT PERFORMANCE IN WIRELINE DRILLING

Nikolay Nenkov, Shteryo Lyomov

University of Mining and Geology "St. Ivan Rilski", Sofia 1700

ABSTRACT. This paper focuses on the application of bottom hole shock absorbers in wireline drilling operations. An attempt to explain the theoretical background of the borehole and core spiralling is made. Some laboratory and field results from bottom hole shock absorber testing are presented.

ПОДОБРЯВАНЕ НА РАБОТАТА НА СКАЛОРАЗРУШАВАЩИЯ ИНСТРУМЕНТ ПРИ СОНДИРАНЕ С ИЗВАЖДАЕМИ ЯДКОПРИЕМНИ ТРЪБИ И ПРИЛАГАНЕ НА ЗАБОЙНИ АМОРТИЗАТОРИ

Николай Ненков, Щерю Льомов
Минно-геоложки университет "Св. Иван Рилски", София 1700

РЕЗЮМЕ. Високите честоти на въртене и осови натоварвания при проучвателното ядково сондиране с изваждаеми ядкоприемни тръби поставя редица проблеми като висок въртящ момент за сондиране, вибрации, спиралообразуване стените на сондажа и ядката, интензивно износване на сондажния инструмент и намален напредък както и механична скорост.
В стаята се разглежда проблема за повишаване производителността и качеството на сондиране с помощта на забоен амортизатор при сондиране с изваждаеми ядкоприемни тръби. Направен е опит за теоретично изясняване на причините за спиралообразуване. Дадени са резултатите от проведените изпитания на оригинална конструкция забоен амортизатор, както в лабораторни така и в промишлени условия.
Направените изводи показват, че прилагането на забойни амортизатори позволява да се разкрият допълнителни резерви за подобряване на технико-икономическите показатели на сондиране.

Introduction

High RPM and WOB in wireline drilling operations leads to excessive torque, vibration, borehole walls and core spiralling, and reduces core bit footage. Due to vibrations often the drill bit and drill string wear is considerable, while ROP decreases as well as the overall drill bit productivity i.e. less meter drilled per bit. Its observed also increased effect of natural deviation tendencies in cases where intensive micro (high frequency, low amplitude) vibrations modes of the system drill bit/string borehole exist.

Theory

Theoretical studies have shown that the problems have several sources. So far "perfect" picture and theory of its explanation doesn't exist. The core/borehole walls spiralling are result from the core bit interaction at the bottom of the hole. Most accepted theory is related with bit whirling with epicycloidsal (The path traced out by a point *P* on the edge of a circle of radius *b* rolling on the outside of a circle of radius *a* – Figure 1) and hypocycloidal (The curve produced by fixed point *P* on the circumference of a small circle of radius *b* rolling around the inside of a large circle of radius $a>b$ – Figure 2) rotations/movements.

At certain geo-technical conditions of drilling (rock hardness, rocks anisotropy, WOB, RPM, borehole-drill string geometry) the core bit rotates around a certain centre of rotation different from the borehole axis. This cause whirling as said above in open epicycloidal or hypocycloidal curves. The length travelled by single cutting structure can be as longer as 25% or even more.

This phenomenon explains why the same core bit type at same conditions might manifest different performance in term of rate of penetration and meterage.

Avoiding those problems can be achieved by two major ways technological and by use of Bottom Hole Shock Absorber (BHSA) as a part of the wireline core barrel.

The first approach requires reducing the weight on the bit and/or rotational speed. This leads decrease of the ROP and drilling daily production.

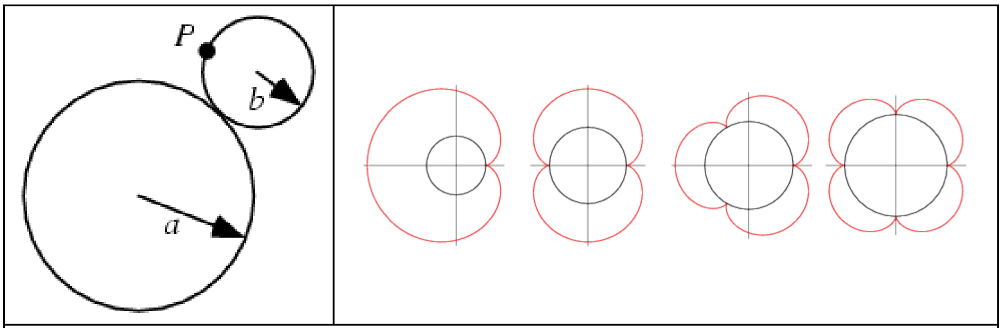

Fig. 1. Epicycloids

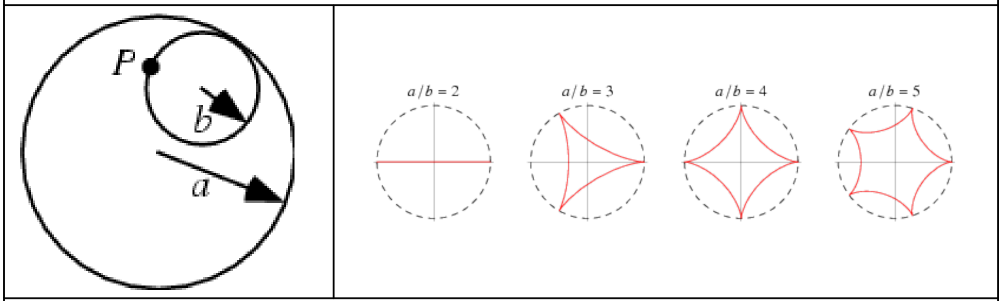

Fig. 2. Hypocycloids

The second approach applies by use if the bottom hole sock absorber. In drilling operations it applications the BHSA reduces the axial vibrations and provides continuous contact between the core bit and the bottom of the hole, which helps reducing core bit vibration and thus bit whirling, wear, drill string fatigue accumulation. The BHSA is placed between the reamer and the core bit Figure 3.

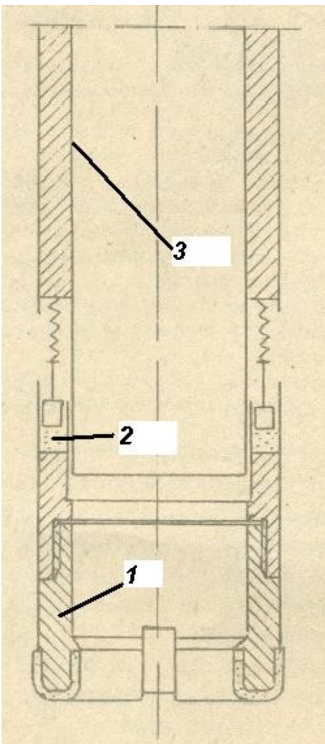

Fig. 3. Bottom hole shock absorber
(1 – core bit, 2 – bottom hole shock absorber, 3 – inner core barrel)

Its aimed to dampen the micro vibrations with an amplitude up to ca. 8 - 10 mm at optimal WOB and RPM.

Bottom hole shock absorber.
In an extensive research study BHSA 46, 59, 76 and 96 mm were developed. The design of the tool consists of the following components:

- Upper sub
- Upper semi ring
- Inner spring ring
- Outer spring ring
- Lower semi ring
- BHSA outer barrel
- BHSA Inner barrel
- Lower sub.

A spring performance curve for NQ –size BHSA spring is shown at Figure 4.

The BHSA – 59 was used in drilling operations at “Elshitza” ore deposits, near Panagurishte. The BHSA was applied at depth from 90 to 450 m. 40 drill bit were observed in the study. In 20 of the cases BHSA was used while the 20 were used as a control to compare BHSA performance.

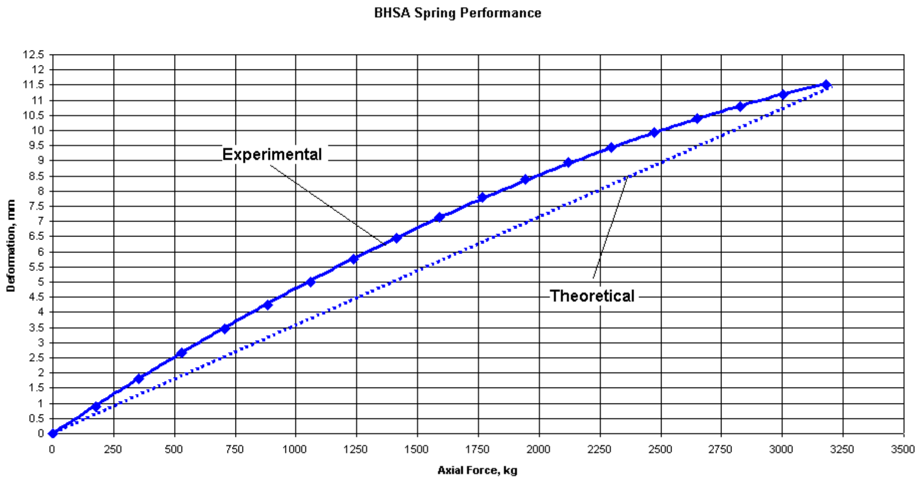

Fig. 4. BHSA spring performance experimental and theoretical

The rock conditions were andezites with quartzs, datzites, porfirites and granodeorites. Rock drillability index was in the range 8 and 9. The results are presented in table bellow.

Nr.	Parameter	BHSA	Conv.
1.	Core Bit Footage, m	24,8	18,6
2.	ROP, m/h	1,8	1,5
3.	Bottom hole power, kW	2,0	1,9
4.	Specific bottom hole power, kW.h/m	1,12	1,25
4.	Avrg Run, m	1,7	1,8
5.	Footage	494	372
6.	Outside diameter wear, mm	0,55	0,71

In Figure 5 below is shown the ROP in drilling with and without BHSA and specific bottom hole power at the bit in both cases.

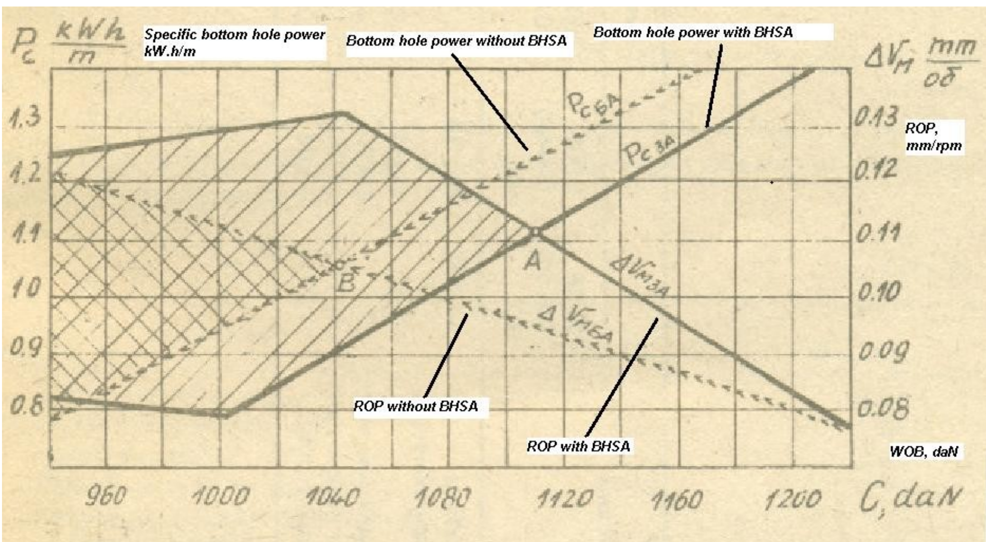

Fig. 5. ROP and Specific bottom hole power

Figure 6 shows effect of BHSA on cores formed during drilling. from drilling without and with application of a BHSA.

Fig. 6. A - core obtained in drilling without BHSA; B – core obtained in drilling with BHSA

When BHSA is employed in WL drilling operations the following main advantages are achieved:

Reduces vibrations;
Increases the ROP;
Decreases the specific drilling energy (Nbit/ROP);
Eliminates the borehole/core spiralling;
Increases the core bit footage;
Reduces the borehole deviation tendencies;
Less need for on-bottom core bit sharpening;
Reduces the core blocking;
Reduces the dynamic loads on the drill string and improves its performance.

Conclusions

The results prove that the application of bottom hole shock absorber in wireline drilling improves drill bit performance and overall drilling project economy. Bottom hole shock absorbers are prospective bottom hole tools that have huge potential in improvement wireline drilling efficiency.

Recommended for publication by Department of Drilling and Oil and Gas Production, Faculty of Geology and Prospecting