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)

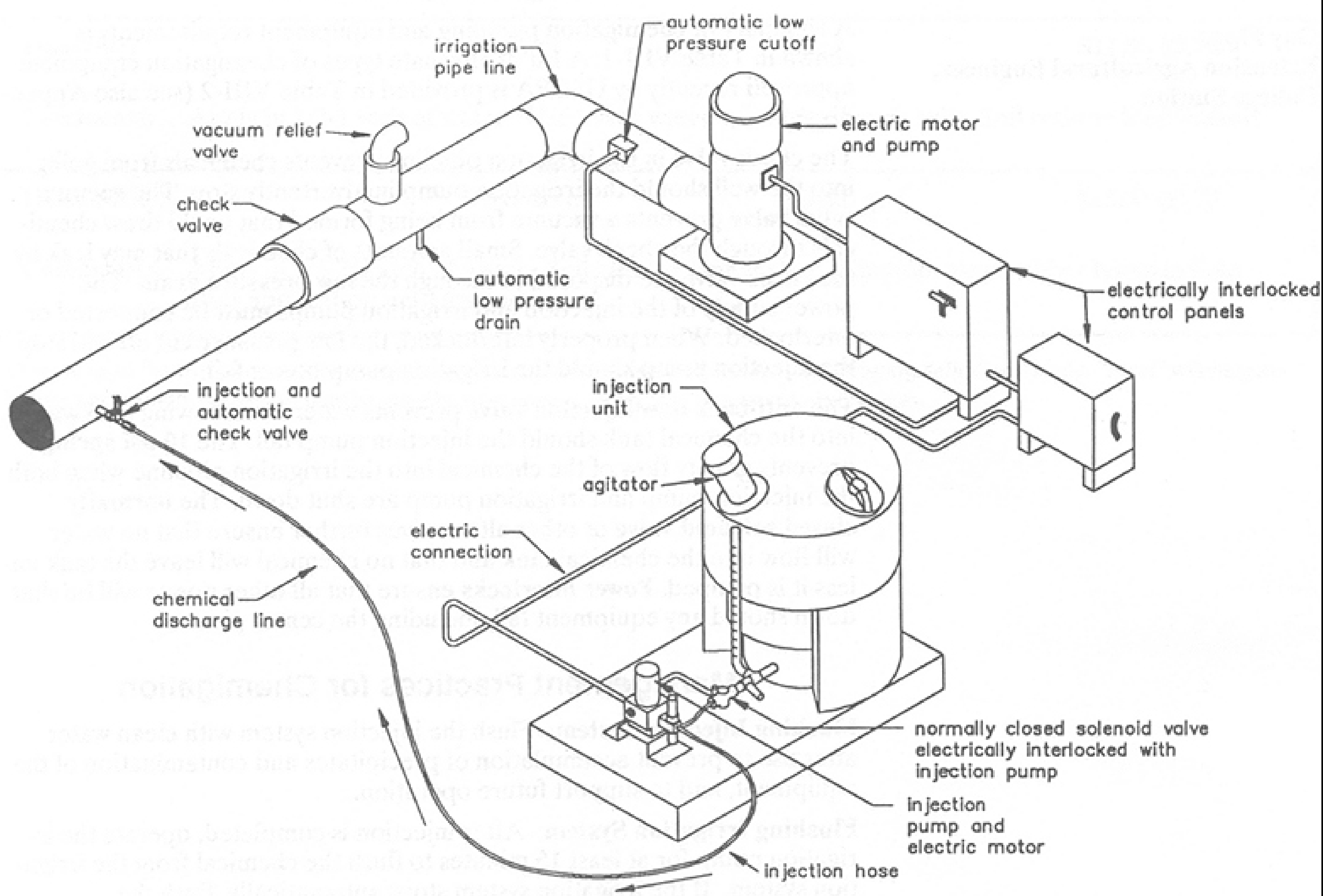
- Established in the 1980's
  (fully implemented in 1988)
- States were required to implement regulations at least as stringent as proposed by the EPA

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



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 micronutirents
- 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 need

(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 downsteam 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 ac x 1.3 gal/ac = 13 gallons of solution

Step 2: calculate injection rate in gal/hr

(13 gal) divided by (1 hour) = 13 gal/hr

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

13 gal/hr x 63.09 = 820 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

$IR = (0.006 \times F \times C) \div P$

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 = (0.006 x F x C) ÷ P

IR = (0.006 x 100 gpm x 5 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 gal/hr of bleach

Step 1: Calculate total flow of irrigation system in one hour

100 gpm x 60 min/hr = 6000 gallons per hour

Step 2: Calculate total gallons of solution to be injected

(divide Step 1 by ratio)

6000 gph ÷ 100 = 60 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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