mi CENSUS®

MOLECULAR BIOLOGICAL TOOL

Rapidly detect and quantify microbial populations responsible for MIC

Microbiologically induced corrosion (MIC) impacts nearly all industries and can exact a severe toll in terms of loss of production, O&M costs, deterioration of equipment, and potentially the health, safety, and environmental consequences of corrosion related failure.

MIC prevention requires detection and quantification of the microorganisms responsible so that appropriate corrective measures can be taken. Currently, assessment of MIC potential is primarily based upon culture-dependent methods like plate counts, MPNs, or Biological Activity Response Tests. However, the overwhelming majority of microorganisms (90–99%) cannot be grown in artificial media in a laboratory. Thus, the conventional techniques used to guide O&M measures may vastly underestimate the potential for MIC activity.

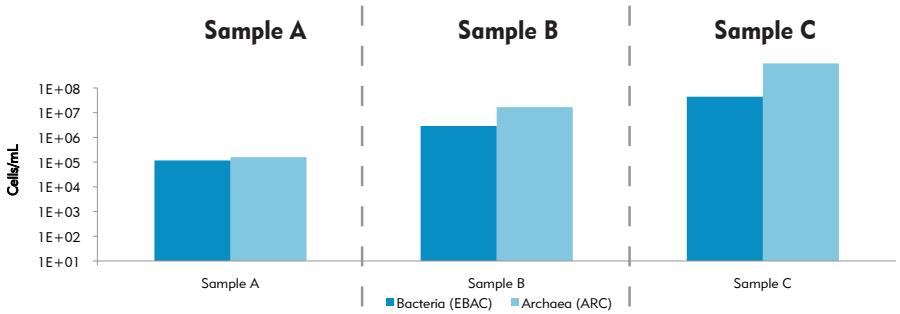
Microbial Insights, Inc. (MI) is now offering CENSUS for more sensitive and accurate quantification of microorganisms responsible for MIC.

Target	Code	Environmental Relevance / Data Interpretation
Total Bacteria	qEBAC	MIC is initiated by growth of a biofilm on the material surface. Monitoring total bacteria would provide a general measure for evaluating bacterial growth in the system.
Total Archaea	qARC	Archaea are another general group of single celled microorganisms which, like bacteria, can initiate and contribute to MIC. Depending on types and environmental conditions, total archaea can outnumber total bacteria and be a more important factor in MIC.
Sulfate Reducing Bacteria	qAPS	Sulfate reducing bacteria (SRB) are the group of microorganisms most commonly implicated in the pitting corrosion of various metals. The qAPS CENSUS assay for SRB targets a functional gene involved in sulfate reduction.
Methanogens	qMGN	Corrosion rates due to methanogens can be comparable to those of sulfate reducing *Desulfovibrio* cultures. In addition to directly promoting MIC, some methanogens may also promote growth and activity of other MIC-associated microorganisms including SRB and acetogens.
Acid Producing Bacteria – Acetogens	qAGN	Acetogenic bacteria are strict anaerobes that produce acetate from the conversion of H_2-CO_2, CO, or formate. Hydrogen mediated acetogenesis has been demonstrated in high pressure natural gas pipelines confirming the in situ activity of this bacterial group. Further, the presence of acetic acid is known to exacerbate carbon dioxide corrosion of carbon steel.
Nitrate Reducing Bacteria	qDNF	Increasingly, nitrate addition is being used to stimulate growth of nitrate reducing bacteria as a bioexclusion strategy to combat SRB-mediated reservoir souring and MIC. The qDNF assay quantifies target genes encoding enzymes responsible for a key step in biological nitrate reduction.
Archaeoglobus	qARG	A specific genus of hyperthermophilic, sulfate reducing archaea implicated in MIC at elevated temperatures.

MIC Example Application

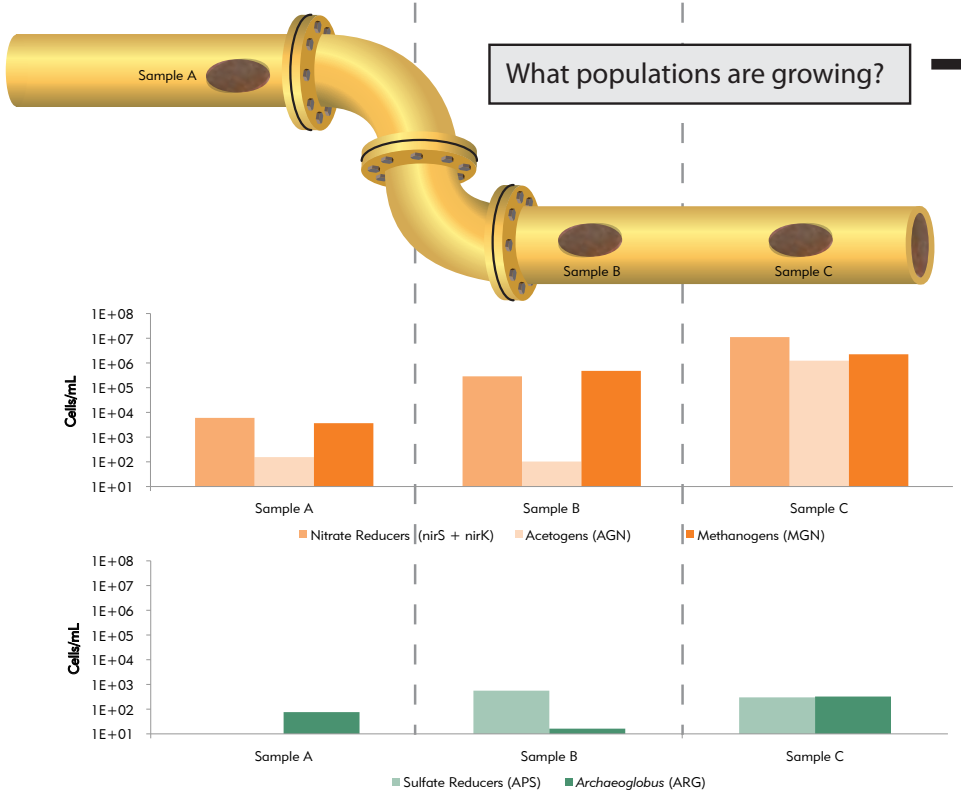
In the following example, samples were obtained at different points to investigate microbial growth along a pipeline.

Are microorganisms growing along the pipe?



- The first question to be addressed was simple – Are microorganisms growing along the pipeline?
- CENSUS analyses demonstrated that total bacteria and total Archaea populations increased by several orders of magnitude and suggested that the potential for MIC increased along the pipeline.
- A broad spectrum of microorganisms can contribute directly or indirectly to MIC. Additional CENSUS assays were performed to quantify specific groups frequently involved in MIC processes.

What populations are growing?



- CENSUS quantification of nitrite reductase genes (nirS and nirK) revealed that populations of nitrate reducing (denitrifying) bacteria increased dramatically along the flow path.
- Likewise, methanogens increased by almost three orders of magnitude. Methanogens utilize hydrogen for growth, can contribute to cathodic depolarization, and can cause corrosion at rates comparable to sulfate reducing bacteria (SRB).
- Acetogens utilize hydrogen and CO^2 to produce acetic acid. In addition to exacerbating carbon dioxide corrosion of carbon steel, production of acetic acid supports growth of other acid producing bacteria and SRBs.
- Although still relatively low at the second location, acetogen populations increased by approximately four orders of magnitude by the last sampling location.
- Sulfate reducing bacteria (SRB) are commonly implicated in pitting type MIC. In higher temperature systems, sulfate reducing archaea such as *Archaeoglobus* may also contribute to MIC.
- While detected at each location, CENSUS analysis demonstrated that the observed increase in biomass along the pipeline was not due to growth of SRB.

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