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The Effect of the Thread Compound Amount on the Make-Up Behavior of a Premium Connection

Marius Bădicioiu[*], Cătălin Teodoriu[**], Mihaela Călţaru[*]

[*] Universitatea Petrol – Gaze din Ploieşti, Bd. Bucureşti 39, Ploieşti, România
E-mail: mbadiciou@upg-ploiesti.ro
[**] Texas A&M University, Assistant Professor, College Station, Texas
E-mail: catalin.teodoriu@pe.tamu.edu

Abstract

This paper presents the experimental results of the make-up performance of a casing premium connection using different amounts of thread compound. The results showed a change of the torque-turn slope, which can be related to the final stress-strain state inside the connection. It was found that a high amount of dope reduces the slope of the shoulder torque, which has a negative effect. The thread torque slope shows a different variation as a function of the dope amount, having a maximum point at 70 g of dope.

Key words: *thread compound, make-up, grease.*

Introduction

When designing a good thread connection with application to Oil Country Tubular Goods, especially casing, three major aspects must be considered: the high resistance of the connection, the gas tightness (leak resistance) and the galling resistance. Usually, the high resistance of the connection is obtained by optimizing the thread geometry, together with high strength materials selection. On the other hand, the gas tightness is provided by the specific design of the metal-to-metal seal area, with the goal of maximizing the contact pressure. Galling resistance can be achieved, conventionally, by means of a lubricant (thread compound) that is applied between the contact surfaces. Modern threaded connections, so called "dope-less connections" are replacing the thread compound with special surface finishing combined with precise thread manufacturing. Generally, dope-less connections are expensive.

For conventional connections, a simple coating (phosphatizing) combined with a good lubricant can solve the galling issue. The problem yet unsolved is the optimum amount of thread compound to be applied on the connection. A too small amount of thread compound may lead to galling if the contact surfaces are not protected by the lubricant film, while applying dope in excess may lead to environmental problems and reduction of the connection resistance, due to additional induced pressure.

Compounds for Oil Country Tubular Goods (OCTG)

Typical threaded compounds for OCTG are formed using base grease in which solid particles are dispersed. The grease is a standard lubricating grease, made of mineral oil, and has a metal soap as thickener (i.e. aluminum stearate). Additives are also added to the compound, in very

low amount, to improve the following properties: the high pressure resistance, the wear protection, the corrosion protection, etc. The role of the solid particles is to provide the compound with anti-galling resistance and sealing properties. Powdered metals and non-metallic particles like graphite or ceramic spheres are used as solid ingredients. Typical metals used for threaded compounds manufacturing are: lead, copper, zinc. The common non-metallic solids used for compounds are graphite, PTFE, ceramics.

The so called "green dope" or environmental friendly compounds have a totally metal-free composition. The Figure 1 shows a classification scheme of thread compounds after [3]. According to [4], the performance general requirements of threaded compounds include: consistent frictional properties, adequate lubrication properties, adequate sealing properties, physical and chemical stability, both in service and in storage conditions, and properties that allow the efficient application of the compound on the connection surfaces. In addition, for RSC threaded compounds they should lubricate the connection during the make-up runs to achieve bearing stresses (buck-up force).

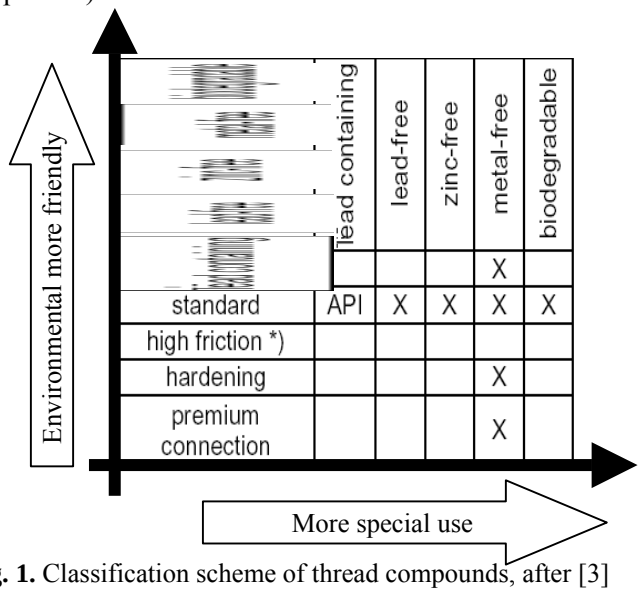


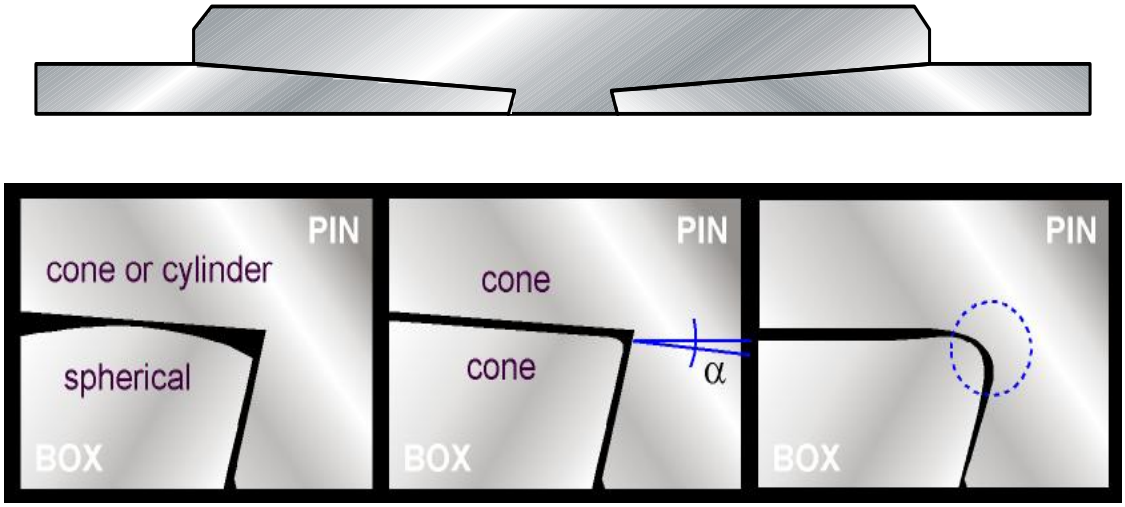
Fig. 1. Classification scheme of thread compounds, after [3]

Experimental Setup

For this study, a premium type casing connection has been used. The connection has a Buttress-thread type and the shoulder a 15 negative angle. The Figure 2 shows a schematic representation of the connection.

The connection has the following dimensions:
- Pipe outer diameter, D: 7 in (177.8 mm);
- Box outer diameter, W: 7.656 in (194.5 mm);
- Wall thickness, t: 0.317 in (8.05 mm).
- Length of the specimens, l_1 şi l_2: 1.200 mm.

An API modified has been used as thread compound and the applied amount has been recorded. The connection was first hand tightened and finally mechanized made-up to the manufacturer recommended final makeup. During the make-up procedure, the torque and turn values have been recorded. After each make-up, the connection was broken-out, cleaned and visually inspected. The process has been several times repeated. In the Table 1 the tests recorded values are synthesized.



Left: cone to spherical seal. *Center*: cone to cone seal. *Right*: radial seal.

Fig. 2. A generic premium threaded connection (top) and a different option for metal-to-metal seal (bottom)

Table 1. Tests recorded values

Test Nr.	Thread compound		Total turns,	Torque, [Nm]		
	Type	Amount, [g]	[°]	minimum	maximum	recorded
1		90				9350
2		80				10270
3	API	70	100	8800	11000	10470
4		50				10100
5		35				9870

Experimental Results

The torque – turn diagram is generally accepted to reveal information about the quality of the makeup process. The torque-turn curve is considered to be linear, as presented in the Figure 2. This is why our efforts have been focused on the analysis of the slope of the torque-turn curve.

The Figure 4 shows selected torque-turn diagrams for different thread compound amounts. The shape of the torque – turn curve contains three major parts: a low torque zone (flat) that corresponds to thread torque, a transition zone, and a high slope zone that corresponds to the thread developed after shoulders are in contact. As Figure 4 shows, the torque-turn curve is slightly non-linear, due to a multitude of factors like dynamic lubrication conditions, geometrical tolerances and makeup tong characteristics. For this study, all recorded curves have been reduced to linear behavior, using a simple interpolation technique for each one of the three curve zones: thread torque, transition zone, and shoulder torque.

The average slope of the thread torque and the shoulder torque have been calculated and plotted as a function of the thread compound amount. The Figure 5 shows the results which are presented in Table 2.

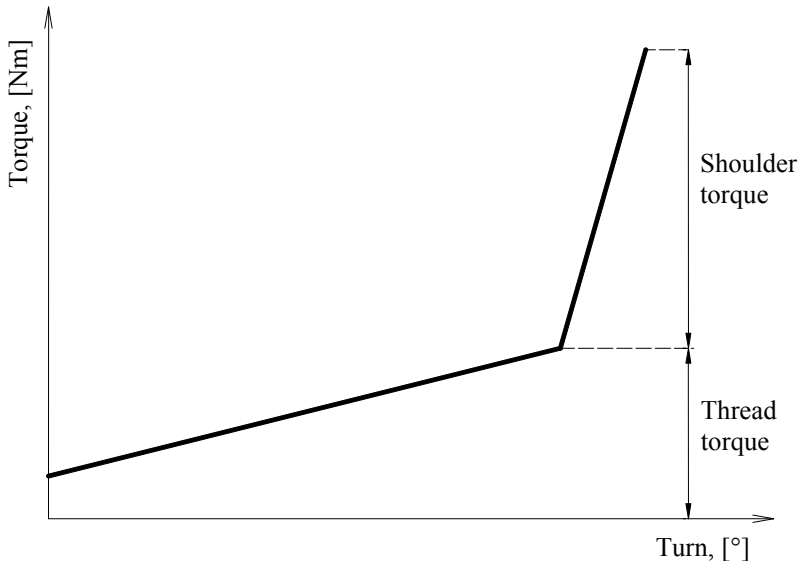


Fig.3. Theoretical torque turn curve of a premium connection

Table 2. Make-up torque results

Test	Thread Compound [g]	Slope	
		Thread torque	Shoulder torque
1	90	2.84	874.99
2	80	8.72	1039.23
3	70	10.71	1141.89
4	50	9.29	1112.97
5	35	8.02	1428.34

Discussion of the Results

The experimental results have shown that, by increasing the amount of the applied thread compound, the thread torque value increases slowly, reaching a maximum for 70 g of applied dope. After that, the slope suddenly decreases and comes to its minimum value at 90 g of applied dope. We assume that, at high values of dope, the friction changes from mixed lubrication to hydrodynamic lubrication, when the metallic surfaces are totally separated by the lubricant. Experiments have shown that a large amount of thread compound leads to pressure zones inside the thread geometry, which generally reduces the connection load envelope.

The slope variation of the shoulder torque shows a different shape than the thread torque slope. It is continuously decreasing with the increase of the dope amount, but has a plateau between 50 and 70 g of dope. To protect the connection against accidentally break out and to increase the torque resistance of the connection, a higher slope is searched, that corresponds to the minimum amount of dope of 35 g. It is also generally accepted that the amount of the dope applied on a threaded connection corresponds to the minimum value at which no galling is observed.

Based on the slope analysis we can conclude that, for a known thread compound, sudden changes of thread torque slope reveal an excessive amount of the dope applied on the connection. The analysis of the shoulder torque alone may not reflect the effect of the dope amount.

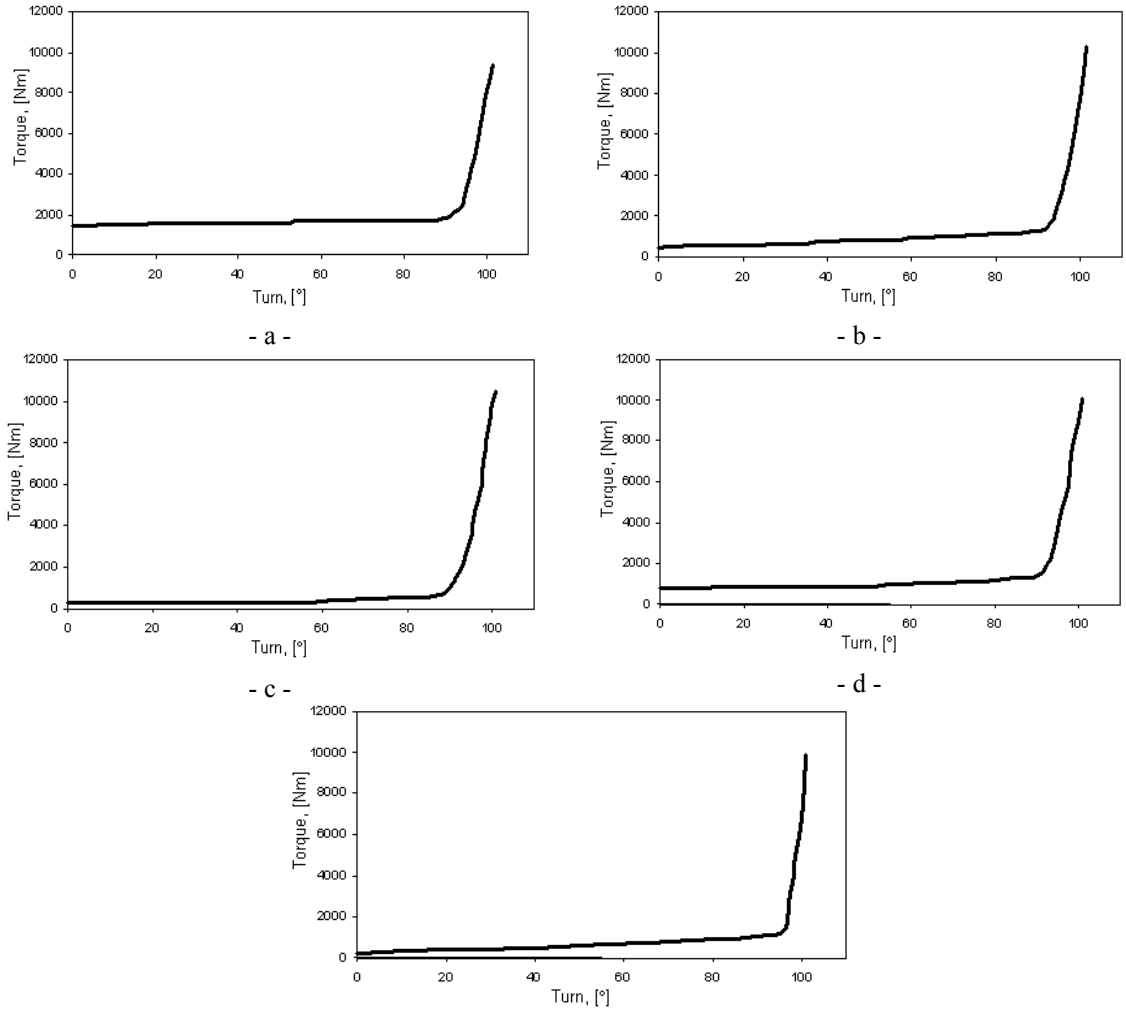


Fig. 4. Selected torque turn plots
a – Test 1; b – Test 2; c – Test 3; d – Test 4; e – Test 5

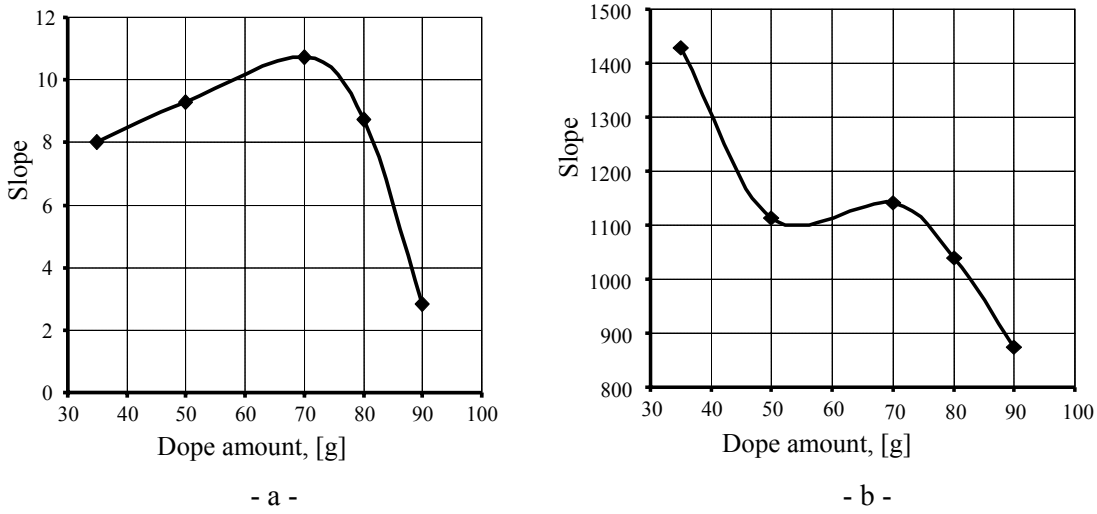


Fig. 5. Slope of the aplied torque for:
a – thread; b - shoulder

Conclusions

A study has been conducted to evaluate the effect of the thread compound amount on the makeup behavior of a premium connection.

A high amount of dope reduces the slope of the shoulder torque, which has a negative effect. The thread torque slope shows a different variation as a function of the dope amount, having a maximum point at 70 g of dope.

Sudden changes of the thread torque slope from one makeup to another reveal an excessive amount of dope applied on the last made-up connection, while the shoulder torque alone may not reflect the effect of the dope amount.

Further tests to check similar behavior on different premium connections are ongoing.

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Cercetări privind influenţa cantităţii de unsoare asupra înşurubării îmbinărilor filetate de tip premium

Rezumat

În prezentul articol se prezintă cercetările experimentale efectuate asupra comportării la înşurubare a îmbinărilor filetate conice premium în condiţiile lubrifierii cu o anumită cantitate de unsoare. Cercetările efectuate s-au efectuat pe o îmbinare filetată premium a carui filet este de tip Buttress, şi au condus la determinarea efectului cantităţii de unsoare aplicate asupra stării finale de înşurubare a îmbinării.