Subsurface Drip Irrigation (SDI) with Livestock Wastewater

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What is SDI?

Subsurface Drip Irrigation (SDI) has been used successfully in Kansas for many years. Typical systems use high-quality groundwater; however, with proper design and maintenance, SDI can be used to apply nutrient-rich, lower-quality livestock wastewater. Characteristics of an SDI system are:

- Low-pressure microirrigation system.
- Uses permanently buried plastic tubes (driplines).
- Water flows through underground driplines.
- Emitters (small openings) along driplines allow water to seep into the soil.
- Deposits water at the growing crop's root zone.
- Allows water to be uniformly distributed, regardless of the field shape.

Advantages of SDI for livestock wastewater

- Eliminates potential for overspray and drift, reducing separation distance requirements for application.
- Conserves fresh water resources.
- Reduces groundwater withdrawal in areas of low recharge.
- Contains essential crop-growth nutrients such as nitrogen, potassium and phosphorus.
- Allows for uniform application of effluent and nutrients in bands across the field.
- Allows for efficient use of nutrients by the growing crop as nutrients are applied directly to the root zone.
- The soil surface is left dry after application which can reduce weed germination and bacteria survival near the surface.
- Eliminates or greatly reduces the potential for odor, ponding and runoff problems during application.
- Uses low pressure, which reduces energy demands for application.
- Reduces potential for human contact with wastewater.
- Reduced weather-related water application limitations (especially high winds and freezing temperatures).
- Increases flexibility to match field and irrigation system sizes.
- System components are resistant to corrosion, because most are plastic.

Disadvantages of SDI for livestock wastewater

- Wetting pattern is fixed and may concentrate materials into too small of a zone resulting in poor crop utilization or concentration of a particular wastewater constituent.
- Monitoring of water and nutrient application may be more difficult as the effluent is distributed in bands along the driplines.
- Emitter discharge rates can exceed the capability of the soil to redistribute materials. If this occurs, wastewater could seep to the surface.
- Emitters can clog, causing sub-optimal system performance or failure.
- Tillage operation options on the field are reduced as affected by the dripline depth.
- High initial investment cost and additional maintenance/treatment costs to prevent emitter clogging.
- System is fixed to a given land area.
- Limited experience base for livestock wastewater application on commercial fields.
- The volume of wastewater may not be sufficient for full irrigation and nutrient balancing, so additional irrigation water may be required.
- It may be risky to introduce wastewater into an SDI system originally designed for fresh water.

Basic Design

One advantage of a well-designed and operated SDI system is its ability to apply water with high uniformity and efficiency. The general recommendation is to design a system that can provide full irrigation for the targeted acreage.

Fundamental components of an SDI system are the same whether you plan to irrigate with clean water or livestock wastewater. Specific differences include the type of filter, size of emitter openings and chemical treatment. Basic components include:

• Pump

• Filtration System – For livestock wastewater, use a filter designed to handle organic materials.

• Pressure-sustaining valve

• Pressure gauges

• Backflow prevention

• Pressure regulation valve

• Chemical injector and associated safety features

• Flow meter

• Zone valve

• Air and vacuum release valves

• Main line, submain

• Header manifold

• Flushlines

• Dripline

• Connectors.

Water distribution components are the pump, main line pipe, submain pipe and dripline laterals. The flushlines also contribute to uniform distribution as well as allow for effective system maintenance. The remaining components allow for system protection, monitoring performance and, if desired, adding nutrients or chemicals for crop production or the treatment of driplines.

Initial investment costs for SDI systems are high compared to other Kansas irrigation alternatives. That investment can be recovered over the life of the system when it is well-designed and properly maintained.

A number of studies have shown SDI offers a range of production advantages and potential for increased water conservation and water quality protection when compared with other types of irrigation systems in the state.

Basic Management

The leading cause of microirrigation system failure is clogging of the emitters. Therefore, clogging prevention is the primary management challenge when using SDI with particle rich, biologically active wastewater. An appropriate filtration system combined with regular maintenance will help keep the system operational when using low-quality water.

Clogging prevention begins with water quality analysis. Knowing the chemical and biological components of the source water will help you select the type of filtration system and emitter size to prevent large particles from entering the driplines and clogging emitters. The water quality analysis can also help determine if chemical water treatments are needed to minimize clogging risks or treatments to remediate the system should clogging begin.

Accurate record keeping is essential. Monitoring will reveal system performance irregularities that may indicate clogged emitters. Begin by recording the results of water quality analysis. Record baseline flow rate and pressure readings at startup. Then compare those readings with the system's design specifications. Regularly check and record the following indicators:

• Water quality test results

• Flow rate of various zones

• Pressure readings

• Dripline chemical treatments

Clogging hazards fall into three general categories:

1. Physical — Source water containing sand or other suspended solids can cause physical clogging of emitters. Physical clogging hazards are usually removed with screen filters, however SDI systems handling wastewater contain clogging hazards other than just physical hazards.

2. Biological — Source water high in organic material can cause biological clogging of emitters. Sand media filters are commonly used to filter suspended materials from many of the canal systems in the United States. Other filter options, such as disc filters, have been developed and used successfully for wastewater conditions. Sometimes pairs of filters are needed so one filter can provide clean water for flushing of the other. Controlling bacterial growth generally requires water treatment in addition to filtration.

3. Chemical — As water is pumped into a microirrigation system, chemical reactions can occur due to changes in temperature, pressure, air exposure or the introduction of other materials into the water stream. Precipitants formed by chemical reactions can clog emitters. Changing the water pH through acid injection and/or chlorination will help remediate chemical clogging.

Introducing Wastewater To An Existing System

Research conducted by KSU irrigation engineers measured the performance of five different driplines with flow ratings from 0.15 gal/hour emitters to 0.91 gal/hr emitters for four growing seasons using filtered but otherwise untreated water from a beef feedlot runoff lagoon. The SDI system was periodically shock treated with chlorine and acid injections. Over the course of four seasons, a total of 66 inches of lagoon wastewater was applied with the SDI system, totaling approximately 9,300 lbs/acre of suspended solids passing through the system, minus the amounts of suspended solids that were removed in periodic dripline flushing events.

The disk filter and automated back flush controller operated well in all four years. Excavation and visual inspection of dripline samples at the end of the first season showed flushing was generally effective for removing accumulation of materials from the driplines. Before flushing, a slimy substance, probably containing both silt and biological materials, was present in the driplines. After flushing, however, the main chamber of the dripline was clean.

Driplines with smaller flow rates (0.15 and 0.24 gal/hr) experienced considerable clogging of up to 40 percent at the end of the study period.

The larger emitters (0.4, 0.61, and 0.92 gal/hr) experienced 7, 8 and 13 percent reductions in flow rate, respectively, during the course of the study. An aggressive flushing program using acid and chlorine prior to the fifth growing season restored a significant amount of the flow rate to the smallest two emitters. Flow rates increased from 62 percent and 71 percent of initial flow rates to 80 percent and 97 percent for the 0.15 and 0.24 gallon per hour emitter treatments, respectively.

This indicates aggressive management may remediate clogging problems associated with the use of watewater. However, laboratory analysis of a portion of the excavated driplines revealed that most of the lowest flow driplines had at least partial clogging in most of the emitters with 4 percent being fully clogged.

The laboratory analysis indicated the flow rates from individual emitters for the wastewater medium flow driplines (0.40 gal/hr emitter) were very good with only small decreases (<10 percent) from the average flow rate of new driplines.

The flow rates from individual emitters for the wastewater highest-flow driplines (0.92 gal/hr emitter) were generally good. The emitters of these driplines were pressure compensating emitters and were the only emitters of this type in the study. Two of the 24 emitters tested in the laboratory analysis had very high flow rates. It is believed the higher flow rate problems were caused by wastewater particles becoming stuck in the flexible diaphragm of the pressure-compensating emitter.

In general, the results of the study indicate that SDI systems have the potential to be used for applying wastewater.

Even though these driplines were tested under harsh test conditions (all application was wastewater), the results indicate potential use of SDI for application of lagoon wastewater. However, since the low-flow emitter dripline used in this study is the commonly used size with groundwater SDI systems in western Kansas, it may be risky to introduce wastewater into an SDI system originally designed for fresh water. SDI systems being designed for specifically for wastewater usage may want to use driplines with higher emitter flow rates.

Under less harsh conditions, such as only a single wastewater application followed by multiple irrigation applications of fresh water, low flow emitter driplines may have potential for use. However, additional preventive maintenance or remediation management procedures following the wastewater application may be needed to protect the longevity of the system.

Management procedures that may be needed to maintain optimal performance in emitters exposed to wastewater include:

- More frequent flushing.
- Flushing with fresh water.
- More frequent and concentrated chemical-injection treatments.

Designing A System For Wastewater

Designing an SDI system to be used exclusively with livestock wastewater requires a high level of operation and management skills.

Because of the variability in wastewater quality, the type of filtration system and the size of emitter openings will be dependent on wastewater analysis results. Manufacturers provide information about filtration requirements for various emitter sizes. Follow the manufacturer's recommendations to ensure system longevity.

Screens, discs and sand media filters are commonly used depending on the water quality. Centrifugal sand separators may be needed when water carries a sand load, such as runoff from livestock bedded in sand. Settling basins can be used to remove some sediment before it enters the filtration system – or combination systems may be necessary for pumping wastewater.

Resources:

K-State Research and Extension Publications:

MF-863, *Irrigation Capital Requirements and Energy Cost*

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

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

MF-2575, *Subsurface Drip Irrigation (SDI) Systems Water Quality Assessment Guidelines*

MF-2576, *Subsurface Drip Irrigation (SDI) Components: Minimum Requirements*

MF-2578, *Design Considerations for Subsurface Drip Irrigation (SDI) Systems*

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

Sources:

Rogers, D. H. and F. R. Lamm. 2005. *Key considerations for a successful subsurface drip irrigation (SDI) system.* In proceedings of the Central Plains Irrigation Conference, Sterling, CO, Feb. 16-17, 2005. Available from CPIA, 760 N.Thompson, Colby, KS. pp. 113-118.

Lamm, F. R., T. P. Trooien, G. A. Clark, L. R. Stone, M. Alam, D. H. Rogers, and A. J. Schlegel. 2002. *Using beef lagoon wastewater with SDI.* In Proc. Irrigation Assn. Int'l. Irrigation Technical Conf., Oct. 24-26, 2002, New Orleans, LA. Available from Irrigation Assn., Falls Church, VA.

Trooien, T. P., F. R. Lamm, L. R. Stone, M. Alam, D. H. Rogers, G. A. Clark, and A. J. Schlegel. 2000. *Subsurface drip irrigation using livestock wastewater: Dripline flow rates.* App. Engr. in Agr. 16(5):505-508.

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