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Standard
Material Requirements

Recommendations for Selecting Inhibitors for Use as Sucker-Rod Thread Lubricants

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Foreword

Downhole corrosion of sucker-rod thread joints can be effectively controlled using an inhibited thread lubricant. This standard materials requirement provides a method of selecting effective sucker-rod thread lubricants for use by oilfield production operators.

This standard was originally prepared in 1974 by NACE Task Group T-1D-11 on Selecting Inhibitors for Use as Sucker Rod Thread Lubricants, in response to a request from the American Petroleum Institute (API).[1] It was reaffirmed in 1988 and again in 1995 (with editorial changes) by Unit Committee T-1D on Corrosion Monitoring and Control of Corrosion Environments in Petroleum Production Operations. It is issued by NACE International under the auspices of Group Committee T-1 on Corrosion Control in Petroleum Production.

[1] American Petroleum Institute (API), 1220 L Street NW, Washington, DC 20005.

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Section 1: General

1.1 Proper selection and use of corrosion inhibitors provides extended protection of sucker-rod threads and box cavities against the effects of corrosive well fluids that may move in and out of these box cavities, and protects the threads from galling.[1]

1.2 This standard defines requirements for inhibited lubricants and suggests types of tests that may be used to select such materials.

1.3 This standard is not a test method. Suggested procedures for testing inhibitors in simulated environments in which they are to be used are described in Section 3. The tests may be run in simulated sweet, sour, aerated, or combination environments with simulated well fluids or actual field fluids.

Section 2: Inhibited Thread Lubricant Requirements

2.1 The inhibited thread lubricant should be an effective corrosion inhibitor and should prevent thread galling during make-up.

2.2 When adding inhibitor to lubricant, an undiluted inhibitor is considered preferable and should remain effective longer than diluted inhibitor mixes.

2.2.1 If the undiluted inhibitor solution has been properly formulated, it can also function as a satisfactory lubricant that prevents galling. Use of a single inhibitor formulation eliminates the need for stocking and using extra materials.

2.2.2 In cold weather conditions, a material with a pour point sufficiently low to permit its use in the coldest weather to be encountered should be used.

2.3 Despite the stated preference for an undiluted inhibitor formulation, nonseparating mixtures of inhibitors in fluids such as diesel oil, alcohol, etc., have been found to be effective and may be acceptable if they pass tests such as those suggested in Section 3 (for example, see Table 1: 99 parts No. 2 diesel oil,[2] 1 part inhibitor).

Section 3: Inhibited Thread Lubricant Selection

3.1 The corrosion inhibitor used as a sucker-rod thread lubricant or used in an inhibitor/lubricant mixture should be a proven corrosion inhibitor for the environment, i.e., for the specific wells and type of production. If there is a lack of experience in an area, corrosion screening tests such as the one outlined in Paragraph 3.2 should be performed to select an inhibitor. Such tests may also be used to verify the effectiveness of an inhibitor/lubricant mixture. Because the inhibitor or inhibitor/lubricant mixture must prevent galling of sucker-rod threads, galling tests such as the one outlined in Paragraph 3.3 should be performed. The inhibited lubricant must not allow galling at ambient or elevated temperatures.

3.2 Corrosion Tests: A proposed undiluted inhibitor or inhibitor/lubricant mix should be tested under severe simulated thread use conditions. The test should evaluate the performance of the product in boxes that will be exposed to corrosive fluids by simulating the most aggressive environment that will be encountered in use. Table 1 gives data from a test that has been used. Briefly, the procedure was as follows:[2]

3.2.1 Mild steel coupons were immersed in the product to be evaluated. This is the least favorable means of applying a lubricant film. Spraying or brushing, which are sometimes used in field service, tend to apply a better film of lubricant.

3.2.2 The metal, filmed as prescribed in Paragraph 3.2.1, was then immersed in corrosive fluids for 72 hours at 71°C (160°F). Corrosive fluids used to obtain the results shown in Table 1 were:

10 cc oil (high-flash, low-viscosity paraffin distillate oil);

[2] SAE[3] J 313 (latest revision), "Diesel Fuels, Recommended Practice" (Warrendale, PA: SAE).
[3] Society of Automotive Engineers (SAE), 400 Commonwealth Drive, Warrendale, PA 15096.

90 cc synthetic brine (10% sodium chloride, 0.5% calcium chloride); and

1 cc of 6% acetic acid (equivalent to 600 ppm acetic acid in test mixture).

This mixture was sparged with carbon dioxide (CO_2) for five minutes.

3.2.3 For sour conditions, the test fluids should be sparged with hydrogen sulfide (H_2S) for five minutes. The suggested test temperature is 50°C (122°F). Safety precautions in handling H_2S are described in Appendix A.

3.2.4 For critical usages, final selection of thread lubricant should be governed by the results of additional tests in which field fluids are used as the corrosive fluids, in the specific environment (sweet, sour, aerated, or combination) and at the temperature considered most critical.

Table 1
Illustrative Data for Simulated Sweet Environment Corrosion Control Tests on Inhibited Lubricants for Sucker-Rod Threads (see test procedure in Paragraphs 3.2.1 and 3.2.2)

Simulated Inhibited Lubricant	Corrosion Penetration Rate in mm/y (mpy)
1. Film-forming Inhibitors:	
Undiluted Inhibitor A	0.041 (1.6)
Undiluted Inhibitor B	0.020 (0.8)
Undiluted Inhibitor C	0.010 (0.4)
2. Mixing Material (99 parts)—Inhibitor (1 part):[A]	
No. 2 diesel oil—Inhibitor A	0.041 (1.6)
No. 2 diesel oil—Inhibitor B	0.030 (1.2)
No. 2 diesel oil—Inhibitor C	0.020 (0.8)
Aromatic Solvent—Inhibitor A	0.041 (1.6)
Aromatic Solvent—Inhibitor B	0.041 (1.6)
Aromatic Solvent—Inhibitor C	0.010 (0.4)
SAE 10W lube oil[B]—Inhibitor A	0.366 (14.4)
SAE 10W lube oil—Inhibitor B	0.284 (11.2)
SAE 10W lube oil—Inhibitor C	0.19 (7.6)
SAE 10W-30 lube oil[B]—Inhibitor A	0.17 (6.8)
SAE 10W-30 lube oil—Inhibitor B	0.20 (8.0)
SAE 10W-30 lube oil—Inhibitor C	0.18 (7.2)
SAE 40 lube oil[B]—Inhibitor A	0.254 (10.0)
SAE 40 lube oil—Inhibitor B	0.18 (7.2)
SAE 40 lube oil—Inhibitor C	0.17 (6.8)
3. 100% Mixing Material—No Inhibitor	
No. 2 diesel oil	0.417 (16.4)
Aromatic Solvent	0.325 (12.8)
SAE 10W lubricating oil	0.366 (14.4)
SAE 10W-30 lubricating oil	0.356 (14.0)
SAE 40 lubricating oil	0.356 (14.0)

[A] The mixing ratio of 99:1 was used because of mixing problems encountered in more concentrated solutions.
[B] SAE J 300 (latest revision), "Engine Oil Viscosity Classification, Standard" (Warrendale, PA: SAE).

3.3 Galling Tests: A proposed undiluted inhibitor or inhibitor/lubricant mix should be tested to evaluate its performance in preventing galling of sucker-rod threads. The following test is an example of one that can be used for this purpose.

3.3.1 Test piece: 1.9-cm (0.75-in.) diameter API Grade "C" or Grade "D" rod with an API Grade "T" coupling.

3.3.1.1 Room-temperature test: The inhibited lubricant to be tested shall be applied to the rod threads by spraying or brushing. The coupling shall then be applied, torqued to 700 N-m (500 ft-lb), loosened, and retorqued to 700 N-m (500 ft-lb) for a minimum of ten times.

3.3.1.2 Elevated temperature test: Test procedure is the same as in Paragraph 3.3.1.1 with one additional step. After the coupling has been torqued to 700 N-m (500 ft-lb), the joint shall be baked for eight hours at 93°C (200°F). After cooling, the joint shall then be loosened and retorqued a minimum of ten times.

3.3.2 An inhibited lubricant is satisfactory if no galling of threads is evident after torquing ten times.

References

1. NACE Publication 1D167, "Corrosion Control of Sucker Rods by Chemical Treatment" (Houston, TX: NACE International, 1967). Superseded by NACE Standard RP0195, "Recommended Practice for Corrosion Control of Sucker Rods by Chemical Treatment," which was also published as Section 3 of API RP 11BR (latest revision), "Recommended Practice for Care and Handling of Sucker Rods" (Washington, DC: API).

2. A.C. Nestle, "Organic Inhibitors for Oil and Gas Wells," *Materials Protection* 7, 1 (January 1968): pp. 31-33.

3. Chemical Safety Data Sheet SD-36 (latest revision), Manufacturing Chemists Association, 1825 Connecticut Ave. NW, Washington, DC 20009.

4. N. Irving Sax, Dangerous Properties of Industrial Materials (New York, NY: Reinhold Book Corp., 1984).

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Appendix A: Safety Considerations in Handling H_2S

H_2S is very toxic. It has been responsible for many poisoning accidents and a number of fatalities. The Threshold Limit Value (TLV) is 10 ppm. The odor is not a reliable alarm system because the olfactory nerves quickly become deadened to H_2S. All experiments shall be conducted in a hood. Additional information on the toxicity of H_2S can be obtained from the "Chemical Safety Data Sheet SD-36"[3] and from *Dangerous Properties of Industrial Materials*,[4] by N. Irving Sax.