Chemigation Uniformity and Safety

Larry Schwankl, PhD, PE

Irrigation Specialist, UC Cooperative Extension
559-646-6569  ljschwankl@ucanr.edu

Presentation will be available at:  http://ucanr.edu/schwankl
Drip Chemigation - General Comments

Do not over-irrigate when injecting.

- Over-irrigation may leach water soluble chemicals (e.g. nitrates) out of the root zone.
  - Once leached, it is no longer available to the plant and it may contaminate the groundwater.
Drip Chemigation - General Comments

- The injection point for chemicals should be downstream of the irrigation system filters.
- This keeps chemical from going out with the backwash water when the filters are cleaned.
- There should be a good screen filter on the line from the injector to the irrigation system.
Injection Systems

Solutionizer Machines

- Originally designed for injecting gypsum, but now used for fertilizer (e.g. potassium sulfate) injections.
- Material is injected as a slurry. It goes into solution after it enters the irrigation system’s pipeline.
- Injection point should be upstream of irrigation system filters.
- There are contaminants in the gypsum and solid fertilizers which must be filtered out.
Chemigation Uniformity in Drip Irrigation Systems
Uniform Chemigation

We want to have the material injected into the drip system to be applied as evenly (uniformly) as the water applied by the drip irrigation system.
Uniform Chemigation

First, it is important to remember that once you start injecting, the injected material does not immediately start coming out of all the drip emitters.

- It takes time for the injected material (and the water) to travel through the drip irrigation system.
0:00 25

6”  1’-0”  1’-6”  2’-0”
Uniform Chemigation

What happens when we stop the injection?
Uniform Chemigation

■ It takes at least as long for most of the chemical to clear from the drip lateral as it took it to initially move through the lateral.

■ To takes a long time for all the chemical to clear out of the drip lateral.
0:10 57

7'6"  8'0"  8'6"  9'0"  9'0"
Uniform Chemigation

What if you don’t have the post-injection period of clean water irrigation?
Field Study:

Chemigation uniformity in a drip lateral (500 ft. long with 1 gallon per hour drip emitters installed at 5 ft. intervals) for various injection time periods and various post-injection clean water irrigations. The water / chemical travel time to reach the end of the drip lateral was 25 minutes.

<table>
<thead>
<tr>
<th>Injection Time (min)</th>
<th>Post-Injection Irrigation Time (min)</th>
<th>Relative Uniformity</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>50</td>
<td>100</td>
</tr>
<tr>
<td>50</td>
<td>0</td>
<td>25</td>
</tr>
<tr>
<td>25</td>
<td>25</td>
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<td>25</td>
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<td>11</td>
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<td>13</td>
<td>25</td>
<td>81</td>
</tr>
<tr>
<td>13</td>
<td>0</td>
<td>7</td>
</tr>
</tbody>
</table>
Uniform Chemigation

We also need to account for the time it takes for the injected chemical to move through the underground pipelines.

How do we do this?
The easiest way to determine travel times of chemicals (and water) through a drip system:

- Inject chlorine (at about 10 - 20 ppm) into the drip system and follow its movement through the drip system.
- It is easy to spot when chlorine reaches any point by testing the water with a pool/spa test kit.
Field Study:

Water / chemical travel times through the pipelines and drip lateral lines for the vineyard and orchard field sites evaluated.

<table>
<thead>
<tr>
<th>Site</th>
<th>Mainline and Submain</th>
<th>Lateral Line</th>
<th>Total Travel</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Travel Time (min.)</td>
<td>Length (ft)</td>
<td>Travel Time (min.)</td>
</tr>
<tr>
<td>1</td>
<td>22</td>
<td>1000</td>
<td>10</td>
</tr>
<tr>
<td>2</td>
<td>30</td>
<td>1500</td>
<td>10</td>
</tr>
<tr>
<td>3</td>
<td>65</td>
<td>5000</td>
<td>10</td>
</tr>
<tr>
<td>4</td>
<td>15</td>
<td>1400</td>
<td>30</td>
</tr>
<tr>
<td>5</td>
<td>8</td>
<td>700</td>
<td>25</td>
</tr>
<tr>
<td>6</td>
<td>17</td>
<td>800</td>
<td>28</td>
</tr>
</tbody>
</table>
Uniform Chemigation

To get uniform chemigation, you need to have the injection period be long enough to move the chemical through the entire drip system.

and

You need to have a post-injection period of clean irrigation water.
Uniform Chemigation

So what should be our best management practice to get a very uniform injection?
Uniform Chemigation

1. The injection period should be at least as long as it takes water / chemical to move from the head to tail-end of the drip system. Twice as long is better.
Uniform Chemigation

2. The post-injection, clean water irrigation period should be at least as long as it takes water / chemical to move from the head to tail-end of the drip system. Twice as long is definitely better.

- It takes a long time to completely remove all the injected chemical from the drip system.
DO NOT inject quickly and then shut down the irrigation system.

- This gives you the worst application uniformity.
- Always run clean water after you inject.
Chemigation Uniformity in Drip Irrigation Systems

If You Don’t Want To or Can’t Measure It:

- **Trees & vines** - injections should last at least 1 hour, and at least 1 hour (longer is better) of clean water irrigation should follow it.

- **Row crop drip** - injections should be at least 2 hours in length, and there should be at least 2 hours (longer is better) of clean water irrigation following injection.
Questions?

Larry Schwankl
559-646-6569
e-mail: ljschwankl@ucanr.edu

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Chemigation Safety

Larry Schwankl
UC Cooperative Extension

ljschwankl@ucanr.edu  559-646-6569
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Chemigation of labeled chemicals

The label specifies the “Required System Safety Devices” in the “USE IN CHEMIGATION SYSTEMS” section.

EPA, CA Dept. of Pesticide Regulation (DPR), and the County Ag Commissioners are all involved in setting and enforcing chemigation standards.

Irrigation Districts and other water suppliers are also involved.
Positive Displacement Pump Injection System

- Chemical supply tank
- Irrigation controller
- Electrically interlocked control panel
- Electric motor and pump
- Positive displacement pump injector interlocked with irrigation pump
- Solenoid valve (normally closed)
- Filter
- Check valve
- Single check valve with vacuum relief and low pressure drain
- Shutoff valve
- Pressure switch
- To irrigation system
Chemigation Safety - Required Safety Devices

1. “A functional check valve, vacuum relief valve, and a low pressure drain”.

Purpose: No water movement back to the water source
Positive Displacement Pump Injection System

Irrigation controller

Electrically interlocked control panel

Positive displacement pump injector interlocked with irrigation pump

Solenoid valve (normally closed)

Filter

Check valve

Electric motor and pump

Single check valve with vacuum relief and low pressure drain

Shutoff valve

Pressure switch

To irrigation system

Chemical supply tank
Single Check Valve
Chemigation Safety - Required Safety Devices

1. “A functional check valve, vacuum relief valve, and a low pressure drain”. (No water movement back to the water source).

2. “Automatic, quick-closing check valve to prevent backflow toward the injection pump”.

Purpose: prevent overflow of the storage tank
Positive Displacement Pump Injection System

Irrigation controller

Electrically interlocked control panel

Positive displacement pump injector interlocked with irrigation pump

Solenoid valve (normally closed)

Filter

Check valve

Electric motor and pump

Single check valve with vacuum relief and low pressure drain

Shutoff valve

Pressure switch

To irrigation system

Chemical supply tank
Chemigation Safety - Required Safety Devices

1. “A functional check valve, vacuum relief valve, and a low pressure drain”. (No water movement back to the water source)

2. “Automatic, quick-closing check valve to prevent backflow toward the injection pump”. (Do not want to overflow the storage tank)

3. “Normally-closed solenoid valve on intake side of injection pump, interlocked to pump”.

Purpose: Prevent flow of chemical to the injector if the pump is shut down.
Positive Displacement Pump Injection System

- Irrigation controller
- Electrically interlocked control panel
- Electric motor and pump
- Positive displacement pump injector interlocked with irrigation pump
- Filter
- Solenoid valve (normally closed)
- Check valve
- Single check valve with vacuum relief and low pressure drain
- Shutoff valve
- Pressure switch
- Chemical supply tank
- To irrigation system
Chemigation Safety - Required Safety Devices

1. “A functional check valve, vacuum relief valve, and a low pressure drain”. (No water movement back to the water source)

2. “Automatic, quick-closing check valve to prevent backflow toward the injection pump”. (Do not want to overflow the storage tank)

3. “Normally-closed solenoid valve on intake side of injection pump, interlocked to pump”. (No flow of chemical to injector if the pump is shut down)

4. “The injection pump is interlocked to the irrigation pump”.

Purpose: No injection will occur without water running.
Chemigation Safety - Required Safety Devices

1. “A functional check valve, vacuum relief valve, and a low pressure drain”. (No water movement back to the water source)
2. “Automatic, quick-closing check valve to prevent backflow toward the injection pump”. (Do not want to overflow the storage tank)
3. “Normally-closed solenoid valve on intake side of injection pump, interlocked to pump”. (No flow of chemical to injector if the pump is shut down)
4. “The injection pump is interlocked to the irrigation pump”. (No injection will occur without water running)
5. “Pressure switch in the irrigation line which will stop the irrigation pump”.

Purpose: Stops irrigation and injection if there is a break in the irrigation line.
Positive Displacement Pump
Injection System

Irrigation controller

Electrically interlocked control panel

Positive displacement pump injector interlocked with irrigation pump

Solenoid valve (normally closed)

Filter

Check valve

Electric motor and pump

Single check valve with vacuum relief and low pressure drain

Shutoff valve

Pressure switch

To irrigation system

Chemical supply tank
Chemigation Safety - Required Safety Devices

1. “A functional check valve, vacuum relief valve, and a low pressure drain”. (No water movement back to the water source)
2. “Automatic, quick-closing check valve to prevent backflow toward the injection pump”. (Do not want to overflow the storage tank)
3. “Normally-closed solenoid valve on intake side of injection pump, interlocked to pump”. (No flow of chemical to injector if the pump is shut down)
4. “The injection pump is interlocked to the irrigation pump”. (No injection will occur without water running)
5. “Pressure switch in the irrigation line which will stop the irrigation pump”. (Stops irrigation and injection if there is a break in the irrigation line)

6. “Use a metering pump (positive displacement pump for injection. Positive displacement pumps include piston/cylinder pumps and diaphragm pumps”.
Positive Displacement Pump Injection System

- Irrigation controller
- Electrically interlocked control panel
- Positive displacement pump injector interlocked with irrigation pump
- Filter
- Solenoid valve (normally closed)
- Check valve
- Electric motor and pump
- Single check valve with vacuum relief and low pressure drain
- Shutoff valve
- Pressure switch
- To irrigation system

Chemical supply tank
Positive Displacement Pumps

Piston / Cylinder

Diaphragm
Chemigation Safety

- Some regulations require a double check valve system to provide safety redundancy.
Chemigation Safety

Some locales even require a *Pressure Reducing Backflow Prevention Valve*. These are the backflow prevention valves used on urban water systems and they are extremely expensive.
Chemigation Safety

There are also approved alternatives to the label’s list of Required System Safety Devices. They include:
Chemigation Safety

Alternative devices:

Replacing the positive displacement injection pump with “a bypass venturi injector”. The same requirements for valves on the intake line to the venturi injector hold for both the inline venturi injector system and for the bypass venturi injector system.
Chemigation Safety

There are also approved alternatives to the label’s list of Required System Safety Devices.

Go to http://ucanr.edu/schwankl for drawings of acceptable alternative configurations.
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