AquaMaster 3™

Remote water metering with Internet delivery of water leakage management

RAY KEECH, BRIAN HAYES, TERRY MIZZI – Much attention is given to the conservation of our precious natural resources. Clean water is, literally, the most vital of these. Whereas extending the supply of water is a key task, it is also of great importance to combat leaks in existing water infrastructure. Indeed, some tens of percent are lost in a typical water supply network, and this trend is increasing in many cases. The hidden and often remote nature of much of the water supply infrastructure makes leak detection particularly difficult. As a direct response to this challenge and to customers' requirements to conserve drinking water, ABB developed and commercialized an exciting new product for the water industry. The new enhanced flow meter, AquaMaster 3™, which delivers measurement data from remote locations directly to customers via the Internet, heralds a new era in water leakage management.

Water use has increased six-fold over the last century, more than twice the rate of population growth. In a growing number of cases, limited freshwater resources are a major constraint on sustainable development and, worldwide, the availability of drinking water per capita is inadequate and shrinking. All of this throws a harsh spotlight on the 10–20 percent leakage loss in many water networks.

The AquaMaster is a product that is on the cutting edge of technology with features and applications that are unique within the water conservation and distribution market and which goes a long way to help utilities address this water leakage loss.

ABB first introduced the AquaMaster flowmeter in 1999. It has come a long way from its basic idea of applying electromagnetic technology to a market dominated by mechanical flow meters. Before, water companies only used electromagnetic devices on large pipes such as district mains; applying them to revenue-collecting situations was then novel. It is telling that many tens of thousands of AquaMasters are now sold annually.

However, ABB's customers are now interested in more than the flowmeter itself – they want the flowrate data, delivered to them as part of their management information system. The third generation of this meter, the new AquaMaster 3, now raises the bar and delivers just this.

AquaMaster benefits

Water companies have been making do with an accuracy of ±2 percent. But now the ABB AquaMaster electromagnetic meter provides them with an accuracy of ±0.5 percent. For pipe sizes above DN100 (4 inch), the meter can pay for itself in under a month by simply measuring and charging the water more accurately. For example, exchanging a mechanical DN150 (6 inch) flow meter, accurate to within ±2 percent, to an AquaMaster would give the operator around US$ 4730 additional revenue. As a consequence many customers are switching to AquaMaster, even in sizes as small as DN40 (1.5 inch).

Further savings and increased revenue come from the maximum and minimum flow rates that can be measured by an electromagnetic meter: the AquaMaster enables previously unrecordable minimal night flow rates to be properly metered, which would double the estimated extra earnings potential to US$ 9,000 per year.

In addition to the headline improvement in accuracy, AquaMaster has many other benefits, inherent in electromagnetic measurement technologies:

- The meter uses the Faraday Principle, which allows it to be constructed with no moving parts thus eliminating the need for routine maintenance.
- Lower installation costs because the end user does not need valves to isolate the meter during maintenance and replacement. Also the possibility of being submerged in water or buried under a busy road without chambers further reduces whole life cost.
- The lack of moving parts also means that meter accuracy will not deteriorate through wear, unlike a mechanical meter.
- Today's AquaMaster meters boast an ISO-certified and Measuring Instruments Directive compliant turndown ratio of 1,000 :1, thus ensuring accurate readings at both high and low flows.
- A novel hydraulic contour of the meter also makes it far less sensitive to hydraulic disturbances up- or downstream, even if the meter is positioned, for instance, near a bend or a valve.

AquaMaster 3 – pressure and power options

This variant of the AquaMaster family offers a range of attractive options. For example, as flow measurement often also involves pressure sensing, then this is included as an integrated AquaMaster option. Power source flexibility is provided too: The AquaMaster 3 can optionally exploit several renewable energy sources, such as wind and solar. Traditional battery and mains power units are, of course, still available. On-board, 21-day backup is standard.

Data logging options

Data logging is another common requirement, so the AquaMaster family offers the option of logging the flow rate and pressure every 15 minutes. The digital connection between the flow measurement and the data logger allows high resolution data to be logged at a rate not possible with traditional solutions. This is very significant: traditional external data logger pulses are captured over the logging interval, but due to upper frequency limitations on the flow meter only a limited number of pulses can be counted in the log interval. So for a meter with a large turndown ratio, it is not uncommon to get measurement or "quantisation" errors of around ± 10 percent or more, the data being very stepped or "quantised" as a consequence. AquaMaster, with its

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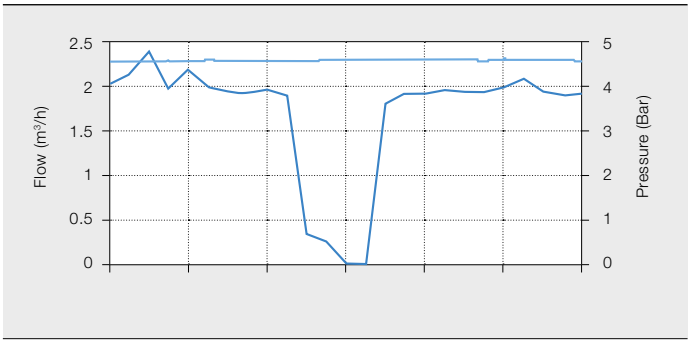
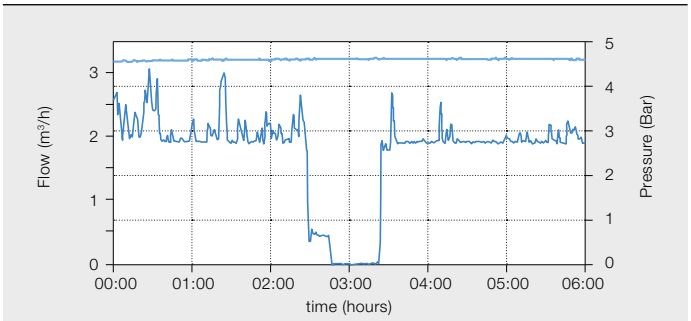
Title picture

Water: every drop lost through leakage is one too many. But how do you detect leakage in a water system that is, for the most part, buried or far away? ABB's new AquaMaster 3 helps solve the problem.

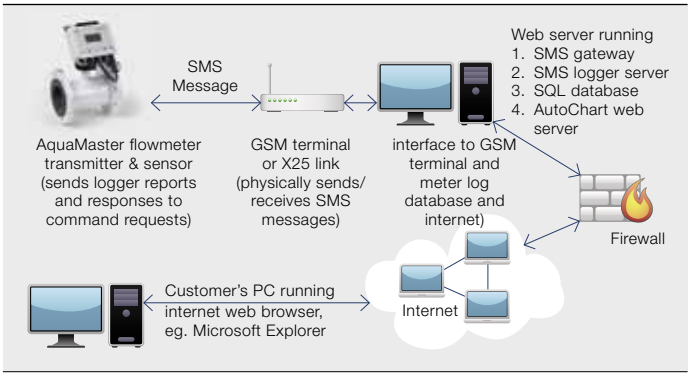
1 Leak Detection: Step testing using 15 min data logging



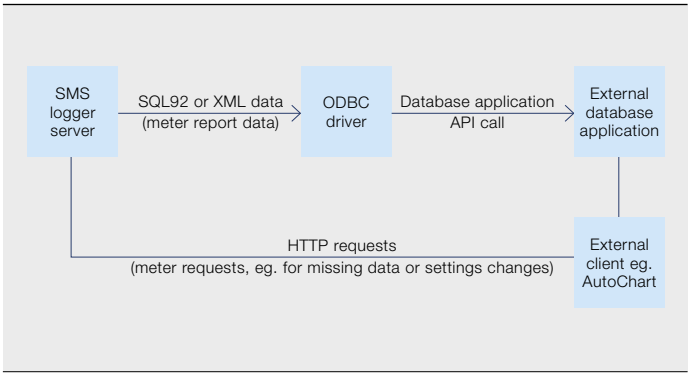
2 Leak Detection: Step testing using 1 min data logging



3 Block diagram: Internet based AquaMaster data



4 AquaMaster SMS data handling to any database or client



digital connection to the data logger, reduces quantisation-associated errors to negligible levels. In addition, AquaMaster offers very high speed, very high resolution logging up to an interval of 15 seconds on a second channel. This is invaluable for capturing transients during network step testing.

Data logging and leak location

Within water networks, step testing is a well-established technique for localising water loss in a zoned distribution system. It requires the establishment of zones where water can be supplied through a single meter after all boundaries and circulation valves have been closed. Closure of a valve isolates a specific section of the zone. A large drop in flow indicates a leak within that section.

The benefit of AquaMaster 3 in such step testing is best illustrated by comparison of → 1, on a traditional 15 min log interval with → 2, captured in great detail from the second channel one minute log.

In this step test, one zone valve was closed at 02:30, with a further zone valve closed at around 02:40. From the one minute log, the zone with a significant leak was clearly identifiable from the sudden drop in flow, with a second smaller leak within the second zone. The magnitude of the leak in the two zones is very significant, at around 2m³/hr.

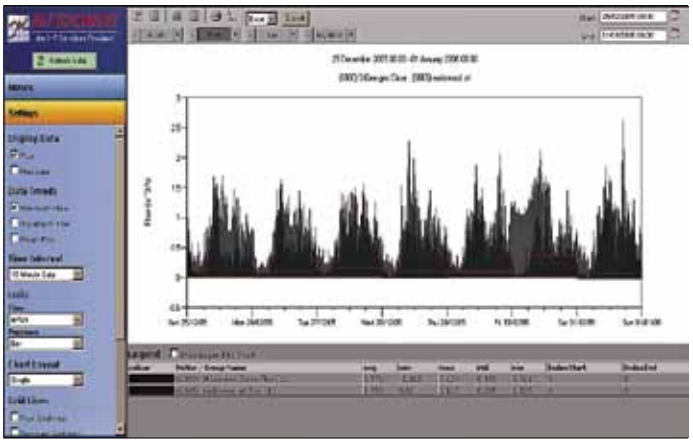
Step testing with AquaMaster 3 is far simpler, cheaper and faster than with established methods. It no longer requires a skilled technician or external step test data logger. It just takes a person to close a valve at specific pre-agreed times. Also, any disruption to water consumers is minimised by restricting the time a valve needs to be closed to only a few minutes. Later, the high resolution log data can be downloaded and analysed to identify the source of the water leak. This step testing process is significantly enhanced by the use of radio communication to obtain meter data, which leads us to ABB's latest AquaMaster 3 with SMS.

AquaMaster 3 with SMS

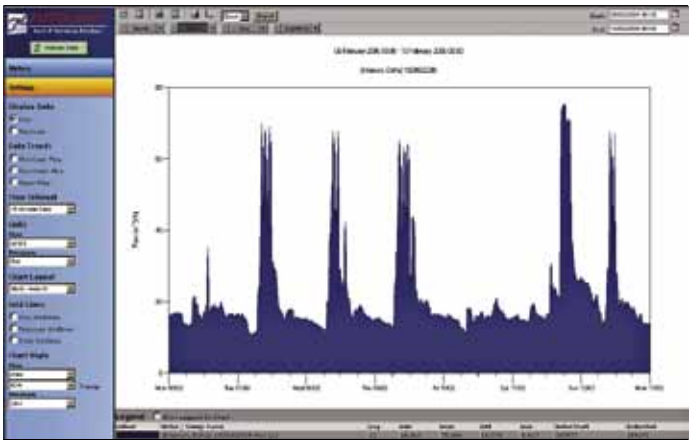
Traditionally, data is logged external to the flow measurement and recovered by someone travelling to site to download it, or, sometimes, to retrieve the entire logger. This procedure is being increasingly replaced by radio retrieval techniques and so the ABB AquaMaster 3 meters now have a GSM SMS radio option and exploit the SMS text messaging feature. Flow and pressure data infor-

Customers want flowrate data, delivered to them as part of their management information system.

5 Example profile from a pair of AquaMaster flow meters



6 Hotel water feed in Qatar, flow consumption profile



The meter pays for itself within less than a month simply by measuring and charging the water more accurately.

mation, as well as fault and tamper alarms, are sent automatically, typically once per day to conserve power in the case of battery/renewable powered AquaMaster units.

The AquaMaster 3 also responds to SMS text messages sent to it, such as configuration changes or requests for specific data. Internally, up to three months of data is stored.

Delivering measurement data to the customer

Measuring and logging flow and pressure are only part of the equation: getting the collected data onto the customer's computer, management information or leakage management system is the other part. Discussions with key global customers showed that they could be partitioned into two groups with different requirements:

– Customers with an existing infrastructure and established water management system.
– Greenfield customers who have measurement requirements but no back office system to handle the measured data.

To address both customers' needs, ABB devised a solution based on delivering remote meter data via SMS text messages to virtually any database, using industry standard programming mechanisms. ABB's SMS Logger Server software delivers the data seamlessly into databases such as Oracle, SQL Server, MS Access etc, solving the data delivery issue for group one. For the latter group there are a couple of options:

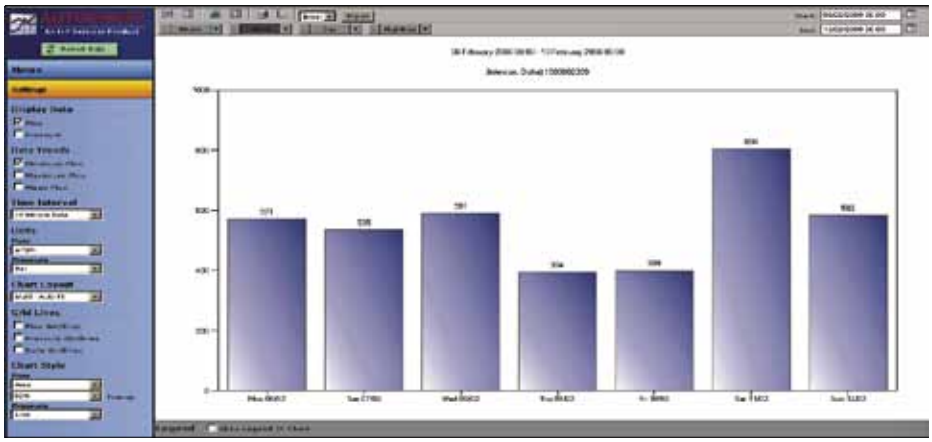
– The customer can easily install any supported database and use the SMS Logger Server software from ABB combined with third party software to manage and display the flow data.
– As above but use a web server to deliver the data via the Internet.

ABB ZeeChart is a web-based presentation system that enables data from equipment such as flow and pressure sensors to be viewed and analyzed quickly and easily. Use of the ABB ZeeChart software to process SMS data sent from an internet-enabled AquaMaster is best illustrated by reference to ➔ 3: SMS data is received, either on an SMS engine connected to a PC via an SMS Gateway provided by ABB, or, alternatively, for high numbers of meters, an X25 link direct from the SMS service provider.

Encryption

In some applications, security of information is critical. To protect the data from eavesdropping, AquaMaster SMS encodes the flow data with a dual-key encryption system. The encryption algorithm, based on a well-known public domain technique, is currently believed to be uncrackable. Every AquaMaster in the world has a unique, hash-encoded, service password which changes every time it is being used, thus protecting the first security key. Received SMS logger data messages are deciphered by a Windows DLL provided by ABB, with the second key for unscrambling the coded message provided by the secure ABB SMS Logger Server application. With this two-key encryption procedure the customers can have total confidence in the security of the data delivered by their AquaMaster SMS flow meters.

7 Hotel water feed, daily totals



Database population

Processing of the SMS data by the ABB server application is best illustrated by reference to ➔ 4. The application handles all incoming and outgoing AquaMaster SMS messages and delivers the data to a database. To make the system as universal as possible it uses Industry standard SQL 92 database queries; these are supported by virtually all existing databases. For newer, platform-independent databases, the ABB server supports an XML-based scheme. Connection to the database is via Industry standard Open Database Connectivity (ODBC). Queries from the customer client to the flow meters use HTTP requests. All this means it is very simple to deliver AquaMaster data to virtually any database.

Auto configuration

One of key design objectives was to make the system as easy as possible to configure and setup: the designers achieved a self-configuring implementation where any number of AquaMaster SMS flow meters can be connected with zero configuration of the ABB SMS Logger Server application. All a customer is required to do is to enter the phone number of the server into the field-located AquaMaster SMS flow meter. Its daily data set will then automatically be delivered. On larger scale systems with thousands of AquaMasters this has immediate time and cost saving benefits.

Measurement data via Internet

This section describes a case study where real data was delivered via Internet to a customer.

A Web server implementation on ABB ZeeChart was used in this case. This utilizes an SQL Server database combined with the ABB SMS Logger Server Application. Being Internet-based, the information is made available worldwide to any registered user. No special software is required on the customer's PC, just a web browser and an Internet connection. ABB ZeeChart delivers information from the customer's AquaMaster flow meters, either singly or as a group, with data available in an easy-to-use graphical or tabular presentation format. An example of a typical diurnal pattern for two meters is shown in ➔ 5. The customer is interested in the unusual daily consumption on Friday 30th December.

With Internet access it is possible not only for the water utility to see the consumption profiles and revenue information but, if so enabled, the same data may be accessed by the consumer. Such a strategy opens up major possibilities for management of water usage and detection of leaks. For instance, one user recently identified an abnormal usage of water that was caused by continuous automatic urinal flushing. A consumption reduction of over 30 percent was achieved by fitting simple motion detectors for controlled flushing. A similar example metering a hotel water feed is shown in ➔ 6.

> Getting the collected data onto the customer's leakage management system is the other half of the equation.

AquaMaster 3 with SMS is also unique in that the volume totals from the instrument index register are also sent by SMS text message. In ZeeChart these are displayed with the profile information and can also be displayed as daily consumption as in ➔ 7. In effect, by combining AquaMaster 3 SMS™ with ZeeChart ABB is now able to offer customers the equivalent of a human meter reader visiting the flowmeter every day to note the totaliser reading on the display – but done automatically and over the internet.

The challenge

When the first AquaMaster meters hit the market in 2001, they were totally unique. Now, a decade later, ABB has raised the bar in providing a total measurement data delivery solution for remote metering for both existing customer information systems and for greenfield installations.

But staying ahead of the competition for the next few years will mean listening to what customers want and continuing the vigorous process of innovation that has already brought the AquaMaster this far.

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