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WATER SOLUTIONS

Water & Waste Water Technologies

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WLM-SYSTEM: integral network monitoring and leakage management

Around the globe, the issues of freshwater security and availability are attracting considerable attention and the quest for answers has sparked an international search for ways to overcome fast growing problems.

According to press reports, more than 50% of carefully treated water put into the distribution system is lost on its way to the tap, which is certainly cause for alarm. Because of the high figures involved, this lost water is often called 'the second water source', and it is now time to make use of it.

Alongside the well-known existing leak detection and applied water loss analyzing tools, there is a need for a tool able to observe and monitor the whole pipe network, enabling a sustainable water loss management. Indeed, long term water loss reduction projects should only be started if the activities can be recorded and controlled via a monitoring system.

A recent technology based around a sensor able to measure water flow (bi-directional), pressure, noise and, optionally, temperature has been proving itself in practical applications for accurately investigating leakage in distribution systems. In an attempt to reduce the volume of water lost from their distribution networks, locations including Tallinn (Estonia), Riga (Latvia), Hof (Germany) and Pula (Croatia), among others, have turned to this system to better identify where leaking is occurring.

The need for clear detection

In the field of water supply management, water loss management – mainly in the reticulation network – is gaining increasing importance. An immediate and reliable record of water losses and a clear identification of leak zones through permanent monitoring provide huge potential for savings. Nevertheless, security of supply must be the top priority. Over the short term, actions such as pressure reduction can provide fast saving results, but such actions eliminate symptoms rather than the ultimate causes and are therefore recommended only as a temporary solution.

The WLM-SYSTEM

The hydraulic operation of a water supply network is extremely complex. The WLM-SYSTEM is an innovative, efficient and integral measuring system that actively supports monitoring of the entire distribution system.

The system measures and analysis are run by using multi-parameter-sensors which enables clear identification of leaks (**Figure 1**). These parameters are measured simultaneously at each position in the network and compared against a reference value. If a reference boundary value is breached, an alarm is raised.

The interaction between the parameters and the automatically calculated boundary values produces a very accurate picture of where possible leakage is occurring. The boundary values can move only in the direction of improvement following each leak repair. The desired minimum or maximum values, for instance for minimum night flow, are individually remote-controlled by the AQUALYS-Software – an application specifically designed for water loss management and diagnosis in distribution networks.

Through optimal positioning of several sensors throughout the network and support from the AQUALYS-Software, a water loss occurrence can be rapidly isolated. Particularly for networks that are not divided into DMAs (district metered areas), this multi-parameter measurement is truly a state-of-the-art technology. Sensors are installed at key positions and create their own zones, specifically virtual zones (**Figure 2**). The installation is independent of material type and pipe size, which can be from DN 80 to DN 2500.

Networks already divided into DMAs offer ideal conditions, but with virtual DMAs a separation into physical zones is not necessary and the advantage of an open network is retained. Comparison measurements for all parameters for values from the day before, with a synchronized time, trigger an alarm at a critical level of change and identify the leak zone.

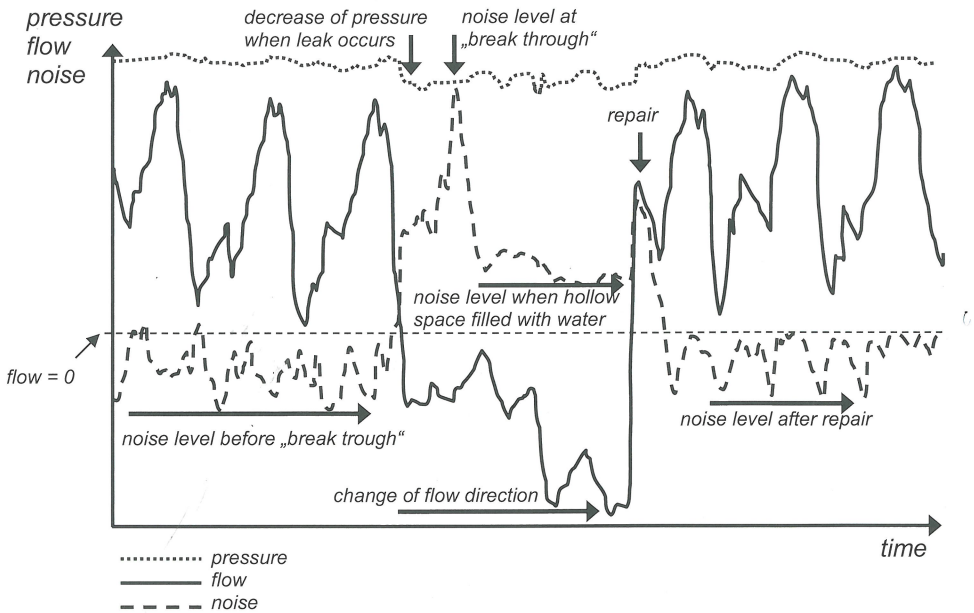

Figure 1: *Growth of a leak – with Multiparameter Measurement (Kölbl, 2009; ÖVGW-W63-2009)*

The measured values are recorded on the WLM-Sensor and automatically transferred via TCP (GPRS) to the AQUALYS Software. This data transfer can take place online or in intervals (battery powered). The data will be analyzed by AQUALYS and displayed as symbols on the GIS network map (**Figure 3**).
These symbols can change their color from green to red whereas red means "over" the artificially set limit. AQUALYS will use this artificial intelligence for single sensors as well as groups of sensors that can display a virtual or fixed DMA. Thus, with one glance on the screen the operator can evaluate if there are significant changes (i.e. leaks) in the network.
Beside this automatic analysis of the data, the WLM-SYSTEM allows an immediate burst warning over 24h regardless if it is battery- or mains-powered. Automatic export and import functions are available, which allows an easy connection to existing SCADA. This is getting especially important when the WLM-SYSTEM is applied to networks with existing measurement infrastructure. The data from any flow, pressure or level meter can be imported and calculated in the same manner which allows a full integration of the existing assets of the network.
The magnetic inductive Flow Sensor is designed to measure very low flow speeds (0,01 m/sec. with a resolution of 0,001 m). Accurate measurements (2%) are possible, but for this application not really necessary. It is important to focus on comparing the measurements from the current day with previous values. Even a small deviation in flow can be identified.
The integrated piezo-ceramic pressure sensor with its measuring range from 0 to 200 m enables the recording of the dynamic pressure behavior in the network and provides all necessary analysis data.
A highly-sensitive microphone is integrated into the WLM-Sensor too, performing a similar function as a noise logger. The key advantage is its positioning, in an area well protected from surrounding noise, and the direct connection to the water column. This allows good detection of typical leak noise not only via the pipe material but also via the water column. The flow noise recording can provide valuable data for analysis.
The strategic use of noise loggers is recommended. If a sensor highlights a flow alarm and no indication of leak noise, the leak is probably out of the noise detection radius of the sensor (see **Figure 1**). In general, for pin-pointing a leak, the traditional methods should still be applied.
The hydraulic parameters are meaningful of course in evaluating the capacity, that is, the condition of the pipe network. At time of peak consumption, measurements can be performed to determine the carrying capacity of the whole or part of the network. The Diagnostic feature is another key aspect of the WLM-Sensors' installation (see Chemnitz report).
The installation is simple, similar to that for a house connection, via a pipe saddle with shutter, valve gate or the special Sensor-Schacht module (**Figure 4** and **Figure 5**). A good coordinated WLM-SYSTEM installation will enable a fast return on investment. Most importantly, the system is sustainable as it creates permanent

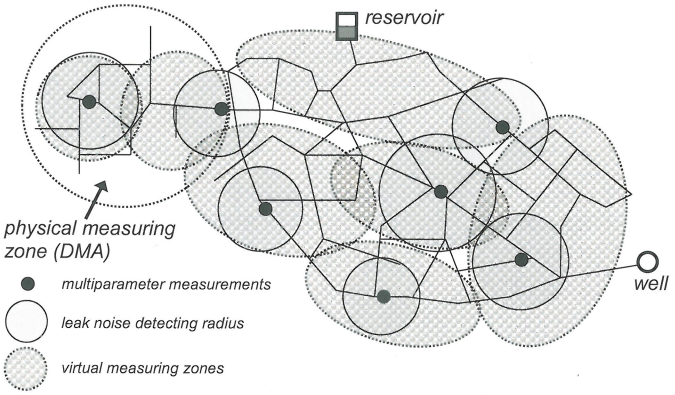

Figure 2: *measuring zones virtually and noise overlapping, (Kölbl; Martinek; 2009)*

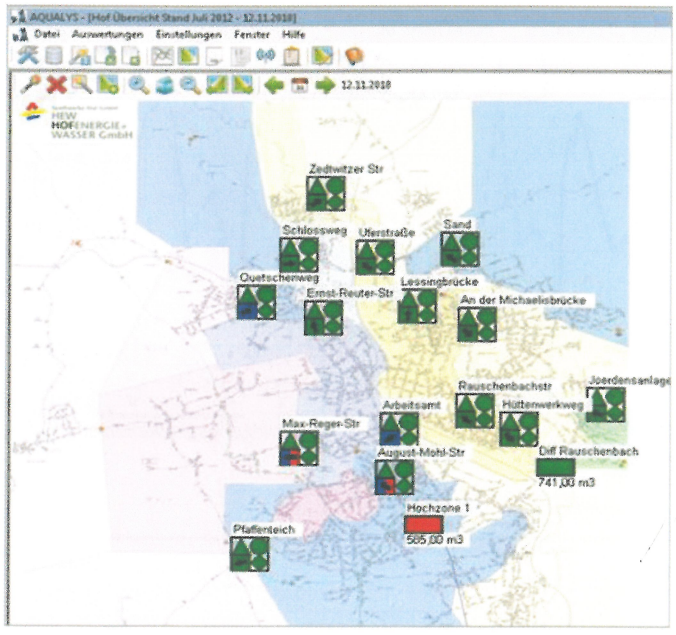

Figure 3: *Conduit – Network overview with pos. of Sensors*

About the WLM-SYSTEM

The WLM-SYSTEM features and advantages include:

- Electromagnetic insertion probe with high resolution (1 mm/s), wide range (1 cm/s to 9,999 cm/s) and a high accuracy
- One sample measuring flow, pressure, noise and temperature
- All diameters / all materials
- Hot tapping with casual pipe saddle "like a house connection"
- Special chamber construction: no need for big concrete chamber construction
- High durability, IP68 and long-term maintenance free
- Wireless or wired transmission (GPRS, TCP, ...)
- Various interfaces to connect to existing SCADA
- Battery- or mains-powered
- Diagnostic tool for any distribution system
- "Online" leakage waring and live data
- Easy zoning tool (DMA or virtual DMA)
- Automatic boundary setting
- Water balance tool

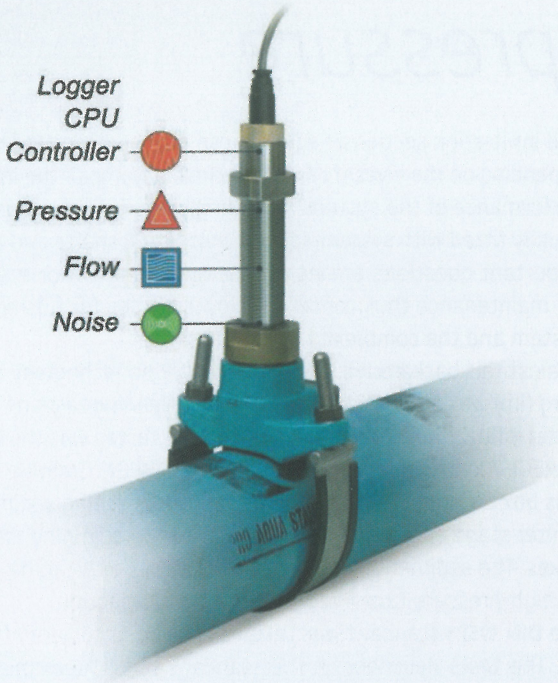

Figure 4: *Sensor installed on Pipe saddle*

Figure 5: *Sensor installed with special Schacht module*

monitoring of the important hydraulic parameters and other key measures enabling an immediate reaction based on facts and measurements and not on estimates.

Reference projects

Tallinn Waterworks

Tallinn Waterworks has started in 2005 purchasing the first six WLM-SYSTEMs. After three months of operation they had reached the Return of Investment (ROI). Meanwhile there are 95 Sensors installed and a full coverage of network monitoring is given.

The Hof Utilities Water Supply (Figure 3)

Hof is the biggest city in the northern part of Bavaria county (Germany) and supplies approx. 130.000 people with potable water. The network mains are around 250 km. The size of the conduits used range from 80 mm to 600 mm and are of different materials (PE, steel, cast iron, etc). Due to high evolutions on the topography, the pressures in the subzones are ranging from 4 to 9.5 bar. Hof is nowadays divided into three main separated huge zones divided partly by valves and partly by flow measurements. The city started in 2004 with the process of applying a monitoring strategy with the first four pieces of WLM-Sensors. The lack of existing concrete chambers made it necessary to look for cost effective solutions to apply a monitoring system. Therefore, the decision was made to use the special chambers offered by Martinek GmbH, which make it possible to install and uninstall the multi-parameter devices within minutes for certain revisions without the need of constructing casual manholes.
At that time the sensors were operating with 4-20 mA to their existing SCADA. After a period of one year they started to extend their network with six to eight sensors annually. Since it was easy and cost effective to apply the transmission of WLM-Sensors they changed the first four pieces to the full version and used AQUALYS for the main analysis and data acquisition. For the connection, their existing self-owned wire system was used, whereby Martinek applied the relevant modems.
In 2009 they were enabled to separate their network in three main "physical measurement zones". Beside the WLM-Sensor they were also using flowmeters that already had been installed before 2004. In order to be able to detect and find leaks faster they decided to sub-divide each of the three "big" zones into smaller virtual subzones. In consideration to the length of the network they now work with approx. 10 km/sensor.
The sensor technology detects leakages at a very early stage. Even minimal flow velocities ≥ 1 cm/s can be reliably recorded. The technology enables high-resolution monitoring of the entire supply network without physically disconnecting the zones, a process that is hydraulically disadvantageous. This greatly reduces the effort involved in locating leaks.
With the installation of WLM-SYSTEM, Hof was able on one hand to have timely information about the occurrence of leakage and on the other to sustainably reduce the cost of leak detection.
Multi-parameter measurement gives a much better picture of a specific control zone than single-parameter (only noise, only flow). To give a musical comparison, one instrument is pleasant to listen, but more instruments create a concert.

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