

# Basics of Microirrigation



Point source emitters, Line source emitters, Classification of microirrigation emitters, Drip emitters, Pressure compensated emitter, Micro-sprinkler bubbler, Vortex, spaghetti, Soaking hose, Single walled, Emitter inserted in line, Twin wall drip tubing, Wetting pattern, Pig tail, Emitter on the line, Double line with emitters, Micro-sprinklers, Sand separator filter, Screen filter, Sand media filter, Injection pump, Atmospheric Vacuum breaker, Check valve Point source emitters, Line source emitters, Classification of microirrigation emitters, Drip emitters, Pressure compensated emitter, Micro-sprinkler bubbler, Vortex, spaghetti, Soaking hose, Single

# Basics of Microirrigation

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**m**icroirrigation involves frequent application of small quantities of water as drops (drip irrigation), tiny streams (micro-sprinklers) or a miniature spray (micro-sprayers), using applicators placed along a water delivery line. The outlet device that applies water to the soil is called an emitter. Emitters dissipate the pressure of the pipe distribution network through a small orifice or by a long, narrow flow path, applying water in small quantities at low pressure. Emitters partially wet the soil, moving water horizontally and vertically.

## Advantages and Disadvantages of Microirrigation

### The main advantages of microirrigation are:

1. **Uniformity.** When properly designed and installed, microirrigation systems can obtain uniformities higher than 90 percent.
2. **Fertilization control and chemigation.** Because of their high uniformity, microirrigation systems can apply fertilizers and chemicals along with water, frequently in small quantities, increasing application efficiencies and minimizing chemical losses through deep percolation or drifting.
3. **Labor savings.** Microirrigation systems require less labor than do surface irrigation systems, although such systems do not necessarily reduce management requirements.
4. **Water savings.** By minimizing water losses through deep percolation and runoff, microirrigation systems conserve water when irrigating crops with shallower root systems such as vegetable crops or crops planted in sandy soils that hold little water. Also, some crops respond better to frequent, light water applications, resulting in higher yields and/or improved product quality.
5. **Deficit irrigation.** When water is limited and water available per unit area is low due to low capacities of canal systems or irrigation wells, microirrigation systems can spread small amounts of water over a bigger area.

### The main disadvantages of microirrigation are:

1. **High initial cost.** These systems cost more to install than do surface and sprinkler systems.
2. **Maintenance and operation.** Microirrigation systems require increased maintenance, with periodic injections of sulfuric acid and chlorine or other chemicals to avoid plugging of emitters.
3. **Higher skills.** Proper, safe use of injection chemicals needed for system maintenance and fertigation requires knowledge of chemical reactions between water and injected chemicals to avoid precipitation and plugging the tape. Microirrigation also requires knowledge about calculating irrigation times and injection rates.

## Emitter Classification

Emitters are classified mainly as point source emitters or line source emitters, according to their position in their supplying laterals.

### Point source emitters

Point source emitters are best suited to irrigate trees, bushes and other similarly managed plants. Single emitters can be inserted directly in a lateral or can be connected at the end of a micro-tube (spaghetti). The main types of point-source emitters are single drip emitters, bubblers, micro sprinklers and spray emitters.

### Drip emitters

In drip irrigation (sometimes referred to as trickle irrigation), drip emitters each applying less than 2 gallons per hour are inserted into plastic pipe or hose. Many possible configurations of drip emitters are used to decrease pressure and distribute water from pipes to the soil. Those configuration use small holes, long passageways, vortex chambers or discs. Pressure-compensated emitters deliver constant flow rates even when pressure supplied to the emitter varies.

### Bubblers

The orifices on bubble emitters are larger than those on drip emitters and produce small water streams rather than sprays. Water is applied to the soil surface and moves down into root zones. Bubblers can control water delivery patterns to avoid spraying streets, fences, brick walls or windows. Such emitters are ideal for shrub plantings, trees, containers and flower beds and can apply up to 35 gallons per hour. Emitter plugging also occurs less often with bubbler emitters than with smaller-orifice drip emitters.

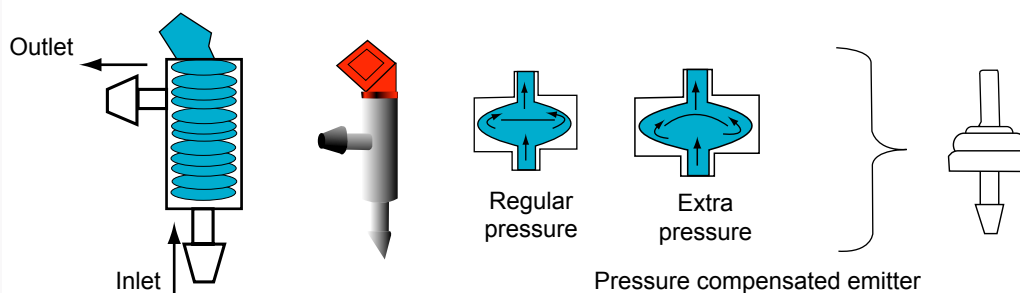
### Micro-sprinklers

Micro-sprinklers consist of an orifice with a deflector; water comes out of the micro-sprinkler orifice and crashes into the deflector to spray the soil. These sprinklers may or may not spin. Wetting patterns depend on micro-sprinkler/deflector type. Some micro-sprinklers have fixed, removable parts. Those with movable parts consist of deflectors that move as they are hit by water exiting the orifice. Micro-sprinklers generally are connected to a micro-tube, often referred to as “spaghetti tubing.”

Micro-sprinklers are used in orchards, greenhouses and flower beds. They can apply from 3 to 138 gallons of water per hour; the higher the flow rate and pressure, the longer the wetted diameter. However, small flow rates are preferred in large orchards with large-diameter laterals.

### Micro-sprayers

Micro-spray irrigation sprays water over mass plantings, ground cover, annual flower beds and containers. It lowers soil temperature for rooting and plant propagation and even provides limited frost protection. The micro-sprayer produces tiny droplets and has a relatively small wetting diameter. Its spray or mist is produced by a flat spreader and a small orifice operating at pressures between 30 and 43 pounds per square inch (psi).

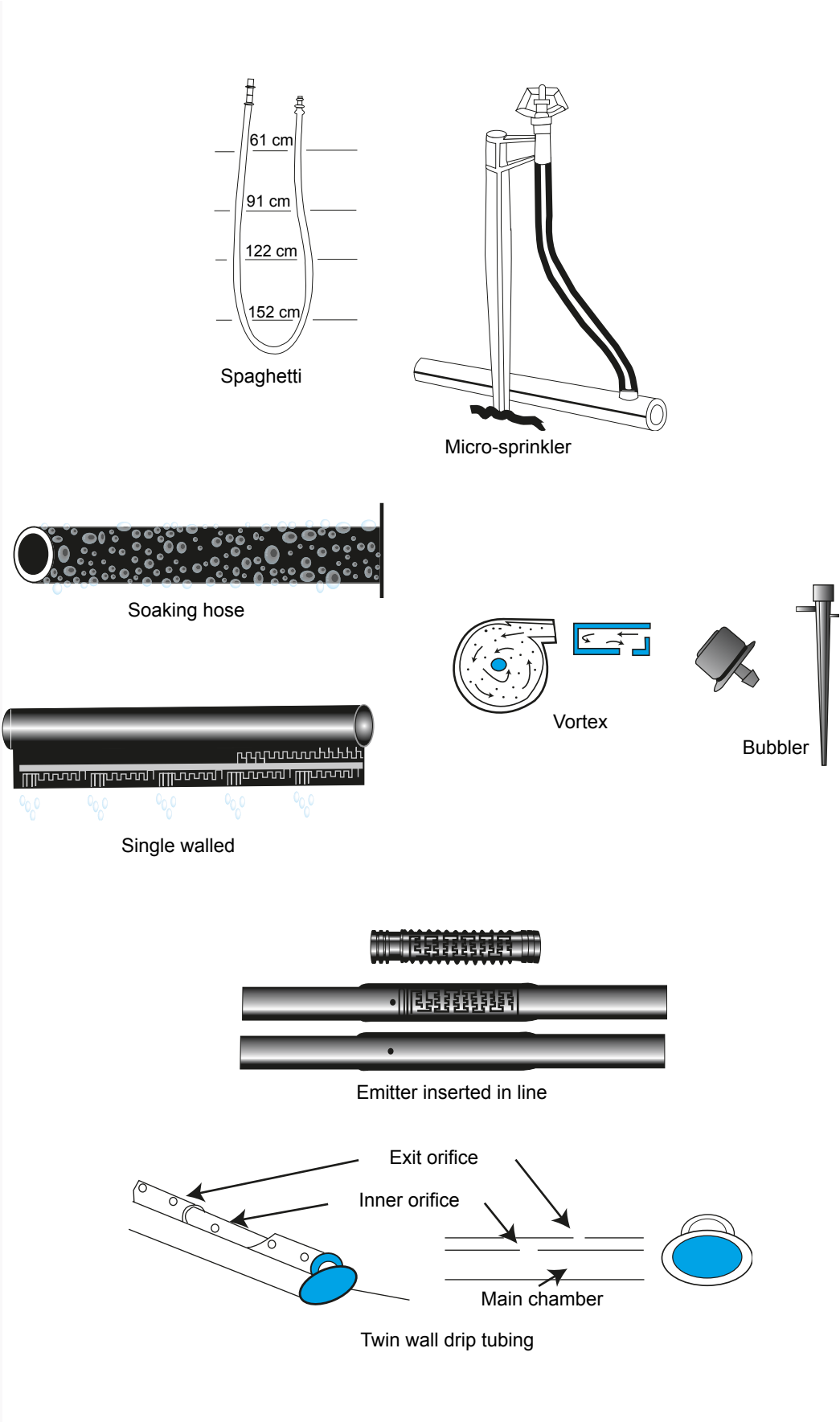


Drip emitters (long path spiral grooved)

Fig. 1a. Classification of microirrigation emitters.



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Fig. 1b. Classification of microirrigation emitters.

## Line source emitters

Line source emitters consist of drip tubing with supply orifices to meter water before it enters the line; then, the water passes through a labyrinth of flow paths to dissipate or compensate pressure and exits to one or more distribution orifices. Line source emitters use three main tubing configurations:

### Soaker hose

Soaker hoses use porous tubing to leak water continuously along the tube length rather than through discreet emitters.

### Single walled tubing

This kind of tubing, generally less than one inch in diameter, has built-in, inserted or attached emitters.

### Double walled or twin wall tubing

These drip lines have two walls forming parallel flow paths; one path delivers water along the length of the tubing, and one contains outlets to deliver water to the soil at set intervals (Fig. 1).

## Soil Wetting Patterns

Drip irrigation wets just part of plants' total root-zone area. The percentage of an area wetted is determined by soil properties, spacing of emitters, spacing of tape laterals and managing irrigation rates and timing. The minimum recommended wetted area is 33 percent for agricultural row crops and 75 percent for landscaping. Thorough partial root-zone wetting with drip irrigation favors aeration of roots, which may increase crop productivity and/or improve health of landscape plants.

Water applied to the soil produces a wetting pattern as it moves downward due to gravity and horizontally due to differential soil moisture and capillary suction (Fig. 2). Wetting-pattern configurations depend on soil type and tillage practices. For example, clay soils have fine particles that exert capillary forces greater than gravity, resulting in horizontal wetting patterns. Sandy soils, on the other hand, have coarser particles that produce faster downward movement of water. Their bigger particles produce bigger voids, making it difficult for water to move horizontally. Most soils comprise a combination of clay, loam and sand particles. The shape of the wetting front is more proportional in medium-textured soils than in other soil types (Fig. 2). Wetting-pattern size will be affected by irrigation dripper-flow rate and application time. Increased application time gives more opportunity for horizontal movement of water, especially in clay soils. Take into account soil characteristics when determining application times, numbers of emitters per plant and emitter flow rates.

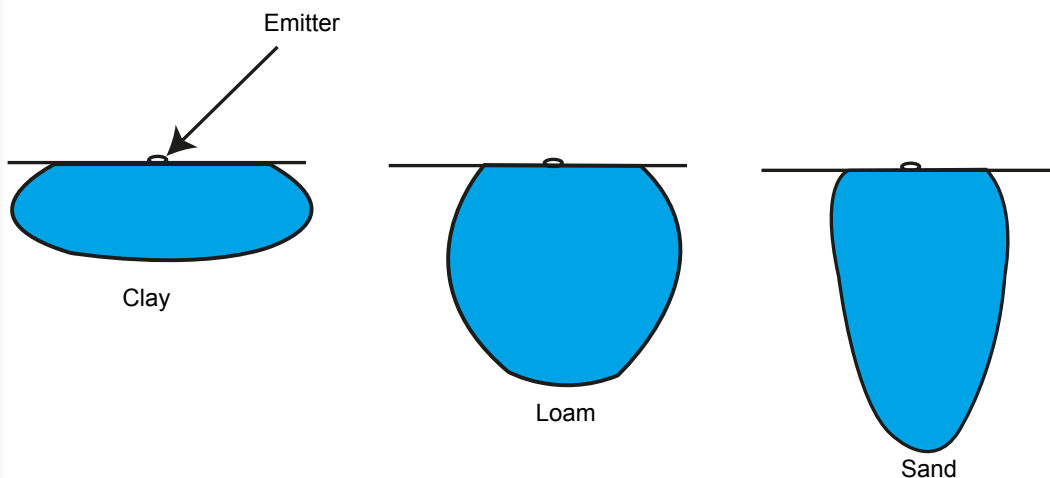


Fig. 2. Wetting pattern shapes for the clay, loam and sand soil textures.

## Emitter Placement in Relation to Plants

Emitter placement and configuration affects water efficiency, plant germination and establishment, nutrient utilization efficiency and soil salinity. Emitter type and placement also affect wetted zone size and horizontal and downward movement of water. When you want a larger wetted area, place more point source emitters per plant (Fig. 3). More emitters can be installed (1) by supplying them from the lateral using several spaghetti tubes or (2) by using a “pigtail configuration” to feed several emitters from a line stemming from a lateral surrounding the plants. Another option is to install two laterals instead of one, distributing several emitters along each.

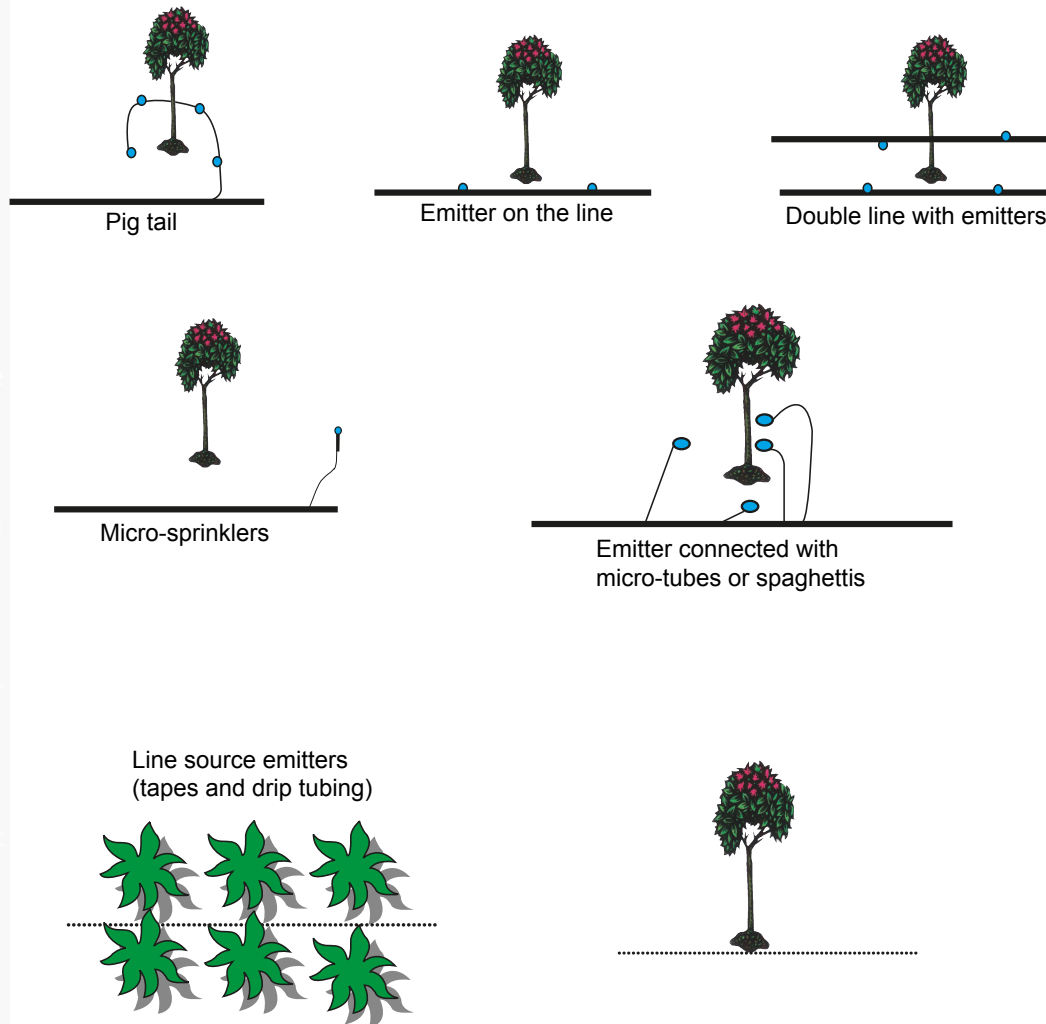


Fig. 3. Installation configurations of point source and line source emitters.

Microsprinklers and bubblers generally are installed one per plant; wetted diameter than can be controlled with pressure and orifice size. For row crops, one lateral can be placed under each row or can be used to irrigate two plant rows (Fig. 4). Configuration depends on factors such as economics, crop tolerance to salinity and soil texture. Spacing between emitters along a lateral depends on the crop. For example, with onions, spacing should be close (less than 8 inches), but with cotton, it can be every 12 inches or more.

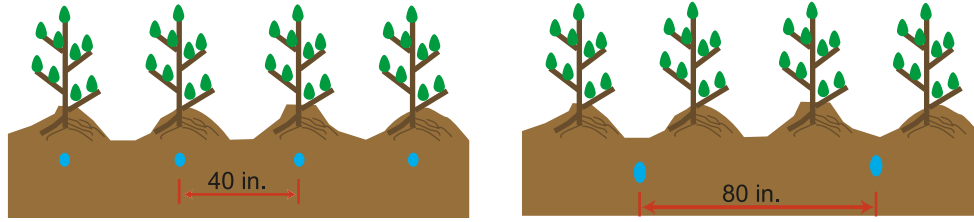


Fig. 4. Typical lateral placement a) under every row; under alternate furrows. This illustration shows tape placement options for a row crop using 40 inch tow spacing.

Wetting patterns can be determined experimentally or by field trials, which can reveal effects of soil layers, compaction and soil variability. Different drip tapes can be tested with water flowing out of an elevated 50 gallon drum. Such trials allow better designs, and it can be especially helpful to consult irrigation professionals and producers experienced with microirrigation in a given area or for a particular crop.

## Components of Microirrigation Systems

Besides emitters, most microirrigation systems include a filter, chemigation units, a mainline, laterals and accessories such as pressure regulators, connections and vacuum and pressure relief valves.

### Filters

- Filters remove impurities that can cause clogging; they are located after the system pump, with multiple filters placed in parallel (side by side, discharging filtered water into the same line). The number of filters needed depends on flow rate and water quality, including suspended particle size:

Particle Size Classification			
Material	Size (microns)	Size (in)	Mesh equivalent
Very coarse sand	1000-2000	0.04-0.08	15-7.5
Coarse sand	500-1000	0.02-0.04	30-15
Medium sand	250-500	0.01-0.02	60-30
Fine sand	100-250	0.004-0.01	150-60
Very fine sand	50-100	0.002-0.004	300-150
Silt	2-50	0.00008-0.002	7500-300
Clay	<2	0.00008	7500

Filter screen openings should be one-fourth the size of emitter openings. Filtration capacity is expressed in “mesh” (mesh numbers correspond to openings per inch, e.g., 200 mesh has 200 openings per inch). Most microirrigation applications require mesh sizes between 100 and 200. The main types of filters are:

- Sand Separator (centrifugal or hydrocyclone) filters** are ideal for removing suspended sand particles (often encountered in pumping from deep wells). Centrifugal separators will remove particles down to 75 microns (200 mesh). These filters spin the water, using centrifugal force to remove high density particles (Fig. 5). Pressures for water passing through the filters decrease by about 8 to 12 psi.



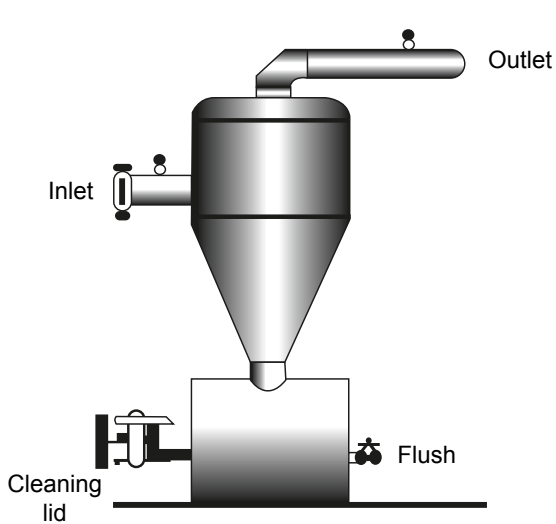


Fig. 5. Sand separator (centrifugal) filter.

- **Screen-mesh filters** (Fig. 6) come in different shapes and sizes, ranging from 20 to 200 mesh. Their mesh can be made of stainless steel, polyester or plastic and can remove very fine sand particles or very small algae. They serve as backup filters to catch particles that get through other filters.

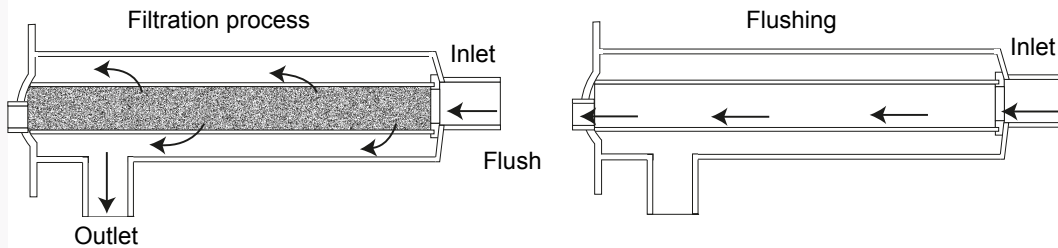


Fig. 6. Screen filter.

- **Sand media filters** contain a vertical cylinder with graded sand inside (Fig. 7). This cylinder efficiently separates organic material (algae, leaves, etc.) and fine sediment, so it often is used to filter water from surface sources such as lakes, rivers or canals. Multiple cylinders can be back-flushed either manually or automatically.

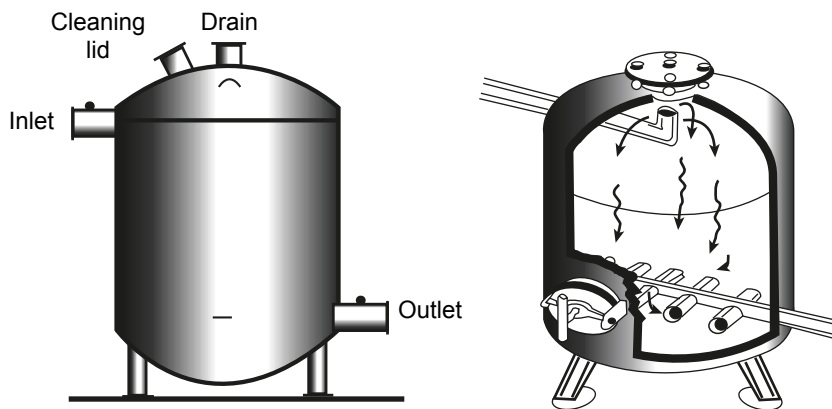


Fig. 7. Sand media filter.

Depending upon water source and quality, more than one type of filter may be needed for a given irrigation system, with typical combinations as follows:

1. If the water source is a deep well, a filter station may consist of a sand separator followed by a screen, disk or media filter.
2. If the water source is a canal, a filter station may consist of a sand media filter combined with a screen filter or a disk filter with screen filter (Fig. 8).

## Chemigation Unit

Microirrigation's high distribution uniformity gives it great potential for uniformly and efficiently applying agricultural chemicals, a process called chemigation. The main components of a chemigation unit are a chemical solution tank, an injection system and chemigation safety devices. [YOU LIST THE CHEMICAL SOLUTION TANK BUT DO NOT DISCUSS IT.]

### Chemical Solution Tanks

Chemical solution tanks generally are constructed of poly or fiberglass. A conical form at the tank bottom facilitates flushing it completely so that no material is wasted. Tanks should have an easy-clean screen downstream of the valve to make them easier to clean.

### Injection system

The main types of chemical injectors are the venturi injector, injection pump, and the differential tank (Fig. 9). Criteria for selecting the proper injection system include cost, ease of use/repair, durability and susceptibility to corrosion.

With *venturi injectors*, water is extracted from the main line, then (1) pressure is added with a centrifugal pump (Fig. 9) or (2) a pressure differential is created by a valve in the mainline forcing water through the injector at high velocity. The high-velocity water passing through the throat of the venturi creates a vacuum or negative pressure, generating suction to draw chemicals into the injector from the chemical tank. Although the venturi is cheaper than a positive displacement pump, its injection rate is more difficult to control.

With *injection pumps*, water is pumped into the system using pistons, diaphragms or gears. An injection pump has a small motor powered either by electricity or by energy from the water itself. The motor moves small pumps (diaphragms) or pistons to inject fertilizer into the system. The advantage of injection pumps is that chemicals can be injected with high uniformity at rates easily adjusted regardless of discharge pressure.

With *differential tanks*, water is forced through a tank containing the chemical to be injected. As water passes into the tank, fertilizer is injected into the irrigation system.

One disadvantage of such a system is that the concentration of the chemical in the tank decreases over time.

### Chemigation safety devices

Backflow can occur in a system due to cross connection between a water source and an irrigation system. For example, water may be turned off, but the chemical injection unit may continue to work, contaminating the water source. To protect groundwater and drinking water supplies from chemical contamination, backflow – whether from *backsiphonage* or *backpressure* – must be prevented. The main chemigation safety devices used to prevent backflow are shown in Figure 10.

*Backsiphonage* is the reversal of normal system flow, caused by negative pressure (vacuum or partial vacuum) in the supplying pipe. Backsiphonage occurs due to low pressure in the water source. For example, the mainline source pipe may break at a spot lower than the irrigation system or pressure may be reduced drastically because a supply pump fails. Such situations can be avoided by installing check valves, vacuum relief valves or vacuum breaker valves.

*Backpressure* is the reversal of normal system flow due to downstream pressure increasing above supply pressure. Backpressure may occur if a system operates at higher pressures than its water supply, perhaps due to use of booster pumps or interconnection of a water source to other water systems. Such situations can be avoided by installing double check valves or special valves that combine check valves with reduced pressure zones inside them (commonly known as reduced pressure principle backflow prevention valves).

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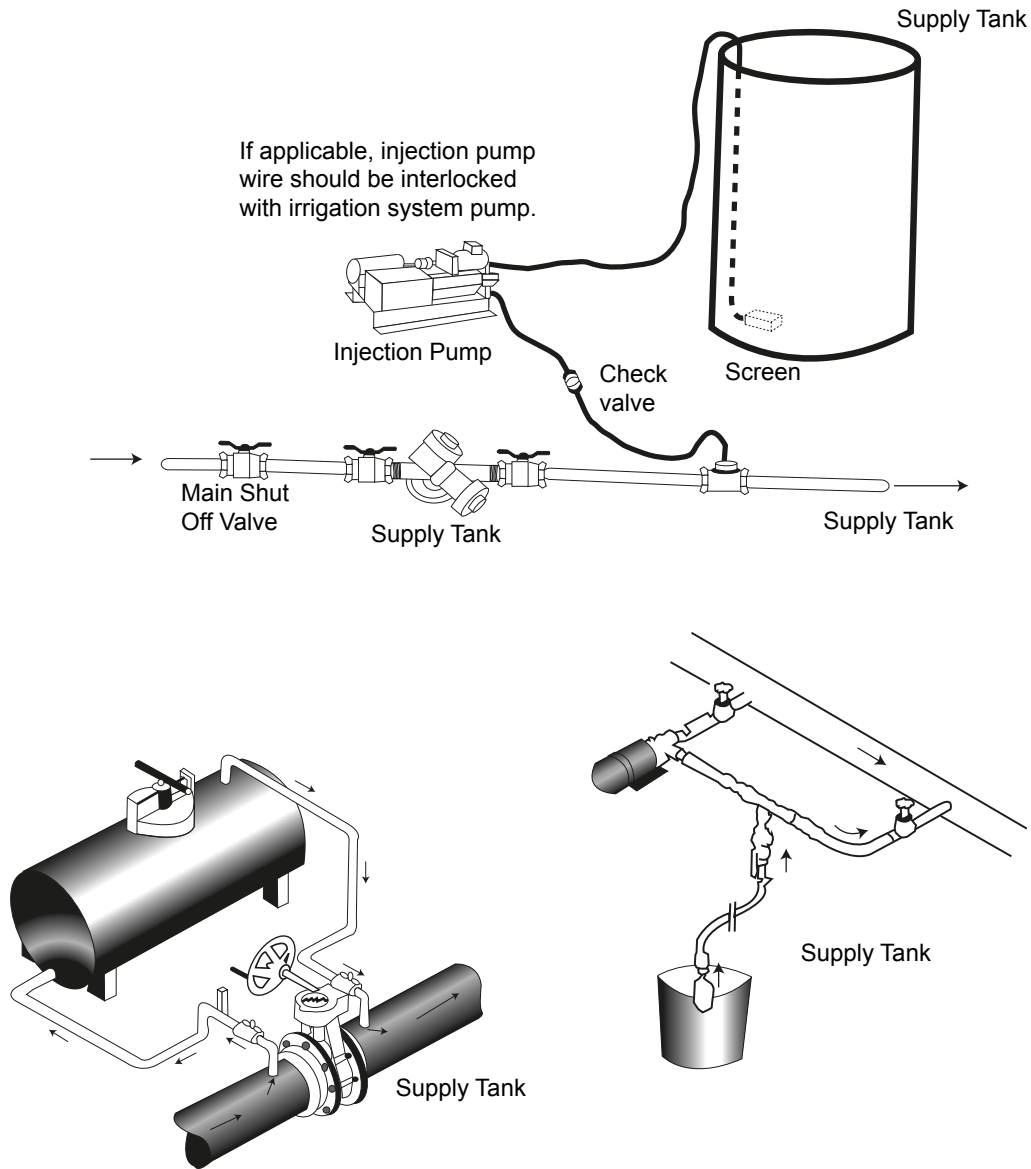


Fig. 9. Fertilizer injectors.

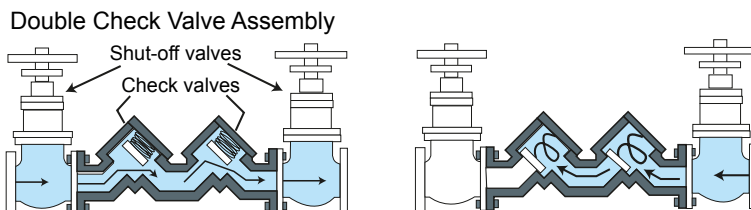
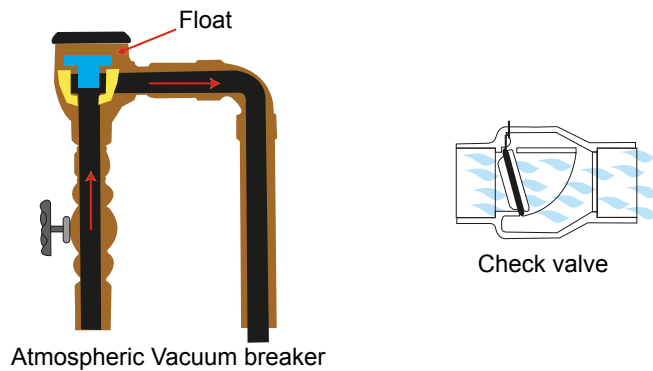


Fig. 10. Chemigation safety devices.

## Laterals

Laterals are the flexible polyethylene tubing used to carry water to areas to be irrigated. They deliver water to plants through spaced orifices or emitters. Layout of laterals is designed according to the dimensions and the topography of the fields to be irrigated. The diameter of a lateral is determined according to hydraulic principles of pipe flow.

## Vacuum and Pressure Relief Valves

Air sometimes enters irrigation pipes, accumulating and becoming trapped in the pipelines' highest points. This trapped air can reduce water flow and increase compression, eventually destroying pipes. Valves help to release the air during pipe filling and draining. An air valve consists of a small orifice with a ball inside. When air is released, the ball lets the air escape but retains the water. Pressure relief valves have an inside spring; when pressure inside the pipe exceeds the pressure of this spring, the valve opens, protecting the pipe from blowing. Pressure pipes are selected according to their resistance.

## Pressure regulators

For areas with irregular topography, particularly in irrigation systems without pressure-compensating emitters, pressure regulators must be used to produce uniform application of water. Pressure regulators dissipate excess pressure or reduce it to normal operating pressure of the emitters. Such regulators use one or more springs to decrease flow diameter and so reduce pressure. Generally, one pressure regulator is used to control pressure in two lines (Fig. 10).

## Summary

Microirrigation systems can help create beautiful landscapes and improve yields and quality of agricultural crops, orchards and vineyards. This publication should have increased your knowledge and understanding about microirrigation systems' advantages and disadvantages and about their components and configuration, as well as about the importance of placing them correctly in relation to soil and plant types for increased irrigation efficiency.



# Point source emitters, Line source



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