by Jesse Yoder, Ph.D.

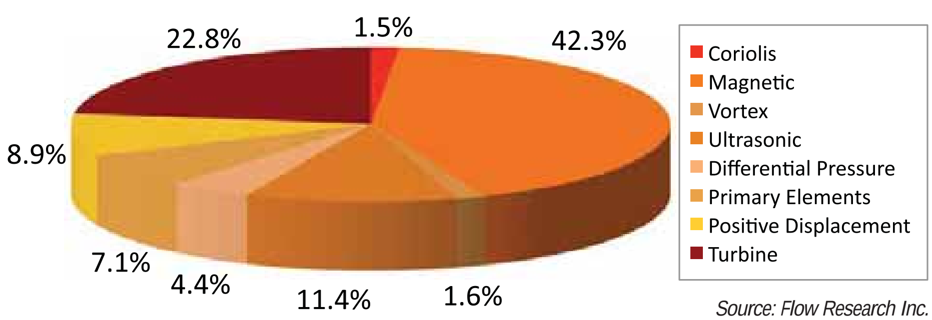
Measuring the World's Water Supply

Flowmeters for Water & Wastewater Applications

Whether or not "water is the new oil," as some say, there is no doubt that water flow measurement is becoming increasingly important. While the world's population has more than doubled since 1965, when it was 3.3 billion, the amount of water available in the world has not increased. Today's world population stands at more than 6.7 billion, and it is projected to increase to 9.2 billion by 2050.

While there is plenty of water in the oceans, this is not drinkable without desalination. According to the U.S. Environmental Protection Agency (EPA, *www.epa.gov*), nearly 97 percent of the world's water is either salty or otherwise undrinkable. Of the remaining amount, two percent exists frozen in glaciers and ice caps, and only about one percent of the world's water is suitable for drinking. While new oil can still be discovered underneath the ground, there is no corresponding "new" water waiting to be found. In fact, the water we are using today is the same water that was used by the dinosaurs millions of years ago. Hence, one could make the argument that water is among the most critically important of flow measurements. As such, the following provides an overview of some of the technologies used for water and wastewater flow measurement.

2007 World Water & Wastewater Flowmeter Market



Source: Flow Research Inc.

Magnetic Flowmeters

Magnetic flowmeters account for close to 50 percent of the revenues spent on flowmeters used to measure fluid flow in the water & wastewater industry, including utility applications. The design of magnetic flowmeters makes them uniquely suited for measuring water flows. Magnetic flowmeters base their flow measurement calculation on the amount of voltage generated by a conductive fluid moving through them. As a result, they create very little pressure drop and can measure flow with medium-to-high levels of accuracy.

While magnetic flowmeters excel at measuring the flow of clean liquids, they also are one of the few types of flowmeters that excel at measuring dirty liquid flows. Even though not all magmeters easily measure dirty liquids, suppliers have made technological advances that make these meters better suited to use with dirty liquids. This makes them especially useful for wastewater, as well as pulp & paper applications.

Magnetic flowmeters generate a magnetic field when electric current passes through wound wire coils that are contained within the meter. This current is one of two types — either alternating current (AC) or direct current (DC). AC magmeters are especially suited for use with dirty liquids, although DC magmeters have also been developed for these applications. Today, DC magmeters are the dominant technology, although some suppliers still manufacture AC magmeters.

Water flow applications for magnetic flowmeters include measuring chilled water, coolant flow, deionized water and drinking water. Wastewater applications include measuring raw water intake, sewage, wastewater influent, irrigation water flow and wastewater treatment. Magnetic flowmeters range in size from less than one inch to over 100 inches, and this makes them suitable for the large pipes that sometimes are used in water and wastewater treatment plants.

Turbine Flowmeters

Both turbine and positive-displacement flowmeters are widely used for water utility applications. Turbine meters compute flow based on the speed of a spinning impeller that sits in the flowstream. Turbine meters are better suited for medium-to-high speed flows than positive-displacement meters, and are also more adaptable to large pipe sizes, such as pipe sizes over 10 inches. Positive-displacement flowmeters, by contrast, excel in measuring low flowrates in small line sizes, including those of one or two inches.

Turbine flowmeters are widely used for custody-transfer measurement of both industrial and commercial water and other liquids. Unlike magnetic flowmeters, they can also be used to measure the flow of hydrocarbon liquids. The American Water Works Association (AWWA, *www.awwa.org*) has issued a standard for the use of turbine meters in custody-transfer applications.

Applications for turbine flowmeters include measuring chilled water, high-purity water, drinking water, anti-freeze flows, water treatment, and measuring flow in heating, ventilating and cooling (HVAC) systems. They are also used to measure water consumption in apartment and office buildings. While some end-users are switching to flowmeters with no moving parts, such as magnetic flowmeters, turbine meters are still entrenched in water flow and water utility applications.

Positive-Displacement Flowmeters

Positive-displacement meters capture the flow in small compartments of known size and count how many times this is done. They excel at measuring low flows, and are widely used to measure water flow in private houses and apartments for billing purposes.

While there are many types of positive-displacement flowmeters, one of the most popular types for water applications is the nutating-disc flowmeter. This flowmeter was invented in 1830. In the early 1900s, it was improved when suppliers began making them out of hard rubber to extend their lifespan. Eventually, the life of these meters was extended even further by employing a construction of hard rubber on brass. In the late 1950s, plastics and composites became the materials of choice for nutating-disc flowmeters.

Examples of water & wastewater applications for positive-displacement flowmeters include municipal water systems, measuring water and process cooling, measuring water flow in plumbing systems, and chemical feed applications.

Ultrasonic Flowmeters

There are two main types of ultrasonic flowmeters — transit-time and Doppler. While the ultrasonic flowmeter market has gained a reputation for being the fastest growing flowmeter market, much of this growth is due to rapid growth in the market for custody-transfer of natural gas. This market is dominated by multipath transit-time ultrasonic flowmeters. While the market for ultrasonic flowmeters in the water & wastewater industry is also showing solid growth, the growth rate is not as high as it is in the natural gas custody-transfer market.

There is an important difference in application between ultrasonic transit-time and Doppler flowmeters. Doppler flowmeters are better suited for dirty water applications than transit-time meters. However, suppliers of transit-time meters have made significant progress over the past 10 years in making transit-time flowmeters more adaptable to measuring the flow of unclean fluids. As a result, transit-time flowmeters have gotten most of the attention in the ultrasonic flowmeter market, and they are the dominant technology. Even so, Doppler flowmeters are still used, especially for wastewater applications.

Some examples of water & wastewater applications for ultrasonic flowmeters include measuring the flow of brine and salt slurry streams, chilled water, feedwater flow, raw water and measuring water flow near dams. Some users are switching to ultrasonic flowmeters because they have no moving parts and cause minimal pressure drop. Also, ultrasonic technology is better understood today than it was previously, meaning that end-users are more comfortable with this technology.

Coriolis Flowmeters

Both Coriolis and vortex flowmeters are used in water & wastewater measurement, but they are not as widely used as the flowmeter types just discussed. One reason that Coriolis flowmeters are less widely used than some other technologies for water flow measurement is that they are typically more expensive than other types.

Coriolis flowmeters are the most accurate flowmeters made, but this high degree of accuracy is often not required for water & wastewater applications. On the other hand, the use of Coriolis flowmeters is growing for custody-transfer of hydrocarbon liquids, especially for downstream applications. As the value of the product measured increases, end-users are willing to pay more to measure it.

Coriolis flowmeters are also not able to easily handle large line sizes. The large majority of Coriolis meters are for line sizes of two inches and less While there is a trend towards larger sizes in Coriolis meters (see "Q&A: Large-Diameter Coriolis," page 32), meaning from six to twelve inches, these flowmeters are often unwieldy and expensive. As such, they are not likely to replace magnetic, turbine, or ultrasonic flowmeters for water applications.

Vortex Flowmeters

Vortex flowmeters are also used in the water & wastewater industry. Vortex flowmeters have the disadvantage that they require the placement of a bluff body in the flowstream. This presents more of an obstruction to the flow than do magnetic or ultrasonic flowmeters, although not as much of an obstruction as an orifice plate. Vortex flowmeters are among the most versatile of flowmeters, as they can effectively measure liquid, steam and gas.

For many years, vortex flowmeters suffered from a lack of industry approvals. This changed in January 2007, when the American Petroleum Institute (API, *www.api.org*) approved a draft standard for the use of vortex flowmeters in custody-transfer of liquid, steam, and gas. Vortex flowmeters are most widely used in the chemical industry, but their use is expected to increase for water & wastewater applications.

Differential Pressure Flowmeters & Primary Elements

Primary elements are used with differential pressure (DP) transmitters to create a pressure differential in the flowstream. The DP transmitter measures this pressure differential and uses it to compute the flowrate. Examples of primary elements include orifice plates, Venturi tubes, Pitot tubes, flow nozzles, and wedge elements. While orifice plates are the most popular kind of primary element, Venturi tubes and flow nozzles are better suited to high-speed flows.

DP flowmeters are the best understood and most studied type of flowmeter. They still have an advantage in installed base in the flowmeter market. However, there is a shift in the flowmeter market away from traditional technology flowmeters, such as DP, turbine, and positive displacement, towards newer technology flowmeters, such as magnetic and ultrasonic. This trend is also evident in the water & wastewater industry, as end-users seek devices that are more reliable, have fewer moving parts, are prone to less wear, and require less maintenance. Expect this trend to continue in the water & wastewater industry, as well in other process industries. FC

***Jesse Yoder**, Ph.D., is president of Flow Research, Inc. in Wakefield, Mass., a company he founded in 1998. He has 21 years of experience as an analyst and writer in process control. Yoder specializes in flowmeters and other field devices, including pressure and temperature products. He has written over 100 market research studies in industrial automation and process control and has published more than 80 journal articles on instrumentation topics. Dr. Yoder can be reached at jesse@flowresearch.com or 781 245-3200.*

www.flowresearch.com