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## Dope-Free Connections Offer Benefits

By Bruce Bradley

HOUSTON—The two primary contaminants in well bore tubulars are pipe scale and the thread compound, or "pipe dope," used to make up the connections. Combined progress in tribology and the design of threaded tubular connections have led to the development of dope-free tubular connections capable of eliminating the thread compounds altogether and improving overall efficiencies.

Dope-free connections first emerged in 1998 as an alternative to threaded connections with grease-based lubricants. Today, these environmentally friendly connections not only provide material management efficiencies, improved connection performance and well completion economics, but also are now available for 13Cr (SPE/IADC 95507 documents the first run of a 13Cr production tubing string), and in some cases, higher-grade alloy materials as well as carbon steel.

Various thread compounds have been used for the last 60-plus years to lubricate and seal tubing and casing connections. Until the mid 1990s, thread compounds mostly were manufactured in compliance with the American Petroleum Institute's API 5A3 (formerly 5A2) standard ("Recommend Practice on Thread Compounds

for Casing, Tubing and Line Pipe," API RP 5A3, Second Edition, July 2003), which specified the composition of API-modified thread compounds.

This specification required that any thread compounds labeled as API-modified contain 30.5 percent lead, 18.0 percent graphite, 12.2 percent zinc and 3.3 percent copper, for a total of 64.0 percent by weight, along with various base greases. This high solids content was present to effectively seal API round and buttress threads, and prevent galling.

While performing well in terms of sealing and anti-galling, these metals had a detrimental impact on the well bores and the environment as a whole. Excess thread compound extruded from the connections during make-up, contaminated completion fluids, plugged screens and reduced formation permeability, resulting in the loss of production and expensive remediation operations. Another concern was the runoff of heavy metals into soil and groundwater, either from pipe storage or thread-cleaning operations on location.

### Environmental Impact

Thread compound manufacturers began addressing the environmental impact of thread compounds about a decade ago

by developing environmentally friendly compounds known as "green dopes." These pipe dopes eliminated the heavy metals, although many contained PTFE (Teflon<sup>®</sup>) particles to maintain sufficient sealing properties for API and thread seal-type connections. Environmentally friendly thread compounds were first included in the First Edition, October 1996, API Spec 5A3.

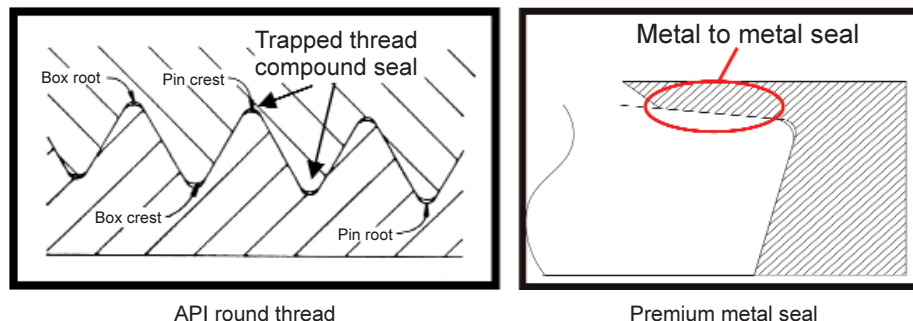
Today, thread compound manufacturers offer various compounds that not only have eliminated the heavy metals and PTFE, but some also have evolved to the point of being totally biodegradable. These latest-generation green thread compounds are widely used and have been tested and approved for use in the most environmentally sensitive areas, such as the North Sea and Alaska. While these environmentally friendly thread compounds have addressed the environmental concerns, various potential issues with doping connections still exist.

Applying the thread compound principally is still a manual operation that results in health, safety and environmental concerns. Incorrect application of the thread compound—or applying too much or too little—can have a negative effect on connection performance. Excessive thread compound still can cause problems with wireline tools, screens and effect formation permeability, resulting in inefficient acid treatments and reducing overall production.

Unlike API connections, premium metal seal connections do not rely on solids in the thread compound to achieve a seal (as shown in Figure 1), and therefore only require sufficient lubrication to prevent the galling of threads and seal surfaces during makeup and breakout of connections. This has allowed connection designers to develop a new generation of premium connections that can provide reliable performances without

FIGURE 1

### API Round Thread versus Premium Seal



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TABLE 1

Average Cleaning and Redoping Costs						
O.D.	Weight	Avg. Length	Clean and Redope Costs	Pipe Movement (0.30/cwt)	Total Cost	\$/ft
(in)	(lb/ft)	(ft)	(\$/ft)	(\$/ft)	(\$/ft)	(\$/ft)
2 <sup>7</sup> / <sub>8</sub>	7.80	32	7.00	0.75	7.75	0.24
5 <sup>1</sup> / <sub>2</sub>	23.00	44	10.00	3.04	13.04	0.30
7	38.00	44	13.00	5.02	18.02	0.41
9 <sup>5</sup> / <sub>8</sub>	53.50	44	15.00	7.06	22.06	0.50
13 <sup>5</sup> / <sub>8</sub>	88.20	44	25.00	11.64	36.64	0.83

additional thread compounds. Eliminating the thread compound improves HS&E and also brings about improved operational efficiencies and overall economics for the user.

Dope-free premium connections improve safety and working conditions at the rig site and on the rig floor. Most recordable injuries from pipe running operations are related to the hands and fingers of rig personnel. Eliminating one source of potential hand injuries can be achieved by eliminating the need for manually applying or reapplying thread compound on location. With dope-free connections, there also is no possibility for the thread compound to be dropped onto the rig floors and walkways, thereby reducing the potential injuries because of slips and falls on slippery surfaces.

Eliminating the thread compound also reduces the environmental risks associated with failing to contain runoff from rainwater or connection cleaning operations on location. This is of particular concern when using thread compounds that contain heavy metals, but also needs to be considered when using environmentally friendly compounds.

### Material Management

Most casing and tubing is shipped from the mill or threader to some stocking or inventory location. To prevent corrosion or pitting of the threaded connections while in storage, special storage compounds often are used, although some thread compound manufacturers do offer special "running and storage compounds."

Prior to shipping to the rig, the tubulars are usually "rig prepped" by removing the storage compound, cleaning and inspecting the connections, cleaning the protectors, applying the running compound, and reinstalling the protectors. Costs associated with these rig prepping operations can range from \$0.25 to as much as \$0.85 cents a foot as shown in Table 1.

Conversely, since most dope-free coat-

ings offer storage protection against corrosion equal to or better than storage compounds, and do not require rig prepping, cleaning and redoping costs can be avoided. Another significant advantage to dope-free connections is that they are immediately available for shipment to the rig. Since there is no need for rig prepping, logistics and planning are simplified, and there is no problem when the pipe is required to be shipped on short notice or at odd hours.

Using various thread compounds, both those containing heavy metals and those that are environmentally friendly, can have considerable effects on connection performance. Applying too much thread compound can increase hoop stresses in connections, and in some cases, cause dangerously low back-out torque levels. Overdoping also can lead to jump out or structural failure of the connections, resulting in a dropped string to be fished out of the well. Applying too little or not properly distributing the thread compound can result in galling and having to lay out connections on the rig. If galling is not detected during makeup, subsequent tubing leaks can occur that require reworking of the well.

Thread compounds also can mask or hide handling and mechanical damage to metal seals on premium connections. A

premium connection with a damaged seal may go undetected during makeup, but lead to a tubing leak down hole.

Occasionally, tubulars have been delivered to the rig with the storage compound applied and mistakenly run, without removing the storage compound and applying running compounds.

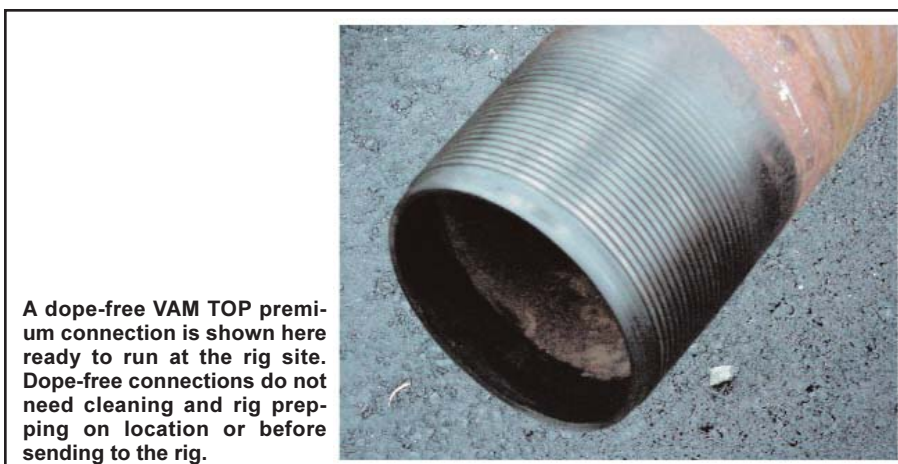
### Performance And Economics

Dope-free premium connections also can offer improved running performance by eliminating the thread compound and the various issues associated with thread compound application. With dope-free pipe, it is impossible to over- or under-dope connections. Most dope-free connections also can be visually inspected during running to catch any handling damage before making up the connections. Problems with using an incorrect thread compound or thread compound with debris or contamination also are eliminated with dope-free connections.

In addition to these operational, performance and HS&E advantages, dope-free premium connections offer benefits in terms of well completions and economics. Cleaning and redoping on location and associated costs are eliminated with dope-free connections. This includes moving and handling the pipe on location, which can add cost and increase running times.

As noted, thread compound—along with pipe scale—is a major contaminant to the well bore and completion tubulars. Thread compound extruding from the connections during makeup can lead to difficulties in running wireline tools and downhole accessories, requiring additional rig time. Screens and gravel packs also are subject to plugging because of excessive pipe dope.

There also is a high possibility of formation permeability damage if the thread



A dope-free VAM TOP premium connection is shown here ready to run at the rig site. Dope-free connections do not need cleaning and rig prepping on location or before sending to the rig.

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A conventional doped connection is shown at left as compared to a dope-free premium connection at right during pipe running operations. Dope-free premium connections offer improved per-

formance by eliminating the various issues associated with thread compound application, including problems with using an incorrect pipe dope or debris and contamination.

compound is pumped into the producing zone. Hydraulic fracturing can carry excess thread compound into the formation, which may result in plugged perforations and reduced production. Tubing pickle treatments can minimize the possibility of damaging the formations, but they must be specifically formulated with the proper solvents to remove excessive pipe dope.

Eliminating pipe dope with the use of dope-free connections reduces the complexity of the pickling fluid and improves its efficiency in cleaning the tubulars and well bore. This, along with the potential of rig time savings and eliminating an acid wash or pickle treatment, can result in substantial savings at the time of completion and improved production economics over the life of the well.

Acid treatment fluids and completion fluids containing heavy metals from excessive thread compounds also can have higher reclamation costs. With dope-free connections, there are no discharges of metals into the fluids to impact these remediation costs.

### Important Considerations

Dope-free premium connections offer significant advantages over conventional doped connections, but several factors must be considered to achieve maximum benefits. First, dope-free connections are available only on proprietary metal-sealing premium connections. The reduced volume and lack of suspended solids of various dope-free technologies would be inadequate for sealing API-round thread

or buttress connections. Premium metal sealing connections do not rely on solids or volumes for sealing, and therefore, can be run dope-free.

Second, dope-free premium connections should be clearly identified before shipping to location to avoid confusion or mistakes at the rig. It also is important to educate supply chain and rig personnel. For example, since dope-free connections do not need cleaning and rig prepping prior to sending to the rig or at the rig site, rig personnel should be informed that dope-free connections are being delivered and that the connections are ready to run. This avoids the possibility of having rig personnel mistakenly conclude that "someone forgot to dope the connections" and proceed to clean and apply thread compound.

Since dope-free connections are usually delivered "ready to run" if the protectors are removed for tallying the pipe, drifting or inspecting the connections, the pin and box protectors should be replaced as soon as possible and left in place until running the pipe.

Different types of dope-free coatings are available from the various manufacturers. If concerns exist with the presence of molybdenum disulfide ( $\text{MOS}_2$ ) and the potential for sulfide-stress cracking (SSC), the composition of the coating should be discussed with the connection manufacturer.

It also is important to remember that accessories such as hangers and chemical injection mandrels need to be prepped as dope-free to match the tubular connec-

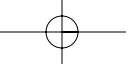
tions. Compatibility of the dope-free coating with standard thread compounds should be confirmed in case accessories are delivered to the rig without the dope-free option.

Finally, any special running procedures related to the dope-free connections should be clearly communicated be-



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tween the manufacturer and the user.

Simply put, dope-free premium metal sealing connections are the state of the art in premium connection design. Environmentally friendly thread compounds exist that even are biodegradable to re-

duce the impact of using doped connections, but do not address many of the issues such as safety, application-related connection problems, and the consequences of excessive compounds in the well bore.

Dope-free premium connections provide a single “mill-to-storage-to-rig” solution with full storage, anti-galling and sealing performance, and offer significant advantages over conventional doped connections. □