



ECF THREAD COMPOUND TECHNOLOGY
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ABSTRACT

Jet-Lube, Inc.'s patented ECF technology was developed to comply with the stringent North Sea environmental guidelines for offshore chemicals while maintaining the required performance standards. Jet-Lube's SEAL GUARD™ thread compound for premium casing and tubing connections and NCS-30 ECF™ thread compound for drill string connections meet Norway's "Yellow" standards and the United Kingdom's "E" classification. The classifications are a result of the OSPAR Commission's Harmonized Offshore Chemical Notification Format (HOCNF), whose directives require pipe compounds to be biodegradable, bioaccumulation-potential-free and nontoxic. These are the most stringent thread compound requirements to date and required a total reformulation of the pipe compounds to meet both the performance and environmental requirements.

Both ECF compounds are entirely nonmetallic, yet provide excellent protection against seizing and galling. They are temperature rated for applications -65°F (-54°C) to 500°F (260°C) and their nonconductive formulas are ideal for high-pH mud (9-10%) applications. SEAL-GUARD™ ECF, with frictional properties similar to API Modified, has been specially formulated for use on premium connections. NCS-30 ECF was formulated for use on rotary shouldered connections, high-torque and high-chrome or nickel alloys.

EXPLANTION

Suppliers of chemical compounds that facilitate drilling operations are faced with numerous challenges today of performance, compliance and cost. With the advancement of drilling technology, drilling conditions have become more severe thus demanding greater performance from products like thread compounds and anti-seizes. In addition to drilling challenges, government regulations regarding drilling operations have become increasingly restrictive and definitive, thus limiting or eliminating the use of many traditional ingredients, like heavy metals, employed in these compounds. The North Sea requirements, outlined in the Harmonized Offshore Chemical Notification Format (HOCNF), are a current example of how well the category is defined. As the focus on safer products as a priority rises, the cost of well permitting and disposal concerns becomes an issue.

In order to meet these challenges of performance, compliance and cost, Jet-Lube In cooperative development with VAM USA and Statoil has developed the new “ECF” series of thread compounds. The family currently consists of NCS-30 ECF, developed for the full array of drill string applications, and SEAL GUARD ECF, designed for premium/proprietary tubing, casing and line pipe applications. The “ECF” series, replace heavy metal laden thread compounds with more health and environmentally acceptable products, like our patented extreme pressure anti-wear additive and proprietary base oil blend, without loss in performance in applications such as rotary shouldered connections, proprietary/CRA tubing and casing.

The performance of thread compounds is characterized by three primary aspects: (1) Sealability, (2) Frictional/make-up characteristics, and (3) Galling resistance. Of primary importance is galling resistance and frictional properties. To measure improvements in galling resistance and frictional properties the “Test Apparatus for Universal Friction Evaluation” outlined in the Friction/Galling Test Update - API Winter Work Week 2002 was utilized. Inconel specimen sets were used to test hundreds of solid additive combinations described above to develop a product formula which subsequently has received a US Patent 7,091,161, Issued August 15, 2006. Two other patents on this technology are pending review.

Jet-Lube has a long term commitment to continuous improvement and in 1995 developed an acceptable biodegradable compound base using esters and aluminum complex thickeners. The compound base passed the required tests but resulted in thread compounds unacceptable due to cost. Since then, extensive environmental studies on synthetic, natural, petroleum base oils and blends have been completed. By building an optimum blend of base oils, non-heavy metal thickener, and patented extreme pressure anti-wear additive, we have built acceptability and performance into the ECF products while constraining costs within Industry expectations.

Combining the proper thickener and fluids, chosen for their non-toxicity and performance, resulted in the core ECF base shown in Table 1 from which a variety of products could be developed based upon the application intended.

TABLE 1 (ECF Base “BIO” Profile)

TEST DESCRIPTION	METHOD	ECF GREASE
Bioaccumulation	OECD 117	None
Biodegradability, 28 days in Sea water	BODIS, seawater	20-61%
Tainting	OSPAR list	None
Bio-toxicity tests with <i>Skeletonema costatum</i> , 72 hours	ISO/DIS 10253	>1000 mg l ⁽⁻¹⁾
Bio-toxicity tests with <i>Acartia tonsa</i> , 48 hours	ISO TC 147/SC 5/WG2	>1000 mg l ⁽⁻¹⁾
Bio-toxicity tests with <i>Scophthalmus maximus</i> juvenile	OECD 203	>1800 mg l ⁽⁻¹⁾
Bio-toxicity tests with <i>Corophium volutator</i> , 504 hours	PARCOM 1995 A	>1800 mg kg ⁽⁻¹⁾

NCS-30 ECF, was developed for the full array of drill string applications. Inconsistent rig-floor make-up can be controlled by the design and manufacture of a less soluble thickener in the thread compound. Frictional properties can change based upon the amount of drilling fluid absorbed. Galling resistance and lubricating properties can also be greatly reduced. Lowered coefficients of friction in some connections could result in stretched pins or belled boxes. If other connections do not engage properly due to high friction (film failure) it can result in wash-outs, wobble damage or uncontrolled down-hole make-up. Thread compounds, therefore, must resist absorption of drilling fluid during application and connection make-up. The ECF base was designed to provide reduced solubility with drilling fluids enabling NCS-30 ECF to provide more consistent connection make-up in field applications. Also, NCS-30 ECF required some solid additives to increase the coefficient of friction to suit severe drilling applications while providing excellent galling resistance on Inconel A-718 alloys. Success on this alloy assured success with other alloys utilized for drill string connections. Currently used by most major operators, drilling contractors and service companies in the Norwegian and UK sectors of the North Sea. Table 2 compares the properties and performance of Jet-Lube's NCS-30 ECF against typical zinc and lead containing thread compounds.

TABLE 2

TYPICAL PROPERTIES	50% Zinc	60% Lead	NCS-30 ECF
Dropping Point	180°C, Min.	138°C typical	>170°C
Specific Gravity	1.80	2.40	1.32
NLGI Grade	1.5	1.5	1.5
Friction Factor, (API connections)	1.0	1.0	1.15
4-Ball Weld Point, [kg (N)]	400 (3920)	800 (7840)	800 (7840)
Metals	Zn, Trace Pb	Pb	None
41/2" XH connections per kilogram of thread compound	29	22	39
ENVIRONMENTAL RATING			
NORWAY, SFT	BLACK	BLACK	YELLOW
UK, CEFAS	A (Worst)	A	E (Safest)
20% Salt Fog Corrosion Resistance	250 hrs, typ.	250 hrs., typ.	>750 hrs

SEAL GUARD ECF, has been tested and approved by many major pipe manufacturers and end-users. It is designed for premium/proprietary tubing, casing and line pipe applications. In this application the high friction additives found in NCS-30 ECF would be detrimental. Removing those and incorporating another additive to improve contrast once applied to threads resulted in Seal Guard ECF. It outperforms API Modified consistently on 22-25% chrome connections. Table 3 compares the properties and performance of Jet-Lube's SEAL GUARD ECF against API Modified.

TABLE 3

PRODUCT PROPERTIES	API-MODIFIED	SEAL GUARD ECF
Dropping Point	138°C Min.	170°C min
Specific Gravity	1.92	1.28
NLGI Grade	1.0	1.5
Friction Factor	1.0	1.0
4-Ball Weld Point, kgf (N)	>800 (7840)	>800 (7840)
Gas Evolution @ 66°C	20 Max	None, typ.
41/2" Premium connections per kilogram of thread compound	48	77
Metals	Pb, Zn, Cu	None
ENVIRONMENTAL RATING		
NORWAY, SFT	BLACK	YELLOW
UK, CEFAS	A-C	E
20% Salt Fog Corrosion Resistance	250 hrs, typical.	>750 hrs.

Applications testing also revealed additional benefits from the “ECF” products:

- Reduced solubility in drilling fluids provides superior adherence to threads.
- Because they are designed to exist in high pH applications, they will not break-down during use, this means more tolerance to drilling mud contamination, lower break-out torque and fewer dry connections, thus decreasing the potential for wear and damage.
- SFT, CEFAS approvals facilitate permitting new well programs, particularly in North Sea. •
Being nonconductive, they reduce the potential for galvanic corrosion.
- A running compound with long-term rust inhibition properties eliminates the need for separate storage compound.

With the introduction of the “ECF” series of thread compounds Jet-lube has successfully met the challenge of developing drilling compounds that provide performance, are environmentally acceptable by today’s standards and do it at a cost that the industry can afford. Additionally, having developed the “ECF” grease base has also allowed for product development in other critical applications where environmental exposure must be addressed. Product formulations for wire line applications and jacking systems are currently in field test. Successful results in these will allow Jet-Lube to bring these products to market in the first or second quarters of 2007.

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