The Deal with Silt in a Micro-Irrigation System

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Last summer we received a call from a colleague inquiring, “How do you deal with silt in a drip system?” We had just finished a project in which we had to “deal with silt”, and a few weeks later we were called out to deal with it again. So, what *is* the “deal with silt”?

Silt, by definition, has a soil particle size falling between clay and sand. The USDA classifies silt as having a particle size between .002 and .05 mm. We generally think of silt as being of a natural origin, but we frequently encounter irrigation systems loaded with “self inflicted silt” whose origins are fertilizer “insoluble fractions”, “solution grade” gypsum and mineral precipitates. Naturally occurring silt, like sand, is typically comprised of particles of irregular shape and size, predominately quartz. Because of its smaller size, however, silt is able to sustain an adhering film of clay to its surface, giving it many clay-like attributes, including plasticity, stickiness and adsorption.[1]

The finest filter used in agriculture is typically 200-mesh equivalent, which will capture particles as small as .08 mm. So silt, smaller than .05 mm, should easily pass through our agriculture filters as well as our drip emitters or micro-sprinklers. If this is the case, why do we have to “deal with silt” at all?

When the irrigation source water contains heavy loads of suspended particles, the first challenge is filtration. The sand and larger silt particles can be effectively removed with hydrocyclonic sand separators, which spin the water and remove the heavier particles through centrifugal and gravitational forces. Larger, less dense particles can be removed by a variety of filtration methods including screens, disks and sand media filters. That leaves the finer silt and clay, which theoretically should pass through the filter. If these particles, finer than 200-mesh, would indeed pass through the filters and the emitters, there would be no need to deal with them.

Unfortunately, due to the sticky nature of silt it can aggregate and become an irrigation challenge, forcing us to “deal with silt” after all. Silt commonly builds up on the surface of a filter and “blinds it”, reducing the flow to nearly zero. Silt that passes through filters can settle out in pipelines and hose laterals where the water velocity is slow enough to allow for its deposition. Silt has also been shown to build up on screen-filters and extrude through the mesh like toothpaste, creating emitter-plugging sized particles downstream of the filters. We will examine each of these phenomena in more detail.

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[1] Brady, N.C., *The Nature and Property of Soils, 8th Edition,* p. 43, Macmillan Publishing Co., New York, 1974.

Media Filter Plugging. Depending on the nature of the silt and the type of filter, it may or may not pass through the filter. For example, the silt may be sticky enough to adhere to the media sand and begin to accumulate. Over a period of time the silt can form a thin layer or cap across the top of the media bed, greatly restricting the flow through the filter. If the silt is sticky enough, it may be very difficult to rinse the silt out of the media bed during a normal backflush sequence. This can be remedied by maintaining a fine-grade media like #20 crushed silica in the tank and increasing the backflush frequency and flow rate to discharge the contaminated top layer of media sand on a regular basis. The accelerated loss of media sand requires careful monitoring and topping off the sand levels, typically on a monthly basis. If the silt is being successfully captured on the surface of the media, the duration (actual flushing time per tank) can be shortened to reduce the amount of media discharged during each sequence.

A second challenge with media filters is when the silt passes through the media bed and accumulates around the filter's underdrain, which is quite common with epoxy-cake underdrains. This occurs gradually and without a noticeable increase in the pressure differential across the filters. It can be detected by digging through the media bed with your hand and inspecting the cleanliness of the sand as you pass deeper into the tank. All of the sand below the top few inches should be clean. If you find silt, mud or clay deep in the media bed, you will soon be forced to "deal with silt".

In the first example the silt was captured on the surface of the media, requiring frequent, quick, high-velocity backflushes to toss out the media sand that had become contaminated with the sticky silt. In the case of silt penetrating deep into the media bed, less vigorous but longer duration backflushing is required to lift the silt out of the media matrix and discharge it without a significant loss of filtration sand. Once the filters have been thoroughly rinsed of silt, the backflushing sequences should be performed on an appropriate *time-clock basis*, not on a pressure-differential basis. The media sand must be inspected regularly (monthly) to insure that the backflushes are adequate to maintain clean media beds.

It may be the case that the silt is of such a size that it is captured in the media, yet it would be small enough to pass through the emission device. An example of this would be plugging a fine grade media sand such as #20 crushed silica, (~200-mesh equivalent), with silt in the range of 180 mesh, and the emitters or micro-sprinklers require only 120-mesh filtration. Replacing the media with a courser grade (#16 crushed silica, ~160-mesh equivalent) may allow the silt to pass through the filters and the emitters without any plugging.

Screen Filter Plugging. Plugging screen filters with silt is generally a result of sticky silt particles adhering to the mesh fabric or a trapped particle (sand) and accumulating to a level where bridging across the screen's openings is achieved. As in the case of media filters, it may be that the problem silt is of a small enough size that it would easily pass through the emission devises without a plugging problem. If this is determined to be the case, changing the mesh size to a courser-grade filtration may prove to be a solution to the problem.

Another potential solution to screen plugging is increasing the velocity of the water across the screen's face. If the velocity is high enough, the energy of the water "pushing" the silt overcomes the ability of the silt particles to stick to one another and bridge across the screen's openings. There a several agricultural screens designed to take advantage of this principle. The most common utilizes "spin-plate" nozzles that force the water into a centrifugal spinning action across the face of the screen. It is possible to place rubber stoppers in one or more of the nozzles to increase the velocity of the water across the screen, depending on the situation. Another design uses a "torpedo" on the inside of a tubular screen to decrease the filter's volume without decreasing the surface area of the screen, resulting in a dramatic increase in the velocity of the water past the face of the screen.

Because silt accumulation on a mesh screen has the effect of gradually creating a finer mesh size until bridging and blinding occurs, the phenomenon of screen plugging appears to be exponential in that very little pressure-differential is observed until the blinding occurs. Because of this, the backflush cycles should be triggered on a time-clock basis, not on a pressure-differential basis, to prevent reaching the "critical mass" of accumulated silt capable of blinding the screen.

Silt Downstream of the Filters. It is most common to find silt accumulated in the mainlines or hose laterals of a micro-irrigation system. This occurs when silt that has passed through the filter (or has been injected below the filter!) reaches an area of the irrigation system where the velocity of the water is low enough[2] to allow the particles to settle out. Similar to "silting out" in a river delta, the particles aggregate to form layers or lenses of sticky mud. Because of the adsorptive properties of the clay fraction, these silt lenses contain the minerals and nutrients necessary for biological growth. Therefore they serve as an energy source as well as a suitable place of attachment for the bacteria and algae that comprise the first link in the food chain of the ecosystem that can potentially exist in any micro-irrigation system.

It is important to frequently flush the silt from the buried lines and hose laterals to keep the biology of the drip system under control. A good flush requires increasing the water velocity in the lines to at least two feet per second. It is important to keep in mind that as the silt lens ages and goes through several wet/dry cycles it hardens and becomes more difficult to remove. In some cases it will actually become cemented together in a limestone matrix, as discussed in previous articles.[3]

To effectively flush the buried mainlines it is necessary to open the flush valves at the ends of the lines and allow the water to run for several minutes. Depending upon the system design and pumping capacity, it may require closing off a portion of the field to generate enough velocity in

[2] The ability of a silt particle to be suspended in water is dependent upon the particle's size, density and the strength of the ionic charge of the clay layer adhering to its surface. Silt may begin to settle out in areas where the water velocity falls below one foot per second.

[3] *Maintaining your Micro-Irrigation and Filtration System*, Practical Vineyard & Winery, January/February 1998 and *Formation of Lime Scale in Vineyard Drip Irrigation Systems*, Practical Vineyard & Winery, March/April 1998.

the mainline to scour the silt out. Some systems must be retrofitted with flush valves of appropriate size to allow for sufficient flow.

In a similar fashion, the frequent flushing of the polyethylene hose laterals will minimize the biological contamination associated with silt accumulation. To achieve an adequate flush velocity of two feet per second through the end of a typical hose lateral (.620 inch inside diameter) requires a flow of approximately two gallons per minute flushing out the end. This increased flow rate causes a much greater pressure loss down the hose length, requiring greater than normal hose inlet pressures to sustain the flow. It is usually necessary to increase the field pressure and only flush a small percentage of the hose laterals at a time. The field pressure can be increased by adjusting the pressure-reducing pilot on the block valve, or by closing a portion of the blocks normally irrigated with the set.

Summary. Here's the "deal with silt":

1. Minimize the entry of silt into the system with appropriate pump intake suction designs (do not pull water off the bottom of a reservoir).
2. Use a hydrocyclone pre-filter if the sediment load is heavy (above 2 parts per million).
3. Adjust the duration and frequency of the filter backflushing sequences to an appropriate level (as described above).
4. With sand media filters, frequently inspect the media bed down to the underdrains for evidence of silt accumulation.
5. Frequently flush all buried pipelines to prevent the accumulated silt from hardening.
6. Insure that the time-consuming hose-end flushes are effective by increasing field pressure and only flushing a few laterals at a time.
7. Silty systems generally require more frequent sanitizing. Monitor the biological growth in the system by capturing hose-end flush water into a clear jar and holding it up to the light. Adjust the chlorine program accordingly.

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