VIA University College

CORROSION Conference & Expo 2019
March 24-28 • Nashville, Tennessee

Management of MIC in the Oil, Gas and Petroleum Industry Forum

Torben Lund Skovhus, Chair
Tom Jack, Vice Chair

NACE International
March 25, 2019
@ 9-12 am
Nashville, TN

Agenda

- **Welcome from the Chair**
- **Project intro:** John Wolodko
- **Speaker 1:** Rick Eckert
- **Speaker 2:** Tom Jack
- **Short Break (15 min)**

Skovhus & Eckert (2014)

Agenda

- **Speaker 3:** John Wolodko
- **Speaker 4:** Torben Skovhus
- **Open discussion from the floor**
- **Forum closing by Chair**
- **Enjoy the Conference & Expo!**

Skovhus & Eckert (2014)

A few practical matters

- Please turn cell phones off
- No written papers or slides are available from this forum
- No recording is allowed
- Majority of questions at "open discussion" part in the 2nd half
- Please state your name and affiliation when asking questions
- A short 15 min break will start at around 10.05 am

The Scope of the MIC Management Forum

- This forum will present practical examples of MIC management in a variety of systems found in the oil and gas industry.
- Case studies will demonstrate how operators are addressing the threat of MIC as part of a corrosion management system.
- The latest developments in MIC assessment, mitigation, and monitoring will be presented. Also, the most recent MIC models will be presented and demonstrated.

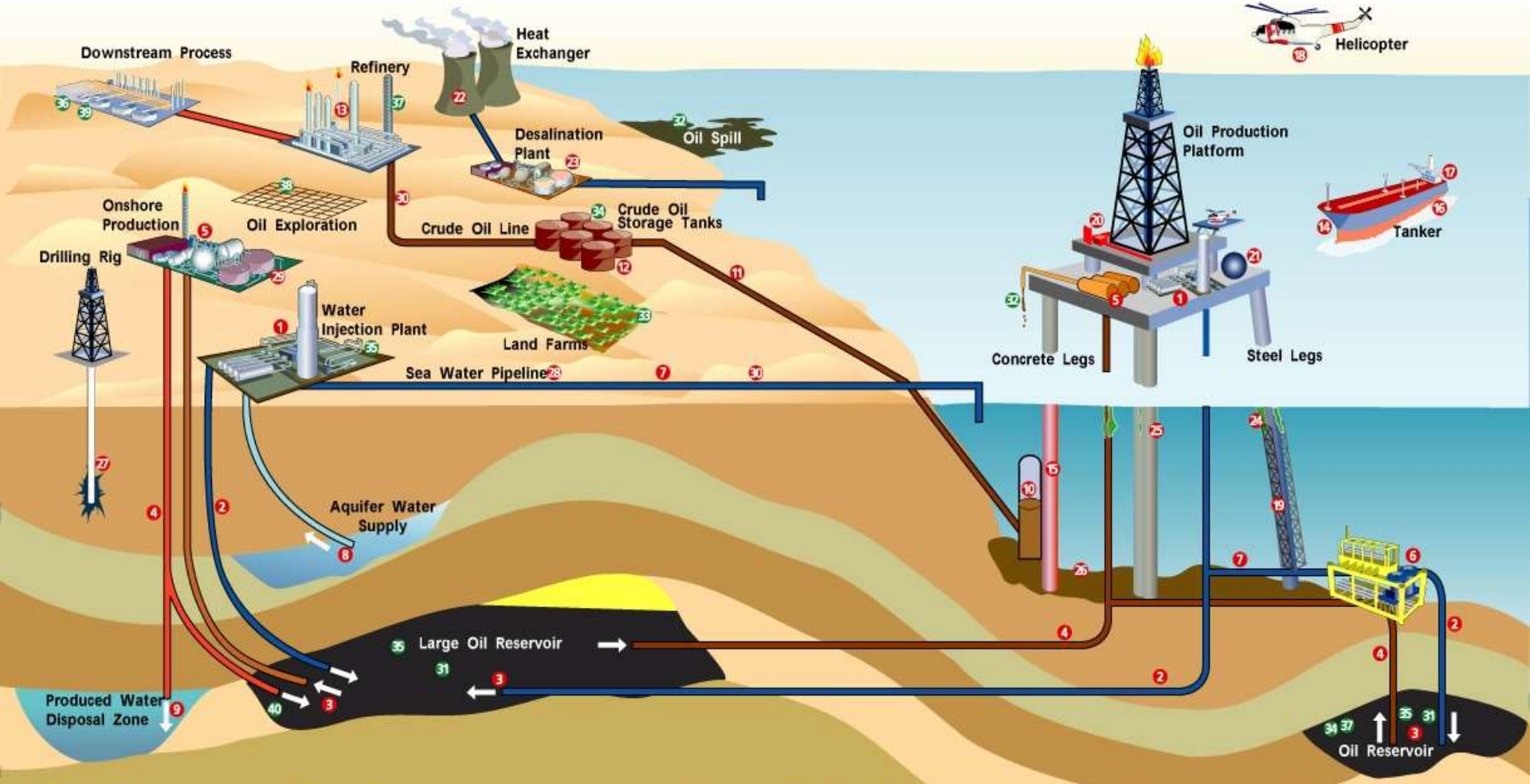
Andersen, Hillier & Skovhus (2016)

Negative

1- Water Injection System fouling/MIC
2- Down-hole MIC (mesophiles)
3- Reservoir souring & plugging
4- Down-hole MIC (thermophiles)
5- Production system MIC, H_2S, Oil in Water
6- Sub-sea manifold MIC
7- Water flowline internal MIC & fouling
8- Aquifer supply-plugging; ESP MIC
9- Produced water injection well plugging
10- Crude oil storage H_2S, H_2SO_4
11- Oil pipline internal MIC & fouling
12- Onshore crude oil tank MIC
13- Refinery MIC
14- Crude oil cargo tank MIC
15- Diesel tank contamination/spoilage
16- Ship fuel fouling, spoilage & MIC
17- Lubricating & Hydraulic oil contamination
18- Helicopter/aircraft fuel contamination
19- Water filled steel legs & hydrotest MIC
20- Firewater system MIC & fouling
21- Potable water MIC & pathogens
22- Heat exchanger MIC & fouling
23- Desalination/RO plant fouling & MIC
24- Marine growth - steel MIC
25- Marine growth - concrete spalling
26- Discarded drill mud - MIC/environmental
27- Drilling/workover fluids contamination
28- NORM concentration by SRB
29- Production chemicals spoilage
30- Coatings biodeterioration

Positive

31- Microbially Enhanced Oil Recovery
32- Oil spill biodegradation
33- Bioremediation - land farming
34- Biodesulfurization
35- Competitive microbes - control MIC/souring
36- Biosensors
37- Biorefining and upgrading oil
38- Microbial prospecting
39- Bacterial production of novel oilfield chemicals
40- Control by specific pathogens



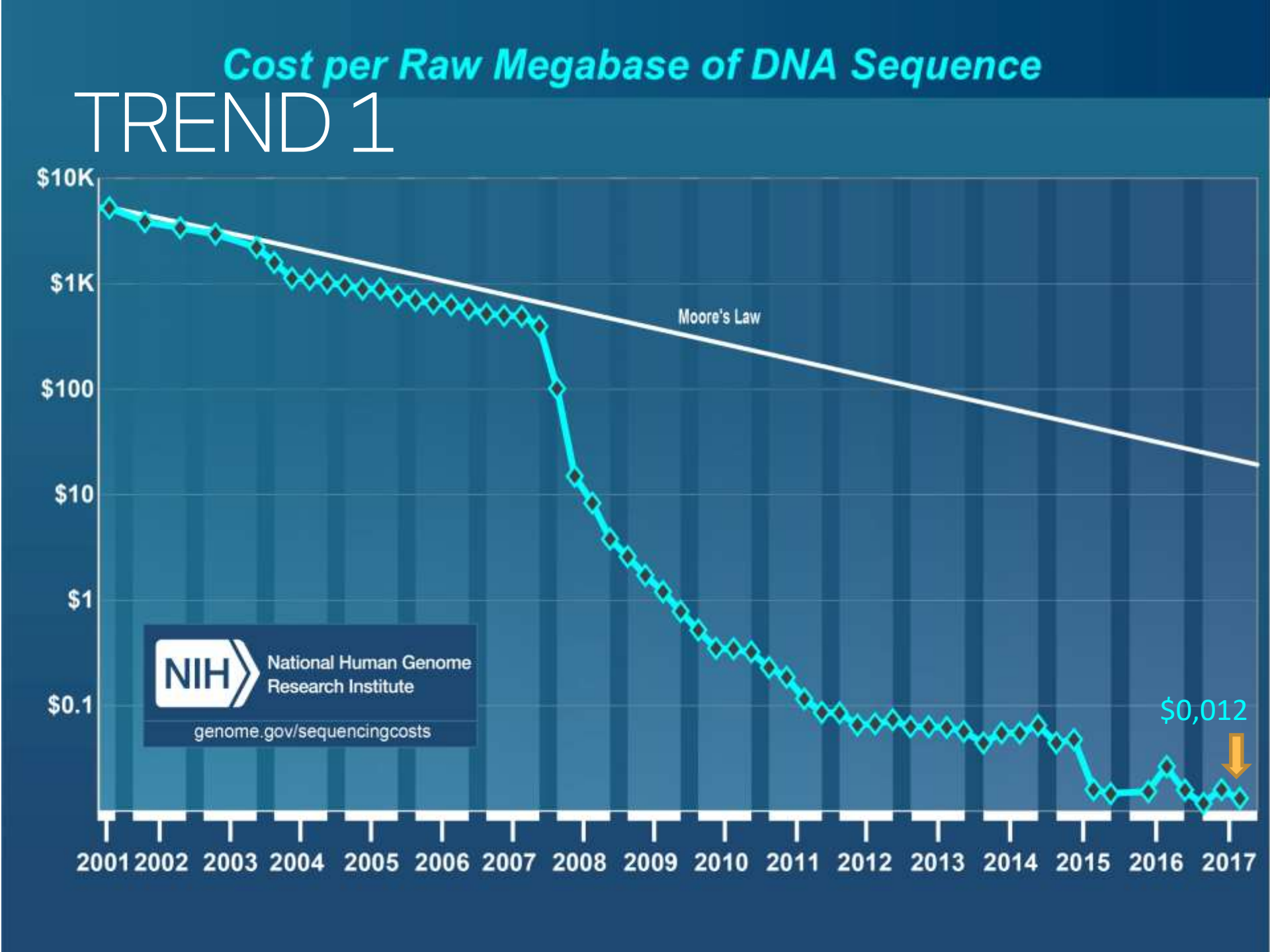
Impact of Microbes on the Oil Industry

Petroleum Microbiology (2006)

Corrosion Management and MIC

We have seen at least *two* trends in the past 10 years related to MIC – and here it is not this well known graph I'm thinking of:

TREND 1


Cost per Raw Megabase of DNA Sequence
$10K
$1K
$100
$10
$1
$0.1
Moore's Law
NIH
National Human Genome Research Institute
genome.gov/sequencingcosts
$0,012
2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017

TREND 2

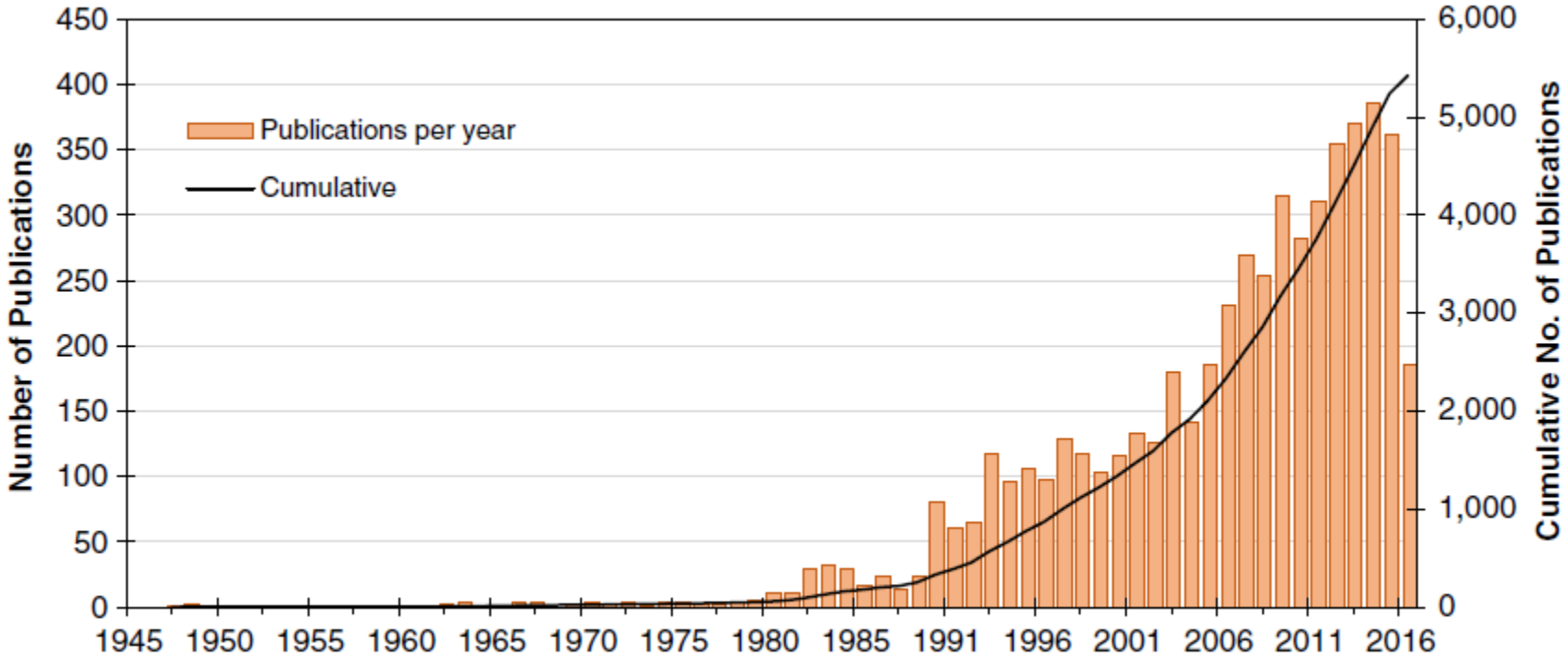


FIGURE 1. *Temporal distribution of MIC publications.*

Bibliometric Analysis of Microbiologically Influenced Corrosion (MIC) of Oil and Gas Engineering Systems — https://doi.org/10.5006/2620

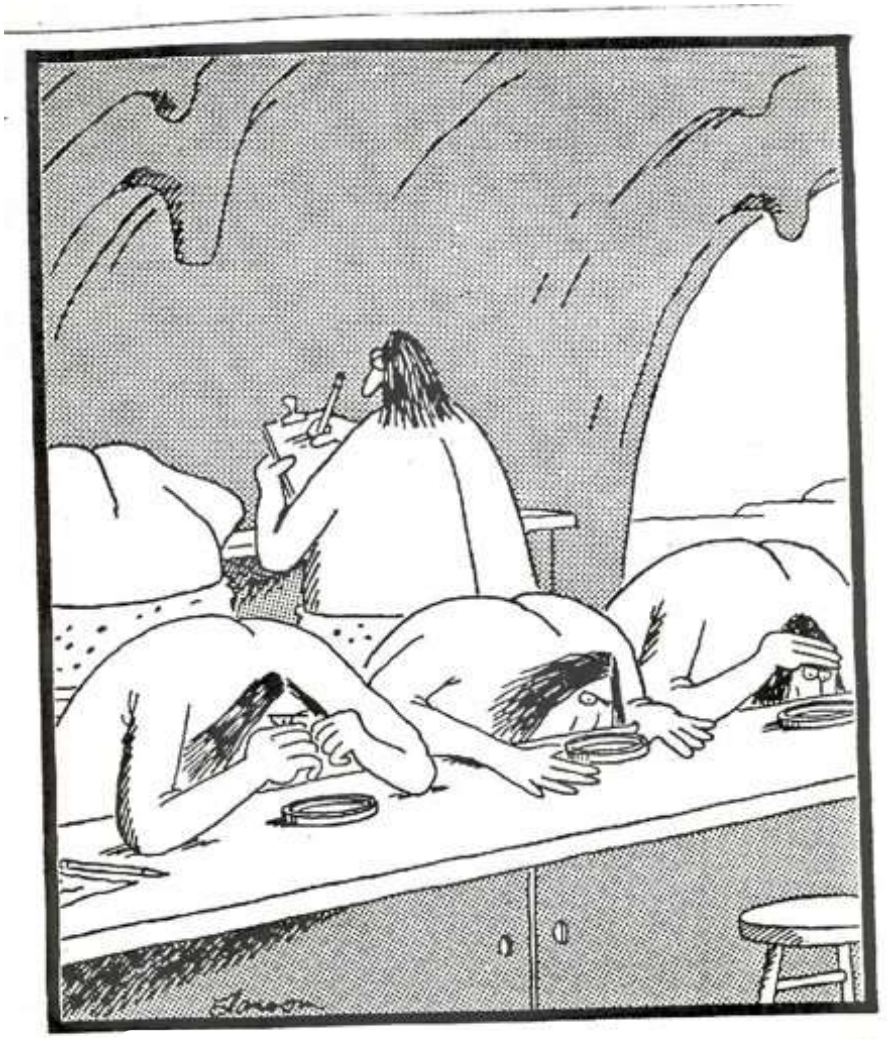
2001

2010

2017-

Several special meetings on MIC

- ISMOS meetings
- RMF/Energy Institute
- SPE meetings & courses
- EuroCorr/EFC
- TEKNA (Norway)
- NACE TG, TEG, Symposia
- NACE MIC Forums



Early microbiologists looking at MIC

MIC Forum
1st Session

Project intro: John Wolodko

Speaker 1: Rick Eckert

Speaker 2: Tom Jack

Short break (15 min)

MIC Forum
2nd Session

Speaker 3: John Wolodko

Speaker 4: Torben Skovhus

Open discussion from the floor

Forum closing by Chair

Open discussion…

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- 1. Where do you see the greatest threat of MIC in the industry (gap in detection technology, mitigation, knowledge among staff and/or management, etc.)?
- 2. How can we predict MIC in the most optimal way (model, analytical, process history, etc.)?
- 3. How is MIC diagnostic best aligned with diagnostics of other corrosion threats in the oil and gas industry?
- 4. Microbiological monitoring – only a part of assessing for MIC – is this enough? Are more holistic approaches needed?

Closing the Forum

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A few important announcements of meetings:

- **ISMOS-7** (June 18-21 2019, Halifax)
- **RMF-25** (November 20-21, 2019, London)
- **Corrosion Atlas** – open for failure analysis cases on MIC
- Several meetings and symposia here at **NACE C2019**

Please join us at ISMOS-7

June 18-21, 2019 in Halifax, Nova Scotia, Canada

Registration is open!

Poster abstract submission deadline: April 18, 2019

Visit our website for ongoing updates: www.ismos-7.org

GenomeAtlantic

Life Sciences. Life Solutions.

Reservoir Microbiology Forum (RMF)
Now accepting abstracts – deadline 1 July

The RMF is an excellent multi-disciplinary platform which brings together oil producers, scientists, technologists, engineers, academics and researchers from around the world to present, share and discuss the widespread and versatile effects of microbes in oil reservoirs. Submit a short abstract now to be considered for a speaking opportunity.

Abstract topics:

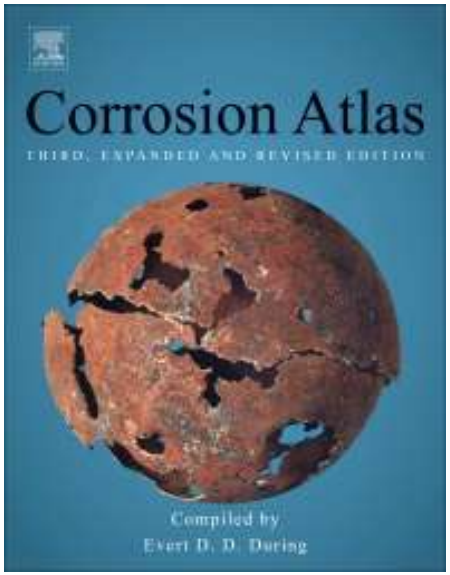
- Microbiologically influenced corrosion (MIC)
- Souring
- Mitigation and remediation strategies and case studies
- Molecular microbiological methods (MMM) and monitoring
- Produced water treatment
- Microbial upgrading and microbial enhanced oil recovery (MEOR)
- Fluid transport and reservoir and biofilm modelling
- Microbiology of carbon capture and sequestration
- Microbiology of hydraulic fracturing
- Innovative technologies and biotechnologies

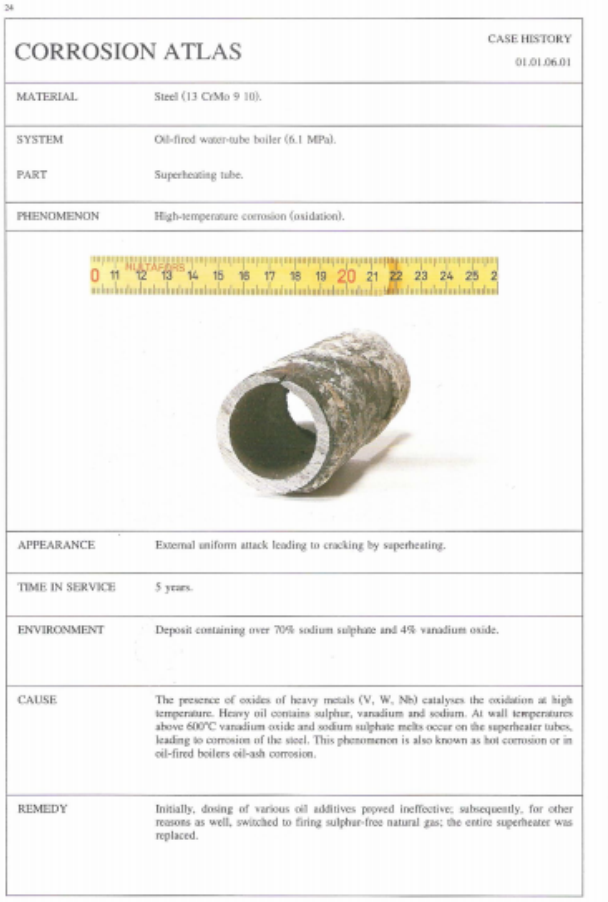
Date of event:
20 - 21 November 2019

Location:
Energy Institute, London, W1G 7AR

More information: energy-inst.org/rmf

Corrosion Atlas Series





CORROSION ATLAS — CASE HISTORY 01.01.06.01

MATERIAL	Steel (13 CrMo 9 10).
SYSTEM	Oil-fired water-tube boiler (6.1 MPa).
PART	Superheating tube.
PHENOMENON	High-temperature corrosion (oxidation).
APPEARANCE	External uniform attack leading to cracking by superheating.
TIME IN SERVICE	5 years.
ENVIRONMENT	Deposit containing over 70% sodium sulphate and 4% vanadium oxide.
CAUSE	The presence of oxides of heavy metals (V, W, Nb) catalyses the oxidation at high temperature. Heavy oil contains sulphur, vanadium and sodium. At wall temperatures above 600°C vanadium oxide and sodium sulphate melts occur on the superheater tubes, leading to corrosion of the steel. This phenomenon is also known as hot corrosion or in oil-fired boilers oil-ash corrosion.
REMEDY	Initially, dosing of various oil additives proved ineffective; subsequently, for other reasons as well, switched to firing sulphur-free natural gas; the entire superheater was replaced.

...open for failure analysis cases on MIC

Web: www.materialstoday.com/corrosion-atlas-series-case-studies

Email: TOLS@VIA.DK (Co-Editor)

NACE C2019

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- **Tuesday and Wednesday:** TEG 187X Symposium - Microbiologically Influenced Corrosion

- **Wednesday 8-10 am:** TG 561 Meeting on "MOLECULAR MICROBIOLOGICAL METHODS – SAMPLE HANDLING AND LABORATORY PROCESSING" (**Room 103A**)

Thanks for joining this morning!