CHEMIGATION BENEFITS THROUGH EQUIPMENT CHOICES

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Both growers and regulatory agencies are becoming more and more concerned about the use and misuse of agricultural chemicals and fertilizers. Equipment decisions today are influenced by economic, environmental and safety considerations. With the increased technology and dependability of today's irrigation systems, chemigation is recognized as an application method which effectively addresses all of these concerns. The intent of this paper is to describe the proper (and moreover recommended) equipment that most thoroughly ascribes to the safety, economic, environmental, and efficiency concerns of the application method. Discussion will first focus on different types of irrigation systems and injection systems as well. The paper will then move into the necessary components of a well designed chemigation system and also provide a listing of the specifications of each major component of the injection system. Finally, the selection process and decision making parameters will be examined.

IRRIGATION SYSTEMS

The first component of a successful chemigation endeavor is the irrigation system. Many types of irrigation systems exist. Systems can be generally categorized into sprinkler, surface, and trickle. Sprinkler types include center pivot, lateral move, traveling gun, linear move, wheel move, tow line, and solid set. Trickle systems are primarily drip applications. Surface systems include gated pipe, siphon tube, and open flood.

Researchers have concluded that sprinkler systems are best suited for chemigation practices. With today's chemical formulations and application rates, along with the precise management practices followed by the modern grower, the irrigation system must provide high performance levels to match the user's exact application expectations. Another consideration is the ease with which the chemigation equipment is integrated and connected to the sprinkler systems (in terms of power and plumbing requirements).

Of the irrigation systems, self propelled linear and center pivot systems seem best for chemigation applications. They have advanced control features and their water application/distribution uniformity are most precise. Drip systems have also been used for chemical applications and can apply products in a very precise area (root zone, plant base, etc.). However, the size of orifice in the emitter sometime presents a clogging problem, given

the nature of the additives. In addition, operations which require foliar or broadcast type application are not possible with this form of application.

INJECTION SYSTEMS

There are three prevalent types of injection setups. One is a positive displacement pumping system. This system generally has a piston or diaphragm type metering pump with an adjustable injection rate. These are normally constructed of chemical resistant, non-corrosive materials and should be accurate to within 1% of rate settings. This setup is the primary choice in injecting chemicals into pressurized irrigation systems.

The second system is the venturi system. The venturi injects chemicals by generating a differential pressure across a venturi device creating a vacuum which siphons the chemical into the irrigation system. The primary drawback to a venturi system is the dependence on differential pressure and the common flow/pressure that occur in irrigation systems.

The third system is a simple siphon setup for non-pressure applications. By utilizing a constant head siphoning device and a specifically sized metering orifice, chemical is allowed to drip into the irrigation stream. Low cost and no power supply is another advantage. Disadvantages are orifice clogging and non-pressure system use only.

The most commonly used and recommended chemical feed systems are those using positive displacement metering pumps. Dependability and regularity are the major factors in these pumping devices and they nearly always utilize the same set of key components of a successful injection system.

SYSTEM COMPONENTS

Irrigation System

Obviously, a critical component of the overall chemigation setup is the irrigation system. The efficiency and uniformity of the water distribution is paramount in effective chemical application. Other issues that arise that can affect chemigation performance and need to be considered are wind and weather, soil types, and land topography. There are continual technological advances that are providing equipment to deal with these issues. However, the equipment that is necessary for satisfactory chemigation is:

Backflow prevention device: This item is required in irrigation pipelines in which chemigation is going to occur. The two components in this device are a check valve and a vacuum relief

valve. Both of these valves need to be located between the output of the irrigation water pump and the chemigation injection point. The check valve prevents water from flowing back into the well in the event of a shutdown. This is a positive closure valve with a water tight elastomer seal. The vacuum relief valve allows air into the pipeline when the water flow stops, preventing a siphoning effect. Often times the relief valve doubles as an inspection port for the backflow device.

Specifications:

a. located between water pump and injection pump.
b. positive closure and seal.
c. inspection port and vacuum relief valve.
d. automatic low pressure drain installed at lowest point.

Electric or mechanical interlock: In essence, this is simply an interlock between the chemigation system and the irrigation system, to guarantee that if the irrigation pump should shut down, the injection pumps stops also, thereby preventing pumping chemical into the main water line after the water flow has stopped. This can also be set up in reverse so that when the injection pump stops or malfunctions, the irrigation system and pump stop also.

Specifications:

a. Mechanical: injection pump driven from water pump drive shaft or accessory pulley.
b. Electrical: injection pump powered from water pump electrical system (12V), or hard wired to allow power to injection pump only when water pump is operating.

Injection Pump

Most chemigation experts agree that of the two major categories of positive displacement metering pumps (diaphragm and piston type), the diaphragm type has the most advantages and best performance. While sometimes being more expensive of the two, the pump typically has a small number of moving parts, very few parts exposed to the actual chemical, and allows adjustment of the injection rate while the pump is operating. The injection pump is a major component of the chemigation system and should be selected very mindfully.

Specifications:

a. Self contained
    1. No moving parts exposed (decreases operator exposure to

danger).

2. Chemical resistant diaphragm acts as membrane between chemical and pumping mechanism.

b. 'On the fly adjustment'. Capacity adjustment is allowed during pump operation. Normally from 10% to 100% of rated capacity.

c. Guaranteed pumping accuracy of +1%.

d. Ideal stroke per minute range of 60 to 120. The higher the stroke count, the better distribution of chemical is attained. However, the trade off is increased stress and wear on the pump as well as possible accuracy problems when pumping higher viscous products.

e. Output range in gallons per hour.

f. Corrosion proof, chemical resistant liquid end, including pump head, check valves and check valve components. Material should be checked for compatibility with chemical.

g. Internal pressure bypass to be set for an operating pressure of 200 psi maximum. This will prevent the possibility of rupture of the discharge lines.

Supply Tank

The chemical supply tank should be well designed in terms of strength, accessibility, and materials to meet the demands of the environment and chemicals.

Specifications:

a. Sized to supply the whole period of application.

b. Constructed of non-corrosive materials such as stainless steel, polyethylene, fiberglass, or other compatible substance. Ultra-violet stabilization is another very important consideration in the material.

c. Marked in gallons with +2% accuracy.

d. Built in raised mounting plates for lid.

e. Built in raised mounting plate for mechanical mixer installation to allow a flush, tight attachment of the agitator motor. This keeps out contaminants such as water and insects.

f. Domed top for water shedding.

g. Vented lid for closure and filling.

h. Completely drainable and easy to clean and rinse.

Agitator

Agitation is very often required when dealing with agricultural

chemicals. Wettable powders, dry flowables, flowables, tank mixes, and other formulations which are to be held in suspension are all candidates for a tank agitation system. Three main types of agitation include mechanical, hydraulic, and air. Hydraulic and air (bubblers) may be sufficient for some soluble chemicals, but mechanical agitation is the mixer of choice. Hydraulic mixing generating by recirculating pumps can cause excessive shear on some chemicals causing separation.

Specifications:

a. Mechanical motor driven agitation.
b. Shaft and propeller setup placed at proper angle to achieve complete mixing while minimizing 'dead' areas in the supply tank.

Calibration Tube

A calibration tube assembly should be located in the line between the supply tank and the injection pump. This device will facilitate precise measurement of the injection pump output. Other equipment such as timers, worksheets, tube marking guides, and calibration logs are very helpful in the calibration process.

Specifications:

a. Sized to hold a volume equal to one to five minutes of pumping, yet small enough to have accurate readings in the amounts to be tested.
b. Graduated to show units of volume (ounces, millimeters, etc.)
c. Covered and vented to keep out contaminants.
d. Constructed of transparent, high strength material for visibility and durability. Material should also be ultra-violet stable and chemical resistant.
e. Long enough to extend above the supply tank chemical level to prevent accidental overflow.

Filter Assembly And Other Plumbing

All fittings and accessories and come in contact with chemicals must be resistant to such chemicals. Hoses, seals, gaskets, filters and other components should be constructed of polypropylene, polyethylene, nylon, Teflon, Viton, or stainless steel. A strainer should be in the suction line to prevent clogging of plumbing components or check valves.

Specifications:

a. Durable in nature, with tight connections to endure pulsating stresses from injection pump.

b. Shut off valves must be positive closing.
c. Discharge tubing and fittings rated at 250 psi.
d. External tube connectors can be used instead of common hose barb fittings.
e. Filter mesh between 20 and 50 mesh depending on the chemical.
f. O-Rings should be chemical resistant and correctly sized.
g. All materials should be checked for compatibility and those exposed to sunlight should be ultra-violet stable.

Injection Check Valve

The injection check valve connects the discharge tubing to the irrigation main water line and should provide two very important safety elements to the system. One is the prevention of chemicals siphoning or draining into the water line after an unexpected shutdown. The check valve will also prevent backflow of water through the injection line into the chemigation system should the injection pump stop.

Specifications:

a. Positive closing to prevent water backflow or chemical siphoning.
b. Minimum opening pressure of 10 psi.
c. Able to integrate with air bleed valve to facilitate pump priming and to release trapped pressure when disconnecting hoses.
d. Designed to optimize chemical injection in terms of placement within the pipe and immediate mixing action.
e. Equipped with a chemical resistant elastomer seal closing device to accommodate inconsistencies or embedded particles in the seat, such as water deposits, sand, or chemical residues 0.020" dia. or smaller.

SELECTING EQUIPMENT

Selection of injection equipment should be done with great care and careful consideration of all the related factors. The producer should determine which chemicals will be injected both today and in the future. Today's equipment is designed to last many years, and it is important to consider future possibilities when selecting a machine. Chemical labels and MSDS sheets should be consulted for any specific requirements that may be necessary in terms of equipment.

Tanks should be sized to supply the entire injection event whenever possible. This prevents refilling which decreases human exposure/error and

minimizes chances of letting the tank run dry.

Injection pumps should be sized so that the desired rate falls somewhere in the middle of the rated capacity range of the pump. When two or more non-compatible products need to be pumped simultaneously, or when there is a large discrepancy in injection rates between products, multi-headed pumps are available that have independent pumping heads (with separate capacities and controls) driven by one drive motor.

Availability and support are other important elements in selecting equipment. Product warranty and technical advice, as well as local support are paramount during pressing application times. Choose a reputable supplier with proven products and a stable background.

Finally, the producer must keep in mind local, state, and federal laws and regulations that may influence or dictate one's equipment decision. One should check periodically with the state regulatory agencies that monitor the use of agricultural chemicals, to be certain that current or new equipment is in full compliance.