1-1-1978

G78-392 Selecting and Using Irrigation Propeller Meters (Revised May 1984)

Dean E. Eisenhauer
University of Nebraska - Lincoln, deisenhauer1@unl.edu

G78-392-A
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Selecting and Using Irrigation Propeller Meters

This NebGuide discusses the use of propeller type irrigation meters to monitor irrigation water use.

Dean E. Eisenhauer, Extension Irrigation Specialist

Measuring irrigation water is important in efficient water management. Measuring water can be used for the following purposes:

1. Checking irrigation efficiency
2. Determining pumping plant efficiency
3. Detecting well and pump problems

There are several instruments available to measure water flow in pipelines. These include differential meters (orifice and venturi), electromagnetic meters, ultrasonic meters, pitot tubes, and propeller meters. This NebGuide discusses propeller type meters.

Propeller meters register the total volume of water that has passed through the meter section. They also have the options necessary to measure rate of flow. An analogy to this is the odometer and speedometer in an automobile. Both flow rate and total volume pumped are important to the irrigator. This, plus factors such as reliability, ease of installation and operation, and economics make the propeller meter a practical method for on-the-farm use.

Selecting Propeller Meters

Propeller meters use a helical-bladed propeller made of a polymer or plastic material. The propeller rotates on a horizontal axle which drives the volume and flow rate indicator.

The propeller shaft usually rotates on a minimum of two bearings. The bearings and shafts are made of stainless steel or an equivalent noncorrosive material.

The drive assembly can be either direct or magnetic. The magnetic drive provides for a fixed seal in the housing between the propeller and the indicating head. Direct drives use a packing-type seal.

Meter Must Match Inside Diameter of the Pipe

The propeller measures the velocity of the water in the pipeline or meter section. To obtain correct registration of the flow rate and/or accumulated volume, the gear ratios in the indicating head must correspond with the *inside diameter of the pipe (I.D.)*. Therefore, when ordering a saddle-type meter, the pipe I.D. must be specified. As an example, if a meter is geared for a 6-inch, .051 wall, aluminum pipe (5.898 inches I.D.) and is installed in a standard 6-inch steel pipe (6.065 inches I.D.), the meter will register 5 percent low. Some companies use a correction factor to account for various I.D.'s rather than changing gears. This should be checked when buying the meter. A recommended practice is to buy the meter already installed in a pipe section complete with straightening vanes.

Size According to the Recommended Flow Range

The size of the meter selected will depend on the nominal size of the irrigation pipeline, the range of flows to be measured, and the head loss characteristics of the meter. The range of flow should be the highest consideration. At lower flow rates, the accuracy of the meter will drop off as illustrated in *Figure 1*.

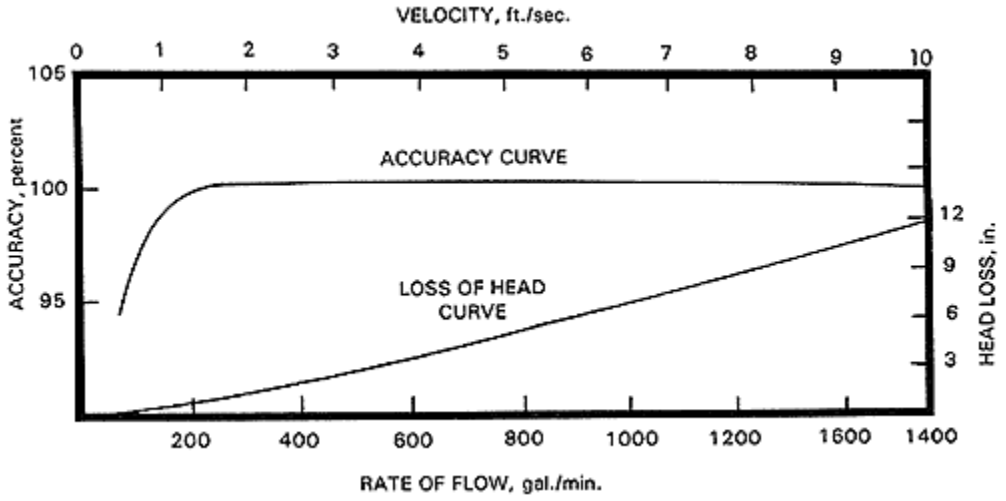

Figure 1. Typical accuracy and head-loss curves for propeller meters.

The diameter of the propeller is usually 50 to 80 percent of the diameter of the pipe. Smaller propellers (relative to the pipe diameter) have a narrower recommended flow measurement range.

When selecting a meter, make sure the lowest anticipated flow rate will be measured at 100 plus or

minus 2 percent accuracy. *Table I* lists the common flow ranges suggested by manufacturers for various sized meters. Note the effect of the smaller propeller.

Table I. Common recommended flow range for propeller meters

Meter Size, Inches	Minimum Flow		
	Regular Propeller	Maximum Flow	
	GPM	GPM	GPM
4	---	60	400
6	300	100	900
8	500	120	1,200
10	700	160	1,600
12	900	200	2,000

Meter Head Options

All propeller meters have a volume totalizer on the indicating head. Most companies have the option to add a sweep hand that can be clocked for flow-rate calculations and/or a flow-rate indicator. Several options are illustrated in *Figure 2*. The meter can be calibrated in whatever common units the buyer desires. Acre inches, acre feet, gallons, and cubic feet are common units for volume. Common flow rate units are gallons per minute and cubic feet per second.

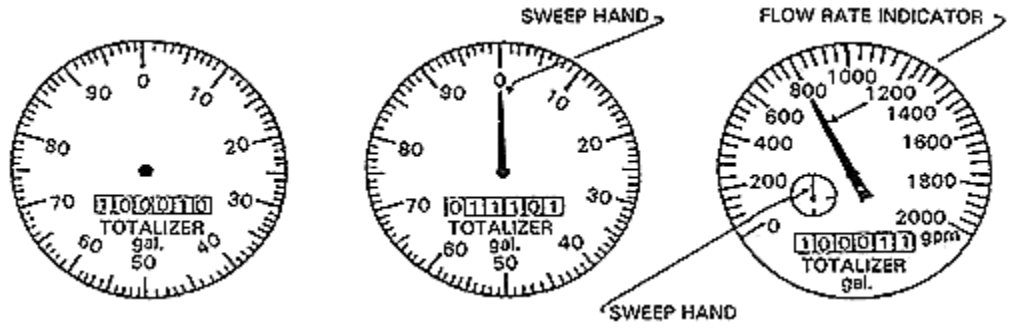

Figure 2. Options available on indicating head.

Installation

Most meter manufacturers offer a wide range of fittings on their meter section so that they can be installed in essentially every irrigation application. Examples of sections and fittings include flanges, aluminum couplings, victaulic couplings, weld-on saddle meters, clamp-on saddle meters, or tubes which can be welded in or installed with dresser couplers. Meters can be installed in a buried pipeline with the indicating head extended above ground.

Excessive Turbulence and Spiraling Must be Eliminated

Proper installation of flow meters is one of the most important criteria for accurate flow measurement.

Spiraling and turbulent flow in the meter section caused by valves, pumps, reducers, increasers, tees, and elbows will reduce the accuracy of the reading. Because of this, most manufacturers recommended a *minimum of five* straight pipe diameters without obstructions ahead of the propeller and at least one straight pipe diameter without obstructions downstream from the meter. As an example, an 8-inch meter requires 40 inches of straight pipe between the propeller and the fitting. For better results, *ten diameters* or more are preferred upstream. If space does not allow for ten diameters, straightening vanes in the pipe section ahead of the meter are recommended. Again, purchasing a meter already installed in a pipe section with straightening vanes is recommended. *Figure 3* shows a meter section complete with straightening vanes.

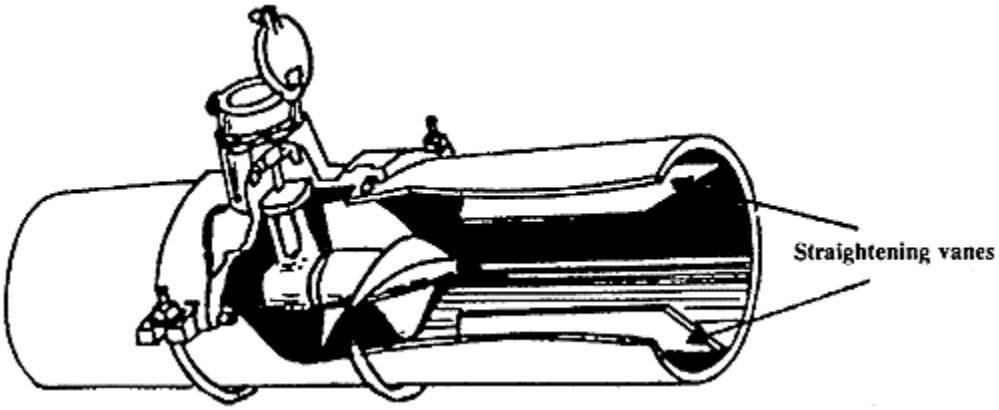

Figure 3. Typical irrigation propeller meter.

The position of saddle meters in the meter section is also important. The propeller shaft should be in the center of the pipe. And, the centerline of the shaft should not be at an angle to the centerline of the pipe.

Proper meter installation is usually easiest during the initial installation of the irrigation system rather than as an afterthought. When metering is planned for during the installation of the irrigation system, enough space can be left for the required length of straight pipe.

Pipeline Must Flow Full

Propeller meters can be installed in any position that is convenient; i.e., vertical, horizontal, or at an angle. It is important that the meter section is always flowing full. A valve downstream of the propeller or blocking the pipeline up higher than the meter section may be required to guarantee full pipe flow.

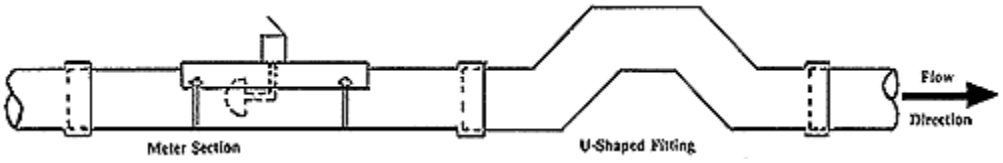

Figure 4. U-shaped fitting installed to guarantee full pipe flow in the meter section.

Another method is to install a "U-shaped" fitting downstream from the meter (*Figure 4*). This fitting can be fabricated by most irrigation dealers.

Maintenance

Propeller meters are no different from any other piece of machinery -- they require maintenance and care. Follow the manufacturer's maintenance recommendations. Some meters require periodic lubrication.

Anything that causes the propeller to drag will cause inaccurate measurement. Therefore, check the meter periodically to make sure the propeller spins easily. If it doesn't, check for obstructions that may cause the propeller to bind or for a worn shaft, bearing, or gear.

A good way to store meters during the off-season is to set them on end with a board over the top. Keep rodents from the propeller.

Clocking A Propeller Meter

Flow rates can be determined by clocking the volume totalizer or the sweep hand. Flow-rate indicators are sometimes inaccurate. Clocking can be used to check the flow-rate indicator. The following equation can be used in conjunction with the equivalents in *Table II* to calculate flow rate after clocking the meter.

Gallons per minute = Volume Timed (gal) × 60 ÷ Time in Seconds

Example: Volume timed = 0.001 acre feet = 325.9 gal. (from *Table II*)

Clocked time = 20 seconds

GPM = 325.9 × 60 ÷ 20 = 978 GPM

Calculating Water Applied

Following is an example of how to use meter readings to calculate the depth of water applied to the field.

Example: Field size = 55 acres

Meter reading after irrigation = 58,924,000.

Meter reading before irrigation = 53,984,000.

Gallons applied = 4,940,000

Acre inches applied = 4,940,000 ÷ 27,154 (from *Table II*) = 181.9 acre inches.

Depth applied = 181.9 acre inches ÷ 55 acres = 3.3 in.

Table II. List of equivalents		
1 acre foot	=	325,851 gallons
1 acre foot	=	43,560 cubic feet
0.001 acre foot	=	325.9 gallons
1 acre inch	=	27,154 gallons
1 acre inch	=	3,360 feet
1 cubic foot	=	7.48 gallons
450 gallons/minute	=	1 acre inch in one hour

File G392 under: IRRIGATION ENGINEERING
B-8, Irrigation Operations & Management
Revised May 1984; 12,000 printed.

Issued in furtherance of Cooperative Extension work, Acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture. Elbert C. Dickey, Director of Cooperative Extension, University of Nebraska, Institute of Agriculture and Natural Resources.