FlowTimes – August 2023

Your strategic update on flow, temperature, and pressure measurement from Flow Research

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1. What summer vacation? We keep on Flowing

Summer is not typically a time for Flow Research staff to lounge on the beach (although our vice president, Belinda Burum, does her best to do just that). Rather we, or at least I, choose to keep flowing as fast as possible to produce the many exciting studies we've scheduled for this year.

Jesse out on the town during CEESI

Belinda and I did, however, enjoy a working vacation at the end of spring when we attended the CEESI Gas Ultrasonic Meter User's Conference in Colorado Springs June 14 & 15. The venue was in a fun downtown location and we thought the conference was excellent, with a lot of opportunities for networking. We really enjoyed talking with many "old" friends at the conference, as well as some new friends, and were impressed with the quality of the presentations.

It was clear from the presentations that suppliers are making a lot of progress on important topics in ultrasonic flow. Those include measuring wet gas, self-verification, diagnostics, the efficacy of multiple paths, gas flow measurement, LNG exports, and many other topics. Ultrasonic flowmeters for both liquid and gas flow measurement have many advantages, and this market is one of the fastest growing markets in flow measurement. Happily, we are working on a three-part study on ultrasonic flowmeters that will reveal just how fast-growing this market is, and why. Look for the clamp-on module of our three-part ultrasonic study in August.

Speaking of clamp-ons, we were interested to learn that suppliers believe clamp-on ultrasonic meters are reaching custody-transfer accuracy. Siemens is actually promoting clamp-ons with a twist for custody transfer. The company claims that once its clamp-on meter is installed on an engineered spool and calibrated, it can reach custody transfer accuracy of 0.5–1.0% of rate or better. The engineered spool includes a meter run with upstream and downstream piping to

handle flow profile issues. Another prominent clamp-on vendor, FLEXIM also claims that it is possible to calibrate its clamp-on to achieve custody-transfer accuracy. However, the company's Izzy Rivera maintains that clamp-ons are better suited to check metering of custody transfer meters, leak detection, and high-accuracy allocation measurement because of the inherent uncertainties in the wall thickness and geometry of the pipes they are mounted on.

While we were in Colorado, we were also excited to travel north to Boulder to visit Emerson for a detailed explanation of the Coriolis effect. This is a topic I've long wanted to understand in depth, and the Coriolis experts there patiently and thoroughly described the Coriolis effect and its relation to Coriolis meters. I'm still digesting the math and the physics of this complex technology, but feel I definitely got some answers to my questions. We were also pleased to learn more about multivariable differential pressure technology from experts in the DP group. All of this understanding is feeding our upcoming studies on mass flow, including Coriolis, which we are publishing at the end of July, and mass flow controllers, due out in the fall. As you will see next, we are pleased to report that the first study in the series, on thermal flowmeters, is now shipping.

2. Thermal flowmeters ride the gas flow surge

We are excited to announce the July publication of our latest study, *The Market for Thermal Flowmeters, 3rd Edition* (www.flowthermal.com), the first of three studies on mass flow measurement, with the next, *The World Market for Coriolis Flowmeters, 7th Edition* (www.flowcoriolis.com) due out in the next few weeks.

The study found that thermal flowmeters are riding the surge of gas flow measurement in both renewable and traditional natural gas applications, with landfill gas and biogas recovery as the fastest growing applications, followed by biomass fermentation and recovery growing second fastest. As Jesse said in our press release: "The future of gas measurement is extremely promising. Natural gas is no longer just a bridge to renewables, it is a renewable. As biogas and biogenic methane become more and more mainstream, new opportunities in gas flow measurement are multiplying, and thermal technology is well positioned to take advantage of that trend. Thermal meters aren't accurate enough for custody transfer measurement, but there are plenty of other applications in the energy chain where they are cost-effective and useful."

The worldwide thermal flowmeter market was substantially larger in 2022 than it was in the past several years, and we project that it will show significant growth through 2027. We expect multipoint thermal meter revenues to grow faster than inline and singlepoint insertion types. Multipoint meters, which traditionally have been used to measure flow in large ducts and stacks, are now being used in other applications and in smaller line sizes. Greater accuracy can be derived from multiple measuring points. Other enhancements that also improve accuracy include

flow conditioners, smart meters, and user-programmable meters that can accommodate changing gas requirements.

Thermal flowmeters, used almost entirely for gas flow, are cost-effective and versatile, respond quickly, and excel at measuring flow at low flowrates. They offer value, high turndown ratio, cost-effectiveness in large line sizes, flexibility for a wide range of gases, and high repeatability.

The study draws on in-person interviews with Dr. Jerome Kurz and Dr. John Olin, who formed Sierra Instruments in 1973, and Bob Deane and Mac McQueen from Fluid Components Int'l. (FCI). Kurz and Olin developed an industrialized version of the hot wire anemometer – a forerunner of the thermal meter. Kurz left Sierra to form Kurz Instruments in April 1977. As a result, Kurz become the first company to bring industrial thermal flowmeters to market. FCI developed thermal flow switches in 1964, and introduced thermal flowmeters in 1981.

3. Emerson sharpens its automation solutions focus

While at Emerson, we found out how the company is advancing its global automation leadership through acquisition, divestiture, and reorganization. In fact, we learned that automation solutions is now a company-wide focus rather than a business segment housing flowmeters and other measurement technology.

Belinda Burum, Flow Research VP, at Emerson in Boulder, Colorado at a rainy-day visit following CEESI

In April of this year, Emerson entered into a definitive agreement to acquire NI (until June 2020 called National Instruments Corporation) for a total equity value of $8.2 billion. NI's best-in-class test and measurement product and software offerings are expected to hasten Emerson's progress toward "a cohesive, higher growth and higher margin automation portfolio," said Lal Karsanbhai, Emerson's president and chief executive officer in an April 12 press release. "With this expansion into test and measurement, Emerson will enhance its automation capabilities and gain a broader set of customers that relies on NI's solutions at critical points along the product development cycle. These capabilities provide Emerson industry diversification into attractive and growing discrete markets like semiconductor and electronics, transportation and electric vehicles, and aerospace and defense that are poised to benefit from secular growth trends. NI's business is well-aligned with our vision for automation and we look forward to working together to bring more comprehensive and innovative solutions to our customers, accelerate growth, and position Emerson to deliver significant shareholder value."

NI posted $1.66 billion in revenue in 2022 and operated in more than 40 countries, serving approximately 35,000 customers. The deal is expected to close by March 2024. Emerson already

owns approximately 2.3 million shares of NI, representing approximately 2% of outstanding shares.

Emerson is financing the NI purchase with $8 billion from the sale of its $14 billion Climate Technologies business to Blackstone, which acquired a 60% majority stake in the business on May 31. The joint venture is now a standalone business named Copeland focusing on the global HVACR market.

To better reflect the company-wide automation focus, Emerson has reorganized from four to six business segments. Automation Solutions – home to Coriolis, ultrasonic, magnetic, differential pressure, vortex, and multiphase flowmeters (under the Micro Motion, Rosemount, and Roxar brands) – as well as and fittings, liquid control valves, and flow accessories and software – is now Measurement & Analytical, and known internally as Measured Solutions. Emerson's other segments are AspenTech, Control Systems & Software, Final Control, Discrete Automation, and Safety & Productivity.

4. Two new U.S. ultrasonic companies ramp up

At CEESI we also learned that two U.S. organizations are drawing on the long-time ultrasonic expertise of founding engineers to launch ultrasonic meters.

One of these, **Insight Metering Systems (IMS)** (insightmetering.com), is now offering an ultrasonic meter for the world market and the entire gas value chain. Its iSonic meter features six or eight paths, patented non-wetted transducer technology, 0.5 class accuracy for custody transfer and ≤0.05% repeatability. IMS is also planning to release ultrasonic meters it calls "replacement systems" for Coriolis, differential pressure, and turbine flowmeters, as well as a meter for hydroelectric systems.

IMS is a division of LETD (Leading Edge Technology Development, LLC), which was founded by Don Augenstein and Bob Beede, two engineers with extensive experience in designing, developing, and distributing ultrasonic flowmeters. They saw what they considered a crucial need for a company committed to serving customers in the US and the Americas. They wanted to offer innovative, accurate, and reliable ultrasonic flowmeters, and have the ability to build, deliver and service these meters efficiently and promptly. Don's experience goes back to Caldon, where he worked with Cal Hastings to develop the first eight-path ultrasonic flowmeter for liquid hydrocarbons. At Caldon, Don also developed the first-to-market eight-path ultrasonic flowmeter for natural gas. Bob sold meters around the world as Caldon's global distributor.

IMS has a strategic partnership with Goldcard Smart Group Ltd in China and representation in the U.S., Canada, Mexico, Peru, and Bolivia.

Houston-based **TMCO** (www.tmcousa.com), which currently supplies SureShot® orifice fittings, is also entering the ultrasonic market and planning to start manufacturing an ultrasonic meter in the U.S. by January 2024. That meter is the TrueShot UIM Series now manufactured by Transus Instruments in The Netherlands. Transus is a TMCO partner founded by senior engineers in 2012 to revolutionize ultrasonic gas flowmetering technology. Those engineers, who claim more than a century of combined industry experience, identified deficiencies in the ultrasonic flowmetering market and left senior positions at other leading companies (including Elster/Instromet) to create Transus. The UIM meter features cutting edge electronic processing and rugged and powerful transducers that operate at a very low transmitting voltage (3.6V.) The meter is already on the market in Europe and Asia. TMCO believes that by manufacturing the meter in the U.S. it will be better able to meet the needs of U.S. customers and deliver meters more quickly.

5. Hydrogen – pivotal in energy transition and promising as a market for ultrasonic meters

One of the recurring themes at CEESI was ultrasonic flowmeters' ability to measure hydrogen and hydrogen blends. That made us to want to know more about hydrogen, which we found is one of the pillars in the current transition to integrating renewables into the broader energy system according to a whitepaper from KROHNE, "H_2 measurement techniques and the European Green Deal."

Green hydrogen (H2)

KROHNE maintains, hydrogen from renewable energy – when sufficiently scaled – "can play a major role in helping Europe become climate-neutral in the next few decades."

The American Gas Association agrees, calling green energy's role "pivotal" in the current energy transition. The AGA believes that the Clean Hydrogen Production Tax Credit and other provisions in the Inflation Reduction Act guarantee that clean hydrogen will be "a critical component of the global energy system going forward." It also believes in the importance of making hydroben use scalable, saying, "the stakes are high in the race to establish sufficient production and distribution capabilities."

Green hydrogen (H2) is a versatile energy carrier that can be applied to decarbonize a wide range of sectors. It can be used directly or in the form of its derivatives like e-methanol, e-ammonia, or e-fuels to replace fossil fuels, coal or gas.

Blue, green, grey or mixed

Most hydrogen today is extracted from fossil fuel natural gas (sometimes called "grey hydrogen"), but two types of carbon-neutral hydrogen, plus a mixed type, are on the rise:

- Blue hydrogen, extracted from natural gas, captures the CO2 generated during the process and stores it permanently underground for a carbon-neutral footprint.
- Green hydrogen (H2) is produced by splitting water into hydrogen and oxygen in an electrolyzer powered by renewable energy. It is a versatile energy carrier that can be used directly instead of grey hydrogen or combined with other elements to create synthetic electrofuels (e-fuels) like e-ammonia and e-methanol.
- Mixed hydrogen combines blue or green hydrogen in natural gas pipelines to reduce carbon emissions. Emerson reports that blending is being rapidly adopted in Europe, with some pipelines targeting 100% hydrogen, and that in North America, customers are adapting and testing up to 30% in the natural gas stream.

Hydrogen for renewable energy transport, storage, and more

Hydrogen is widely used today in industrial processes, including, for example, manufacturing high-grade steel and as a reactive agent to refine petroleum products by breaking down heavy molecules and removing impurities.

Hydrogen can also be used to power vehicles, generate electricity, power industry, and heat homes and businesses – although some research indicates that heating with hydrogen is a lot less efficient and more expensive than alternatives such as heat pumps, district heating, and solar thermal.

Using clean or cleaner hydrogen, therefore, is an important step forward in reducing carbon emissions. As a side benefit, blue or mixed hydrogen leverages the natural gas infrastructure, which potentially can help scale up the clean hydrogen industry more rapidly.

One of the most important aspects of green hydrogen, however, is that it can be used to store and transport solar and wind energy for use where and when it is needed. As KROHNE points out, solar energy is most available in the summer, but most needed in the winter, and wind energy is increasingly available, so how to store excess renewable energy and transport it at critical times is an important concern.

Happily, green hydrogen can be stored for long time periods, in large quantities, and without loss, and then transported and used directly or converted back into electricity and heat.

According to the AGA, hydrogen has "immense potential" for energy storage because the capacity of America's gas pipelines and gas storage facilities exceed all battery capacity provided by every lithium battery on earth. (Lithium-ion batteries are currently the dominant storage technology for ensuring a reliable supply to electricity grids.) Using hydrogen would allow us to transition to a higher mixture of renewable energy without diminishing the reliability of our energy distribution infrastructure.

Hydrogen and ultrasonic flowmeters

Hydrogen's physical properties are quite different from other gases, including natural gas, and flowmeter suppliers have had to adapt to those differences, as well as figuring out ways for ultrasonic meters to accurately measure hydrogen blends.

KROHNE's 12-chord ALTOSONIC V12 ultrasonic custody transfer (CT) flowmeter, for instance, measures pure hydrogen, natural gas, and blends of hydrogen with natural gas. Emerson's four-path Rosemount™ SeniorSonic 3414 gas ultrasonic meter allows customers to blend hydrogen into their current pipeline at levels of up to 30% and still maintain high accuracy and reliability.

KROHNE's ALTOSONIC V12 ultrasonic custody transfer flowmeter measures pure hydrogen, natural gas, and blends of hydrogen with natural gas

FLEXIM offers FLUXUS G ultrasonic systems that can measure the flow of many types of gas, including hydrogen. In 2021 it was the representative clamp-on supplier invited to participate in a joint industry project on the suitability of natural gas flowmeters for renewable gases at a multiphase flowlab in DNV's Technology Centre in Groningen, The Netherlands. The FLUXUS G 721 successfully performed within its specified measurement uncertainty (±1…2%) and repeatability (0.15%) in natural gas mixtures with up to 30% hydrogen and up to 20% CO2.

First, we need production capacity. Green hydrogen is typically made with electrolysis powered by renewable energy. This allows hydrogen to be harvested directly from the atmosphere, making the process carbon neutral. Therefore, for a truly secure energy supply chain, the United States could manufacture electrolyzers domestically and at scale and use this to set up a domestic production capacity sufficient to meet our needs in conjunction with blue hydrogen. Using blue hydrogen in addition to green hydrogen has a side benefit of using existing equipment, enabling us to start scaling up the clean hydrogen industry sooner.

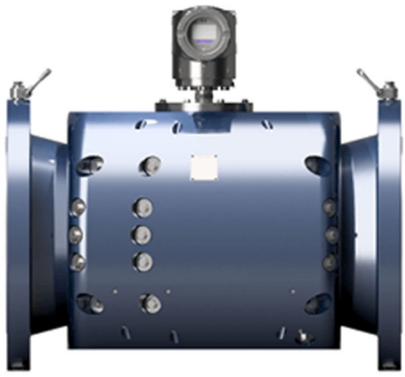
But is renewable hydrogen affordable?

Currently, renewable hydrogen is expensive, but costs can potentially follow the declining costs of wind and solar, according to the AGA and a BloombergNEF report on the economic outlook for hydrogen. A prime key is the cost for electrolyzers. Between 2014 and 2019, the cost of alkaline electrolyzers made in North America and Europe fell 40%. Chinese-made systems are already as much as 80% cheaper than those made in the West. The report indicates that if electrolyzer manufacturing can further scale up, and costs continue to fall, renewable hydrogen could fall as low as 32 cents per pound in most of the world by 2050 – less than a third of the $1/pound "Earthshot" goal declared by the Biden administration – making it competitive with natural gas prices in Brazil, China, India, Germany, and Scandinavia and cheaper than producing hydrogen from natural gas or coal with carbon capture and storage.

China is currently the world's largest producer of hydrogen and aims to transition to widespread use of green hydrogen by 2025. India plans to produce five million tons of green hydrogen per year by 2030 and announced a $2.5 billion investment in green hydrogen production.

6. Sensia SVM – a breakthrough in ultrasonic metering

Also at CEESI, Ross Johnston presented the patented, "cutting-edge technology" of Sensia's new self-verifying (SVM) custody transfer ultrasonic flowmeter, which he says is the first of its kind in gas or liquid custody transfer to deliver a quantitative and continuous evaluation of its performance, calculating live uncertainty output from an augmented measurement configuration.



Sensia's CALDON SVM 289Ci Self-Verifying Meter for Liquids

The SVM meter builds on the company's Caldon eight-path Caldon 380Ci 280 (liquid) and 380 (gas) models and incorporates three new features to estimate additional uncertainty and enhanced self-verification capatilities:

- Axial velocity measurement verification per chord
- Fifth chordal measurement plane
- Vertical reflective path for detection of contamination

Sensia's Caldon SVM 298Ci self-verifying meter for liquids (so far the only SVM Sensia markets on its website) enables simultaneous calculation of measurement uncertainty alongside each flow measurement calculation, updated once per second. The 16-path meter uses Sensia's proven 8-path configuration for its primary measurements and a fifth chordal measurement plane to compare 4-chord (8-path) versus 5-chord (10-paths) results of flow profile uncertainty. The SVM technology also provides axial velocity measurement verification for the chords and a vertical reflective path to detect entrained gas or contamination.

Sensia's SVM 289Ci meters can measure crude oils and refined products in single or multi-product pipelines from 8" to 40" with ±0.10% linearity over the nominal flow range.

The meter removes time-based recalibrations by dynamically alerting operators to any issues in and providing a quantitative evaluation of the meter's performance. They are also totalised, and can be logged and examined for future reference. Like Sensia's 8-path meter, the SVM does not require a flow conditioner to address the effects of non-axial flow/swirl. Error detection is more reliable than two meters in one body, which can be subject to false alarms. The meters can detect and quantify the influence of complex changes such as variations in path geometry and signal detection issues

7. New schedule for 2023 Flow Research studies

We have slightly revised our schedule for the rest of this year. We welcome your orders now. Here's what you can expect:

- ***Now shipping!*** July 2023 (xx pages): *The World Market for Thermal Flowmeters, 3rd Edition* (www.flowthermal.com)
- July: *The World Market for Coriolis Flowmeters, 7th Edition* (www.flowcoriolis.com)
- August: *Module B: The World Market for Clamp-on and Insertion Ultrasonic Flowmeters*
- September: *Module A: The World Market for Inline Ultrasonic Flowmeters* and *Core Study: The World Market for Ultrasonic Flowmeters, 7th Edition*
- October/November: 20th birthday release of *Volume X: The World Market for Flowmeters, 9th Edition* and its *Module A: Strategies, Industries, & Applications* standalone companion study (www.flowvolumex.com)
- November: *The World Market for Vortex Flowmeters, 7th Edition* (www.flowvortex.com)
- December: *The World Market for Mass Flow Controllers, 4th Edition* (www.flowmfc.com) and *The World Market for Mass Flow Measurement core study* (www.massflows.com)

In addition to ordering our exciting 2023 studies, there's still time to profit from earlier Flow Research studies that cover nearly every flowmeter technology in depth:

- October 2022 (384 pages): *The World Market for Variable Area Flowmeters*, our first VA study ever, found that the market is holding its own as suppliers introduce improvements to meet the increasingly sophisticated needs of today's users. (www.flowva.com)
- September 2022 (566 pages): *The World Market for Turbine Flowmeters, 3rd Edition* reveals that new product developments are keeping the large and stable turbine meter market competitive. (www.flowturbine.com)
- July 2022 (526 pages): *The World Market for Magnetic Flowmeters, 7th Edition* finds that magnetic flowmeters are running neck and neck with Coriolis meters as a revenue leader in the global flowmeter market. Magmeters are among the most widely used types of meters for measuring the flow of water and other liquids. (www.flowmags.com)

- June 2022 (460 pages): *The World Market for Pressure Transmitters, 5th Edition* finds that pressure transmitter revenues worldwide equal more than 40% of the worldwide flowmeter market. Pressure is one of the most widely measured variables in the process industries, with an important relation to flow, level, and temperature. Differential pressure flow measurement overlaps with the worldwide flowmeter market. (www.pressureresearch.com)

- April 2022 (1,316 pages): *Volume X: The World Market for Flowmeters, 8th Edition* and *Module A: Strategies, Industries, and Applications* finds that the worldwide flowmeter market is now strong and trending upward following the pandemic slump as the economy regains its footing and rising oil & gas prices drive exploration and production. The two studies cover market share, market size, industries, applications and more for all 11 flowmeter technologies. (www.FlowVolumeX.com)

- December 2021 (476 pages): *The World Market for Positive Displacement Flowmeters, 3rd Edition,* our first PD study in a decade, finds that despite competition from new-technology meters, positive displacement meters are holding their own, especially in the oil & gas market. PD flowmeters are the workhorses in the flowmeter world. (www.FlowPD.com)

- May 2021 (1,634 pages): *The World Market for Ultrasonic Flowmeters, 6th Edition* and its companion modules on inline and clamp-on/insertion ultrasonic meters found that the ultrasonic flowmeters is growing faster than expected. (www.flowultrasonic.com)

- September 2020 (536 pages): *The World Market for Coriolis Flowmeters, 6th Edition* found that Coriolis is one of the fastest growing flowmeter markets. Coriolis is also one of the flowmeter technologies that companies invest most in for research & development. (www.flowcoriolis.com)

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