A technology coming of age

Andrew Sutton, Managing Director, Katronic Technologies, UK, investigates the improvement in technology and increasing use and acceptance of ultrasonic flowmeters in a wide variety of measurement applications.

Before looking into the progress of one specific instrument, it is important to recognise that 'ultrasonic flow measurement' is a term that covers a considerable range of different products. Firstly, it should be considered that the measurement of flow using ultrasound can be achieved in two different ways. Some flowmeters are based on a Doppler-type ultrasonic measurement technique whereby flow is obtained by looking at frequency changes in ultrasonic signals, caused by particulate in the flowing media. Devices of this nature can be used for measurement on closed pipes, open conduits or rivers where they can also be operated as profiling devices.

The second family of products employ variations of the transit time measurement principle through which the flow velocity is calculated. They interpret the time differences in upstream and downstream pulses sent and received from pairs of ultrasonic transducers. This style of instrument operates on full pipelines and was traditionally used for clean process fluids. However, as will be discussed later, this is no longer the case. The third group of products make use of ultrasonic level

Figure 1. The new KATflow 170 from Katronic is typical of a new generation of clamp-on flowmeters offering customers greater levels of performance and reliability.

technology to measure the flow in open channels and are very common in the wastewater industry.

There is additional segregation of the technology as the transit time principle can be applied in two different ways. In the first instance, pairs, or multiple arrays of ultrasonic transducers, are built into measurement spools or inserted directly into pipes to provide a highly accurate measurement of liquids or gasses. The second variation of the technology – and the one that we will be focusing on – is based on the use of non-invasive ultrasonic sensors which are mounted onto the outer surface of the pipe and which remove the need for the user to make modifications to previously installed pipework.

Inline ultrasonic flowmeters were adopted more quickly and are now considered accurate and reliable to the point when used on fiscal flow measurement applications. In contrast, clamp-on equivalent technologies were traditionally employed for niche requirements rather than as a conventional measurement technique. It is probably only now, after 30 years of use, that customers are learning to trust and accept the instruments as a standard solution.

Misapplication and misunderstanding

The path of the clamp-on ultrasonic flowmeter from niche product to accepted measurement technology has not been simple. Initial concerns about reliability caused customer wariness about its use and operation. There was also the suggestion of the clamp-on flowmeter being the instrument of last-resort where, for reasons of complex process conditions, alternative flowmeters had been considered and rejected leaving the ultrasonic meters as the only possible solution. This misapplication of the technology led customers to ignore good installation practice in the hope of a successful outcome and placing the blame for unsatisfactory results on the instruments.

Fortunately, this is no longer the case as technological developments have allowed manufacturers like Katronic to develop reliable and accurate instruments that meet the needs of its customers. When looking at the operation of an ultrasonic flowmeter, it is important that the customer has a realistic level of expectation and that the manufacturer ensures the technology is correctly used. Given that the flowmeters are properly specified, there is no reason why they should not provide the customer a cost-effective, hassle-free solution across a range of measurement requirements.

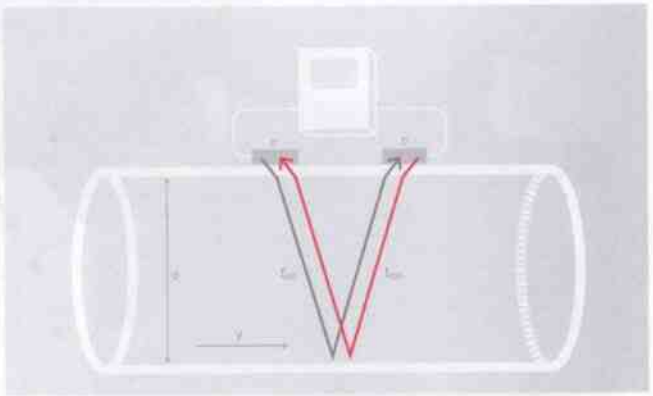

Figure 2. Clamp-on ultrasonic flowmeters use sensors to send and receive ultrasonic pulses. The difference in the time of the upstream and downstream pulses is directly proportional to the flow velocity, which is then integrated with the pipe dimensions and flow profile correction in order to provide the measurements.

One technology, two uses

The clamp-on flowmeters remain unique in that they are able to provide users with two distinct measurement solutions from the same standard technology. Only ultrasonic meters can offer reliable flow measurement that can be moved between locations and take numerous flow measurements in a short period of time. The same core system can also be employed for permanent installation on pipes with the identical level of ease of use and operation. The difference in the use of these instruments could be best described by stating that portable flowmeters are for identifying problems through testing and fault-finding, and that permanent clamp-on flowmeters are used for solving problems. In this case, the meters would be installed for measurement in locations where a need for a flowmeter is proven and meters are not already in place.

Katronic have two portable flowmeters to best meet the needs of their customers. The KATflow 200 is a simple to use lightweight hand-held flowmeter as opposed to the more advanced KATflow 230, which is designed to be able to offer engineers a variety of different configuration options. There is equal diversity on the instruments for permanent installation with three different configurations being available from the lower-cost KATflow 100 to the highly developed KATflow 150 and the new KATflow 170, an ex-certified flowmeter for operation in hazardous areas.

Diversification and standardisation

The growth in the use and acceptance of clamp-on flowmeters has come about through two different driving factors. The fact that the transit-time flowmeters are mounted on the outside of the pipe has meant that they have always lent themselves to unusual applications. There are obvious benefits to a meter that can be installed on toxic, aggressive and dangerous applications without compromising the systems or risking the safety of personnel. To give an indication on the breadth of uses that can be found for clamp-on flowmeters Katronic are presently working on a project for the installation of KATflow 100 flowmeters in space, and have also supplied instruments for submarines. The meters are utilised in purified non-conductive fluids in the pharmaceutical industry and are equally suited for sewage in the wastewater sector. This in itself is testament to how far the technology has evolved. In the past, heavier effluents and sludges would only have been suitable for measurement with a Doppler flowmeter whereas now transit-time flowmeters are able to provide reliable results.

The real change in the use of the clamp-on flowmeter has come in the standardisation of the product with clamp-on instruments now being specified as a direct alternative for

more traditional flowmeters for reasons of simplicity, cost and commercial justification.

Use in industrial applications

One example of how clamp-on flowmeters have found their way into the mainstream is the new KATflow 170 from Katronic. This instrument is specifically designed for the petrochemical and offshore industries where reliability and robustness are the key concern of the end user. The fully Zone 1 ex-certified flowmeter is available in both stainless steel and epoxy-coated aluminium alloy and can be retrofitted onto pipes greater than 5 m in diameter. The meter can be used to measure a range of process fluids and is trusted for diverse applications.

One location where the KATflow 170 has found popularity is on oil blending systems, for customers such as Cameron. The Katronic meters are needed to provide reliable data on the crude oil flows. As Cameron themselves state "crude oil blending equipment is designed and selected to ensure minimum pressure drop and maximum reliability". It is for this reason that the KATflow 170 was used as the clamp-on design delivers stable and dependable measurement with no reduction in system pressure.

Figure 3. Clamp-on flowmeters provide the user with the unique functionality of a genuinely portable measurement, seen here the KATflow 200 and transducers in operation.

Another area where there is a potential for considerable growth on the use of the new technology is on large distribution pipelines, where the non-invasive nature of the flowmeters provide a highly robust and cost-effective alternative to invasive instruments on pipes containing a variety of petroleum products. In addition, due to the advanced diagnostics found in the KATflow 170, it can offer the customer more than just flow data. By looking at other measured variables such as fluid speed of sound, temperature and pressure, the Katronic meters can be used as part of a product recognition system for pipes where the content of the pipe may vary during the pumping process. For example, the KATflow 170 is being trialled by Petrobras in Brazil to detect changes in fluid type and condition on pipelines hundreds of kilometres in length. Another sector where this technology can be employed is on tanker unloading systems where the customer needs to be able to determine between flows of seawater and crude oil in order to minimise wastage and ensure correct storage of the products.

Flowmeters like the KATflow 100 and the KATflow 150 are already a cost-effective solution for pipes greater than 200 mm in diameter and once the additional installation costs are taken into consideration then the meters can offer the customer significant cost savings.

Unlike clamp-on flowmeters, when fitting an electromagnetic device, elements such as manpower, tools and lifting equipment, can add to the cost of installation. Additionally, consumables such as seals and bolts and longer-term considerations like recalibration mean that the cost of ownership of any inline device can quickly add-up to the point where a device such as a KATflow 150 is the cheapest solution. To this end, the instrumentation frameworks for the UK water companies now require that bidders be able to offer clamp-on flowmeters as part of their standard product offering.

The future for the technology

All recent market forecasts would seem to indicate that the future is bright for the ultrasonic flowmeter in general, and specifically the clamp-on devices, as part of a new generation of instrumentation finding maturity and acceptance. As manufacturers find new uses for the technology supported by advances in electronic component production, clamp-on flowmeters will be found on an ever widening range of applications. Clamp-on gas devices are already going through the same development cycle that the liquid ultrasonic meters went through twenty years earlier. As customer's requirements drive companies to try alternative concepts, and legislation further opens the door for new instrumentation, an innovative breed of ultrasonic meters will be fully and fairly taking their place alongside and sometimes replacing traditional technologies.