BULETINUL Universităţii Petrol – Gaze din Ploieşti	Vol. LXVII No. 1/2015	113 – 118	Seria Tehnică

Interpretation of Rock-Bits Wear

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Abstract

An analysis of the bit wear provides information about the consistency of a bit with the rock, about the future orientations of the manufacturing company, correctness of the drilling practice used in work and about the decisions made in selecting a next bit. There are several methods of encoding and analysing the bit wear. The onsite data taken in view of utilising rock bits can be used on three oilfields i.e.: Colibasi, Piscuri Filipesti and Caragea

Key words: *wear, consistency, encoding, proposals of readjusting denominations, other factors of wear influence*

Encoding of Bit Wear

A. Encoding of bit wear according to STAS:

Wear of Teeth is encoded for the three "D" types for excessive wear, (even), "DR" for teeth breakage and "DN" for uneven wear. Encoding of wears per each teeth row is assessed into % (quarters), of the teeth height, as follows: code"1" corresponds to 0...25% wear; code "2" corresponds to 25...50% wear; code "3" corresponds to 50...75% wear; code "4" corresponds to 75... 100% wear;

Wears can be of two types: by self-sharpening / bit dressing (code "A") and blunting (code "T"). Breakage of teeth are assessed into % (quarters) of the total number of each crown with codes 1...4 like in encoding of each row wear. For an example: d-(4T-2T-4T)(2T-2T-3A)(2T-2T-4T). This means: uneven worn teeth bit; in roller 1, rows 1 and 3 and in roller 3 row 3, wear of 75...100%; in roller 2, row 3, wear of 50...75 % and for the others, 25...50%. All wears are by blunting except for roller 2; row 3 that is worn by self-sharpening.

Wear of Bearings is shown by indicating: the general code of wear: "L" for proper wear and "LB" for blocked bearings; degree of wear, indicated within brackets per each roller cutter apart (in the order of the roller number) and by indicating the radial or axial (only the largest, into mm). Example of written down grading: L (1.5-1-2).

That signifies encoding of the wear of a bit having the bearing of roller 1 with a maximum clearance of 1.5mm, for the roller 2 the clearance is of 1mm, and for roller 3 the bearing maximum clearance is 2 mm.

B. Encoding of bit wear according to I.A.D.C. is the most frequently used worldwide and starting from 1999 it is also applied in Romania. The manner how rock bit wear occurs brings

essential information about what happens at the well bottom during work. Information refer to two aspects: bit consistency with the crossed formation and the drilling practice of the bit in the bottomhole. IADC established eight factors allowing for encoding of the wear of a rock bit. The first four refer to the active part or cutting structure and we have: internal cutting structure -1, external cutting structure -2, main wear - 3; location of wear on active part– 4; the next two refer to bearings and size (wear on diameter): bearings – 5, bit caliber-6; and the last two to atypical wear and because of bit withdrawal: other types of wear -7, cause of bit withdrawal – 8.

The tracking log of a bit includes 8 columns (table 1) each of which hosting one of the eight factors the significations of which will be presented hereinafter:

Table 1. Bit Tracking Log

Inner Rows	**Outer rows**	**Wear Feature**	**Location**	**Bearing Wear**	**Nominal Dia. Wear**	**O**	**R**
1	2	3	4	5	6	7	8

In column 1 wear is described of the inner area **I** (inner) of the active part and namely the one limited by a radius equal to 2/3 of bit radius measured from its centre towards outside. Because it expresses into eighths a linear scale is used from 0 to 8 in order to describe wear of cutting elements (teeth, nose, diamonds, tips of polycrystalline).

In column 2 wear is written for outer area **O** (outer) a circular crown with inner radius equal to 2/3 of the bit radius measured from centre to outside taking outer radius equal to bit radius.

Wear is also described into eighths as in previous case.

In column 3 the manner is specified how wear **D** (dull) occurs. Table 2 shows codes to add up column 3 (and 7) and their significations.

In column 4 the **L** wear location is shown. Location of wear (column 4) is encoded with roller bits by two elements: the first is a letter specifying the place on the roller along the generatrix of the teeth row and a cipher specifying the number of the roller – **N (**nose row**)**, **M** (middle row) in the median area of the roller, **H** (heel row) on the basic crown, **A** (all rows) on all rows, on rollers **1**, **2** or **3**; in diamond bits wear is shown by one of the six initials of the various areas on active part: **C** (cone) on roller, **N** (nose) maximum prominence, **T**(roller) transition (elongation) area, **S** (shoulder) on the bit shoulder, **G** (gauge) on the size (overall) area and **A** (all) across all the active face.

In column 5 wear of bearings is written **B** (bear) and takes into respect the type of bearing. For open bearings there is a **0** to **8** linear scale (wear is depending on the time of rotation in the bottom versus the total service life of the bearing). 0 indicates a new bearing and 8 indicates a completely worn bearing. In sealed bearings (rolling of friction bearings) wear is marked by one of the following three letters - **E** (effective seal), **F** (failed seal), **N** (not able to grade), and for fixed cutting bits letter **X** is used – bits without bearings (diamond bits).

In column 6 wear is written per diameter (of gauging), **G** (gauge) is expressed into sixteenths of inch (1/16). The nominal diameter bit will have the code **I** (in gauge), there is no reduction of diameter. 1/16 stands for the reduction in diameter by this value. This wear is measured by means of the annular gauge. For roller bit rules 2/3 is applied. More specifically, the gauge is fixed so that to come in touch with two rollers outside while clearance in front of the third roller is multiplied by 2/3 ratio in order to establish the overall wear value.

In column 7 written with letter **O** (Other Dull Characteristics) the same symbols are used like in column 3, but also specifications are made about the state of wear of other areas of the bit.

In column 8 written with letter **R** (Reason Pulled) the reason is shown for bit withdrawal. Symbols composed of two or three letters are written in Table 3 that are used in adding up the column.

Table 2. Indicator 3 Featuring of wear D

Item	Code	Code meaning	Signification in English language
1	BC	Broken roller	Broken Cone
2	BF	Loss of polycrystalline tips	Bond Failure
3	BT	Broken cutting elements	Broken Cutters/Teeth
4	BU	Balled up bit (mud sleeves)	Balled Up
5	CC	Fractured roller	Cracked Cone
6	CD	Blocked roller	Cone Dragged
7	CI	Roller coming in touch	Cone Interference
8	CR	Central wear	Cored
9	CT	Chip broken cutting elements	Chipped Cutters/Teeth
10	ER	Erosion	Erosion
11	FC	Crest flattening	Flat Crested Wear
12	HC	Bit overheating	Heat Checking
13	JD	Wear due to junk on bottom	Junk Damage
14	LC	Bit overheating	Heat Checking
15	LN	Expelled (lost) nozzle	Lost Nozzle
16	LT	Lost cutting elements	Lost Cutters/Teeth
17	OC	Eccentric wear	Off Centre Wear
18	PB	Wear by pinches	Pinched Bit
19	PN	Plugged nozzle/cooling channel	Plugged Nozzle/flow passage
20	RG	Rounding across guiding area	Rounded Guide
21	RO	Wear ring	Ring Out
22	SD	Wear on jaws	Shirttail Damage
23	SS	Wear by self-sharpening	Self-Sharpening Wear
24	TR	Wear by hauling bit on bottom	Tracking
25	WO	Bit washing out	Wash Out on Bit
26	WT	Worn cutting elements	Worn Cutters/Teeth
27	NO	Does not show any wear	No Dull Other Wear

Table 3. Causes for Bit Withdrawal

Item	Code	Code meaning	Signification in English language
1	BHA	Change of the bottomhole assembly	Change Bottom Hole Assembly
2	CM	Conditioning of drilling fluid	Condition Mud
3	CP	Sampling of mechanical core	Core Point
4	DMF	Failure of bottomhole motor	Down Hole Motor Failure
5	DP	Development of cement plug	Drill Plug
6	DSF	Failure of drill string	Drill String Failure
7	DST	Procedure for isolating and testing the pressure, permeability and productive capacity of a geological formation during the drilling of a well	Drill Stem Test
8	DTF	Failure of operating tools	Down Hole Tool Failure
9	FM	Change in the lithology of geological formation	Formation Change
10	HP	Difficulties in drilling	Hole Problems
11	HR	Achievement of times of keeping bit on bottom	Hours on Bit
12	LOG	Performance of geophysical investigations	Run Logs
13	LIH	Metallic remains in the bottomhole	Left in Hole
14	PP	Raise of pumping pressure	Pump Pressure
15	PR	Decrease of penetration rate	Penetration Rate
16	RIG	Repairs in the drilling rig	Rig Repairs
17	TD	Reaching of final casing depth	Total Depth/Casing Depth
18	TQ	Table twisting momentum	Torque
19	TW	Pipe breaking due to twisting.	Twist Off
20	WC	Unfavourable climate conditions	Weather Conditions
21	WO	Washout bit or drill string	Wash Out Bit or Drill String

Proposals for Adaptation of Literal Code Signification in Some Bit Wear Featuring

Hereinafter we tried to adapt in tabular form the due meanings and explanations, as applicable, corresponding to the English significance for the main codes featuring wear (D), by means of words having letters identical, likely or at least half of them compared to English letters in the codes. I was successful in a percentage of 71-74%.

If English people explain it in as few words as possible (sometimes two or even a single one) why shall we, Romanian, use more and very often much more? Examples: „Rounded Guide", marked with symbol RG means „Rounding in the guiding area"- it could be more simply translated with „Guide rounding" or „Circling of guide" or „guide circle"- that is also a rounding as the name comes from „circle" which means „round shape"; or Cracked Cone, symbolised CC translated „fractured roller" could be adapted to „Chapped cone", that would be the same; or, for code CI- „cone interference" it could be said „interfered cones"... And the examples may continue. Below, my adaptations have been arranged in two tables (4 and 5).

For the causes of bit withdrawal before completion of the work, we propose the significations indicated in Table 5.

In view of an analysis in as much correct as possible, results were herewith considered that were obtained in utilisation of three roller rock bits both in the country in wells under patrimonial property of the SNP PETROM S.A. and abroad in wells of Kazakhstan performed by S.C. UPETROM FOSERCO S.A. for various beneficiaries under the same conditions of operation.

Moreover, other valuable information were obtained by consulting various specialty literature among which [1] and [5]; to the same extent, information related to bit drilling can be obtained directly from well logs concerning bit withdrawn, hydraulics, teeth, details from bits in the area, formation, fluid etc.

Table 4 Signification proposed for codes

Item	Code	Code Meaning/ Proposed Signification	Signification in English
3	BT	Broken cutting elements/ Cutter breaking	Broken Cutters/Teeth
4	BU	Balled-up bit (mud sleeve muffed)./ Cuttings accumulation	Balled Up
5	CC	Cracked roller/ Broken cone.	Cracked Cone
6	CD	Locked roller/ Brought along cone (dragged or draggled).	Cone Dragged
7	CI	Roller interference/ interfered cones	Cone Interference
8	CR	Cantered wear/ Centralization of eating away (wear off).	Cored
9	CT	Broken cutting elements/ Chipping of cutter(teeth)	Chipped Cutters/Teeth.
11	FC	Flattening on top / Shattering of crests.	Flat Crested Wear
12	HC	Overheating of bit/ Cone hot run	Heat Checking
14	LC	Cone left in the well/ lost cone	Lost Cone
15	LN	Expelled (lost) nozzle/ Lack of nozzle	Lost Nozzle
16	LT	Lost cutting elements/ lack of cutters	Lost Cutters/Teeth
19	PN	Nozzle/cooling channel being plugged / Obstructed passage (for nozzle or flow channel)	Plugged Nozzle/flow passage
20	RG	Rounding in guiding area / Guide rounding	Rounded Guide
23	SS	Wear by self-sharpening / Damaging of bit structure	Self-Sharpening Wear
24	TR	Wear by pulling the bit on bottom/ Hauling with rounding	Tracking
26	WT	Worn cutting elements/ Wear of cutters	Worn Cutters/Teeth
27	NO	No wear /Not worn	No Dull Other Wear

Table 5. Signification proposed for some codes of bit withdrawal

Item	Code	Code Meaning/ Proposed Signification	Signification in English
2	CM	Conditioning of drilling fluid / Conditioning of mud (sludge)	Condition Mud
3	CP	Sampling of a mechanical core / Sampled core	Core Point
5	DP	Execution of a cement plug / Plug for well plug back (cement).	Drill Plug
6	DSF	Damaging of the drill string / Drilling system damaging	Drill String Failure
8	DTF	Failure of operating tools / Damaging of tools	Down Hole Tool Failure
9	FM	Change in the lithology of the geological formation / Altered rock formation	Formation Change
10	HP	Difficulties in drilling / Drilling problems/ Oilfield malfunctioning	Hole Problems
11	HR	Achievement of bit bottomhole holding interval /Completed (drilled) hours	Hours on Bit
12	LOG	Completion of surveys/ Logging	Run Logs
13	LIH	Scraps left over the bottomhole / Metal interposed on bottom	Left in Hole
14	PP	Increase in pumping pressure / Increased pumping pressure	Pump Pressure
15	PR	Decrease of penetration rate / Slow-down penetration	Penetration Rate
16	RIG	Repairs in the drilling rig / Repairs in string installation	Rig Repairs
17	TD	Reach the ultimate depth / casing depth/ Finalised bottom	Total Depth/Casing Depth
19	TW	Breaking of pipes due to twisting / Drill pipe twist off	Twist Off
20	WC	Unfavourable climate conditions / Bad weather/ Weather conditions	Weather Conditions

Conclusions

There is a multitude of factors contributing to the wear of drilling bits: some of them are related to the material or technology of manufacturing bit, other to the structure and slope of geological strata, and other are depending on the bit operation. Other factors (causes) as well as steps to be taken were presented in Table 6 (see next page) were also failing to observe requirements were presented for the concerned wells. On the three geological fields: *Colibaşi, Piscuri- Filipeşti* and *Caragele* one or several of these factors were encountered in many wells and in some cases one factor was encountered several times.

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Table 6. Other possible causes and actions to prevent roller bits from getting worn

Causes	Failed Requirements	Preventing Actions
Bit low mechanical strength	Inadequate selection of bit	Reconsidering bit selection
Little traces (scratches) left by rocks on the bit	Torque increase may lead to starting first cracks	Change in diameter and tapering (crest angle) =bit selection upon soil structure
Inadequate ratio generatrix length versus bit diameter	Incorrect length and diameter affects accuracy of borehole	Adequately set out length and diameter
Tungsten carbide/ other material, improper.	Strength of cross section less cutting strength	Use of wear-resistant tungsten carbide (WC) materials
Bit not correctly balanced (centring error, difference in height and roller offsetting).	Evenness of the hole gets damaged after using asymmetrical bits showing wobble, height difference/ roller offset	Check geometrical points opposite to rollers and bit
Excessive diameter at taper part outside the bit.	Increased strength on cutting and occurrence of cracks	Check out the good part after bit withdrawal
Decreased load.	Increase in load decreases accuracy of hole and generates problems	Apply the right load according to drilling practice.
Overload	Cuttings plugging mark the bit and hole due to increasing the pulling force	Apply proper fluid and drilling practice
High speed of rotation axis (high RPM)	Due to an increase of cutting load rollers/bearings may damage/break	Apply the adequate RPM
Low RPM of the bit	Increasing the friction coefficient leads to wear and breakage of rollers and bearings	RPM shall be increased
Construction material and/or thermal/ thermochemical treatment are improper	The bit „jumps” out of contact with rock surface and gets worn and failed	Adequate conditions shall be observed to be according to the cutting practice
Improper drilling practice	Removal of cuttings may lead to plugging and bit wearing	Recalculate the drilling parameters involved
Thrust over allowed limits	Rocks generating more cuttings	Apply a more adequate regime
High alternation of layers	Increased cutting loads and occurrence of cracks	More moderate drilling practice
Overstressed rollers	Increase and interruption of cutting loads	Reconsider another regime of bit
Imprints of hits on bit cutting areas	They may generate deviation and breakage of some elements	More detailed checkout of bit on entering it downhole
Improper hardness of bit	Cutting elements become brittle, jump and accumulate scrap in the well	Reconsider thermal and thermochemical treatments
High stiffness of elements	Indent, cracking and breakage of elements	Reconsider the stiffness of elements
Uneven area of previous bit and insufficient run-in	It can lead to hole deviation, cracking and breakage of elements	Run-in shall be done to proper parameters
Uprightness of bit, drill string	It leads to uneven wears, deviation	Have derrick, drill string, bit balanced
Low tightening of bit	Uneven wears, scrap in the well (JD)	Check out the tightening torque

Interpretarea uzurii sapelor cu role

Rezumat

Analiza uzurii sapei dă informaţii despre compatibilitatea sapei cu roca, despre viitoarele orientări ale firmei constructoare, corectitudinea regimului de foraj aplicat şi despre deciziile de alegere a sapei următoare. Există mai multe metode de codificare şi de analiză a uzurii sapei.