Injecting Chemicals into Drip Irrigation Systems

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Chemigation

The process of injecting an approved chemical into irrigation water and applying it through the irrigation system to a crop or field
Chemigation

*General term that includes:*

- Fertigation
- Insectigation
- Fungigation
- Nematigation
Advantages of Chemigation

- Uniformity of application
- Precise application
- Economics
- Timeliness
- Reduced soil compaction and crop damage
- Operator safety
Disadvantages of Chemigation

- High management
- Additional equipment
- Must calculate injection rates and volumes
Chemigation and Regulations

General Classes

- Controlled Substances (pesticides and herbicides)
- Fertilizers and Nutrients
- Drip Maintenance/Clogging Control Chemicals (chlorine, acid)
Controlled Substances
(pesticides and herbicides)

• Highly regulated by the EPA and States

• Regulations cover labeling, mixing/injection, and equipment

• Regulations designed to protect the environment, human health and water supplies
The US EPA’s Label Improvement Program (LIP)

- Established in the 1980’s
  (fully implemented in 1988)
- States were required to implement regulations at least as stringent as proposed by the EPA
The US EPA’s Label Improvement Program (LIP)

- Labels must state whether product is approved to be applied through the irrigation system.
- Application instructions are provided.
- Requires use of specific safety equipment and devices designed to prevent accidental spills.
Summary of Chemigation Equipment Requirements
CHEMICAL INJECTION SAFETY CONNECTIONS

- irrigation pipe line
- vacuum relief valve
- check valve
- automatic low pressure cutoff
- electric motor and pump
- electrically interlocked control panels
- injection and automatic check valve
- injection unit
- agitator
- electric connection
- chemical discharge line
- normally closed solenoid valve
- electrically interlocked with injection pump
- injection pump and electric motor
- injection hose
1. Irrigation Pipeline

- Check valve between well and injection points*
- Vacuum relief valve between check valve and well
- Low pressure cut off
- Low pressure drain*

*Alternative safety equipment may be substituted approved by EPA, March 1989.
2. Injection Hose

- Anti-back flow injection valve – 10 psi
- Normally closed solenoid valve between injection pump and chemical tank*
- A metering type injection pump*

*Alternative safety equipment may be substituted approved by EPA, March 1989.
3. Power Interlock

- Interlock injection pump and water pump power
- Interlock normally closed solenoid valve and injection pump power
Other Chemicals

Fertilizers and Nutrients
Drip Maintenance/Clogging Control Chemicals

- Regulated by the Texas Commission on Environmental Quality
- Requires backflow prevention devices for public water supply and groundwater protection
Other Chemicals

Fertilizers and Nutrients
Drip Maintenance/Clogging Control Chemicals

- TCEQ regulations are designed to protect water supply
- Basic requirement is a check valve (backflow prevention valve) when connected to a water well or public water supply
Requirements for water wells...

All irrigation distribution systems ... into which any type of chemical ... or other foreign substances will be injected into the water pumped from wells shall be equipped with an in-line, automatic quick-closing check valve capable of preventing pollution of the ground water.
Other Required Devices

Installed between the pump discharge and the check valve

- Vacuum-relief device
- Automatic low pressure drain
- Inspection port
Chemigation Injectors and Pumps

The most common types:

- **Mechanical**
  - Piston (positive displacement) pumps
  - Diaphragm pumps
- **Venturi meters**
Piston/Positive Displacement Pumps

Injection rate remains constant and does not change if the irrigation pipeline pressure varies

- Injection rates cannot be adjusted while operating
- Commonly used to inject fertilizer (large rate injection)
Diaphragm Pumps

- Easy to adjust flow rate while operating
- Commonly used for low-rate injection (pesticides, etc.)
- Easy to calibrate and maintain
Venturi Meters

- Reduced diameter throat tube
- Velocity changes in throat create vacuum to pull chemical into stream
Venturi Meters

• Most low-end venturi injectors are not adjustable and have a constant proportion injection rate such as a 50:1 ratio

(one gallon injected for every 50 gallons flowing through meter)
Fertilizers

- Solubility of dry formulas varies depending on type and water quality
- Incomplete dissolving may result in clogging of emitters and lines
- Solubility in **Pure** water
  - ammonium nitrate 9.8 lb/gal
  - calcium nitrate 8.5 lb/gal
  - potassium chloride 2.3 lb/gal
  - potassium nitrate 1.1 lb/gal
Fertilizers

- Test solubility first
- Beware of formulas containing phosphorus/sulfur in waters with calcium/magnesium
- Use soluble chelated forms of micronutrients
- Liquid fertilizers are more expensive, but easier to deal with
Chlorine

- Injected to control biological clogging of lines and emitters
- Household bleach is often used in small systems (5.25% chlorine)
- 5 ppm solutions commonly used
- Higher concentrations (up to 100 ppm) if iron bacteria and/or organic matter are problems
Chlorine

- Chlorine concentration at the end of the drip line should be:
  - 1 to 2 ppm for occasional treatment
  - 0.5 to 1 ppm for continuous treatment
- Begin with a low concentration (5 ppm to 10 ppm) for one hour
Acid Injection

- Acid is injected to control mineral clogging of emitters
- Water with a high pH (>7.5) or "moderate" to "hard water" (>60 ppm Ca) more likely to cause problems
Acid Injection

- 98% sulfuric acid is commonly used in drip irrigation
- Citric acid or vinegar can be used in organic farming
- Titration can be used to determine concentration of acid needed
  (adding acid to a sample of the water to see how much is required to lower pH)
### Acid Injection

- Experimentation is used in absence of titration
- Acid is injected until pH is lowered to 6.5 (measured at end of drip line)
- Higher concentrations are added if needed, lowering pH to as low as ~4
- Acid is corrosive – inject downstream of filter if made of metal
Calibration of Equipment

- Small differences in injection rates make large differences in total amount of chemical applied
  - Results in insufficient or excessive application
- Calibration involves injecting water and checking the actual volume of water injected
Calibration of Equipment

For fixed ratio injectors, check the injection ratio

100:1 means that in one hour

- one gal of solution will be injected
- in an irrigation system with a flow rate of 100 gal/hr
Calibration of Equipment

For adjustable injectors:

- calculate the desired injection rate (gal/hr, ml/min)
- then calibrate/adjust injector accordingly
Calculations - Example 1

Calculate injection rate based on volume of solution per acre

Step 1: total gallons of chemicals needed
multiply the total acres by the chemical solution to be applied (gal/ac)

Step 2: calculate injection rate in gal/hr
divide by the length of the chemigation event

Step 3: Convert gal/hr to milliliters per minute (ml/min)
1 ml/min = 63.09 gal/hr

Step 4: set/check injector rate by injecting water for 1 minute
Calculations - Example 1

10 acres to be chemigated with
- 1.3 gal of solution per acre
- in one hour

Step 1: total gallons of chemicals needed

\[ 10 \text{ ac} \times 1.3 \text{ gal/ac} = 13 \text{ gallons of solution} \]

Step 2: calculate injection rate in gal/hr

\[ \frac{13 \text{ gal}}{1 \text{ hour}} = 13 \text{ gal/hr} \]

Step 3: Convert gal/hr to milliliters per minute (ml/min)

\[ 13 \text{ gal/hr} \times 63.09 = 820 \text{ ml/minute} \]

Step 4: set/check injector rate by injecting water for 1 minute
Calculations - Example 2

Calculate injection rate based on concentration (ppm) of solution to be injected

\[ IR = \frac{(0.006 \times F \times C)}{P} \]

*IR = injection rate (gal/hr)*

*F = flow rate of irrigation system (gal/hr)*

*C = concentration of chemical wanted (ppm)*

*P = Percentage of chemical in solution*
Calculations - Example 2

I want to inject chlorine at a concentration of 5 ppm for one hour. My irrigation system has a flow rate of 100 gpm, and I’m using household bleach (5.25% chlorine)

\[ IR = \frac{0.006 \times F \times C}{P} \]

\[ IR = \frac{0.006 \times 100 \text{ gpm} \times 5 \text{ ppm}}{5.24\%} \]

**IR = 0.571 gal/hr of bleach**

* IR = injection rate (gal/hr)
* F = flow rate of irrigation system (gpm)
* C = concentration of chemical wanted (ppm)
* P = Percentage of chemical in solution
Calculations - Example 3

Determining amount of solution for fixed ratio injectors

For example 2, my venturi injector has a 100:1 ration
(injecting chlorine at a concentration of 5 ppm for one hour, a flow rate of 100 gpm, and using household bleach)

\[ IR = 0.571 \text{ gal/hr of bleach} \]

Step 1: Calculate total flow of irrigation system in one hour
\[ 100 \text{ gpm} \times 60 \text{ min/hr} = 6000 \text{ gallons per hour} \]

Step 2: Calculate total gallons of solution to be injected
(divide Step 1 by ratio)
\[ 6000 \text{ gph} \div 100 = 60 \text{ gallons of solution} \]

Step 3: Mix the 0.571 gallons of bleach with 60 gallons of water in the injection tank
Handout:

Maintaining Subsurface Drip Irrigation Systems (TCE L-5406)

Note: mistake in equation
(should be gpm, not GPH)
For a copy of this presentation, see

http://gfipps.tamu.edu

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