AUTOMATIC RESTART

Center Pivot Irrigation Systems

by Hal Werner, Extension irrigation specialist

Restarting electrically powered irrigation systems has always been a chore whenever power failures caused system shut down. With many electric suppliers implementing load management programs, having to restart systems has become much more commonplace. You may want to consider a control package that will maximize pumping time by automatically restarting your irrigation system after these shutdowns.

Most electrical irrigation pumps can be restarted automatically after power is restored. Unattended restarting of center pivot systems after a power failure or peaking control is important to increase pumping time and to reduce the hassle of manual restarting.

What is automatic restart?

Automatic restart is the process of returning the center pivot system back to a safe running condition without being present or providing manual intervention. Such intervention could involve repriming (where needed) and restarting the pump, pressurizing the pipeline and system, and returning the safety controls and center pivot to the "run" operation.

Most irrigation pumps will not require repriming as they are turbine pumps in wells. Centrifugal pumps will need controls to insure that the pump is primed before the system is restarted.

ADVANTAGES

A major advantage of automatic restart is that it maximizes pumping time. Operators often may not be able to restart the irrigation system immediately after power is restored, thereby decreasing available pumping time. During periods of high crop water needs, which often occur at the same time as electric peak load management, loss of pumping time could be costly if the crop runs short on water.

Another advantage is the convenience of automatic restart after loss of power. Irrigation systems often are several miles away from home operations, and frequent trips to check on status and then manually restart systems are time consuming and costly. Automatic restart may even add a sufficient convenience for systems close to home base, especially where the investment to add the controls is minimal.

Finally, properly installed automatic restart systems can assure the operator that the equipment is protected from the hazards of either attended or unattended starts. Electrical controls and valves, where needed, can prevent problems with water hammer. Equipment for automatic priming of centrifugal pumps can also simplify manual starting of those units.

Water hammer—a rapid change in pressure caused by sudden changes of water flow in pipelines, such as starting and stopping of pumps—is a consideration when restarting irrigation systems, especially for units that have high pumping lifts and/or long pipelines. Water hammer control can be designed for almost any system, but the potential for problems is minimal and control generally is not needed when the pump arid well are located next to the pivot.

DISADVANTAGES

A disadvantage of automatic restart is that some irrigation systems can be costly to convert when pumps need priming and water hammer is probable. Equipment to restart complex irrigation systems could cost several thousand dollars. Some operators may desire to maintain manual control of the restarting process because of intricacies of the system and concerns about malfunction.

Another disadvantage is that complex irrigation systems require specific design solutions. Improper

installation of an off-the-shelf package of controls may not prevent water hammer and could result in damage to the system.

Automatic restart systems

Automatic restart for a center pivot is designed to return the system to operation as it was prior to loss of electric power. Restart systems can vary from simple, economical packages to complex, expensive control systems.

Where the well and pump are near the center pivot, restart packages generally are easy and economical to retrofit. A common package involves installing two timers—the first to delay the restart cycle so that the pump does not start immediately when power is restored, the second to delay the safety shutdown sequence until water and pressure are restored. Some packages are somewhat different in their control but accomplish the same task.

Several other factors contribute to the need for additional equipment and controls when restarting center pivot systems. These include:

- Type of pump
- Length of pipeline
- Elevation difference from the pump to the pivot
- Pipe pressure rating
- Pivot operating pressure

Elevation difference between the pump and center pivot determines whether the pipeline is likely to be filled when the system is automatically restarted. Pipelines that slope uphill will remain filled after initial filling unless there is a leak in the check valve or line. Pipelines that slope downhill may empty each time the pump is started and require special equipment if automatically restarted.

Water hammer

Water hammer in irrigation pipelines is similar to banging of household pipes except that the result of water hammer is much larger in irrigation lines and can be very damaging. Uncontrolled water hammer can explode pipelines, bust pumps, and blow pivots apart. Many operators will not start their system without manually controlling a valve in an attempt to minimize water hammer.

Water hammer pressure adds to the normal operating pressure of the system without proper precaution, water hammer pressures can exceed 400% of the normal operating pressure of the system and can easily exceed the pressure rating of the pipe. Negative water hammer pressure also is possible and can collapse pipelines.

The length of irrigation pipelines is one indication of the water hammer potential. Short pipelines have less water hammer potential than longer pipelines. Other factors that affect water hammer are pipe size and material, flow rate (GPM), how fast the flow rate (velocity) changes, and whether there is trapped air in the pipeline.

Pipeline water velocity is directly related to flow rate and thus to water hammer. It is recommended that water velocity be less than one foot per second when filling pipelines. Maximum velocity once the line is full should be less than five feet per second.

Irrigation pumps can deliver much more water following startup before pressure develops in the pipeline and pivot, unless flow is restricted. This results in a higher flow rate (and velocity) than under normal operating conditions. The higher the operating pressure of the pivot, the higher the differential in flow rate, and thus the higher the water hammer potential.

Air pockets in a pipeline can cause water hammer when the air compresses and moves along the line. Pipelines that have set idle for even a few minutes will often have air in them due to vacuum relief valves at high points. It is very important to have air release valves where needed along the pipeline to safely discharge air.

Water hammer control can be designed for almost any system. Two general solutions are available: various automatic valves or motor speed controllers.

AUTOMATIC VALVES

Automatic valves are common on many existing systems and are reliable if maintained and adjusted properly. The type of equipment to use is based on each specific application and should be designed and installed by a qualified dealer. Costs can range from a

couple of thousand dollars for single pivot applications to several thousand for more complex systems. There are several common choices:

Two-stage valve—An automatic valve installed in the pipeline that is set to open in two steps. The first step restricts flow during filling or refilling. The second stage normally is full open for unrestricted flow. Switching between stages should be regulated and can be accomplished using a timer or differential pressure sensor. The two-stage valve often is the simplest and cheapest of the automatic valves, but it offers the least flexible control.

Line fill valve—An automatic valve that controls the actual filling rate of the pipeline. Flow is restricted when filling or refilling and then is gradually opened until the system is filled and pressurized.

Surge anticipator valve—A valve that incorporates a sensing device that detects the onset of surges or water hammer. It then opens quickly to discharge water and lessen the effect of the pressure surge. Surge anticipator valves are more common when pumping from surface water and allow for discharging water during surges. Most other options for controlling water hammer reduce flow while the pipeline is filling. Only the surge anticipator valve is designed to detect and discharge surges.

MOTOR SPEED CONTROLLER

Frequency-regulated motor speed controllers allow selection and automation of a wide range of motor speeds By controlling electric motor speed, the output of the pump can be adjusted to regulate filling and refilling of pipelines. Motor/pump speed can be reduced during initial filling, then slowly speeded up to full operating speed. Changes in speed can be accomplished using timers or feedback from pressure/flow sensors. Automatic valves generally are not needed when motor speed control units are used.

Pump priming

CONCERNS

Priming centrifugal pumps is one of the most frustrating and time-consuming tasks when restarting irrigation systems. If a centrifugal pump is used, the automatic restart system must insure that the pump is primed before restarting the system.

It is important that all air is evacuated from the suction line and pump before it is started or restarted. An air tight check valve is needed in the pipeline just downstream from the pump. All fittings and seals must be air tight. Otherwise, priming will be difficult, if not impossible.

SOLUTIONS

An automatic priming system is helpful for initial priming of centrifugal pumps and for whenever they need repriming. And, it is required for automatic restart.

Several automatic priming solutions are available. Commercial packages can be installed but will cost several hundred dollars more than repriming systems using off-the-shelf components.

Two basic types of systems are common: the vacuum priming method and the pump-fill method. The vacuum method can be used with or without foot valves, while the pump fill method can only be used on suction lines with foot valves.

Vacuum method — This requires an air-tight check valve on the pump. The vacuum pump evacuates the air from the suction line and pump and fills them with water. A water sensor on the top of the irrigation pump switches power from the vacuum pump to the irrigation pump.

Pump-fill method— A small submersible or sump pump is used to fill the suction line and pump. An air release valve lets air escape and a pressure or water sensor switches power from the sump pump to the irrigation pump. The check valve on the pump discharge must have sufficient back pressure to activate the sensor.

For more information on automatic priming systems, see Extension Fact Sheet 898.

Equipment solution examples

EXAMPLE #1: Well and turbine pump delivers 800 gpm to a full sized center pivot. The center pivot has been converted to lower pressure (40 psi) and the well is located 30 feet from the pivot point.
The restart system would be an automatic restart

package from a pivot supplier and would include safety timers and controls. No water hammer control is needed because of proximity of pump to pivot and lower operating pressure. Total cost for the package is about $300 to $500.

EXAMPLE #2: A centrifugal pump delivers 1500 gpm from the river to two center pivots which are 4000 feet away and 100 feet higher than the river. Pump pressure is 135 psi to get pivot operating pressure of 60 psi. The pipe is 10-inch Class 160 PVC.

Automatic priming would be needed. Cost for controls, vacuum pump, and installation is about $600 to $1000. Water hammer control is necessary for automatic restart. The cost of the system is about $3000 to $4000 which includes an automatic valve, safety timers, and controls.

Considerations and precautions

Some older center pivot systems may not be suitable for retrofitting for automatic restart. If the center pivot is plagued with problems and shutdowns, automatic restart may only aggravate the situation. A good time to add automatic restart is when components of the system are repaired or replaced. Always make sure that the safety shutdown controls can override the restart controls and that the total control system operates as designed. It is important to have controls that will try to restart the system no more than two or three times before aborting. Otherwise, continuous attempts to restart might damage the system when other safety faults exist.

Closely monitor chemigation used with automatic restart. Avoid automatic restart altogether when chemigating with products that could cause problems if misapplied.

It may not be desirable to use automatic restart with some high-pressure systems or with very high lifts. However, many center pivot systems that have been converted from high to low pressure may have an adequate safety factor to restart without fear of damage from water hammer, especially those without long pipelines. Any systems that presently are started without manual control of valving are good candidates for automatic restart and automatic valves may not be needed.

Irrigation systems with complex combinations of pumps, piping, and/or center pivots pose unique problems for automatic restart and should be designed by a qualified dealer. Systems that have downhill sloping pipelines may need more than one automatic valve to adequately protect against water hammer problems.

Recommendations

Center pivot systems that are near the pump and well should be considered for automatic restart. Water hammer control is seldom needed. The delayed timer control for restarting is routinely used and is economical.

Be sure the irrigation pump is not started immediately after power is restored, otherwise momentary loss of power could damage equipment. Once the center pivot is pressurized, the restart system must activate the safety controls and return the pivot to the run mode.

Where excessive water hammer is possible, use automatic valves or motor speed controls to minimize the pressure surges. Water hammer control is site-specific and should be designed and installed by a qualified dealer.

An automatic priming system is desirable for most electrically powered centrifugal pumps, even if automatic restart is not used. Automatic priming of centrifugal pumps is required when automatic restart is used.

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