

Dry dope-free premium connections: a zero discharge technology validated through laboratory and field testing and usage*

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Abstract. Dope-free alternatives to standard thread compounds used for casing and tubing connections became commercially available around 2003. The challenges from galling resistance needs and handling and storage requirements were addressed. The lessons learnt from the initial uses and experiences with the dope-free solution were incorporated into products that are reliable and have proven their suitability in environments that vary from the extremely humid and cold North and Barents Seas to the sandy and hot environment of the Middle East. The experiences to date not only confirm the validity of initial drivers—mainly related to the environmental care—for the development of these alternatives, but also open up the possibility of the complete elimination of thread compound from the casing and tubing installation and storage processes.

The dope-free solution has demonstrated suitability for application in all tubing and casing dimensional size ranges including: all type of steels (such as common carbon steel—both API grades and proprietary), 13Cr, and corrosion resistance alloys (CRA), premium connections with metal-to-metal seal both threaded and coupled (T&C), as well as integral connections. Experience with large outside diameter (OD) semi-premium connections indicates that this can be another area of application for dope-free solutions. This paper describes the different experiences related to the field use of dry, dope-free solutions, the improvements and adjustments incorporated after initial experiences and operators feedback and the verification activities in laboratory and especially in experimental rigs under actual field conditions. The intention of this presentation is to present the advantages and the value obtained through the use of this technology.

Keywords: Dope-free, dopeless, HSE, casing, tubing, premium connections

Introduction

The use of API threaded connections and proprietary premium connections for tubing and casing pipes in the oil and gas industry has been linked in the past to the need for some particular dope or thread compound to guarantee proper thread engagement, to assure that no damage occurs on the threaded surface, and to provide limited sealing at least in standard Rounded or Buttress API connections.

This extended abstract describes the development and field experience related to a particular fully dry dope-free technology that has undergone extensive development in the laboratory and

now has been fully proved in different environments varying from very cold weather offshore applications to very hot sandy onshore operations.

Potential problems or risks are also evaluated and discussed.

The basic design, laboratory development, experimental rig evaluations and the extended field verifications form an extensive package that allows a major shift in rig operations: the doping of premium connections during running operations of rigs is no longer required.

The dry dope-free solution adopted and described in this paper (Dopeless®) is an engineered combination of multiple layers that aims to provide key benefits and advantages during pipe assembly

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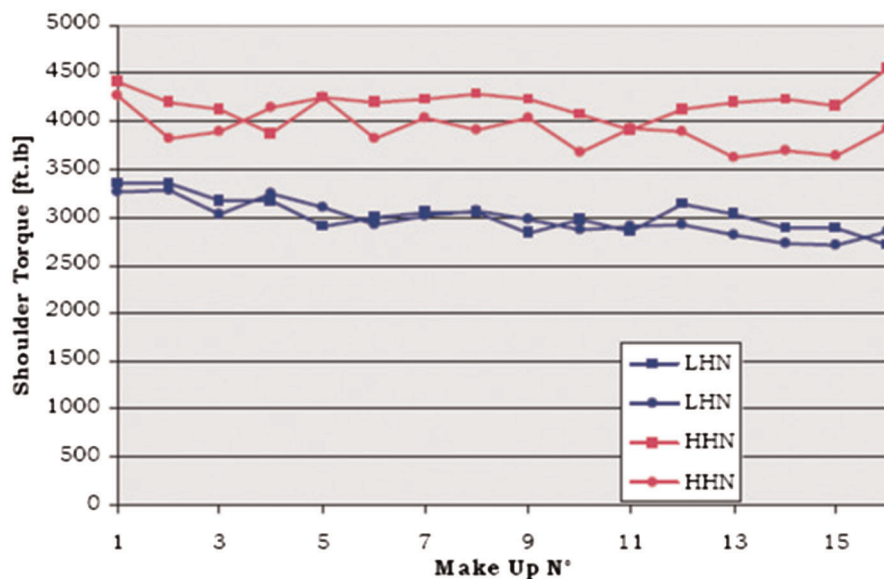


Fig. 1. Evolution of parameters with M&B cycles.

even under harsh conditions. The coating was developed to assist the connection assembly by providing the required tribological properties. The connection can be subjected to repeated assembly (make-up) and dis-assembly (break-out) operations without the need of re-application of any lubricant with consistent make-up performance even exceeding that for one of connections assisted with thread compounds.

No removal of storage compound is performed. The Dopeless® coating is applied at the mill facilities and no treatment is required until field running, leading to a ready-to-be-used connection. Through strict process quality control, lubrication and corrosion resistance are guaranteed.

R&D on dope-free connections—from the laboratory to the field

Prior to the commercial launch of Dopeless® solution in 2003, extensive research and development around dope-free technology was carried out. All potential demands and requirements for a dope-free solution for connection assembly were surveyed.

A simple and efficient testing scheme was developed in order to characterise, reformulate, discard, verify and validate any new potential dope-free solution for oil and gas pipe connections. Several types of coatings have been evaluated, aiming for an optimum balance on frictional performance, galling resistance, storage capability and industrial deployment.

Coatings that have shown good corrosion resistance and frictional properties have been subjected to full-scale test to determine their suitability as a potential dope-free solution in real full-scale connections. Repeated assembling and disassembling operations (Make and Break [known as M&B] test) have been performed in order to evaluate the tribological properties and galling resistance of the coatings.

Several coatings were tested through full-scale tests. Some coatings showed friction consistency during the successive M&B operations.

Fig. 1 shows how a coating looks like after being subjected to 15 M&B operations. Some coatings had poor performance, such as high friction, premature wear, inability to maintain a constant shoulder torque value.

Thus these coatings were discarded as potential dope-free solution or were reformulated after a study to determine the main cause of this poor performance. This is a valuable stage since deep knowledge of the coating and its interaction with the connection was acquired. A reformulated coating was tested again from the beginning of the testing process.

Coatings with good full-scale performance were further tested on full-scale samples aiming to determine their behaviour on the exposure to real situations. Therefore, corrosion resistance in outdoor storage (yard), autoclave and immersion tests were carried out.

Outstanding performance of a dope-free solution is not only limited to M&B under the most demanding environmental conditions, but also has to be demonstrated that it has no detrimental effect on connection performance under combined load test.

Quite apart from the extensive and complete laboratory developments and verifications that can be done, it is important to recognise the difficulties of reproducing all the possible field scenarios and conditions that could affect the coating/connection performance. Field trials under controlled conditions are considered a key element in the validation process of dope-free coatings and connections. To cover this need, an experimental rig was rented for testing new coating developments, improvements and applicability in new connections. In addition to typical M&B evaluations that are affected by pipe weight and inertia, some other running conditions can be simulated with the aim to validate the product performance and robustness under tough real conditions (Fig. 2).

Field experience summary

As a summary of five years of field experience, the following advantages have been identified:



Fig. 2. Condition of Dopeless pins after 5, 10, 15 M&B cycles.

- Remove operational risks: Dopeless® reduces the human factor of Oil Country Tubular Goods (OCTG) installation. This reduction of operational risk can lead to fewer problems for operators and significant cost savings.
- Faster, safer installation: The advantages of the Dopeless® connections regarding installation are due to a safer, more stable and easy make up. There is a lower possibility of miss-runs of the connections due to:
 - a. No human intervention in the doping process (over-doping, under-doping, dirty dope). Dopeless® guarantees that the doping of connections are removed from the critical path.
 - b. The concept of an engineered lubricant as opposed to an operator applying a thick fluid with a brush, with little process control—in the Dopeless® industrial process, all the critical processes are controlled, measured and monitored.
 - c. The capacity of the dope-free solution to perform better during make up and with more stable, uniform make up indicators: shoulder torque, torque turns, linearity of thread interference, etc.
 - d. The ability of dope-free solution to be broken out, easily inspected and re-run in a fraction of the time required for normal connections.
 - e. The coating protects the metal surfaces, avoiding handling damage to ruin a make up.
- Simple preparation for well delivery—cold weather.
- Easier management of rig returns.
- Reduced connection repairs.
- Zero discharge because Dopeless® is completely dry.
- Small environmental footprint: Dopeless® eliminates all cleaning solvents, and the soaps and chemicals used in high pressure cleaning of typical OCTG connections.

- Safer workplaces: Non-slippery rig-floors and yards, as the absence of dope and slurries eliminate slippery surfaces caused by dope. This could reduce accidents.
- Less OCTG handling.

From 2003 to now there are ~1,000,000 feet of Dopeless® products installed and a similar quantity in new orders. Some of the new areas where this dope-free solution will be used in the very short term are: Australia, New Zealand, Italy, Russia and Denmark.

Conclusions

After five years of field deployment in difficult and diverse environments, it is possible to confirm that dope-free technology has a real possibility of becoming a new standard in the oil and gas market, eliminating the need of using poorly controlled, compositionally diverse and environmentally aggressive thread compounds.

The technology has evolved since the initial introduction in 2003. The key improvements have been: better storage capacity through improved corrosion resistance and achieved by improved coating design and the development of improved thread protectors; lessons learned on frictional issues and problems in the field related to make up or break out operations, that have been solved through further research and optimisation. Extensive validation has been achieved by the use of this dope-free alternative in different field and weather conditions, for different sizes and grade combinations.

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