Latest Trends in Open Channel Flow Measurement

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Introduction

In July 2008, I was interviewed by *Water and Wastes Digest* for an article that was published in August of that year on the trends in open channel flow measurement and associated technologies. While none of my observations were Nostradamus-like by comparison, much of what I saw as trends then have become commonplace today.

Almost every customer conversation I have today carries similar themes. Customer responsibilities have grown. Teams are short-staffed and being asked to do more flow monitoring with little chance of adding headcount. Budget constraints are constant, so customers need the lowest total cost of ownership. Lastly, improved data quality, reliability, and real-time system awareness round out the list of common wishes. One way to meet all these requirements is to become more efficient.

The goal of any flow monitoring program is to obtain good flow data. The less effort and resources we have to expend to acquire that good data, the more productive we become. To become more efficient at anything, we need to reduce or eliminate waste. Lost data (due to fouling or sensor damage), scrubbing sensors, over processing (installing and maintaining area velocity sensors where level only sensors are needed), traffic control, manually downloading data, and laborious data editing are just some examples of wasteful tasks you may be doing with your traditional flow meters and sensors.

Imagine how much more productive and efficient you and your team would be if you could reduce or eliminate these chores.

A modern flow monitoring system can provide you with good data, but that data does you no good if it is sitting in the flowmeter waiting to be collected. Data needs to be accessible and actionable. In this instant-information society we live in, it's no longer acceptable to find out about an overflow by watching the evening news. You need to know BEFORE manhole lids start flying, basements start flooding, or beaches are closed. Real-time data accessibility and notification alerts help you manage your flow network like never before, helping you be proactive rather than reactive.

Here's what I see trending in 2016:

Non-Contact Sensors

While not exactly a new trend, non-contact sensors are gaining more acceptance, and as a result, more widely used than ever before. Non-contact sensors have many benefits. Non-contact sensors are mounted above the flowing water, meaning they won't foul under non-surcharge conditions. If the sensors stay clean, that translates into less lost data, better data, reduced maintenance, and longer sensor life. Let's dive deeper into each benefit:

Less lost data/better data – The number one cause of lost and/or bad data is sensor fouling. If your sensors are non-contacting (mounted above the flow), they are less likely to foul.

Longer sensor life – Besides being susceptible to fouling, submerged/wetted sensors are subjected to constant bombardment by sand, grit, rocks and construction debris. Let's not forget all the wastewater, petroleum products, and chemicals the sensors are soaking in.

Reduced sensor maintenance – A sensor that isn't fouling requires far less maintenance. Sensor maintenance typically requires confined space entry, traffic control, multi-person crews, and, on average, about an hour per maintenance event per site.

Less lost data, better data, longer sensor life, and reduced maintenance add up to much improved total cost of ownership; real savings you can quantify for yourself.

Non-contacting sensors come in two types: area velocity and level only.

Non-contacting area velocity measurement is more than a trend. It is the standard bearer of modern flow measurement. Methods vary from manufacturer to manufacturer, but in general, area velocity measurement is accomplished using a Doppler velocity sensor and ultrasonic (typical) level sensor mounted above the flow.

Both technologies often reside inside of one enclosure for mechanical convenience and cabling ease. Highly evolved algorithms convert the Doppler velocity data to average velocity and the ultrasonic sensor provides the depth of water which in turn gives us the wetted area.

Average velocity times the wetted area (thus the term area velocity) is equal to the flow rate. If I have 0.5 ft^2 of water moving at 4 ft/s my flow would be 2 ft^3/s. Area velocity is accurate, reliable, and applicable to a wide variety of site conditions and applications. Additionally no flume or weir type structure is required. These features make it ideal for your critical flow monitoring needs such as modeling, billing, I&I, stormwater and process control.

The technology of choice for non-contacting level sensors is ultrasonic. This technology has been popular for decades in weir and flume applications. The ultrasonic sensor works by bouncing an ultrasonic pulse off the water's surface. The time it takes for the pulse to make the round trip is used to calculate the distance by using the speed of sound. When installed over a flume or weir with a known flow curve corresponding to water level, an ultrasonic sensor can provide a reliable and accurate flow measurement. Ultrasonic sensor applications include irrigation, collection system, industrial discharge, and influent/effluent of treatment plants.

Over the past several years, I have witnessed an increase in the use of ultrasonic sensors to collect correlative data where accuracy is less important than the trend information that a level only sensor can provide. I am speaking of applications where primary device structures like flumes and weirs are not present. I like to call this application "network extension." Because they inexpensively extend your network of flow meters, accuracy may be less important than being able to see tendencies. Install a handful of ultrasonic sensors and over time identify differences between dry and wet weather flow indicative of I&I. Then allocate more accurate area velocity sensors in locations where they are needed most to quantify the flow.

Complete system awareness can be achieved by utilizing area velocity in the critical sites like billing applications, and ultrasonic sensors to provide additional data where needed. Connect any of these sensors to a wireless data logger with alarm notification capabilities and you can manage your system more efficiently than ever before.

Wireless Data Transmission and Alarms

The benefits of data loggers that are capable of wireless data transmission are game changers. Let's start with the fact that you can receive your flow data and alarms in real- or near-real time. Access your data from anywhere on practically any device that has an internet connection and a web browser with no additional software or applications to install. Imagine getting an e-mail or text alert from one of your monitoring locations informing you that you are dangerously close to an overflow event. Safely retrieve and review data without having to go on-site, re-direct traffic, or open manhole lids. Monitor your systems health and allocate resources to perform maintenance only when needed.

One under-utilized aspect of wireless loggers is the notification. Alarms can be triggered on any parameter that is stored in the flowmeter/data logger memory. For example, set an alarm on a high level and the logger can send a message to your maintenance crew. Set another alarm to alert you of a pending overflow condition with the same or a totally different set of alarm recipients. Need to collect a stormwater sample? Set an alarm to notify your team and trigger the start of an automatic sampler based on flow and or rain triggers. The alarm possibilities are vast and all this functionality is included at no extra charge with the wireless logger!

Data Delivery

A growing number of customers want good flow data, not a flowmeter inventory and the related maintenance/repair and update costs associated with

those inventories. For a set monthly fee, data delivery provides the data and an uptime guarantee while the manufacturer or third party takes care of everything else. Raw un-edited real-time data is accessible via a secure server using most internet browsers. A wise man named Leo McGivena is credited with saying "Don't sell drills—sell holes." Getting flow data without the hassle of managing a meter network is the equivalent of simply buying the hole, not the drill.

Reporting Software

The best software should be intuitive and easy to use. Whether it is web-based software or an application installed on a laptop, the software should complement the instrumentation. Web-based applications are great for viewing data anytime, anywhere, and give the ability to securely and selectively share data with colleagues, clients, consultants, administrators, or the public. Laptop applications enable on-site setup and data collection. Laptop applications are also used for data review and report generation when wireless loggers are not used.

Rain Gauges

Rain gauges can be attached to loggers and their data can be synchronized with one or more loggers. Good local rain data is essential in I&I studies, modeling, and stormwater applications. Recent heavy rains in the Carolinas and Texas highlighted the need for rain gauges installed at the point of interest when differences of as much as 3 inches were seen at stations less than a mile apart. I consider rain gauges another necessary "network extension," allowing you to know exactly what's happening throughout your system and why.

Automatic Samplers

Automatic samplers can be added to the system and run independently, or driven by the logger, to capture flow-weighted samples required to characterize discharge at critical outfall locations. When connected to wireless loggers, sampler status and history can be seen through a web interface.

Summary

In summary, what's trending in open channel flow monitoring in 2016 are features that support system awareness, reliability, lower cost of ownership, better data, and efficiency. The top three features that deliver these benefits are:

- **Non-contact sensors** providing high quality reliable data with minimal effort or hidden expenses like maintenance and replacement expense.
- **Wireless data transmission**, alarm notification support, real-time data accessibility and increased awareness and efficiency.
- **Data delivery** provides a hands-off option and uptime guarantee, utilizing state-of-the-art equipment for a set monthly fee.

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