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Nebraska Cooperative Extension EC 89-730-B

Anti-pollution Protection when Applying Chemicals with Irrigation Systems

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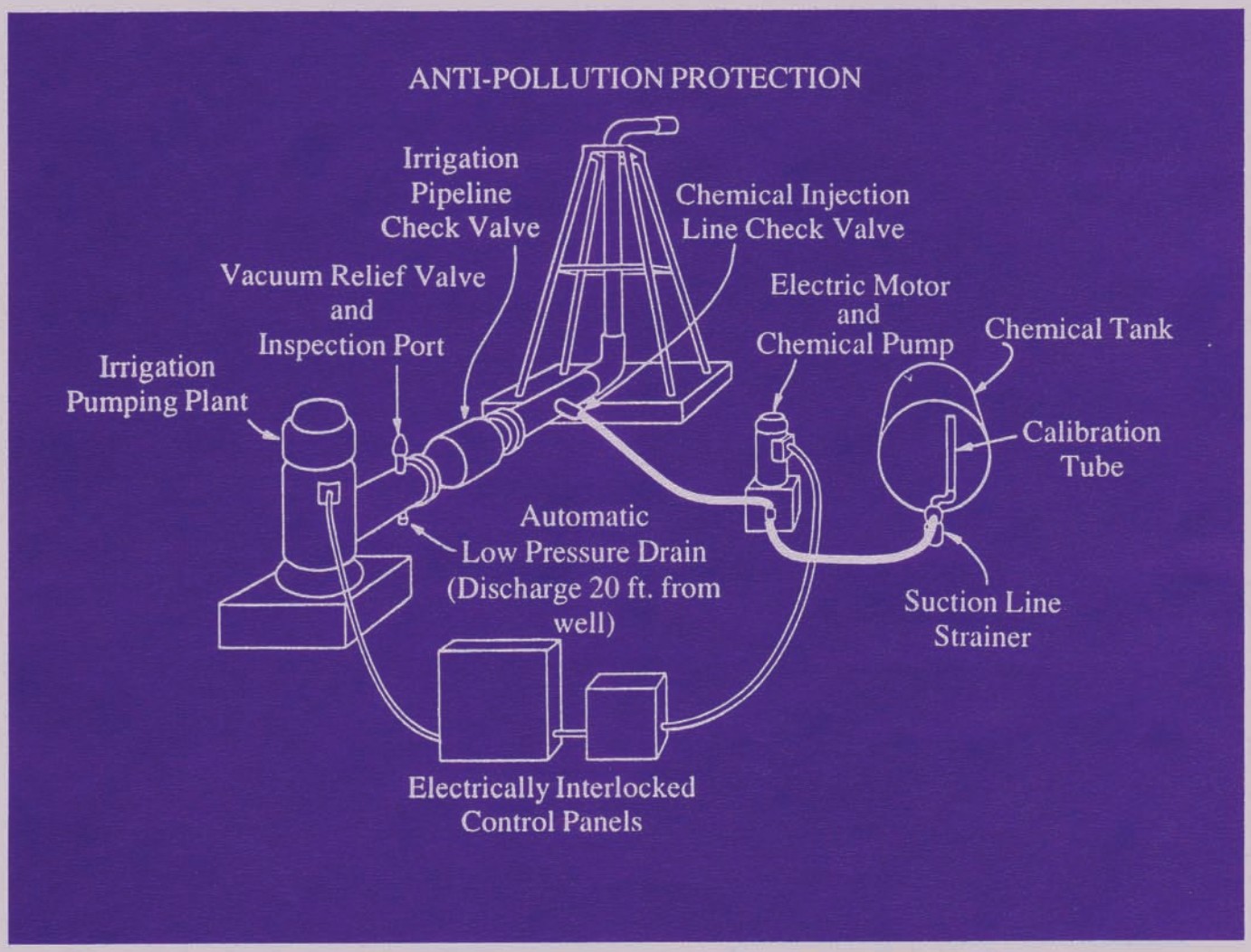

Issued in furtherance of Cooperative Extension work, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture. Kenneth R. Bolen, Director of Cooperative Extension, University of Nebraska, Institute of Agriculture and Natural Resources.

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Many irrigators apply chemicals such as fertilizers, herbicides and insecticides with their irrigation systems. This practice, called chemigation, can be an effective application method if the chemical is suited to this practice and the irrigation system is properly engineered.

One disadvantage of chemigation is potential contamination of the water source if proper anti-pollution devices are not in place. There are at least three pollution possibilities.

First, the injection pump could shut off unexpectedly while the irrigation pump continues to operate, causing water to backflow through the chemical injection system and overflow the chemical supply tank as shown in *Figure 1a*. The spill of the injection mixture could contaminate surface water due to runoff or contaminate ground water by leaching or flow directly down the well's gravel pack.

Second, the irrigation pump could shut off unexpectedly due to mechanical or electrical failure and allow a portion of the water and chemical mixture in the irrigation piping to flow directly into the irrigation water supply as shown in *Figure 1b*.

Last, the chemical concentrate or injection mixture could flow from the supply tank towards the water source following an unexpected shutoff of the irrigation pump. The latter is the most hazardous and can be caused by either gravity flow through the injection system *(Figure 1c)* or continued operation of the injection pump after shut off of the irrigation pump *(Figure 1d)*. In either case the remaining concentrate or injection mixture in the supply tank could flow into the irrigation pipeline and then directly into the water supply.

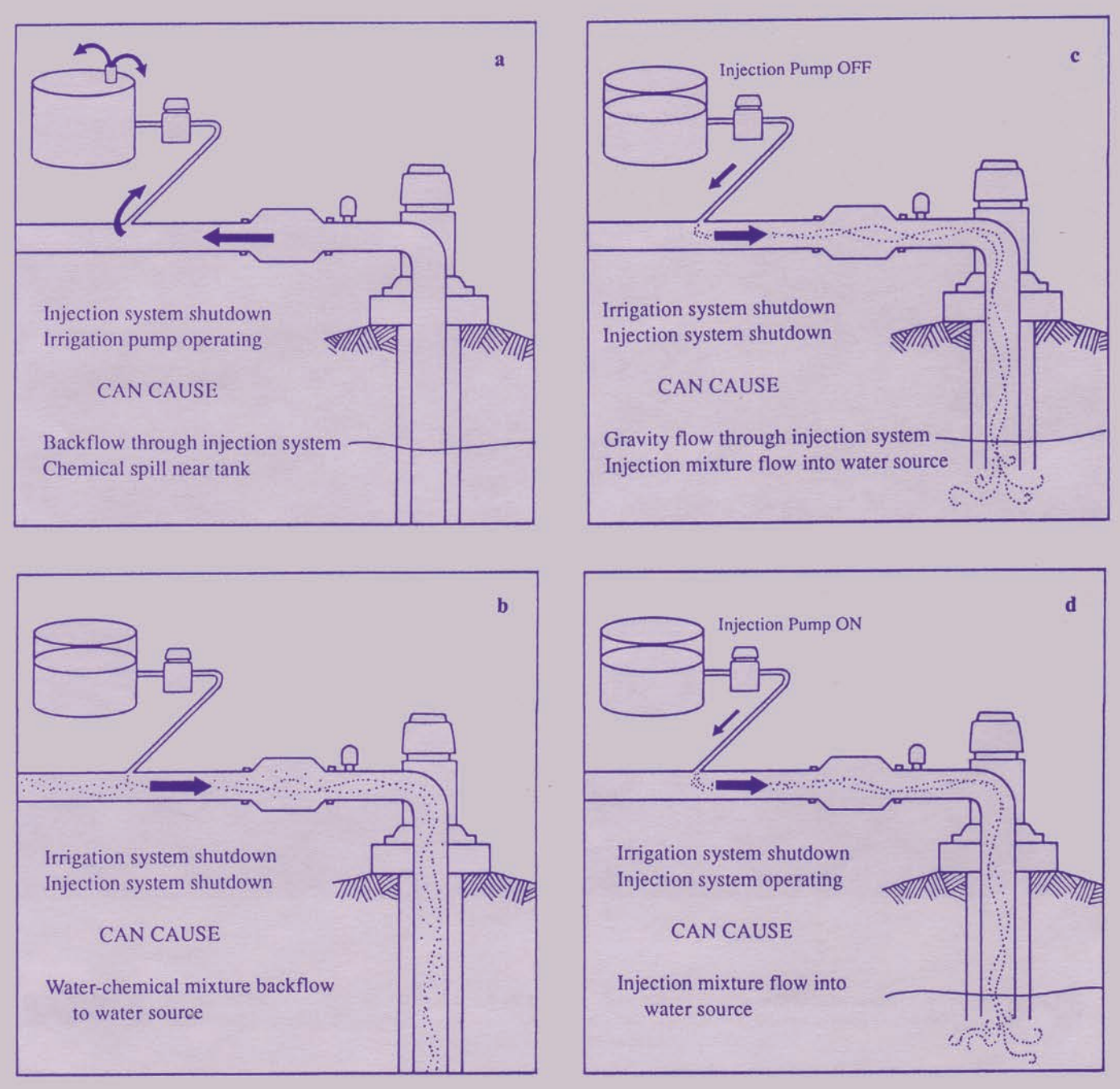

Figure 1-a, b, c, d. Potential sources of contamination due to system failure during chemigation.

Equipment Required by the Nebraska Chemigation Act

Chemigation is regulated in Nebraska. The Department of Environmental Control (DEC) and the Natural Resource Districts (NRDs) conduct inspection and enforcement programs.

This guide describes only the equipment requirements of DEC's regulations. Consult your local NRD for information on other requirements of the Nebraska Chemigation Act, and additional regulations specific to your NRD.

Also, if pesticides are being injected, follow safety equipment requirements specified on the product label. Pesticide labels will require equipment in addition to that required by the Nebraska Chemigation Act and the local NRD.

The pollution hazard to the water source can be minimized by installing and maintaining the proper equipment. The following equipment items are required by the Nebraska Chemigation Act. For the exact wording of the regulations, refer to DEC's Title 195, *"Rules and Regulations Pertaining to Chemigation."*

Interlock. The irrigation pumping plant and the chemical injection pump must be interlocked or connected so that if the irrigation pump stops, the chemical injection pump stops also. This one-way interlock prevents pumping the injection mixture from the supply tank into the irrigation pipeline after the irrigation pump stops. An illustration of this feature is shown in *Figure 2.*

For internal combustion engines the chemical injection pump can be belted to the drive shaft or an accessory pulley of the engine. Other alternatives include operating the injection equipment with the engine's electrical system or using the power source (oil or electric) of the sprinkler system drive which often is powered by the engine itself.

For an electrical motor driven irrigation pump, a separate electric motor usually is used to power the chemical injection pump. The controls for the two electric motors need to be interlocked so the injection pump motor stops when the irrigation pump motor stops.

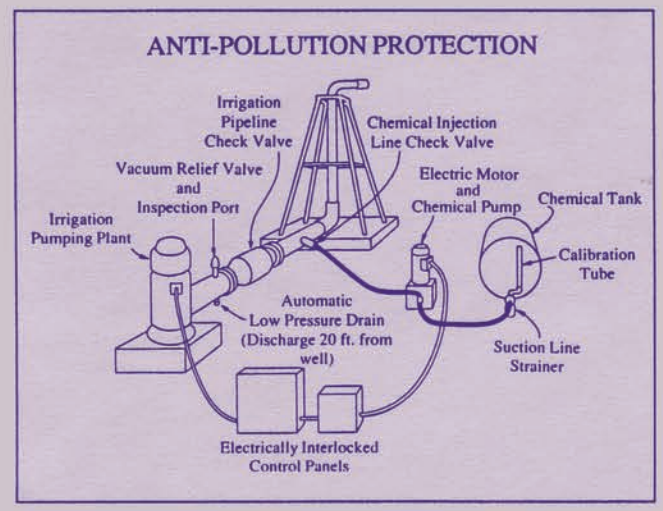

Figure 2. A properly equipped chemigation system includes the equipment and antipollution and safety devices depicted in this diagram.

In all cases, if the irrigation pump stops, the chemical injection pump also must stop.

Irrigation Pipeline Check Valve and Vacuum Relief Valve. Check and vacuum relief valves (sometimes referred to as anti-siphon devices) are needed in the irrigation pipeline. They keep the mixture of water and chemical from draining or siphoning into the water source. Both valves are located between the irrigation pump discharge and the place of chemical injection into the irrigation pipeline, *Figure 2.*

The check valve assembly must be resistant to corrosion, provide a watertight seal, and be easy to repair and maintain. It should be installed with fittings that allow for easy removal for maintenance and repair.

New check valves must meet DEC's certification requirements. Any existing check valve that cannot be repaired to provide a watertight seal must be replaced with a certified model. A list of currently certified valve models is available from your local NRD.

The vacuum relief valve allows air into the pipeline when the water flow stops. This prevents the creation of a vacuum that could lead to siphoning. The vacuum relief valve must be located between the irrigation pump and the irrigation pipeline check valve.

Inspection Port. An inspection port must be located between the pump discharge and the irrigation pipeline check valve. This port allows for a visual inspection to determine if the irrigation pipeline check valve leaks. Inspection should be done prior to each chemigation event.

In many cases the vacuum relief valve connection can serve as the inspection port. To simplify and encourage frequent inspections, the port should be easy to open.

Two specific DEC requirements are: (1) the inspection port shall be situated so the low pressure drain can be observed through the port, and (2) if a new port is installed, it must have a minimum four-inch diameter opening.

Chemical Injection Line Check Valve. A check valve in the chemical injection line is needed for two purposes: 1) to stop flow of water from the irrigation system into the chemical supply tank, and 2) to prevent gravity flow from the chemical supply tank into the irrigation pipeline following an unexpected shutdown.

If this check valve were omitted and the injection pump stopped, irrigation water could flow through the chemical line into the chemical supply tank, overflowing the tank and causing a spill near the irrigation water supply. This check valve must be located between the chemical injection pump and the point of chemical injection into the irrigation pipeline. It should be constructed of chemically resistant materials.

The DEC requires that when the irrigation water is under normal operating pressures and the injection pump is not operating, the chemical injection line check valve must prevent irrigation water from entering the chemical injection line.

DEC also requires that this valve prevent leakage from the chemical supply tank into the irrigation pipeline when both the chemical injection and irrigation pumps are shut off. To accomplish this the valve must have a minimum opening (cracking) pressure of 10 psi.

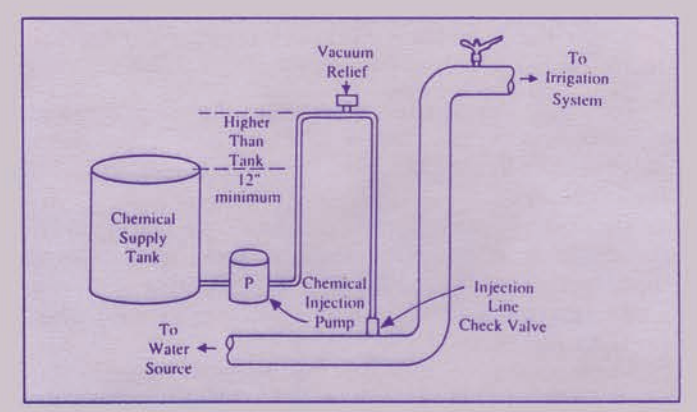

Figure 3. Vacuum relief on chemical injection line to prevent siphoning from tank to water source upon system shutoff.

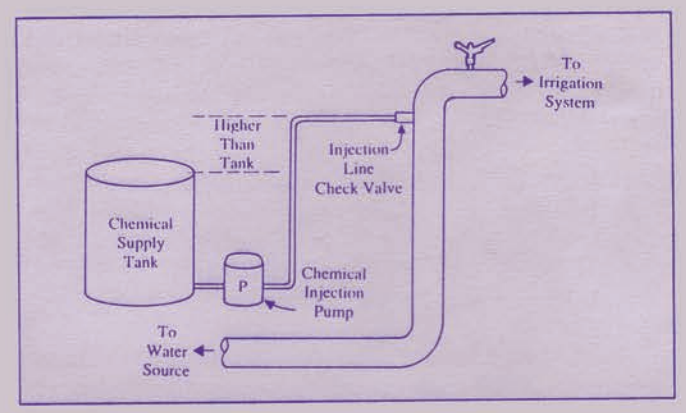

Figure 4. Injection point higher than chemical supply tank to prevent chemical flow towards water source upon system shutoff.

An allowable alternative to the 10 psi opening pressure requirement is to use a vacuum relief valve in the injection line between the injection pump and the chemical injection line check valve. The vacuum relief valve must open at atmospheric pressure, be positioned at an elevation higher than the highest part of the chemical supply tank, and be at the highest point in the injection line *(Figure 3)*. It also should be constructed of chemically resistant materials.

With the vacuum relief alternative, a chemical injection line check valve still is required, but it does not have to have a 10 psi opening pressure.

Low-Pressure Drain. An automatic low-pressure drain must be placed on the bottom side of the irrigation pipeline between the irrigation pump and the irrigation pipeline check valve. In the event the irrigation pipeline check valve leaks slowly, the solution would drain away from, rather than flow into, the water supply.

The drain must discharge at least 20 feet from the water source and the flow must be directed away from the water source. A hose, pipe or other conduit commonly is needed to conduct the drain discharge. The DEC requires that the drain have an opening with at least 3/4-inch diameter.

The drain inlet must not extend into the irrigation pipeline beyond the inside surface of the pipe, unless special provisions are made upstream of the drain that force leakage to flow into the drain inlet.

The low pressure drain is only a backup to the irrigation pipeline check valve. It is not the primary device for preventing water source contamination.

Additional Protection

In addition to the items required by the Nebraska Chemigation Act, there are other equipment items that can improve the safety and effectiveness of chemigation. These include:

Chemical Suction Line Strainer. A strainer is essential on the chemical suction line to prevent foreign materials from clogging or fouling the injection pump, chemical injection line check valve, or injection system safety equipment.

Supply Tank. To prevent direct contamination of the water source due to spills caused by leakage from the chemical supply tank, several precautions are recommended.

First, the tank should be constructed of materials resistant to the chemical being used and resistant to degradation by sunlight. It should be of adequate strength to withstand hydrostatic pressures developed by the contained liquids. The tank should be protected from damage by farm equipment and livestock.

The tank should be located so any leakage from it would flow away from, rather than towards, the water source.

Hoses, Clamps and Fittings. Keep all hoses, clamps and fittings in good repair, and inspect them before each use. All components in contact with the concentrate or injection mixture should be constructed of chemically resistant materials and should be resistant to degradation by sunlight. The pressure rating of all components sould be adequate to withstand all operating pressures. It is a good practice to replace hoses annually.

Injection Location. When physically possible, the point of chemical injection should be higher than the chemical supply tank and lower than the lowest sprinkler *(Figure 4)*. This prevents siphoning from the tank.

Solenoid Valve. For further safety, a normally-closed solenoid valve on the chemical suction line can be electrically interlocked with the engine or motor driving the injection pump. This valve, to be located on the inlet side of the injection pump, provides a positive shut off on the chemical injection line. The chemical cannot flow if the injection pump is stopped.

Since this valve will be subjected to the concentrate, it must be compatible with the chemicals being injected. A solenoid valve may be required by some pesticide labels.

Two-way Interlock. With a two-way interlock, the irrigation pump and injection pump are interlocked so that if either pump stops, the other also stops. A two-way interlock eliminates untreated areas in the field by stopping the irrigation pump and distribution system if the injection pump stops.

Two-way interlock equipment is available commercially for electrically driven irrigation pumps. For internal combustion engines a flow sensor, discussed below, may be needed.

Flow Sensor. An injection line flow sensor, located just upstream from the chemical injection line check valve, assures system shutdown if flow in the injection line ceases. This safeguards against continued operation after:

1. Rupture or disconnection of injection line.
2. Injection pump failure.
3. Loss of prime.
4. The chemical supply tank is emptied.
5. Injection port becomes plugged.

Bleed Valve. A bleed valve, located immediately upstream of the chemical injection line check valve, can be used to relieve "locked-in" pressure in the chemical injection line. The pressure should be relieved any time the injection line is to be disconnected. This prevents the operator from being sprayed with the chemical in the line. The valve is especially helpful while making equipment inspections.

Backflow Prevention Alternative

There are alternatives to the safety measures discussed above. One method of preventing direct contamination of the water supply is to use a two pump system with an air gap between the discharge of the water source pump and the intake of the irrigation distribution pump. In this situation one pump would open discharge the water into a reservoir while the second pump draws water from the reservoir. The chemical then is injected downstream of the second pump, and there is no direct connection between the chemical and the water source.

Management Practices

Flushing Injection Equipment. To prevent the accumulation of precipitates in the injection equipment, flush the injection system and the chemical injection line check valve after use. Flush with clean water or other solvent specified on the chemical label.

Flushing Irrigation System. After injection is completed, operate the irrigation pump long enough to flush the irrigation system of the chemical. For most systems, 10 to 15 minutes of flushing is adequate.

Inspect Equipment Before Each Use. Although chemical injection safety equipment is inspected periodically by the NRDs, injection system operators should inspect the system prior to each use. This minimizes the potential of failure of the safety equipment.

In addition to the supply tanks, hoses, clamps and fittings, four other items should be inspected prior to use. The irrigation pipeline check valve can be inspected by the following procedure:

1. Start the irrigation pump and pressurize the irrigation system to normal operating pressure.
2. Shut off the irrigation pump.
3. Open the inspection port and observe for leakage from the check valve.

The irrigation pipeline check valve should be repaired if leakage is found. **DO NOT** chemigate if the check valve leaks. Remember, the low pressure drain is for backup only.

The low pressure drain also should be inspected. If the drain is functioning properly, some water should discharge from the outlet immediately after start-up. The drain valve eventually should close as the system pressure increases.

Another item to inspect is the chemical injection line check valve. To inspect for backflow prevention, remove the chemical injection line from the inlet side of the injection line check valve and observe whether back leakage occurs when the irrigation system is pressurized.

Also inspect the chemical injection line check valve for leakage in the normal direction of flow. The goal is to prevent gravity flow from the chemical supply tank through the injection pump and chemical injection line check valve. To inspect the valve, remove it from the irrigation system and have it connected to the chemical injection line. Insert the discharge end of the injection line check valve into a bucket and start the injection pump. Pump some concentrate or injection mixture through the system. Now shut off the injection pump and observe whether leakage occurs through the chemical injection line check valve.

Passing the above two tests does not guarantee the chemical injection line check valve will pass a more rigorous NRD inspection test. However, failure of one of the above two tests would almost guarantee failure during an actual unexpected shutdown of the irrigation system.

The interlock system also should be inspected before each use since the switches and other items could fail after weathering and wear.

Chemigate Only with Reliable Irrigation Systems. The direct flow of chemical to the water source can occur only if the irrigation pump is shut off. To minimize the risk of water source contamination, chemigate only with reliable systems. For example, a center pivot system that is prone to shutdowns while it is unattended is a poor system to use for chemigation.

What to do if an accident occurs. The Nebraska Chemigation Act requires that, if an accident occurs, it must be reported within 24 hours to the DEC and the NRD.

Examples of accidents include backflow to the water source upon system shutdown, flow from the chemical tank to the irrigation pipeline upon system shutdown, or chemical leakage near the supply tank.

The NRD and DEC will make recommendations for the chemigator to clean up any contaminated soil or water. Typical actions may include pumping the water supply to remove the contaminant if a backflow event is suspected or, in the case of a spill around the chemical supply tank, excavating the soil in the vicinity of the spill and disposing of it by distribution on a larger land area.

Conclusion

Chemigation can be a relatively safe practice provided proper precautions are taken. The list in *Table I* summarizes the steps necessary to minimize contamination of the water source.

Acknowledgement

Many of the anti-pollution concepts presented in this paper were taken from the NebGuide written by Paul E. Fischbach in 1973, *Anti-Pollution Devices for Applying Chemicals Through Irrigation Systems, G73-43.*

Use all pesticides safely. Read the pesticide product label completely and comply with all directions given. Failure to do so may subject you to sanctions or penalties provided by federal and/or state laws.

Table I. Chemigation Anti-Pollution Protection

A. Nebraska Chemigation Act requirements:

1. Interlock irrigation pumping plant and chemical injection pump
2. Irrigation pipeline check valve
3. Irrigation pipeline vacuum relief valve
4. Irrigation pipeline inspection port
5. Irrigation pipeline low-pressure drain
6. Chemical injection line check valve

B. Additional Protection:

1. Chemical suction line strainer
2. Safe chemical supply tank and injection line hose
3. Inject higher than supply tank when possible
4. Normally-closed solenoid valve on chemical suction line
5. Two-way interlock between irrigation pumping plant and injection pump
6. Flow sensor in chemical injection line
7. Bleed valve in chemical injection line

C. Management Practices:

1. Flush injection system, including the chemical injection line check valve, after use
2. Flush the irrigation system after injection is complete
3. Inspect equipment before each use
4. Chemigate only with reliable irrigation systems — not those prone to shutdown while unattended
5. Report accidents to NRD and DEC

Table II. Metric Equivalents

1 psi (pound per square inch) = 6.895 kPa (kilopascal)

1 foot = 0.348 meters.