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AD INDEX

Coriolis Flow Transmitter Delivers Detailed Data

Device translates measurements into useful information for deeper process insight

THE MICRO Motion Model 5700 Coriolis flow transmitter is designed to translate measurement data into meaningful insight and instruction. It provides users access to detailed measurement history for troubleshooting or optimizing the process. The graphical user interface was designed for intuitive operation, with simplified installation, configuration, maintenance and troubleshooting. The transmitter translates Coriolis measurement data through robust, time-stamped history files for process and meter health data, and logs for configuration changes and alarms.

The Model 5700 digital signal processing architecture provides fast flow response time, making it optimal for custody transfer proving and short batching applications. The historian feature also improves Micro Motion Smart Meter Verification, which provides measurement of the full meter health without process interruption, improving measurement confidence and easing regulation compliance.

Compatible with new and previously installed Micro Motion ELITE Coriolis sensors, the Model 5700 has a field-mount design that's suitable with most hazardous area installation practices and with both integral and remote installation options. It currently includes options for analog, pulse, discrete and Modbus outputs and an analog or HART input.

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Match the Flow Meter to the Service

Consider operating conditions not just specifications and price

By Dirk Willard, Contributing Editor

"LIKE SO many beached whales on the pier at Santa Monica," I told my boss with a wink. Paul winced, then smiled. "Expensive whales," he replied curtly. Someone had ordered a dozen or so direct-mounted Coriolis meters without checking their temperature limits. Flow meter selection and specification is crucial. With the wrong choice you'll be floundering or worse. So, let me make some suggestions.

Flow meters infer flow by measuring how a property changes over time. They do so using a variety of techniques: differential pressure (dP) — orifice, venturi, V-cone, flow nozzles, wedge and pitot tube; velocity — magnetic, vortex shedding and ultrasonic; displacement — lobe or vane, piston, turbine, target and variable area (rotameter); and open channel — weir and flume. Coriolis and thermal meters infer mass flow from the force change caused by accelerating a mass away from a center of gravity. There also are special meters — e.g., nuclear and weight/time.

If you need an FDA-approved meter, your choice is limited. FDA-approved meters must meet two conflicting objectives: cleanability — e.g., polished surfaces, no dead spaces, large surfaces; and, extreme accuracy. Coriolis flow meters fit these criteria, challenging all comers with the possible exception of magnetic meters.

In all other cases, select your meter based on operating conditions. Let's subdivide these into clean, corrosive or erosive, and mixed phases.

For clean, single-phase fluids, the choice depends upon needed accuracy and acceptable price. Where there's space in the pipe, cost isn't an issue, and diameter is less than 6 in., the vortex shedding meter is the best choice. Beyond 6 in. diameter, accuracy and turndown suffer but nothing really beats the orifice plate. You can improve the accuracy of orifice plates and other dP meters and vortex-shedding meters by using multivariable technology to correct for property variation. If you're dealing with an under-6-in.-dia. pipe and accuracy isn't critical, rotameters and displacement meters can fit the bill nicely without the space requirements of the vortex shedders.

Dirty fluids pose more of a challenge. Muck can clog unpurged dP impulse lines and pitot tubes, grit can cut or foul vortex shedding bars and gnaw at wedges, orifices, rotameter floats, weirs, flumes and even Coriolis vibrating tubes. But it's possible to use many of these flow meters if there are allowances for maintenance or purging. Vortex shedding meters are completely unacceptable in erosive or fouling service.

If erosion is the issue, consider hard ceramic dP elements, such as flow tubes and venturis, for pipes up to 6-in. dia. (Fabrication isn't practical above 6-in.) Ceramics in order of performance are: silicon nitride, silicon carbide, zirconium carbide and, finally, aluminum oxide, the least expensive choice. A less-effective alternative is a

COLUMN WITH GRAVITY-FLOW LOOP

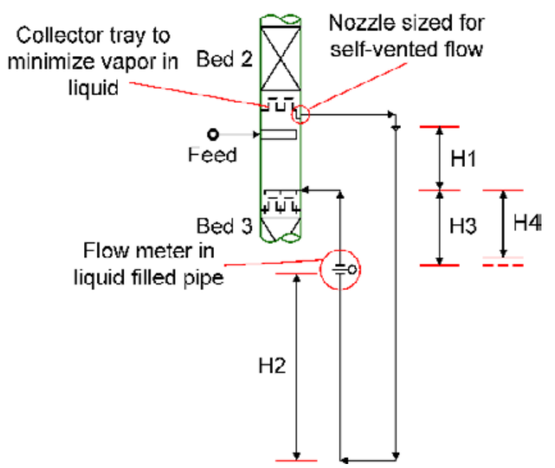

Figure 1. Liquid from collector tray goes into loop, gets metered, and then returns to tower.

vapor-deposition coating on a metal. Such a coating may work with hard alloys based on nickel, zirconium or tantalum but avoid soft alloys containing a lot of titanium or copper.

Corrosive fluids, such as wet (above 12 ppm-m) chlorine or high-sulfur gas oil, raise an additional challenge beyond the debris created by corrosion. Impulse lines require special attention; small pipes and tubing risk fouling as witnessed in several recent pipeline thermal-relief failures. If you have to guess, go with nickel-chromium-tungsten alloys for chlorine and iron-nickel-molybdenum-chromium alloys for sulfur. Alloy steels tend to suffer local attacks; their surface doesn't wear away like carbon steel, making erosion mil rates superfluous. Whenever possible, use corrosion coupons to decide on the material. Corrosion particulates like ferric sulfite, common with high-sulfur crude intermediates, are as hard as ceramics, so consider ceramics as replacements for metals. Erosion and fouling largely rule out velocity, mass and displacement meters for closed flow but not special meters.

Weight-time systems typically are reserved for solids and slurries but have been used for liquid measurement. Methods involving non-intrusive techniques such as ultrasonic have had some success. Another technology, used for emulsion interface detection, may be on the horizon: nuclear magnetic resonance.

Lastly, let's consider options for multi-phase flow. As of 2011, there are 3,000 multiphase "flow meters" being used in crude oil production. These are simply process controller accountings of separate phase flow measurements using sophisticated phase models often employed in process simulations. An unexpected benefit of this approach is the testing of these phase models in the real world.

Once you've installed a meter, check on its performance using field measurements. Theses can include how long it takes to empty a tank to measuring the dP through pipe and equipment and comparing this to known flow rates.

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Handle More Flow

Success often depends upon lowering head losses or raising pump pressure

By Andrew Sloley, Contributing Editor

STRAIGHTFORWARD HYDRAULIC systems follow simple rules. For non-Newtonian and incompressible fluids, flow and net pressure drop are directly related. Consider the water transfer system shown in Figure 1. Wastewater generated in Unit 1 is stored in tank T1. Some of the water is reused in Unit 2. The remaining wastewater goes to treatment via vessel V1 in Unit 2. When Unit 2 isn't running, centrifugal pump P1 provides the head for transferring the water from tank T1 to vessel V1.

Plant management wants to increase the average water rate by 20%. Equipment elevations must remain the same, as must upstream or downstream process conditions. Because the system has simple hydraulics, providing more flow requires some combination of reduced head losses in the system or increased pressure generated by pump P1.

The control valves balance the pump performance curve against the system curve. As long as the control valves can open and the flow rate is within the pump's capability, more flow is possible.

In this case, with the control valves wide open, the new flow rate can't be achieved. Even with modifications the system is in a gray area. Some simple modifications may — or may not — allow the desired flow rate.

Already identified modifications include:
- moving exchangers E1/E2 into parallel; and
- replacing orifice flow elements FE1 and FE2.

Plant management must accept some combination of:
- lower flow;
- removal of more pressure drop; or
- increase in head available.

The solution may include all or any combination of these steps. Let's look at the flow scheme and then examine each area in turn.

The system has a fixed static head loss. Because the equipment and process don't change, the static losses don't either. The entire pressure-drop reduction must come from cuts in dynamic head losses. Three components — the exchangers E1/2, the control elements and the piping — mainly contribute to the dynamic head losses.

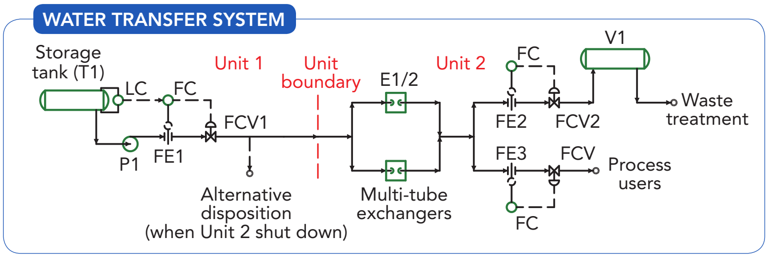

Figure 1. Plant management wants to increase the average water flow rate by 20%.

Exchangers E1/2 originally were in series. At the higher flow rate, the units will operate in parallel. They are multi-tube exchangers with the inlet water on the tube side. Unless they are completely replaced, the exchangers now have a minimum pressure drop.

The control elements include two orifice flow elements plus two control valves. The modifications already include replacing both flow elements. Changing the orifice plates saves 13.2 psi of pressure drop. At the desired rate, the two new flow elements will have a combined pressure drop of 5.1 psi.

After the modifications are made and with the existing pump, if it performs per the manufacturer's performance curve, the system can meet the required flow rate with control valves FCV1 72% open and FCV2 80% open.

To provide the best control, good operating practice suggests having FCV1 and FCV2 operate between 25% and 75% open. The new maximum rate has FCV1 just within the good practice range and FCV2 just outside that range. However, little control flexibility is available to handle temporary excursions to higher rates.

The second question is pump performance. The hydraulic analysis assumes the pump operates on its performance curve. Pump performance often deviates from that curve. After long in-service time, delivered pump head may differ by up to 10% from that shown on the performance curve.

The system with the base modifications can't effectively handle higher rate excursions above the average value nor could it run at the desired rate if the pump operates with heads below those documented on the pump curves. Increasing the operating margin requires removing more pressure drop from the system or adding more head.

Reducing pipe pressure drop gives little benefit. The piping system has no specific hydraulic choke points. Achieving pressure drop savings from pipe changes would necessitate extensive pipe modifications for modest benefit.

The two new orifice plates incur a 5.1-psi pressure drop. Using a lower-pressure-drop measuring instrument could reduce this. Ultrasonic flow meters might be a good choice.

Replacing exchangers E1 and E2 could save some pressure drop. However, this would be an expensive change for a modest gain.

Increasing the head available requires pump modification or replacement. Pump P1 has a less-than-maximum-diameter impeller. Switching to a larger diameter impeller would add more than 10% head capability. Unfortunately, the motor on P1 is too small for a larger diameter impeller. Installing a larger impeller also demands a larger motor.

Regardless of the solution, the plant must accept some combination of:

- potentially lower-than-desired flow rates;
- further capital investment to lower pressure drop; or
- additional spending to increase head available.

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Properly Size Control Valves

Oversizing afflicts many plants but is avoidable

By Michael McCarty, Emerson Process Management

A SURVEY of more than 500 individuals involved in process engineering, procurement, operations and maintenance at over 200 plants worldwide identified "oversizing" as the number one control valve problem. In a few instances, oversizing is intentional (e.g., to prepare for future production rate increases). However, in most cases, oversizing results from well-meaning but misguided decisions during the valve selection process. Unfortunately, an oversized valve can incur a sizable economic penalty and cause significant operating problems. So, let's look at how to avoid oversizing.

REASONS FOR CONCERN

At full operating conditions, control loops operate over a very narrow, essentially steady-state throttling range where small input signal changes to the control valve result in small valve stem or shaft movements. As you might expect, a small position change by a valve that's oversized gives a larger-than-desired change in flow. Depending upon the accuracy of the elements in the loop, the control system then responds to correct the situation, which can result in a throttling sequence that oscillates back and forth, causing continuous variation in process conditions.

While a higher-performance digital valve controller can mask this "dithering" by the control valve to give the appearance of acceptable loop performance, oversizing problems remain. In fact, an incorrectly sized control valve can result in problems even though the plant appears to be running smoothly.

During a system startup or a turndown to 25% maximum continuous rating (MCR), operating conditions will fall outside of the oversized valve's ability to adequately control because of the need for extremely small valve movements. Process control in this range may be near impossible depending upon the inherent flow characteristic of the valve. High gain characteristics (i.e., the amount of change divided by the amount of input) can result in instability, again causing the valve to cycle.

In addition, these off-case, low-flow conditions can lead to valve throttling occurring essentially right at the seat or seal. The resultant high-velocity flow across the narrow opening causes wear and erosion. Impingement of the accelerated process media can cut lines into sealing surfaces, an effect that reduces the control element's

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FLOW COEFFICIENT VERSUS TRAVEL

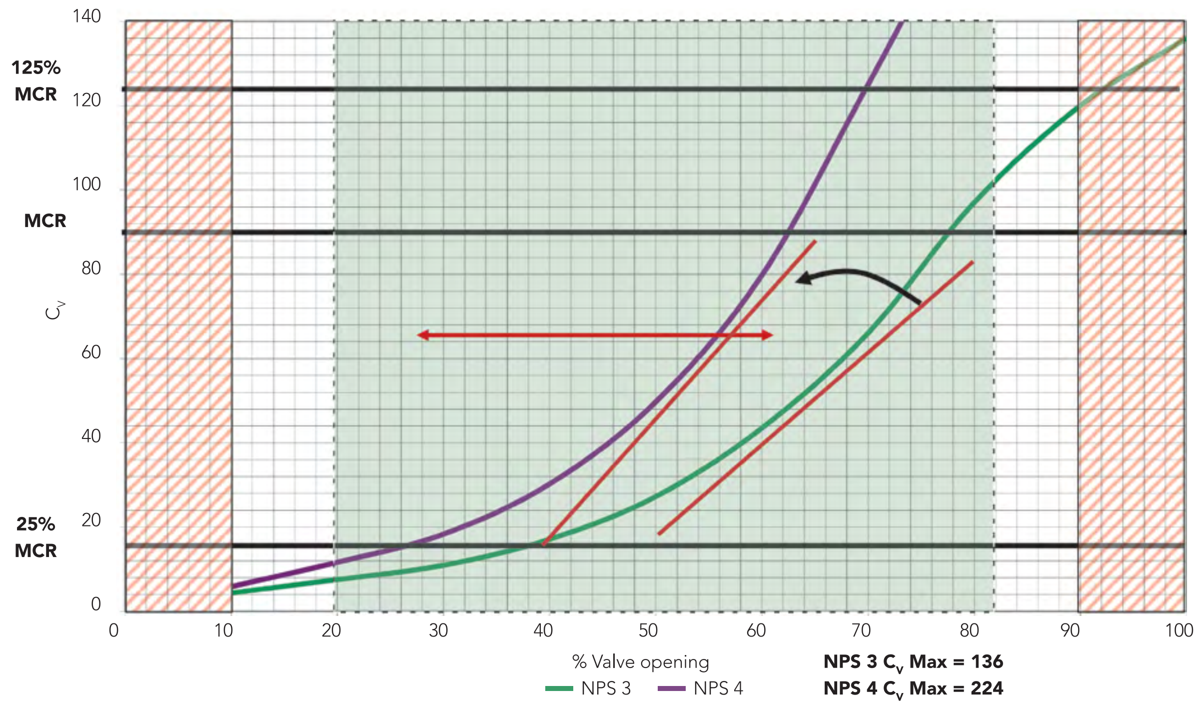

Figure 1. Oversized valve (NPS 4) can't provide adequate performance.

GLOBE VALVE SIZE VERSUS WEIGHT

NOMINAL PIPE SIZE	APPROXIMATE WEIGHT, LB
6	350
8	900
10	1,640
12	3,100
16	5,600
20	11,500
24	17,000

Table 1. Going up a valve size incurs a substantial penalty in weight.

ability to prevent or minimize leakage when the valve closes. Erosion to the contour of the valve's flow-control element alters its flow characteristic and ability to control as intended. More severe cases can prompt vibration that causes additional damage and, ultimately, equipment failure.

A valve gives the best control when it's sized to operate around 60%–80% open at maximum required flow and not less than 20% open at minimum required flow. Using a larger-than-necessary valve compromises performance, as indicated in Figure 1, which compares flow coefficient, C_v, versus travel for Nominal Pipe Size (NPS) 4 and NPS 3 valves for a service needing an NPS 3 valve.

Because of their compromised rangeability, improperly sized control valves also can cause problems during process transients. A typical control valve with an equal-percentage flow characteristic has about a 30:1 turndown ratio (i.e., the ratio of maximum C_v to minimum C_v). However, when the valve is oversized and throttling at the low end, its turndown ratio falls to 3:1 or less.

Also, installing too large a valve amplifies mechanical problems such as stiction and hysteresis, making the system difficult to control and potentially causing process upsets.

Oversizing of control valves has a domino effect. Safety relief valves must be sized to match the capacity of the control valve. Within a bypass configuration, isolation valves, bypass valves and drain valves all must be larger, which can impact the size of piping and structural pipeline supports.

Consider also that to achieve or maintain flow velocity in a loop equipped with an oversized valve requires a dramatic increase in compressor or pump horsepower (Figure 2). Sizing issues can propagate beyond erection costs into perpetual operational cost increases as pumping horsepower increases by a power of three to maintain the desired fluid velocity within the piping.

SOLVING THE VALVE-SIZING PUZZLE

When trying to avoid — or correct — valve-sizing problems, it's important to understand the causes of valve-sizing errors. Emerson research has identified several major

IMPACT ON HORSEPOWER

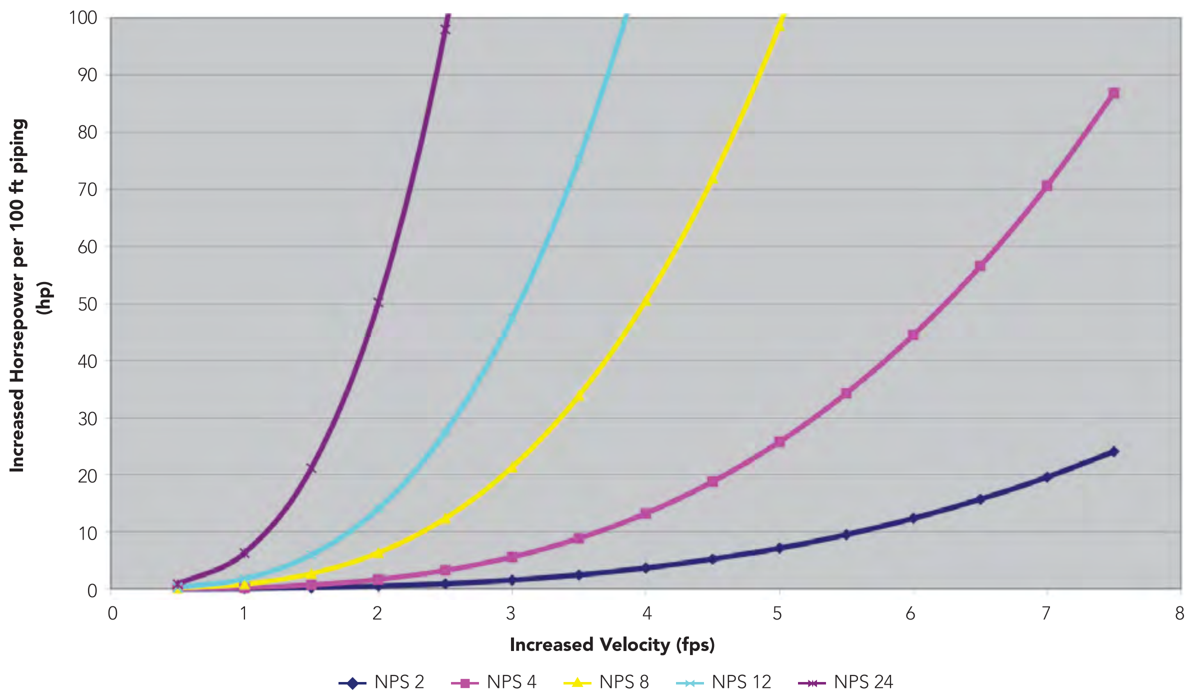

Figure 2. An oversized valve requires a dramatic increase in compressor or pump horsepower.

contributors: multiple safety factors, selecting line-size valves, and out-of-date process data resulting from changes in process conditions or conditions that differ from the original design.

To correct systems with improperly sized equipment, it's vital to obtain accurate process data at all expected operating conditions. Then, size the valve to perform optimally at these conditions.

Multiple engineering disciplines impact valve sizing, with each contributing their specialized flow-control know-how to valve selection.

For example, *process engineers* determine the fluid flow rates, temperatures and pressures that must be established and then maintained based on the feedstock being handled and the desired system output.

Their goal is to maximize output with minimum input and, to do so, they design the process for a 100% MCR.

They also develop control strategies for process turndown and turnup scenarios as well as those to be encountered at startup and shutdown, taking into consideration fluid flow rates and process conditions.

Piping engineers determine system layouts and equipment supports necessary to meet structural and mechanical needs. They size piping for appropriate fluid velocities and line losses at 100% MCR. These engineers also consider the potential

COST IMPLICATIONS

Elements Impacted by Capacity

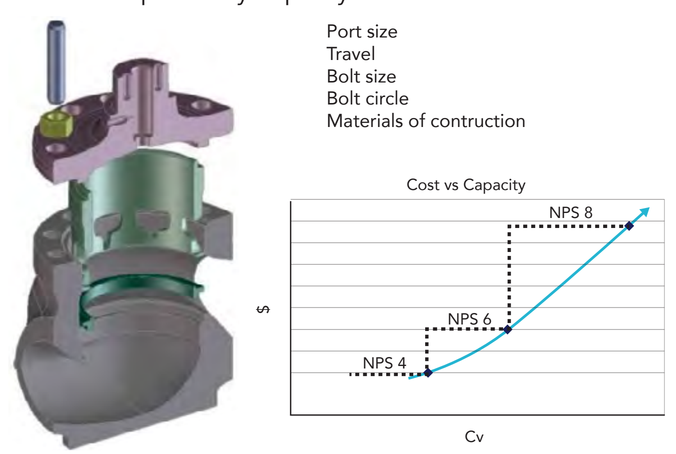

Figure 3. A decision to add "a little more margin" often will hit equipment limits, forcing a step-change in size and cost.

impact of corrosive or fouling fluids upon design margins. The ultimate goal is to balance energy costs (i.e., pressure losses) and piping/equipment costs (driven by size). As valve size increases, so does weight (Table 1), which can dramatically affect associated piping arrangement and supports; so, oversizing in this phase of system design impacts cost considerably.

THE RIGHT APPROACH

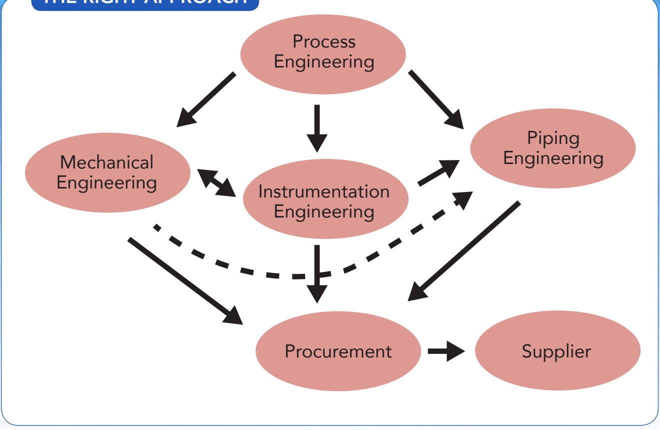

Figure 4. Close collaboration among the design groups and the supplier is needed to optimize system components and minimize unintentional equipment over-specification.

FINANCIAL IMPACT OF GOING FROM NPS 6 TO NPS 8

ELEMENT	FOR 6-IN. CONTROL VALVE, $	FOR 8-IN. CONTROL VALVE, $	INCREASE, %
Control valve	16,200	22,400	38
Relief valve	8,500	13,400	58
Isolation valves	8,200	8,200	0
Bypass valve	16,200	22,400	38
Drain valves	2,600	2,600	0
Vents/silencers	12,100	16,500	36
Total System	63,800	85,500	34

Table 2. Increasing the control valve size leads to a number of other changes that raise total cost.

Instrument engineers size control valves to pass the required flow rates yet maintain appropriate loop controllability. The underlying goal is to make economic yet appropriate equipment specifications.

The instrument engineers not only establish equipment requirements and specifications for normal system operation but also size equipment for worst-case scenarios. They may add extra safety factors at this point — so you can begin to see how flow control and measuring equipment starts to become "oversize" for the task at hand.

It's critical that instrument engineers communicate with process and piping engineers to ensure that valves, meters and controllers not only meet but also, importantly, don't exceed system flow and pressure-drop requirements.

Valve supplier *application engineers* convert process control requirements into detailed equipment specifications that lead to determining the right valve for the job. The application engineer must ensure the valve operates within reasonable throttling limits, being able to pass the required flow rates. Borderline applications almost always are pushed into the next larger size, resulting in a significant step-change in equipment cost (Figure 3).

For example, when an NPS 6 valve can meet a design's expected process flow requirements but oversizing by the plant's engineers push the parameters past that valve's capacity, forcing a move to an NPS 8, then cost takes a significant jump upward (Table 2).

It's appropriate — and necessary — for the application engineer to question an apparent oversizing of a control valve. A review of valve requirements before the purchase order is placed saves both cost and time for all involved.

Don't ignore control valves already installed. You often can identify a poorly sized control valve by its disc or plug position. During normal operations, a valve throttling at less than 10% open or greater than 90% of valve travel is inappropriately sized. Another indicator of a valve being oversized is when a 1% change in controller output causes a greater-than-3% change in the process.

Globe valves have a number of available port sizes for a given body size. So, changing the trim may alter the throttling position of the flow element into a more optimal range. Other control valves, such as rotary ones, don't offer such flexibility and must be changed out for a properly sized version.

ADDRESS OVERSIZING

The use of multiple safety factors — some inherent, some discretionary — by different design functions can lead to specifying an oversized control valve. It's important to know that a seemingly small amount of added capacity doesn't result in a proportionally small increase in equipment cost. Mechanical piping components have discrete sizes. A decision to add "a little more margin" often will hit equipment limits, forcing a step-change in size and cost. Even the oversizing of a small valve can significantly impact system cost, performance and, ultimately, maintenance.

Avoiding or at least alleviating oversizing requires close collaboration among the engineering groups and their equipment suppliers as each applies best practices in process system design (Figure 4).

MICHAEL MCCARTY is vice president of the Fisher Sliding Stem and Baumann Valves Business Unit of Emerson Process Management, Marshalltown, Iowa. E-mail him at Michael.McCarty@emerson.com.

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Tackle Biogas Flow Measurement Challenges

Two case studies highlight the need for accurate biogas flow measurement

By Rich Lowrie, Krohne, Inc

ANAEROBIC DIGESTION occurs in biodigesters and produces a fuel (biogas), removes biochemical oxygen demand (BOD) from sewage, conserves nutrients (especially nitrogen compounds) and most importantly reduces pathogens. The biogas, in turn, can be used as a supplemental heat or power generation energy source. Depending on the influent, and the treatment facility's size and design, the resulting biogas flowing conditions can vary greatly from season to season and from plant to plant.

Modern flowmeter solutions must be able to meet growing demand for accurate biogas flow measurements while handling a wide and seasonally varying operational range. Here are two stories that highlight these challenges and the resulting solutions.

MEASURING BIOGAS ENERGY TRANSPORT

Ara Region Bern, ag (arabern) operates a wastewater treatment plant in Herrenschwanden, Switzerland. The plant also generates renewable energy. The company obtains CO2-neutral biogas (methane) from biogenic waste and sludge. Using a combined heat and power plant (CHP), the operator is able to convert a portion of this biogas into electrical energy, covering 24% of its power requirements from its own production. The heat energy released in the process is used to generate thermal energy. Another portion of the biogas is converted to natural-gas-quality biomethane in a treatment plant for injection into the public gas grid.

APPLICATION REQUIREMENTS

To produce digester gas, arabern delivers the sludge from the primary treatment stage and the biological purification stage to digestion towers where it is circulated for 25 days and heated to 35° C (95° F). The biogas mixture released in the process contains methane (65 vol.%). Other components include carbon dioxide (> 25 vol.%) and water (5–7 vol.%).

Immediately following production, the biogas runs through various filters and is transported through a pipeline system at 24° C (75.2° F) to a gas storage tank which then supplies the gas motor of the CHP with energy. For the production measurement of the biogas flow from the digestion tower to the storage tank, arabern needed a technical solution that provides reliable and accurate biogas volume measurements (0...2,000 Nm^3/h / 70,621 scf/h) despite very high moisture in the gas flow and very low pressure (about 35 mbar / 0.5 psi). The application allows virtually no pressure loss and also requires approval in accordance with the ATEX directive on protection against explosion (Zone 1).

BIOGAS MEASUREMENT SOLUTION

To measure the biogas, Krohne provided the Optisonic 7300 F Ex-version for ATEX compliance (Figure 1). When installing the ultrasonic flowmeter, the stainless steel pipe-

BIOGAS FLOW MEASUREMENT

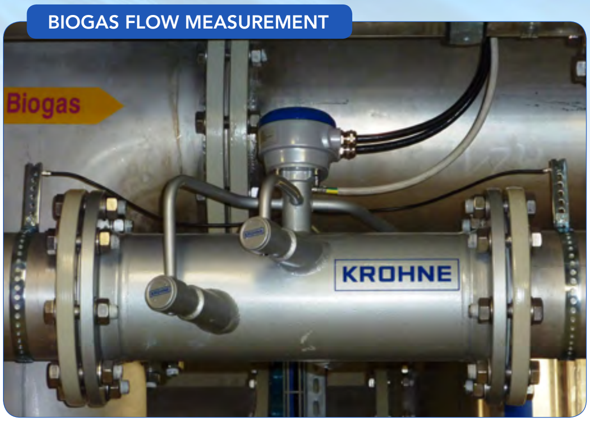

Figure 1. The OPTISONIC 7300 F ultrasonic flowmeter is used to determine biogas flow.

line was brought from DN200 / 8 in. down to DN150 / 6 in. to increase the flow velocity of the biogas mixture. The free measuring tube means no loss of pressure.

The ultrasonic flowmeter determines the biogas flow by way of the transit time differential measuring principle. The velocity of sound of the gas is measured at the same time. On this basis and with the input of gas temperature, adiabatic index and the molar gas constant, the signal converter also calculates the molar mass which is used to determine the methane content with 2% accuracy.

BYPASS MEASUREMENT

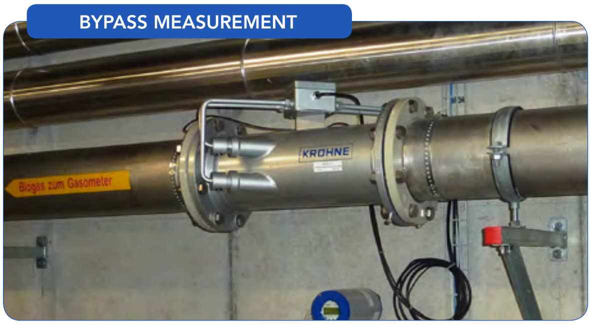

Figure 2. A Krohne GFM 700 ultrasonic device is used for a bypass measurement.

A GFM 700 ultrasonic device which has been used for years and is still used for a bypass measurement complements the ultrasonic flowmeter (Figure 2). Another GFM 700 is installed in front of the flare stack where it measures the flow of the methane gas that is burned when the CHP is switched off.

BENEFITS

The Optisonic 7300 provides arabern with precise flow measurement of the biogas produced on-site. The integrated calculation of the methane content in the biogas allows the operator to accurately determine the wastewater plant's energy production. This also is important for arabern to know because the engine of the CHP runs smoothly only with a minimum methane content.

The flexibility of the ultrasonic device provides reliable measurements in a pressure-sensitive environment and independent of the gas composition. The device's titanium sensors provide good signal strength and high measuring accuracy even with moist gas, high CO_2 content and low pressure.

SEWAGE PLANT

Figure 3. The Burghausen public utility company in Germany operates a sewage plant including sewage treatment and connected combined heat and power plant fueled by digester gas.

The measuring instrument also is maintenance-free and boasts long-term stability.

CHECKING ENERGY PRODUCTION

The Burghausen public utility company (Figure 3) in Germany operates a sewage plant including sewage treatment and connected combined heat and power plant fueled by digester gas (methane). To this end, the sewage sludge is transported from the sewage treatment plant to the digestion tower where the residual solids are partially decomposed by microorganisms. The methane released in the process is then supplied to the biogas plant as an energy source.

APPLICATION REQUIREMENTS

To obtain accurate information about the energy production of the sewage treatment plant, the operator requires continuous measurements of the volume and energy flow of the methane being transported from the digestion tower to the CHP. Despite two water separators installed in the pipeline (Figure 4), the exhaust gas is still very wet. The pressure of the gas was initially very low at 65 mbar / 0.94 psi and decreased over time to 20 mbar / 0.29 psi and then to an average of just 7–8 mbar / 0.10–0.11 psi with the installation of a low pressure system (Figure 5). Despite the insulation in the digestion tower, the gas is exposed to external influences such as seasonal temperature fluctuations, which then affect the gas density (0.717 kg/m³i.N. / 1.565 lbs/scf). The operator of the sewage treatment plant had already tried using a differential pressure device but stopped using it due to faulty measurements. Based on this experience he was very skeptical about finding a measuring principle that would work with the existing parameters.

WATER SEPARATOR

Figure 4. Here, the gas inlet with first water separator is shown.

GAS PRESSURE

Figure 5. With the installation of a low-pressure system, the flowmeter still reads reduced gas pressures of just 7–8 mbar (0.10 psi).

TRIAL INSTALLATION

Krohne provided the Optiswirl 4070 C vortex flowmeter, initially as a test device, in the recommended size of DN 25 / 1 in. To accommodate, the pipeline had to be reduced to DN 25 / 1 in. from the original DN 50 / 2 in. The device was installed per customer request with a flange connection in a descending pipeline (Figure 6). The necessary inlet and outlet runs were provided.

INSTALLATION

Figure 6. The Optiswirl vortex flowmeter from Krohne was installed with a flange connection in a descending pipeline.

The vortex device (pressure rating PN 40/300 lbs) measures the operating pressure, temperature and volume flow and then automatically calculates the mass and energy flow of the methane gas based on those measurements. As the instrument also features a shut-off valve, its pressure sensor can be replaced if necessary, even during operation and without process intervention.

The 2-wire plug-and-play device with non-wearing, fully-welded stainless steel construction is highly resistance to corrosion, pressure and temperature.

CONTINUOUS MEASUREMENT

With the Optiswirl, the operator of the Burghausen sewage plant can accurately test and demonstrate the performance and energy production of his sewage treatment plant. In so doing he benefits from the Optiswirl's large span. Even though the system pressure following the conversion decreases to 7 mbar / 0.10 psi or even lower and the gas is extremely wet, the device still measures continuously and provides accurate measuring results.

Given the measuring parameters, the customer was surprised by the flowmeter's measuring performance and made the decision to purchase the instrument. The device has now been running without interruption for more than three years and without any maintenance requirements. The vortex device in the sewage plant has measured over 620,000 m³ / 21,891,171 f³ of digester gas to date.

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