Benefits of Keeping a Well Active

By Michael Schnieders, PG, PH-GW

Initial discharge from an idle well. Heavy anaerobic growth, sulfate-reducing bacteria influence, and high turbidity are evident in the produced water.

Water well systems are designed to pump water for a variety of needs in a variety of locations. Design, construction, and pumping rates can all vary with location and seasonal demand. Wells are often designed to meet the needs of the customers, with little respect paid to the needs of the well.

But one thing to remember is each well is more than just a hole in the ground with a limited number of influences. Each well is a great collector, drawing in different characteristics from each water-bearing unit—the watershed that recharges the aquifer, upper soil horizons, non-producing units, and even the borehole itself.

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As anaerobic conditions develop, the growth and development of anaerobic bacterial populations increase.

In the simplest sense, this can mean varied water chemistry with different levels of ions including calcium and iron, but it can also mean drastically different water quality, sediment, and a variety of biological species.

How the well is constructed, developed, operated, monitored, and maintained will dictate how each of these variables impacts the operational life of the well system.

Research has shown that during periods of flow in and around a well system, bacterial communities and the biofilm they have produced contract as a near constant supply of nutrients are delivered to the well.

As the flow decreases, the biofilm expands as the need for nutrient capture grows. It is during this time period when we often see population sizes within a given system expand greatly. Bacteria can be active initially in stagnant water situations as they seek to capture nutrients necessary for their growth and propagation.

Similarly, as the flow of a well system decreases, the entrance and influence of oxygen on the system decreases. This can lead to more anoxic or anaerobic environments to develop. As anaerobic conditions develop, the growth and development of anaerobic bacterial populations increase.

Troublesome Bacteria

Anaerobic bacteria are often the more troublesome bacteria. Anaerobic bacteria create fouling problems as they produce a dense slime coating (biofilm) to block oxygen and allow for the anaerobic community to flourish.
As the dense biofilm expands, the inflow of water into the well system can be im-

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pacted. This is particularly true of lower producing zones.

Anaerobic growth is often found in the lower extensions of the well, including sumps. Anaerobic bacteria are evaluated in the laboratory through growth occurring in sealed tubes inoculated with the sampled water. If present, these tubes will show signs of slime growth or discoloration, which in turn allows for the evaluation of the presence and fouling potential of the anaerobes present.

Anaerobic bacteria are reported by labs as a percentage of the overall bacterial population. Percentages of 5% to 10% of the total population are common. However, when the level of anaerobic activity nears 20%, fouling problems develop rapidly.

A second problem with anaerobic growth is the presence of sulfate-reducing bacteria, a common nuisance organism often identified in fouled or stagnant well systems. SRBs are identified through a presence-absence test. However, their presence is readily identifiable by the distinctive rotten egg (hydrogen sulfide gas) that is produced by the bacteria.

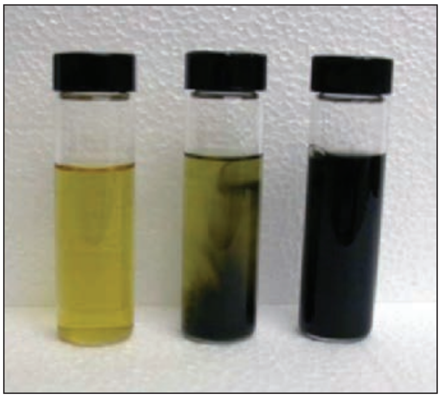
SRBs obtain energy by oxidizing organic compounds and reducing sulfate (SO_2^{-4}) to hydrogen sulfide (H_2S). As the hydrogen sulfide is released, the environment often turns acidic and corrosion can develop as the H_2S is mobilized up the well column.

Relationship with Coliforms

Also of concern is the relationship of anaerobic bacteria and coliforms. Many coliform bacteria are facultative anaerobes, meaning they grow primarily in anaerobic environments but can survive in aerobic conditions. As facultative anaerobes, coliforms can remain in well systems, existing in the lower regions until disrupted. Once disrupted, coliforms may disperse into the rest of the well and result in a positive total coliform test.

Disruption can be a result of physical work being performed on the well or simply a cycling of the well following a period of inactivity. Specific testing can determine if the offending coliform is environmental, which indicates a naturally occurring bacteria common to soils and water, or if the coliform is fecal related and reflects contamination of the well environment.

Test tubes exhibiting varying levels of anaerobic and sulfate-reducing bacteria growth.



If a coliform presence is detected, speciation (identification) and enumeration (count) is recommended as is an evaluation of the level of anaerobic activity.

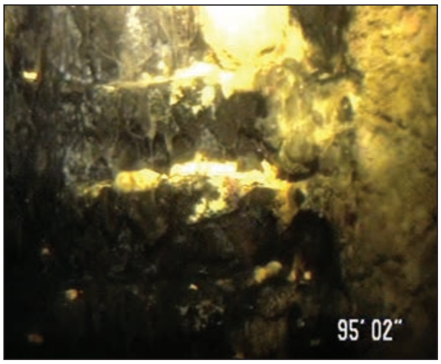
In addition to limiting anaerobic conditions, operational wells continually purge debris from the system, reducing the likelihood of accumulations developing within the borehole. Hardness loss, geochemical congestion, and sediment accumulation are also limited in active well systems. While it is true that pumping draws different water chemistry as well as sediment towards the borehole, it also purges the bulk of these materials from the well in a properly designed well.

In our work in fouled well systems, regularly operated wells see scale and sediment accumulation at a slower rate. Exceptions include wells with higher average water temperatures, compromised structures, lack of or poor sizing of gravel pack, and improperly developed wells.

With the increased rate of foreclosures in recent years, a significant number of home well systems have sat idle. When the home is purchased, required water testing has identified an increasing number of coliform-positive well systems. When tested, these wells often exhibit higher rates of anaerobic growth, higher dissolved solids, and increased turbidity from biomass and sediment.

In the coliform-positive residential wells we've worked on in the past four years, coliform occurrence has been the result of the high anaerobic percentages and not septic influences as is often assumed. Each of these troublesome wells sat idle and out of service for a minimum of six months prior to testing.

Screen capture from a well video of a shallow potable water supply well. The new well sat idle for 10 months prior to pump installation, only to identify significant anaerobic and sulfate-reducing bacteria populations had developed, impacting water quality.



In some areas, well use is restricted due to water rights and regional aquifer conditions. Oftentimes in these restricted use wells, fouling occurs at a faster rate and well owners are forced to clean or disinfect their wells more frequently. While the restrictions are a valid concern, taking the time to understand the well and the costs associated with the extra effort, and discussing this information with those overseeing water governance, is vital. The required cleaning efforts can often result in a greater loss of available water than the amount conserved.

In a similar phenomenon, changes in pump size from design can have a significant impact on the well for much the same reason. A client in Missouri changed from a vertical line-shaft turbine pump to a submersible pump, which was sized to operate at a higher capacity.

This change allowed for a shorter pumping schedule, reducing the well's activity from 16 hours a day to an average of eight hours a day. In the additional time the well sat idle, the quality of the water dropped significantly with odors and discoloration noted at startup, and a sharp increase in the chlorine demand. As it turns out, the extended idle period led to a significant increase in the level of anaerobic growth, including sulfate-reducing bacteria. While this case is an extreme example of rapid fouling, it clearly illustrates the unintended results of a well-meaning change.

Simple Changes

Simple changes in the operation of new and old wells alike can have large and drastic effects on the downhole environment. Responding to this information is a bigger challenge than just leaving the well running.

Each well needs to be evaluated on an individual basis as well as being an integral part of a water system. In evaluating the well, the specific capacity, well efficiency, pump or intake placement, maintenance schedule, and structural integrity should be examined. In a similar sense, wellfield conditions, recharge, aquifer behavior, and the operational history should be evaluated. As part of a larger water system plan, the demand placed on each well should be balanced with the needs, quality, and treatment efforts.

Keeping an active well will aid in improving the operational lifespan of the system by reducing fouling potential, limiting maintenance requirements, and reducing corrosion potential. However, all parameters need to be considered before making decisions on well use and maintenance applications. *WWJ*

Use NGWA's Best Suggested Practices

The National Ground Water Association has published 15 Best Suggested Practices. Among the topics are reducing problematic concentrations of iron and manganese, residential well cleaning, water well system inspection, and more.

The BSPs are not standards, but practices that have been demonstrated to show superior results. They are prepared by a consensus of groundwater professionals.

NGWA members can download the BSPs for free as a benefit of membership. Go to *www.NGWA.org* for more information.