

WHAT'S NEW IN SURFACE IRRIGATION EQUIPMENT

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Advances are being made to improve and develop new equipment for both furrow and flooding methods of surface irrigation.

SURGE IRRIGATION

The one single advance in recent years which is having the greatest impact on furrow irrigation is surge. Surge irrigation is the intermittent application of water to alternating blocks of furrows. This technique reduces the infiltration rate on most soils so that less water is required to wet the furrows throughout their length and it is easier to advance water to the end of the field. It is sometimes possible to wet two sets of furrows by surging with approximately the same volume of water and in about the same time as would be required for one set of furrows using continuous flow streams. Surging works best on lighter textured soils and during the first irrigation of the season or irrigation following tillage when soils are loose. Most researchers also report that furrow streams advance more uniformly from furrow to furrow by surging.

In order to utilize the surge technique, a system must be automated. Consequently, several equipment manufacturers are supplying surge irrigation valves and controllers for gated pipe systems. This equipment is now beyond the development stage, is reliable, and can be used to reduce water losses and provide greater management versatility for the irrigator. Besides hastening advance, most surge valves allow the irrigator to use different management options to control runoff. Since two blocks of furrows are irrigated together, the number of set changes is reduced by half compared to conventional irrigation.

AUTOMATED LAYFLAT IRRIGATION TUBING

Layflat tubing has been used for many years for irrigation. Once installed, it provides most of the benefits of rigid surface irrigation pipe and is commonly used as a low-cost alternative to gated pipe. It is also used to divide irrigation run lengths. Most tubing presently used is a low-cost, thin-wall tubing with approximately a one-year life. However, a uniquely constructed tubing is being developed for irrigation. This tubing is reinforced so as to last a number of years and is made with an interior membrane so that one tube can be used either to carry water across a field or to distribute water to individual furrows. The tubing is fitted with outlet gates on one side so that it acts as gated pipe when water is flowing on the distribution side of the interior membrane. When water is flowing on the conveyance side of the membrane, the membrane covers all of the outlets on the opposite or distribution side of the tube so that flow to the furrows is shut off. Irrigation sets can be changed by just diverting the water from one side of the membrane to the other and manually opening and closing gates is eliminated.

Manual, semiautomatic, and automatic diverter valves to divert water between the transmission and distribution sides of the tubing are being tested. The end of the tubing's interior membrane is attached to a flat, stainless steel, spring band mounted inside a short length of PVC surface pipe. A small cable is used to pull the band, and with it the end of the membrane, from one side of the pipe to the other to shift water flow from one side of the membrane to the other. A linkage and lever arrangement is used, as shown in Fig. 1, to pull and release the small stainless steel cable from side-to-side on the manual and semiautomatic valves. A small DC motor is used on the fully automated valve. The motorized valve can be used for surge irrigation where the water is alternately switched from one set to another.

Presented at the Idaho Irrigation Show and Exhibition, January 30 - February 1, 1989, Boise, Idaho.

In Proc. Univ. of Idaho Winter Commodity
Schools 1989, Vol. 21, Univ. of Idaho
College of Agric. Res. & Ext. Center,
Twin Falls, ID

Fig. 1. Manually-operated diverter valve.

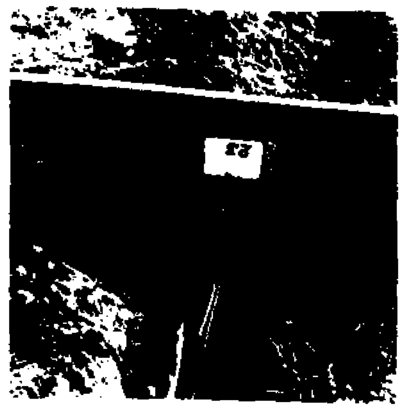

Fig. 2. Flow outlet with slide gate.

Fig. 3. Method of attaching tubing and membrane to valves and couplings.

Flow outlets in the flexible tubing consist of a pocket cemented to the side of the tube with a circular flow opening and a mating slide to adjust the flow as shown in Fig. 2. The slides can be removed to allow the tubing to be easily rolled up at the end of the season. The tubing is considered permanent and not a temporary throw-away item or system. A fabric fastener material is used to attach the interior membrane of the tube to that of a valve or tubing coupler as shown in Fig. 3. The diverter valves fit the couplings and other fittings commonly used for gated pipe.

CABLEGATION

Recent advances have been made in cablegation equipment components, feedback control systems, and border systems. Cablegation plug gaskets are now commercially available made from flexible PVC to satisfy various stiffness, strength, and size requirements. Plugs with flexible gaskets permit the use of both aluminum and PVC gated pipe with a wide variety of outlet gates. Special outlets are available with which to adjust flow rates, dissipate energy, and cut off low flows to prevent dribble. Recent controllers use hydraulic cylinders or a low-cost water brake to control plug speed with no power requirement. A commercially available electronic controller uses a microprocessor-based timer to advance the plug at precise, preset intervals.

Two types of feedback control for furrow systems are being developed. A plug speed control system uses an instrumented flow measuring flume at the lower end of the field to continuously monitor runoff. Runoff information is transmitted to a microprocessor controller at the upper end of the field via infrared telemetry. The controller interprets the feedback information and, by using the cablegation controller, either speeds up or slows down the plug speed to change irrigation times and maintain a predetermined rate of runoff.

A tailwater pumpback system consists of a return flow system which pumps the runoff back to the head of the field where it is added to the initial supply flow. This system is feasible because, after equilibrium is reached, runoff from a cablegation system is constant. Adding the recycled water to the inflow increases the set width to utilize the extra water and thus all of the water applied to the field is infiltrated. A high irrigation efficiency is possible, particularly on soils with fairly constant infiltration rates.

Design procedures and installation criteria have been developed for border cablegation systems. Two problems inherent with border cablegation systems that must be considered are designing for the large stream sizes required and providing sufficient operating head, since the cross slope on fields suited for borders is characteristically quite flat. These problems can often be overcome by using multiple risers with their outlets elevated to provide an artificial slope for operation. Belled outlets for the risers were designed and calibrated to reduce operating head requirements. Riser shut-offs were developed to further reduce land slope requirements and increase system applicability. A shut-off consists of a short pipe section that is suspended over the riser outlet prior to and during irrigation. When irrigation proceeds to the next downstream border, the pipe section is dropped into the belled riser outlet to shut off the discharge. This allows the riser outlet to be near the ground surface. Different means of releasing the suspended pipe section are being developed. A schematic diagram of a border irrigation system is shown in Fig. 4.

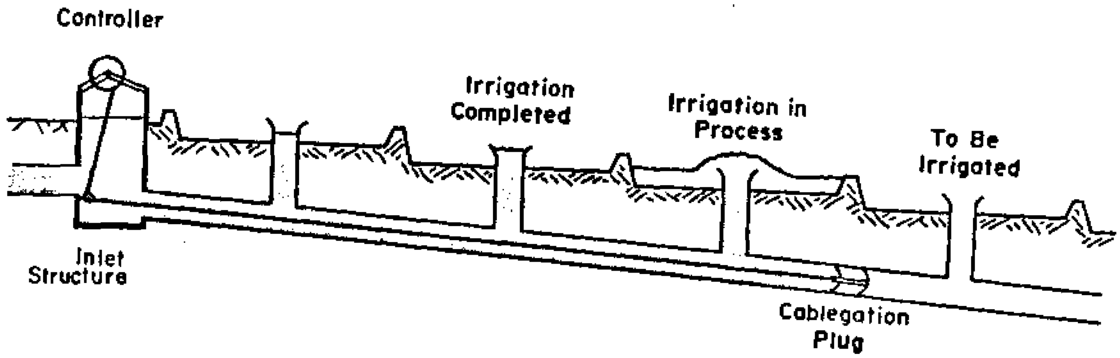

Fig. 4. Schematic diagram of a border cablegation system.

AUTOMATED BORDERS AND LEVEL BASINS

Surface flooding systems require precise set times to prevent dike overtopping and excess runoff. Predicting the time required for water to advance to the end of the field is often difficult and irrigators sometimes must visit the field frequently to observe the water's progress. Recent advances include the development of improved semi-automated gates and sensors to provide feedback for irrigation control. Use of this equipment can provide greater convenience and save both time and labor for the irrigator as well as increase irrigation efficiency by reducing water losses.

FIELD TURNOUT GATES

Drop-closed gates. Two types of semiautomated gates developed to fit rectangular and pipe-type turnouts commonly used in these systems are shown in Figs. 5 and 6. The rectangular gate fits into slots originally used for sheet metal panels, lift or slide gates, or check boards. The gate is designed so that it seals tight when closed and is much tighter than the metal slides or check boards used originally. A special rubber seal with a curved lip helps sealing.

The gate shown in Fig. 6 can be used to retrofit new or existing pipe turnouts for semiautomation. The gate is mounted on a bracket attached to the upper edge of the ditch lining. The original slide gate is removed to allow the drop gate to seat over the seal ring.

The only operational problem encountered with either of these gates is occasional leakage caused by trash which becomes trapped beneath the gates when they close. This is a problem common to most automated gates which can be eliminated by using trash screens to clean the water. A trash screen should be considered a necessity for all open-ditch irrigation systems, especially those that are automated.

Butterfly gates. The gate shown in Fig. 7 is a new style, dual-function gate which first opens to admit water to the field for irrigation and then closes to terminate irrigation. It consists of a sheet metal gate panel which rotates about a horizontal axis at the top of the turnout opening. When the first latch is released, the gate is pushed open by water on its upstream side and rotates 90° to begin irrigation. When a second latch is released, the gate rotates another 90° to its second closed position to end irrigation. It is manually reset prior to the next irrigation. This type gate is needed for most border and basin systems because supply ditch slopes are flat and there are usually a number of outlets between ditch checks. Thus, gates are needed which can begin and end irrigation of a border or basin while the supply ditch remains full.

Fig. 5. *Drop-closed gate for ditch turnout with control timer.*

Fig. 6. *Drop-closed gate for pipe outlet.*

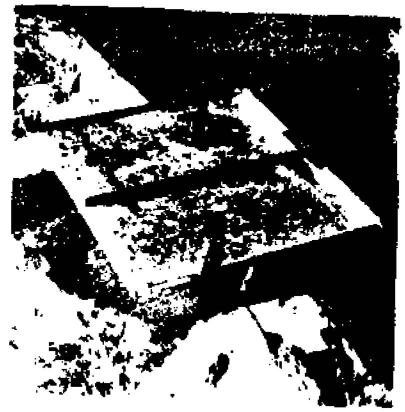

Fig. 7. *Butterfly dual-function gate.*

DITCH CHECK GATE

A trapezoidal center-of-pressure check gate can be used in a lined supply ditch to release water to downstream sets when irrigation proceeds in the downstream direction. This gate is designed to open when the water level in the ditch reaches a predetermined depth. Thus, it can be opened by an incremental increase in depth caused by upstream gates closing.

GATE RELEASE SYSTEM

Large borders and level basins often have multiple turnouts because of the large irrigation streams used. In an automated system, all of the turnout gates serving one basin or border must be released at the same time. This can be done electrically, but a mechanical trip-cord system is usually more reliable and costs less. The trip-cord system consists of a 1/8-inch polypropylene cord installed in a PVC pipe buried along the ditchbank. The cord has short, miniature, stainless steel cables attached to each end which in turn are attached to the activating gate on one end and the latch of the activated gate on the other end. Thus, when one gate closes, it pulls the cord to release the next gate in the sequence. The first gate of a series is released by an electric solenoid activated by a controller. The short steel cables at the gates are enclosed in 1/2 inch EMT conduit so that the entire trip-cord is enclosed for protection.

Solenoid-released gates can be activated by mechanical timer controllers (Fig. 5), electronic controllers, or by controllers which use feedback from sensors located near the end of the field.

WATER SENSORS

A simple, low-cost water sensor is being developed to provide a feedback signal to the upper end of a field for gate control. The sensor can be assembled from available materials for about $15. The sensor is placed about three-fourths the distance down the length of a field being irrigated. When water reaches the sensor, a signal is sent to a controller at the head of the field which activates a solenoid-released gate. Other gates in a series are released by the trip-cord system. Communication between the sensor and controller can be by direct buried wire or by infrared telemetry. Controllers used with the water sensors can be made from readily available parts for about $50.