New Electromagnetic Water Meter Technology Improves Accuracy And Reliability

Electromagnetic water meters are becoming more and more popular for bulk measurement of residential and commercial drinking water, especially as pricing and metering gain traction as tools for more efficient use of water and water conservation. The more valuable water becomes, the more interested the market is in the accuracy and reliability of water meters. Other traditional metering technology, like mechanical and flow obstruction meters, are less effective in precisely measuring water.

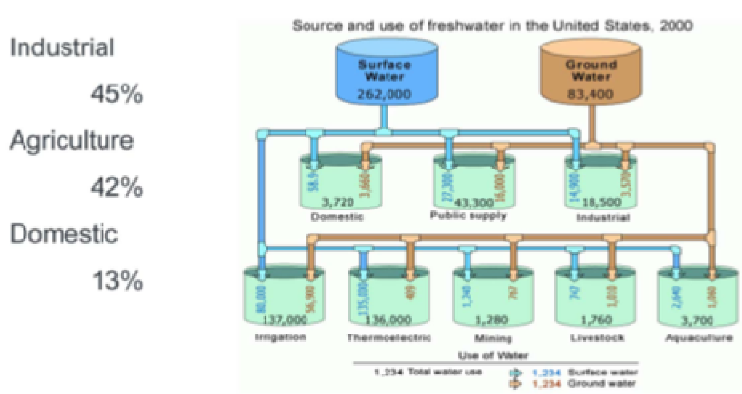
In the past, several issues stood in the way of electromagnetic water meter accuracy and reliability, including situations in which there are minimal flows, and close quarter installation with less than optimal up and downstream straight runs. In addition, the need for mains and backup power in the event of a power failure detracted from the usefulness of electromagnetic meters. Cabling costs can be high, especially in remote areas as well as highly populated areas, and cables are subject to tampering.

New technology on the market, like the KROHNE WATERFLUX electromagnetic meter, eliminates these challenges, offering excellent low-flow accuracy with no upstream or downstream straight run requirements. Equipped with batteries that can last for ten years or longer, the new technology also facilitates automatic data reading and collection. This is especially beneficial for water meters distributed over wide areas or located in remote areas or locations that are difficult to reach.

Why measure water?

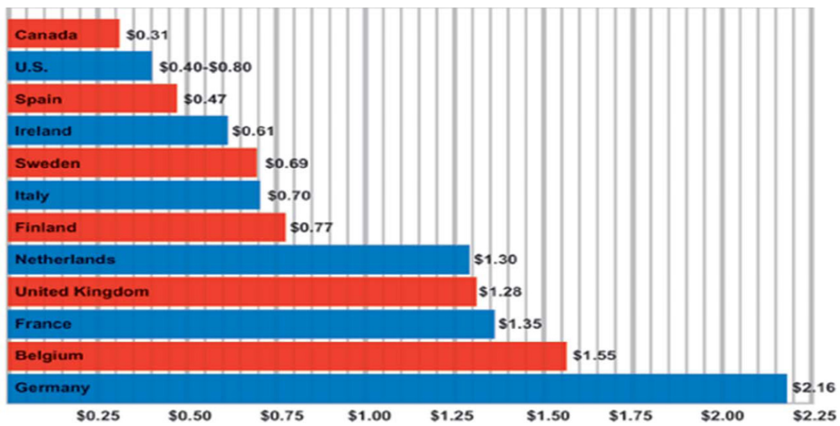
As shown in **Figure 1**, the competition between domestic, commercial, industrial and agricultural sectors for clean water is intensifying and putting enormous pressure on fresh water resources. As the price of water is increasing in the U.S., pricing and metering is being used more and more – examples include measuring raw, potable, and irrigation water, as well as measuring well chambers, monitoring of distribution networks, pipeline leak detection, and of course, for facilitating billing or revenue collection based on actual water consumption.

Figure 1 – Competition for water in the U.S.



The cost of water is the main driver in the increasing interest in accurate metering. **Figure 2** shows how the price of municipal water varies around the world. Canada has the lowest water cost, $0.31 per cubic meter, while Germany has the highest water cost, about $2.16 per cubic meter. In the US, 25 percent of all water used is in the four states of California, Texas, Idaho, and Florida, with California being the largest user. US water costs are on the rise.

Figure 2 – Typical municipal water prices in North America and Europe



Varied meter options – but can they do the trick?

Commercial and industrial water meters (known as bulk meters) are used for monitoring and billing large water consumers, like industrial plants, office buildings, hospitals, schools, hotels and apartment buildings. This group consumes a relatively large share of the total water supplied by a water company and thus a significant part of their revenues. The three main types of meters used are mechanical meters, flow obstruction meters, and electronic meters.

Mechanical meters once dominated the water meter market for bulk measurement of residential and commercial users' drinking water consumption. In fact, the most prevalent method of measurement, the turbine flow meter, is based upon an 18th century design that has been commercially available for more than one hundred years. Over the past decades, a wide variety of mechanical bulk water flow meters have been developed, using turbine rotors, positive displacement (PD) designs, and propellers.

With a turbine meter, each blade revolution means certain amount of fluid has passed through the meter. A magnetic pick up then causes an increment in a counting device. Turbine meters are set to have a specific number of pulses per unit of measure. Turbine meters are accurate mechanical devices, but because they have moving parts they require frequent maintenance and calibration.

A positive displacement (PD) meter has cavities that each hold a certain volume of liquid. With each revolution, the fluid moves from the upstream piping into the chambers and then into downstream piping. Each time a chamber deposits the fluid, a counter moves incrementally to show the volume that has been measured.

Much like a turbine meter, the propeller meter rotates with the flow, and each rotation is the equivalent to a certain volume of liquid. A counter totals the flow by moving with each rotation. **Figure 3** illustrates these mechanical meter options.

Figure 3 – Mechanical meters

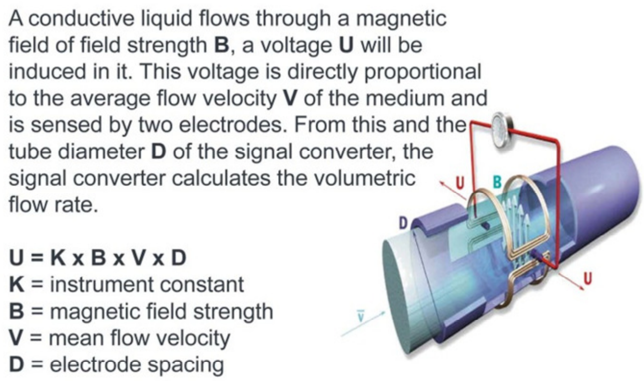
Turbine *Positive displacement* *Propeller*

However, all such mechanical devices have inherent shortcomings because they contain moving parts that require periodic testing, recalibration and repair, and because they contain components that protrude into the measuring path, drawing kinetic energy from the fluid and impeding flow. To mitigate these problems, ancillary piping and equipment is often required, such as filters/strainers and firefighting hydrant bypasses, adding significantly to installation and maintenance costs.

Flow obstruction devices, such as Venturi meters and orifice plates, present an obstruction to the flow that will cause a known pressure drop. This pressure drop is proportional to flow rate. Each device has its own formula to equate level to flow. Other flow obstruction devices such as weirs and flumes create a level that is proportional to flow in these devices a level device is needed to complete the measurement. The pressure drop devices are widely used in water treatment plants (Venturi) and the orifice plates are widely used across all industries to measure lower viscosity liquids. The weirs and flumes are used in irrigation, water distribution, collection, in the water industry and also widely used in the waste water industry.

With electromagnetic (MID) water meters, a conductive liquid flows through a magnetic field inducing a voltage directly proportional to the average flow velocity of the media, which is sensed by the electrodes. From this and the cross sectional area of the measuring tube, the signal converter calculates the volumetric flow rate. **Figure 4** illustrates how MID devices operate.

Figure 4 – Electromagnetic flow meter operating principle



MID water meters are relatively new devices, designed to have the operational simplicity of a mechanical flow meter without the disadvantages of a mechanical device. Extremely simple and reliable, MID flowmeters have no moving parts and nothing protrudes into the smooth, measuring tube. They are actually streamlined versions of the more sophisticated electromagnetic flow meters that have been widely used for nearly fifty years in some of the most demanding industrial processing and custody-transfer applications, where they are valued for their ability to provide highly-accurate flow measurement of difficult fluids despite turbulent flow and the presence of bubbles, suspended solids, and abrasive material.

Water distribution applications require a much simpler and lower cost meter. Service workers in the field need to be able to read and maintain meters and repair them when necessary. Newly designed electromagnetic water counters are even simpler than their mechanical counterparts. No maintenance is required, except to replace the batteries, every 10 years or so, a process as easy as replacing the batteries of a flashlight. The display has the same look and feel as a conventional water meter register, with an LCD readout replicating the appearance of the classic mechanical odometer.

The primary reason mechanical meters held a large market segment in the past was because they did not require power, which was important, given that meters are often located in remote areas or locations that are difficult to reach, such as underground installations in busy city centers, or in areas in or close to buildings that are often closed or locked. For most applications, the geographic location of the site makes connecting the meter to the power grid too expensive and complex. DC-powered devices have been available, but until recently, battery life was limited to 3-5 years, an unacceptably short interval.

The single largest factor in the rise in MID meters for measuring water is the improvement in battery technology, particular the increase in use of long lasting lithium-ion (Li-ion) batteries. Because these batteries have long life, manufacturers are able to power signal converters and mag tubes for extended periods of time, sometimes as long as 15 years.

Lower maintenance and higher accuracy make MID meters the most cost-effective choice

MID meters save money because they require less maintenance and have greater accuracy which improves revenue collection. The following real-life example demonstrates these money-saving features using actual numbers from a water district in central California, where water is becoming an expensive commodity and water measurement is becoming critical.

The information in the case study is based on use of KROHNE's WATERFLUX electromagnetic bulk water meter, which has a battery life of 10 years or more, and a high accuracy rate (+ 0.2 percent compared to 2 percent or even 5 percent for mechanical meters). The battery driven, stand-alone water meter can be equipped with a data logger and wireless communication modem. Wireless meter reading saves the high costs of manual reading and can also be used to check the water meter condition and rapidly identify meter failure, vandalism or tampering.

A major drawback of mechanical water meters is that they have difficulty with accurate measurement of low flows and with large variations in flow rates. If the water meter is sized too high, flow rate will be relatively low, leading to significant under-registrations. If a meter is undersized, it will frequently operate at high flow rates and will degrade much faster. The WATERFLUX measures very accurately at both low and high flow rates. Its high turndown ratio allows for accurate metering both day and night. It also has no upstream or downstream straight run requirements, unlike mechanical and other electronic flow meters that require five to ten straight pipe feet both up and down from the flow meter.

Figure 5 illustrates maintenance and meter replacement savings achieved. Assuming labor costs of $60,000 dollars a year, 4.5 hours to replace each meter, 5 percent (125) of meters replaced each year, and additional costs for annual checking and calibration, potential savings could be $340,000 dollars a year.

Figure 5 – EMG maintenance and meter replacement savings

Maintenance	
Technician Salary & Benefits	$ 60,000.00
Meter Inspection, incl. travel (hour)	2
Time to Pull Meter	1
Time to install replacement (hour)	0.5
Time to validate meter at lab (hour)	1
Meter Replacement	
Cost of Meter ($)	1500
Total Metering Points	2500
Replacement % per year	5
Annual qty of mechanical meters	125
Annual qty of WATERFLUX meters	5

Maintenance	**Annual**
Mechanical Meter Inspection	$150,000.00
Mechanical Meter Replacements	$196,875.00
Waterflux Meter Inspection	$ -
Waterflux Meter Maintenance	$ 7,605.00
Potential Waterflux Savings	**$ 339,270.00**

Now let’s look at savings due to improved accuracy, by examining how much lost revenue is recovered due to the overall accuracy of an EMG meter (.2 percent) compared to that of a mechanical meter (around 5 percent).

Figure 6 – Metering losses

Water Metering			
	Unaccounted for Metering Losses		
	Metering Uncertainties	**Daily**	**Annual**
	Mechanical	$ 9,250.00	$3,376,250.00
	Other Magmeter	$ 925.00	$ 337,625.00
	Waterflux	$ 370.00	$ 135,050.00
	Potential Waterflux Savings		**$3,241,200.00**

In the central California example cited above, if we assume a usage of 450,000 acre-feet of water per year at a cost of $150 per-acre foot, the daily water cost is almost $185,000. With a daily usage of 1233 acre-feet of water at $150 per acre-foot and an inaccuracy of 5 percent, there could be more than 61 missed acre-feet of water a day, which is a daily loss in revenue of $9250. With an accuracy of .2 percent, the EMG meter would miss less than 2.5 acre-feet of water, less than $375 dollars a day. The potential accuracy savings is more than $3.2 million dollars a year for this water district. **Figure 6** shows the calculations and **Figure 7** is a picture of the meter used in the example.

Electromagnetic water meters offer major benefits for monitoring and billing of cold water usage for industrial, commercial and agricultural user. The accuracy, robustness and long battery life have brought electromagnetic meter technology to the front of the pack. Magnetic flow meter technology can now be applied wherever mechanical meters were traditionally used.

Figure 7 – WATERFLUX EMG Meter