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Standard Test Method

Laboratory Screening Tests to Determine the Ability of Scale Inhibitors to Prevent the Precipitation of Calcium Sulfate and Calcium Carbonate from Solution (for Oil and Gas Production Systems)

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NACE International
1440 South Creek Drive
Houston, Texas 77084-4906
+1 (281) 228-6200

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Foreword

Scale is an adherent deposit of inorganic compounds precipitated from water onto surfaces. Most oilfield waters are brines containing large amounts of calcium salts. When calcium is deposited as calcium sulfate or calcium carbonate scale, a loss of production and increased maintenance expenses can result; therefore, effective scale inhibition is of primary importance to the oil producer.

Scale inhibitors can be used in many circumstances to control scale formation, thereby reducing production difficulties. Scale inhibitors are commercially available and are widely used in oil and gas production systems. The test methods in this standard are designed to provide a relative and quantitative measure of the abilities of scale inhibitors to prevent the precipitation of solids, a necessary and critical stage in the formation of scale. The laboratory screening tests described in this standard cannot and do not allow for the wide variation in water chemistry and system properties seen in field operations. As such they must only be regarded as a starting point in the evaluation of scale inhibitors. The existence and use of these methods allow for a uniform mode of collection of screening test results and facilitate discussion of the results by interested parties.

The test methods in this standard have been selected as a means of comparing, under the specified laboratory conditions, the effectiveness of scale inhibitors in preventing precipitation of calcium sulfate and calcium carbonate from solution. Because the prices of scale inhibitors change with time and may be unknown to the tester, no attempt has been made to dilute the scale inhibitor to a common cost base.

This standard was originally prepared in 1974 by Task Group T-1D-9 and was revised in 1990 by Task Group T-1D-31, a component of Unit Committee T-1D on Corrosion Monitoring and Control of Corrosion Environments in Petroleum Production Operations. It was reviewed and reaffirmed in 1995 by members of T-1D, and in 2001 and 2007 by members of Specific Technology Group (STG) 31 on Oil and Gas Production—Corrosion and Scale Inhibition. It is issued by NACE International under the auspices of STG 31.

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Section 1: General

1.1 The test methods described in this standard are static laboratory screening tests designed to give a measure of the ability of scale inhibitors to prevent the precipitation of calcium sulfate and calcium carbonate from solution at 71°C (160°F).

1.2 These test methods are recommended only for ranking the performance of different scale inhibitors under laboratory conditions set by these methods. They are not intended to provide actual field treating rates.

1.3 Many factors, such as reaction kinetics, fluid velocity and composition, variable temperatures and pressures, scale adherence, and solids dispersion can significantly affect actual scale deposition under field conditions. Detailed consideration of these parameters is deemed to be outside the scope of this standard. However, field

conditions, field brine composition, and other variables noted above should be considered at some point in scale inhibitor evaluation prior to final scale inhibitor selection for field use.

1.4 Tests should be conducted at various scale inhibitor concentrations in order to obtain a better understanding of performance under laboratory conditions set by these methods. The scale inhibitor concentration required for a field application is likely to be different from that determined under these laboratory conditions.

1.5 This standard lists the necessary apparatus, reagents, and procedures for conducting these laboratory screening tests.

Section 2: Calcium Sulfate Precipitation Test

2.1 This section lists the apparatus, solutions, and procedure for conducting the calcium sulfate precipitation screening test.

2.2 Apparatus and Solutions

2.2.1 Constant-temperature water bath or forced-draft oven with the capability of maintaining the specified temperature within $\pm 1^\circ\text{C}$ ($\pm 2^\circ\text{F}$).

2.2.2 Clean and dust-free glass test cells (approximately 125-mL [4-oz] bottles with positive seals).

2.2.3 Synthetic brines prepared with distilled or deionized water, as follows:

2.2.3.1 Calcium-containing brine: 7.50 g/L NaCl (ACS⁽¹⁾ reagent grade); 11.10 g/L $\text{CaCl}_2 \cdot 2\text{H}_2\text{O}$ (ACS reagent grade).

2.2.3.2 Sulfate-containing brine: 7.50 g/L NaCl (ACS reagent grade); 10.66 g/L Na_2SO_4 (ACS reagent grade).

2.2.3.3 Note: Very small quantities of insoluble materials may remain after the specified reagents have completely dissolved. For consistency of

results, solutions shall be filtered through a 0.45- μm filter.

2.2.4 Apparatus for reproducibly delivering 50 \pm 0.5 mL (e.g., graduated cylinders or volumetric pipets).

2.2.5 One percent by weight (1 wt%) and 0.1 wt% dilutions of the as-received scale inhibitors to be tested, prepared with deionized water.

2.2.6 Graduated measuring pipets in the following sizes: 0.1, 0.5, and 1.0 mL.

2.2.7 Standard reagents and apparatus for determination of calcium concentration in accordance with ASTM⁽²⁾ D 511,¹ ASTM D 1126,² APHA⁽³⁾ *Standard Methods for the Examination of Water and Wastewater* (Part 300),⁴ or another accepted test method.

2.3 Test Procedure

2.3.1 Pipet the desired amount of scale inhibitor into each test cell using the 1 wt% and 0.1 wt% dilutions. The 0.1 wt% dilution shall be used for tests in which scale inhibitor loadings are less than 10 mg/L. Run duplicates of each concentration.

⁽¹⁾ American Chemical Society (ACS), 1155 16th St. NW, Washington, DC 20036.

⁽²⁾ ASTM International (ASTM), 100 Barr Harbor Dr., West Conshohocken, PA 19428.

⁽³⁾ American Public Health Association (APHA), 800 I St. NW, Washington, DC 20001-3710.