ADVANCED IRRIGATION TECHNIQUES AND CONSERVATION STRATEGIES

Subsurface Drip Irrigation

Subsurface drip irrigation offers significant opportunities for water savings and improved irrigation uniformity when compared to traditional overhead sprinklers.

SNAPSHOT

Subsurface drip irrigation delivers water directly to the rootzone more efficiently than sprinklers. It is a high-impact, high-cost strategy applicable for golf courses with sufficient financial resources and major conservation goals.

Expected cost	> $50K per acre
Ease of implementation	Large capital project
Potential water savings for affected area	> 30%
Highest potential impact areas	Arid and semiarid regions like the southwestern U.S.

OVERVIEW

Subsurface drip irrigation (SDI) is plastic tubing placed below the soil surface that delivers water into the rootzone. SDI has been used in agriculture for several decades but isn't as common in golf course irrigation. When it has been used in golf, it's typically in landscape beds and bunker faces. It has also been widely used for other turfgrass areas that require precise watering and are difficult to reach, such as parking lot islands.

When water is sprayed into the air from a sprinkler, it's subject to wind drift, overspray, runoff, evaporation and possibly missing the target. For these reasons, at best, an efficient sprinkler system can theoretically achieve 75% distribution uniformity of the low quartile (DUlq) under field conditions. This means at minimum 25% of irrigation water is misapplied even when a system is functioning well, and delivering adequate moisture to the entirety of the coverage area will require increased irrigation runtime (which may result in overwatering other areas) or supplemental irrigation, often in the form of labor-intensive hand watering to prevent localized drying. In contrast, SDI systems are highly efficient, achieving 95% DUlq when properly installed and functioning (Camp et al., 1997).

Recent research has demonstrated SDI's ability to sustain turfgrass with 50% to 80% less water than overhead irrigation when used on small island tees (Whitlark et al., 2023). Several golf courses in the Southwest are implementing small-scale SDI along with their sprinkler systems. However, there are limitations to SDI, such as the cost and disruption of installation and its potential vulnerability to damage during aeration.

SCENARIOS FOR USE

Drip irrigation is most commonly used in ornamental planting beds. However, this application involves different tubing and very different management considerations than SDI in turfgrass areas. Perhaps the most common use of SDI in golf course turfgrass areas has been on bunker faces to reduce imprecise irrigation, soil erosion and runoff that often leads to droughty turfgrass. Without SDI, the most common solution to managing dry bunker faces is supplemental hand watering, which is time and labor intensive and may not deliver the desired results.

Irrigating the turf around bunkers is probably the most common current application for SDI on golf courses. It is a more effective and efficient way to water these difficult areas than overhead sprinklers or hand watering.

Several golf courses are also implementing SDI on smaller island tees. SDI allows the direct application of water only to the turfgrass rootzone, avoiding any overspray to nonirrigated areas. In addition to saving water, this reduces weed control and other maintenance of the tee surrounds, especially if they are intended to be nonirrigated. Other golf courses have used SDI on driving range tees, which has the added benefit of eliminating irrigation hitting synthetic mats that may be placed behind the tee. There are also some instances of SDI use for independent irrigation of trees in naturalized areas. There are not many examples of SDI being used in fairway and rough areas, but the few courses that have tried it report water savings of up to 40% compared to overhead irrigation. A few superintendents have also tested SDI on putting green collars. In one known instance, SDI has been installed in a putting green constructed according to USGA recommendations.

SDI systems have proven to be highly effective on island tees where they deliver significant water savings and improved distribution uniformity compared to overhead sprinklers.

BENEFITS

Water Conservation

Studies have shown that SDI can reduce water use by 30% to 80% compared to overhead irrigation (Serena et al., 2019; Whitlark et al., 2023). How much water can be saved will depend on various factors, including the irrigated turfgrass species, the local climate, soil type, existing irrigation system and the watering schedule. In research and demonstration studies, the larger water savings from a percentage standpoint are primarily correlated with eliminating overspray into off-target areas. A good example is the potential water savings on individual island tees surrounded by nonirrigated naturalized area. Using SDI over a larger area like a fairway would offer more modest water savings from a percentage standpoint, but a higher potential savings in terms of total gallons. Increased soil moisture uniformity, reduced evaporative losses, and reduced wind-drift losses associated with SDI may still deliver an estimated 40% water savings compared to a sprinkler system in fairway or rough areas.

Improved Turfgrass Quality

SDI can improve turfgrass health, appearance and playability by providing more precise and uniform irrigation. Reducing surface wetness can reduce disease incidence and weed populations. Less water at the surface also reduces the risk of runoff, compaction and soft playing conditions.

Greater Precision

SDI essentially eliminates off-target irrigation due to overspray or runoff, which greatly improves precision. Not only does this translate to water savings and improved turf quality as noted in the sections above, but this can also help to reduce maintenance and improve the aesthetic presentation of adjacent areas. In situations where off-target irrigation leads to unwanted plant establishment and growth in naturalized areas, there may be considerable labor costs associated with dense growth or weed establishment that requires some combination of mowing, hand labor and/or herbicide applications to manage.

Overspray from these tee sprinklers not only wastes water, it also promotes unwanted plant growth in the native areas surrounding the turf, which then requires additional maintenance. SDI can eliminate these issues.

Less Impact on Play

SDI allows irrigation to occur without interfering with play. Many golfers do not like to see sprinkler heads running in front of them and they certainly don't like being hit with irrigation water. SDI eliminates these issues and allows areas of the course to be watered during play, if necessary.

Ease of Use and Maintenance

Once in place, SDI systems are arguably easier to use and repair than traditional irrigation systems with more complex components. Repairs are straightforward and although regular cleaning of filters is required, it is a minor task.

CONSIDERATIONS

Installation

SDI installation costs and challenges are greater over a given area of turf than overhead sprinklers. Therefore, water cost and water availability likely play an important role in the decision to invest in SDI. More research and demonstration projects are needed to test the suitability of SDI for watering larger areas like fairways, where more meaningful water savings can be achieved but installation complexities also increase. More product and machinery development is needed to improve installation methods, increase speed and lower cost.

Climate

SDI is most valuable where evapotranspiration rates are high, precipitation is scarce and water must be purchased at a significant cost, making dry climates like the western and southwestern U.S. ideal opportunities to use this technology.

Installing SDI is more challenging and expensive over a given area of turf than installing overhead sprinklers. (USGA/Bill Hornstein)

Soil Type

Soil type can affect the design, installation and scheduling of SDI. For instance, water movement in clay soil is slower than in sandy soil; therefore, irrigation timing can be challenging and needs to follow a cycle and soak schedule. Installation spacing, depth and emitter flow rate are other considerations when installing SDI in heavy soils. Most of the research conducted so far has been in sandy soil, but it's expected that the benefits of SDI are similar in clay soils.

Turfgrass Species

SDI has been successfully tested on most turfgrass species used in the golf industry. However, there is limited information about its use on annual bluegrass and perennial ryegrass. SDI might be less suitable for these species because of their shallower root systems. This may be a particularly important factor where perennial ryegrass is used to overseed bermudagrass fairways.

Checking and cleaning filters is part of the routine maintenance that is necessary to ensure SDI systems function properly. (Bernd Leinauer)

Maintenance

Like any other irrigation system, SDI systems require continual maintenance. Insufficient care will lead to diminished performance and ultimately, the failure of an SDI system. System filters need to be checked on a regular schedule and the drip tubing needs to be monitored for leaks and clogging.

With the system buried in the ground, these issues can be difficult to identify. However, when leaks happen, water bubbles will form on the surface or there will be washed-out soil where water gushes to the surface. Dry or dead turf in an area with SDI may indicate some type of clogging malfunction. We recommend checking the area with a portable soil moisture meter and if dry, exposing a few drip emitters in these droughty areas, running the system and visually inspecting the delivery of water.

System filters will require frequent cleaning. However, self-flushing filters or better filtration at the pump station can reduce maintenance requirements for these components.

Water Quality

Turf areas that are irrigated with SDI have been shown to accumulate more salts in the top few inches of soil (i.e., between the surface and the tubing emitters) compared to a sprinkler system. Leaching of these salts is limited to rain events unless sprinklers are also maintained. This means the risk of salinity stress for turfgrass is greater with SDI than overhead irrigation when irrigation water is high in salts and annual precipitation is low and infrequent. Water hardness or the presence of biofilms and algae can promote emitter clogging as well.

Root Intrusion

SDI system manufacturers have developed different strategies to prevent root intrusion, which is particularly important for emitter lifespan. For instance, some emitters are embedded with preemergence herbicide with a slow rate of release. Other companies use copper to prevent roots from entering and clogging emitters. Another way to prevent root intrusion is installing a slow-release herbicide filter. Other root-intrusion preventions consist of injecting chemicals such as herbicides or acids into the irrigation water.

Cultivation and Topdressing

Because SDI is commonly buried only 4 to 6 inches below the surface, deep cultivation may damage tubing. Regular topdressing may eventually reduce the efficacy of an SDI system by raising the rootzone beyond its reach.

SDI tubing can be damaged by aeration and cultivation equipment, which may limit the cultural practices available in areas irrigated by SDI. This section of dripline was punctured by an aerator. (Bernd Leinauer)

Double System

Many turfgrass fertilizers, pesticides and other products are currently formulated for application to the turfgrass surface followed by overhead irrigation to water them in. For these reasons, an SDI system should currently be considered as an add-on to a traditional overhead system. However, installing and maintaining two irrigation systems may not be feasible for some golf courses.

Unresolved Technical and Cost Factors

While SDI has proven effective in agriculture, landscape settings and on small golf course tees, listed below are some of the important challenges that must still be resolved to make expanded use on golf courses a reality.

Design and installation

Few have experience designing or installing large SDI systems for golf course turfgrass because there are not many currently in existence. Cost-benefit analyses are currently difficult to perform due to the lack of firm pricing information on material, design and installation costs. However, installing SDI is currently more expensive than installing a standard overhead sprinkler system.

Depth and spacing

The recommended lateral spacing and depth of driplines is currently generalized, but likely has site dependencies related to soil type, topography and turfgrass species. The standard recommendation for a spacing of 12 inches and depth of 4 to 6 inches should be tested in different scenarios.

Durability

The long-term performance of SDI systems must be evaluated. They are typically assumed to last 20 to 40 years, but there are no examples of large-scale systems that have been in place on a golf course for that long.

IMPLEMENTATION

Installing an SDI system requires several steps which are outlined below. Before getting started, you should consult with a qualified irrigation designer and contractor with experience in SDI to ensure the quality of design and installation. Every site and situation will present unique challenges, so there is not a one-size-fits-all approach to installing an SDI system. However, there are fundamental steps that apply to most projects

Once you have identified a target area for SDI, work with a qualified irrigation designer to develop a plan for the system layout and components. (USGA/Bill Hornstein)

Step 1: Planning

Evaluate the area to be irrigated

First, determine the size and shape of the area to be irrigated (hydrozone) and consider the longest dripline run. Remember that there are manufacturer-dependent limits for the length of each run of drip tubing. Next, evaluate the soil composition to ensure drip tubing can be buried – it's a good idea to test a small area before deciding on tubing installation method (pulling or trenching). If slopes are present, the driplines should run perpendicular to slopes and water should enter the zone at the highest point to minimize resistance from gravity when filling the lines. Independent zoning, flush valves at the lowest point, and pressure-compensating drippers can all help increase the DU on slopes. Finally, determine the irrigation requirements and root depth of the grass species and make sure the SDI can meet those needs.

Recommendations for selecting and laying out SDI components

Drip system components, dripline spacing, tubing depth and emitter flow rate will all be site dependent. At minimum, the system should have emitter filtration, pressure compensation, check valves and root-intrusion prevention. Begin by determining the location of the header, footer and main valve. Consider installing multiple valves and zones for larger areas. Header and footer lines that are 1 inch in diameter allow for a zone of up to 1,200 square feet. Emitter flow rate should typically be between 0.5 and 0.6 gallons per hour (GPH). In clay soils, a lower flow rate should be used, about 0.3 or 0.4 GPH. Do not exceed the maximum allowed slope for pressure-compensating emitters; this is typically 10 ft of difference from the highest to the lowest point in any zone.

For drip tubing, do not exceed the manufacturer-specified maximum length of a single line of drip. Each manufacturer guarantees uniform water distribution up to the maximum length, after which water friction and pressure loss disrupt functionality. Lines should be buried 4 to 6 inches deep. It is not recommended to install SDI shallower than 4 inches because of potential damage to the lines and components from aeration. Installing deeper than 6 inches reduces the capillary rise of water to the surface, which may negatively impact turfgrass quality. Keep in mind that the depth of drip tubing will increase over time with frequent topdressing.

Step 2: Determining Installation Method and Site Preparation

New construction

If there is no turfgrass present, the drip lines can be laid out and covered with soil or capping material, followed by final grading and turfgrass installation. This method avoids the process of trenching or pulling the lines into the soil and can work particularly well on tees if there is no concern about raising the level of the tee with new capping material. This approach is more difficult over large areas where stripping and replacing topsoil or importing and spreading material to cover the drip lines becomes more challenging and time consuming. Trenching or pulling the lines is still an option in new construction settings if it is desired to avoid the material capping process.

Existing playing surface

When turfgrass is present, several different approaches can be utilized. The first is to remove all the existing turfgrass from the target area using a sod cutter, assemble the SDI system at grade, cover it with a new capping material and replace the sod. This works well in situations where the cost of additional capping material and the increase in elevation of adding it are not significant considerations. You can also remove sod and strip the existing rootzone material to the desired depth of the SDI system and then replace that material once the SDI system has been assembled. This approach has the advantage of maintaining the existing grade and using on-site material, but you have to excavate, store and replace the rootzone material, which has costs and challenges associated.

Removing turf and rootzone material prior to installing drip irrigation allows you to lay out, assemble, and test the entire system at the desired grade.

Another method is to trench directly into the turfgrass and place drip tubing, or use a vibratory plow or a mole adapter to pull drip tubing into place. Trenching or pulling dripline into existing turfgrass may generate turf damage requiring longer recovery and there will be disruption to the surface grade that needs to be addressed. It is also more challenging to maintain accurate depth and spacing when trenching or pulling drip tubing. Regardless of the installation approach, some trenching will be necessary to connect drip tubing to header and footer lines or other components.

A hybrid version of the above approaches is to remove the existing turf, trench or pull the SDI pipes into the exposed soil, smooth out the surface to a finished grade and then replace the turf. It is easier to smooth out the disruption caused by pulling or trenching the pipes when the soil is exposed than when it is covered with turf and the overall disruption to the turf would potentially be less.

One method to install drip irrigation is by pulling the pipes. If pulling drip lines into existing turf, there will be surface disruption that needs to be addressed. (USGA/Bill Hornstein)

Once the SDI system is fully assembled and tested, cover the piping, grade the surface smoothly and install the turf.

Step 3: Installation

There are many different ways to install SDI systems depending on the nature of the project and the particular circumstances of the site. An experienced contractor or golf course superintendent will have a method that works best for them, but there are several key factors to be mindful of in any installation regardless of the specifics.

Don't allow soil or debris to fall into the drip tubing during the layout or installation process. This material can lead to clogging and reduced performance in the future. For oddly shaped or round areas, the last few rows of tubing do not have to be connected to the header. Instead, an extension loop can be made from the last header-connected dripline. Successive extensions are permissible.

Once everything has been connected, run water through the system for several minutes with the flush valve at the end of the line open to remove any soil particles or debris that might have entered the system during installation. Pressure test the system and check for leaks by closing the flush valve and charging the system. Let it run for several minutes and several cycles of pressurization and depressurization. Repair any leaks you observe. If the system has been installed into exposed soil, run it again prior to finished grading and grassing to observe the wetting pattern and make sure nothing has been damaged during the installation.

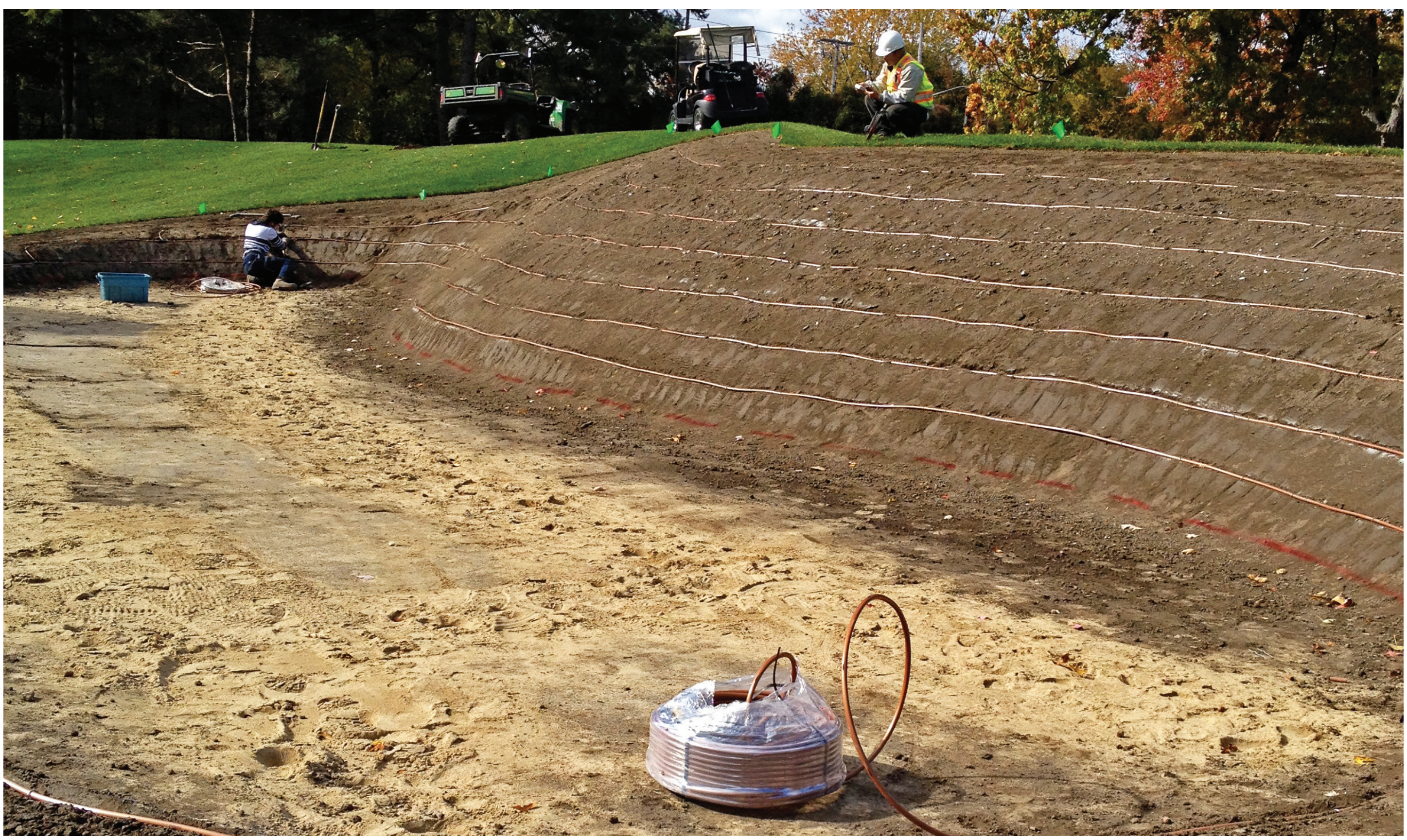
TIPS FOR SUCCESS

Test your planned SDI layout in a small area prior to making a large installation.

Standard spacing is 12 inches between driplines and emitters, however, there are various factors that influence what will be the best layout for a specific application – e.g., topography, soil type and turf species. Golf courses should test different layout options in representative areas before moving forward with a larger project. You may develop one layout or flow rate that works best in certain areas and another for different situations. Testing will help you gain comfort with installing and operating the system, and will help optimize performance.

Evaluate slope impacts in the installation area.

In flat areas, like teeing grounds, the direction and orientation of the dripline are not important, as the flat area ensures excellent water distribution and uniform movement. On slopes, it is recommended to install the dripline across the slope to limit the impact of gravity. Keep in mind that higher ground will require more frequent watering and drip tubing should be appropriately zoned along slopes to accommodate.



On steep slopes, like this bunker face, it is recommended to install driplines across the slope to limit the impact of gravity on flow through the pipes.

Emitter orientation is not critical, spacing is.

Staggering emitters to achieve some form of triangulation comparable to sprinkler layouts is not as important as ensuring the proper spacing between lines. Additionally, the orientation of the emitter hole is not important, it doesn't matter if the holes are pointing up or down in the trenches, water will seep out and moisten the soil in all directions regardless.

Ensure your drip system contains all essential components.

Manufacturers require filtration and a flush valve, and driplines and emitters should be protected against root intrusion. Consider the optimal operating pressure and adjust by installing a pressure regulator. Most manufacturers also require an air-release valve in SDI systems. Occasionally, the installation of an automatic flush valve or an indicator is recommended. Make sure to include recommended components and install them properly to ensure desired performance.

Consider installing a way to check functionality.

It can be difficult to know if an SDI system is operating correctly because all the components are underground. Major leaks are usually evident, but clogged emitters and other issues may not be easy to identify. Installing water meters or moisture sensors can alert you to a malfunction. Some superintendents use a small pop-up sprinkler at the end of the line with no nozzle as an indicator. If the sprinkler pops up when the line is charged, then you know the valve is functioning properly and the line has adequate pressure. There are specifically designed indicators that can be used instead of a pop-up head, however these are more common in landscaping installations.

Installing a closed pop-up sprinkler at the end of a drip line allows you to see if the line is properly charged and coming on when expected.

A filtration system at the main valve is a good investment.

If larger areas or numerous zones will be installed, consider including a large filtration system at the main valve. These will optimize performance and longevity of the other system components. These valves are often self-flushing, which eliminates the need for constant maintenance.

SDI installation involves some disruption.

Installing SDI systems requires a certain amount of disruption to the soil and turf if it is present. In smaller settings, turfgrass removal prior to installation has resulted in faster and better recovery than disk-trenching directly into the turf.

For larger installations, consider using a vibratory plow to minimize damage to the existing stand. Compacting the ground with a heavy roller may be necessary after plowing drip lines.

Leaving the turf in place has the advantage of being less labor-intensive and more cost effective; however, it requires a longer healing time than removing and replacing the sod. Ideally, SDI system installation can be timed to coincide with renovation or regrassing projects when the existing turf has either been removed or is not a concern.

Installing SDI systems involves some disruption. Ideally, drip systems are installed into exposed soil where the surface can be easily smoothed out prior to grassing.

There's no need to use special backfill material.

We have tested SDI and observed no issues in native soils with higher sand or clay content, as well as in a sand profile amended with organic material. You do not need to remove the native soil and install a special backfill material over the drip lines.

SDI systems require routine maintenance.

It's common to develop leaks or clogging in SDI systems. Periodically check the efficiency and proper functionality of the system. A flow meter or pressure gauge can be used to easily determine the appropriate frequency for cleaning filters. When flow and pressure fall below the optimal range, the filter must be cleaned.

TECHNICAL NOTES

Glossary of SDI System Components and Their Basic Function

Drip tubing

The drip tubing is the irrigation line buried in the ground. It can be made of polyethylene (PE), polyvinyl chloride (PVC) or rubber. PE is the most commonly used material because it is flexible, durable and resistant to chemicals, temperature fluctuation, and ultraviolet radiation during storage. In general, drip tubing is approximately 0.5 inch in internal diameter, with different manufacturers differing slightly to allow perfect fittings with their branded components. The thickness of the drip tubing wall varies across manufacturers but is generally greater than agricultural and landscaping products. Drip tubing is equipped with emitters, which are described in the following section. Prior to 2000, commercial drip tubing was made of a porous material with the entire line seeping water. However, tubing of this nature had short longevity and its use is now limited to vegetable gardens.

Drip tubing is commonly made of flexible polyethylene with an internal diameter of 0.5 inches.

Emitters

Emitters, occasionally called drippers, are devices placed inside the drip tubing that control the flow and delivery of water into the soil. In the early implementation of SDI, an emitter was a perforation in the tubing that allowed a small amount of water to escape.

Today, there are several types of emitters. Most manufacturers use "integral emitters." These emitters are an integral part of the tubing, meaning they are incorporated during the manufacturing process and molded into the tubing. They are spaced at a predetermined distance (e.g., 9, 12, 15, 18, or 24 inches). "In-line emitters" are an evolution of the integral emitter. These are designed and constructed separately from the tubing and inserted into the line. In-line emitters are classified by their flow rate, normally expressed in gallons per hour (GPH).

Emitters are typically pressure-compensating. This means they are designed to provide a constant flow of water and maintain the same delivery under sloping conditions – typically up to 10 feet of slope per zone. Rarely, emitters can be used that are not pressure-compensating, making their flow rate dependent upon water pressure.

Emitters are now built with a microfiltration system. This labyrinth of channels is designed to capture any particulates that might have entered the system. Other modern features include self-cleaning emitters with a built-in check valve, as well as patented technologies to prevent root intrusion. The emitter check valve is an essential component for installation on slopes, as they prevent water from draining out when the system is shut off. Built-in check valves also prevent any debris from entering the system through the emitters. For these reasons, emitters equipped with a check valve are becoming an industry standard.

Filter types

Filtration is essential for an SDI system to operate properly. Filtration prevents clogging of the emitters from debris and sediment in irrigation water. Filtering requirements depend on the quality of the irrigation water source and the particle size of what needs to be removed. Common filtration systems for SDI include screen filters, media filters and disk filters. Each type is described in detail below.

Screen filters

These filters are designed to remove solid particles and debris from the water. They work by physically straining the water as it passes through a screen or mesh. Screen filters are generally rated by the size of the particles that can be captured, usually measured in microns. The smaller the micron rating, the finer the mesh of the filter and the more particles they can remove from the water. To prevent clogging, screen size needs to be chosen based on the water quality and the size of the emitters. In general, screen filters do not remove bacteria, algae or microfilm from the water.

Media filters

Media filters are designed to remove particles such as sand, sediment and debris from the irrigation water. The basic principle behind a media filter is to force the water through a medium that captures and collects impurities. This type of filter mimics the natural filtration that happens during aquifer recharge when water moves through the soil profile. For this reason, the normal medium used is sand. These are typically referred to as “sand filters” and perform like the ones commonly used for swimming pools. However, the medium can be fine gravel or other porous materials like plastic or PVC. They can be operated by pressure using a pump or they can be gravity driven.

Disk filters

These filters are preferred to screen filters for their durability and resistance to corrosion. While regular screen filter mesh and disk filters are both made of metal and/or plastic compounds, disk filters are more durable and resistant to rips and tears of the membrane. They consist of a series of disks, stacked on top of each other, that allow water to pass through and suspended particles to be captured. They are relatively low-maintenance and have good longevity.

Disk filters are durable and require relatively little maintenance. They are typically used for smaller SDI systems and would be installed at the valve to the drip system.

Filter location and maintenance

Correctly locating filters and maintaining them regularly is necessary to ensure the SDI system’s proper functioning. Below are some key considerations.

Position of filters

Where filters are placed will depend on the type. Typically, large screen filters and sand filters are placed after the pump station and provide filtration to large quantities of water. Smaller filters will be placed after the valve and their size will be a function of the flow rate.

Cleaning filters

Regular filter cleaning is required to ensure proper function of the SDI system. Media filters are typically cleaned by backwashing (or backflushing), which consists of running water in the opposite direction and expelling debris from the system. This results in some waste if there isn't a way to reuse the backflushed water. It might also be necessary to occasionally add or replace the filter media as some may be lost during the backwash cycle.

Screen and disk filters are easier to clean. These filters can also be backflushed, and some manufacturers provide an automated system for cleaning. However, the easiest way is to periodically remove the screen or the disk, check their integrity and wash them clean of debris. The frequency of cleaning and maintenance of these filters can be easily estimated by the presence of a flow meter or pressure gauge. When the flow and pressure are reduced below the optimal range, the filter must be cleaned.

Pressure regulator

Drip systems work at a lower pressure than the overhead irrigation system. Therefore, a pressure regulator is essential to ensure that consistent and appropriate water pressure is delivered to the emitters throughout the SDI system. The primary function of a pressure regulator is to reduce and maintain the water pressure within a suitable range for the emitters according to each manufacturer's specifications. High pressure can damage emitters and burst driplines, leading to leaks and inefficiency. Conversely, low pressure reduces irrigation volume, uniformity and ultimately turfgrass performance.

Pressure regulators can be installed in various locations within the SDI system. Typically, the pressure regulator is combined with the valve and installed before the header line.

Air release valve

Because SDI tubing is buried, any air that enters the system during installation or as a result of changes in pressure or temperature can become trapped and cause blockages or uneven water distribution. Air release valves allow air to escape the system and be replaced with water, ensuring that the system operates efficiently and effectively. The valve is typically installed at high points in the SDI system, where the air will most likely accumulate. As water flows through the system, any air present will be pushed toward the valve, which opens to allow the air to escape. Once the air has been released, the valve closes again to prevent water escaping.

Moreover, air release valves serve the critical function of preventing the formation of a vacuum (i.e., negative pressure) in the irrigation pipes and driplines when the system turns off. When water flow in the SDI system stops, a vacuum can occur in the pipes due to the residual water remaining in the driplines. This can cause problems such as soil and debris being sucked into the driplines, leading to clogging and reduced water flow in subsequent irrigation cycles. The air release valve is designed to automatically open when the pressure in the irrigation pipes drops below a certain threshold, allowing air to enter and replace the water in the driplines, preventing the formation of a vacuum. This helps maintain the irrigation system's efficiency and ensures consistent water flow and distribution.

Flush valve

An automatic flush valve is a device used to remove debris and sediment that may accumulate in the SDI system. The valve is typically installed at the low point in the SDI system and is designed to open periodically, allowing water to flow out of the system. The automatic flush valve is triggered by a timer or a pressure-differential switch, which opens the valve and allows water to flow through the system for a predetermined amount of time. During this time, any debris or sediment accumulated in the system is flushed out, preventing clogging and ensuring the water is evenly distributed throughout the SDI system.

When the drip system is turned on, the automatic flush valve opens briefly to allow a surge of water to flow through the system. This allows any debris that might have accumulated at the system's lowest point to be flushed out. The automatic flush valve typically operates for a short period of time at the beginning of every cycle. In smaller installations, a pressure-differential valve is typically preferred. In larger installations, a manual or time-triggered flush valve is preferred.

When the SDI system is turned off, the flush valve functions as an air release valve. Allowing water to exit and empty the dripline is important to prevent root intrusion, mineral buildup and to avoid excessive growth of bacteria, algae and fungi within the drip lines.

Automatic flush valves need to be inspected periodically. Some larger debris can block or limit the functionality of this device. This could lead to automatic valves remaining open during system operation. When the valve is stuck open, the system loses an excessive amount of water and the distribution uniformity is reduced.

Drip systems have various fittings that allow the user to design a layout for any area.

Fittings

Other minor components for SDI systems include typical irrigation fittings such as couplings, tees and elbows of various angles. These fittings allow the user to design a layout to fit irrigated areas of any shape. Couplings or small rubber plugs are used to make repairs when driplines are compromised.

BMP CASE STUDIES

"Subsurface Drip Irrigation Reduces Water Use on Tees"

USGA Green Section Record, 2019

In 2016, 12 tees at the Club at Las Campanas in New Mexico were fitted with differing SDI systems using various installation methods. Each system has performed very well. An average of 50% less water is used compared to overhead irrigation. Using SDI on these island tees has also eliminated overspray into adjacent areas.

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