CONTRIBUTING EDITOR

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How to get the most benefit from plastic pipe

Buried pipelines are rapidly replacing many open-channel farm irrigation ditches. Both lined and unlined ditches may likely become obsolete in many areas in the future.

Buried pipelines have many advantages. They eliminate seepage, provide better weed control, take less land out of production, enabling squaring fields by eliminating open ditches and provide better water control with less labor. Also, pipelines have a greater potential for automation. Automatic surface irrigation is just around the corner and installing buried pipelines is a first step in that direction.

Plastic Irrigation Pipe. One factor responsible for the trend toward buried pipelines is the availability of plastic pipe. Three kinds of plastic pipe are used in irrigation: polyvinyl chloride (PVC), polyethylene (PE), and acrylonitrile-butadine-styrene (ABS). Of the three, PVC is by far the most widely used, followed by PE. Because of its higher design stress, PVC is more economical in larger sizes, whereas PE, because of its much lower design stress, is used mainly for small diameter pipe where flexibility is desired, such as in drip, turf, and small sprinkler lateral systems.

Plastic pipe, and particularly PVC, has a number of desirable qualities for irrigation pipe. It is lightweight and thus can be handled in long lengths, it has a low friction loss because of its smooth surface, is easily joined and installed, is corrosion resistant, and is relatively low in cost. In addition, PVC is not attacked by rodents. PVC for irrigation was pioneered in the U. S. in the 1950s and gained widespread acceptance and use during the 1960s.

Different methods are used for sizing plastic pipe. PVC and ABS are controlled by the outside diameter (OD), while PE is inside diameter- (ID) controlled. The 'controlled' diameter remains the same for a given size or classification of pipe, while the uncontrolled diameter varies as the wall thickness varies for different pressure ratings.

Most PVC pipe used for irrigation is made in two general size classifications: "iron pipe size" (IPS), and "plastic irrigation pipe" (PIP).

IPS pipe sizes have the same outside diameter as iron or steel of the same nominal size. PIP sizes are entirely different than IPS and were developed primarily for irrigation use with size designations established jointly by plastic pipe manufacturers and the Soil Conservation Service. PIP of the same nominal diameter is smaller in size than IPS pipe and therefore has a smaller flow capacity which varies from about 18% less for 4-inch pipe to about 8% less for 12-inch pipe.

PIP is further divided into high-head or "pressure rated" pipe and "low-head" or 50-foot head pipe used in surface or gravity flow systems. PIP pressure rated pipe is used mainly in the central and midwest regions of the U. S. irrigation, while in the eastern and western regions, IPS is predominantly used.

Both IPS and PIP PVC pipe are pressure rated using the "standard dimension ratio" (SDR). This ratio is obtained by dividing the average *outside* diameter of the pipe by the minimum wall thickness (for PE pipe, the average *inside* diameter is used).

Thus, pipes of all sizes made from the same material and having the same SDR value all have the same pressure rating. Although used to a lesser extent for irrigation, Schedule 40, 80, and 120 PVC pipe is also available with dimensions corresponding to those of the Schedule series steel pipe. This pipe does not have a constant SDR, and the pressure rating decreases with an increase in diameter because the wall thickness does not increase at a rate to maintain a constant pressure rating.

ASAE Standard. In addition to the various size classifications, thermoplastic pipe is manufactured from different materials of various grades, types, and formulations involving many different specifications. There is a need to establish a uniform standard for materials used in the manufacture of plastic irrigation pipe and to promote uniformity in classifying, pressure rating, testing, and marking.

Because of this need, the Water Supply and Conveyance Committee (SW-243) of the American Society of Agricultural Engineers (ASAE) developed a standard specifically for irrigation pipe. This standard entitled "Design, Installation and Performance of Underground, Thermoplastic Irrigation Pipelines" was recently published by the Society as ASAE Standard: ASAE S376. Copies may be obtained from Society headquarters in St. Joseph, Michigan 49085.

(Continued on page 30)

TABLE 1

SDR	Pressure class rating-without surge (psi)	Maximum operating pressure with surge (psi)
13.5	315	227
17.0	250	180
21.0	200	144
26.0	160	115
32.5	125	90
41.0	100	72
51.0	80	58
81.0	50	36
Low-head	—	22 (50' head)

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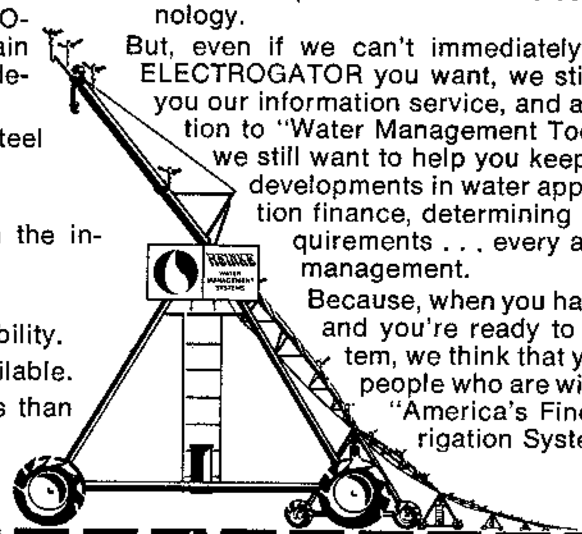

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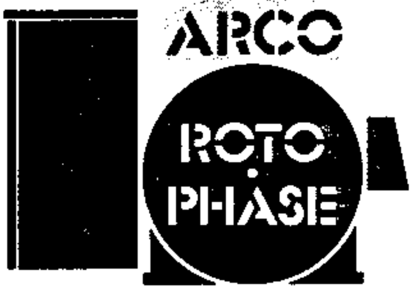

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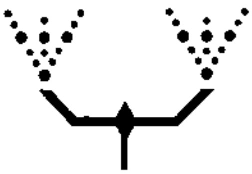

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Waterhammer. An important consideration in the design of a pipeline is that of waterhammer. The ASAE standard specifies that the normal operating pressure plus surge pressures shall not exceed the pressure class rating of the pipe. If the actual surge pressures are not known, then it is recommended that the maximum operating pressure not exceed 72% of the pressure class rating. To limit the amount of surge pressure that can develop, the water velocity at system capacity should not exceed 5 feet per second.

Maximum operating pressures for PVC pipe without and with surge for various SDR values are shown in Table 1. Values shown are for PVC 1120, which is the material from which over 90% of the PVC irrigation pipe is made.

Excessive waterhammer pressures can occur by closing the pipeline valves too rapidly. To limit the pressure buildup to that which will not damage the pipe, the minimum valve closing times should not be less than those shown in Table 2 for various classes of pipe.

If valve closing times are not less than those shown, the surge pressure due to valve closing, for most operating conditions, will not be greater than about 1/5 of the pressure class rating of the pipe. Thus, for pipe operating at pressures shown in Table 1, the operating plus surge pressures together will not exceed the pressure class rating of the pipe. The longer the pipe, proportionally longer times should be taken to close the discharge valve.

Entrapped air can both restrict the flow at high points in the line, and also cause waterhammer problems, especially when released suddenly from the pipeline. Air release and vacuum relief valves, as indicated in the standard, should be installed at all high points, at the ends, and at the entrance of pipelines to provide for air release and air entrance.

Install pressure relief valves between the pump discharge and the pipeline if excessive pressures can develop by operating with all valves closed, and on the discharge side of the check valve and at the end of the pipeline if surge pressures can develop. The ASAE standard contains minimum guidelines for sizing air/vacuum release valves for both high and low pressure systems. Minimum design criteria and vent requirements for low-head pipeline systems open to the atmosphere, including systems with different types of stands, are also shown.

Installation. A number of pipeline failures have occurred, particularly with thin-walled, low-pressure/low-head pipe. These failures occurred primarily because of improper installation and/or operating procedures. It is important that you follow minimum installation requirements concerning trench construction, pipe handling and placement, bedding, and backfill procedures.

Low-head and low-pressure (SDR 81) pipe have adequate strength to withstand internal design pressures, but because of their thin walls are very susceptible to damage and collapse from external loading. Always use the water-packing method when installing this pipe. The initial backfill material immediately surrounding the pipe should be fine-grained and free from sharp or pointed rocks or stones and aggregate no larger than ½-inch diameter. The backfill is consolidated by adding water to completely saturate it. The pipe must first be filled with water and the pressure maintained during the complete backfill process. Good packing and consolidation of the backfill around the pipe are necessary to support the sides of the pipe which increases its resistance to vertical loading.

After installation, take care not to overload the backfill in the trench without the pipe being full of water and under positive pressure. Unusual or extra loading can occur when heavy equipment crosses over the pipe, or when the soil over it becomes saturated, such as during irrigation, or if

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TABLE 2

SDR	Pipe Class (Pressure rating) (psi)	Valve closing time in seconds — Pipe Length 1,000 ft.	2,000 ft.	10,000 ft.
13.5	315	7.9	15.8	79 (1.3 min.)
17.0	250	8.8	17.6	88 (1.5 min.)
21.0	200	9.9	19.8	99 (1.6 min.)
26.0	160	11.3	22.6	113 (1.9 min.)
32.5	125	12.3	24.6	123 (2.0 min.)
41.0	100	14.0	28.0	140 (2.3 min.)
51.0	80	15.4	30.8	154 (2.6 min.)
81.0	50	19.5	39.0	195 (3.2 min.)
Low-head	50-ft. head	21.9	43.8	219 (3.6 min.)

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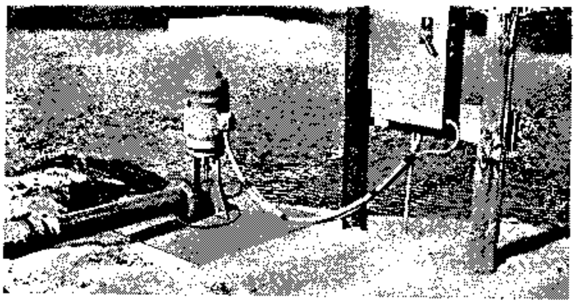

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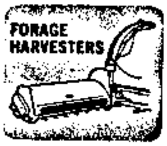

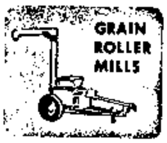

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negative pressures occur during pipe operation which, in effect, increases the external loading. A minimum 30-inch depth of cover is needed for pipes larger than 4 inches in diameter. Scratches on the surface of the pipe impair its ability to withstand cyclic pressure fluctuations, depending upon the scratch depth.

Special handling is often required because of temperature effects on PVC pipe. During unusually warm weather, the pipe expands and is 'snaked' when put in the trench to prevent joint separation when it cools and shrinks. When warm, the pipe is susceptible to permanent distortions caused by improper handling, shipping, or installation. The pipe also becomes increasingly stiff and brittle at low temperatures, meaning special handling is needed during cold weather.

Thrust blocking requirements and related information are also presented in the standard. Thrust blocking prevents the pipe from moving and is needed primarily with rubber gasket joints which otherwise could separate. Blocking is generally required at changes in flow direction, changes in pipe size, at the end of the pipeline, and at the valve locations.

The standard also contains information on wall thickness and tolerances, diameters, and applicable ASTM specifications pertaining to materials and fittings to assure uniformity in the manufacture and testing of plastic irrigation pipe. Pipe complying with the standard will also be marked uniformly to provide certain basic information, including pipe size and sizing system, I.E., PIP and the ASTM designation where applicable, type of plastic material used in manufacturing the pipe, and the pipe pressure rating.

Operation. Plastic pipe, particularly PVC, has many advantages for use in irrigation systems and, when proper installation and operating procedures are followed, will give many years of satisfactory service. The irrigation system should be operated to prevent negative pressures or unnecessary surging and waterhammer pressures from occuring in the pipeline. This can usually be done by slowly opening and closing all valves, slowly filling the pipelines, carefully controlling velocity and pressure buildup in the line at system start-up, removal of entrapped air, and careful system shut-down.

A recommended safe guide is to take at least 10 minutes to bring the pipeline to full operating pressure. For lines larger than 6 inches in diameter, longer than 1,000 feet in length, and for pressures exceeding 100 psi, take proportionately longer times to bring up the pressure.

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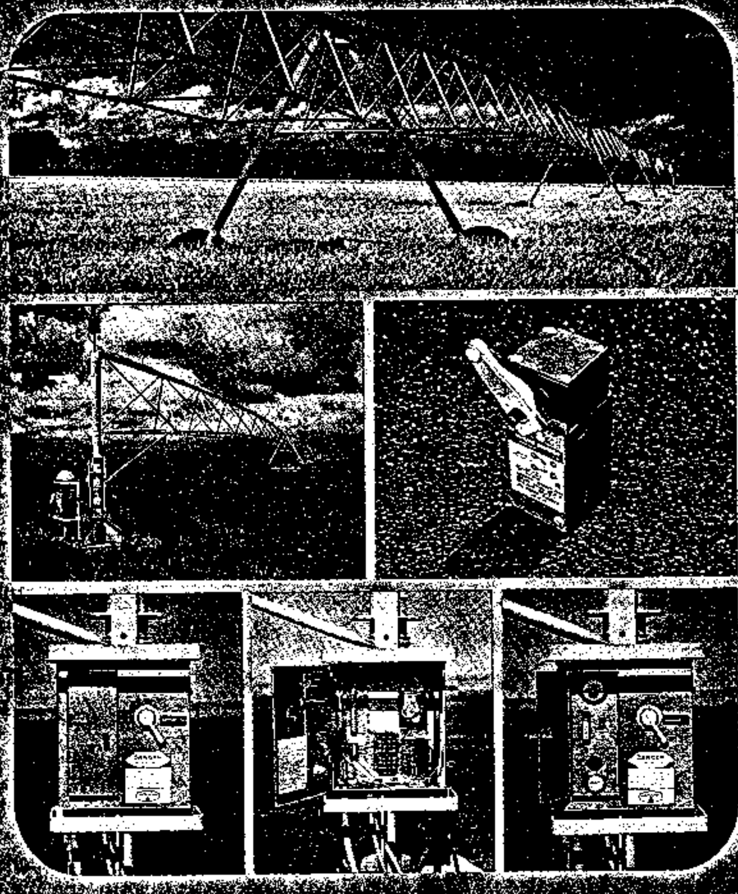

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