SPE 95507

Worldwide First Run in Hole of a Dope-Free 13Cr Production Tubing String

J. Rignol, Total E&P Nederland, and A. Parde, E. Thoreau, and L. Verdillon, Vallourec & Mannesmann Tubes

This paper was prepared for presentation at the 2005 SPE Annual Technical Conference and Exhibition held in Dallas, Texas, U.S.A., 9 – 12 October 2005.

Abstract

Thread compounds are used on a common basis throughout the full life of Oil & Gas Tubular Goods (OCTG), whether as a storage compound applied in the mill, or in the yard, or as a make-up compound for running in hole.

Dischargeable compounds have an impact on the environment, due to some of their components such as lead and due to the quantity released. Past initiatives - like green dopes - have brought valuable, but only partial resolution to this problem.

The optimum solution is the increasingly popular dopefree connection approach. This paper presents the first worldwide implementation of a complete Cr13 production string applied with a dopefree connection: 16000 ft of 4”1/2 13%Cr-L80 Premium CLEANWELL© tubing joints run in a North Sea offshore gas well in the Netherlands.

The paper explains the specific requirements for using this new “no application - no discharge” lubricating film. It also examines the present QA-QC procedures (storage, thread inspection, tally, drift etc…) that ensures“ no leaks” in the production string as well as the lessons learnt throughout the entire implementation of this dopefree system.

Finally, in addition to the improvements of existing HSE practices, the paper highlights the other benefits recorded during this first implementation, including rig time savings, improvement of the protection of the threads, reduction of pipe handling .

Introduction

HSE improvement is a major priority of today`s Oil Industry. All players (Governmental HSE Authorities, Oil Companies and services/equipment providers) are actively participating in continuously raising the level of the HSE practices.

As such, leaded compounds typically used for making-up connections have been identified as a hazard to health and environment if not properly handled. Furthermore, the necessary changes of greases (for storage, for make-up, for threads inspection or for dry out) and its extrusion at make-up, generate detrimental discharges which can lead to high cost for proper disposal.

"Environmentally friendly" greases, so called “green dopes” have been available on the market for many years, and these greases have had an impact by substituting detrimental components for less harmful ones. Unfortunately, these greases present 3 major drawbacks:

- the list of restricted components is increasing each year leading to the continuous replacement of products and continuous field trials,
- the handling of the grease is still required for storage, thread inspection, make-up etc…
- the anti-galling properties are known to be weak creating difficulties when making up Cr13, Super Cr13 and CRA material.

Therefore, a dopefree connection is the complete answer to these drawbacks. It emerged from the simplest of ideas: *To eliminate the problems of grease handling, eliminate the grease itself.*

Beyond the technical definition and validation of such a solution, the field experience demonstrated the importance of the operational procedure to successfully implement such a product. This procedure eventually yielded a much larger range of benefits which, when combined, deliver a true rig ready solution.

An innovative coating

A semi-dry coating was designed to eliminate both storage and running compounds. It is a wax based product with visco-

plastic mechanical properties and a strong self-healing behavior. Additionally, it contains anti-galling and anti-corrosion agents. In terms of application, the Premium connection is machined with unchanged geometry. Surface preparation is pin as-machined and metal-platting on the box. Eventually the coating is applied with an even +/- 0.001 inch (~ 25 microns) thick layer. Moreover, the dopefree connection is fully compatible when used with dope.

Figure 1. Dopefree coated pin end (4"1/2)

From the overall qualification program of the dopefree connection, three performance characteristics are presented below:

- Corrosion resistance
- Make/break performance
- Sealability

Corrosion Resistance

Long storage periods are common for tubulars between manufacturing and final use in a well. The storage of tubulars is often under critical corrosion conditions, such as yard storage, sea shipping etc.

All tests were performed on a comparative basis with storage dope and dopefree coating. Metal plate coupons were subject to 11 weeks of Humid Cabinet test with temperatures ranging between 81°F and 104°F (DIN 50018). More coupons and actual threaded parts were salt-spray tested during 1000 hours with 5% sodium chloride (derived from ASTM B-117 Salt Fog Spray Test). The results demonstrated the product corrosion resistance is as good as common storage dopes, when compared to a corrosion classification standard [9].

Make/break Performance

Dopefree connections, covering a large range in sizes, weights, materials and grades, from 3-1/2" to 9-5/8", were prepared with extreme tolerances defined by the ISO 13679 procedure. Make and break tests, simulating rig conditions, were performed up to 10 times with no refurbishment in between break outs.

Torque characteristics are essential in the make-up performance of premium connections. During the validation program, torque generated with dopefree connections fell into the current make-up torque acceptance criteria. This demonstrated that the torque specification by the manufacturer is identical to the existing torque specification for pipe with standard API modified dope (see. figure 2).

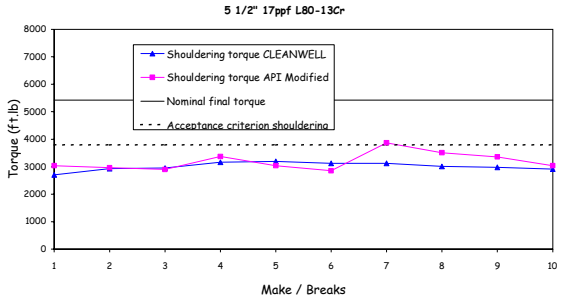

Figure 2. Shoulder torque comparison between Dopefree and API modified dope.

Sealability

The metal-to-metal seal of premium connections is a key feature to cope with the hostile environments experienced in oil and gas wells. Whilst the seal does not rely on dope to ensure its functionality, it can be affected when changing the lubricant. Various dopefree connections were tested based on ISO 13679 [10], including . tension, compression, internal pressure with gas, external pressure with water and temperatures up to 390 °F.

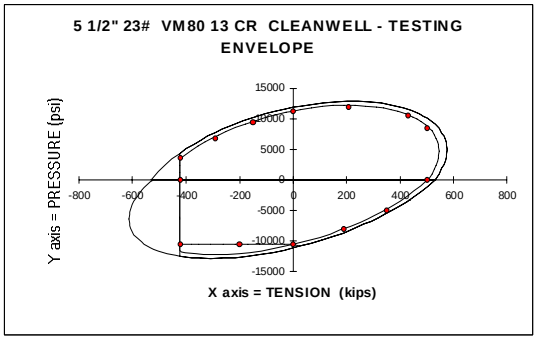

Figure 3. Sealability tests.

History

The Netherlands is a very populated country, and is geographically and historically very open toward the sea. The first offshore well in the North Sea was drilled in the Netherlands in the early 60's. The Netherlands was among the first countries to take into consideration the impact of industrial activity on the environment.

TOTAL E&P Netherlands b.v. has operated in this country since 1964 (formally ELF Petroland b.v. at that time), both onshore and offshore. In common with most of the North Sea, 13Cr tubing is used for offshore well completions. Initially, leaded compounds were used for making up all tubulars.

TOTAL E&P Netherlands b.v started to use "green" dope technology in 1996 while it was made available. Despite satisfactory results on Carbon steel, difficulties were encored on 13Cr. Therefore the search for environmentally friendly alternative to the green dope was open.

Whilst dopefree solutions on OCTG have already been studied in the 1990's, to date there has been no real break through. When.TOTAL E&P Netherlands b.v was approached

in 2001 with a product named CLEANWELL© it quickly realized the potential for improvement of current HSE practices and volunteered for a product trial on its offshore production tubing, namely 4½" 12.60# L80/13Cr.

For this field test, it was decided to choose a gas well, with a 7" cemented liner (as opposed to a pre-slotted liner) to offer the best safety conditions for the trial. Two wells complied with this criteria : K4BE3 and K1A4.

K4BE3 experience

The production of 496 joints of 4 ½" 12.60# VM 80 13CR VAM© TOP CLEANWELL© took place in October 2002, at the V&M Tubes plant in Aulnoye-Aymeries, Northern France. This production trial was characterized by :

- Manual coating application with solvent based product
- Standard internal corrosion inhibitor for 13CR
- Modified protectors with a sealing mechanism.

All pipes were then trucked to Den Helder yard in northern Netherlands (TOTAL logistic base), and stored from November onwards.

In accordance with the drilling program, the K4BE3 operations took place several months after the delivery. In July 2003 a visual yard inspection was carried out, after more than 7 months in storage. This demonstrated that the coating was in good conditions, so that the joints could be used safely. In addition, various opportunities for improvement were identified :

- Making the internal corrosion inhibitor a dry coating to avoid thread possible contamination
- Improving the sealing mechanism of the protectors
- Improving the protector design to avoid thread contamination by plastic slivers

The completion operations started in early August 2003 on the Global Santa Fe Galaxy 3 jack-up rig. All pipes were received and racked in 11 layers on the deck prior to commencing running operation. Protectors were removed to tally the pipe according to standard practices. When the CLEANWELL© specialist team arrived on board, they immediately noticed that the pin threads were covered with paint flakes (see figure 4).

Figure 4. Paint flakes on dopeless coated threads

As the priority was to achieve a no leak completion, it was unanimously decided to stop the dopefree test and to revert back to the "standard" running procedure. The removal of the CLEANWELL© coating with a high pressure washer was straightforward and the running in hole was performed with a standard make up grease (this contingency plan was tested in the V&M laboratory using a standard grease on top of the dopefree coating).

Only five dopefree tubing joints were unaffected by the flakes and ran successfully providing a good turn-torque graph (see figure 5). Whilst these 5 make-ups demonstrated that the dopefree solution performed well, it was clear that a more representative number of connections needed to be made-up to validate the reliability of the dopefree technology.

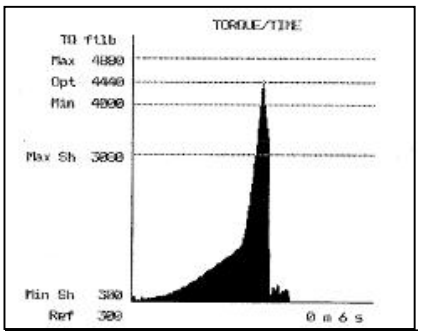

Figure 5. : Torque-turn graph for dopefree make-up

The investigation highlighted the root cause of the dopefree contamination : The anti-corrosion inhibitor applied as standard on the internal pipe coating, dripped on to the outside diameter of the already mill varnished thread protector. In time, this protector contamination led to paint flaking which was eventually found on the dopefree thread coating.

Despite the disappointing outcome of this first 13CR dopefree completion, this proved to be a valuable learning experience highlighting three key points:

- Dopefree products significantly impact on the way pipes are handled at each stage of the supply chain.
- A cleaning procedure is required in the event of contamination is necessary
- Compatibility with standard approved dope is essential as a contingency

A dedicated handling procedure was to be built which shall include all learning and provide an opportunity to bring an answer to the following question :

What would it take as a procedure to enable a truly "rig ready solution" ?

Developing the dopefree procedure

A first set of improvements was applied to the protector.

- The sealing mechanisms were modified in order to better prevent advert intrusion, and associated thread contamination.
- The protector thread was modified in order to prevent any contact with the connection imperfect thread area, thus eliminating slivers.
- Not painting the protectors was an easy decision, but efficient industrial implementation proved challenging.

Figure 6. Sealing mechanism on a pin protector

K4BE3 experience demonstrated that the rig has many reasons to remove the protectors, as a standard practice. In addition to being an operation with no value, it leaves the connections unprotected, sometimes for several days. To resolve this issue, driftable protectors were selected and adapted, to allow tallying the pipe with protectors on.

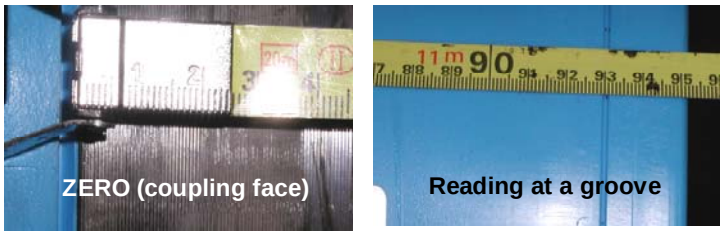

Figure 7. Tallying pipes with protectors on

The pipe internal corrosion inhibitor was changed to a dry coating, thus eliminating the risk of thread contamination by paint flakes.

A foreign particles removal procedure was developed, starting with simulating various solid contamination including paint flakes and 2 types of sand. Using a high pressure washer, available on any rig, it was possible to clean the coating by adjusting the equipment settings, like water pressure, temperature or nozzle type.

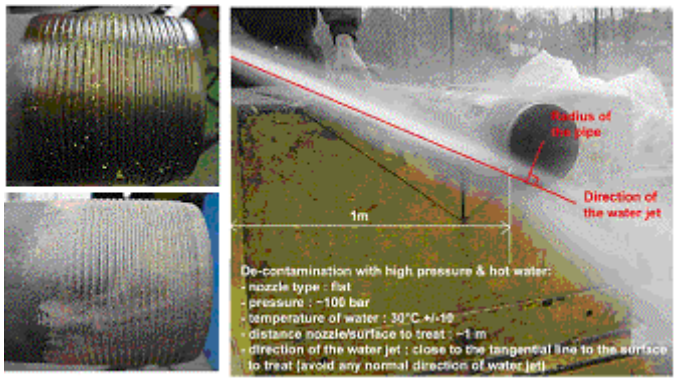

Figure 8. Particles removal from dopefree coating illustrations

It was recognized prior to the trial on K4BE3, how important the changes in practice would be using dopefree products. Despite the significant simplification of the onshore and offshore handling process, care must be taken to implement these changes. A vital part of this process is to ensure that all parties involved in the tubular supply chain are fully aware of the new system. Some of those involved are the Dutch environmental authority (SODM), completion engineers, completion supervisors, casing crews and yard superintendents. For instance the CLEANWELL© running procedures were incorporated into the TOTAL E&P Nederland b.v completion program.

"Rig Ready" procedure

The rig procedure put in place for K1A4 completion, integrated all of the above improvements. Importantly this procedure strips out all unnecessary costs by significantly streamlining handling operations. For example, no cleaning is required at any stages, nor is systematic protector removal required from the mill to the rig until running downhole.

Manufacturing	Dry internal pipe coating Special protectors No painting of the protectors
Transportation	
Yard	Don't clean Don't remove protectors Drift with protectors on
Rig shipment	
Deck preparation	Don't clean Don't remove protectors systematically Tally with protectors on Inspect connection as is (random)
V-door	Lift pipe in the V-door Drift with protector on Remove box protector Don't clean
Rig floor	Lift pipe with elevator Remove pin protector Don't clean Last visual inspection as is Stabb and make-up
Back-up	Use decontamination procedure if needed Full compatibility with thread compound

Figure 9. K1A4 simplified procedure

Running dopefree in K1A4 well

The production of 617 joints of 4 ½" 12.60# VM 80 13CR VAM© TOP CLEANWELL© took place in July 2004. This production was characterized by:

- Industrial coating application with 100% solvent – free product
- New dry internal corrosion coating for 13CR
- Improved protectors

In October 2004, operations started on the Global Santa Fe Labrador jack-up rig. Representatives of both the operating company and the supplier were on site to oversee the operation to a conclusion. 536 joints were successfully run, with 4 rejects not linked to the dopefree technology. Wireline operations ran troublefree and the different gauges cutters used to drift the completion did not came back at surface loaded with grease as usual.

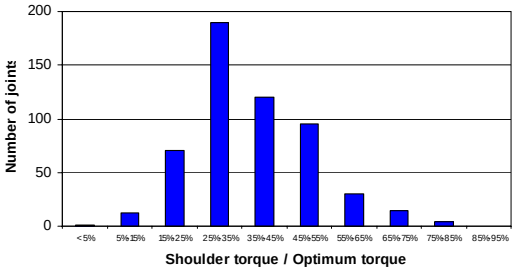

Figure 10. Shoulder torque analysis

The completion was successfully pressure tested and started production in November 2004.

The worst scenario was prepared and the best arrived.

Results – Benefits – Conclusions

The results from this successful completion using a dopefree solution are:

- CLEANWELL© dopefree technology is working in offshore conditions on 13%Cr material.
- No grease entered the wellbore.
- Most standard handling, inspection and make up operations are saved.
- All dope disposal is eliminated.

Beyond these results, the expected benefits of using dopefree technology are to prevent reservoir contamination, to enhance safety thanks to reduced pipe handling and cleaner workplace, to save rig time and to improve overall the quality management of OCTG.

Close co-operation between the end-user, supplier and all parties involved in tubular management, was a key element in achieving success in this first dopefree running of 13Cr in the North Sea. The dopefree concept was derived from a simple idea: *no application - no discharge*. To achieve this goal, and gain all the associated rewards and benefits, a high technological product is required in addition to a well thought out field implementation plan.

Acknowledgement

The authors would like to thank the Dutch State Department of Mining (SODM) that made these trials possible by their very cooperative attitude during all the different phases of this project.

The authors would like to thank also TOTAL Exploration and Production Netherlands, and Vallourec and Mannesmann Tubes for allowing the publication of this paper.

References

[1] Tsuru, E., Maruyama, K., Oka, M., and Higuchi, S.: "Innovative Technology for Tubular Connection To Eliminate Thread-Compound Grease", SPEDC (June 1998)

[2] Pauleau, Y., "Les Revêtements anti-Frottement", Innovation 128, June 1996

[3] Zambelli, G., Vincent, L., "Matériaux et Contacts"; Presses polytechniques et universitaires romandes, 1998

[4] CETIM publications, "Conception mécanique et tribologie", CETIM, 1993

[5] API spec., "Recommended Practice on Thread Compounds for Casing, Tubing, and Line Pipe", API RP 5A3, Second Edition, July 2003

[6] ISO spec., "Petroleum and natural gas industries – Procedures for testing casing and tubing connections", ISO/FDIS 13679, May 2002

[7] EEC directive, "Modalités du système d'information spécifique relatif aux préparations dangereuses", 91/155/CE ,March 1991

[8] EEC directive, "Modalités du système d'information spécifique relatif aux préparations dangereuses", 93/112/CE, December 1993

[9] "European scale of degree of rusting for anticorrosive paints", Stockholm, 1961

[10] API spec., " Recommended Practice for Evaluation Procedures for Casing and Tubing Connections", API RP 5C5, Second Edition