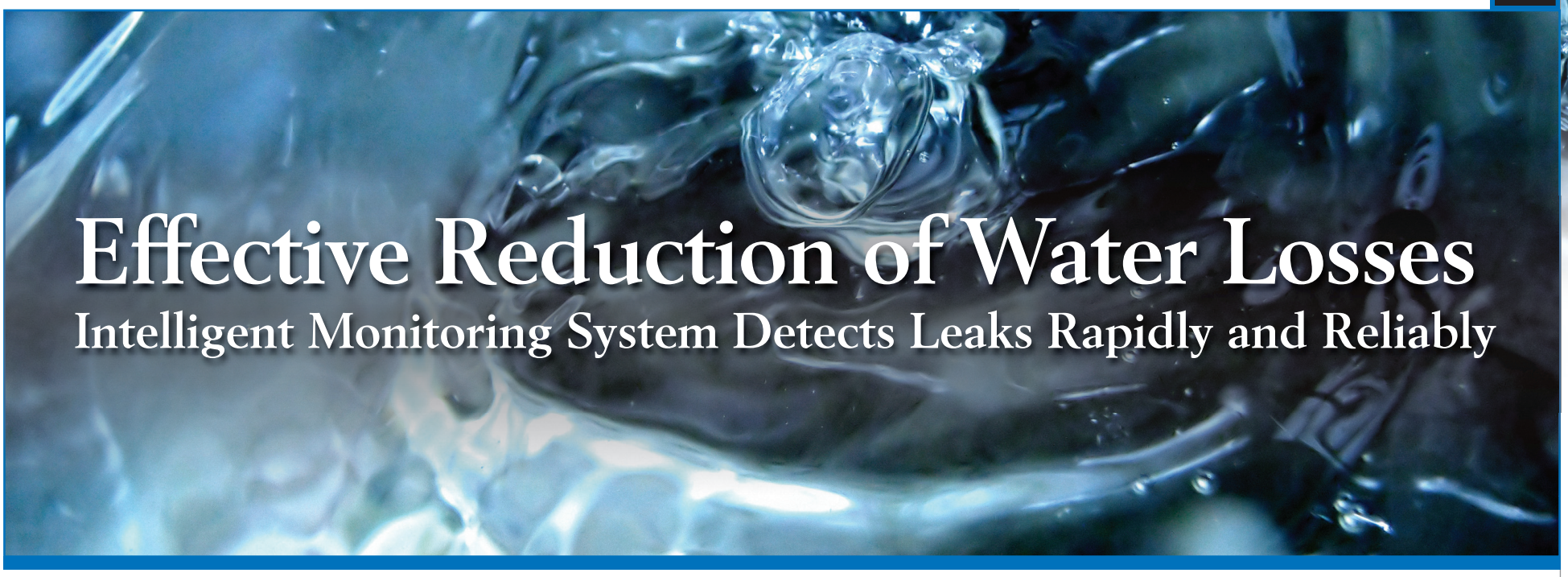

Effective Reduction of Water Losses

Intelligent Monitoring System Detects Leaks Rapidly and Reliably

Exact knowledge of water losses in drinking water supply networks is an elementary requirement for efficient operation and for the planning of maintenance measures. A specially developed, continuous monitoring system detects leaks in pipeline networks rapidly and reliably, thus helping to reduce water losses. The clamp-on flowmeters used allow simple and cost-effective retrofitting of the required instrumentation.

The demand for clean drinking water is rising, and it is becoming increasingly scarce as a valuable resource – a pressing global problem of our time.”

A metropolis like Berlin uses approximately 585,000 cubic meters of drinking water per day. The water networks of municipalities and cities are extremely complex systems in which leaking pipes can rapidly lead to high costs and significant financial losses.

It is essential to detect leaks at an early stage. 90 percent of all water losses result from minor leakages where a period of 100 or more days can pass before they are detected. Altogether, these water losses are usually significantly higher than those from large pipe bursts which are noticed far more quickly.

Water loss volume = leak rate (in m3/d or l/h) x duration (in d or h) per leakage (in accordance with German drinking water worksheet DVGW W392)

Continuous monitoring works magic

Especially for such problems, Siemens has developed an ingenious monitoring and localisation system called Siwa LeakControl which allows rapid and reliable detection of leaks. The continuous monitoring system checks the pipeline network and automatically indicates areas in which a leak has occurred. What is more: it is unnecessary to produce hydraulically separated zones – a great advantage.

The system's method is based on the monitoring of changing flows compared to reference values. For this purpose, sensors are permanently installed at appropriate positions in the network in order to record the inlet and outlet flows of the drinking water in these zones. The best time for such measurements is between two and four o'clock in the morning, since the flow quantity is relatively low and uniform during this period. This increases the success rate and also reduces the number of false alarms. The measuring instruments are permanently active. However, the data is only recorded within an individually defined period in the PLC, preprocessed, and sent to the central unit. Usually three values (min., average min., and max.) are recorded and transmitted from one measuring point per measuring interval. If necessary, however – e.g. for display in the control system – values can be recorded cyclically and transmitted without preprocessing.

The components (transmitter, power supply, backup batteries, controller, and communication) are integrated in an instrument cabinet and the measured values transmitted wirelessly via GSM/GPRS to special evaluation software.

Flexibility is the key

A great advantage of the system is that it can be flexibly expanded according to requirements and available budget. Complete coverage of the network is not essential. For example, the first measuring points can be installed by the water suppliers at sensitive positions, i.e. in areas with an increased probability of damage. The Siwa LeakControl system is equally suitable for monitoring small networks with few measuring points or for monitoring hundreds of points in a megacity. Practically no limits exist for the system, since it can be used for almost all sizes and types of pipeline. Autonomous use of the Siwa LeakControl software is possible, but the data can also be passed on via an interface to a Scada system (e.g. Simatic WinCC).

Figure 1: Siwa LeakControl system from Siemens including Sitrans FST020 transmitter for clamp-on flow measurement

This innovative system for early detection of leaks and continuous monitoring of water networks helps to keep water losses as low as possible, which significantly reduces maintenance overhead. It can increase the cost effectiveness of the water supply and reduce consequential damages. Siemens offers customers expert advice and planning in the area of network hydraulics to enable optimum selection of mounting positions for the individual monitoring points.

State-of-the-art flow measurements

An essential component of the solution is the instrumentation. Ultrasonic and electromagnetic instruments are the most widely used technologies for flow measurements on drinking water pipelines:

Ultrasonic flowmeters operate according to the transit time procedure. The sonar wave starting at point A and transmitted upstream reaches the detector at point B faster than the wave transmitted downstream. Ultrasonic transducers function as transmitters and detectors for the ultrasonic signals. The accuracy of ultrasonic flowmeters depends on the

Author Details:
Christian Pust, Siemens AG
Tel: 0721-595-6893
Email: christian.pust@siemens.com

pipe diameter (the accuracy improves along with an increasing pipe diameter), the pipe geometry upstream and downstream of the flowmeter and the number of ultrasonic measuring paths. Turbulences which result in different flow velocities should be avoided. Inlet and outlet pipe sections should be as straight as possible in the ideal case, without obstructions such as bends, pumps or valves. Dual-path ultrasonic flowmeters feature a reduced sensitivity to such obstructions. The measurements deliver highly repeatable values in the low flow range. The measuring reliability is also higher since the instrument continues to measure should one of the paths fail. In networks corresponding to the above requirements, the accuracy achievable for a dual-path system is typically +/- 0.5 %.

The so-called clamp-on ultrasonic flow measurement, a relatively new and highly successful measuring principle, is appropriate for the Siwa LeakControl complete solution. For the evaluation, SiwaLeak requires high repeatability in the low flow range, where the accuracy is of lesser importance since the evaluation is based on the comparison of data and not on absolute measured values. Sitrans F clamp-on flowmeters can measure a flow velocity of less than 0.03 m/s without any problem, and this corresponds to 0.3 l/s for a pipe of nominal diameter DN100.

The sensors are simple and easy to install and can be retrofitted at any time since the ultrasonic transducers are simply clamped onto the existing pipelines from the outside and send and receive the acoustic signals through the pipe wall. Installation is therefore possible without having to work on the pipeline or interrupt the supply, in contrast to a compound meter or electromagnetic flowmeter (MAG meter). The transducer cables can be shortened by the installation engineer on site as required and the connectors installed.

The patented wide-beam ultrasonic transducers use the pipe wall as a type of loudspeaker in order to optimise the signal/noise ratio and to provide a larger oscillation range. Transducers of this type are thus less sensitive to changes in the liquid medium.

The sensors can be used for almost all pipeline materials, including plastic, concrete or metal and can be flooded or installed underground.

Clamp-on measurements additionally mean that there are no costs for the building of a shaft: the price for the process engineering including purchase and installation of an electromagnetic flowmeter is approximately 40,000 € in Germany for a pipeline of nominal diameter DN200, and even approximately 110,000 € for a pipeline of nominal diameter DN5001). Considerable cost savings can therefore be achieved by using the clamp-on instrumentation.

The advantages of clamp-on flow measurements are quite clear:

- No working on pipes, thus low installation costs as well as simple and fast assembly
- Mounting and dismounting of measuring point possible without high-cost shaft
- No interruption in supply
- High repeatability in the low flow range

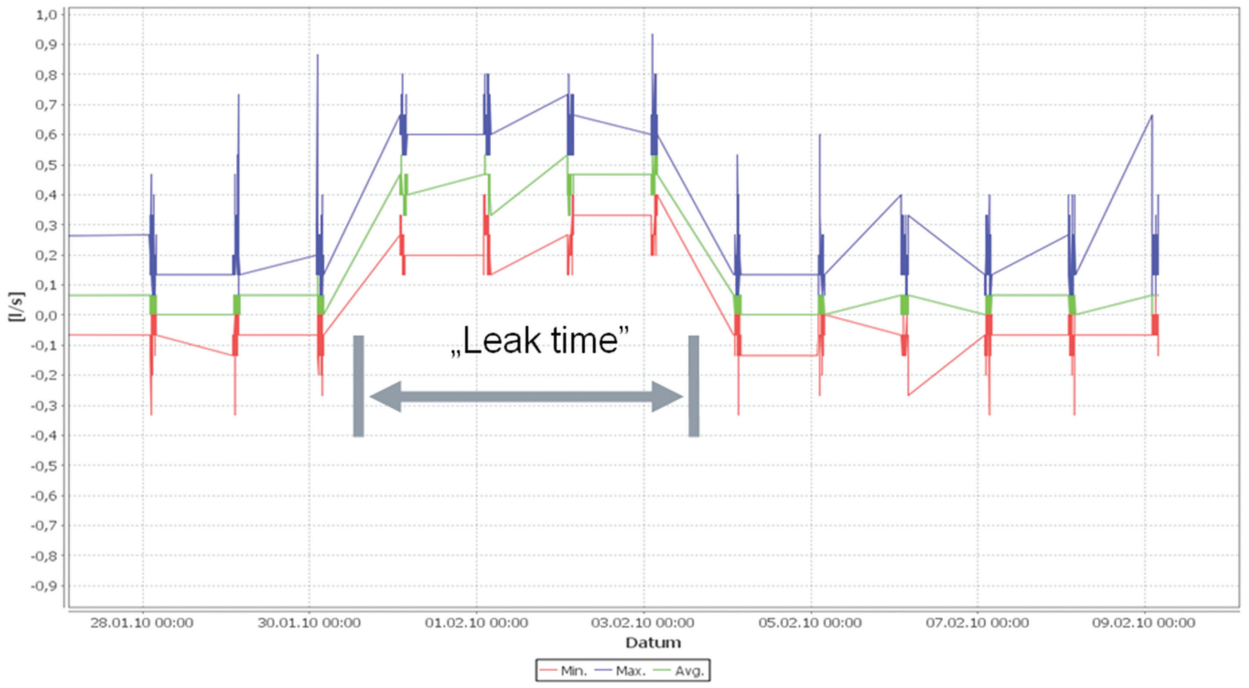

Figure 2: Siwa LeakControl software application: example of results of flow measurement Left: normal nighttime flow with an average minimum flow rate of ~ 0 l/s Center: occurrence of leak, leak time Right: normal state following localisation and repair of leak

- No contact with clean drinking water, perfectly hygienic, special drinking water approval unnecessary
- No contact with measured medium, therefore no deposits on the sensor surface.
- Temporary use also possible (mobile measurements)

1) Example calculation

Successful practical applications of the procedure

The efficiency of this procedure is demonstrated by the example of a municipality in Upper Swabia/Germany where the supply network covers approximately 40 kilometers. Following installation of the monitoring system, the municipality could significantly shorten the duration of leakages and reduce the specific water losses by about half.

Another water supplier in Baden-Wuerttemberg primarily wanted to significantly reduce the localisation overhead by using this innovative procedure. On account of the size of the zones, the search for leaks using the existing monitoring solution took far too long. With this procedure and additional flow measuring points, it is now possible to monitor the 120 km long supply network rapidly and simply. Using a few specific valve activations, the area of a possible leak can be exactly localised within a few reaches. The effort for fine localisation is minimal. The customer is highly satisfied with this solution and has achieved his objective.

The example shows that the installation of additional measuring points in association with the data obtained from existing zone inlet measurements can significantly facilitate the identification of leaks.

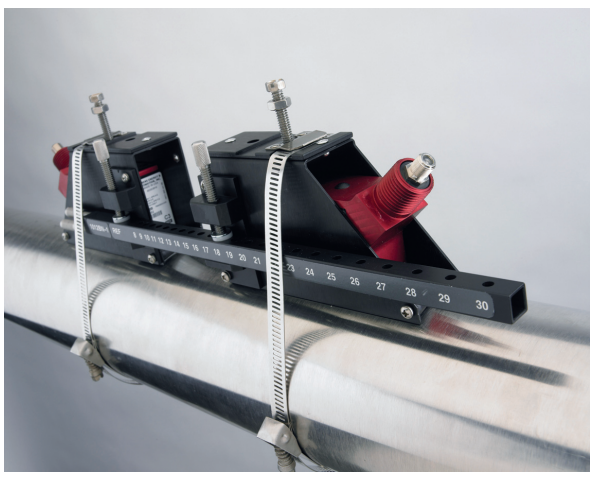

Figure 3: Ultrasonic transducer for clamp-on flow measurement.

Water suppliers also profit from the solution's flexibility. For example, the measuring equipment present in a zone with 95,500 inhabitants and a network length of 242 kilometers was successfully integrated into the monitoring system and supplemented by new measuring instruments. As a result of the increased amount of flow data, this water supplier can make more reliable statements in the future, especially regarding small water losses.

Meas. Principle	Electromagnetic flow, MAG	Ultrasonic flow	
Name	SITRANS FM MAG8000	SITRANS FU SONOKIT	SITRANS FU Clamp On
Type	Flow- / Water meter, contacting	Flow- / Water meter, contacting	Flow- / Water meter, non contacting
Pipe diameter	DN25…DN1200 Qmax 17,6m³/h…40700m³/h (MAG5100W DN15…DN2000)	DN100…DN4000 Qn 100m³/h… 144000m³/h	DN10…DN9000
effort of Installation	medium to high: depends on size 1 to 4 hours, for big sizes heavy equipment needed	medium, approx. 4 Stunden	low, approx. 10 minutes, portable version available.
Type of installation	cut pipe, direct bury possible (IP68).	drill holes and install sensors, direct bury possible (IP68).	clamp on pipe, direct bury possible.
Influence on Process	stop water flow, extensive pipe work.	no stop of water flow, small pipe work.	no stop of water flow, no pipe work.
power supply	battery supply, 24V or 230V with battery backup	battery supply, 24V or 230V with battery backup	24V or 230V, battery backup with SIWA via external buffer battery
typical accuracy, Measurement uncertainty	DN50…DN300: +/- 0,2% +/- 2mm/s (with extended calibration) DN350… DN1200: +/- 0,4% +/- 2mm/s	2-track: <= +/- (0,5… 1,5%) 1-track: <= +/- (1,0…3,0%)	<=+/- 0,5…2,0% for v > 0,3m/s +/- 0,0015…0,006m/s for v < 0,3m/s
repeatability	+/- 0,1% for v > 0,5m/s	better 0,25% for v > 0,5m/s	+/- 0,15% for v > 0,3m/s +/- 0,0005m/s for v < 0,3m/s
approval for custody transfer	DN50 to DN300: OIML R49, PTB type approval and MI001cold water	local approval in some countries	no approval
specifics and other informations	liner: EPDM, drinking water approval electrode: Hastelloy 10 year battery life time, integrated data logger, statistics, tariff, leak detection	1- or 2-track measurement, 4- track on request	lower meas. limit < 1cm/s, flow sensitivity 0,0003m/s, patented Wide-Beam Clamp On ultra sonic measurement, 1- or 2- track measurement, 4- track on request

Table 1: Technology overview of modern flow measuring processes

Figure 4: The battery-operated Sitrans MAG8000 electromagnetic water meter is also available with integral GSM/GPRS communication

Flow technologies for water applications

In addition to the clamp-on procedure preferred for detecting leaks, Siemens offers appropriate flow technologies for further water supply applications.

In the case of the ultrasonic flowmeters of type Sitrans FUS Sonokit, the sensor surfaces are directly in contact with the medium – in contrast to the clamp-on procedure. The ultrasonic signal is therefore transmitted directly between the transducers. The advantage of this procedure is the exceptionally high signal strength.

The installation is carried out using a gate system without interrupting the supply ("hot tap"). Minor pipework is required to install the transducers in existing pipelines. An advantage is that the battery-operated Sitrans FUS080 also allows measurements without a power supply.

The measuring principle of the electromagnetic flowmeters (MAG meter) is based on Faraday's law of induction. The MAG meter consists of a metering tube with a magnetically non-conducting internal lining, magnet coils connected in series and secured diametrically on the pipe and at least two electrodes inserted through the pipe wall and in contact with the measured medium. As a result of the technical construction, a MAG meter is always delivered as a pipe section. This means that the flow must be interrupted in order to install the sensor, a section of the pipe removed and a flange welded on depending on the type of connection, e.g. with a steel pipe. Since there are no moving parts, the instrument generates a negligibly small pressure loss in the pipeline network.

To prevent microbiological growth, a special internal lining with drinking water approval is used for the Sitrans FM MAG8000. The devices are water-tight in accordance with IP68. Therefore the installation type and location is highly flexible and cost-effective for this equipment (flooding and direct burying possible). The transmitter can be installed in compact form on the sensor or also remote at a readily accessible location. The electromagnetic flowmeters have an impressively high accuracy (see table). They are approved for custody transfer in Europe in accordance with the new Measuring Instruments Directive MI-001, i.e. they can also be used for billing purposes; straight inlet and outlet pipe sections are not required.

In the case of a power failure, a backup battery for the Sitrans FM MAG8000 ensures that the equipment continues to measure. If a power supply is not available at the measuring location, the water meter can also be operated completely using batteries with a service life of up to 10 years. The instrument has an integral data logger and the measured values can be transmitted via a pulse output, Modbus RTU, or wireless over GSM/GPRS.

Sitrans FM MAG8000 benefits:

- Drinking water approvals
- Water meter with type approval certificate and verification in accordance with OIML R49/MI001 for custody transfer for water billing purposes
- IP68/NEMA 6P enclosure, for compact or separate installation, with connectors and preassembled cable
- Sensors suitable for underground use or installation under water
- Detection of low flow rates with minimum pressure losses
- Reliable, long-term and interruption-free battery operation (internal or external battery packs) without additional power supply
- No moving parts, therefore long-term stability and accuracy
- Comprehensive diagnostics functions and self-test

Conclusion

The demand for clean drinking water is rising, and it is becoming increasingly scarce as a valuable resource – a pressing global problem of our time. The reduction in water losses due to leaks in supply networks can help meet this challenge.

The Siwa LeakControl system can be used in the public pipeline network without fixed zone limits. A strategic distribution of the measuring points enables optimum adaptation of the monitoring system to any existing supply configuration. Whether ultrasonic clamp-on or MAG meter, Siemens offers its customers all modern flow measuring technologies. A further asset: the flexible solution from Siemens for reduction of water losses allows extremely simple integration of water meters already present in the supply network.

Whether for a small municipality or a large metropolis, the flow measuring technology, controller, communication and evaluation can be tailored to customer requirements thanks to the modular principle. In addition to this, Siemens offers support covering hydraulic advice, selection and installation of the measuring points and exact localisation of leaks.

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