SOUTH DAKOTA ENGINEERING STANDARD

IRRIGATION WATER CONVEYANCE (ft)
Aluminum Tubing Pipeline (430-AA)

Definition

A pipeline and appurtenances installed in an irrigation system.

Scope

This standard applies only to buried aluminum pipelines, coated with plastic tape on the exterior surface.

Purpose

To prevent erosion or loss of water quality or damage to land, to make possible proper water use, and to reduce water conveyance losses.

Conditions Where Practice Applies

All pipelines shall be planned and located to serve as integral parts of an irrigation water distribution system that has been designed to facilitate the conservation of water on a farm or group of farms.

All lands served by the pipelines shall be suitable for use as irrigated land.

Water supplies and irrigation deliveries to the area shall be sufficient to make irrigation practical for the crops to be grown and the irrigation water application methods to be used.

Design Criteria

A. Working Pressure - The maximum permissible working pressure in the line will be determined by the following equation:

$$P = \frac{2St}{d}$$

Where:

S = 7,500 pounds per square inch

P = Maximum working pressure in pounds per square inch

d = Inside diameter of tube in inches

t = Tube nominal wall thickness in inches

B. Capacity - Design capacity shall be based on whichever of the following is greater:

1. The capacity shall be sufficient to deliver the volume of water required to meet the peak consumptive use of the crop.

2. The capacity shall be sufficient to provide an adequate irrigation stream for all methods of irrigation planned.

C. Friction Losses - Friction head losses in the pipe shall be computed by Manning's Formula as follows:

Formula: $H_f = K_p L \frac{v^2}{2g}$

Where: $K_p = \frac{5087\ n^2}{d^{4/3}}$ or $\frac{157.64\ n^2}{a^{2/3}}$

Where: H_f = Friction head loss in feet
L = Length of pipe in feet
V = Velocity of flow in feet per second
g = 32.2 ft./sec./^{2}
n = Coefficient of roughness
a = Cross-sectional area of pipe in square feet
d = Inside diameter of pipe in inches

For design purposes the value of "n" shall be considered to be 0.010 except where joints, connections, condition of the pipe, etc., indicate that a higher value is required.

D. Low Pressure Lines Open to the Atmosphere

Stands - Stands shall be used wherever water enters the pipeline, to avoid entrapment of air, to prevent surge-pressures, collapse due to vacuum failure, and prevent pressure from exceeding the design working stress of the pipe. The stand will be designed to:

1. Allow a minimum of 1 foot of freeboard. The stand height maximum above the centerline of the pipeline must not exceed the maximum working head of the pipe.

2. Have the top of each stand at least 4 feet above the ground surface except for surface gravity inlets which shall be equiped with trash racks and covers.

3. Have downward water velocities in stands not in excess of 2 feet per second. In no case shall the inside diameter of the stand be less than the inside diameter of the pipeline.

The cross sectional area of stands may be reduced above a point one foot above the top of the upper inlet but in no case shall the reduced cross section be such that it would produce an average velocity of more than 10 feet per second if the entire flow were discharging through it.

When the water velocity of an inlet pipe exceeds three times the velocity of the outlet, the centerline of the inlet shall have a minimum vertical offset from the centerline of the outlet at least equal to the sum of the diameters of the inlet and outlet pipes.

Sand traps, when combined with a stand, shall have a minimum inside dimension of 30 inches and shall be constructed so that the bottom is at least 24 inches below the invert of the outlet pipeline. The downward velocity of flow of the water in a sand trap shall not exceed 0.25 feet per second. Suitable provisions for cleaning sand traps shall be provided.

Gate stands will be of sufficient dimensions to accommodate the gate or gates required and will be large enough to make the gates accessible for repair.

Flat valve stands shall be of sufficient size to provide accessibility for maintenance and to dampen surge.

Construction shall be such as to insure the vibration from the pump discharge pipe is not carried to the stand.

Vents - Vents must be designed into the system to provide for the removal of air and prevention of vacuum collapse. They shall:

1. Have a minimum freeboard of one foot above the hydraulic grade line. The maximum height of the vent above the centerline of the pipeline must not exceed the maximum working head of the pipe.

2. Have a cross sectional area at least one half the cross sectional area of the pipeline (both inside measurements) for a distance of at least one pipeline diameter up from the centerline of the pipeline. Above this elevation the vent may be reduced to 2 inches in diameter.

3. Vents shall be located:

   a. At the downstream end of each lateral.

   b. At points where there are changes in grade in a downward direction of flow of more than 10 degrees.

   c. At summits in the line.

   d. Immediately below the pump stand if the downward velocity in the stand exceeds one foot per second.

4. A combination air-vacuum relief valve may be used in lieu of an open vent. Air-vacuum relief valves shall have a 2-inch minimum diameter. Two-inch valves shall be used for lines of 6-inch diameter or less, 3-inch valves for diameters from 7 inches through 10 inches, and 4-inch valves for 12-inch pipe.

Outlets - Appurtenances to deliver water from a pipe system to the land, a ditch, or any surface pipe system shall be known as outlets. Outlets shall have a capacity to deliver the required flow, (1) to the hydraulic grade line of a pipe or ditch, or (2) to a point at least 6 inches above the field surface.

E. High Pressure Closed Systems

Check Valve - A check valve shall be installed between the pump discharge and the pipeline where detrimental backflow may occur.

Pressure Relief - A pressure relief valve shall be installed at the pump location when excessive pressures can be developed by operating with all valves closed. Also in closed systems where the line is protected from reversal of flow by a check valve and excessive surge pressure could be developed, a surge chamber or pressure relief valve shall be installed.

Pressure relief valves shall be no smaller than ¼ inch nominal size for each diameter inch of the pipeline, and shall be set at a maximum of 5 psi above the pressure rating of the pipe.

A pressure relief valve or surge chamber shall be installed at the end of the pipeline when needed to relieve surge.

Pressure relief valves do not function as air release valves and shall not be used as substitutes for air release valves or to perform the air release function of vents or valves.

Air Release - Air release valves, which have small venting orifices and release entrapped air in lines under pressure, shall be installed at all summits.

Air and Vacuum Relief - Air and vacuum relief valves, which have large venting orifices and exhaust large quantities of air from pipeline when filling and allow air to re-enter the line and prevent a vacuum when draining, shall be used at all summits when needed and at ends of pipelines when needed to provide a positive means of air entrance or escape.

Combination air release and air-vacuum relief valves which combine both of the above listed air release and air-vacuum functions, may be used when both are needed. Air release and air-vacuum relief valve outlets of at least ½ inch nominal diameter shall be used in lines of 4 inches or less in diameter, at least 1-inch outlets shall be used in lines 5-8 inches in diameter, and at least 2-inch outlets in lines 10-16 inches in diameter.

F. Drain Requirements - Provision shall be made to completely drain the pipeline. Drainage outlets should be provided at low points in the system and may either discharge into a dry well or to a point of lower elevation. If these gravity discharge points are unavailable, provision shall be made to empty the line by pumping.

G. Joints and Connections - All connections shall be constructed to withstand the working pressure of the line without leakage and leave the inside of the line free of any obstruction which would reduce the line capacity below design requirements. All fittings such as risers, ells, tees, couplings, and reducers shall preferably be of similar metal. However, if dissimilar metals are used, proper protection against galvanic corrosion, such as separating dissimilar metals with a rubber or plastic insulator, shall be taken. The connection between the pump discharge pipe and the aluminum line shall be made with a suitable insulating material such as rubber or plastic.

H. Quality of Water - Water quality tests shall be made for all aluminum pipeline installations. Copper content in excess of 0.02 ppm will produce nodular pitting and rapid deterioration of the pipe, if water is allowed to remain stagnant.

I. Materials - Pipe and coating materials shall equal or exceed the physical requirements of SCS National Engineering Handbook, Section 2; Standard 430-AA, pages 430-AA-11 to 16.

J. Working Head - Tubing with nominal wall thickness as listed in Table I shall be acceptable for all installations where the operating pressure does not exceed 150 psi.

Table I

Tube Diameter inches	Nominal Wall Thickness, inches Acceptable All Installations to 150 psi working pressure
2	.050
3	.050
4	.050
5	.052
6	.058
7	.064
8	.072
9	.082
10	.094
12	.110

K. Corrosion Protection - All aluminum tubing installed under this standard shall be wrapped with a plastic tape for corrosion protection. All joints and field connections shall be field wrapped with plastic tape and bonding material.

L. Placement - All pipe shall be placed deep enough below the land surface to protect it from hazards imposed by traffic crossings, farm operations, freezing temperatures, or soil cracking. Two feet minimum cover shall be provided except in soils subject to deep cracking, where the cover shall be a minimum of 3 feet. Extra fill may be placed over the pipeline to provide the minimum depth of cover of the top width if the fill is not less than 10 feet and side slopes are not steeper than 6 to 1.

For traffic crossings pipe may be encased in corrugated metal pipe or other protective measures.

M. Thrust Control - Abrupt changes in pipeline grade, horizontal alignment, or reduction in size require an anchor or thrust block to absorb any axial thrust of the pipe.

Thrust blocks shall have a minimum thickness of 6 inches and a minimum height equal to the outside diameter of the pipe. The blocks shall fill the space between the pipe and the undisturbed earth at the side of the undisturbed earth or earth compacted at least to the density of the surrounding natural material. Blocks at ends of lines where the maximum working head exceeds 25 feet shall be reinforced concrete.

The area of thrust block required is given by the following formula:

$$A = \frac{98\ HD^2}{B} \sin \frac{a}{2}$$

Where:

H = Maximum working head in ft.

D = Inside diameter of pipe in ft.

B = Allowable passive pressure of the soil in lbs. per sq. ft. (soft clay = 1000, sand = 2000, and sand and gravel = 3000.

Peat and muck = 0 so block weight must = thrust = $98\ HD^2$.)

a = Deflection angle of pipe bend (at ends of lines a = 180°.)

Anchors and thrust blocks shall be constructed of either:

1. Concrete poured to fill the space between the pipe and the undisturbed earth at the side of the trench on the outside of bends.

2. Soil cement with at least one part of cement to 12 parts of soil of sandy loam or coarser texture, similarly placed and thoroughly tamped.

N. Water Bars - Small diversion dikes (water bars) shall be installed across the completed trench on long slopes or other locations where runoff water could become concentrated.

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430 - AA

Planning considerations for water quantity and quality

Quantity

1. Effects on the components of the water budget, especially infiltration and evaporation.

2. Effects on downstream flows or aquifers that would affect other water uses or users.

3. Potential use for irrigation water management.

4. Effects of installing a pipeline on vegetation that may have been located next to the original conveyance.

Quality

1. Effects of installing the pipeline (replacing other types of conveyances) on channel erosion or the movement of sediment and soluble and sediment-attached substances carried by water.

2. Effects on the movement of dissolved substances into the soil and on percolation below the root zone or to ground water recharge.

3. Effects of controlled water delivery on the temperatures of water resources that could cause undesireable effects on aquatic and wildlife communities.

4. Effects on wetlands or water-related wildlife habitats.

5. Effects on the visual quality of water resources.