



Standard Test Method

Field Monitoring of Bacterial Growth in Oil and Gas Systems

This NACE International standard represents a consensus of those individual members who have reviewed this document, its scope, and provisions. Its acceptance does not in any respect preclude anyone, whether he or she has adopted the standard or not, from manufacturing, marketing, purchasing, or using products, processes, or procedures not in conformance with this standard. Nothing contained in this NACE standard is to be construed as granting any right, by implication or otherwise, to manufacture, sell, or use in connection with any method, apparatus, or product covered by letters patent, or as indemnifying or protecting anyone against liability for infringement of letters patent. This standard represents minimum requirements and should in no way be interpreted as a restriction on the use of better procedures or materials. Neither is this standard intended to apply in all cases relating to the subject. Unpredictable circumstances may negate the usefulness of this standard in specific instances. NACE assumes no responsibility for the interpretation or use of this standard by other parties and accepts responsibility for only those official NACE interpretations issued by NACE in accordance with its governing procedures and policies which preclude the issuance of interpretations by individual volunteers.

Users of this NACE standard are responsible for reviewing appropriate health, safety, environmental, and regulatory documents and for determining their applicability in relation to this standard prior to its use. This NACE standard may not necessarily address all potential health and safety problems or environmental hazards associated with the use of materials, equipment, and/or operations detailed or referred to within this standard. Users of this NACE standard are also responsible for establishing appropriate health, safety, and environmental protection practices, in consultation with appropriate regulatory authorities if necessary, to achieve compliance with any existing applicable regulatory requirements prior to the use of this standard.

CAUTIONARY NOTICE: NACE standards are subject to periodic review, and may be revised or withdrawn at any time in accordance with NACE technical committee procedures. NACE requires that action be taken to reaffirm, revise, or withdraw this standard no later than five years from the date of initial publication and subsequently from the date of each reaffirmation or revision. The user is cautioned to obtain the latest edition. Purchasers of NACE standards may receive current information on all standards and other NACE publications by contacting the NACE *FirstService* Department, 15835 Park Ten Place, Houston, TX 77084-5145 (telephone +1 281-228-6200).

Revised 2014-03-08
Revised 2004-11-15
Approved 1994
NACE International
15835 Park Ten Place
Houston, Texas 77084-5145
+1 281-228-6200

ISBN 1-57590-192-7
© 2014 NACE International

This is a preview of "NACE Standard TM0194...". [Click here to purchase the full version from the ANSI store.](#)

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 may be used, but 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, "Corrosion Monitoring in Petroleum Production." It was revised in 2004 by Task Group 214, "Bacterial Growth in Oilfield Systems—Field Monitoring: Review of NACE Standard TM0194," which is administered by Specific Technology Group (STG) 31, "Oil and Gas Production—Corrosion and Scale Inhibition," and sponsored by STG 60, "Corrosion Mechanisms." It is issued by NACE under the auspices of STG 31.

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*. The terms *shall* and *must* are used to state a requirement, and are considered mandatory. The term *should* is used to state something good and is recommended, but is not considered mandatory. The term *may* is used to state something considered optional.

⁽¹⁾ Institute of Corrosion (Icorr), P.O. Box 253, Leighton, Buzzard Beds, LU7 7WB, England.

TM0194-2014

Standard Test Method
Field Monitoring of Bacterial Growth
in Oil and Gas Systems

Content

1. General.....	1
2. Sampling Procedures for Planktonic Bacteria	2
3. Assessment and Sampling of Sessile Bacteria	4
4. Culture Techniques	5
5. Evaluation of Chemicals for Control of Bacteria.....	7
6. Non-Media-Based Field Methods	8
References.....	9
Bibliography.....	11
APPENDIXES	
Appendix A: Glossary (Mandatory)	12
Appendix B: Alternative Methods for Assessing Bacterial Populations (Nonmandatory).....	17
Appendix C: Growth Medium Formulations (Nonmandatory)	19
Appendix D: Membrane Filtration-Aided Bacterial Analyses (Nonmandatory).....	24
Appendix E: Bacterial Culturing by Serial Dilution (Mandatory)	25
Appendix F: Example of Use Flow Chart (Nonmandatory)	28
FIGURES	
Figure E1: Schematic of triplicate serial dilution inoculation (MPN).....	25
Figure F1: Decision Tree for Microbial Testing	28
TABLES	
Table 1: Results Interpretation Table	6
Table C1: SRB Growth Media	19
Table C2: Media for Heterotrophic Bacteria.....	21
Table C3: Media for Various Types of Phenol Red Broth	21
Table C4: Nitrogen Utilizing Bacteria Media.....	22
Table C5: Nitrogen Reducing Bacteria Media	22
Table C6: Methanogenic Media	22
Table C7: Iron Bacteria Media.....	23
Table C8: Phosphate-Buffered Saline (PBS)	23
Table E1: Single Serial Dilution	27
Table E2: Duplicate Serial Dilution.....	27
Table E3: Five Replicate Serial Dilution	27

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. Regardless of the method chosen, all techniques should be applied in a consistent manner. It should be recognized that transportation of samples from the field before analysis may significantly change the viability of the bacteria and therefore, whenever practical, analysis should be initiated in the field. 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 The 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. Bacterial population determinations are one more diagnostic tool useful in assessing oilfield problems.

1.1.3 A glossary of terms used in this standard is provided in Appendix A (Mandatory).

1.1.4 This standard deals only with oilfield bacteria generally recognized as harmful in oilfield systems and does not consider other organisms that may be found in oilfield fluids, such as phytoplankton (algae), protozoa, or marine organisms such as zooplankton (copepods).

1.1.5 Emphasis is given to sampling methods that are suitable for use in oilfield conditions because effective sampling is essential to any successful analysis.

1.1.6 Not all bacteria and archaea species can be cultured, and newer molecular microbiology methods are provided in Appendix B (Nonmandatory) to help in identifying microorganisms that cannot be cultured and assessing their roles in the oilfield. Media formulations for enumerating some oilfield bacteria commonly recognized as harmful are given in Appendix C (Nonmandatory).

1.1.7 This standard describes dose-response (constant concentration versus time-kill) testing for evaluating biocides used in oilfield applications. *Minimum inhibitory concentration* testing versus biostat inhibitor concentration needs to be addressed. Minimum inhibitory concentration refers to the amount of inhibitor required to create the desired result. In some cases, the desired result is simply to retard the activity and/or growth of the bacteria in the system. In this case, a biostat may be used with more efficiency than a biocide. In cases in which the desired result is for there to be as few viable bacteria available as possible, a biocide may be necessary. There may be cases in which a biostat and a biocide are the same chemicals applied at different dosages. The minimum inhibitory concentration should be determined by testing using the methods outlined in this and other standards. The minimum inhibitory concentration varies with the required result, type of inhibitor, and required dosage to accomplish the objective.

1.1.8 Methods for evaluating surface attached (sessile) bacteria are addressed in Section 3. 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

1.1.9 Methods for the rapid enumeration of bacterial populations' activity are addressed in Appendix B. The user must determine the applicability of these methods to the site/system. Similarly, there are a number of commercially available "test kits" for detecting various types of microorganisms that 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.

1.1.10 Additional information on the corrosion problems associated with bacterial growth in oilfield systems is given in NACE Standard TM0106 and NACE Standard TM0212.^{2,3}