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AUTOMATIC PRIMING of Centrifugal Irrigation Pumps

by Hal Werner, Extension irrigation specialist

Automatic restart of irrigation systems increases pumping time and reduces the inconvenience of manual restarting when pumps are shut down by power outages or load management. An automatic priming system is required for automatic restart with centrifugal pumps. It also is helpful for initial priming or anytime the pump is started.

This fact sheet outlines some alternatives for automatic priming of centrifugal pumps. (See FS 897 for a discussion of automatic restart systems.)

Centrifugal Pumps

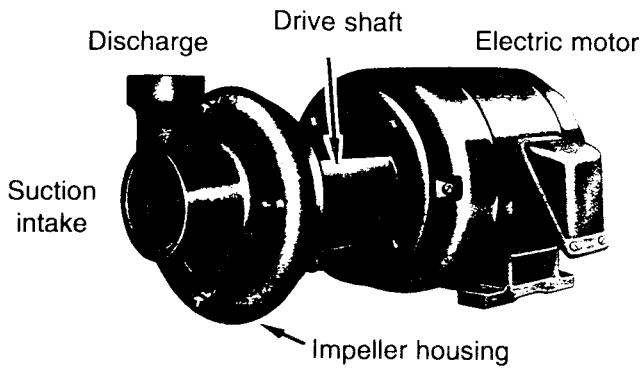
Centrifugal pumps are widely used for irrigation and are most common where pumping from surface water supplies such as rivers, lakes, and streams. Since the pump is physically located above the water surface, centrifugal pumps must be primed (filled with water) before they can be operated.

The first step in automatic restart is to automatically prime the pump. Failure to prime a centrifugal pump can cause pump damage since the water being pumped provides necessary lubrication and cooling.

A centrifugal pump has an impeller located inside a sealed impeller case (Figure 1). An external drive shaft from the power unit drives the impeller. Water is drawn into the eye (center) of the impeller through the suction intake on the side of the pump case opposite the drive shaft. Centrifugal force moves the water outward through the impeller and discharges it to a pressurized pipeline.

A typical centrifugal pump installation consists of an air-tight suction line extending below the water surface, the pump, a check valve, and the discharge pipeline. Removing the air from the suction line and pump case and filling it with water primes the pump. When the pump is started, the centrifugal force of the spinning impeller discharges water from the pump case and creates a vacuum in the suction line pulling more water into the pump.

Figure 1. Example diagram of a centrifugal pump directly connected to an electric motor.



Most centrifugal pumps are primed manually by the operator or by using another vacuum source. One method of manual priming uses a hand-operated suction pump. Many irrigators use other combinations of equipment for priming including engine manifold suction or vacuum pumps.

Automatic Priming

Unattended, automatic priming of centrifugal pumps is necessary for automatic restart of an irrigation system. Automatic priming is the first step in the automatic restart process. When centrifugal pumps powered by electric motors are shut down by load management control or power outages, a system for automatic priming must be combined with the necessary controls to ensure priming and to power up the main pump once it is primed.

Repriming is not always required if the plumbing is sufficiently tight to hold prime during the power outage. This often is the case with newer equipment; however, it is necessary to have the controls that ensure the pump is primed before restarting.

Automatic priming also simplifies the normal pump startup process since the pump controls use a single start sequence regardless of the priming status. The operator does not have to connect various hoses and fittings and then manually start the various components individually. Automatic priming controls also can serve to protect the equipment from loss of prime while the irrigation system is operating.

There are various automatic priming solutions. Commercial packages are available but will cost several hundred to several thousand dollars.

Repriming systems using off-the-shelf components can be installed more economically, however, the installer must understand the control system when installing a combination of components.

Two basic types of priming systems are common—the vacuum method and the pump-fill method. The pump fill method only can be used where there is a foot valve on the suction line; the vacuum method can be used with or without a foot valve.

Foot valves are one-way valves installed on the intake of the suction pipe. Foot valves maintain pump prime after initial filling, provided there are no leaks in the foot valve, suction line, or pump. Since the foot valve is submerged, corrosion and sediment may cause the valve to lose its seal and leak. Foot valves may not be desirable on long suction lines because of the difficulty in draining the line for repair and at the end of the season.

PUMP-FILL PRIMING

The pump-fill priming method uses a small submersible or sump pump to fill the suction line and pump (Figure 2). An air release valve lets air escape and a pressure or water sensor switches power from the fill pump to the irrigation pump when the pump and suction line are filled with water.

Components of pump-fill priming:

Check valve. Installed in the pipeline on the discharge side of the irrigation pump and must be spring loaded to provide enough back pressure to activate the pressure sensor.

Foot valve. Installed near the inlet of the suction line and must be tight enough for the fill pump to accomplish filling without excessive loss of water from leakage.

Submersible or sump pump.

Air release valve. Installed at the discharge of the irrigation pump but before the check valve.

Hose and fittings. The hose connecting the fill pump should be connected into the discharge side of the irrigation pump rather than the suction side so water is not drawn through the fill pump after the irrigation pump is started.

Hose check valve. A small check valve is needed where the hose connects to the discharge pipeline in order to prevent back flow through the fill pump when the irrigation pump is operating.

Pressure switch or water sensor. Detects when water has filled the pump and activates the controls to deactivate the fill pump and activate the irrigation pump. The switch could be set for a pressure rise of 2 to 5 psi.

Wiring and controls. A 120V outlet is needed to run most submersible/sump pumps.

How the pump-fill method works:

When the start button for the pump is pushed or when power is restored after a power outage or Toad management, the controls start the fill pump.

Water is pumped to fill the suction line and pump.

When all the air is released through the air release valve, pressure builds behind the check valve and the pressure sensor signals the control relay to switch power from the fill pump to the irrigation pump.

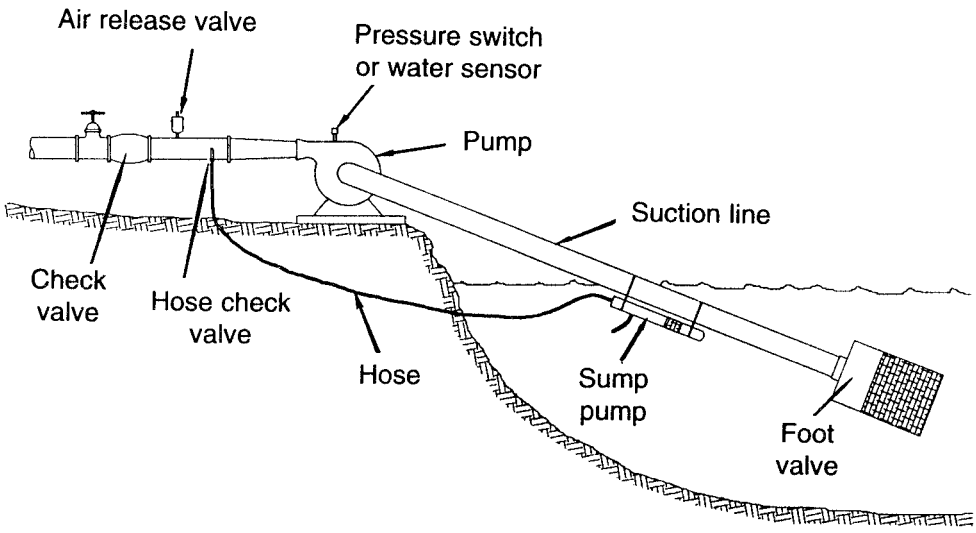
After operating pressure is reached, safety controls switch from manual ("hand") to auto which then protects the main pump from loss of pressure.

The control circuitry should also determine whether the start cycle should be attempted one or more times before aborting automatic restart effort. It is not desirable to continue to attempt to prime the system if it is not successful after a few attempts.

VACUUM PRIMING

The vacuum method uses a vacuum pump to evacuate the air from the suction line and pump (Figure 3). Atmospheric pressure then fills the suction line with water through the submerged intake. This method requires that all components be air tight from the water surface to the discharge check valve near the pump. A water sensor is installed on the top of the irrigation pump and switches power from the vacuum pump to the irrigation pump when the pump case is filled with water.

Figure 2. Pump-fill priming method.



Components of vacuum priming:
Vacuum pump. Adequate capacity to remove air from the suction line.

Combination air release and small check valve. On top of the pump discharge or pipeline and needs fittings for connecting to the vacuum pump. A small check on the valve prevents pressurized water from entering the vacuum pump while the irrigation pump is operating.

Check valve. Installed in the pipeline on the discharge side of the irrigation pump and must provide an air tight seal.

Hose and fittings. Vacuum hose is needed to connect the vacuum pump to the air release valve.

Water sensor switch. Detects when the pump is full of water and signals the controls to switch from the vacuum pump to the irrigation pump. Located on the top of the pump or pipeline where it is readily contacted by water filling the system.

Wiring and controls. A 120V outlet may be needed to run the vacuum pump.

How the vacuum method works:
When the start button for the pump is pushed or when power is restored after load management, the controls start the vacuum pump.

The vacuum pump fills the suction line and pump with water by evacuating the air through the air release valve.

When water closes the contact on the water sensor, the control relay switches power from the vacuum pump to the irrigation pump. Safety controls switch from manual ("hand") to auto after operating pressure is reached which then protects the main pump from loss of pressure.

The control circuitry also should determine whether the start cycle should be attempted one or more times before aborting the automatic restart effort. It is not desirable to continue to attempt to prime the system if it is not successful after a few attempts.

Wiring and Controls

The principle of operation for automatic priming is not complex. It is essential, however, that the wiring and controls accomplish the desired task without safety hazards to the operator or the equipment. Therefore, comply with all National Electric Code provisions and any local codes that may apply. Make sure that the equipment and installation are suitable for the situation to prevent any hazard to operator or system. Contract with a certified electrician who is familiar with irrigation systems to do the work.

Figure 4 is a simplified diagram of the electrical controls for automating the priming of a centrifugal pump. The diagram does not include any additional timers and controls that would be used to implement automatic restart of the remaining parts of the irrigation system. A delay timer could be installed in parallel with the start/stop circuit to enable automatic restart when power is restored.

Figure 3. Vacuum pump priming method.

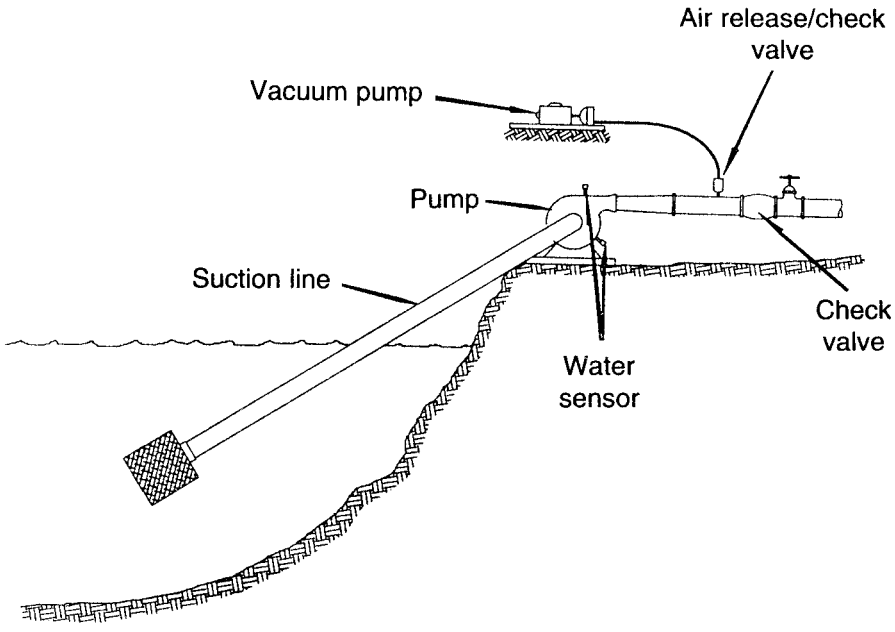
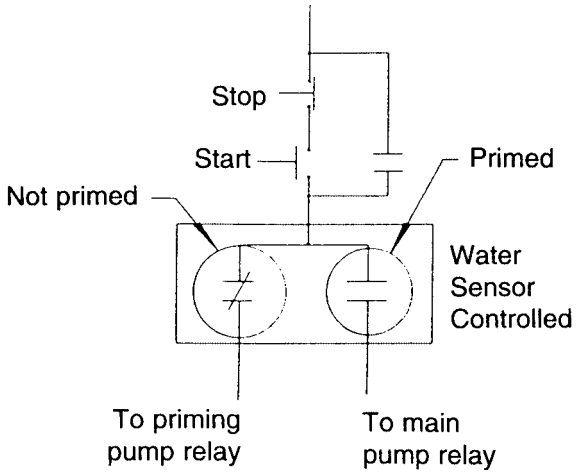


Figure 4. Example of control circuit for automation of centrifugal pump priming.



Troubleshooting

Automatic priming of centrifugal irrigation pumps can make the task of starting and restarting the irrigation system much easier. Any system, however, is not without potential problems. **Remember that if your pump is difficult to prime now, automatic priming will not solve the problem. All of the equipment must be in good working condition for automation to be successful.**

Make sure that all fittings and pipe on the suction side of the centrifugal pump are air tight. Air leaks or a leaky foot valve will prevent priming. The check valve near the irrigation pump discharge should be air tight. When the pump-fill method is used, the check valve also needs to be spring loaded to provide enough back pressure to activate the pressure sensor when the priming system is filled with water.

Controls should prevent continuous restart attempts when unsuccessful. Then there needs to be a simple reset to allow the automatic priming to proceed once the restart fault has been corrected. The water sensor or pressure switch should be located to readily activate the control switches that change from the priming pump to the irrigation pump.

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