
A practical evaluation of 21st century microbiological
techniques for the upstream oil and gas industry

A PRACTICAL EVALUATION OF 21ST CENTURY MICROBIOLOGICAL TECHNIQUES
FOR THE UPSTREAM OIL AND GAS INDUSTRY

1st edition

November 2012

Published by

ENERGY INSTITUTE, LONDON

The Energy Institute is a professional membership body incorporated by Royal Charter 2003

Registered charity number 1097899

The Energy Institute (EI) is the leading chartered professional membership body supporting individuals and organisations across the energy industry. With a combined membership of over 14 000 individuals and 300 companies in 100 countries, it provides an independent focal point for the energy community and a powerful voice to engage business and industry, government, academia and the public internationally.

As a Royal Charter organisation, the EI offers professional recognition and sustains personal career development through the accreditation and delivery of training courses, conferences and publications and networking opportunities. It also runs a highly valued technical work programme, comprising original independent research and investigations, and the provision of EI technical publications to provide the international industry with information and guidance on key current and future issues.

The EI promotes the safe, environmentally responsible and efficient supply and use of energy in all its forms and applications. In fulfilling this purpose the EI addresses the depth and breadth of energy and the energy system, from upstream and downstream hydrocarbons and other primary fuels and renewables, to power generation, transmission and distribution to sustainable development, demand side management and energy efficiency. Offering learning and networking opportunities to support career development, the EI provides a home to all those working in energy, and a scientific and technical reservoir of knowledge for industry.

This publication has been produced as a result of work carried out within the Technical Team of the EI, funded by the EI's Technical Partners. The EI's Technical Work Programme provides industry with cost-effective, value-adding knowledge on key current and future issues affecting those operating in the energy sector, both in the UK and internationally.

For further information, please visit <http://www.energyinst.org>

The EI gratefully acknowledges the financial contributions towards the scientific and technical programme from the following companies

BG Group	Nexen
BP Exploration Operating Co Ltd	Phillips 66
BP Oil UK Ltd	Premier Oil
Centrica	RWE npower
Chevron	Saudi Aramco
ConocoPhillips Ltd	Shell UK Oil Products Limited
EDF Energy	Shell U.K. Exploration and Production Ltd
ENI	SSE
E. ON UK	Statoil
ExxonMobil International Ltd	Talisman Energy (UK) Ltd
International Power	Total E&P UK Limited
Kuwait Petroleum International Ltd	Total UK Limited
Maersk Oil North Sea UK Limited	Valero
Murco Petroleum Ltd	World Fuel Services

However, it should be noted that the above organisations have not all been directly involved in the development of this publication, nor do they necessarily endorse its content.

Copyright © 2012 by the Energy Institute, London.
The Energy Institute is a professional membership body incorporated by Royal Charter 2003.
Registered charity number 1097899, England
All rights reserved

No part of this book may be reproduced by any means, or transmitted or translated into a machine language without the written permission of the publisher.

ISBN 978 0 85293 638 2

Published by the Energy Institute

The information contained in this publication is provided for general information purposes only. Whilst the Energy Institute and the contributors have applied reasonable care in developing this publication, no representations or warranties, express or implied, are made by the Energy Institute or any of the contributors concerning the applicability, suitability, accuracy or completeness of the information contained herein and the Energy Institute and the contributors accept no responsibility whatsoever for the use of this information. Neither the Energy Institute nor any of the contributors shall be liable in any way for any liability, loss, cost or damage incurred as a result of the receipt or use of the information contained herein.

Further copies can be obtained from: Portland Customer Services, Commerce Way, Whitehall Industrial Estate, Colchester CO2 8HP, UK.
t: +44 (0)1206 796 351 e: sales@portland-services.com

Electronic access to EI and IP publications is available via our website, www.energypublishing.org.
Documents can be purchased online as downloadable pdfs or on an annual subscription for single users and companies.
For more information, contact the EI Publications Team.
e: pubs@energyinst.org

CONTENTS

	Page
Foreword	5
Acknowledgements	6
1 Introduction	7
1.1 Background.	7
1.2 Troublesome microorganisms.	8
1.3 Executive summary of results.	10
2 Samples	12
2.1 Water sampled from a seawater injection system.	13
2.2 Water sampled from an oil production system	14
2.3 Pigging debris sampled from an oil production pipeline	15
2.4 Surface solids sampled from an oil export spool section	16
3 The techniques	18
3.1 Analysis by traditional microbiological techniques (TMT)	19
3.2 Analysis by molecular microbiological methods (MMM)	22
4 Results	26
4.1 Water sampled from a seawater injection system.	26
4.2 Water sampled from an oil production system	30
4.3 Pigging debris sampled from an oil production pipeline	35
4.4 Surface solids sampled from an oil export spool section	39
5 Discussion	43
5.1 Overall comparison of TMT and MMM	43
6 Conclusions	51
7 References	52
8 Glossary	56
Annexes	
Annex A Results of analysis by traditional microbiological techniques	59
Annex B Results of analysis by molecular microbiological methods	64

FOREWORD

Despite the repeatedly demonstrated financial and operational risk from the activity of microorganisms, the oil and gas industry has largely depended upon the development of microbiological monitoring and identification techniques intended for other commercial sectors and adapted these for its own needs. This is still true in the 21st century, but the rapidly increasing dependence upon molecular microbiological methods (MMM) in fields such as clinical diagnostics and the food industry, is only slowly being embraced by the oil and gas industry. One of the reasons for this is the relative lack of knowledge of the strengths and weaknesses of MMM in relation to microbiological problems in oilfield, refinery and pipeline situations. Therefore, in general there is an inability to take full advantage of the power of molecular biology to help understand and solve the wide variety of microbiological problems which may occur in both the upstream and downstream sectors of the oil industry.

The aim of this report is to compare traditional oil industry microbiological monitoring techniques with MMM. A total of 10 samples were collected from three oil production platforms in the North Sea, including water from a seawater injection system, produced water from oil separators, pigging debris, and surface solids from an oil export spool section. Each sample was analysed using a suite of traditional microbiological techniques and MMM. The strengths and weaknesses of each technique were assessed in relation to oil industry requirements. The intention was not to recommend the 'best applicable' technique but rather to discuss the results from the various techniques in terms of the underlying science. By understanding the underpinning technology of each technique, the reader will be better equipped to specify techniques appropriate for the elucidation of a particular problem and also to make reasoned interpretations of the results from the chosen techniques.

The information contained in this publication is provided as guidance only, and while every reasonable care has been taken to ensure the accuracy of its contents, the Energy Institute and the representatives listed in the Acknowledgements, cannot accept any responsibility for any actions taken, or not taken, on the basis of this information. The Energy Institute (EI) shall not be liable to any person for any loss or damage that may arise from the use of any of the information contained in any of its publications.

ACKNOWLEDGEMENTS

This project was commissioned by the Energy Institute's (EI) Microbiology Committee.

The work was carried out by Dr. Susanne Juhler & Dr. Torben Lund Skovhus, DTI Oil & Gas, Denmark and Dr. Ian Vance, Centromere Limited, United Kingdom and steered by members of the Microbiology Committee, who during the project included:

Simon Ashton	ExxonMobil
Simon Christopher	BP
Brian Crook	HSL
Carol Devine	North East Corrosion Engineers (NECE)
Bob Eden	RawWater Engineering Company
Beate Hildenbrand	Energy Institute
Graham Hill	ECHA Microbiology
Joan Kelley	CABI UK
Jan Kuever	Bremen Institute for Materials Testing
Jan Larsen	Maersk Oil & Gas
Bart Lomans	Shell
Torben Lund Skovhus	Danish Technological Institute (DTI)
Elaine McFarlane	Shell Global Solutions
Andrew Price	Oil Plus
Tony Rizk	Saudi Aramco
Kerry Sinclair	Energy Institute
Jim Stott	Intertek - Capcis
Ian Vance	Centromere
Neil Whitehead	Minton Treharne & Davies Ltd

The Institute wishes to record its appreciation of the work carried out by the authors and also its gratitude for the valuable contributions made by the Microbiology Committee during the course of the project.

The EI would also like to thank BP Norge and Maersk Oil for providing valuable samples for this study.