IRRIGATION MANAGEMENT SERIES

Subsurface Drip Irrigation (SDI) Components: Minimum Requirements

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Subsurface drip irrigation (SDI) systems provide water and nutrients directly to the plant root zone through built-in emitters on polyethylene tubes that are buried below the soil surface. Experience in Kansas has shown that properly designed and managed systems can maintain or potentially improve yields, while saving water, fertilizer, energy, and money. However, these systems also require careful management to function properly. A good first step toward maintaining a profitable SDI system is proper selection of the system components.

This publication:
1. Lists the basic components for a subsurface drip irrigation system.
2. Explains the important factors to consider in selecting components.

Figure 1 shows the basic components of a typical SDI system and a general organization of the components. These basic components are required for any system.

Required System Components

An SDI system can function without all of the listed components, but it may be difficult to manage and maintain and may perform poorly. Eventually, the system may fail due to the lack of cues to the manager on the status of performance or insufficient emitter protection. Usually there are several versions of each component; these are listed as options below. A specific option may or may not be acceptable for your application depending on the specific site and system conditions. The major factors that should be considered when selecting each component are listed under considerations. Make sure the characteristics of your site and system are specifically addressed in your SDI system design.

1. **Pump**. SDI systems generally have low pressure requirements. Only one pump is needed, as is the case for most irrigation systems in Kansas. The pressure requirement is in the range of most low-pressure center pivot sprinkler systems. The size of the pump depends on flow rate and total head requirements. The total head requirements include pumping lift, friction/losses, elevation changes, system pressure and, for SDI systems, the pressure loss across the filter and other structural components, such as control valves, flow meter, check valves, main, and submain supply lines.

   - Considerations. The size of the pump will depend on the water supply capacity, system pressure needs, zone size (area to be irrigated at one time), and the filter and flushline flushing requirements.

2. **Filter system.** The filter system removes suspended particles from water to prevent emitter clogging. A group of filters can be installed in parallel to increase total flow rate. A series of filters can be used to improve filtration.

   - Options. Screens, discs, and sand media filters are commonly used depending on water quality. Centrifugal sand separators are used when water carries sand load from deep wells. Settling basins to remove sediment load for surface water supply system may be required in addition to regular filter system. A combination of devices may be used to remove suspended particles. Many of these systems have automatic backflush capability.

- Considerations. Water quality, emitter requirements (maximum allowable particle size), and system flow rate are important filtering factors. Water quality relates to the amount, size, and type of particles (organic or mineral) to be removed. For example, surface water typically has much higher organic matter content than groundwater, which affects the type of filter that can be used. Filtration requirement is determined by the emitter size or opening. That information is provided by the manufacturer and must be followed to help ensure system longevity. In general, filtration is provided to prevent passing of particles ¹⁄₁₀ the size of the smallest passageway. Primary filters are grouped as screen, disc, or media filters. K-State Research and Extension publication, MF-2361, *Filtration and Maintenance Considerations for Subsurface Drip Irrigation (SDI) Systems*, discusses filtration needs in more detail.

3. **Pressure-sustaining valve.** Depending on the type of filtration, the unit may be equipped with a pressure-sustaining valve to facilitate flushing (automatic or manual).

4. **Pressure gauges.** The filter(s) should have pressure gauges at the inlet and outlet points to show pressure differential for initiating flushing of the filtration unit, either manually or automatically. Follow the manufacturer's recommendation on the pressure differential value at which flushing should be initiated. It also is recommended to have pressure gauges at the beginning of the main delivery system and at the distal end of the system fitted on flushline. The flow rate from the meter and the pressure reading of the system provide cues to the operator about emitter performance and clogging.

5. **Backflow preventer.** These devices prevent the backflow of fertilizers, chemicals, or particulates into the water supply and are installed between the water supply or pump and the chemical injection line.

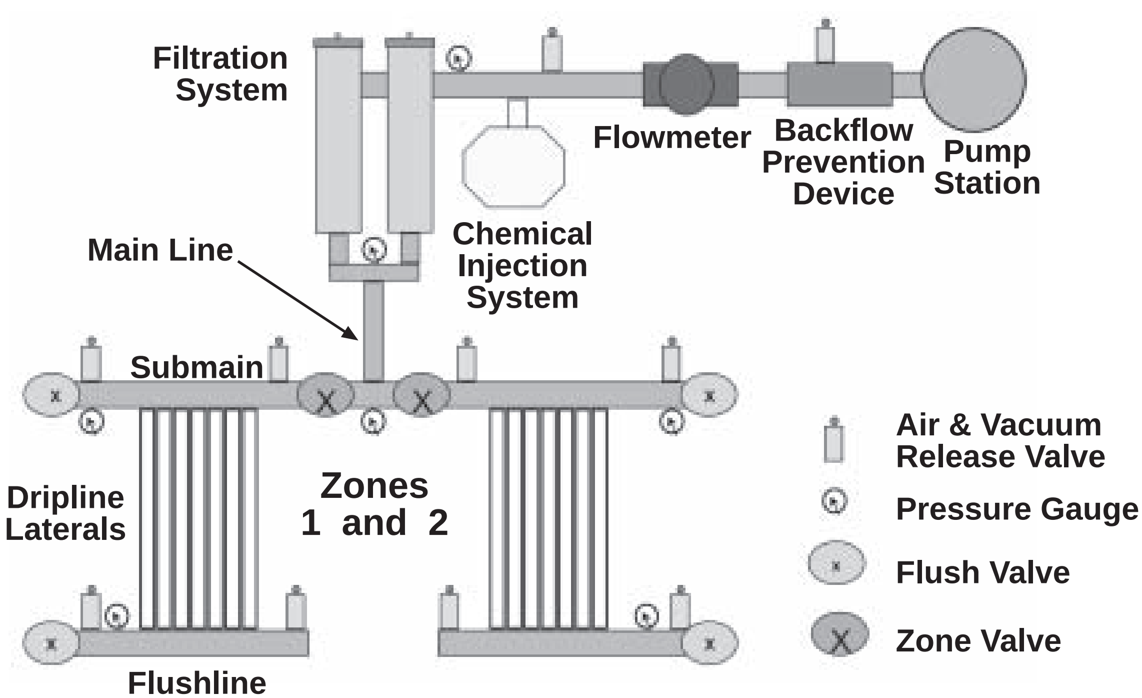
   - Options. A physical air gap between waterline and fertigation tank, an atmospheric vacuum breaker, a pressure vacuum breaker, or a double-check valve are options to prevent backflow.

   - Considerations. The type of fluid that can backflow (toxic or nontoxic), and whether there can be back pressure or back siphonage are important considerations. State and local regulations and codes must be followed.

6. **Regulation valve.** These valves are used to help maintain the proper pressure in irrigation lines.

   - Considerations. The manufacturer's emitter rating and the pipeline pressure losses during the delivery of

Figure 1. *Schematic of Subsurface Drip Irrigation (SDI) System. (Components are not to scale.)*



the water to the dripline connection point are important considerations. Emitters are typically rated by manufacturers to provide a specific flow rate if operated at a given pressure. The regulation valve must be sized to provide this pressure while accounting for pressure losses that occur between the valve and the emitter.

7. **Chemical injector.** A chemical injector precisely injects fertilizers or pesticides into the irrigation stream.

- Options. There are two types of chemical injection units: *1) Constant rate* (positive displacement): diaphragm, piston, or gear pumps and *2) Variable rate*: venturi pressure differential injectors or bladder tanks.

- Considerations. The types of chemicals used, rate of injection, method of injection, and the precision required are determining factors in selection of the best type of injector. The required number of injection systems and their injection point location depend on the clogging hazard and/or the material being injected.

8. **Flowmeter.** The flowmeter measures the volume of water moving through the system, either as a flowrate or as an accumulated total volume basis. The flowmeter provides the operator with information on how the system is performing and how to schedule the water application.

9. **Chemigation line check valve.** This valve, installed between the injector and the water source, prevents backflow of water into the chemical supply tank in case of injector failure. This valve is often an integral part of an injector unit and can handle both backpressure and backsiphonage.

- Considerations. State and local codes must be followed.

10. **Zone valve.** These valves are opened or closed to control the flow to appropriate zones. They can be automatically controlled using an electronic control system. In production agriculture, these zone valves are often manually operated where the zone size is appreciably large.

11. **Pressure regulator.** Pressure regulators are typically located on the manifold to help regulate operating pressure for emitters.

- Considerations. Manufacturer emitter rating and line pressure losses are the major considerations. Emitters are typically rated by manufacturers to provide a specific flow rate if operated at a given pressure. The pressure regulator must be sized to provide this pressure while accounting for pressure losses that occur between the regulator and the emitters.

12. **Air and vacuum release valves.** These valves prevent soil or particulate material from being sucked back into emitters when the irrigation system is turned off or when driplines are drained. They cannot handle backpressure, only backsiphonage. All high elevation points of system should have air or vacuum relief.

13. **Main line, submain.** The main line and submains are the delivery pipelines that supply water from the system headworks control to manifolds connecting dripline laterals.

- Considerations. System pressure, required flow rates, water hammer, and pipe cost are the consideration factors for consideration.

14. **Flushlines.** The flushlines at the tail end of the system serve three purposes:
1) Allow any sediment and contaminants to be flushed from dripline laterals at a centralized location,
2) Equalization of pressure in the dripline laterals, and
3) Allow positive pressure on both sides of a dripline break to prevent soil ingestion into the dripline.

15. **Header manifold.** The header manifold delivers water from the submain to the laterals and links a number of driplines together into one controllable unit. In most agricultural fields, the submain serves this function.

16. **Dripline.** The dripline is the polyethylene tubing that includes a built-in emitter. Emitter spacing and rate are selected to match crop demands and soil water-holding capacity. They must be compatible with the pumping pressure and flow capacity. Driplines are available in a variety of wall thicknesses, diameters, emitter spacings, and flow rates. Most SDI systems in Kansas use driplines with 8 (0.250 mm) to 15 (0.375 mm) MIL wall thickness. SDI systems for row crops tend to use large diameter ($^7/_8$ inch or greater diameter), thin-walled and low-flow driplines, which are sometimes referred to as driptapes. Larger diameter and lower flows

allow longer length of runs and larger zone size that are appropriate for the typical field sizes in Kansas. Pressure-compensating driplines are available, but are generally not used in Kansas due to higher cost. Water quality also may be a consideration in the choice of emitter size and spacing to avoid clogging. K-State Research and Extension publication, MF-2578, *Design Considerations for SDI Systems*, discuss these considerations in more detail.

- Considerations. Tubing wall thickness, emitter spacing, discharge rate, soil texture, and soil water holding capacity are considerations because these affect plant root zone water content and distribution.

18. **Connectors.** Connectors are needed to attach the dripline to the manifold or submain. The number and type depend on system layout. There are many types of connectors. Connector options include glued, grommet, barb, and compression. These can have a direct dripline connection or may receive a supply tube that is attached to the dripline. The dripline connector options are wired, clamped, or interference (compression) fit.

Optional Automatic System Control

Automatic control may be useful for precise delivery of water and nutrients according to design or crop need. This also reduces the need for manual control.

Automatic controls. Pumps, valves, and injectors can be turned on and off or opened and closed to allow automatic timing and sequencing of irrigation zones. These may be linked to automatic timers, soil water sensors, or weather-based models to determine when irrigation system should run. Computer control and monitoring is an option, but not required for automation.

Summary

SDI systems have higher initial investment costs compared to traditional types of irrigation systems used in Kansas, so efforts to minimize initial investment costs whenever possible is a practical goal. However, cost reductions should be attempted only if system design and operating integrity are not compromised. Cost cutting that results in a poor design or a difficult to manage system may increase operating costs, decrease system performance and increase the chance of system failure.

Additional Resources

MF-2361 *Filtration and Maintenance Considerations for Subsurface Drip Irrigation (SDI) Systems*

MF-2242 *Economic Comparison of SDI and Center Pivots for Various Field Sizes*

MF-836 *Irrigation Capital Requirements and Energy Cost*

MF-2578 *Design Considerations for Subsurface Drip Irrigation*

MF-2590 *Management Consideration for Operating a Subsurface Drip Irrigation System*

MF-2575 *Water Quality Assessment Guidelines for Subsurface Drip Irrigation*

K-State Research and Extension SDI Web site
www.oznet.ksu.edu/sdi

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