

DNA Sequencing to Pinpoint Corrosion-Causing Bacteria in Steel

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A major federal facility has a condenser water system as a primary cooling supply for its air conditioning. The system uses primarily schedule 20 carbon steel piping, ranging from 61 cm to 25.4 cm (24 to 10 inches) in diameter. To get the system operating more expeditiously it was made using Victaulic couplings rather than welding the piping joints. Now some nine years after going on line it has been discovered that there is extreme corrosion and metal loss in the joints. MATCO Associates, an independent materials testing lab, was brought in to discover the cause of the corrosion.

One difficulty is that the system now requires 24/7/365 operation, making shutdowns for maintenance a serious problem. In the months before MATCO was hired, some 15 pieces of pipe had been removed from the system and replaced with new materials. The old corroded pipes were available for analysis. The operating reports from the water treatment company were also available for review.

The interior of many of the pipes was covered with a fairly thick tubercular deposit, almost entirely iron oxide and oxyhydroxide. The deposit had as much as 2.3% sulfur concentration. The lips of the pipes inside the joints appeared in many places to almost have been "chewed" off, with irregular deep metal loss around the entire circumference.

Microbially influenced corrosion was immediately suspected. Fortunately it was possible to isolate a joint in the system and remove both some of the water at that point and the gasket from the joint. Aerobic and anaerobic culturing of these samples showed elevated concentrations of sulfur-reducing bacteria and high heterotrophic plate counts, especially on the gasket.

A wet slime from another joint and a dry joint deposit sample were submitted to Microbac Laboratories for polymerase chain reaction analysis. Microbac was able to isolate and sequence DNA

from both of these samples, identifying acinetobacter junii as the probable slime-former and alpha-proteobacterium as the ferromangous degrader forming the red-brown deposit. This is one of the first times DNA sequencing has been used commercially in pinning down the specific organisms causing MIC.

The probably scenario for the system failure is as follows: The system was completed in October, 1993, and was probably pressure tested by the contractor soon there after. The facility opened in the spring and the water treatment contractor began treatment in April 1994, using both corrosion inhibitors and biocides in the system. But it was already too late. Biofilms had already started forming in the stagnant areas of the joints and biocides could not penetrate the polysaccharide slimes forming over them. Thus water treatment records showed little indication of either bacteria or corrosion, although both were present in abundance.

The system will have to be thoroughly acid cleaned and every joint disassembled and cleaned to get rid of the biofilms. Biocide treatment has to start from Day 1 of the refurbished system.

Donald L. Gibbon, in press, Materials Performance, March, 2004.