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Myths About Microbiologically Influenced Corrosion (MIC) in Water-Based Fire Protection Systems by Daniel H. Pope, Ph.D.

First, as the investigator who first coined the term microbiologically influenced corrosion (MIC) and defined it as "any form of corrosion which is *influenced* by the presence and/or activities of microorganisms" (ref.1) I am disturbed by the notion presented by some (e.g. Potter video on MIC) that microbes only affect pre-existing corrosion sites. This is clearly not the case as microbes can *initiate* corrosion, especially at sites in steel which are prone to microbial colonization and subsequent corrosion, such as manganese sulfide inclusions in the steel (Pope and Duquette, ref.2), in water puddles on the bottom of a horizonta

Third, Pope (ref.4 1986 article) first proposed models for MIC showing that mic-related microbes (MRM) influence corrosion by creating a variety of conditions under which several corrosion mechanisms can occur. These can change over time and with changing conditions at the corrosion sites. I noted that when the corrosion sites reach the point where pitting has begun under the discrete deposits killing the microbes or inhibiting their activities will NOT stop the pitting from continuing. This is because the pitting has become autocatalytic and is not controlled by MRM. l pipe in a pre-action FPS or holidays in galvanized pipe.

Second, the claim that MIC cannot occur in steel pipes in dry and pre-action FPS if they are nitrogen inerted is incorrect (see Pope article in FPC September 2016 page 36 for a detailed discussion of this issue ref.3). It is also noted that microbes can establish pitting corrosion sites very rapidly-long before nitrogen inerting (NI) is completed. These pitting sites can continue to corrode even after NI is thought to be complete, see below.

Fourth, the claim that the autocatalytic pitting will not continue in the absence of oxygen is also incorrect as anaerobic corrosion by sulfate reducing bacteria, methanogens (which use carbon dioxide and hydrogen, which are abundant in MIC corrosion sites, to produce methane), iron reducing bacteria and nitrate reducing bacteria can continue as long as there are ANY electron acceptors (e.g. sulfate, carbon dioxide, ferric iron, and nitrate) are present.

Fifth, the claim that limiting the amount of electron acceptors and substances, such as chloride which enhance pitting corrosion, will stop pitting corrosion is incorrect. It is important to note that simply measuring the amount of electron acceptors and aggravating ions such as chloride in a water sample does not account for the fact that in wet FPS the *total* amount of these substances available to microbes and corrosion sites over time is much larger than measured in a single sample of water. In dry and pre-action FPS puddles form at low points and against grooves and against or in fittings. These puddles contain concentrated problematic substances since these are washed from the internal pipe surfaces into the puddles. Also all types of FPS see additional inputs of these substances every time the FPS receives new water.

Sixth, the claim that adding biocides and/or corrosion inhibitors to an FPS with existing under-deposit pitting sites is incorrect as killing the microbes on the outside of the corrosion deposits will not stop autocatalytic pitting at mature corrosion sites. Likewise corrosion inhibitors cannot effectively penetrate the corrosion deposits or the underlying pits.

Seventh, the claim that simply raising the pH using alkalis such as potassium carbonate will stop MIC is incorrect due to the fact that an alkaline pH in the bulk fluid does not counter the acidic pH in some regions of the corrosion deposits and especially in the very acidic interior of the pits. The reason is related to the fact that the negatively charged carbonate ions do not penetrate the deposits very well and are not very mobile as compared to chloride a negatively charged ion which is very mobile and which accumulates in the pits forming hydrochloric acid.

Eighth, the idea that control over MIC can be achieved by treating water entering the FPS by slug dosing with biocides, corrosion inhibitors, and/or oxygen scavengers once year is incorrect since most of these chemicals degrade over time and when new untreated water containing new microbes enter the FPS the MRM quickly propagate throughout the FPS and cause corrosion. The only way to ensure that MIC does not occur in an FPS is to treat *all water* entering the FPS, even when the jockey pump adds small amounts of water to the FPS, with an effective and long-lasting biocide and oxygen scavenger.

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