A Place for Positive Displacement

PD flowmeters quietly excel in low-flowrate, high-viscosity, and liquid and gas metering applications

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Positive displacement (PD) flowmeters are the workhorses of today's flowmeter world. They perform many important flow measurements most people take for granted. For example, they are widely used for metering both water and gas in residential, commercial, and industrial applications. Chances are good the flowmeter that measures how much water you use at your house is a PD meter.

PD flowmeters separate the fluid to be measured into distinct compartments of known volume. As the liquid or gas passes through the flowmeter, the compartments are repeatedly filled and emptied. Flowrate is calculated from the number of times these compartments are filled and emptied. PD meters differ according to the shape and size of the compartments involved, and according to whether they are designed for liquid or gas.

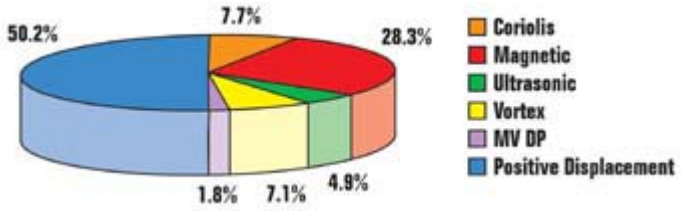

Figure 1: Big Displacement

More positive displacement flowmeters were sold worldwide in 2001 for commercial and industrial applications than

Coriolis, magnetic, ultrasonic, vortex, and multivariable DP meters put together. Source: Flow Research

Positive displacement flowmeters excel where many other flowmeters have difficulties: low flowrates and high-viscosity liquids. In addition, they provide a very cost-effective solution for utility applications requiring low-cost meters that last for many years. While PD meters are losing out to Coriolis meters for some hydrocarbon measurements, and to magnetic flowmeters for some industrial liquid measurements, they still occupy a niche where they are the best solution. And with annual worldwide sales that exceed $500 million (Figure 1), PD meters will be around for many years to come.

Applications for PD Meters

The use of PD meters can best be understood by dividing them into water utility, gas utility, oil, and industrial liquid applications:

**Water utility applications* mainly are for billing purposes. Water utility companies buy these meters and put them in industrial plants, commercial buildings, and homes to measure how much water is used at those facilities.

Just as private homes need flowmeters to measure the amount of water used, so do hotels, apartment complexes, and other commercial buildings. These buildings are likely to use PD, although they may use turbine meters instead for higher volume flows.

Many smaller commercial buildings use PD flowmeters to measure water use within the building. Most PD meters for line sizes of 1 1/2 or 2 in. are for commercial applications. These meters can handle flow in the 5-100 gpm range, though some meters can go both lower and higher. The American Water Works Assn. (AWWA) specifications for PD water meters are for meters of size two inches and less.

PD meters are used to measure water use at industrial plants as well as at commercial businesses. This is still a utility measurement since it is generally the utility company that buys and installs the meters. Some flowmeter suppliers do not distinguish their commercial from their industrial measurement water meters, since they are doing the same type of measurement whether they are in a commercial or an industrial building.

**Gas applications* include billing meters to measure the amount of gas used at houses, commercial buildings, and industrial plants. The meters used for billing purposes in industrial plants such as chemical, food processing, and pharmaceutical plants are different from the meters used to measure gas as part of the manufacturing process.

Many of the PD meters used for gas utility measurements are diaphragm meters. However, these are being replaced by rotary meters for some applications, since rotary meters are smaller and lighter. Rotary meters are also used for non-utility gas flow measurements in industrial environments.

**Oil, refined fuels, and hydrocarbon products* are a very

large PD flowmeter market segment. Some PD meters are used for loading and unloading trucks, tankers, airplanes, and ships. Most of this measurement is for the purpose of custody transfer. This measurement occurs both upstream and downstream of refineries. Oil trucks that deliver oil to people's houses use a flowmeter to measure the amount of oil dispensed. Often this is a PD meter.

Some PD meters rely on the lubricating property of oil or hydrocarbon liquid when the liquid is in contact with the measuring chamber. These meters can measure gasoline, diesel fuel, heavy fuel oil, and many other hydrocarbon-based liquids.

Unlike turbine meters, PD flowmeters can easily handle high-viscosity liquids. For this reason, they are often used to measure petroleum at terminals, in production, and downstream for delivery. PD meters can measure heavy crude oil accurately, and they are not affected by variations in velocity or viscosity of the measured product.

* *Process liquid applications* include industrial chemicals, pharmaceutical chemicals, paints and varnishes, printing ink, dairy products, cosmetics, and many other liquid products. In many cases, PD meters provide a highly accurate measurement for a lower price than meters such as magnetic or Coriolis.

Positive Displacement vs. Turbine

Turbine meters are more complementary than competing with PD meters. Turbine flowmeters are used when the line

sizes are larger and the flow volume is greater than can be handled by PD meters. PD meters do better with low flowrates and low flow volumes, while turbine meters excel with medium to high flowrates and volumes. Therefore, turbine meters are often used in the larger line sizes, especially greater than 4 in.

The relationship between turbine and PD meters somewhat mirrors the relationship between ultrasonic and Coriolis meters, which differ based on line sizes. Ultrasonic meters are most widely used on pipe sizes of 4 in. and larger, while Coriolis meters are most widely used on pipe sizes smaller than 4 in. So ultrasonic and Coriolis meters also are more complementary than competing. However, turbine and ultrasonic meters are competitors, since they are both used on larger line sizes.

Change Is Evolutionary

Change in the positive displacement flowmeter market is more evolutionary than revolutionary. Some PD meter companies are not even currently investing in new product research. However, there are some new developments in PD meters. Some of these developments focus on improved methods to increase component manufacturing precision. For example, improved coordinate measuring machines make it possible to create more perfectly round pistons and other components. And as is the case with turbine flowmeters, improved bearing technology is making ball bearings more reliable and less prone to fail.

One difference between positive displacement flowmeters

and new-technology meters (Coriolis, magnetic, ultrasonic, vortex, and multivariable differential pressure) is in the displays. PD meters typically compute flow by counting pulses. The pulsed output of PD meters is typically not a flowrate but a pulse value. To compute flowrate, these need to be related to time. This computation is often done not in the flowmeter but in a separate totalizing device that may be panel-mounted. One potential growth path for positive displacement meters is integrating this computational capability in the flowmeter instead of having it done in a separate totalizing device, and some vendors are already doing this.

One aspect of transmitter technology that has not yet had a major impact on positive displacement meters is communication protocols. While some magnetic flowmeter and pressure transmitter suppliers have made HART a default capability for their products, only Brooks Instrument and Bopp & Reuther have so far introduced HART versions of PD meters. It is likely that more "smart" PD meters will be produced in the future as new technology meets old.

PD Prospects

Positive displacement flowmeters are a traditional-technology flowmeter that will be around for many years to come (Figure 2). Even though they face stiff competition from new-technology meters in some segments, they still remain the best solution for certain applications. This market is so large that, like differential pressure flowmeters, they will still be around 50 years from now.

Positive displacement meters are very effective at making low-cost mechanical measurements for utility purposes. These include residential, commercial, and industrial utility applications. In these segments, the main competition for PD meters is from single jet, multi-jet, compound, and Woltman turbine meters rather than from new-technology meters. The reason is that widespread industry approvals for new-technology meters such as magnetic and Coriolis in utility applications are at least several years away. This market segment is growing.

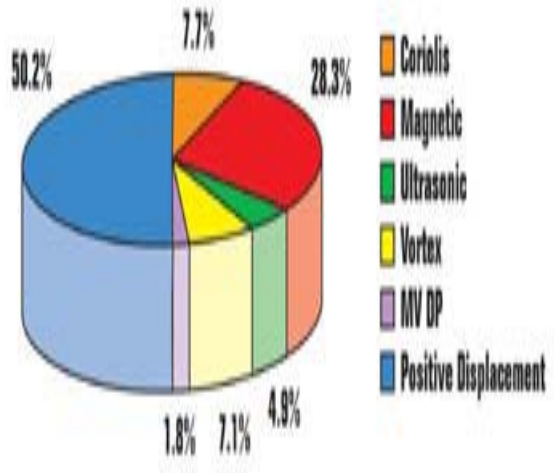

Figure 2: Slow Decline

Though sales are not expected to rise, positive displacement flowmeters will be around for many years to come. (Source: Flow Research)

Positive displacement meters for gas applications also face some competition from turbine flowmeters. However, PD meters are mainly used for the smaller pipe sizes, and most PD meters for gas applications have sizes somewhere between 1 1/2 and 10 inches. Turbine meters, by contrast, perform best with steady, high-volume flows. For this reason, turbine meters are more likely to be used for pipe sizes

larger than 10 inches. This is also the range where ultrasonic meters excel. While ultrasonic, turbine, and PD meters overlap in the 4-10 in. size range, PD meters still have an advantage in the smaller sizes. Low flowrates are not a barrier to PD meters. For this reason, PD meters will continue to be used in the smaller line sizes to measure gas flow.

Technology improvements are also occurring within the PD gas flow market. Rotary PD meters are replacing the older-style diaphragm meters. These newer rotary meters are smaller and lighter. In some cases, when customers take a diaphragm PD meter out of service, they replace it with a rotary PD meter. Rotary meters represent a newer technology, and they allow end users to upgrade their measurement capability while staying within the class of PD meters.

In the area of oil flow measurement, PD meters face a stiff challenge from new-technology meters. In this category the main competition for PD meters comes from Coriolis meters. Because oil is a high-value product, users are more willing to pay the higher prices of Coriolis meters to measure its flow. PD meters are widely used to measure the flow of hydrocarbon products both upstream and downstream of refineries at custody transfer points.

PD meters also face a challenge from new-technology flowmeters in measurement for industrial applications. Both Coriolis and magnetic flowmeters are making inroads here, with some users seeking the high accuracy of Coriolis

meters, while others are looking for meters that have no moving parts.

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