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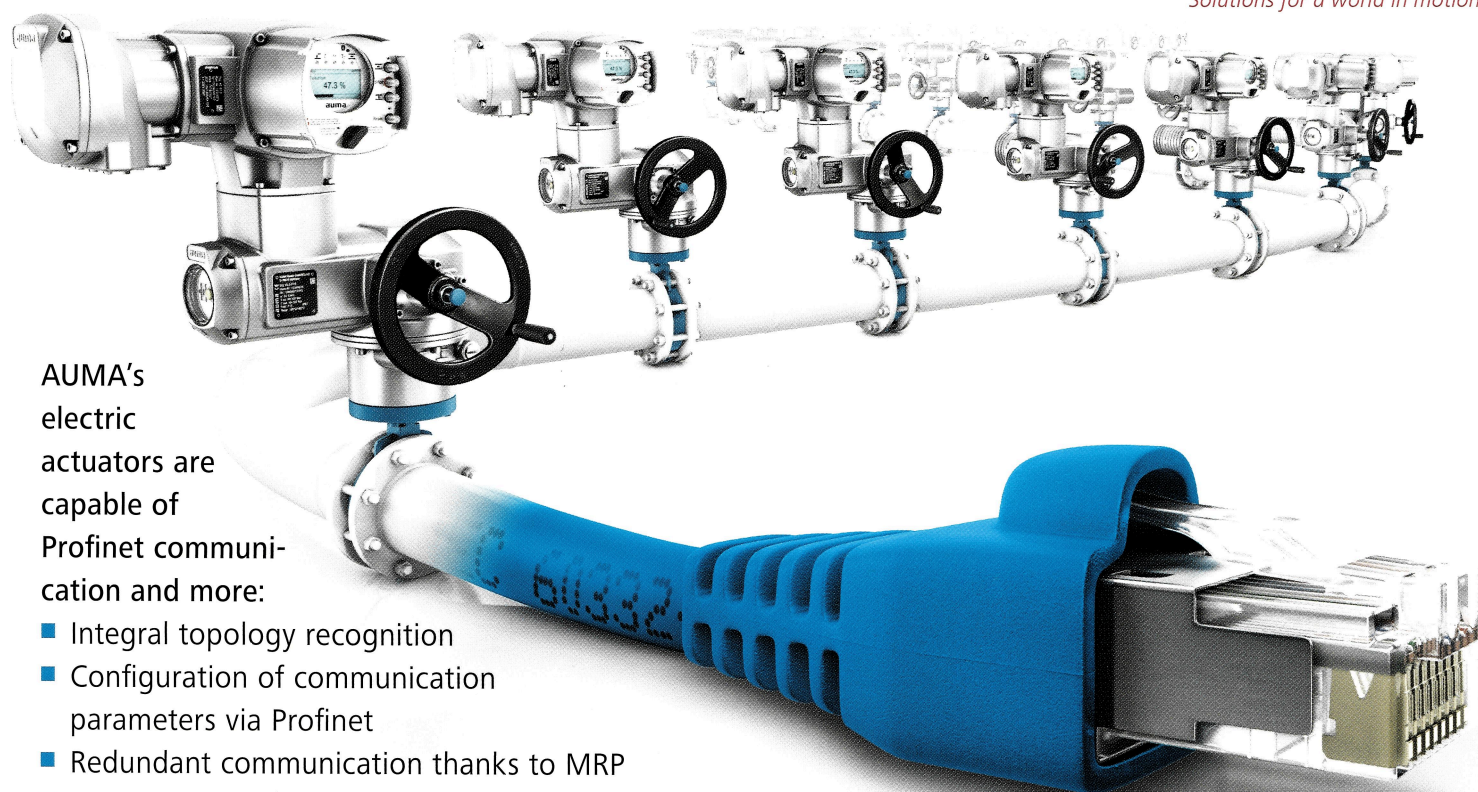
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Leakage detection for safe water supply networks and smart valves

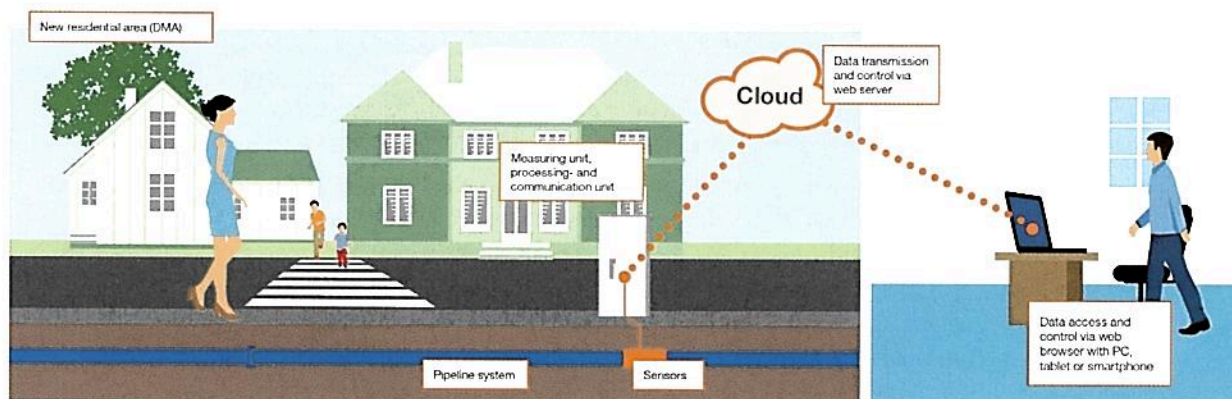
ANTON RIENMÜLLER, JÖRG BAADER

In an age when valves communicate with each other and sensors are combined with data transmission techniques, the VAG-Group is expanding its extensive range of valves for water and wastewater applications with an intelligent system for monitoring and detecting water losses in supply networks: LeakMonitoring 4.0. This special solution includes hardware (sensors) as well as software and makes wiring networks and valves smarter. The operator automatically receives information about the state of his supply networks, as well as any leaks in the system. The use of LeakMonitoring 4.0 significantly reduces leakage times. Municipalities and water companies can use this solution to reduce their costs for leak detection, but above all water losses and consequential damage, to a fraction. Ultrasonic sensors monitor relevant flows in pipelines and send the measured data to a web server. Proactively, those responsible are informed about leaks, their size and their geographical location. The required measuring points and their correct arrangement using a hydraulic calculation network model are part of the service package.

In Europe, water losses caused by leaks in public water supply networks amount to more than one third of the total water consumption. In Germany as well, water losses and the detection and elimination of leaks cost cities and municipalities quite a few million Euros per year. Pipe breaks are hardly ever visible on the surface as the major part goes unnoticed for weeks or even months, depending on the size of the leakage. Conventional leak detection methods involve considerable expenditure in terms

of manpower, time and money. A budgetary item which could be significantly reduced, as the combination of sensor technology and modern IT makes new solutions possible.

With VAG LeakMonitoring 4.0, the VAG-Group offers a ready-for-use solution that tackles the leakage problem by two approaches: It detects leaks as soon as they occur and locates them so precisely that the costs of final pinpointing are minimal (Picture 1). VAG LeakMonitoring 4.0 combines the technical



Picture 1: Operating principle of VAG Leak Monitoring 4.0



Picture 2: Leak Control Area

possibilities of cloud-based applications with the processing of large amounts of data (big data) and modern machine learning. The solution consists of two components: the LeakMonitoring software and the LeakControl sensor technology.

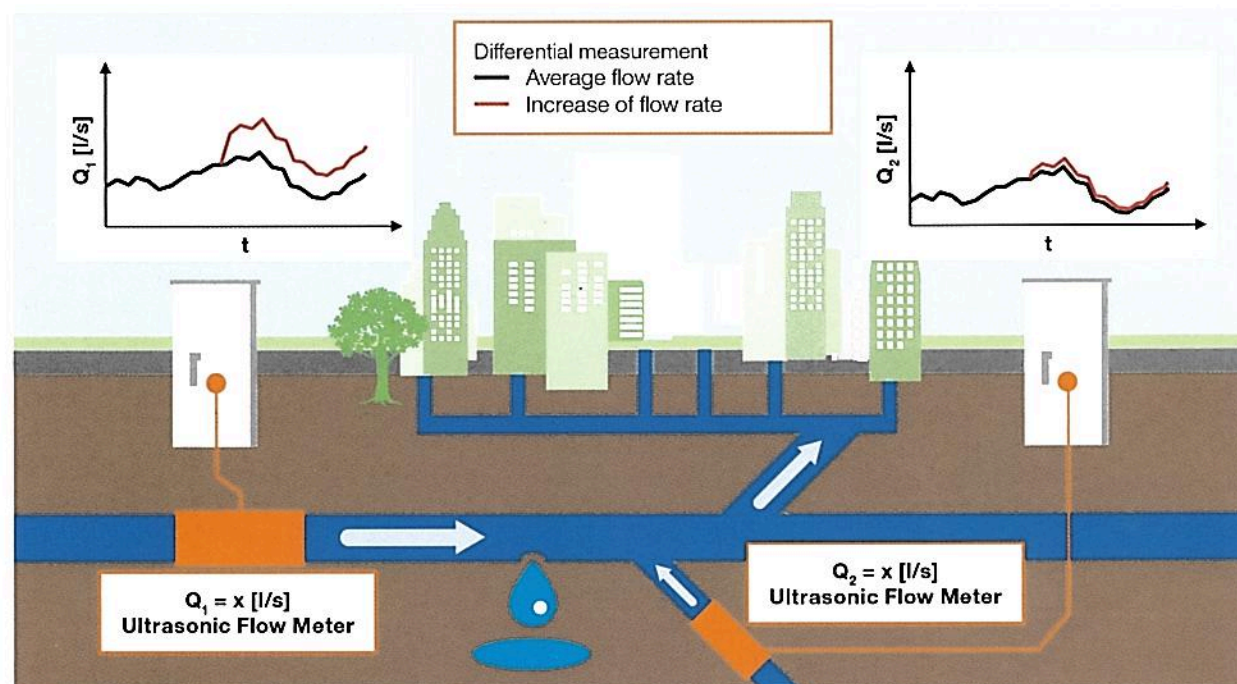
OPERATING PRINCIPLE OF LEAK DETECTION

The system is based on a hydraulic model of the supply network. The solution detects increased flow rates and compares them with the normal flow rate from several smartly arranged metering points located in the supply network. Typical consumption cycles, temporary changes of levels of water withdrawal, caused e.g. by construction work, and seasonal fluctuations, due to e.g. the irrigation of agricultural areas, are incorporated into the computing model, thus making it a self-learning system. If the changes in the flow remain stable for about two to three days, they are very likely caused by leakage and not by changes in consumption. Each characteristic is saved and considered in future forecasts (machine learning). The strength of the system lies in its precision. VAG LeakMonitoring 4.0 detects leaks with high accuracy. Based on a mathematical-hydraulic algorithm, the flow data are analysed, and the leaks detected are indicated. In

addition to this, the system supplies important key indicators. These include, for example, the point of time at which the leak was detected, how many litres per second are lost, which financial loss results from the leak per day and the time it took to detect the leak.

SMART AND INSTALLATION-FRIENDLY SENSOR TECHNOLOGY

The hardware is easy to set up. Based on the hydraulic model (Picture 2), LeakControl determines where the metering points will be located. While it is being set up, LeakControl first simulates several thousand leaks by calculation, then evaluates the resulting flow conditions and thus identifies the hydraulically relevant pipelines. The metering points are positioned on these pipelines. On average, a metering point is installed at every 10km in the supply network. It consists of two ultrasonic sensors that transmit signals in and against the flow direction and measure the flow rate with an accuracy of 0.0025m/s (Picture 3). This permits the detection of even the minutest deviations. The ultrasonic sensors are attached to the outside of the pipe by means of metal clamps. Unlike with conventional measuring systems, drilling or cutting



Picture 3: Operating principle of VAG LeakControl with ultrasonic sensors

the pipeline is not necessary here. Another advantage is the fact that the cross-section of the pipe is not reduced. The sensors are suitable for use with all kinds of pipe materials and nominal diameters. The measuring sensors are suitable for buried installation or for installation in available shafts or even without a shaft. The entire measuring and

transmission equipment is well protected as it is housed in an outdoor switching cabinet located close to the metering point. Uninterruptible power supply (UPS) ensures continued measuring for 20 hours in the event of a power failure. Weather conditions have no influence on the function of the sensors.



Picture 4: The measurement data are transmitted to a web server via mobile communications devices. The data is password protected and can be accessed over the Internet.

VAG DUOJET® AUTOMATIC AIR VALVE

The VAG DUOJET® Automatic Air Valve is a heavy-duty, single-chamber air valve with triple function: supply and release of air and venting under operation of water supply pipelines. An epoxy-powder coating (EPP) in German GSK* quality with an overall coating thickness of 250 microns, interior parts made of stainless steel and a floater made of plastic ensure absolute corrosion protection. The integrated float guide guarantees permanent reliable and safe operation even at high venting speeds of up to the speed of sound. The VAG DUOJET® Automatic Air Valve is designed for use in water treatment, water distribution, in dams, power plants and in industry and has proved itself for many years already.

With the VAG DUOJET®-I Automatic Air Valve the VAG-Group now offers the smart monitoring of pipeline networks through additional sensor technology on the valve. The smart device allows the monitoring of all operating conditions and delivers information about air vent orifices for air supply, the pressure prevailing in the system and the temperature of the medium. Based on a cloud solution, the data can be transmitted to a SCADA system and, in the event of critical operating conditions, inform the operating staff by way of warning messages sent per SMS or email. The analysis of the data allows conclusions about the entire pipeline network to be drawn.



VAG DUOJET® Automatic Air Valve

*GSK = Gütegemeinschaft Schwerer Korrosionsschutz: The Quality Assurance Association for Heavy-Duty Corrosion Protection (GSK) is the global industry network of companies operating drinking water, waste water and gas supply networks.

FROM BIG DATA TO A USER-FRIENDLY OVERVIEW

Each sensor is connected to the Internet and transmits its flow data to a safe cloud. With the use of an existing infrastructure – a SCADA system, for example – the data can also be transmitted to a control centre. Despite the enormous amounts of data, the representation of the data evaluated is always very clearly structured and easy to understand.

The operating staff, e.g. a waterworks technician, accesses the graphical user interface of the Leak-Monitoring software (**Picture 4**) via the web browser on their desktop PC, tablet PC or smartphone. The user interface shows all metering points in the network on a map. Any unusual condition becomes visible by so-called hydrographs. A key indicator cockpit visually displays the condition of the supply network practically in real time. If a leak occurs, VAG LeakMonitoring 4.0 proactively informs the staff and departments in charge, supplies the geographical allocation of the leak and shows both the size of the leak and the quantity lost. These indicators allow the operator of a water supply system to optimise its operation planning. Once the loss

by leakage is known, it is easier to set priorities as to when and where the damage must be repaired. If the geographical position of the leak is pinpointed, on-site activities can be considerably reduced. Leaks can be located more accurately than with conventional systems. Supported by Google Earth maps, the street or place concerned can be easily recognized.

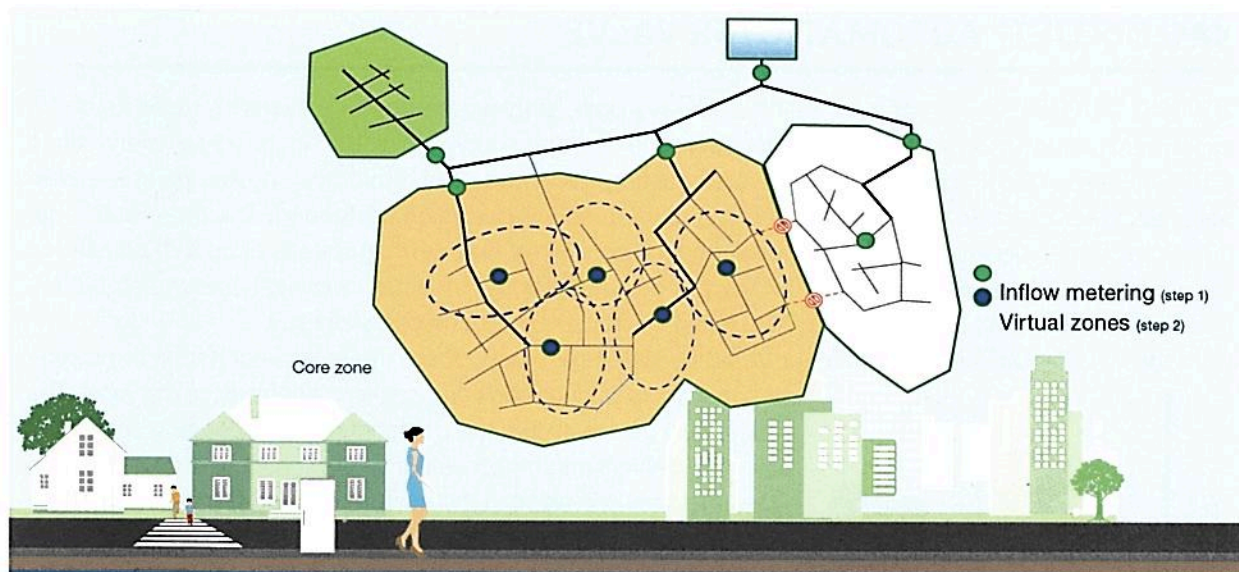
No specialist knowledge is required as the software is largely self-explanatory.

NO DMA REQUIRED

Contrary to conventional systems, VAG LeakMonitoring 4.0 operates without strictly separated district metered areas (DMAs), see **Picture 5**. This eliminates the disadvantages of a hydraulic subdivision of the network, i.e. disadvantages such as poorer supply by pipelines located in the area, less reliability of fire-water supply or hygienic problems in dead water zones caused by low flow velocities.

SAVINGS POTENTIAL AND PAY-OFF

The ease of installation and assembly of VAG LeakMonitoring 4.0 in existing supply networks furthers quick pay-off. The sensors can be installed during



Picture 5: Virtual zones: No hydraulically separated DMAs are required for operation

operation and at relatively low cost and time expenditure. Leak-detection lead times and losses can be reduced to a minimum. The planning of resources for the elimination of the leaks becomes easier and the amount of work needed is reduced. Compared to classical leak detection systems, VAG LeakMonitoring 4.0 can reduce the area for pinpointing by up to 90 per cent, which results in further savings. The example of a leakage on a house connection pipe – detected by the operating staff – with a loss of 0.1 litres per second demonstrates the typical savings potential. VAG LeakMonitoring 4.0 detected the leak 15 days earlier and with less than 150 metres from the location of the leak.

The savings potential was around 130m³ of water, which corresponds to an amount of 350 euros. Depending on the condition of the water supply network, one can assume that the installation of the VAG-Group LeakMonitoring 4.0 pays off within about 6 to 24 months. Based on empirical values gained by municipalities, the solution saves about 8 working hours per leak and reduces the leak-detection lead time by an average of 15 days. In larger cities, a reduction of the leak-detection lead time by 10 days can be assumed.

The municipal utility of Fellbach, a mid-sized town near Stuttgart, Germany, was able to reduce water

losses by 50 per cent within one year. During this period, there was not a single pipe break that was not detected by the system. The minimum night flow was reduced by 34 per cent. VAG LeakControl 4.0 is a product jointly developed by VAG GmbH, RBS wave GmbH and Spanish software developer Bunt-Planet.

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