



NACE Standard TM0194-2004
Item No. 21224

Standard Test Method

Field Monitoring of Bacterial Growth in Oil and Gas Systems

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Foreword

This standard describes field test methods that are useful for estimating bacterial populations, including sessile bacterial populations, commonly found in oilfield systems. The described test methods are those that can be done on site and that require a minimum of laboratory equipment or supplies. The described test methods are not the only methods that can be used, but they are methods that have been proved to be useful in oilfield situations. This standard is intended to be used by technical field and service personnel, including those who do not necessarily have extensive or specific training in microbiology. However, because microbiology is a specialized field, some pertinent and specific technical information and explanation are provided to the user. Finally, the implications of the results obtained by these test methods are beyond the scope of this standard. The interpretation of the results is site- and system-specific and may require more expertise than can be provided by this standard.

This standard is loosely based on a document produced by the former Corrosion Engineering Association (CEA). CEA operated in the United Kingdom under the auspices of NACE and the Institute of Corrosion (Icorr).⁽¹⁾ This NACE International standard was originally prepared in 1994 by NACE Task Group T-1C-21 under the direction of Unit Committee T-1C on Corrosion Monitoring in Petroleum Production. It was revised in 2004 by Task Group 214 on Bacterial Growth in Oilfield Systems—Field Monitoring: Review of NACE Standard TM0194, which is administered by Specific Technology Group (STG) 31 on Oil and Gas Production—Corrosion and Scale Inhibition and by STG 60 on Corrosion Mechanisms. It is issued by NACE under the auspices of STG 31.

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In NACE standards, the terms *shall*, *must*, *should*, and *may* are used in accordance with the definitions of these terms in the NACE Publications Style Manual, 4th ed., Paragraph 7.4.1.9. *Shall* and *must* are used to state mandatory requirements. The term *should* is used to state something good and is recommended but is not mandatory. The term *may* is used to state something considered optional.

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Section 1: General

1.1 Scope

1.1.1 This standard describes field test methods for estimating bacterial populations commonly found in oil and gas systems. Although these techniques have been successful in the oil field, they are not the only methods that are used. It is not the intent of this standard to exclude additional techniques that can be proved useful. However, caution should be exercised with any technique that is at variance from those outlined here.

1.1.2 A glossary of terms used in this standard is provided in Appendix A.

1.1.3 This standard deals only with bacteria and does not consider other organisms that may be found in oilfield fluids, such as archaeobacteria, phytoplankton (algae), protozoa, or fungi. In addition, these methods are not applicable to marine organisms such as zooplankton (copepods).

1.1.4 Because effective sampling is essential to any successful analysis, emphasis is given to sampling methods that are suitable for use in oilfield conditions.

1.1.5 Media formulations for enumerating common oilfield bacteria are given.

1.1.6 This standard describes dose-response (time-kill) testing for evaluating biocides used in oilfield applications.

1.1.7 Methods for evaluating surface attached (sessile) bacteria are addressed. The importance of these bacteria in oilfield problems is usually not adequately considered. Attached bacterial populations are often the most important component of a system's microbial ecology.¹

1.1.8 Emerging technologies for the rapid determination of bacterial populations and bacterial activity are addressed (See Appendix B). While these technologies are not specifically recommended, it is not the intent of this standard to prevent the use of any technology that can be useful. However, the user must determine the applicability of these new methods to the site/system. Similarly, there are a number of commercially available "test kits" for detecting various types of microorganisms; these are not discussed in this standard. However, the user could use this standard to evaluate the suitability of these test kits for any particular situation.

1.1.9 The simple presence of bacteria in a system does not necessarily indicate that they are causing a problem. In addition, bacterial populations causing problems in one situation, or system, may be harmless in another. Therefore, "action" concentrations for bacterial contamination cannot be given. Rather, bacterial population determinations are one more diagnostic tool useful in assessing oilfield problems.

1.1.10 Further information on the corrosion problems associated with bacterial growth in oilfield systems is given in NACE Publication TPC #3.²

Section 2: Sampling Procedures for Planktonic Bacteria

2.1 Baseline Sampling

2.1.1 Natural bacterial population fluctuation and uneven bacterial distribution within water systems may hamper accurate assessment of bacteria numbers. If baseline studies described here show a large variation in reported bacterial populations, several samples should be taken on each occasion and combined (bulk). However, this procedure may mask fluctuations in population profiles, if determining such profiles is a goal of the work.

2.1.2 Field operators should be solicited for valuable information. These operators can often provide, or obtain, critical past biological monitoring (background) data taken from the system. Communication with operators can also ensure that baseline sampling occurs during normal operations and not during excursions (pigging, shut-ins, biocide treatments, etc.).

In addition, selection of proper sample sites can best be made in cooperation with operators.

2.1.3 Sampling Frequency

2.1.3.1 Sampling frequency depends on how the field system operates and should encompass the various stages of its operation.

2.1.3.2 Some systems may exhibit large population variations over a short time. To establish the natural variation in bacteria numbers, samples (bulk or otherwise) should normally be taken randomly over several days to establish a baseline. This work should also establish the sample points that are representative of the system. As an example of what sample frequency might be required, twice-daily sampling over three to five days is often used. In other cases, greater