Comparison of
CST impeller type flow sensors paired with irrigation control valves
Vs.
Netafim/Bermad Hydrometers

Introduction

The measurement and control of water flow in irrigation systems has become increasingly more popular as a water conservation and control measure. Once only available with high end central control systems, technology has brought this added capability to stand alone controllers for smaller commercial and residential applications. These "Smart" controllers can interpret a rate of flow input signal, compare it with data stored in memory and initiate control actions through valve outputs. Continual monitoring, comparison and control can increase water use efficiency and improve landscape quality. However, results can vary greatly with the quality of the input and the ability of the control logic.

There appears to be some debate and many varying opinions comparing the use of a combination flow sensor and control valve (a hydrometer) vs. the separate Creative Sensor Technology flow sensor and a commercial grade irrigation control valve as the input and output devices in a control system. This white paper is intended to identify pros and cons of both types of products in terms of performance, accuracy and cost. The control logic will not be discussed at this time.

It is recognized that site conditions or personal designer preferences may also dictate product selection that is not address in this analysis.

Assumptions

In the interest of comparing the combination flow sensor/master valve product marketed by Netafim USA or Bermad, Inc. as the Hydrometer with a CST flow sensor and separate master valve, performance criteria of Hunter ICV, Superior 3000 Series and Nelson 800 Series control valves have been used. Other commercial irrigation valves would have similar performance but should be validated as a matter of practice.

Comparative Data

First let's look at published data in terms of available product features and sizes.

Available Sizes

CST Flow Sensor Series		Typical Hydrometer Series	
Available Size	End Connection	Available size	End Connection
1"	PVC Socket	NA	None
1 1/2 "	PVC Socket	1 1/2" MPT	MPT
2"	PVC Socket	2" FPT	FPT
3"	PVC Saddle	3"	Metal Flange
4"	PVC Saddle	4"	Metal Flange
6"	PVC Saddle	6"	Metal Flange

In this table, CST offers a wider range of flow sensors particularly in small sizes. CST has a 1-inch PVC Sensor in the FSI series, Hydrometers is not offered in this size. With today's emphasis on drip irrigation, stream rotors and other lower precipitation products, smaller irrigation zones and lower flow rates require smaller size, more sensitive flow sensors. CST FSI series includes a 1- inch PVC sensor that measures flow rates below 1 gpm. This cost effective sensor features socket connections to easily install on PVC piping without adapters. PVC saddles design requires no extensive over-excavation compared with a flanged or MPT/FPT connection.

Operating Flow Range of Sensors

CST "Tee-type" sensors measure flows from ¼ to 15 fps (feet per second) and "Saddle-type" sensors measure flow from 1/4 to 12 fps.

By contrast, flow measures can vary from size to size for a typical hydrometer for irrigation purposes. The following table shows the published minimum and maximum flow rates in gallons per minute for both products.

CST Flow Sensor Series			Typical Hydrometer Series		
Available Size	Minimum	Maximum	Available size	Minimum	Maximum
1"	0.86	52	NA		
1 1/2 "	1.8	108	1 1/2" MPT	1.8*	55
2"	2.8	170	2" FPT	5.3	95
3"	6	300	3"	14	220
4"	10	480	4"	21	380
6"	30	1000	6"	53	860

- Hydrometer claims 1.8 gpm minimum flow but many irrigation controllers cannot accept any pulse rate slower than 4 pulses per minute. So the effective minimum is 4 GPM.

So, CST flow sensors detect lower flow rates in all cases. They also measure to a higher flow rate in every size. Installing a smaller CST flow sensor size enhances the ability to detect leaks and will save costs without sacrificing the ability to measure larger flow

zones.

CST sensors can measure lower flows because the sensing device, the impeller, is smaller and lighter than the rotor in the Hydrometer and the sensor insert and mounting tee have been custom designed to enhance the path of the water through the device.

Signal Output

CST sensors are most commonly used with a 2 wire, square wave frequency output. The connected controller provides DC power to the sensor in a range of 8 to 36 VDC. While other electronic configurations are available, this is the standard that the irrigation industry has been using for 30 years. CST flow sensors are compatible with all irrigation controllers capable of monitoring flow.

Hydrometer outputs are generally a reed switch contact closure magnetically coupled to the totalizing gear train. They produce 1 contact closure per revolution of the register typically 1 pulse per gallon in meters up to 4 inch and 1 pulse per 10 gallons in 6 inch and larger meters. This contact closure output was developed for totalizer applications. When driven into frequency ranges (above 5 pulses per second) the mechanical switch may bounce causing pulses to be missed or over counted. To update this old technology, Hydrometer offers a 3 wire higher frequency photo-diode output. This device requires three wires to connect the meter to the controller and is not constructed for underground service nor protected against mis-wiring or high voltage.

Friction Losses

The table below lists published friction losses through competitive globe-style remote control valves when compared against typical hydrometer series. Friction losses will vary not only between different valve sizes but valve materials (plastic vs. brass) and lastly valve configurations (globe vs. angle). Verify the friction losses of the valve to be used for comparative purposes.

Pressure drop comparison of master valves with Hydrometer at maximum flows

		Hunter ICV	Superior 3000	Nelson 800		Hydrometer
Available Size	Flow Rate					
1 1/2 "	55	2.6	3.2			5.7
2"	95	3.7	3.0	0.8		7.4
3"	220	5.3	5	1.7		5.7
4"	380			0.9		7.5
6"	860			1.0		6.1

The CST Series "Tee" type flow sensors have virtually no pressure loss throughout their range of operation. Pressure drop readings during flow tests indicate less than a 0.1 lb. pressure drop at 10 fps flow rates. However, for comparison purposes the table shows the pressure drop comparison between selected irrigation valves used as master valves and hydrometers.

Because the CST sensor can operate over a wider range of flows with practically no friction loss, an argument could be made for using a one size smaller CST flow sensor and Nelson master valve, to reduce cost and lower the minimum measured flow rate. The CST flow sensor with its extended range can operate at 2 ½ to 3 times the design flow rate of the pipe while the Nelson 800 master valve can control the larger flow with significantly less pressure loss than a hydrometer series. Example, a 2 inch FST-T20-001 sensor and 2 inch Nelson 800 will measure up to 170 gpm with a friction loss of less than 3 psi. A hydrometer would be sized at 3 inch and create a pressure drop of 3.7 psi.

Serviceability

CST Sensor Assembly
The CST sensor insert is held into the mounting tee or saddle of a larger diameter, ACME threaded retaining nut making disassembly and assembly quick and easy, particularly in underground valve boxes. The only moving part is the impeller. The molded HDPE impeller has an integral high clearance, self-flushing bearing allowing it to handle suspended solids. The wide open flow passage will handle solids or debris that may be found in re-cycled or reclaimed water. Replacement impeller/shaft kits are available for $35.00 and take less than a minute to install. Servicing needs to be completed with the mainline depressurized and partially drained.

Hydrometer Assembly
The flow sensing portion of the device is located inside the cast iron body and is accessed by removing the meter register assembly, the top cover and the valve diaphragm assembly and spring. Then the impeller and shaft may be removed for cleaning or replacement. Handling these five or six parts plus six or eight nuts and bolts while keeping the body clean in an underground valve box may take some time. These too require servicing with the mainline de-pressurized and drained.

Ease of installation

The most commonly heard reason for using a hydrometer is the claim that it is much easier to install. Hydrometer combines flow sensing and valve control in one housing, eliminating the need for a straight pipe section before and after the flow sensor. This is valid particularly in situations where a flow sensor and control valve are being retrofit into existing piping systems where there is insufficient horizontal piping distances to accommodate two separate components. But how much easier is it? In small diameter piping, 1 ½ or 2 inch applications, the total difference in laying length between the CST flow sensor plus master valve and a hydrometer may amount to less than 10” for the 1 ½ inch and 15” for the 2 inch size.[1] Is more digging required, yes, but also consider handling a flow sensor that weighs less than 1 pound and a master valve that weighs less than 3.5 pounds vs. a cast iron bodied unit that weighs 16 pounds. Also, care must be taken not to damage the polyester coating on the hydrometer. Scratching the coating will expose the cast iron to corrosion which may shorten its service life. Finding an alternative site to mount the flow sensor/master valve may be a better choice.

In larger diameter piping, the net difference in laying length is similar. Straight pipe requirements are the same for separation purposes but using a saddle type CST flow sensor

means the installation is practically the same. In both cases, the installation will require cutting the pipe and adding companion flanges to connect the valve or hydrometer body to the pipe. The length of a 3 inch wafer style Nelson 800 series valve is 7 inches, making it 5 inches shorter than the 12 3/16 length of the Hydrometer flanged unit. The flow sensor, mounted 15 inches upstream of the valve only requires a single 1 ¾ inch hole be drilled in the pipe. Weight may also be an installation consideration. The CST saddle type sensor weighs less than 3 pounds and the Nelson 800 wafer valve weighs 7.3 pounds compared to 35 pounds for the hydrometer. Cost of shipping with ever-increasing cost of fuel is something commonly not considered but is a "hidden" cost not always considered when specifying product.

[1] Dimensions calculated from published dimensions of sensors, valve and Hydrometer plus fittings and pipe nipples between flow sensor and master valves.

Accuracy

It's important to note that "accuracy" may be stated in so many ways that it is often mis-interpreted or misunderstood. Often times more than just published figures must be taken into consideration to determine the best product to use.

The accuracy of a measurement system may be defined is the degree of closeness of measurements of a quantity to that quantity's actual (true) value. However, accuracy is often stated with varying conditions to make the results in product specifications more favorable to the product being described.

Accuracy statements for flow measuring devices may compare the indicated or signaled quantities with the actual quantity as a percentage, but caution must be used to interpret the conditions attached to the number:

- Is it a percentage of rate of flow or volume?
- Is it stated as a percent of full scale or actual rate?
- Is it stated as plus or minus X% or just a percentage? Two such devices advertising accuracy of 2% could disagree by 4% and still be within the specification.
- Does the statement narrow the measurement range to "tighten" the percentage?

Both CST flow sensors and hydrometers are most commonly used in irrigation applications as rate of flow sensors to supply data to an irrigation controller capable of making logical control decisions based on that data. The controller receives the information from the flow sensing device as a stream of pulses or frequency.

Creative Sensor Technology does not publish it sensor accuracy. However, to establish our calibration constants, the K and Offset numbers used to convert our frequency output to a flow rate by the irrigation controller, we employ the services of NIST traceable calibration laboratories to collect data from multiple sensors over the full range of flow for each given size. The data is analyzed using linear regression techniques to produce conversion constants for each flow sensor size. Mathematically these numbers may be expressed by the equation GPM= (FREQ+Offset)/K. Individually, the frequency, produced by a flow sensor may be within +/- 1 % of actual flow.

CST sensors are true "rate-of-flow" devices, measuring the speed of the water as it travels

through the pipe. They produce a frequency in the range of 2- 150 Hz (cycles per second) proportional to the velocity of the water. This frequency equals about 90 pulses per gallon for a 1 ½ inch sensor. A hydrometer is actually a mechanical totalizer fitted with a switch output that closes every time the gear assembly makes one revolution, resulting in an output of 1 pulse per gallon for all meters up through 4 inch size.

How the firmware in the microprocessor in the irrigation controller processes that information may have more to do with overall accuracy than the flow sensing device. Consider the consequence of missing pulses at the beginning or ending of an irrigation cycle, or while the microprocessor in the controller is performing other functions.

In the case of the CST sensor, the missed pulse represents fractions of ounces while the Hydrometer pulse represents a gallon.

Furthermore, when measuring higher rates of flow, the CST sensor is still measuring velocity and producing a digital frequency within the same range. A hydrometer equipped with the reed switch maintains the same one-gallon value per pulse. At higher rates of operation, a mechanical reed switch may begin to float or bounce. Can a mechanical switch open and close faster than six times per second without adding or missing pulses as it would be required to do to measure 380 gpm with a four inch hydrometer?

Cost Comparison

The combined list prices for a CST flow sensor and commercial grade master valve is less than ½ the list price of a Netafim Hydrometer with reed switch output.[2]

[2] Comparison of 2014 pricing of CST FSI-T20-001 flow sensor and 2" Hunter ICV-201G-FS master valve with Hydrometer LHM2TG1-MEL. Choosing another valve would not change the cost comparison.

Summary

Compare the CST flow sensor and separate master valve vs. the Hydrometer

1. **CST/MV is available in a one inch size, Hydrometer is not.**
2. **CST/MV has a much broader flow range for each size often allowing smaller sizes to be used.**
3. **CST/MV has significantly lower friction loss improving performance and efficiency.**
4. **CST/MV has separate components and is easier to service.**
5. **CST/MV may not be harder to install when considering the size and weight of components.**
6. **CST/MV has a frequency output signal that may result in higher overall system accuracy.**
7. **CST/MV costs less than half the cost of the same size Hydrometer.**

This white paper is intended to provide fact vs. fiction and to dispel misnomers specific to this topic. As previously noted, unique site conditions, design considerations and personal design preferences may also interplay or over-ride a decision to consider CST flow sensors.

Need more information, call us (508) 763-8100 or go online
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Note: All specifications taken from date published by the reference manufacturers and available on their websites