

CHAPTER 3 **Biofouling Significance in Decontamination**

Bacterial growth is responsible for more than 80% of the blockage in wells. Not only are bacteria responsible for biofilm structures that can block flow pathways in the well environment, but the sticky adhesive polymeric material they produce provides an excellent base for mineral accumulation. The matrix that is produced is often a hard, cemented mass capable of extensive blockage of screen and slot openings as well as gravel pack and formation flow paths. In addition, bacterial growth accounts for a major portion of the corrosion process in the well resulting in the accumulation of iron oxides that block flow and cause water quality decline. Bacteria reside in fluid environments, and indeed in wells, either as a free-swimming microorganism, which microbiologists refer to as planktonic, or they are attached and participate in a structure known as biofilm.

Biofilms

The biofilm is actually the natural habitat of the bacteria and consists of the bacteria and the exopolymer they produce. The exopolymer is a polysaccharide polymer that is produced by the bacterium as a means of attaching to a surface, protection from

for nourishment and waste removal? After a great deal of time we would begin to see a growth and a little later that growth would appear to be expanding much faster. In fact, growth would continue rapidly until half the room was full. Now, water flow is directed around this blockage and for the most part no reduction in flow has been observed. What would happen in the next 20 minutes? We would see a complete blockage of all flow. In other words, even though the mass of bacterial growth was doubling every 20 minutes it was so small it made very little impression on the water flow. Once it had achieved "critical mass," so to speak, it was able to block flow completely very quickly. What well consultant or contractor has not received a call from a client who was complaining about production loss from a well ten or fifteen years old. *"It could not possibly be bacteria because the loss just started to develop!"* Production loss won't be 100% and usually does not happen overnight, but it can appear in a relatively short time due to the bacterial growth over an extended period.

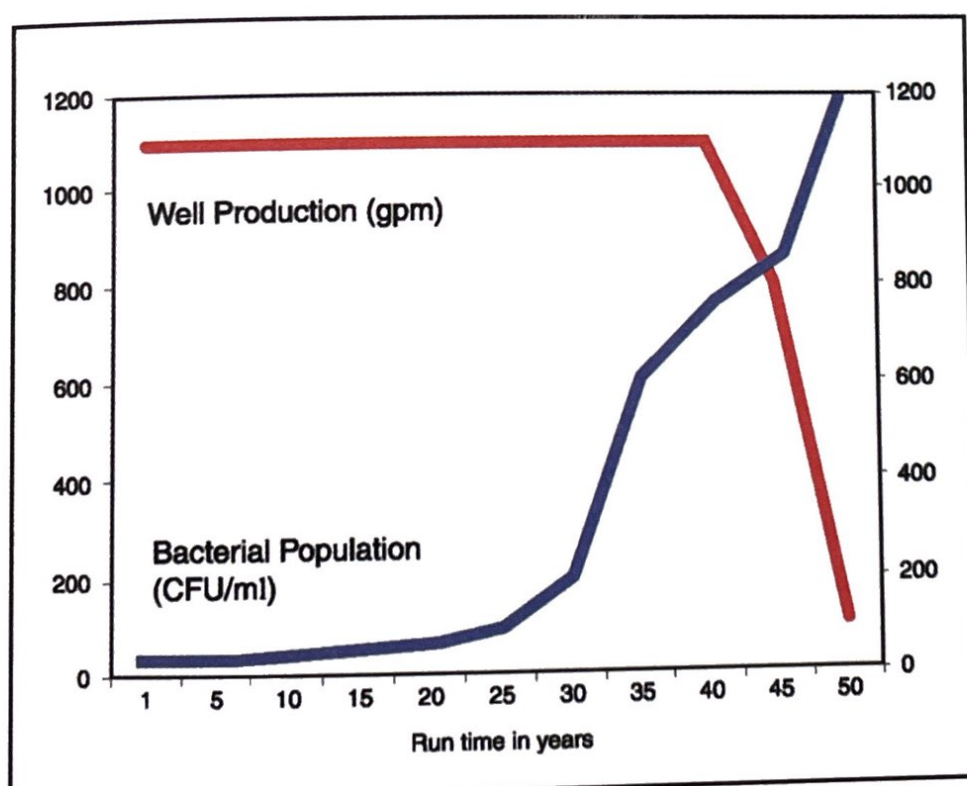


Figure 4.2. Bacterial growth vs production – 50 year well

Figure 4.2 shows a well in California that was 50 years of age when the data was reviewed. It shows a graph depicting the growth

of bacteria in the well. The mass of bacteria gradually increased for 50 years. At age 45 the well began to experience loss of production and by age 50 had lost more than 95% of its original capacity. It had been decided at age 45 not to rehabilitate the well because of its age. Unfortunately in the last five years water needs had escalated and the city was in need of its former production. Analysis showed the well was severely biofouled with little probability of mineral plugging. Loss of production was due to the gradual increase in biogrowth that could have been prevented if the well had been periodically cleaned. If someone had removed the bacterial growth in our make-believe room when it first appeared, the room would have never been filled. Preventative maintenance, which could include some chemical cleaning when pump maintenance is performed, would go a long way in keeping a well free of blockage.

Growth of Bacteria in the Water Column

A third phenomenon we often see in well systems has to do with the bacterial growth throughout the water column. In most well systems the column of water, while agitated during pumping, spends considerable time in a quiet non-mixing state. During these quiet periods bacterial life thrives at all levels. In Figure 4.3 the top part of the water column shows the presence of aerobic bacteria. This community of bacteria uses molecular oxygen as the final electron acceptor. They are able to do this because of catalase, an enzyme they produce that breaks down hydrogen peroxide into water and molecular oxygen (when oxygen is dissolved in water, hydrogen peroxide is formed). Since hydrogen peroxide is a strong oxidant, the catalase not only provides oxygen as a final electron acceptor but protects the cell from damage.

Further down in the column the oxygen becomes less concentrated and those bacteria such as the iron oxidizer *Gallionella* live in this zone that divides the area of oxygenated water from the anoxic zones near the bottom. *Gallionella* obtain their energy from the oxidation of ferrous iron which is present primarily in the