APPLICATION OF SURGE IRRIGATION

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Surge irrigation is a method of applying water intermittently between two irrigation sets. The results of surge indicate that on the average, water will advance faster in a furrow using surge flow than in a furrow using the conventional continuous flow irrigation method.

By alternating irrigation water between two irrigation sets several times, the furrows are allowed to dry slightly. This wetting and drying action consolidates the soil particles and reduces the intake rate of the soil. The result is the ability to advance water to the end of a field in less time and using less water.

Surge flow irrigation has found its way into the commercial arena with a number of different surge valves being marketed. Surge flow is typically practiced on furrow irrigated fields that are equipped with gated pipelines for water delivery. Lay flat plastic ditch offers an alternative to gated pipe.

Normally, the water is regulated between two sets by an automatically controlled tee-valve, i.e., the surge valve. Water is cycled by the valve between two irrigation sets. One set is located on the left of the valve and the other set on the right of the valve. General guidelines suggest using approximately the same stream size as was used with continuous flow. The stream size should be less than the maximum non-erosive stream size. If gated pipe is currently being used, additional equipment requirements are minimal. The basic requirement in addition to the gated pipe is a surge valve. Field layouts for surge irrigation systems are shown in Figure 1. An ideal situation is to have the irrigation well or water supply located near the middle of the gated pipeline (Figure 1A). Locate the valve so that there is equal land area on each side of the valve. Many times this is not possible and the water supply must be brought to the appropriate location using mainline pipe (Figure 1B). The surge control valve diverts water alternately to either side of the gated pipeline. This requires that gates are opened on each side of the water source each time two new irrigation sets are made. A second method is to place the surge valve at the edge of the field and use two parallel lines halfway across the field (Figure 1C). This is the desired layout if lay flat plastic pipe is being used to achieve constant down hill water flow.

Another alternative is to use buried pipelines with risers spaced at intervals

that will allow an irrigation set on each side of a riser (Figure 1D). This system does not require opening and closing of gates once they are set, but does require moving the surge controller to each of the risers.

On irregular shaped fields (Figure 1E), the valve can be placed so that there are an equal number of acres on each side of the valve. With this option, the cycle times are the same for each side but the number of furrows per set on each side is indirectly proportional to the furrow length. For example, if the furrows are 300 feet long on the left set, and 900 feet long on the right set, there would be one-third as many furrows irrigated per set on the right side.

Another way of dealing with irregular shaped fields is to place the valve in the middle of the pipeline and have different cycle times for each side of the valve (Figure 1F). The goal should be to apply the same amount of water on each set.

Finally, if adequate slope in the pipeline exists, and the gated pipe does not flow full, the surge valve can be used as a gate valve to stop flow part way across the field (Figure 1G). When released to the downstream side, the flow must be below the gates in the first section and thus, surge can be accomplished.

If surge flow is not desired, the valve can be set for two long cycles. This would allow two irrigation sets, one on each side of the valve, to run for a given time period. Labor requirements would shift by only having the irrigator come to the field to make a set change one time for every two irrigation sets. The time required to make these two sets will increase because two sets of gates will have to be opened and closed. In addition, the valve may also need to be relocated or reprogrammed.

The irrigation on-times, during which water is applied to one side of the surge valve, are normally between 20 minutes and 2 hours. For each irrigation, an equal amount of off-time occurs during each cycle. This will not be the case when different cycle times are used to compensate for an irregular shaped field. The cycle times, the time to complete a full on-time and off-time cycle, are based on furrow length, soil texture, and field slope. The number of surge cycles to use will vary and should be determined based on field length and field condition. Long fields and fields with high intake soils will require more cycles, five to six. Shorter fields with low intake soil will need less cycles, three to four.

A rule of thumb for surge irrigation is to advance water during each surge cycle a distance that is equal to that fraction of the number of surge cycles used. For example, if using four surge cycles, divide the field into four parts and advance the water one-fourth of the field distance during the first surge cycle. The time required to move the water that distance is the cycle one on-time. For the second and subsequent on-times, multiply the factors given in Table 1 by the cycle one on-time. Tables 2 and 3 give the on-time factors for 5 and 6 surge cycles, respectively.

Following the final surge cycle, set the valve for a cutback phase. During cutback, the valve cycles the water at a shorter frequency between the two irrigation

sets until irrigation is complete. A cutback cycle time of 65 percent of the last on-time is recommended. Tables 1-3 give the factors for the cutback cycle.

Example:

Determine the surge cycle times to be used to irrigate a 1000 foot field. Four surge cycles are to be used while advancing the water and water reached 250 feet in 20 minutes.

Use Table 1, to calculate the four surge cycle times and the cutback cycle time.

Cycle number 1, 1.0 X 20 = 20 minutes
Cycle number 2, 1.9 X 20 = 38 minutes
Cycle number 3, 2.6 X 20 = 52 minutes
Cycle number 4, 3.1 X 20 = 62 minutes
Cutback cycle, 2.0 X 20 = 40 minutes

Table 4 gives the cycle times and the actual clock time for irrigating on a twelve hour set time starting a 7:00 a.m. The final cutback on the right side receives less irrigation time in order to remain on the 12 hour schedule.

One manufacturer uses "out-time" as the input to their controllers program. Out-time is the irrigators estimate of how long it would take water to advance across the field with continuous inflow. For example, if it takes 9 hours for water to go from the upper end of the field to the bottom, the out-time is 9 hours. Once the irrigator enters this number, the program then calculates the schedule of all of the surge cycles. One key assumption in the controller's program is that with surge, the inflow time needed for advance will be reduced by 50 percent. Nebraska research shows that on the average, this is not true. In fact, the average reduction is less than 20 percent. To determine the correct out-time to enter, take your best estimate for advance time with continuous flow and multiple it by 1.6 (0.80 x 2). For example, if the advance time is 9 hours, enter 14.4 hours into the computer. The controller will then determine a schedule so that advance occurs with 7.2 hours (9 hours minus 20 percent) of inflow into each of the two sets.

If water does not reach the end of the field by the last surge cycle, adjustments may be necessary. Options include increasing the number of surge cycles or decreasing number of furrows to increase furrow flow rate. If water reaches the end of the field sooner than desired, increase the number of furrows or decrease the number of surge cycles.

Adjustment in cycle times and number of cycles will be necessary to fine tune the process for each set of conditions. A number of the commercially sold valves will have preprogrammed cycle times based on furrow length or expected advance time. In addition, you can develop your own cycle times based on your conditions and the valve will automatically change at those times selected.

SUMMARY

The application of surge irrigation will require a change in management strategy. Surge often allows the irrigator to apply water more uniformly as well as more effectively apply a specific amount of water. As a result of improved irrigation performance with surge, soil moisture monitoring will play a more important role in assuring that adequate water is applied and that excessive irrigation is reduced.

For the first few years additional time will be required to fine tune the surge system to your particular operation. Once this is accomplished, surge irrigation can assist in achieving more uniformly irrigated crops, conservation of water, reduced pumping costs and improved water quality by reducing deep percolation.

Table 1. Surge irrigation on-time factors when using four surge cycles.

Cycle No.	Fraction of field	On-time factor
1	.25	1.0
2	.50	1.9
3	.75	2.6
4	1.00	3.1
Cutback (.65 X 3.1)		2.0

Table 2. Surge irrigation on-time factor when using five surge cycles.

Cycle No.	Fraction of field	On-time factor
1	.20	1.0
2	.40	1.9
3	.60	2.6
4	.80	3.1
5	1.00	3.4
Cutback (.65 X 3.4)		2.2

Table 3. Surge irrigation on-time factors when using six surge cycles.

Cycle No.	Fraction of field	On-time factor
1	.17	1.0
2	.34	1.9
3	.51	2.6
4	.68	3.1
5	.85	3.4
6	1.00	3.8
Cutback (.65 X 3.8)		2.5

Table 4. Surge irrigation schedule for example using 12 hour set time.

Cycle Advance	Surge On Time(min)	Left Set	Right Set	Total Time 1 Cycle(min)	Cumulative Time(min)
1	20	7:00am	7:20	40	40
2	38	7:40	8:18	76	116
3	52	8:56	9:48	104	220
4	62	10:40	11:42	124	344
Cutback 5	40	12:44	1:24	80	424
6	40	2:04	2:44	80	504
7	40	3:24	4:04	80	584
8	40	4:44	5:24	80	664
9	40	6:04	6:44	56	720
New set		7:00pm			

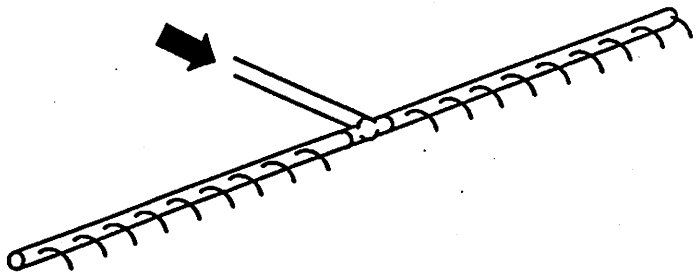

Figure 1A. Water source and surge valve in middle of pipeline.

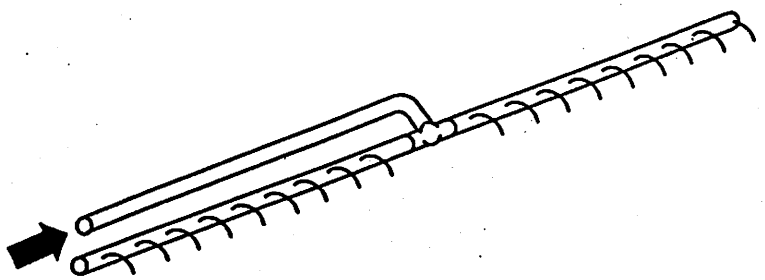

Figure 1B. Water source at edge of field, surge valve in middle of pipeline.

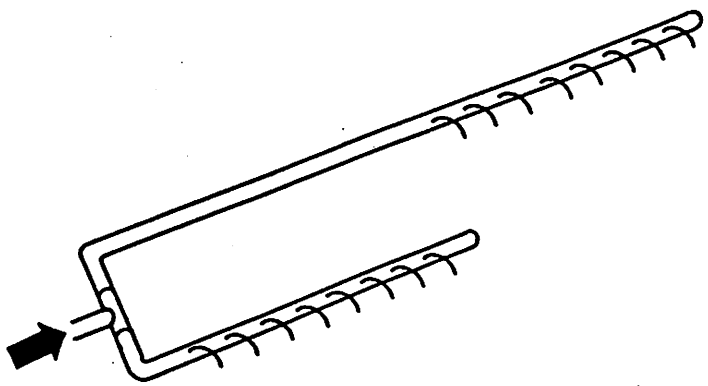

Figure 1C. Water source and surge valve at edge of field.

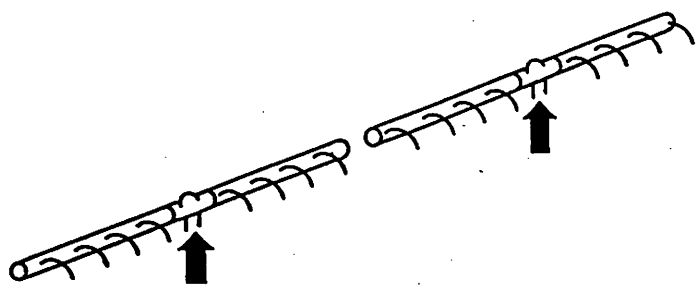

Figure 1D. Buried pipeline with risers, surge valve moved to each riser.

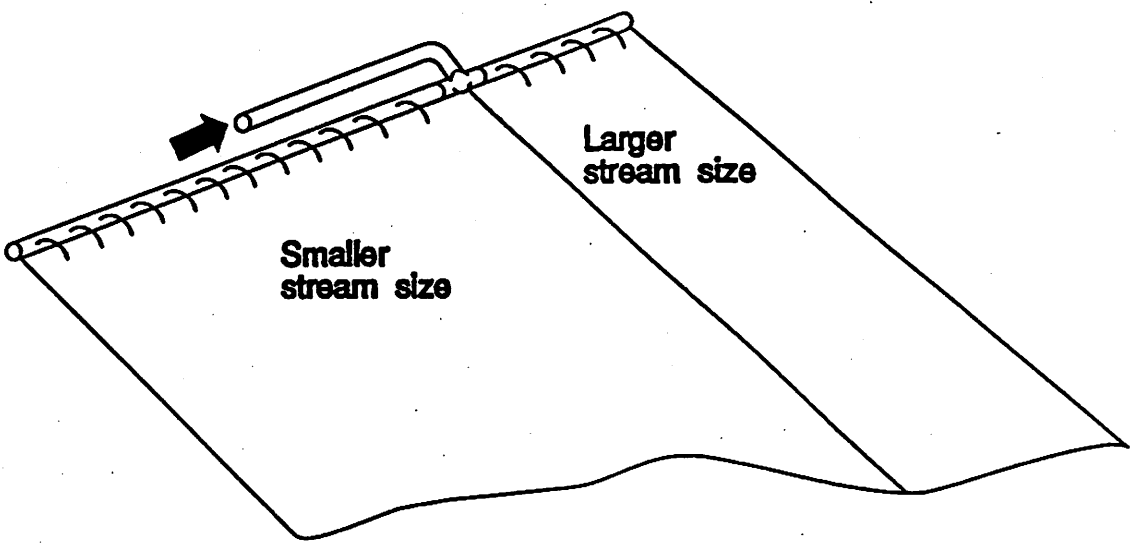

Figure 1E. Irregular shaped field, surge valve in pipeline so equal area on each side using different stream sizes for each side.

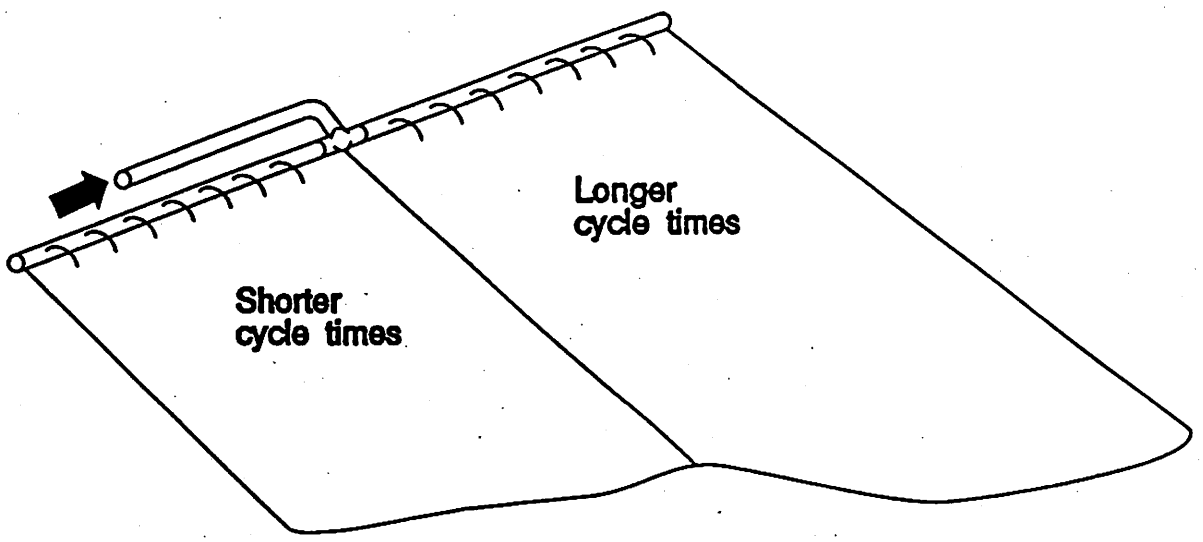

Figure 1F. Irregular shaped field, surge valve in middle of pipeline using different cycle times for each side.

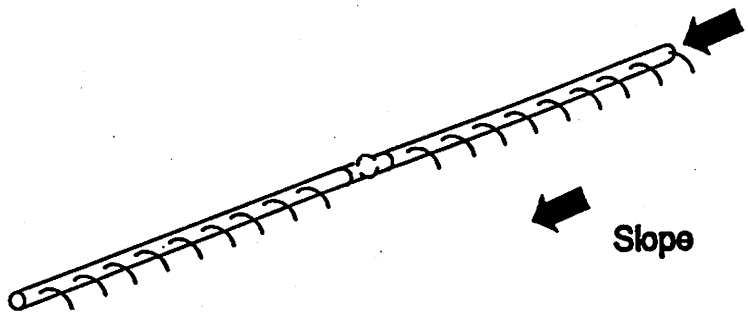

Figure 1G. Surge valve used as gate valve, requires pipe flow below gate level.