IRON BACTERIAL SLIME
in Wastewater Drip Dispersal Systems

WASTEWATER DIVISION

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Iron in Wastewater Drip Dispersal Systems

The quality of water in any system using low-volume, drip or drip dispersal could have an impact on the maintenance requirements and life expectancy of the system.

This paper focuses on the potential affect of iron in any brand or type of wastewater drip dispersal system.

While the water may contain varying amounts of any of the following, unless noted, their presence is not automatically a cause for concern:

- Suspended solids – Effectively treated with filtration
- Varying pH:
  - Does not typically present problems when it is in a range of 6.5 – 8.5
  - Depending upon the level, it may help or hinder the action of chlorine to control biological growth
- Calcium (Ca)
- Magnesium (Mg)
- Sodium (Na)
- Potassium (K)
- Manganese (Mn):
  - Much less common than iron, but like iron, dissolved Manganese may precipitate in a system due to chemical or biological activity and may disrupt or block emitters.
  - Dark brown sediment indicates a mixture of Manganese and Iron whereas black sediment is manganese oxide.
  - Treat with chlorine as early in the treatment process as possible due to the time delay between chlorination and development of the precipitate.
- Bicarbonate (HCo3)
- Carbonate (Co3)
- Chloride (Cl)
- Sulphur – Sulphur bacteria may grow in any piping network, forming masses of slime which could adversely affect filters, nozzles or drippers when in concentrations > 0.1 ppm of total sulphides.

An Introduction to Iron

Iron deposit is described as, "A filamentous amorphous gelatinous type of brown-reddish slime that precipitates from water that contains iron". Iron deposits can become affixed in a variety of water conveyance devices including drippers and could lead to plugging of a low volume system.

As we will discuss later, in the absence of iron bacteria, even high levels of iron can often be managed by simply reducing the pH. This increases the solubility of iron, favoring the ferrous side of the oxidation equation. However, this paper focuses primarily on the impact of Ferrous iron converting to Ferric iron, its cause, its impact and how to deal with it.

Ferrous to Ferric

There is a class of bacteria that feed on Ferrous iron, converting it to a slimy matrix of bacterial bodies and into Ferric iron.

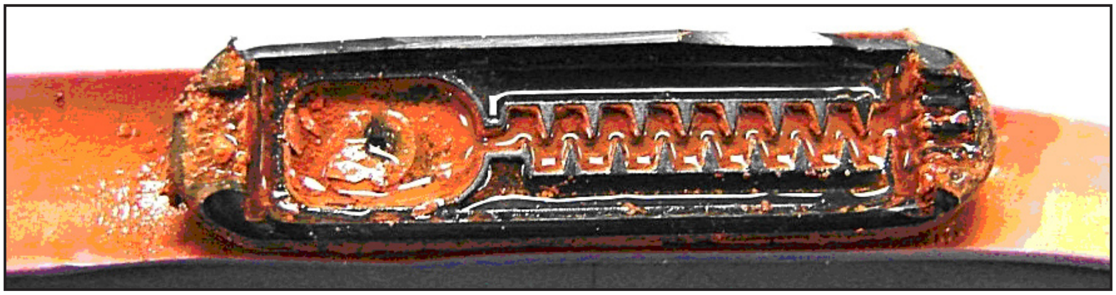
The problem typically exists in well water areas where the groundwater aquifers are formed mainly of sandy soils or organic musk soils (very common in Florida) usually with a pH of below 7.0 and in the absence of dissolved oxygen. These waters contain Ferrous iron (Fe^{+2}) which is chemically reduced, 100% water soluble and which serves as the primary raw material for potential slime formation. The dissolved iron may precipitate out of the water due to changes in temperature and pressure, an increase in pH, or through the action of bacteria. The result is a sludge or slime that may reduce system performance.

SYMPTOM: Reduced dripper flow rate or drippers stop operating.

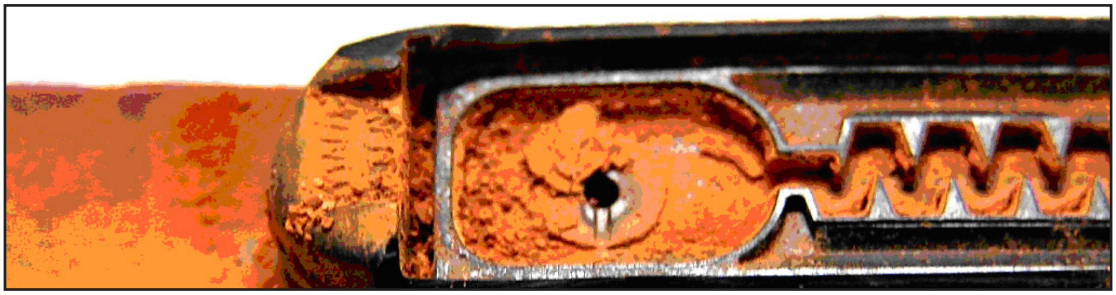
Identifying the Cause:

- The first clue that the problem may be caused by other than a manufacturing defect is that flow rates of the Bioline® dripperline are reducing.
- The performance of Netafim Bioline® drippers is so superior that even a couple of drippers in the same line not operating is a good indication that the problem may be due to other conditions.
- A visual review of a dripper affected by iron bacterial slime may look like the photos on the following page:

Visual Review of Iron Bacterial Slime



A visual clue of iron bacterial slime - all surfaces of the tubing and dripper are covered with a reddish slime or cake.



Close-up of the pressure-compensating bath of the dripper.

How the Problem Occurs

Iron bacteria present in the water react with the Ferrous iron (Fe+2) through an oxidation process. This changes the iron form to Ferric iron (Fe+3) which is insoluble. The insoluble Ferric iron is surrounded by the filamentous bacteria colonies and creates the sticky iron slime gel that is responsible for clogging any brand or type of dripper.

Concentrations of Ferrous iron as low as 0.15 - 0.22 ppm are considered a potential hazard to drip systems (H.W. Ford 1982). Between 0.2 - 1.5 ppm, emitter clogging hazard is moderate. Concentrations above 1.5 ppm are described as severe (Bucks and Nakayama - 1980). With any water source that contains concentrations higher than 0.5 ppm of iron, consider chemical treatment before using drip. Experiments in Florida have shown that chlorination can successfully control iron slime when iron concentrations were less than 3.5 ppm and the pH was below 6.5 (Nakayama and Bucks - 1986).

- Ferrous (+2 charge) iron in the water stream comes in contact with wastewater that has an organic load associated with it.
- The bacteria in the wastewater stream react with the Ferrous (+2 charge) iron through an oxidation process.
- This oxidation process results in the Ferrous iron becoming Ferric (+3 charge) iron.
- The resulting Ferric iron is insoluble and can adhere to and potentially close off the dripper.

Action Items:

- Be aware of iron's ability to negatively interact with wastewater.
- Have a water analysis done anytime iron presence is suspected.

Control and Treatment

Iron Control Methods:

As noted earlier, in the absence of iron bacteria, even high levels of iron can often be managed by simply reducing the pH. This increases the solubility of iron, favoring the Ferrous side of the oxidation equation.

There are several ways to control iron slime, but the common denominator of all treatment should be prevention of the formation of slime before it occurs.

There are two preventive treatments:

- Stabilization (Precipitation Inhibitors) treatments keep the Ferrous (+2) iron in solution by chelating it with sequestering agents
- Oxidation – Sedimentation – Filtration

This three-step process oxidizes the soluble "invisible" Ferrous iron into the insoluble "visible" Ferric iron. It will then precipitate out, making it possible to physically separate it from the water by sedimentation and/or filtration.

The Oxidation – Sedimentation – Filtration procedure is the preferred treatment for severe iron problems in supply water.

The various means to oxidize iron include aeration, chlorination and potassium permanganate. There are also other oxidizers as well.

Oxidation through Chlorination:

Media filters and chlorine are often used in non-wastewater situations. Among other safety precautions to consider with chlorine is that the chlorine has to be well mixed, and sufficiently upstream of the media filters for the reaction to be completed. Otherwise, the oxidation could occur downstream of the media filters, and the situation could worsen.

Other Considerations When Using Chlorine:

While some jurisdictions require that wastewater effluent be treated with a disinfectant prior to land application, many designers incorporate the practice solely out of habit. Surface discharge, including spray dispersal of secondary effluent, is commonly disinfected to remove water borne disease-carrying microorganisms. To protect those who may come in contact with the effluent and to prevent objectionable odors, it is common practice to use ultraviolet light or some form of chlorine to remove the objectionable organisms.

Even though the need to disinfect the effluent that is not land applied but dispersed subsurface is debatable, it is not our intent to argue the efficacy or the regulations requiring disinfection for these systems. Rather we will review how the most commonly used method of disinfection affects the life and material compatibility of Netafim Bioline® wastewater drip dispersal tubing.

The customary method of feeding chlorine disinfectant in residential systems is the tablet feeder. In these devices calcium hypochlorite cake tablets, about 3" in diameter, are dropped into a tube over which the effluent flows. The tablets slowly dissolve producing a hypochlorous acid solution thus introducing the disinfecting agent into the effluent. Many jurisdictions expect the homeowner to maintain these systems and leave it up to them to purchase and replenish the chemical when needed.

Difficulties can arise when homeowners substitute chlorine tablets that are made for swimming pools. These tablets are actually a stabilized chlorine compound, not calcium hypochlorite, used to mitigate the effects of sunlight: trichloroisocyanuric acid or sodium dichloroisocyanurate. One of the difficulties with these compounds is that they make the chlorine less effective thereby reducing the efficacy of the disinfection process.

The chemical produced by these swimming pool tablets, cyanuric acid, does not hold up as well as a wastewater disinfectant and is not recommended for Netafim Bioline® dripperline dispersal systems. The concentration of cyanuric acid can be detected with a special test kit (not a chlorine test kit which would produce false low "chlorine residual" readings since the dominant chemical produced is not hypochlorous acid but cyanuric acid).

Only chlorine tablets approved for wastewater, those made from calcium hypochlorite, are acceptable.

Bioline® emitters have "excellent" and "good" resistance ratings to chlorine (calcium hypochlorite and hypochlorous acid) and are compatible with chorine compounds produced from calcium hypochlorite tablets.

Netafim USA strongly suggests following the recommendations of the manufacturer to ensure that the warranty remains valid.

For more information, refer to the following for additional information regarding disinfection practices for wastewater effluent disinfection:

EPA Onsite Wastewater Treatment Technology Fact Sheet 4, Effluent Disinfection Processes

Oxidation through Aeration:

- The intent here, depending on water analysis and amount of iron present, is to force the oxidation process to occur prior to the effluent entering the drip dispersal system.
- In non-wastewater applications such as agriculture, this entails pumping water into the air or running water over a set of baffles to incorporate air into the water to force oxidation.
- In wastewater systems it may include adding air into the treatment train as early as possible.
- In ATU systems the aeration regime within the system could provide adequate treatment.
- It may also include adding aeration to the dose tank to ensure complete oxidation.
- The resulting Ferric iron will fall to the bottom of the vessel or be filtered out through a media filter (if present).

Sedimentation - Filtration:

When available, a sand media filter is the best type of filter for settling down the oxidized iron and filtering it from the water. Where media filtration is not available, settling tanks or ponds should be used to allow the iron to physically separate.