Comparison of
CST impeller type flow sensors
Vs.
FLOMEC QS200 ultrasonic flowmeter

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.

The impeller type flow sensor or flow meter, the terms are used synonymously in the irrigation market, has long been the standard type of device for measuring irrigation flow. The following features of impeller technology have made it an ideal choice for this application:

- wide range of flow measurement
- low operating pressure loss
- self-cleaning design
- long wearing bearings
- with ease of installation
- simple to troubleshoot and service

Recently, flow sensors using other technologies have appeared on the market. This white paper will compare the Creative Sensor Technology impeller type sensor with the Great Plains Industries, FLO MEC QS200 insert type ultrasonic sensor.

Comparative Data

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

Available Sizes

Creative Sensor Technology				**FLOMEC**		
Series	Available Size	End Connection		Series	Available size	End Connection
ELF	3/4"	PVC Socket			NA	
ELF	1"	Male Thread			NA	
FSI	1"	PVC Socket		QS200	1"	PVC Socket
FSI-B	1"	Brass Female Thread			NA	
FSI	1 1/2 "	PVC Socket		QS200	1 1/2" MPT	PVC Socket
FSI-B	1 1/2"	Brass Female Thread			NA	
FSI	2"	PVC Socket		QS200	2"	PVC Socket
FSI-S	3"	PVC Saddle		QS200	3"	PVC Socket
FSI-S	4"	PVC Saddle		QS200	4"	PVC Socket
FSI-S	6"	PVC Saddle			NA	

This table above shows that CST offers a wider range of flow sensors with different mounting options. CST has a 3/4 inch PVC Sensor in the ELF series, FLOMEC does not offer a sensor in this size. The ELF Series is also available in a 1 inch male thread version for indoor applications, or for easy conversion to any piping material. ELF sensors need no straight pipe before or after them so they can be installed in tight places. A master valve can threaded directly to the downstream side and fit in a standard rectangular valve box. ELF sensors will measure flows as low as 0.2 GPM. CST's FSI Series includes a 1- inch PVC sensor that measures flow rates below 1 gpm and a I inch brass tee for metallic piping. FLOMEC offers only a I inch PVC sensor. CST offers both a PVC and a brass sensor in 1 1/2 inch while FLOMEC offers only a PVC tee version. 2 inch PVC sensors are offered by both. For larger PVC sizes FLOMEC offers 3 and 4 inch PVC tees while CST offers 3, 4, and 6 inch saddle mounts. The saddle design is preferred by most installers because it avoids the tougher job of solvent welding larger sizes.

Operating Flow Range of Sensors

Creative Sensor Technology					**FLOMEC**			
Series	Available Size	Range - Velocity in FPS	Range -Flow in GPM		Series	Available size	Range - Velocity in FPS	Range -Flow in GPM
ELF	3/4"	0.1 - 15	0.2 - 20			NA		
ELF	1"	0.1 -15	0.2 - 20			NA		
FSI	1"	0.25 - 15	0.8 - 50		QS200	1"	0.1 - 15	0.22 - 33
FSI-B	1"	0.5 - 15	1.5 - 22			NA		
FSI	1 1/2 "	0.25 -15	1.5 - 100		QS200	1 1/2" MPT	0.1 - 15	0.55 - 82
FSI-B	1 1/2"	0.5 -15	3 -90			NA		
FSI	2"	0.25 -15	3 - 160		QS200	2"	0.1 - 15	0.92 - 138
FSI-S	3"	0.25 -12	6 - 300		QS200	3"	0.1 - 15	2 -309
FSI-S	4"	0.25 -12	10 -480		QS200	4"	0.1 - 15	3.5 -537
FSI-S	6"	0.5 -12	50 - 1100			NA		

CST ELF sensors can measure flows from 0.1 to 15 fps (feet per second), while CST FSI "Tee-type" sensors measure flows from 0.25 to 15 fps. The FSI "Saddle-type" sensors measure flow from 0.25 to 12 fps. and CST Brass bodied sensors measure flow from 0.5 to 15 fps.

Most irrigation designs feature hydro zones that are well above the lower limit for the practical reason of cost effectiveness. No one can afford to oversize the piping system and control valves to the point where flow rates are below 2 or 3 feet per second. At the other end of the range, most design criteria limit the maximum rate of flow through piping systems at 5 to 6 feet per second to limit friction losses and water hammer. CST flow sensors should be sized to the flow range not pipe size and a smaller size than the pipeline may often be installed.

FLO MEC QS200 sensors have a published flow range of 0.1 to 15 feet per second, very similar to CST. They are able to measure somewhat lower minimum flows, but in practical application, there is a 1 gallon per minute difference in the minimum flow rates of both 1 1/2 inch size sensors. At the other end of the scale at maximum flow, both sensors claim to measure 15 feet per second in velocity, but FLO MEC's published maximum flow rate in GPM is 18 gpm less than CST's published rate. No explanation is given for this difference.

Friction Loss

CST flow sensors are designed to have a smooth, straight through water passage interrupted only by the blade of the impeller that is turning on a low friction axle. This design results in very low friction loss or pressure drop across the device. We publish the friction loss to be less than 0.1 lb at a velocity of 10 feet per second.

FLO MEC has a straight through design but it appears to be more restrictive than the CST unit. No information on pressure loss could be found in their literature.

Pressure Rating

Working pressure rating at 70° F.

CST Sensors:

ELF Series 240 psi
FSI Series PVC Tee type 240 psi
FSI Series Brass Tee type 250 psi
FSI Series Saddle Type 150 psi @ 90°F
(limited by saddle specification)

FLO MEC Sensors:

QS200 Series 150 psi

⚠ The FLO MEC QS200 sensor was designed to replace existing Data Industrial sensor inserts so it had to use the same mounting arrangement. Data Industrial sensors are only rated at 100 psi because of failures caused by the mounting design. The retaining pin is located very near the top of the mounting tee. Over time, under continuous higher pressure, the PVC material stretches until it fails due to a phenomena called PVC creep. Since the FLOW MEC design is very similar, long term exposure to the rated pressure could cause the tee to fail.

Accuracy

FLO MEC publishes a rate of flow accuracy of 2% in their bulletin IND-1105 dated 419. Creative Sensor Technology does not publish accuracy figures because there is no standardized definition used in the irrigation industry. In an independent testing agency, under laboratory conditions, CST sensors have been found to have a margin of error of less than 2%of rate of flow. However, this means nothing in real world applications.

1. Any accuracy statement must be defined by parameters and qualifying statements
2. In all extruded pipe, there are manufacturing tolerances that change the internal diameter of the pipe rendering any velocity measuring sensor to less accurate than presented.
3. Accuracy of a flow reading depends on the receiving flow monitor or controller as much if not more than the sensor. What purpose does knowing the accuracy of the sensor serves unless you also know the accuracy of the controller?

Serviceability

Creative Sensor Technology

Sensors are available in socket weld tees for PVC installation, threaded Brass and Noryl for use with any pipe material and clamp-on saddles for large diameter PVC pipe. Saddles make the installation much quicker, cleaner and more secure than solvent welding 3, 4 or 6 inch pipe.
All sensor inserts are self aligning, and the jar top retaining nut sets the depth and holds the insert in place. The insert is easily removed even from a 7 inch round valve box.

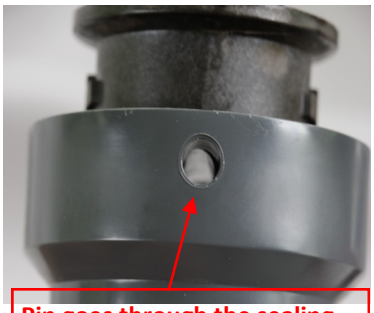
FLO MEC

Sensors are available only in socket weld tees for PVC installation. Even for 3 and 4 inch pipe Requiring a higher level of skill to weld in place particularly on hot days.
Sensor inserts are not self aligning and require two hands in the valve box to feel where the hole in the insert lines up with the holes in the tee to insert the pin.
Then he split ring must be opened and guided through the drill hole on the pin again a two handed job.

⚠ The CST flow insert is entirely contained in the top of the tee with only the impeller in the flow path. The FLO MEC insert must be pushed all the way to bottom of the mounting tee. Any silt or sediment can jam the insert making it very difficult to remove or re-install. If the insert isn't pushed all the way to the bottom, then the pin will not fit through the holes and secured.

Things to Know

1. FLO MEC claims to be new technology when if fact the technology was patented in the 1950s. CST has received a new patent on its ELF impeller sensor in 2018.
2. FLO MEC published an introductory bulletin referenced 4/19 IND-1105.
    - They stated that the retrofit insert is compatible with all Data Industrial PVC Tees. Reliable sources say it does not fit in the 1 1/2 inch tee.
    - By making an insert that can retrofit existing Data Industrial tees, which are nothing more than a modified plumbing tee, they incorporated one of the worst features of the Data Industrial sensor-its mounting arrangement. Tee insert is held in the tee with a pin that passes through the encapsulation that is supposed to seal the electronics. Trying to seal underneath a round pin is nearly impossible and is the reason Data Industrial sensors fail so often. Additionally, this pin is located in the wrong position. It is too close to the top edge of the tee. This location does not provide the strength to hold the insert in the tee over the wide range of pressure. Notice that Data Industrial only rates their PVC sensors at 100 PSI. FLO MEC has to use very similar dimensions for its tees, How can they be rate any higher? What will be the long term result of this poor design?



Pin goes through the sealing epoxy in the insert and is too close to the top of the tee

- FLO MEC states that they have a one inch PVC Sensor and that CST does not, of course that's an error, CST has 3 one inch sensors, PVC, Brass and Noryl.
- FLO MEC makes a point of not having any moving parts claiming that they wear out. How many impellers have you changed? Impeller wear is almost never a problem. Having a moving impeller makes trouble-shooting easier for the contractor.

- FLO MEC also makes the claim that no moving parts are maintenance free, they don't mention that silt and sediment can coat the ultrasonic transmitters and reflectors making the readings inaccurate.
- FLO MEC also states in their Features/Benefits section that the is the "ideal meter for clean water applications. What they don't mention is that they need clean water and don't measure accurately in water containing any impurities like silt, sediment, or even bubbles or turbulence. Ultrasonic sensors transmit acoustic signals across the path of flow. Anything that interrupts those signals even for an instant, changes the accuracy. Are all your irrigation sources clean water?

3. FLO MEC claims they have higher accuracy than other meters and in fact criticizes CST for not publishing any accuracy figures. Consider these facts:
    - There is no standard way of stating accuracy. Every manufacturer may use language that puts their device in the best light.
    - Repeatability, the ability to produce the same signal for the same flow rate time after time is more important in irrigation applications.
    - The measurement accuracy of any insertion type flow device is dependent on all kinds of variables; the location in the piping system, the class schedule and type of pipe, the depth and alignment of the insert. So, any number that is produced in a calibration laboratory may never be attained in the field.
    - All flow sensors or flow meters used in irrigation control systems transmit an output signal to be used by an irrigation or pump control device to display, record or use that signal for control. The accuracy of the flow measuring device is meaningless without including the accuracy of the receiving device. Does Rain Bird, Toro, Hunter or Weathermatic publish the accuracy of their flow calculating algorithm? The overall accuracy of a measuring system is the product of the sensing device accuracy times the accuracy or the receiving device. So a flow sensor that has an accuracy of 98 percent connected to a control device with an accuracy of 97 percent may display flow that could be off by 5% high or low.

4. FLO MEC claims they can "detect leaks at 0.1 fps. That may be the case, or it could be just noise or vibration. Ask the manufacturer of the control system your using if they can receive signals that low. Many of them can't.

Conclusions

1. Both CST and FLO MEC offer sensors that measures flow rate, using proven detection technologies.
    - The flow ranges for each size are similar with FLO MEC having a slightly lower minimum flow and CST a slightly higher maximum flow.
    - The pressure ratings of both products are acceptable for use with most irrigation systems using PVC or polyethylene piping systems. But the higher rated CST sensor will withstand higher surge pressures and last longer even at lower working pressures.
    - Friction loss may be similar although FLO MEC does not report theirs, both products are certainly much better than domestic style water meters.
    - CST sensors are easier to install and service by design
    - Cost difference between the two products is not a large factor

2. CST has a wider product line and accessory products that make connecting multiple sensors, sharing sensors or retrofitting sensors easier.

3. CST has a proven track record of fast delivery, excellent customer support and reliability backed by a lifetime warranty against manufacturing failure on flow sensor inserts.

4. What provides you with the best value?