ANALYSIS OF THE VARIATION OF MAKE-UP TORQUE ON THE THREADED AREA OF NC50 SPECIAL COUPLINGS

Ioana Gabriela STAN, Claudia Gerogeta NICULAE**

Abstract: *The special connection thread is a tension concentrator that can cause the break of the drill string. The values of the screwing moment in this area are relatively high and the analysis of the variation of these values is important. This paper presents the methodology for testing NC 50 special connections, analyzing the variation of screwing moment on the threaded area*.

Keywords: *drilling pipes, special connections, the moment of screw driving*

1. Introduction

The drilling string is composed mainly of drilling pipes (the number of steps formed by drilling pipes is much higher than the number of steps made from the other types of rods: heavy weight or intermediate drilling pipes).

According to the RP 7G API for 5 1/2 inch drilling pipes, type S 135 steel, the nominal dimensions of the NC 50 special connection are shown in table 1.

Table 2 shows the dimensions of the NC 50 thread joint and figure 1 shows the API thread geometry V-0.038R.

Table 1 *Nominal Standard API Dimensions for Special NC50 Connection*

Dimension	*Nominal value [mm]*	*Tolerance [mm]*
Outside diameter of pin and box	168,275	±0,794
Inside diameter of the pin	69,850	+0,397 - 0,794
Pin tong space	177,8	±6,350
Box space	254	±6,350
Box Counterbore	139,9375	±0,794
Bevel diameter of pin and box shoulder	153,988	±0,397

Table 2 *The dimensions of the V-0.038R thread*

Thread geometry	Conicity mm/m	Theoretical hight of the thread, H	The hight of the truncated tread, $h_n=h_s$	Truncation		Chamfer width		Bottom radius of the thread, $r_{rn}=r_{rs}$	Radius of thread edges, r ±0,20 mm
				Bottom, srn=srs $f_{rn}=f_{rs}$	Top, $f_{cn}=f_{cs}$	Top, $F_{cn}=F_{cs}$	Bottom $F_{rn}=F_{rs}$		
V-0,038R	166,67	5,4865	3,0948	0,9652	1,4265	1,65	–	0,97	0,38

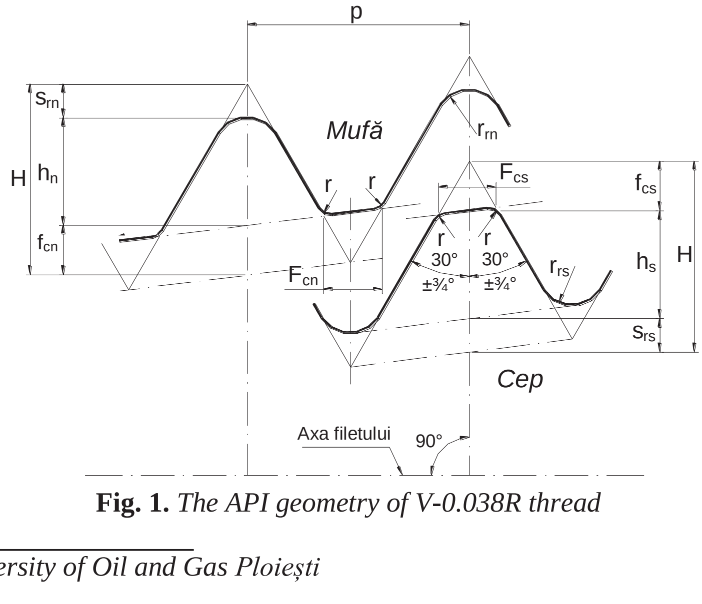


Fig. 1. *The API geometry of V-0.038R thread*

* *Lect.Ph.D.eng., University of Oil and Gas Ploiești*

2. Presentation of thread testing methodology

Numerous screwing and unscrewing of drilling pipes lead to quick thread wear. Therefore, the thread is a tension concentrator and the screwing moment on the threaded area is very important.

The test specimens used to perform the experimental experiments were 5 inches drilling pipes of S135 resistance class with NC50 thread joints. The test specimens were new. Figure 2 shows the geometry of the box and pin tested.

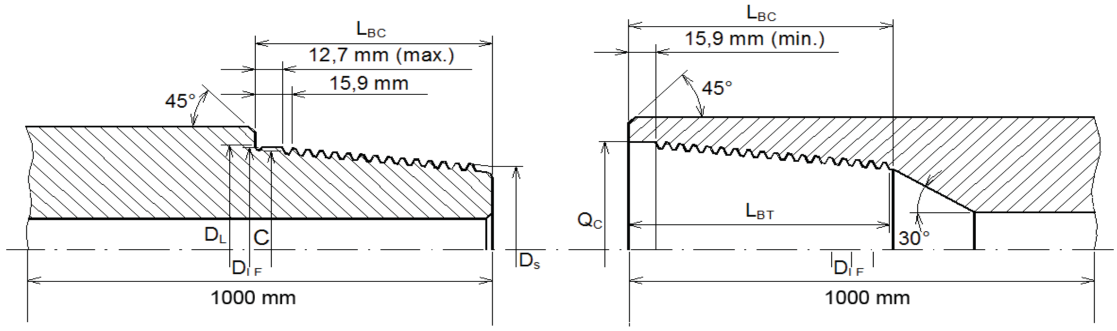


Fig. 2. *The geometry of the tested specimens a) box; b) pin*

Test methodology consisted of the following steps:

1) Check the dimensions of the pin and box threads

Checking the dimensions of the thread of the pin and the box consisted in measuring the dimensional deviations of the pin and the box, respectively, checking the thread profile. The values of the measured dimensions are as shown in Table 3. By comparing these measured values with the API standard dimensions it has been found that the special fitting corresponds to the Premium wear class, with no dimensional deviation compared to the standard ones. Thread profile verification was performed using the thread microscope. The conicity, flank angle, thread pitch and no profile deviation were found.

Table 3 *Measured dimensions og the tested specimens*

Measured dimension [mm]	**Specimen 1**	**Specimen 2**
Outside diameter of box	156	156,4
Inside diameter of the pin	69	69,5
Box shoulder width	7	7
Length of the box	267	267
Length of the pin	186	186
Depth of clearance for sealing the box	18,5	18
Box counterbore	135	135,5
Sealing shoulder length	7	7
Pin neck length	9	9
Total length of the specimen	2000	2000
Thread joint specimen	NC50	
Thread geometry	V-0,038R	

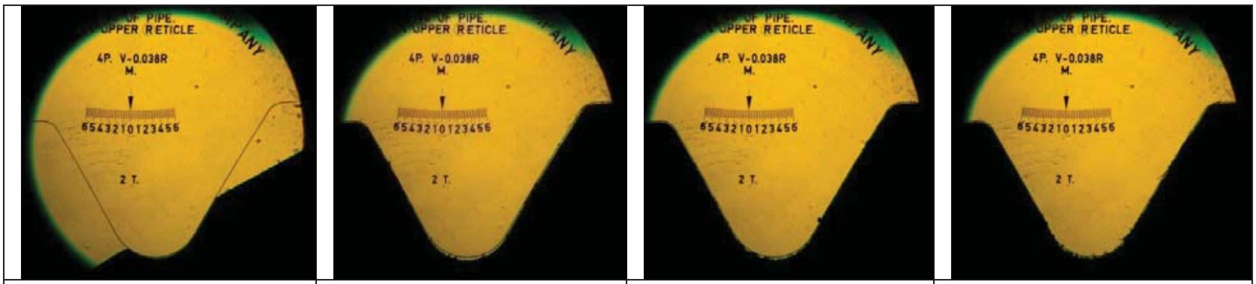
Figure 3 shows some eloquent images of the threaded profile verified with the thread microscope.

2) Preparation the connection thread

The preparation of the connection thread consisted of washing with diesel, cleaning and degreasing using MEK (Methyl Ethyl Keton) and drying under compressed air.

3) Apply the solid grease to the thread

A special grease (Jet Lube 21) for drilling pipes has been used to lubricate the thread of the plug and pin. According to the requirements of the API standard (2), 15 grams of grease were applied to the pin and box thread and 15 grams of grease on the the front face of the box.



Spire 1	Spire 4	Spire 8	Spire 13

Fig. 3 *Verification of the thread profile*

4) Gripping the specimen in the testing machine

Before gripping the specimen to the testing machine, a manual pre-screwing of the joint was performed until the front face of the boxt reached a distance of 12,7 mm (the equivalent of two complete turns of the pin relative to the box).

After manual pre-screwing of the thread joint, the specimen was attached to the clips of the testing machine as follows: the pin was fixed in the movable clips and the box was fixed in the immovable clips.

5) Controlled joining of the thread joint until the optimum torque value is reached

To perform controlled screwing of the specimen with the testing machine, the working parameters were programmed in accordance with the NC50 special joints API prescriptions used for the S135 5-inch drilling pipes.

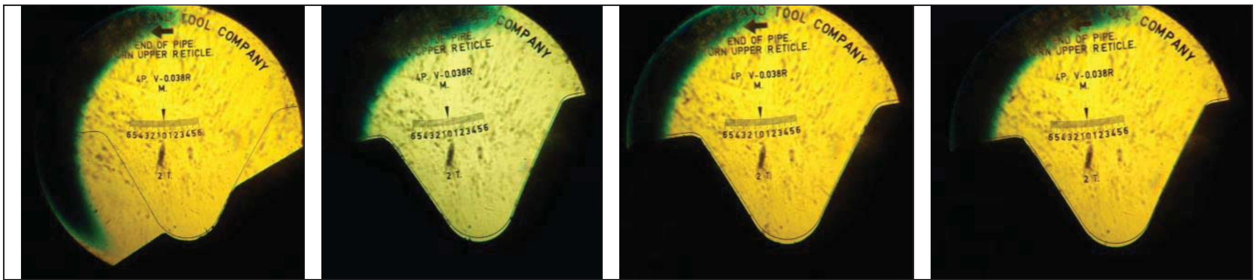
6) During the tests, the make-up torque values were determined depending on the angle of rotation until the prescribed make-up torque was reached.

After screwing, the specimen was unscrewed with 2 complete turns of the pin against the box, the distance between the front face of the box and the pin face being 12,7 mm (2 steps). Grease was applied only to the shoulder face and a new screwing was made.

After a total of 10 successive screwings, the connection was completely unscrewed, washed with diesel, cleaned and degreased using MEK (Methyl Ethyl Keton) and dried under compressed air.

The integrity of the thread and shoulder sealing was checked using the thread microscope to determine their wear.

Figure 4 shows the thread profile of the threads after 10 screws.



Spire 1 after 10 screwings	Spire 4 after 10 screwings	Spire 8 after 10 screwings	Spire 13 after 10 screwings

Fig. 4. *Verification of the thred after 10 screwings*

It can be noticed that the thread has not gripped and its profile does not deviate from the standard dimensions after the first 10 screws. The experiments resumed on the same connection by repeating the stages presented. After a further 10 successive screws, the connection was completely screwed off, washed with diesel, cleaned, degreased and dried under compressed air.

The thread profile deviations were checked and it was found that after 20 successive screwdrivers on the shoulder end there are traces of wear and the coils of the threads have deviations from the profile without the thread grips as shown in figure 5.

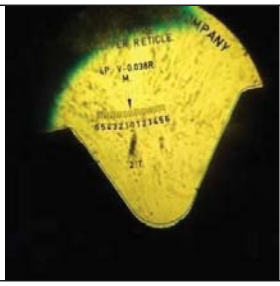
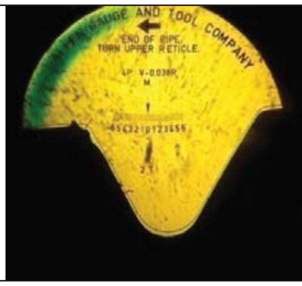
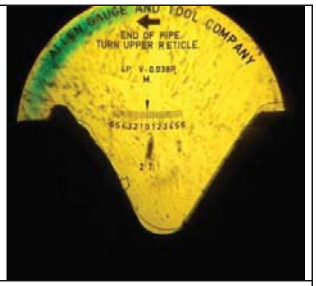
			
Spire 1 after 20 screwings	Spire 4 after 20 screwings	Spire 8 after 20 screwings	Spire 13 after 20 screwings

Fig. 5. *Verification of the thred after 20 screwings*

3. Experimental data

The processing of the experimental data is done for the analysis of the variation of the make-up moment until the front face of the pin is approached to the box seal part.

The screwing theoretical diagram (variation of make-up torque at screwing) is given in figure 6.

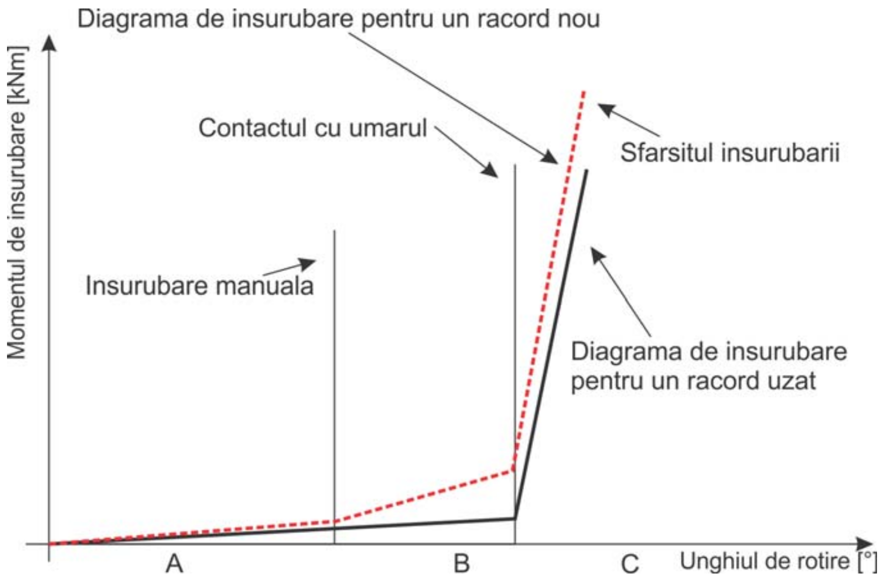


Fig. 6. *Screwing theoretical diagram for new and used specimens*

Region B corresponds to the situation when after the connection has been manually screwed until the front face of the box has reached a distance of 12.7 mm from the pin(the equivalent of two complete rotations of the pin relative to the box), the screwing continues on the testing machine, the make-up torque value increasing more pronounced in the case of the new joint than for a worn threaded joint.

For the analyzed specimens, the make-up torque diagram on the threaded area is shown in figure 7. Both the first screw of each specime and the eleventh (that is, the first screw after the thread has been washed, cleaned and checked) is performed at high make-up torque values due to the uneven or over-applied grease layer, the surplus being threaded during screwing to the threads.

4. Conclusions

On the screws of specimen 1, after 4-5 successive make-ups, an increase in the make-up torque value at the beginning of the clamping and a sharp decrease in its value is noted as the distance between the front face of the pin and the sealing surface of the box decreases.

This trend is also confirmed by the analysis of the screw thread moment variation for the specimen 2.

For the first 10 screws of the specimen 1, it is estimated that the value of the make-up torque at the start of the strain increases from 0.03 kNm, the first make-up to 0.1 kNm at the tenth make-up. The variation of the same moment for the 11-20 make-ups of the specimen 1 is from 0.11 kNm to the eleventh make-up at 0.28 kNm at the twentieth make-up.

For the second specimen, we identify a variation from 0.16 kNm, at the first make-up to 0.39 kNm at the tenth make-up and from 0.17 kNm to the eleventh make-up at 0.29 kNm at the twentieth make-up.

The values recorded before reaching the frontal face of the pin with the box are from 0.22 kNm, at the first make-up at 0.16 kNm at the tenth make-up for specimen 1 and from 0.58 kNm at the first make-up at 0.51 kNm at the tenth make-up for specimen 2.

The 11-20th make-up of the first connection lead to a variation of the make-up torque moment before reaching the front face of the pin with the box from 0.48 kNm to 0.18 kNm and for the second specimen from 0.53 kNm to 0, 49kNm.

At the first make-up of the specimen after the grease has been applied over the entire length of the thread, there are slightly increased values of the make-up torque moment for the approaching of the facets, which reflects a "difficult" make-up due to excess grease that is directed towards the sealing surface.

From the experimental make-up torque/ rotation angle diagrams, it is found that after 4-5 make-ups, the make-up torque moment of the lateral parts is increasing by 12.8% (relative to the mean screw thread momentum), which increases accentuates after several successive make-ups and corresponds to the spreading of solid component particles of grease on the thread flanks for the first 10 screws of the thread joints.

On 11-20th make-up of the specimen, an increase of 22% (relative to the average moment of make-up torque) is identified, an increase corresponding to the occurrence of traces of wear on the thread flanks.

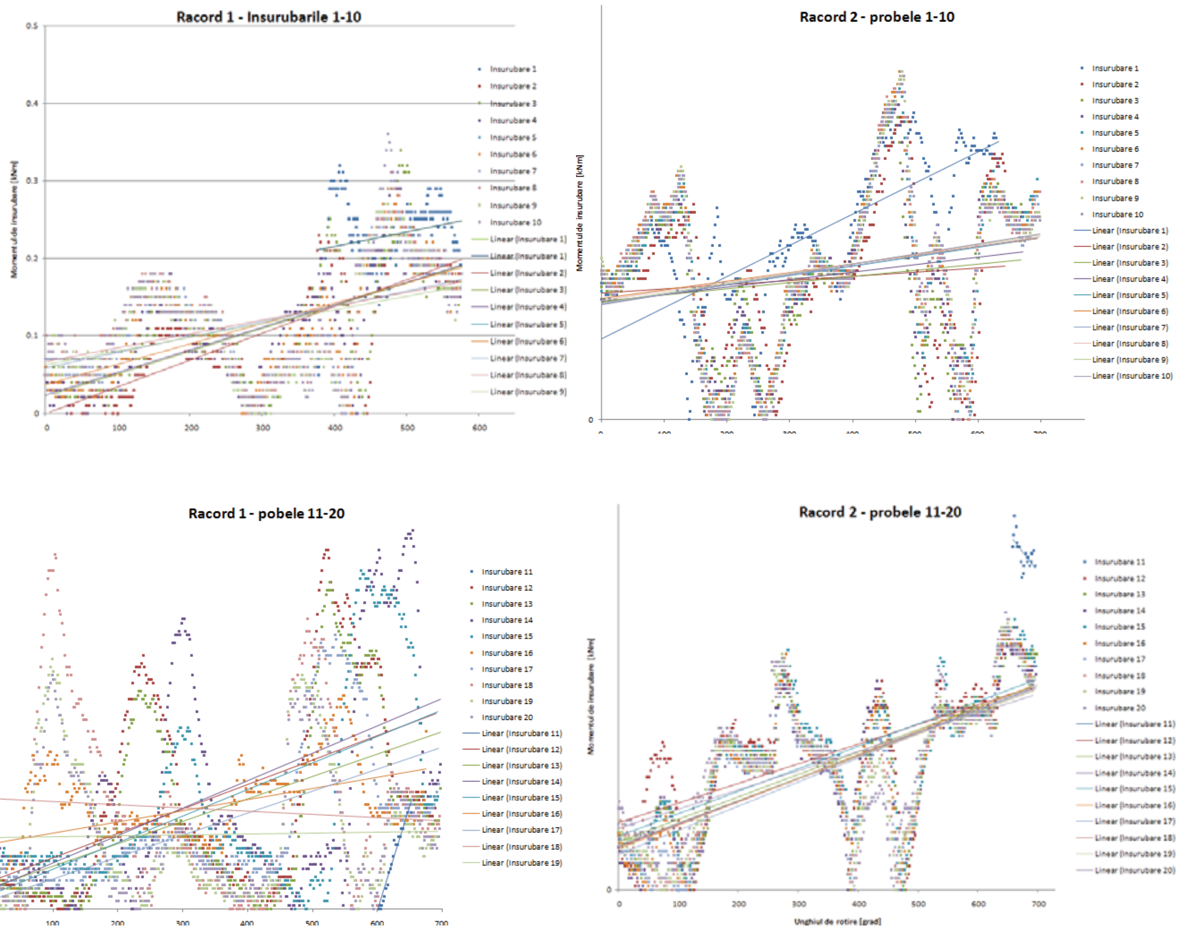


Fig. 7 *The experimental variation of the make-up torque on the threaded area*

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UNIVERSITY OF PETROȘANI