WATER LOSS DETECTIVES

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EDITORIAL

WATER LOSS DETECTIVES

The reviews for the first number were positive. We received appreciation and support from important people and, most importantly, we received some suggestions that we try to account for improving this publication.

A detective of water losses is a person with the following qualities: it is a good observer of details (seeking to uncover evidence of losses, such areas with more green vegetation, subsidence, wet walls, area history, etc..), Has a fine ear (developed to differentiate in terms of noise from traffic noise of water), able to process the received information, analyze results and make a hypothesis. He does not rely on luck - he discerns water stream, but needs intuition and luck. In his job, the biggest enemy is the information wrong (diameter, material, pipe connections, etc. unknown), And other factors are running out of time and ambient noise.

At the beginning of each journey, especially for beginners who are initiated in the art to detect defects, there are two different entities: man and machine. Only when you experience linking man and machine, we can say that there is only one team. In my opinion, the most useful electronic device is the ear (ground microphone, because he is the man who put the value and then confirm or not what has indicated the correlator). There is no perfect device, but the team consists of operator and the machine, wich is able to solve the most difficult situations.

I invite readers of the publication "Water loss detectives" to take part in the debate about the situations encountered in the field, new and modern techniques:

www.pierderiapa.forumactual.com forum.

I hope you are proud of the job you have. You have an advantage but also a responsibility to be good water detectives! I wish you good and useful reading!

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SEEK THAT LEAK!

The Romanian Water Association through Water Training Center and with support of RAJA Constanta will organize the 5rd regional **Leak Detection Competition** this year in Constanta, Romania. From the first until the 4th edition the number of participants have constantly increase from 5 till 19.

We expect that between **13-15 May 2012** the operational teams (with their own autoloboratories) from Serbia, Hungary, Moldova and Romania and observers teams to gathered again to find out who could track down leaks most accurately and with the greatest speed.

Beyond the promotion of best practices among the specialist, this annual competition helps raise awareness about the significant problem of water loss that is shared by utilities around the region, and provides a great opportunity for them to learn from one another. After the competition, the teams always want to know, "how did they do it?" and this leads to some great peer learning.

Together with the support of equipment producers dedicated to this activities and along with sharing the good practice with the sector in one day seminar, we will create the complete platform for Reducing the Non-revenue Waters. More details about the completion can be retrieve from mr Silviu Lacatusu 0040 744 215 772 or wide@ara.ro.

2012 EVENTS

- Water Loss 2012 – Manila, Philippines, 26-29 Feb 2012
- Seminar AQUADEMICA – Leakage seminar – 28-30 may 2012 Timisoara, Romania
- Water Loss UK 2012 (26-27 March 2012, Birmingham, UK)
- IFAT ENTSORGA 2012, 7-11 May 2012, Münich, Germany
- Seak that leak 2012 competition for water loss detection, 13-15 May 2012, Constanta, Romania
- 1st Bulgarian YWP Conference 2012 – Sofia, Bulgaria, 17-18-May 2012
- Water Loss Europe 2012 – Ferrara, Italy, 23-25 May 2012
- Regional Water Forum - EXPO APA, 11-13 June 2012, Bucharest, Romania, Web: www.araexpoapa.ro
- 2nd Regional African Water Leakage Summit 2012 & WMD Workshop, 29-31 August 2012, Cape Town, South Africa, 3-5 September 2012, Johannesburg, South Africa, Web: www.wrp.co.za
- 5th International Conference "Water Loss Reduction in Water Supply Systems", 19-20 Nov 2012, Sofia, Bulgaria.

FREQUENCY BANDS ANALYSIS FOR SIGNALS GENERATED BY LEAKS IN PIPE SYSTEMS

Correct filtering of parasite frequencies which reside in the spectral densities of signals generated by leaks in pipe systems, represents an important step in the process of Cross – Correlation Function (CCF) calculation. The frequency domain (FD) in which the signals should be analyzed is the one where their coherence is maximal. For establishing the appropriate FD one can choose to implement the calculus of the Coherence Function (CF) for the recorded signals. An automated implementation of the CF can be found in programs which process leak signals (Example: Coherence option from CorreluxP200, v.1.21).

This paper presents an experimental method of improving the quality of the calculated CCF, using an automatic filtering on different frequency bands. The quality of the resulting CCF can be observed both in the CCF maximum peak position and in the graphical representation.

For experimental purposes the author has chosen a pair of experimental signals, recorded for a leak debit of 4.27 l/min. The sampling frequency is Fs=15 kHz, each signal contains 131072 samples. The time frame covered by the signals is 8.73 s and the acquisition system used 40 dB of amplification. In order to eliminate modal components and achieve a stationarity characteristic these signals were filtered. Figure 1 presents 16384 samples from the recorded signals, while figure 2 presents the initial spectral distribution in the range of 0 – 7.5 kHz.

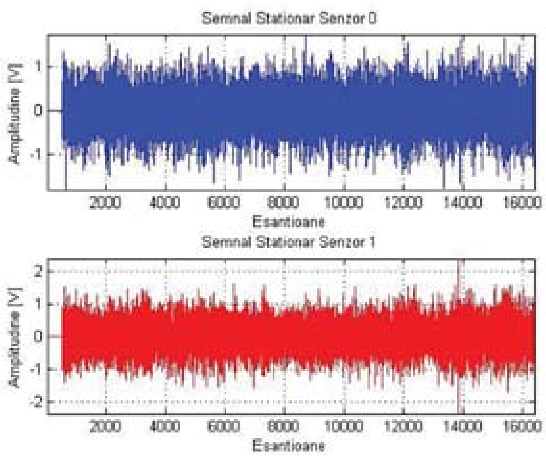

Fig. 1. Experimental signals at 4.27 l/min leak debit

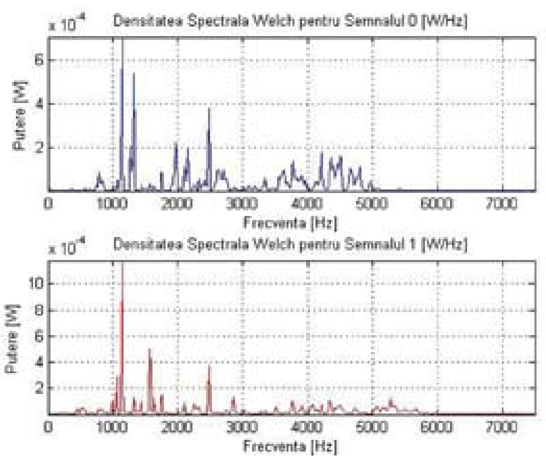

Fig. 2. Power Spectral Densities (PSD) for the experimental leak signals

Figure 3 shows the calculated CCF for the initial experimental leak signals, before the use of the frequency bands analysis. One can notice the presence of unwanted parasite peaks close to the value of interest (marked with red). For this particular case, the displacement of the maximum peak is 14 samples to the right from the CCF center value. The correct position for the peak, which was presented by the author in reference [1], should be 18 samples to the right of the CCF center value. Using a quality coefficient (described in [1]) which established a value for the CCF representation, for this pair of signals QEF = 4.087.

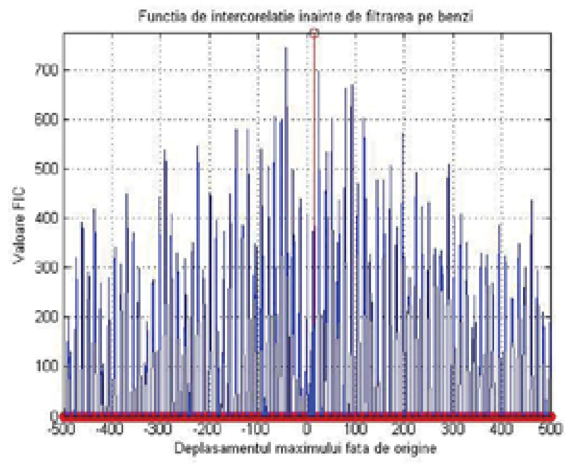

Fig. 3. CCF calculated for the experimental leak signals

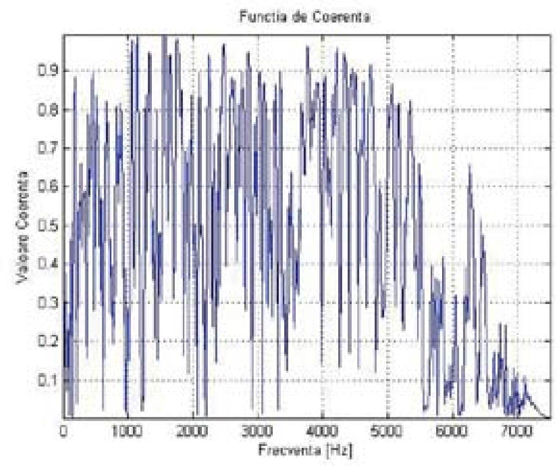

Fig. 4. CF calculated before frequency bands analysis

As stated in the second paragraph, two aspects should be improved after applying the frequency bands analysis: obtaining the correct CCF displacement of the maximum peak and a rise for the value of QEF (quality of representation).

An automatic program, implemented by the author, filters the initial CF (figure 4) until a uniform representation is obtained (figure 5). The next step is a determination of the two most appropriate bands for frequency analysis. For this pair of signals, the intervals expressed in Hz are [3903 – 4912] and [1944 – 4970]. For each interval, the proposed method applies the following steps: filtering of initial signals, "whitening" of filtered signals and calculation of the improved CCF [3]. In this case, the experiment results indicate that it is better to use the second interval. Figure 6 presents the improved CCF computed after the frequency bands filtering was used.

For the resulting CCF, the displacement of the maximum peak is 18 samples to the right of the CCF center value. The quality coefficient has the value QEF = 10.086. The representation

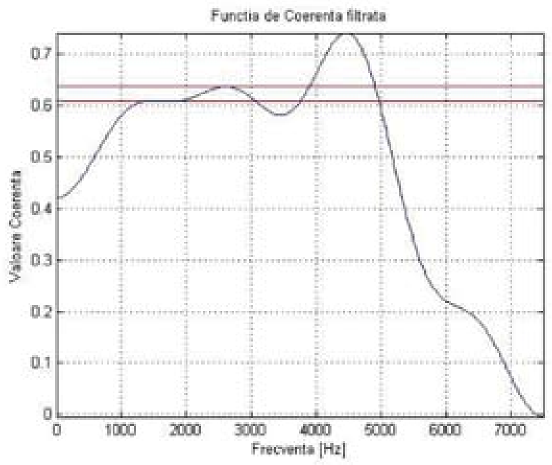

Fig. 5. Uniform CF obtained by low – pass filtering

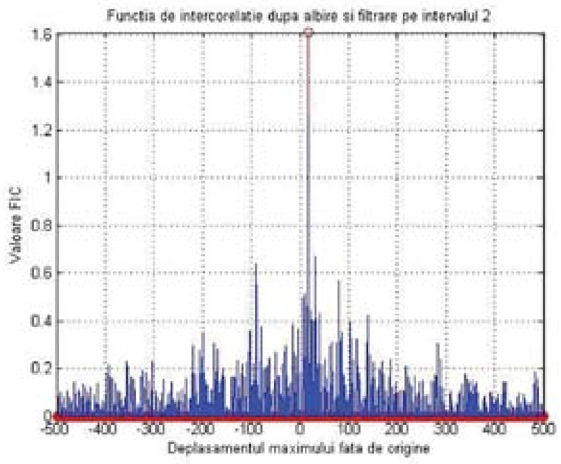

Fig. 6. CCF obtained after analysis using the second frequency band

is superior when compared against the one presented in figure 3.

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A drop of history

SEXTUS IULIUS FRONTINUS, WATER COMMISSIONER IN ANCIENT ROMA

Sextus Iulius Frontinus (40-103 AD) was one of the most distinguished aristocratic Roman of the first century after Christ, he is best known as an author of technical treaties, including one dealing with the aqueducts of Rome, De Aquis Urbis Romae or De Aqueductibus.

Born in Gallia Narbonensis, Frontinus had brilliant political and military career. In AD 95 he was appointed curator aquarum (Water Commissioner) for aqueducts in Rome by the Emperor Nerva, a function conferred on persons with high social status. In this capacity, he presented the late first century AD, an official report on the state aqueducts serving Rome, the first official report of an investigation on engineering works that was ever published.

In this capacity he followed another distinguished official of the Roman Empire, Agrippa, friend, ally and son in law of Augustus, who organized, in 34 BC., a campaign of public repairs and improvements, including renovation and expansion of the aqueduct Aqua Marcia. Agrippa, after being elected in 33 BC., as one of aediles, officials responsible for buildings and festivals in Rome, repaired roads and cleaned and renovated sewers. He was known by extending the mandate and restoring the main sewers of Rome, the Cloaca Maxima, constructing baths, porticos and gardens.

How were maintained the Roman aqueducts

De aquaeductu, the main writing of Frontinus, the history and description of water supply in Rome, including laws regarding the use and maintenance of existing systems. Contains the channel dimensions and flow of the Aqua Appia, Aqua Alsietina, AquaTepula, Anio Novus and Aqua Virgo Aqua Claudia. The largest of all Roman aqueducts, Aqua Traiana, was built later in the year 109 AD It ends at Ianiculum, in a series of water mills. Frontinus describes the quality of water supplied by each water supply, depending on their source, be it river water, lake or spring.

According to calculations by Frontinus, Roman aqueducts flow was 1,030,000 cubic meters / day, but by the fraudulent embezzlement and evading various incontinence, it was lost about 450,000 cubic meters of water per day, ie 44% of the flow. As administrator, he returned to normal initial distribution of aqueducts, after ended misappropriation and negligence

One of the first tasks that he received when he became curator aquarum was to prepare maps of the system, so their status can be assessed before taking the necessary maintenance measures. Frontinus reported that many pipes water were neglected and not working at full capacity.

He was especially concerned about the water diversion by farmers and traders, which were introducing pipes into aqueduct channels to achieve their illegal power supply. For this,he made a meticulous study on the entry and exit for each line, and after that he investigated the discrepancies.

The water distribution depended on the height, location to the town, the quality and flow source. Thus, poor water quality was sent for irrigation and gardens, while only the best water use may be reserved for drinking purposes. Intermediate water was used for baths and fountains. However, Frontinus criticized the practice of mixing water from different sources, and one of his decisions was to separate the waters of each system.

Another concern was related to leaks in the system, especially for the underground pipes,difficult to locate and repair, a problem faced by the specialists also today. Air aqueducts had tended to keep the masonry in good condition, especially those crossing the arched superstructure. Frontinus claimed that it was essential that the superstructures to keep a distance from trees, so their roots will not affect them.

Breakthroughs were a source of income both for those who had the care of the water inlet and for different offenders. All were causing penetrations of the underground channels and were directing the water to the properties of those who pay. All actions of water pipes degradation were sources of income higher on the expense of public use.

Thefts of aqueducts' water were produced also outside Rome, for the benefit of reach people with wealthy areas and villas. Those could increase their luxury with free water supply for their large gardens, ornamental fountains and pools of their own.

So, Frontinus revised legislation that regulates the aqueduct state and the need for its application.

Calix - monitoring tools

Staff dealing with water network consisted of 700 people. For the most part, were slave workers. Frontinus apart as workers: villicus (which dealt with control of water distribution), castellarius (which dealt with maintenance of water castles), circitor, custos, inspectori. Silicarius tended paving, because the lead pipes were under the pavement, all over the city. Plumbari were those who were making lead pipes, and those who were perforating the pipes to allow connection at the water supply, were called the punctis. Obligations of workers were covered daily.

To avoid fraud water distribution, the supervisory distribution personnel had an instrument with legal regulation sizes, called calix.

Was made of bronze, being harder than deformed lead. As Frontinus says, bronze tube was fixed in a divisorium castellum wall or on secondary Castella, and then combined with the lead pipe. Numerals on calix were binding only on the first 50 pedes lead pipe (about 14.8 meters).

The owner had leased the supply water system and his followers had to renew it, because the concession was life annuity, but not for posterity, even if they paid a vectigal, a tax on water. Normally, on these parts had to be a stamp, indicating at least its size. We do not know if it was required to apply the name of the owner, manager or representative government.

Scam possibilities were numerous. It could be installed a calix with a size greater than that authorized, by bribing those who were making the actual connection. The brass tube could burn a different stamp or none. By attaching a pipe larger than the calix, a pump effect was created. Another possibility of deception was installing lead pipes without any monitoring and control tools.

Lead pipes were made by casting on rectangular marble sheets. On marbles were dug various inscriptions, obtaining, after casting, the so-called silloge Aquaria. After that the sheet was rolled around a wooden pillar. The edges were bound upper perpendicular to be easier to combine with molten lead. Connection between two fistulas was made, either by pouring molten lead, or by enlarging one of the ends.

Frontinus, referring to making lead pipes, shows that, at the run sheets, appears an expansion at the outside and a contraction at the bottom. Therefore, he proposes measuring diameter pipe after running. After corrections of Frontinus, shows an excess of diameters data given by Vitruvius.

In his treatise on aqueducts, Frontinus did a careful checking job of the figures from the imperial records, which added the fruit of experience. Moreover, he expose the program of measures which in his view, should be taken to improve the organizational system and all other water supply problems.

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WATER LOSS REDUCTION IN SOFIA – ALL FOR ONE GREEN CAPITAL CITY

Sofia – the capital of Bulgaria

Sofia is the capital and the largest city of Bulgaria with a population of more than 1, 4 million people.The construction of water and sewerage networks started at the end of 19th century, but the biggest construction took place in 50-70s of the 20th century. Currently the whole Municipality of Sofia is serviced by one single water supply and sewerage operator – Sofiyska Voda AD. The company was established in 2000 as a form of public-private partnership based on a concession agreement. Now it is a part of the Veolia Water Group – its majority shareholder.

Sofiyska Voda provides a full range of services, including production and supply of potable water, sewerage and wastewater treatment. The company is responsible for more than 1, 4 million people living in Sofia and the villages in its outskirts.

Sofiyska Voda operates 4175 km of water supply network, 4 potable water treatment plants; 1 554 km of sewerage network, 64 reservoirs, 13 pumping stations; 35 chlorination stations and 1 wastewater treatment plant.

How does Sofiyska voda deal with water losses?

In the last 10 years water loss reduction has become the principle concern of all drinking water operators in Bulgaria and in many other countries worldwide. This is a big challenge for Sofiyska Voda too. The company has applied

some of the best world practices to manage the "unaccounted-for water" issue. The first step was to provide permanent monitoring of the water supply network by separating the whole network into many district metering zones (DMAs). That allows to measure and control both flow and pressure and to analyze the monthly balance at any zone.

The water network in Sofia was separated into nearly 195 inhabited district metering areas (DMAs) and another 70 DMAs with strategic reservoirs and water mains. All of them have their permanent monitoring points at the inlets and at the outlets. All data are being transferred towards the central company's headquarters via telemetry system. Apart from that, a number of key points along the network are linked to a real-time Supervision, Control and Data Acquisition System (SCADA). Up to now, Sofiyska Voda has installed about 360 measuring devices to monitor the water flow. SCADA is also linked to all reservoirs, pumping and chlorination stations.

Now, the separation of the water network allows us to analyze a number of indicators in each DMA - minimum night water flow; the correlation between the night water flow and the average water flow per hour at the zone, pressure, water network parameters, frequency of failures, and the billed water consumption related to the total water flow and etc.

The separation of the network is the core of the whole water loss reduction process.On one side, smaller areas are easier to monitor and control. Each small zone has its specific water and sewerage network that needs an individual approach. In other words, each DMA is like an individual body, which calls for a special "diagnosis" and an adequate "cure".

Experience in examples

Two examples would give a clear view of the efforts of Sofiyska Voda to reduce water losses. In 2011 the company implemented some successful projects in two big residential quarters, Obelya and Mladost .

What happened in Obelya?

The DMA has 3 505 m of water network, most of which was constructed up to 1990. The house connections there are about 96, supplying nearly 4 600 consumers. The initial investigation showed that the water flow at the inlet was 3 334 m3 per day on average, and the billed water amount was just about 672 m3 per day, i.e. the "diagnosis" was more than 2 600 m3 water losses every day. The works within the area took a few months. We carried out some step tests, construction works, pipe reconstructions, stop valve repairs, pressure reduction and finally removed some hidden leaks. In the end we have registered 976 m3 of water flow per day compared to the preceding 3 334 m3/d or the actual water loss reduction there is more than 70%. The reduction in the minimum night flow was from 120 m3/h (starting point) to almost 16 m3/h (final point). All works in the zone lasted more than 4 months.

How did we manage with the water loss issue in Mladost?

A similar program was implemented in another DMA, located in another big residential quarter of Sofia – Mladost. The total water network there is 6 737 m, constructed mainly between 1980 and 1983, mostly by cast iron. This network supplies nearly 11 350 people (about 4 464 households). The network study showed a water flow of 4 243 m3 per day and

only 2 236 of them were billed. The remaining 2007 cubic meters are left in the column "unaccounted-for water". Different DMA – different "cure" required. Here we carried out the following complex of actions – replacement of house connections and stop valves, repair of old stop valves, interruption of street water main, and installation of fire hydrant, detection and removal of hidden leaks. In the end we have registered 1 322 m3 of water flow per day or 5 000 m3 of water less. The reduction in the minimum night flow was from 130 m3/h to almost 20 m3/h. All works in the zone lasted 4 months in 2011, apart from proactive block connections replacement in 2010.

The balance

These examples show the individual approach the company applies. Sofiyska Voda has planned works in another 48 DMAs for 2011 using the same approach. Consequently, the total result for the period of January-August 2011 is significant: the total water flow input in the water system of the capital city is by 5,3 million m3 less compared to the same period last year. The figure for the total water loss also dropped down by 4.7 million m3. The balance is: 55.48 % total water loss or in short every day we lose 51.69 m3 of water per kilometer of network.

The results are clear when we talk about DMAs, which have mainly operational problems. We should point out that we have DMAs, where the problems with the water loss reduction come mainly from illegal use. The total number of unaccounted-for water is much higher due to the serious part of illegal water consumption. This, however, is another "diagnosis" - much more expensive and more difficult to identify and "cure", but possible.

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LOST ENERGY, A DIRECT CONSEQUENCE OF WATER LOSS

Introduction

Water leakage represents the volume of water which enters in the system but is not used for its intended purpose. Depending on how one is looking at the problem, the water leakage can be defined in several ways such as: real (water that is physically lost from the system) or apparent leakage (due to some measurement errors or other causes), commercial leakage ("Non-Revenue Water" as formulated by the International Water Association – meaning the water that does not produce any benefit for the provider), paid or unpaid leakage, wasted water etc.

The difficult part of this problem is the fact that in the end this water must be paid for and usually this payment it is done by the consumer at a calculated water tariff that includes the water loss. When the water provider is calculating the cost of water (the price per cubic meter) that has to be paid by each water consumer, several factors are considered including the lost water due to the system's leakage. Because it is not completely fair to the customer to pay for some water that he is not using, the provider has the obligation to keep the leakage to a minimum (by ensuring that the pipes are checked regularly and the leakage points are identified and repaired) as well as keep a minimum cost for the water that is lost (meaning the provider should not try to have a profit for the quantity of water that is lost).

Leakage consequences

Water leakage creates several collateral consequences. One of them is mentioned above (the fact that the consumer has to pay for some water that he is not consuming) but there are other consequences of water loss such as technical difficulties, social problems, environment aspects (water resources protection) etc. Most of these consequences are discussed in several publications /1/ but one of them is very important – the loss of energy. The lost water contains a great quantity of energy due to its preparation and transportation (figure 1). The chances of finding a system in which the water comes from a clean source and the transportation is done by gravity (hence no energy or minimum energy is required) are very low. Most important to remember is the fact that the water lost from the system could be recovered through the natural hydrological cycle but the energy cannot. Therefore, the energy must be evaluated and reduced to a minimum level.

Normally in the water supply system in Romania the supplied water contains about 0,4-1,0 kWh/m3. So, if the average water loss is 35% this means that there is a great quantity of energy that is also lost. Non-renewable sources such as coal, gas or oil are generally used in Romania to produce energy stressing even more the importance of preserving the resources hence reducing the energy consumption to a minimum. The process of producing energy using the above mentioned resources is generating great quantities of CO_2 that have a direct negative impact on the surrounding environment. All these issues should be considered when designing a water supply system. Pumping and transporting water from the source to the water supply system through hundreds of meters of pipe not only that will waste energy, waste resources and pollute the environment but will result in an increased cost of water which is not in anybody's benefit. Several specialists that analyzed this subject /1,3/ have noticed that the lost energy can represent in some cases up to 25% of the total energy needed for delivering the water to the consumers. For example, Mexico City's water supply system has been found to have a very high energy consumption of around 15 kWh/m3. This is due to the fact that 30 m3/s of water needs to be pumped about 1000 m over hight at 100 km distance /2/.

Case study. A short example to leakage calculation

To demonstrate the importance of this problem and to show a way to obtain a good estimation of energy consumption for water transportation a short example is described below.

Let's consider two pipes as part of a distribution system as follows:

First – a pipe that is under pressure, having to deliver water to a p+10 story building,

Second – a pipe using a lower pressure, having to deliver water to a p+4 story building.

For the simplicity of this example lets also assume the following:

– both pipes have the same length (300 m),

– both pipes are placed horizontally on the ground,

– the pipes may carry different amounts of water,

– water loss is uniform along both pipes and it represents 40% from the supplied water,

– the flow capacity is considered continuously variable for both pipes,

– both pipes are made from plastic material,

– during the time the roughness of pipe remain the same.

The pipes will be analyzed in 2 scenarios: (a) the pipe is new (hence the leakage is low, around 10% as per Romanian standards) and (b) the pipe is old and poorly managed (hence the water leakage is as high as 50%).

Situation a: Pipe working at high pressure (5 bars)

For the initial flow of 100 l/s the required pipe diameter is of 315 mm; the pipe length is 300m as mentioned above and the consumption is uniform (0,05 l/s*m); the leakage is 6 l/s (40% of the supplied water for the old pipe case). Pressure in the initial nod will be 51,8m for the system using a new pipe and 52,1m for the system using the old pipe; power needed to pump the water is 63,88 kW respectively 70,51 kW for the case of the old pipe. Energy consumption will be E=P*T resulting Ei = 63,88 kWh/h and Ef=70,51 kWh/h. Finally we noticed that difference of energy consumption is:

ΔE = (Ei –Ef)/ Ei =6,63 kWh/h = 9,4%.

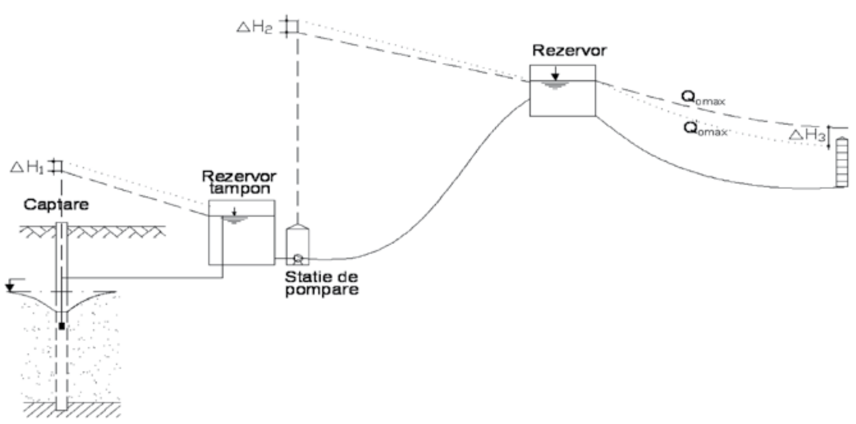

Figure 1. General drinking water supply syste

Situation b; Pipe working at low pressure (2 bars), and a small flow

The uniform flow is 0,05 l/s.m; pipe will have 160mm,

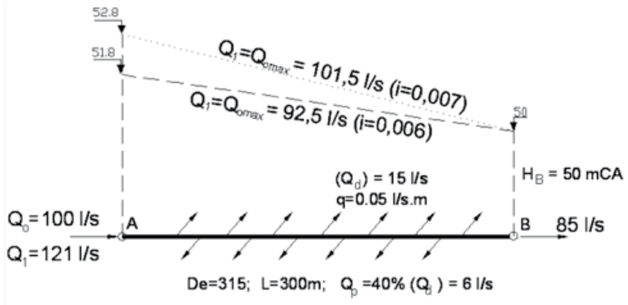

Figure 2a. Pipe working at high pressure (5 bars) required for a 10 storey building

PE; in the case of the new pipe the required pressure is of 21,26m but in the case of the old pipe (50% leakage) the required pressure is of 21,30m. Therefore the required power will be 5,67 kW for the new pipe or 7,59 kW for the old pipe. This leads to an energy loss of:

ΔE = (Ei –Ef)/ Ei = (7,59- 5,67)/ 7,59 = 1,92 kWh/h.

which translates into 25,3% of initial energy.

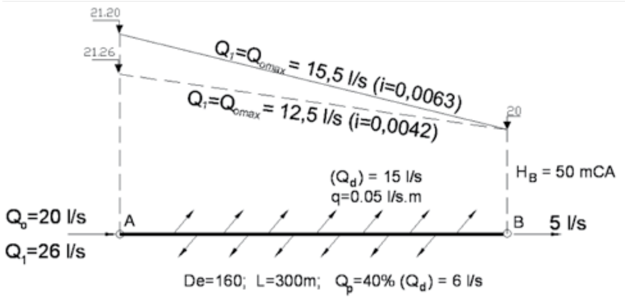

Figure 2b. Pipe working at a low pressure (2 bars) required for a 5 story building

Conclusions

– As long as there is water in a water supply system, the water leakage will also be present. Water leakage is the most "constant consumer".

– If there is a water leakage most certain there is a an energy leakage; the water lost from the system could be recovered through the natural hydrological cycle but the energy cannot. Some specialists say that the energy lost in the distribution system could represent as high as 25% of the total energy involved in the water supply.

– It is important for working water supply systems that have great energy consumption to analyze the system including the energy consumption.

– Because the energy production directly relies on non-renewable resources (limited resources), the price of both water as well as energy will most probably rise.

– A small reduction of the pressure values in the distribution systems could have a great impact on the energy consumption; so a system for pressure control will be welcome.

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Professor Alexandru Manescu, PhD. Eng.

Technical University of Civil Engineering, Bucharest/Romania, May, 2012

ADVANCED PRESSURE MANAGEMENT TECHNIQUES TO REDUCE AND CONTROL LEAKAGE

It is common practice for water utilities to design their distribution networks to provide the minimum standard of service to the customers who are at the highest location of the system at maximum demand. This means that the minimum pressure occurs at this location at some time during the day when demand is at its maximum. Depending on how well designed the network is, significant variations in demand are reflected in varying pressures ranging from minimum at maximum demand to maximum at minimum demand at the critical point .

Understanding the impact that pressure management will have on the operation of a distribution system is essential in the application of the correct type of approach and equipment. Pressure management is the optimisation of pressure in a distribution system to provide the minimum level of service to all customers, which ideally should be between 20m and 40m with absolute minimum of 15 m if conditions allow.

Pressure management is achieved through pressure control devices, such as pressure reducing or regulating valves. The types of pressure management that are most commonly used are:

- Fixed outlet
- Multi point control (Time or Flow)
- Flow modulation

In the case of a fixed outlet Pressure Regulating Valves (PRV) the pressure is continuously regulated immediately downstream of the PRV irrespective of the value of the pressure in the network. The pressure at the PRV is usually set so that the minimum level of service is achieved at the critical point in the network at maximum demand. The draw back of this particular method is that the pressure in the network rises during periods of minimum demand without effectively being able to apply further control. The other two types provide better control of pressure.

Multi point control PRV is used to regulate the pressure in the network at different pressures depending on the demand for flow or the time period. Again the setting of the pressure is on the downstream side of the PRV at a fixed value.

Flow modulation is the most advanced method of pressure regulation and it is increasingly gaining ground as the benefits from using such a method are becoming known and are backed up by tangible evidence form field applications worldwide. With this method, pressure is continuously controlled based on the demand so that at the critical point in the network the pressure is always maintained at the minimum level of service thus achieving maximum pressure reduction at any time whilst maintaining the desired level of service to the customers.

Recent advances in technology have introduced systems with continuous monitoring of the pressure at the critical point / points and the data is fed to self learning algorithms which in turn control the PRV / PRVs in order to maintain the desired pressure in the system. In this way the response to any pressure changes in the system is immediate and the maximum pressure reduction is achieved always maintaining the set level of services to the customers.

Implementing Advanced Pressure Management

The Water Board of Lemesos continuously strives for further improvement of the operational performance of its network. To this end it has applied pressure management with fixed downstream control as a standard for all DMAs. Where possible the Water Board is examining to optimise the pressure further using advanced techniques such as flow modulation or multi point control in order to achieve further reduction thus driving leakage to even lower levels.

Flow Modulation

Flow modulation provides an advanced method of controlling pressures and the outlet pressure is continuously controlled and varied so that the pressure required at the critical point in the network is always maintained at acceptable levels. In this manner during periods of high demand the valve adjusts itself to increase the flow in order to maintain acceptable pressures in the system. When demand in the system is reduced the valve readjusts so that excess pressures are reduced thus reducing leakage further. In order to examine the benefits of this technique the Water Board installed flow modulation on an existing PRV in DMA 230.

Photos of the flow modulation PRV having a hydraulic control

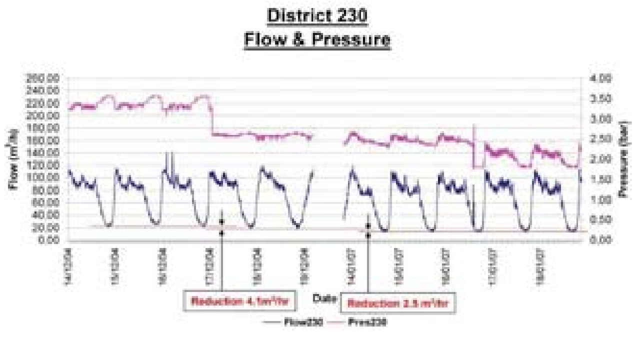

Figure 2. Application of fixed outlet and flow modulation PRV

It should be noted that since the installation of the fixed outlet PRV in this DMA no proactive leakage repair activity was undertaken except for reported leaks. The reason behind this was to have a clear picture of the benefit that each pressure management method will have in reducing leakage. The benefit can clearly be seen in Figure 2 below. It is evident that after installing a fixed outlet there was a reduction in the Minimum Night Flow (MNF) of 4,1 m^3/hr. When flow modulation was effected there was a further reduction of 2,5 m^3/hr, which proves that provided the conditions are such that favour the application of flow modulation further reduction in leakage is possible.

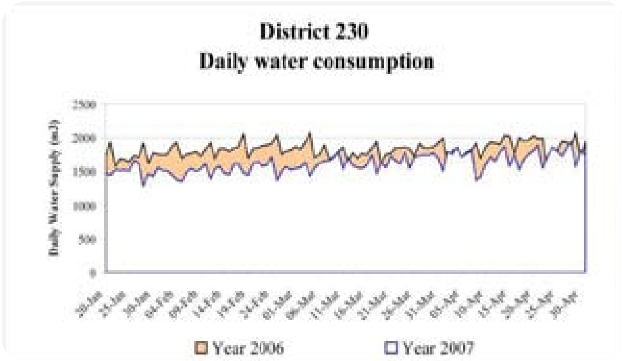

Figure 3. Comparison of flows with fixed outlet and flow modulation PRV

In order to highlight further the benefits in applying flow modulation the daily water consumption of DMA 230 was plotted for exactly the same period in 2006 when pressure was controlled by fixed outlet PRV and in 2007 when pressure was flow modulated. It is evident from Figure 3 that the installation of flow modulation resulted in a reduction in the volume of water registered by the area meter over the 101 days period under examination of the order of 6.000 m^3 which means that over a 12 month period the volume saved will be of the order of 21.500 m^3 valued at approximately €17.000.

Without a doubt flow modulation is an investment worth making considering that the cost of modulation together with its installation in the case of DMA 230 was less than €3.000. It must be stressed that flow modulation can not be applied effectively in all DMAs. Flow modulation calculations must be carried out beforehand to establish the potential of flow modulation applicability in each DMA.

The main criterion for applying flow modulation is that the pressure difference at the critical point between high and low demands is large enough say in excess of 5m, in order to be able to apply modulation. For DMA 230 this difference is 7m and the pressure is modulated between 1.7 bar at the lowest demand, usually at around 3am, to 2.4 bar at maximum demand which is usually at about 9am (Figure 4).

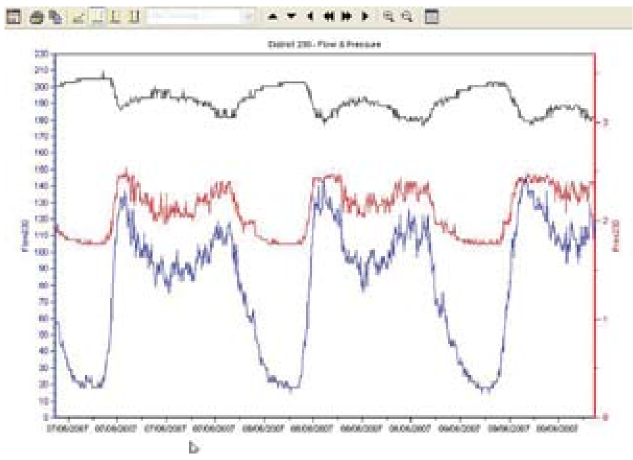

Figure 4. Graph showing flow, pressure upstream of the PRV and modulated pressure in DMA230

Multi Point PRV

This method of pressure management is a variation of a fixed outlet PRV. It has more than one fixed downstream pressures depending on demand. The fixed outlet PRV is set so that irrespective of demand the pressure immediately downstream of the PRV is fixed at a given value. The Multi Point PRV has several settings of pressure which are effected automatically depending on demand. The PRV can also be set to change over from one pressure setting to the other based on time. In this trial it was set to operate at two flow control points and it was installed in DMA 123 which supplies water solely to the port of Lemesos.

The use of this type of pressure management was chosen for this area due to the irregular demand of water at the port. For flows up to 20 m^3/hr, sufficient for all activities in the port area apart for providing water to any ships docked in the harbour, the pressure setting is at 1.7 bar. In case of supplying water to a ship the flow immediately increases beyond 20 m^3/hr and the pressure changes to the second setting which is set at 4.7 bar in order to satisfy the demand (figure 5).

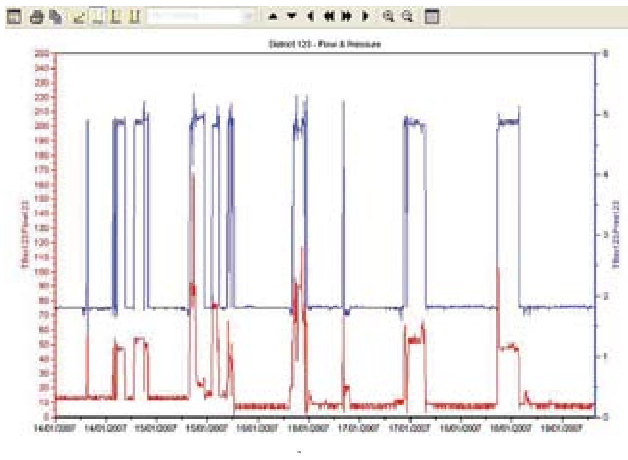

Figure 5. Graph showing flow and pressure response in DMA133

The system operates only a few hours a day at the high pressure in order to supply water to the ships. Once demand falls below 60 m^3/hr the pressure setting changes back to 1.7 bar. This system was an improvement to the fixed outlet in that pressure surges were eliminated and the MNF was reduced from 12 m^3/hr to 5 m^3/hr.

Conclusions

Based on the experiences gained in trialling advanced pressure management methods the following conclusions could be reached:

• Flow modulation seems to be more efficient in district metered areas, eliminating pressure shocks to the area since the pressure is continuously controlled based on the demand (smooth change over time).

• Other forms of pressure control, e.g. multi point PRV, are beneficial based on the specific operational conditions of the network.

• The pay back period in most cases is very short (only a few months) depending on the size of the PRV.

• Reduction in the produced volume of treated water can be achieved by efficiently applying pressure management techniques.

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AQUADEMICA - PRESENT AND FUTURE SOLUTIONS FOR PROFESSIONAL DEVELOPMENT

Aquademica is a non-profit organization in Romania activating in the environmental, water and wastewater sector. The Romanian-German Foundation Aquademica was established in March 2009 by Aquatim, the regional water and wastewater operator in Timis county/Romania, and the Municipality of Munich (Waste Water Department).

Being an information and knowledge center strongly committed to the development of secure and sustainable water and wastewater management, the Foundation promotes professional development and offers itself as a networking platform supporting specialists, professional organizations and companies in the field. It also offers services aimed at providing sustainable solutions and excellence in the water and waste water sector such as: studies and surveys, developing regulations and advisory services to public authorities, environmental, economic and engineering expertise, consultancy and design.

Main advantages of Aquademica are national and international networking with universities, consultancy and engineering offices, manufacturers, regional water and waste water operators as well as governmental bodies, and the transfer of good practices, already validated and acknowledged by our German partners. Pilot stations, donated by our German members, can be used for simulations of existing technologies to be optimized, or for modelation of new technologies to be implemented.

The issues of water and wastewater concern everybody: professionals, citizens, politicians, educators and students - thus we are constantly concerned with improving, updating and disseminating knowledge. Seminars and workshops promoted by Aquademica include theoretical support and practical simulations. They take place in locations in Romania or abroad and provide specific training on critical issues in the water sector - water resource management, wastewater and sludge management (in accordance with the urban and rural development), modern technologies in the field, implementation of the EU *Water Framework Directive,* pollution etc.. The transfer of the German know-how is done directly by the German specialists or by using knowledge multipliers.

Our goals set for 2012 include strengthening the exchange of experiences between countries, strengthening the cooperation with municipalities as decision makers on the public water sector, cooperating with the government on development of regulations, and strengthening the communication towards civil players in the water and wastewater sector.

If you feel committed to defending water - nature's most precious gifts to mankind, and are interested by our activities, please feel free to join us! (aquademica@aquademica.ro)

eng. Monica Isacu
Executive Manager of Aquademica

ALBSTADTWERKE
ENERGIE FÜR DIE REGION

OPERATIONAL EFFICIENCIES FROM PERMANENT LEAKAGE MONITORING

Introduction

Albdtadt is a town located in southwest Germany, about 80km south of Stuttgart. Alstadtwerke are the utility network distribution provider in this region supplying potable water, natural gas and electricity. In addition to managing and maintaining the local distribution assets in Albstadt, Albstadtwerke operate and maintain two more potable water distribution networks, seven natural gas distribution networks and an electricity supply.

Albstadtwerke is efficiently run with 80 employees for the entire operation and construction of our networks and facilities. It has been a corporate policy for many years to continuously evaluate current methodologies and introduce new innovative methods in leak detection and trenchless pipe installation.

In this paper we will share information about our vast experience with innovative technologies in reducing water loss and information about our latest system that permanently monitors the network and alerts us as soon as a leak appears.

Figure 1 – The Albstadt Region spread across 3 valleys with 400 m height variance.

An Overview of our Network

Albstadtwerke is more than a network operator, we are an energy service provider for the region and have developed a sizeable business with 37,000 customers, 46,000 residents and Sales of €70,000,000.

We have to be innovative in network operation and provide an entire portfolio of energy to survive in this deregulated energy market.

Figure 1, shows a picture of the Albstadt region which is spread across three valleys and has a height variation of 400 meters. This geographical landscape creates a number of operational challenges including;

- A large number of different pressure zones
- Long sections of trunk main
- Long distances for maintenance staff to drive to reach the extremities of the network

Approximately 50% of the water we supply comes from our raw water catchment and is processed in several stages at our water plant to produce high quality drinking water.

The other 50% is purchased from a total of 3 suppliers. We are about 80km away from the Lake of Constance, which is one of the biggest lakes in Europe.

Our current Non-Revenue Water is 20% (500,000 cubic meters) which has increased from 10% five years ago. The increase in the NRW percentage is due to a 50% reduction in total consumption, our water loss has remained constant. The ground is lime stone which means that almost no leak is visible on the surface as they always find good drainage in this ground. We have had massive leaks of 25L/S disappear underground.

Figure 2 – Ground is Lime Stone

In figure 3 we show the Braunhartsberg reservoir zone. This zone consists of 52KM of pipework with a mixture of cast Iron, UPVC and ductile iron and as it is over 30 minutes drive from our office to this zone a great deal of time can be wasted driving back and forth. The zone consists of residential dwellings, small industrial enterprises, a highway and some busy roads. So it contains most of the factors that make leak detection difficult.

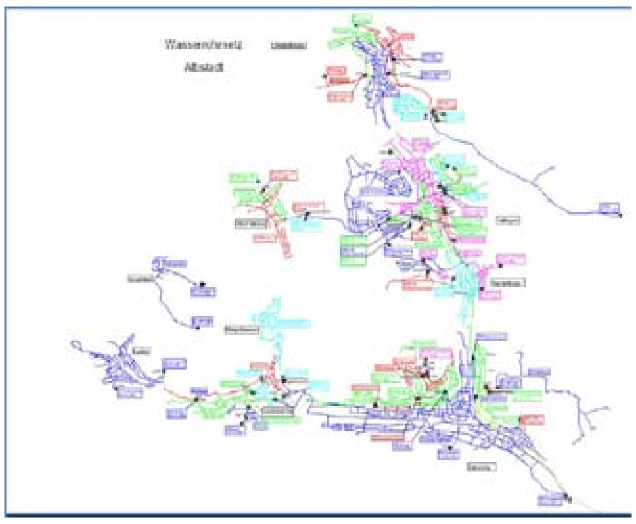

Figure 3 – The Braunhartsberg network design

Water loss Innovations

Our first strategy to improve network efficiency was to install a flow meter on the reservoir outflow and have the data sent to our office on a daily basis with alarms to advise us if there was an increase in minimum night flow (MNF).

This is shown in Figure 4.

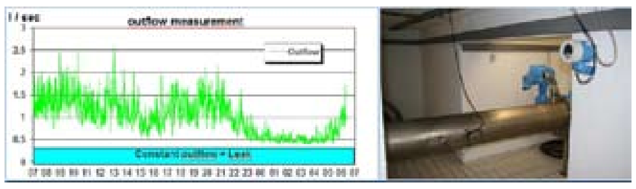

Figure 4 – Flow Meter Installation

In addition to providing an alarm warning us the MNF was rising, we could also quantify the size of the leak.

Leaks in networks are common: When you begin to look at the right end of the network, you will find the leak at the left end. Start at the left end, you will find the leak in the right.

The leak detector must usually search the complete pressure zone to ensure that they have found all the leaks. Leak detection was performed by sending a team out in a van to deploy noise loggers with radio communication and then download the data in a drive-by survey the following day to localize the leak position and use a ground microphone and correlator to pinpoint the leak. This is equipment we have been using for many years and we found only loggers with radio communication could be used efficiently. The loggers are mounted directly on the pipeline with a magnetic connection, to provide a good sound recording. It would often take this two man crew 5 to 10 days to find the leak in this large zone, driving an hour each way every day.

Figure 5 "Drive-by" Leak Detection Crew

The next strategy made to improve efficiency was to install additional flow meters within the zone to localize the leak position to a smaller area within the zone and reduce the amount of time spent searching for the leak. Figure 6 shows location of the additional six flow meters installed.

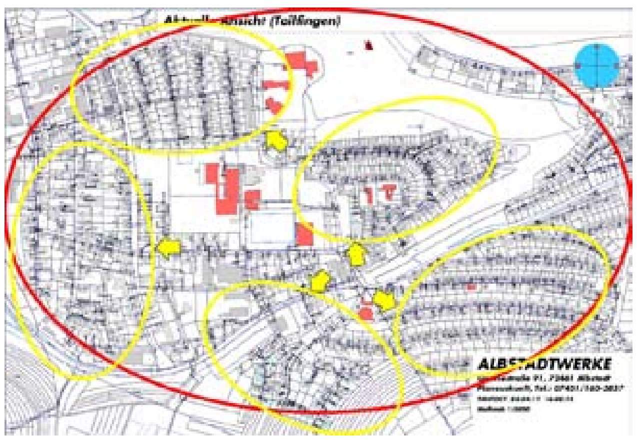

Figure 6 Sub-Metering the Braunhartsberg pressure zone – The Yellow Arrows represent new flow monitoring points

It is important to note that we have not divided this large pressure zone into smaller sub-zones, we have just installed additional flow meters. Careful consideration to the hydraulic model was made to identify the best places to install these additional metering points.

We were not measuring or analysing total flow into sub-zones, we are just looking at significant changes in daily water flows to localise the leak positions.

We have tried a number of different flow measurement devices but it has always been imperative that the data could be transmitted to our office.

Our next improvement - the optimal solution?

With the previously identified systems, we were able to achieve good results. However, there was always still a certain amount of effort to carry the measured data to the office for any detailed analysis and then send a crew to pinpoint the leak before the leak is repaired.

Because of our geographical situation, a lot of time was wasted driving back to the office to analyse the data and then back to the field to pin-point the leak.

Therefore, we decided to introduce a system that transmits the data every day to the decision makers in the office to reduce the response time and time lost travelling.

Noise loggers have been deployed through the network, as previously they record the noise levels and sound. If pre-determined limits are exceeded, the logger sends a leak alarm to headquarters.

Each logger is connected by radio with a repeater. All repeaters are in contact with a data collector (ALPHA) using radio to collect the data from the repeaters and GPRS to send the data to the server. We then have immediate access to the measurement data and can make a leak assessment.

By modeling the system with geographic network data, the loggers are able to recognize their position in the network and create the relationship to its "neighboring" loggers. This fact allows a direct correlation between the loggers and thus a quite precise determination of the leak.

Figure 6 – Installation pictures of the noise logger, radio repeater and GPRS data collection unit
left: Zonescan Correlating noise logger deployed magnetically on a hydrant
centre: Zonescan Repeater installed on Streetlamp
right: Zonescan Alpha installed on a mast above the water tower

The installation is fast and economical without any structural changes to the distribution system.

Eighty loggers, forty two repeaters and 2 Zonescan ALPHA were deployed in the Braunhartsberg pressure zone enabling fully automated leak monitoring of the entire zone, consisting of 52 km of pipe.

Based on experience with loggers previously deployed, we identified areas for assessment.

Communication Reliability: Since the measuring points is always "on the street", in the past there was often a problem with wireless communication. Especially with transmissions in the GSM network, we found the communication to be very good without the need to install an antenna close to the surface.

Behaviour with different weather conditions: We still have really harsh winters. Therefore, it is possible that the road surface sometimes is covered for long periods with a thick layer of snow or coated with thick ice. We expected this to impact the reliability of communication, however there were no problems last winter.

The Lifetime of batteries: We operate in a temperature range from -30 ° C in winter to +30 ° C in the summer; sometimes.

After 12 months of operating the Zonescan, we have had no problems with any of the above points!

The Monitoring Platform

The data is hosted on the Gutermann webserver and accessible via a log in to the ZONESCAN net software. There is mapping, amplitude distribution graphs, frequency spectrum and correlation data in this software platform. Figure 7 shows a map in the ZONESCAN net software, the green, orange and red dots are the loggers. They are colour coded green for no leak, orange for possible leak and red for probable leak. The fuzzy orange dot is a correlated leak position.

Figure 7 Braunhartsberg pressure zone in ZONESCAN net software

In figure 8 you can see a list of automatic correlations ranked in order of correlation quality. The highlighted correlation in the table is also highlighted in blue on the map. As you can see it is also possible to show the loggers in a satellite picture, this provides better orientation. When this particular leak appeared it was identified with correlations from over 15 logger combinations and we repaired the leak in record time, it started on the 9th February and was repaired on the 10th.

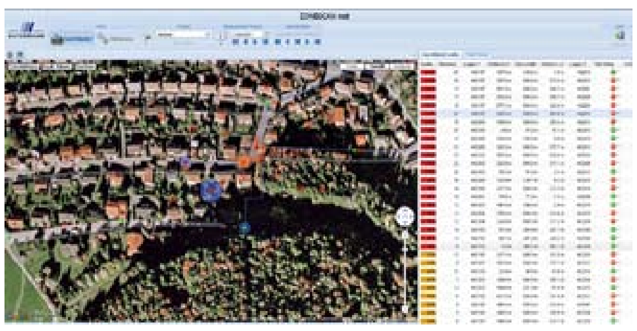

Figure 8 Satellite Image and Automatic Correlation in ZONESCAN net

We can select each of the correlations and view the graph to assess the data, using the correlation spectrum we can identify mechanical noises which reduces the amount of time wasted searching for noises that are not leaks.

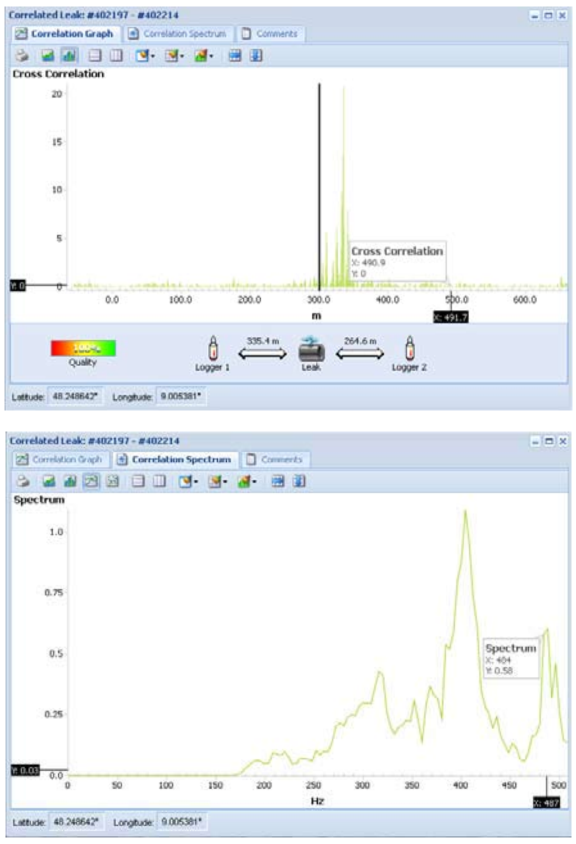

Figure 9 – Correlation graph and Cross Spectrum Graph

All of this analysis is performed in the office before any employee goes out to the site!

This leak can be seen in Figure 10, the correlation provided by the Zonescan system was less than half a meter from the actual position!

Figure 10 Leak found by Zonescan

Conclusions

With this technology we have been able to continue to maintain our MNF to 0.4L/S with an average run-time of a leak event being 1.5 days enabling us to reduce our water losses to lower levels than ever before. In addition to this we have reduced the effort and cost of localization by 98%.

With very good maps of the pipeline network the Zonescan produces a precise location of the leak. Considering the excavation cost is € 3,000, we still confirm the leak position with a ground microphone before digging.

We had no communication problems during a particularly cold winter, with a thick layer of snow on the ground.

We found small leaks that our experienced leakage team would not have discovered and my leak hunters tell me they can hear the worms cough!

Frank Tantzky
Network Operations Manager at Albstadtwerke.
Presented at the Global Leakage Summitt, London 2011.

WATER INFRASTRUCTURE MONITORING: A NEW APPROACH TO MANAGING AND SUSTAINING WATER DISTRIBUTION INFRASTRUCTURE

Today's water infrastructure networks are aging, with over 50% of mains in the western hemisphere aged 80 or more. Utilities face huge requirements for replacement and maintenance, stressing their resources and affecting sustainability. As controlling the water distribution infrastructure becomes more challenging, water loss and un-accounted for water increase, as do damages from bursts, leaks and emergency repair work.

Water Infrastructure Monitoring helps utilities ensure that water flows continuously, smoothly and efficiently to consumers. Timely warning and analysis of network anomalies means that the utility's operational staff can react before a visible and costly failure develops, energy is wasted or quality degrades. It cuts the guesswork out of utility personnel's jobs and gives them a simple procedure to follow.

Water infrastructure monitoring is not only about reducing water loss; it also promotes sustainability by saving energy and other inputs wasted through production and pumping of water that is then lost to network inefficiencies. Sustainability is also promoted by the ability to prevent "Network Events", e.g. when energy is wasted without water loss in pressure zone boundary breaches. Ultimately, water loss is the cheapest way to make more water available to consumers, reducing the need to seek new water sources, as current water sources are more effectively utilized.

Controlling Water Distribution Networks

One of the main issues with current water networks is insufficient ability to detect anomalies as they happen. Leaks, bursts, inefficient pumping, pressure discrepancies and other problems are often not evident from the raw data, certainly not in real time. Water use is spiky, resulting in "noisy" data. As a result, using the raw data to monitor and manage the network is complex and impractical.

The main approaches to reducing water loss require considerable effort on the side of the utility. Current water loss reduction techniques include:

- Human- and capital-intensive acoustic surveys
- Heuristic-based water balance calculations
- Metering small sections of the distribution network to detect night flow changes
- Management of network pressure
- Manual or PC-aided analysis of flow and pressure data, and the use of 'fixed-bound' alarms.
- Relying on customer calls to identify visible bursts or leaks

Active Leakage Control: Traditional water network monitoring provides raw or barely-processed data from sensors measuring flow, pressure, and water quality indicators. The utility's expert analysts and engineers are left to puzzle over this information with the aid of some fixed-bound alerts and rough rules of thumb. Raw SCADA readings contain the information that can reduce water loss, but such information is obscured by noisy readings, network operations activities, faulty meters, variable consumption, and many other complications. While Active Leakage Control is at the forefront of water loss prevention, it can be significantly complemented and improved using the Water Infrastructure Monitoring Approach.

What is Water Infrastructure Monitoring?

Computer Science and Statistics offer several approaches applicable to analyzing water networks based on historic and on-line data, which have not previously been used in this context. The Water Infrastructure Monitoring approach demonstrates the abilities of an algorithmic-statistical approach in monitoring water networks, using sensor data already available at the utility, and the capability of such a system to detect actionable events: leaks, thefts, sensor failures, boundary breaches, and various other network malfunctions.

SCADA systems have become a mainstay of water utilities throughout the world, collecting near-real-time continuous data from sensors which measure flow and pressure at key network points, as well as other data, such as reservoir levels, various water quality indicators, valve positions, and more. Today, most utilities use these systems mainly for ongoing operational needs. This data can also be used as the raw input into Water Infrastructure Monitoring systems, even in cases when sensor readings are not transmitted in real time but rather with a delay of hours or even days.

Water Infrastructure Monitoring utilizes data collected by SCADA and logging systems, such as flow meters, pressure valve data, quality sensors readings and more. Advanced analysis is used for establishing the "routine" behavior and to compare the current state of the network to that baseline, in order to produce real-time alerts on deviations from the expected behavior. Water Infrastructure Monitoring can be implemented as a pure software layer that requires no physical installation and no capital expense. Alerts provided by the system trigger corrective action by the utility, which saves water and contributes to asset longevity.

Early and accurate detection not only saves water but also repair work, regulatory sanction, and collateral damage. This is the case both for leaks and for pre-empting dangerous visible bursts.

TaKaDu – and example of Water Infrastructure Monitoring Service

General approach

TaKaDu is a software-as-a-service (SaaS) solution analyzing data as soon as it is received from the utility systems, and alerts as soon as an anomaly is detected and classified. In the case of TaKaDu, all data processing is performed remotely, and the utility is not required to install any software or hardware. Viewing the alerts and reports is done through a secure web interface. Briefly, the SCADA data (real time readings of the network meters: flow, pressure, etc.) and other data about the network is transferred online to the TaKaDu server; the server cleans and analyses the data to detect anomalous events, using various algorithms.

The overall approach of the system is one of detecting statistical anomalies in data, compared to what the system observes and models as "routine behaviour". This relies to some extent on existing Computer Science methodologies in Anomaly Detection, and is a different approach than systems based on extensive hydraulic modelling, where very explicit assumptions and precise physical calculations are required for any sort of meaningful result. In any case, good statistical analysis is a necessary mainstay of any analysis of the water network, because of the typical scarcity and inaccuracy of the data collected, the very partial data coverage (e.g. consumption data is very low-resolution), and the many unknown variables which create random-seeming fluctuations in demand or in internal network behaviour.

The benefits of TaKaDu's generic approach include ease of deployment (uses existing sensor array, no intensive modelling required of the utility), a wide and flexible range of possible input and output data types, and the ability to detect even anomalies of types unforeseen when designing the system.

Data analysis engine

Network data is frequently affected by "noise" such as sensor errors, transmission and data handling errors, transient hydraulic effects, intentional network operations (such as planned valve operations or pressure changes), and unpredictability in consumption patterns, e.g., due to individual large consumers or to weather changes. Any of these may be mistaken for an interesting anomalous event, or adversely impact the ability to statistically identify such an event (by being sampled as part of the "routine" distribution). Thus, the first step in any effective analytical solution is to employ signal-processing techniques for validating and "cleaning" faulty data. Notable data problems encountered in actual deployment, and which the system identifies and overcomes, include transient noise, coarse granularity sensor data, data gaps (e.g. due to transmission problems), wrong time of day, and real but transient hydraulic effects (which do not represent the network's real routine behaviour), e.g. because of valve movements.

The core of the system is a statistical anomaly detection engine. This uses multiple statistical tests to determine when the data from one or several sensors is exhibiting a significant deviation from "routine behaviour". Some of these tests are generic, and can be used for any input data type.

The system continuously models what is normal or routine for the monitored network, so that anything sufficiently different from this may be detected as anomalous. This automatic process searches for several strong statistical structures, which enable the prediction of routine behaviour. These structures range from the seemingly obvious – though still non-trivial to exploit statistically – periodicity of consumption patterns (daily, weekly, and annual), to more surprising relationships, such as very accurate correlations between measurements at distant and hydraulically separate points (presumably brought about by the similarity in network layout and especially in consumption patterns, e.g. between two mostly residential neighbourhoods). Linear regression methods are used to further find combinations of measurements which provide such strong correlations.

This solution thus offers better resolution of the prediction engine which can detect smaller anomalies that cannot be detected by fixed bound alerts and other threshold-based systems. For example, a single sample of a 1% increase in flow (relative to prediction) may be found to be perfectly normal random fluctuation, whereas such an increase appearing for six hours may be highly unlikely in a "routine" scenario.

Benefits

TaKaDu's unique approach helps monitor the network's "blind spots" more effectively, control water loss, find more leak events and identify many small leaks before they become large. The system's ability to identify and alert upon faulty meters is in and of itself a major benefit. Most importantly, the system doesn't require any physical network or equipment investment on the utility side.

Benefits include the ability to:

- Increase the efficiency of all operational staff – network and leakage analysis, field operation and executive management
- Reduce physical detection time and costs
- Save water lost to network issues through leaks and bursts
- Save energy and other inputs wasted by producing water that is then lost to network inefficiencies
- Prevent "Network Events", e.g. energy wasted without water loss in pressure zone boundary breaches

Even with well-established active leakage control practices, the system is proven to detect many network events, water loss events and other issues earlier and more efficiently. In many cases, this is done without prior notification by existing monitoring methods.

Monitoring for Sustainability

Water loss in the distribution network is estimated by the World Bank at an average of around 30% worldwide, and is a severe problem at utilities with older infrastructure. Water lost to leakage is unnecessarily extracted from water sources. With today's focus on new water sources, including costly alternatives such as desalination, controlling leakage is the cheapest and most immediate water source.

Moreover, lost water implies lost energy. Water extraction, transmission, treatment, and distribution all carry significant energy cost, so a distribution network which is water-inefficient is also energy-inefficient.

Although a burst pipe is the most visible waste of resources, the wider view is that the more the water network is "out of control", the lower its efficiency, and conversely that a system under tight control is necessarily more efficient and more sustainable. Breached DMA or pressure zone boundaries – a common network anomaly detected by TaKaDu – can incur great costs in wasted energy due to inefficient or excessive pumping. Abnormally high or low pressures may lead to wasteful consumption. And, perhaps most importantly for the long run, asset longevity is severely affected by repeated leaks and repairs, pressure spikes or high-pressure periods, increased flow associated with constant water loss, and other network anomalies. Making the same pipes, valves, and other assets last longer has a significant positive impact both on utility finances and on long-term sustainable planning.

Early and accurate detection of these anomalies in the network allows them to be repaired or corrected earlier and while still small, significantly reducing the associated loss and inefficiency.

Water Infrastructure Monitoring and Smart Metering

Typically, Water Infrastructure Monitoring uses raw data from network sensors, meters and valves. However, additional data types can be used as well. Using data from Smart Meters at consumer premises can increase the benefits of water infrastructure monitoring, but smart metering is not at all a prerequisite for Water Infrastructure Monitoring. Water Infrastructure Monitoring uses the data that exists; it can work with non-real time data that is sparse and based on a relative few sensing/metering points within the core water distribution network.

The Future: Smart Water Networks

Just like the electric grid is evolving today into a smart electric grid, water distribution networks are set to evolve into smart water networks, or a smart water grid, breaking away from the ancient methods used to run water distribution networks.

While parts of this vision are still a few good years away, the data revolution in the water space has already begun. In fact, analyzing available flow and pressure data to determine anomalies in real-time or scheduling pumps and valves according to energy consumption peaks and lows is already part of the *Smart Water* definition today. There's no shortage of data in distribution networks, even if universal adoption of Automated Meter Reading and online transmitting meters has yet to occur.

Urban water distribution systems are not exactly 'grids'. A lot of energy (and money) is invested in water production, treatment, distribution and reuse, but current water systems don't comprehensively measure usage in real-time. Without measurement, there is no data to base grid management upon. The electric Smart Grid leverages the proliferation of measurement points collecting large amounts of data, but this is not the case in water networks.

Nevertheless, even sparse data can take a utility a long way, without consumer-side measurement. Analysis is the real enabler of the Smart Water Network, and if you are able to collect the data, clean it and then crunch it in a meaningful way, you can manage your network more effectively, the way it's done in IT or Telecom networks. The result may be higher efficiency in water use, optimized energy expenditure and obviously consumer-side savings.

In the future, defining the smart water grid will involve the delivery of water from suppliers to consumers using two-way digital technology to control consumption at consumers' homes to save water, reduce cost and increase reliability and transparency. It will overlay the water distribution system with information systems and net metering gear.

With the increased instrumentation and telemetry of water networks, especially of distribution systems, a new layer of smart data applications has become possible. Data technologies for water networks span from water sources and production, through transmission and distribution, to the consumers and their networks. Smart water networks are layered (as any data ecosystem) from sensors, remote control, and enterprise data sources, through data collection and management, and up to decision support, automation and analytic solutions. Smart Water Network solutions improve the efficiency, longevity, and reliability of the underlying physical water network by better measuring, collecting, analyzing, and acting upon a wide range of events.

Haggai Scolnicov, Chief Technology Officer
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LOCATING LEAKS IN UNDERGROUND LINES

At Schoonover (www.schoonoverinc.com), we specialize in technologies that are capable of locating very small leakage rates. These technologies have in the past involved helium leak detection as helium leak detectors were the most sensitive but also most complex and expensive. In the past few years, great strides have been made in new technologies that now can provide the water and pipeline industry new improved tools to eliminate leaky pipes and lines.

Traditional methods of locating leaks in underground lines has been mostly pressure decay, visual and ultrasonic leak detectors. These methods and equipment have been cost effective and can operate in less than pristine conditions. The drawbacks have been that locating the leak can be hit or miss and small leaks were difficult to find at all.

In development of new technologies for finding very small leaks, research has been focused on eliminating the need for a high vacuum environment inside the leak detector. This would enable the cost and complexity

to be reduced. At the same time, helium has been becoming scarce and more expensive. Development was directed at equipment using a different tracer gas that was :

1) Abundant

2) Enviromentally friendly as well as non-toxic

3) Minimal background in atmosphere

4) Low Cost

Hydrogen was a gas that met all criteria except that in concentrations over 5% was either combustible or flammable. Thus equipment using these as a tracer gas would have to be capable of finding leaks with 5% concentrations of hydrogen with the rest of the gas being nitrogen (5% hydrogen with air is still a combustible gas). The Sensistor Hydrogen Leak Detector was capable of meeting the criteria of great sensitivity in 5% hydrogen concentrations. But the high cost of the unit has kept it from being used in a lot of industries.

As far as using hydrogen as the tracer gas in underground line applications, hydrogen leak detectors were used extensively in the telecom boom of the late 1990's to locate leaks in underground applications. Hydrogen, being a high energy small molecule gas, is capable of exiting a leaky location 6 ft underground and coming in a straight up pattern until escaping the ground. Using a hydrogen detector, the leaking area can be isolated to a 3 foot circle from the highest leak rate point. The area can then be excavated and the leak repaired in a cost effective manner. This application was the real birth of the hydrogen leak detector. With the telecom industry in recession, the hydrogen leak detector moved to more high dollar applications replacing helium leak detector sniffing applications. The main drawback was price of the hydrogen leak detector that was in excess of $12,000USD.

In the past few years, the technology of the hydrogen leak detectors has improved and the pricing has come down to a level affordable by many technicians. The drive to acquire the best technology to find leaks quickly can mean that an early adopter gaining a technology advantage over competitiors in productivity gains and the ability to find harder to find leaks that are more lucrative in pay.

Our first experience was a customer purchasing a hydrogen unit to find leaks in swimming pools near Fort Lauderdale, Florida. The local Port Authority had a half mile fuel pipeline in which the leaking area could not be located with traditional methods. Making things more difficult was the fact that the area was asphalt paved, thus any digging to find the leak would have to be minimized. The customer called asking if the hydrogen leak detector was capable of finding this leak. Once that was affirmed, the company was able to bid as the only company capable.

Over the half mile mine, approximately 20 cylinders of 5% hydrogen/95% nitrogen tracer gas(green label non-combustible) was put into the line and allowed ot escape the leak overnight. The next day, using the leak detector, the leak was located and found within a few hours and repaired.

Today, a hydrogen leak detector can be purchased for under $1000 with sensitivity over 1000 times that of a ultrasonic leak detector. While this is a handheld unit, it can be coverted over very easily to a tool that a leak detection

technican could use. We recommend attaching it to a retractable pole or handle so that the operator can easily walk along the length of the pipeline. A collector, such as a common funnel can be placed on the tip to help collect the hydrogen escaping the ground. So what a few years ago was $12,000USD is now about $1000. This should allow for rapid deployment since finding leaks in water line and other pipelines is now not only a cost but environmental factor of our time.

To get more information on the Vulcan Lokring Hydrogen Leak Detector visit the Schoonover website at http://www.schoonoverinc.com/products/Leak%20Detection/Leak%20Detectors%20%20Hydrogen%20Leak%20Detectors%20-%20Sensistor%20Selection.htm

Product information and a manual are available on the website for download.Other Web Links that detail hydrogen leak detectors for underground applications:

Verizon In NYC locating leaks in manholes containing buried cables- http://www.airtalk.com/newsletter13.html

Journal AWWA Article – Very long but at the end confirms that tracer gas leak detectors are more effective than ultrasonic- http://www.nrccnrc.gc.ca/obj/irc/doc/pubs/nrcc42813.pdf

Underground Leak Detection Tech Note – Details using hydrogen and helium in finding underground pipe leaks http://www.lacotech.com/ProductFiles/SMT-04-1010%20revA1%20(App%2003-16%20Underground%20Leak%20Detection).pdf

Companies currently using Hydrogen Leak Detectors to detect leaks in underground lines:

Chiltern Mains- UK http://www.chilternmains.co.uk/water-leak-detection.html

RJM – Vancouver, Washington http://www.rjmcompany.com/Water-Leak-Helium-Gas-detector.htm

LDS-UK – http://www.leakdetectionspecialists.co.uk/leak-detecting-services.htm

Detect-A-Leak Austrialia http://detectaleak.com.au/underground_leaks.php

Smart Plumbing South Africa

http://www.smartplumbing.co.za/plumbing_tips.htm#tracing_leaks

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Do you want to promote your business, products, or to bring a contribution in the field of water losses?

We offer the opportunity to make known your business, products and innovations in the field of water losses. Send an article related to water losses.

People with experience in this field are invited to share their experience in some aspects like: monitoring, control, detection, tracking or any topic related to water losses.

The proposed article must be written in Word (Office) with a font size: 12 Times New Roman.

Articles can be submitted at: alin.anchidin@gmail.com