The irrigation industry's answer to effluent water usage on turf grass

By John L. Brewer

The Irrigation Industry now has one of the biggest challenges it has ever had.

A commonly unrecognized fact that in excess of 70% of the water pumped in the U.S. is used for irrigation purposes precipitates a real challenge. Potable water once believed to be an inexhaustible supply is now a vanishing resource.

We have the challenge to explore all viable alternatives to reduce the use of fresh water. A solution to the challenge is to utilize effluent water whenever possible in irrigation systems. The challenge is to efficiently utilize this valuable by-product as a resource, not as a product for disposal.

The Irrigation Industry's attempts to efficiently utilize effluent water in turf grass irrigation systems have resulted in many less than satisfactory projects.

The irrigation community has not addressed itself to the fact that typical types of irrigation technologies and equipment used on fresh water irrigation projects may not always be effective when effluent water is utilized on turf grass.

Problems

The following problems must be recognized and dealt with to insure optimum benefits provided by effluent water usage.

Large sprinklers that "blast" water as far as possible are now typically used in single row turf irrigation system designs.

High sprinkler pressure and flow rates required to operate these "water cannons" compels the irrigation system designer to specify large horsepower pumps that are high in capital and consume excessive energy.

Large sprinklers require high pressures that:

Cause extremely high pressures to be experienced in the piping system, valves and sprinklers, increasing maintenance part and labor costs, and reduces product life.

Pressures of 6 times the working pressure can be experienced in the system because of water hammer. These pressures exceed maximum pressure ratings of irrigation products and will render them inoperative.

As an example, a slow closing gate valve can cause three times operating pressure to be experienced in the irrigation system. With the automatic control valves, 6 times the working pressure can be experienced in the irrigation system if the valve opens or closes rapidly.

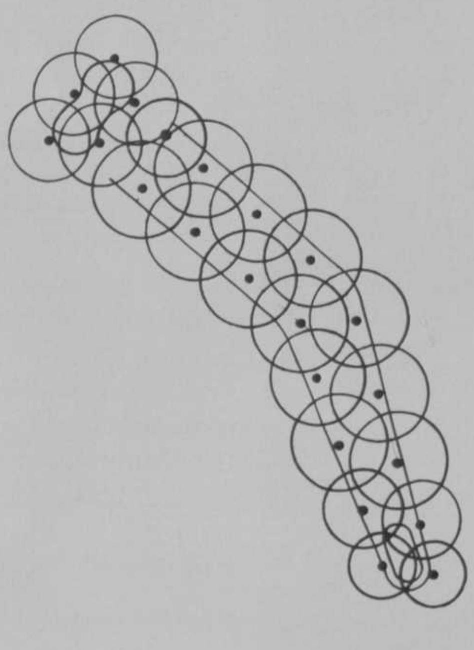
Pipe

The piping industry has a solution to this situation, and we would be wise to take heed and be aware of what may be a problem. "Pressure pipe" commonly used in irrigation systems has a safety rating of 2:1 or twice its maximum operating pressure.

If the irrigation system utilizes 160 psi pressure pipe, its safety rating is 320 psi. If the system pressure is 100 psi, the resultant water hammer pressures can reach 600 psi. Double the rating of the pipe in the system, over-stressing the capabilities of the piping system.

A pipe break experienced in a potable water project is annoying. A pipe break in an effluent project can be hazardous or disastrous.

To reduce this concern, "class" pipe should be used to insure the maximum protection against typical water hammer pressures. Class pipe has a safety factor of 4:1 or four times its rated pressure. If 160 psi pipe is used, the safety rating is 640 psi or above the water hammer pressures experienced.



Sprinklers

Large sprinklers are not always conducive to uniform application or lower rates of precipitation. Often times low precipitation rates and uniform application of water is essential to the correct operation of effluent water projects.

The high water pressure and high angles of trajectories required for proper operation of large sprinklers can create tremendous distortions of the water pattern and objectional wind drift.

Distorted water patterns and high rates of precipitation of water create overwatering and underwatering conditions within the area of coverage.

Soil compaction, effluent water runoff and puddling of water and nutrients will occur and will overload the soil and destroy the grass. An even more hazardous condition can be created if runoff of effluent flows onto adjacent property or streams or rivers.

A typical low pressure, double-row irrigation system required 40-60 psi at the base of the sprinkler with advantages over high pressure, single row systems of:

a. Lower capital cost for the pumping system.
b. Lower power and maintenance costs because of smaller pump horsepower requirement.
c. Lower water hammer pressure shocks on pipe, valves and sprinklers.
d. Larger water droplet sizes on low pressure systems are more effective against wind distortion than higher pressure systems.
e. Larger water droplet sizes resist wind drift more effectively than the small droplet sizes of the high pressure systems. Justification of the concerns created when wind drift of effluent is experienced is largely unproven.

Large sprinklers with 27° or 28° angles of trajectories aim water streams high into the air which increases the possibility of wind drift and distortion by wind. Greater levels of concern are created, the higher the effluent water stream is thrown into the air.

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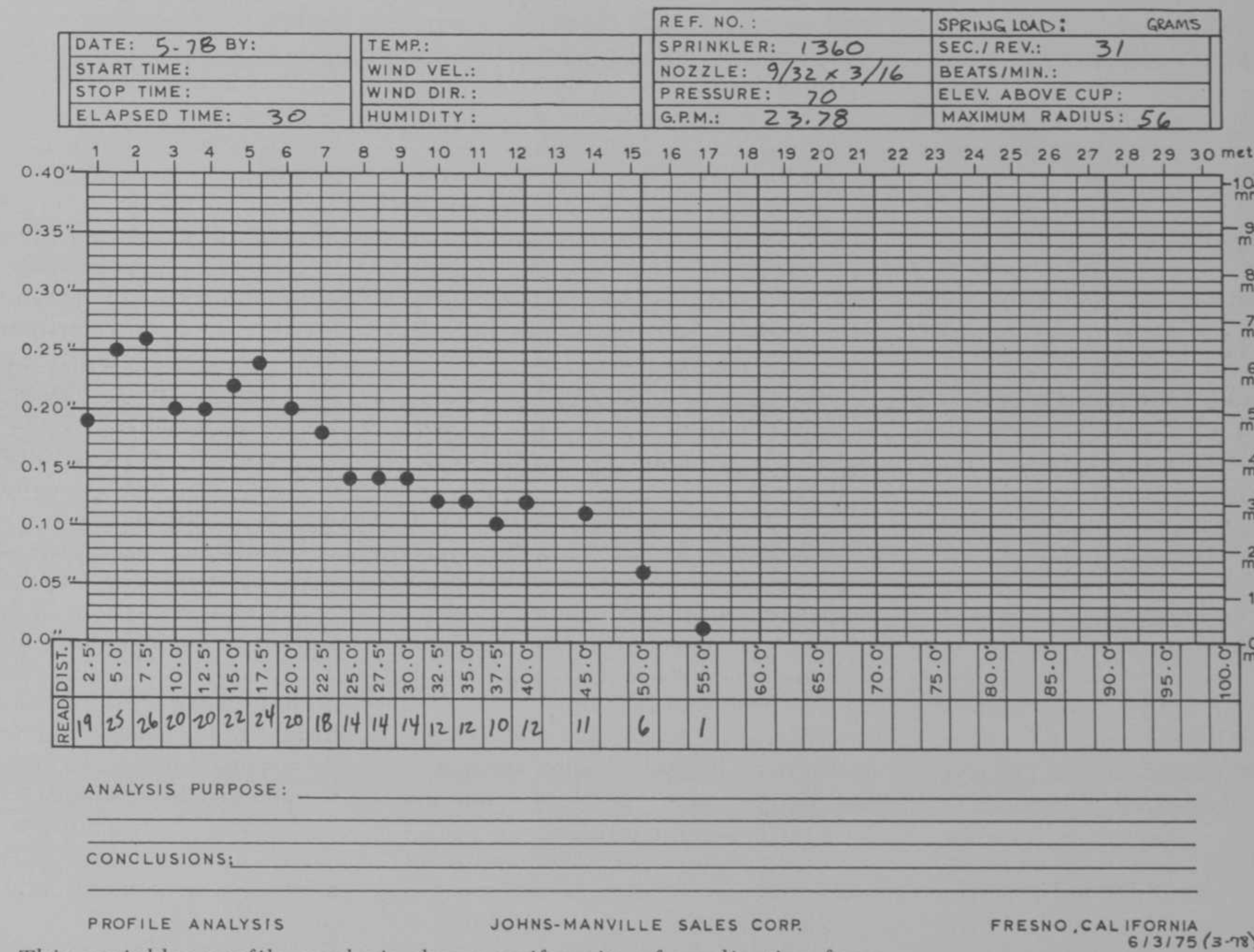

This sprinkler profile analysis shows uniformity of application for a particular sprinkler under a given set of conditions.

Uniformity

In the past, there has been little regard to uniform application of water within the turf grass irrigation system.

Spacings of sprinklers has been based solely on the percentage of their diameter as determined by each manufacturer.

This spacing generalization is based upon theoretical sprinkler profile patterns that were developed by Christensen in 1942.

Christensen's rule of thumb method of determining sprinkler spacing and resultant water uniformity was acceptable in the 1940's and 1950's when water and power costs were low and usage of effluent was at a minimum. In the 1960's and 1970's, the cost of water and power has increased phenomenally and usage of effluent water is booming.

Now there are new techniques of optimization of water applications in irrigation systems. One such method is the computer selection of sprinklers and optimization of sprinkler spacings. This analysis utilizes actual sprinkler profile performances obtained from sprinkler test facilities. Sprinklers are operated and actual sprinkler profiles (the amount of water deposited at different distances from the sprinkler) are obtained at the actual pressures and appropriate nozzle sizes required for the irrigation system.

The actual sprinkler profile data is input into a computer. The computer then simulates the overlap of water from the adjacent sprinklers in the system.

The reports generated provide data for the analysis to allow optimization of the uniform application of water.

The report is a summary of the actual performance data obtained from the tested sprinklers and indicates the performance of the sprinkler at the sprinkler spacings of interest to the end user. Included is the Sprinkler Spacing, sprinkler spacing as a percentage of the sprinkler diameter, Uniformity of Coefficient, Precipitation Rate in inches per hour and Water Accumulation times for each spacing for ⅛", ¼", ½", ¾" and 1" of accumulated water.

The Water Accumulation Table indicates catchments being spaced on a 2½ ft. grid. Each number indicates a single catchment with each number indicating the variance in accumulated water from the mean amount of water caught in the spacing. This report can be read similarly to a topographic map. The high numbers indicate the high concentrations of water application, i.e. mountains, the low numbers indicate the low areas of water or deserts.

Remember the goal is to use every square inch of the soil as a living filter and to insure that runoff will not occur. This cannot be accomplished if poor water distribution is experienced. Further analysis of the uniformity of the application of water can be made by reviewing a Histogram which is derived from the water accumulation quantities obtained in the water accumulation table.

Histogram analysis provides rapid visual indications of the uniformity of applied water within the sprinkler spacing.

Irrigation equipment proven dependable on fresh water irrigation systems is not always adaptable to effluent water projects.

Valves

Automatic control valves for irrigation usage have proven to be a concern and a problem where nonpotable water is utilized. A typical problem experienced has been clogging of the small orifices in the control valves. Small particles of contaminants in the water eventually clog small orifices in the valves or valve-in-head sprinklers and render them inoperative.

Recent valve construction and design changes were made to eliminate the clogging problems experienced in automatic control valves.

Some recent valve design changes include:

1. Filtering out the contaminants that are in the water that flow through the valve control orfices.

   Some valve manufacturers provide small grit filters that filter the contaminants out of the water. These filters are used on 2-way solenoid control valves or 2-way valve-in-head sprinklers. Unfortunately, the design of the 2-way solenoid products are such that water flows through the small control ports as long as the solenoid is energized and the valves are open.

   Eventually the solenoid will be exposed to contaminants and clog, thus rendering the valve inoperative.

   If the valve or valve-in-head solenoid is energized for 4 hours a day, water and contaminants will flow through the small control ports for the time the valve is open, 4 hours.
2. One of the more effective methods of reducing the concerns associated with the non-performance of automatic control valves is to utilize three-way solenoid control valves.

   The three-way solenoid operated valves only let water in the small orfices when the valve is in the opening and closing modes. Thus, by reducing the amount of water flowing in the small ports, the probability of the valves clogging is reduced.

   For example, if the valve is open for four hours, the water flowing through the small ports is experienced for only 30-40 seconds.

Controls

Over the years, many types of automatic control sysstems have been developed to effectively irrigate golf courses. They were of the designs that eliminated or improved upon the manual operation of the irrigation systems. The performance requirements established for the golf course markets were broad in scope and could generally suffice.

These same systems are not sufficient when effluent water is utilized on turf grass projects.

Several aspects particular to effluent water utilization on turfgrass make the selection of the type of automatic system important.

Flexibility in both programming and operational characteristics is extremely important. Effluent utilization systems require exacting techniques to insure proper application of the effluent within the irrigation system.

Optimization of automatic controls for irrigation systems utilized on effluent water projects is essential to insure total control of the system, reliable performance and data accumulation for state and federal reporting requirements.

The following features and related benefits outline basic requirements established for effluent water projects:

Central control of golf course automatic systems is extremely beneficial utilizing effluent water because of the control capabilities provided.

Central control provides manual or automatic control of the complete golf course from one location.

Provides individual field controller irrigation start, stop, syringe or manual advance functions from the Central Processor location.

These features provide benefits of either complete automatic shut-down of the irrigation system or complete manual shut down of the system during inclement weather. Total system shut down is important to reduce the possibility of runoff of effluent into low areas or adjacent lakes or streams.

Provides capability of syringing dew or frost off of greens and/or tees.

Allows complete irrigation system start up before scheduled irrigation time to increase available water in extremely high temperatures and high turf stress situations.

Central control provides capabilities of automatic environmental control. Optional programmable automatic rain shut-down on a daily basis is extremely important to insure runoff of the effluent is not experienced. Display of daily rainfall amounts and yearly accumulated rainfall levels provides data often required to satisfy state and federal reporting requirements.

Optional wind direction and wind speed indicators connected to the central processor provide control of the irrigation systems in situations where wind direction and speeds create objectionable wind drift of the effluent into areas adjacent to the golf course.

The irrigation system can automatically switch the irrigation portion to a non-critical wind drift portion of the course until the wind direction and speed reduces below a programmable threshold. At this point, the system will automatically return to the original irrigation location and complete the scheduled time programmed on that location.

The field control units must have features for ease of operation, accurate timing, and flexible programming.

Ease of operation to allow use of the control system by all responsible personnel. A very complex programming system will not be utilized by all responsible personnel and too basic of a system will not provide the flexibility required to optimize the irrigation system.

Accurate timing features are mandatory to insure proper and consistent water application.

Under- or overwatering that results in effluent runoff or excessive turf stress will occur if inconsistent station timing is experienced.

Flexible field controller programming capabilities are mandatory to provide features such as:

Syringe for frost or dew removal to protect greens and tees.

Manual start to allow on-site starts for irrigation after fertilizing or additional irrigation in high turf stress periods.

Programmable skip days to stop the irrigation schedule from one up to nine days without reprogramming the field controller. After the number of omit days is completed, the program automatically resumes conserving time and elimininating effluent runoff.

Multiple station repeats will provide from zero to nine repeats to minimize runoff by applying small amounts of water more frequently with delays between applications.

Station repeats are ideal where heavy soils, slopes, low areas or seed germination is experienced.

Computed total irrigation time for an irrigation sequence for any day is valuable for reporting of total effluent water used. This is often required by state or federal water authorities.

With an appropriate rain collector connected to the field controller, the field controller has the capability of automatic shut down or yearly rain fall accumulation data that is extremely desirable for remote sections of the golf course.

In conclusion, since the concept of effluent water utilization on turf grass is a controversial subject, caution must be stressed when the project is in the design stage.

Present design concepts and product technologies utilized must be carefully scrutinized to optimize the system's operation, to minimize the concerns.