

“This type of thing can only be achieved as a team”

Endress+Hauser launched an innovative ultrasonic flowmeter for the oil & gas, chemical and other process industries in January. The Proline Prosonic Flow G 300/500 is particularly robust and even measures wet gases with reliability and precision. A four-person team of engineers is responsible for the innovation and has now been nominated for the renowned AMA Innovation Award.

The title of the AMA Innovation Award submission is “ultrasonic flowmeter device with a gas analysis function for process gases”. Each year, the award honors innovative projects and product ideas in the field of sensors and measurement, with the award being presented to the corresponding development teams. The team behind the Proline Prosonic Flow G 300/500 is made up of Dr. Michal Bezděk as Project Manager in addition to Pierre Ueberschlag, Frank Wandeler and Dr. Oliver Berberig – three electrical engineers and a mechanical engineer, all of whom work as developers at Endress+Hauser Flow in Reinach. They are already eagerly anticipating the award ceremony on 22 June 2020.



Fig. 1: The ultrasonic flowmeter device Proline Prosonic Flow G was developed for measuring even liquid gases and gas mixtures under fluctuating process conditions.

1.1 The challenges: Liquid components in gas and variable pressure

Just like other ultrasonic flowmeter devices, the Proline Prosonic Flow G 300/500 works on the principle of the transit time difference: A pair of transducers placed at an angle to the tube wall measures the flow of gas while a second pair measures against the flow, resulting in a transit time difference between the two measurements. This allows the average flow speed to be determined along with the average volume flow rate when multiplied by the pipe cross-section. “This works really well with dry gases,” Michal Bezděk explains, “unlike wet gases with variable compositions and pressures.” Ultrasonic technology has therefore barely been used to measure “impure” gas mixtures so far, but the Proline Prosonic Flow G 300/500 is set to change this.

The upstream measurement of natural gas is a typical example (see box): Raw natural gas tends to contain high quantities of liquid in addition to fluctuating pressure and temperatures. Similar challenges are encountered with additional Proline Prosonic Flow G 300/500 applications such as measurements in underground gas storage outlets or LNG regasification plants as well as chemical and petrochemical processes. It is precisely these types of applications which Endress+Hauser is now focusing on: “The new measurement device is also opening doors to the oil and gas industry for us,” Michal Bezděk states.

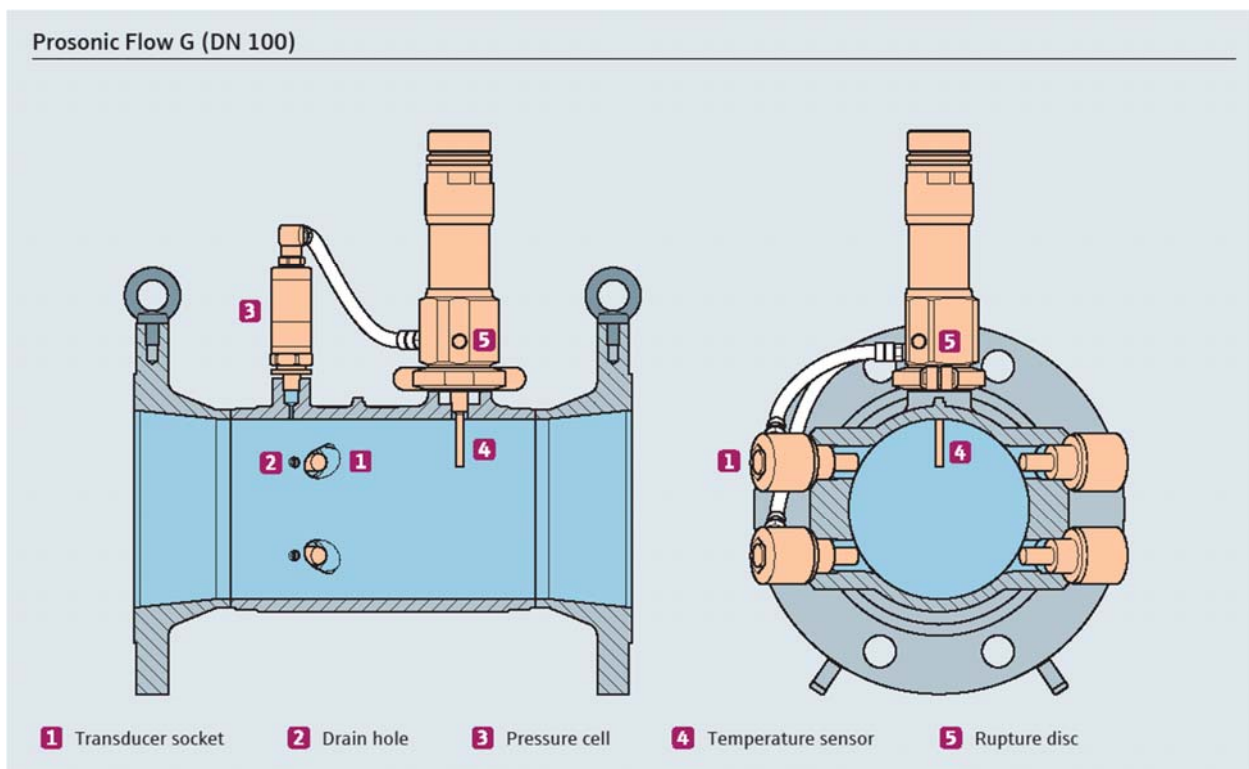


Fig. 2: Layout of the ultrasonic transducer and the optional pressure and temperature sensors for advanced gas analysis

1.2 The innovations: New transducer, advanced gas analysis

Ultrasonic measuring procedures may have been the standard at Endress+Hauser for decades, allowing the development engineers to apply their long-term experience. Yet, due to the specialist challenges, all the significant components required redesigning, including the ultrasonic transducer, measurement tube, electronics and software.

The ultrasonic transducer, which has the task of transmitting the ultrasonic waves into the media as effectively as possible, presented a particular challenge. The structure-borne soundwaves should be prevented from projecting backwards inside the measurement tube, thereby causing signal distortion. An attenuator was not an option as the transducer should be made entirely of metal due to the necessary robustness and corrosion resistance. Success was ultimately achieved with a specialist design of ring-shaped structures that act as a mechanical band-stop filter in the measurement's frequency range. "We determined the ideal form by running a finite element simulation," Project Manager Michal Bezděk reports.

The developers faced a difficult task when it came to gas flows with a potentially high liquid content: If liquid penetrates the pipe socket that the transducer is installed in this can cause a "short circuit" in the mechanical filter. The solution involved a specialist system with large distances between the transducer and pipe wall in addition to integrated drainage that allows liquid components to flow back into the main stream from any position. "Numerical simulations were also applied during the optimization of the measuring tube geometry," Project Manager Michal Bezděk outlines. "The measurement is highly reliable using the solution that was found, even if the gas is very wet."

1.3 The development process: Six years from the initial idea to the completed system

Developing an entirely new measuring device takes more than just a few months – when it comes to the Proline Prosonic Flow G 300/500 it was a matter of six years between the initial idea and the completed product. The team also had to deal with a major setback when a concept that appeared to be promising during simulations did not work during the field test, meaning they had to come up with a new idea, which proved to be successful. "This showed us the importance of field tests when it comes to new applications," Michal Bezděk states. "Simulations and laboratory work alone aren't sufficient."

The result was ultimately worth all the effort: The Proline Prosonic G 300/500 enables the precise measurement of any gases, including wet gases, across a very wide pressure range including atmospheric pressure up to 100 bar while maintaining a high level of measurement accuracy and repeatability. Ultrasonic measurement furthermore makes it possible to operate a device long term without maintenance, thus significantly reducing costs in comparison to conventional measuring

procedures (see box). And that's not all: With optional pressure and temperature sensors and a specially developed software function package, the Proline Prosonic Flow G 300/500 can calculate additional parameters and process variables such as mass and energy flow, calorific value, Wobbe index, molar mass, methane content, density or viscosity. "This level of versatility is unique to the market," Michal Bezděk emphasizes.

Each of the four team members was able to incorporate their specialist knowledge during the development process. In addition to his role as Project Manager, Michal Bezděk was also responsible for the ultrasonic simulations. Oliver Berberig designed the measurement tube, Frank Wandeler was in charge of the measurement engineering hardware and software and Pierre Ueberschlag developed the transducer design as well as the advanced gas analysis software. "As a matter of fact, many others were involved in the project besides the four of us," Michal Bezděk states. Many other departments assisted and contributed to the project over the six-year development process: "This type of thing can only be achieved as a team." Those involved are all the more pleased about the successful completion of the measurement device which has been on sale since 31 January 2020. The Innovation Award would be the icing on the cake.

1.4 Highlights Proline Prosonic Flow G

- ± 0.5 % measuring accuracy
- Long-term, maintenance-free operation
- Can be used for process temperatures of up to 150°C and pressures up to 100 bar
- Suitable for safety-related applications compliant with IEC 61508 (SIL)
- Optional pressure and temperature measurement
- Advanced gas analysis software function package
- Heartbeat technology for self-diagnostics and inline device verification

1.5 Measuring upstream natural gas



Fig. 3: The Proline Prosonic Flow G 300/500 offers a more precise and economic alternative to traditional upstream measuring procedures.

Mixtures emitting from a drill hole are anything but clean: In addition to solid particles, they tend to contain liquid oil and water. The first measuring point is located by the separator outlet which should contain these fractions, although a residual amount of fluid components often remains in the gas stream. Traditional measurement procedures such as differential pressure measurement using an orifice plate are primarily used nowadays under harsh conditions such as these. The issue is that this type of flow measurement is inaccurate and requires a lot of maintenance due to the wear-prone orifice.

The new Proline Prosonic G flowmeter provides the remedy by enabling precise, low-maintenance measurement as the ultrasonic method requires no moving parts. Despite the higher acquisition costs, the system is more economic overall in terms of its long service life due to the low maintenance costs

compared to mechanical meters. It also offers the advantage of significantly more reliable volume flow calculation in addition to being able to determine additional process parameters via optional temperature and pressure measurement.

Autor:

Reinhardt Huschke (Text & Co.)

Interview partner:

Dr. Michal Bezděk Head of Dept. Ultrasonic Flow Sensors, AUS Sensor Endress+Hauser Flow