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CLEAN WATER

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Chemigation Safety Measurers

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Chemigation is the process of applying an agricultural chemical (fertilizer or pesticide) to the soil or plant surface with an irrigation system by injecting the chemical into the irrigation water. Depending on the type of agricultural chemical being applied, chemigation may be referred to as fertigation, herbigation, insectigation, fungigation, etc.

Chemigation, like other chemical application methods, has its advantages, limitations and risks that a farm manager must consider in deciding which method of application is the best choice. The greatest risk of chemigation is the potential for accidental backflow of all or part of the chemical into the irrigation water source if the system is not properly set up, operated and maintained.

Chemigation can be an effective and safe way of applying certain agricultural chemicals to some irrigated crops if the proper irrigation system and antipollution safety devices to protect the water source are utilized. Application of a portion of a crop's nitrogen requirement with irrigation water is a recognized best management practice to reduce nitrate leaching losses by both University of Minnesota and Minnesota Department of Agriculture crop specialists for high nitrogen use crops grown on coarse textured soils.

The 1987 Minnesota Legislature mandated that chemigation regulations and a permit program be developed for pesticide application and expanded the law in 1989 to include fertilizers. Both laws granted administration responsibilities to the Minnesota Department of Agriculture (MDA), Agronomy Services. The MDA initiated the pesticide chemigation regulations in January 1989 and adopted regulations in fall of 1992 for fertilizer chemigation. The Minnesota Department of Health (MDH) also has rules associated with chemical storage tanks, chemigation systems and water wells (irrigation, potable & public water systems) that are referenced in the MDA regulations.

This publication does not discuss the protection requirements for chemigation systems connected to a potable well or public water supply system.

The purpose of this publication is to describe the general chemigation safety measures and management practices. These practices minimize the potential risk of accidentally allowing any injected chemical to flow back into the irrigation well, surface water source or to discharge onto the land where not intended, possibly creating a public health problem.

Specific details on the safety devices and measures should be obtained from the MDA before installing any chemigation equipment.

Major pollution risks

Chemigation has three main ways of potentially polluting irrigation water sources if safety devices are not functioning correctly. These three are:

(1) The chemical in the supply tank and in the irrigation pipeline could flow or be siphoned back into the water source when the irrigation system shuts down (Figures 1 & 4).
(2) The chemigation system could continue to inject chemical into the irrigation pipe line when the irrigation system shuts down causing the chemical solution to flow back into the water source or spill onto ground (Figure 2).
(3) The chemigation system could shut down while the irrigation system continues to operate and force water back into the chemical supply tank causing it to overflow and spill onto the ground (Figure 3).

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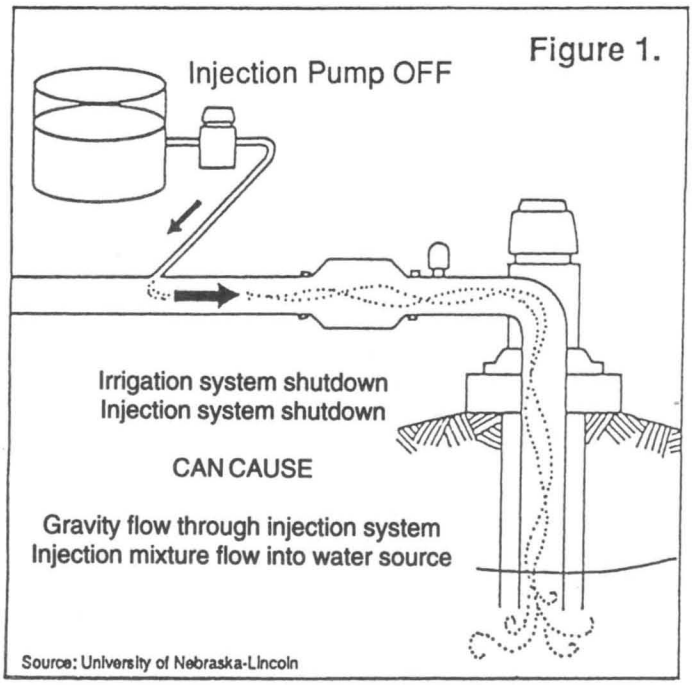

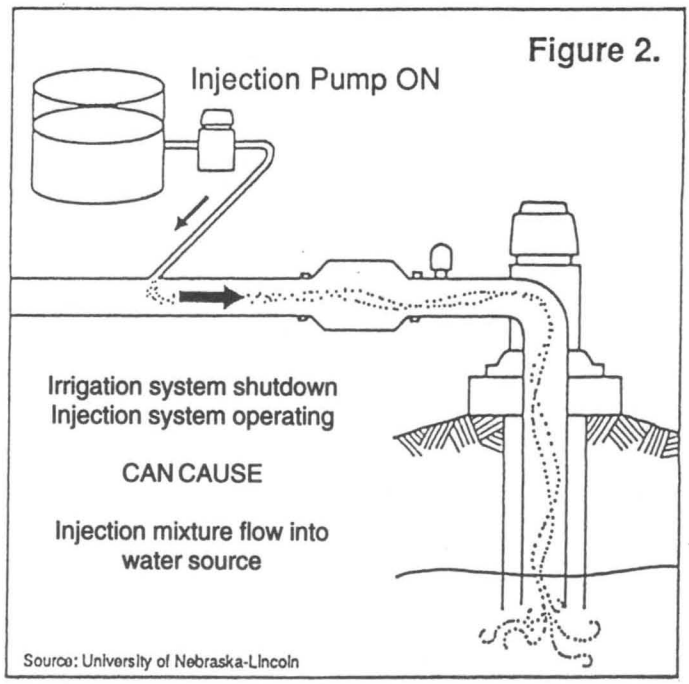

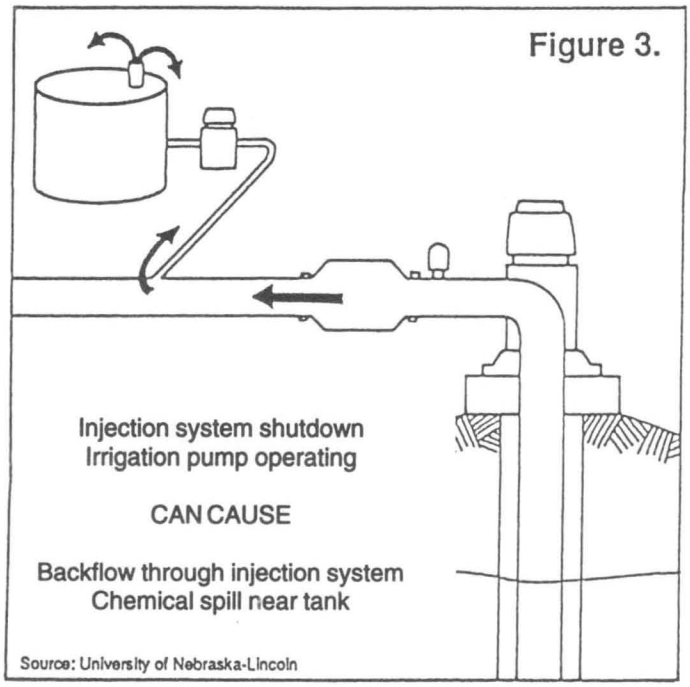

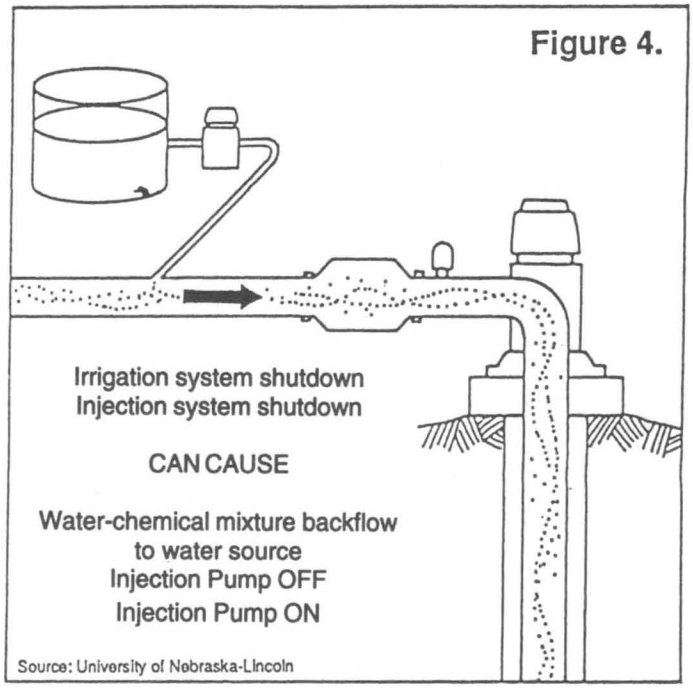

The chemigation operator and farm manager/owner are responsible for seeing that these pollution risks and others are minimized through the use of proper safety devices and management measures.

Safety measures required by chemigation law

The Minnesota Pesticide and Fertilizer Chemigation Regulations require the owner/operator of any irrigation system intending to practice chemigation to obtain a chemigation system user permit, install several safety (antipollution and safeguard) devices, comply with MDH's well separation distance rules and implement several management measures.

A chemigation user permit application form and details on safety equipment requirements are available from the Minnesota Department of Agriculture, Agronomy Services office at 90 West Plato Boulevard, St. Paul 55107 (612/297-2614). The MDA staff will inspect chemigation systems both on a routine and complaint basis.

Figures 5 and 6 show typical arrangements of the basic safety devices. Some requirements will vary

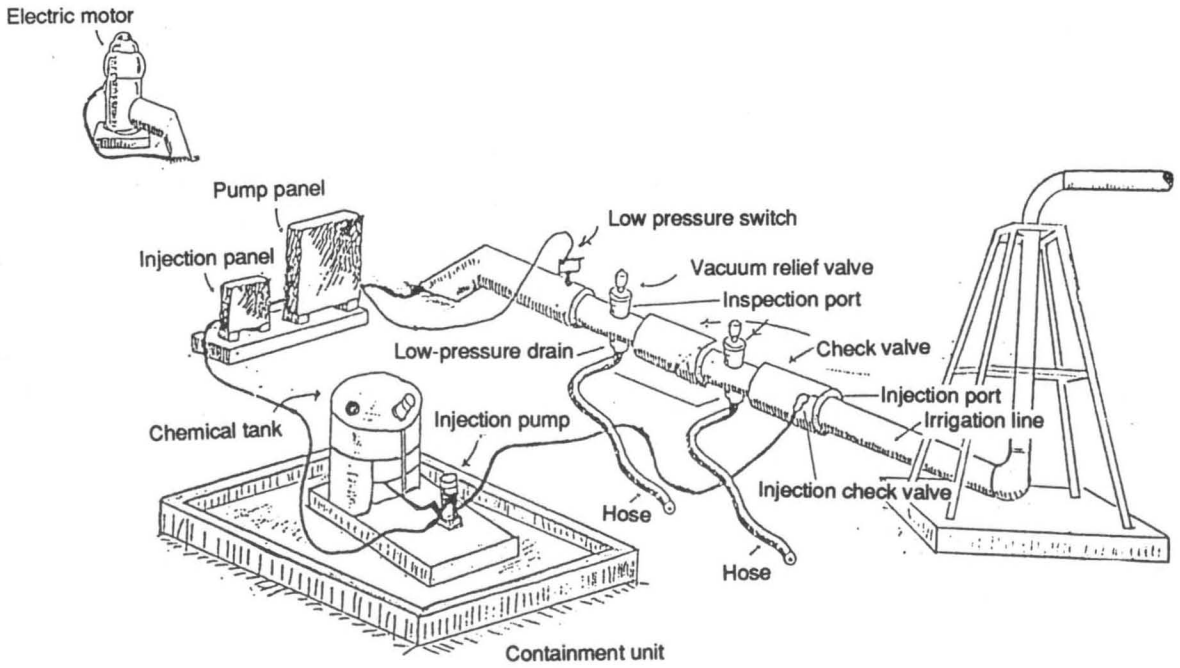

Figure 5. Chemigation safety equipment arrangement when applying a pesticide with an irrigation system connected to an irrigation well. (Diagram adapted from South Dakota Cooperative Extension Service Fact Sheet 860).

depending on type of chemical (pesticide or fertilizer) and location of the water source. Alternative safety devices can only be used if approved in advance by MDA staff. Actual language for the MDA chemigation regulations can be found in Minnesota Rules, parts 1505.2100 - 1505.2800. MDH regulations related to well separation distances from potential contamination sources are listed in Minnesota Rules, part 4725.4450.

The basic safety devices and measures (as outlined in the MDA chemigation regulations) to protect the irrigation water source from any of the above pollution risks are as follows:

1. Irrigation Main Pipeline Check Valve. While injecting a pesticide, an MDA approved reduced pressure zone (RPZ) backflow preventer or two check valves in series must be provided in the main irrigation water supply pipeline of any system directly connected to an irrigation water well or a surface water source. If you intend to only inject fertilizer, a single MDA approved check valve may be used in the main pipeline.

The check valve(s) or RPZ assembly must be located between the point of chemical injection and the irrigation water supply pump. Their main purpose is to keep the water and chemical mixture from flowing back or being siphoned back into the water source. Check valves should be installed with fittings that allow for easy removal for maintenance or repair. A check valve(s) assembly may be installed as a portable unit and moved to other permitted irrigation systems.

Each check valve assembly must contain an air vacuum relief valve and automatic low pressure release drain on the water supply side of the check valve flapper. The check valve assembly must also have an inspection port which can be easily opened to inspect the check valve flapper and the low pressure drain when the irrigation system is shut down.

The vacuum relief valve allows air to enter the pipeline when the water stops flowing. This prevents the creation of a vacuum that could cause siphoning of the water and chemical mixture down-stream of the check valve back into the water supply.

The low pressure drain must be located on the bottom of the pipeline on the supply side of the check valve and have a fully functioning drain opening of at least a 3/4 inch diameter. It must open automatically whenever the irrigation water flow stops. This provides a secondary safety backup to preventing any chemical and water mixture from entering the water source if the check valve should leak. The drain outlet must be positioned or the drainage directed to flow away from the well or surface water source during shut-down. A hose, pipe or open conduit can be used to direct the drain discharge.

Approved check valve assemblies must meet MDA design and operating standards and be certified by an independent testing laboratory. **A list of currently approved check valve models can be obtained from the MDA.** Check valve assemblies will be quick closing by spring action, provide a water tight seal, constructed of material resistant to corrosion or protected to resist corrosion, and easy to maintain and repair.

2. Power Interlock. The chemigation injection system must be interlocked with the irrigation system's power or water supply so it will shut down anytime the irrigation system or pumping plant stops operating or the water flow is disrupted. In all cases this measure must prevent injecting chemical from the supply tank into the main irrigation pipeline after the water supply stops flowing.

If electric motors are used for both the irrigation and chemigation systems, the control panels for the two systems must be interlocked. This interlock must be set up so the injection pump motor stops whenever the irrigation system or pump stops.

Irrigation pumps driven by an internal combustion engine can be interlocked with an injection pump by being belted to the drive shaft or an accessory pulley on the engine. If the injection pump is electrically powered it should be connected to the engine's generator or electrical control system.

Some chemigation systems use flowing water or water pressure to power the injection meter or pump. In most cases these systems will stop injecting a chemical when the irrigation water supply stops flowing.

If chemical flow from the supply tank could possibly continue after shutdown, a normally closed solenoid valve should be provided in the chemical injection line, preferably on the suction side of the injection meter. The solenoid valve must be interlocked and powered by the irrigation system control panel, water supply pressure or the injector power supply.

3. Chemical Injection Line Check Valve. The chemical injector's discharge line/hose must contain a positive closing check valve which will not allow flow either way when the injection system is not operating. The check valve must be located between the injection meter and the point of the chemical injection into the irrigation pipeline.

This valve should 1) stop flow of water from the irrigation system into the chemical supply tank if the injection system stops and 2) prevent gravity flow from the chemical tank into the irrigation pipeline following an unexpected shutdown. To provide two way protection the valve should have a watertight sealing check valve with a minimum opening (cracking) pressure of 10 pounds per square inch. It should also be constructed of an agricultural chemical corrosive resistant material.

If irrigation water is allowed to flow back into the chemical supply tank it could overflow the tank causing chemical to spill onto the ground. If chemical in the supply tank is allowed to flow into the irrigation pipeline by gravity or be siphoned when the irrigation system was not operating, it could create a potential danger to the crop or leak onto the ground. Then it could get into a surface or ground water source.

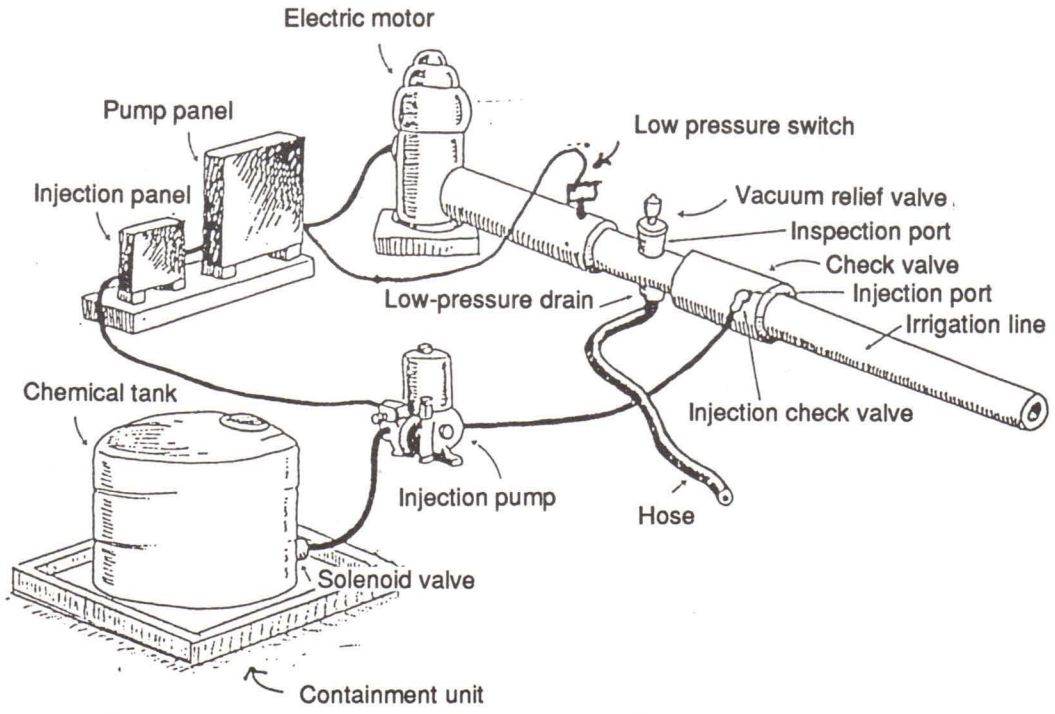

Figure 6. Chemigation safety equipment arrangement when applying a fertilizer with an irrigation system connected to an irrigation well. (Diagram adapted from South Dakota Cooperative Extension Service fact sheet 860).

4. Low Pressure Shut Down Switch. The irrigation system must contain a low pressure shut-down switch or device with similar operating characteristics on the main pipeline that will shut down the irrigation system and the chemigation system if the operating pressure drops to an unsatisfactory level for proper agricultural chemical distribution.

5. Chemical Supply Tank. The chemigation supply tank must not be located closer to an irrigation well than the distance specified in the MDH rules, chapter 4725. And, it must be safeguarded according to the MDA specifications described in the following discussion. The separation distance from a surface water source must likewise be no less than that specified for an irrigation well unless other state/federal regulations are more applicable.

- The chemigation supply tank must be housed in a secondary containment (dike) unit if the tank storage meets at least two of the following conditions: a) the supply tank has a rated capacity of more than 1500 gallons, b) the tank is located within 100 feet of a water supply, and c) the supply tank storage is located at the site for more than 30 consecutive days.

- The minimum required capacity for a secondary containment unit is 125 percent of the tank capacity (110% if under a roof). Its walls and base may be made of ferrous metal, reinforced concrete, solid reinforced masonry, synthetic lined earth or prefabricated metal or synthetic materials. Synthetic liners must have a minimum thickness of 30 mils.

- The unit must be leakproof and built to withstand the hydrostatic pressure from the release of a full tank. The walls or base must not contain a drain. Design specifications for some types of units are described in MidWest Plan Service Bulletin 37, *"Designing Facilities for Pesticide and Fertilizer Containment."* This bulletin is available at county extension offices.

The chemical supply tank must be constructed from materials such as fiberglass, polyethylene or stainless steel that are resistant to the chemical being stored and resistant to degradation by sunlight. If not contained in a secondary unit, the tank should be located and landscaped so if a leak develops it will direct any leakage away from entering the water source. The tank should also be protected from damage from farm machinery and livestock.

6. Posting of Field All sites being treated with a pesticide through the irrigation system must be posted with signs during the complete chemigation treatment.

Signs must contain the signal word from the pesticide label, name of the pesticide, date of treatment and reentry date as described by the pesticide label. Example of a sign can be obtained from the MDA.

Signs must be posted at usual points of entry and at property corners immediately adjacent to public transportation routes or other public or private property. Signs must be placed no greater than 100 feet apart for a field that is located adjacent to a public area such as a park, school or residential area. If more restrictive instructions for posting are described on the label, those restrictions must be completely followed.

Additional protection measurers

In addition to the safety equipment and measures previously described, several other devices and management measures can improve chemigation operation and safety to the environment. These include:

1. Hoses, Clamps and Fittings. All components in contact with the chemical mixtures should be constructed of materials that are chemically resistant and resistant to sunlight degradation. The pressure rating of all components should be adequate to withstand all operating pressures. Hoses and fittings should be protected from mechanical damage.

2. Injection Line Strainer. Install a strainer on the chemical suction line/hose to remove foreign materials that could plug or damage the injection meter/pump or chemical injection line check valve.

3. Injection Port Location. When possible, locate the port for chemical injection higher than the chemical supply tank but lower than the lowest sprinkler outlet to prevent siphoning from the tank. In all cases the injection port must be located downstream from the main pipeline check valve.

4. Injection Line Flow Sensor. An injection line flow sensor installed just upstream from the chemical injection line check valve and interlocked with the injection device can be used to shut down the injection system if flow in the injection line ceases. This safety measure would prevent continuous operation after a line/hose ruptures or disconnects, injection device loses prime or fails, supply tank is emptied or injection port becomes plugged. The flow sensor could also be interlocked with the irrigation system to shut down the whole system if injection line flow stops.

5. Two-way Interlock: A two-way interlock between the irrigation system and the injection system can stop either system if the other system also stops. This interlock will eliminate untreated areas in the field by stopping the irrigation pump and sprinkler system if the injection system stops or malfunctions. The interlock can be done electrically or with the use of a flow sensor on the discharge side of the chemical injection device. When there is no flow in the injection line, the irrigation system and pumping plants will shut down.

6. Solenoid Valve. For added safety, a normally closed solenoid valve could be installed on the suction side of the injection device to provide a positive shut down on the injection line when not in use. The solenoid valve must be interlocked with the injection device power supply to open or close properly.

7. Bleed Valve. A bleed valve, located upstream and next to the injection line check valve can be used to relieve "locked-in" pressure in the chemical injection line any time the line is to be disconnected. This will prevent the operator from being sprayed with the chemical in the line during line removal.

8. Calibration Equipment. A calibration tube or in-line flow meter installed on a chemigation system can provide an easy way to measure the rate of flow of the chemical being injected into the irrigation system. A calibration tube is typically a clear tube with markings in milliliters or fluid ounces and used with a stop watch to measure the flow rate. The tube should be placed on the suction side of the injection device with the necessary valves and fittings so the injection rate can be checked during a chemigation. An in-line flow meter can be installed in either the suction or discharge side of the injection device. Its markings are typically expressed in flow units of volume per time.

9. Injection Meter/Pump. Locate the injection meter or pump within the chemical supply tank containment unit when available and possible.

10. Portable Chemigation System and Chemical Supply Tank. Install the chemigation injection meter/pump and chemical supply tank onto a portable trailer or truck. Construct a secondary containment unit of appropriate size on the bed of the trailer or truck.

11. Chemigation System Location. When developing a new irrigation system locate the irrigation well at least 150 feet from the chemigation system, chemical supply tank, injection port, power interlock controls, etc.

Management practices

1. Review Operation of Irrigation System. Periodically observe the irrigation system's water distribution pattern and conduct a water distribution test of the spray pattern. Remember that the uniformity of the chemical distribution will be no better than the distribution of the water.

Adjust the irrigation system (such as the end gun) to prevent spray going beyond the boundaries of the target field. Shut the irrigation system down if wind will carry chemical drift off target. The irrigation system should be managed to prevent runoff or deep percolation of the water-chemical mixture.

Do not chemigate in areas containing wetlands and other surface water bodies. **Do not apply any pesticide that is not labelled for use in an irrigation system.** Such applications are illegal and may adversely affect wildlife, non-target plants, and water quality.

2. Inspect Safety and Antipollution Equipment Before Each Use. Inspect all components of the chemigation and irrigation system before each use. Components not working at the time of inspection should be repaired or replaced before chemigating. Routine inspections should minimize the potential for failure of any component during chemigation. A record of inspection dates must be kept for MDA.

Follow the procedures listed below to inspect the irrigation pipeline check valve, low pressure drain, injection line check valve, low pressure switch and the power interlock. RPZ backflow preventers and some other types of check valves will require a different approach to inspection. Contact MDA staff for directions on inspecting if assistance is needed.

- Connect the chemigation system to the irrigation system but leave the chemical injection line/hose disconnected from the injection port check valve.

- Start the irrigation pump and pressurize the irrigation system to its normal operating pressure.

- Observe the injection line check valve to see if any water is leaking back out the inlet side of the check valve. There should be no leakage observed when the irrigation system is operating or shut down.

- Connect the chemical injection hose to the injection check valve and start up the chemigation system. The chemigation system should be operated only with clean water.

- Turn down the main pipeline control valve (reducing the operating pressure) until the low pressure switch shuts down the irrigation system. The pressure switch should be set to cause the irrigation pump and system to shut down when the normal operating pressure has been reduced by 25 to 50 percent. If no flow control valve is present, shut power off to the pump and/or irrigation system.

- Immediately after shut down check to see if any water is flowing from the low pressure drain(s). Some drainage for a short period of time after shut down is normal; then drainage should stop.

- Check to see if the chemigation injection device has stopped operating. This device should stop when the irrigation system and pump shuts down. If the chemigation system has an agitation system this unit does not have to shut down when the injection device stops.

- Open the inspection port at the main pipeline check valve assembly after the low pressure drain has stopped flowing. Inspect for any leakage from the check valve flapper. No leakage should be observed coming from the downstream flapper. Also check for proper functioning of the flapper valve assembly.

3. Filling of Supply Tank/Mixing of Agricultural Chemicals. Direct suppliers to closely monitor the delivery of products to a supply tank. Make sure that they first check the condition of the supply tank and plumbing before filling. Fill the supply tank to no more than 95% of capacity. Monitor the inventory of product contained in the supply tank between chemigations in order to determine if the supply tank is leaking.

Triple-rinse pesticide containers at time of use and add the rinse water into the supply tank. Rinse over the opening of the supply tank to minimize risk of spilling on the ground.

4. Keep Chemigation Site Uncontaminated. To facilitate safe monitoring of the chemigation operation, do not allow the irrigation system to spray water and chemical into the chemigation equipment area. This may mean plugging a couple nozzles on the irrigation system near the chemigation site.

5. Calibration. Accurate calibration of chemical injection device is essential for proper application. Periodically recheck the calibration setting of the injection device. Follow calibration procedures described by the chemical label, chemigation equipment manufacture or Minnesota Extension Service. Minor differences in injection rate over an extended period can cause too high or low a chemical application. This may produce unsatisfactory results or cause potential pollution or crop damage when high applications are made.

6. Empty Chemigation Supply Tank. Left-over pesticide mixtures should be immediately applied to another crop or site listed on the label or removed from the supply tank and stored in an appropriate place and in a marked container for later use. The empty tank should be rinsed out and rinsing water applied to the irrigated crop or another labelled site. More specific information on storage or disposal can be obtained form MDA.

For tanks containing left-over N solution that you're not planning to use in the next week or two, remove the N from the supply tank, or relocate the tank away from the water source, unless safeguarded according to MDA and MDH requirements.

7. Flush Injection Equipment. Flush the chemigation injection device, hoses and check valve with clean water after each use. Flush cleaning water into the irrigation system while it is operating so the cleaning water will be applied to the field. Clean strainer after each chemigation.

8. Flush Irrigation System. After a chemigation event is completed and the chemigation system is cleaned, operate the irrigation pump as long as necessary to flush the irrigation system of chemical. This may take 10 to 15 minutes for most systems.

9. Report Accidental Spills. If an accident occurs (regardless of size), avoid personal contamination, take action to keep potential spill to a minimum, and report the incident to the MDA immediately (1-800-422-0798) for assistance.

References

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