Operating Benefits Achieved with SCADA for Water Distribution

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Abstract

Efficient monitoring of water distribution networks have long been a challenge for management, even in countries with a well-developed infrastructure and good operating practices. Improperly managed water networks might result in increased cost of supply, insufficient supply of potable water, inconvenience, not satisfied customers and more. Such problems might not only be caused by operating a poorly maintained infrastructure but also by excessive use or misuse of water due policy of some governments to provide low tariffs for water usage. Aimed to minimize these problems water utilities are required to introduce improvements by operating their system based on real time data communicated from remote sites to the control center.

Supervisory Control and Data Acquisition (SCADA) solutions for water systems combined with, leak detection and use of Pressure Regulating Valve (PRV) stations may significantly improve the situation. These measures have to be complemented with adapted water conservation programs aimed at minimizing excessive water usage. These initiatives shall combine to form a "water strategy" for conserving this valuable resource and making it available at an affordable price.

Implementing Water Management Strategy

Water companies are able to provide estimates of their production, imports, exports and consumption, but are less able to point on reasons for unaccounted-for water. Water losses can be determined by conducting periodic water balance in defined sections of a water network. This calculation is based on the measurement of water flow, produced and imported quantities compared to exported and consumed quantities. This can be done automatically by the SCADA system and with RTUs, and the outcome provides a guide to how much water is lost as a result of leakage from the network and how much of the water loss can be attributed to other undetectable reasons.

It is important to differentiate between water losses caused by non-significant but continuous leakages and other factors. A tiny burst in a distribution pipe could go undetected for months and consequently such low-rate leakages are usually the most significant component of water losses even in well-maintained systems. In some regions accumulated meter errors, data collection mistakes or accounting errors might become significant contributors to unaccounted-for water.

The key to implementing a water loss reduction strategy must start with thorough understanding of each of the contributing components and ensure that the related parameters pointing on specific type of loss is measured as accurately as possible. This way, priorities aimed towards reduction of unaccounted for water can be set via a series of action plans. Some typical measures are:

- Measure, calculate and record the supply balance and determine the unaccounted-for water.

- Conduct a network audit and determine as accurately as possible where losses might occur.

- Analyze the network operation and figure out why those losses occur in each segment.

- Develop constantly running leakage detection practices and appropriate response actions with the aim of reducing water losses and improving overall supply reliability.

Minimizing Water Losses

Figure 1 bellow illustrates example for a SCADA control center screen showing measured and calculated parameters for a wide area water distribution network, with multiple reservoirs and pumping stations. The shown details refer to water level in reservoirs, indication on operation of specific pumps, etc.
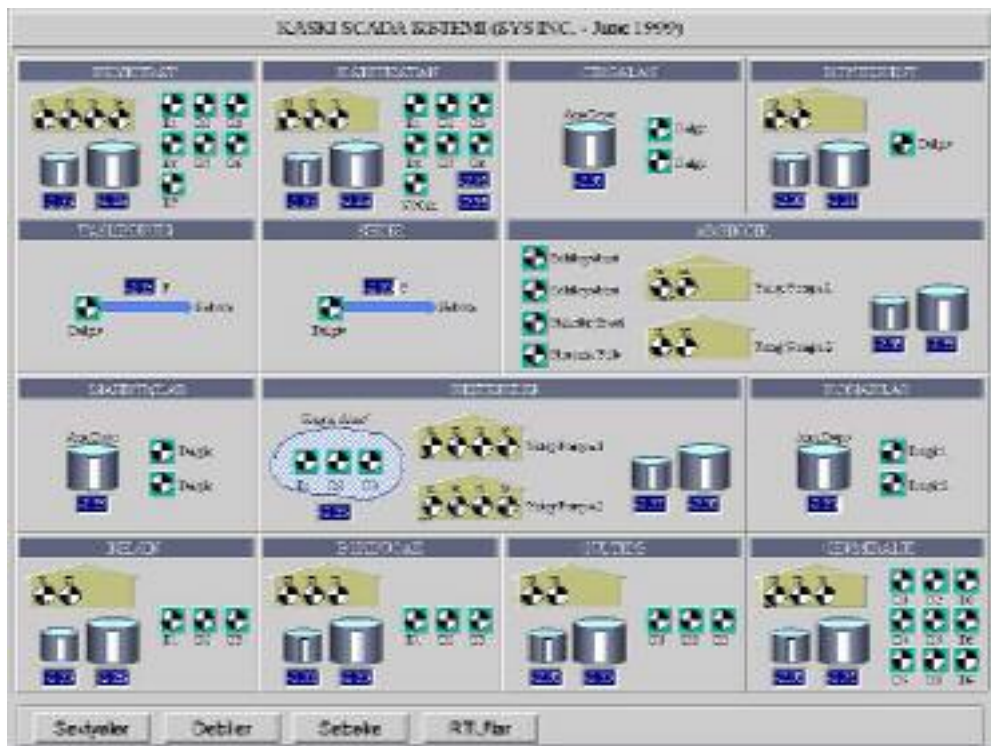

Figure 1. Region-wide Water Supply Monitoring

SCADA solutions may contribute a great deal towards integration of leak detection means and practices as well as implementing periodically planned repair programs. The following relevant measures and practices can be implemented with use of a SCADA system:

- Estimating the level of water losses via undetectable small leaks (in unknown locations)
- Constant monitoring and regulating of the pressure in the network at critical locations
- Recording an analyzing sudden changes in flow rates for detecting new leaks and bursts
- Reducing the actual response time to isolate the troubled section (if possible at all)

Pump Station Efficiency and Health Monitoring

Water utilities are now seeking new ways to introduce improvements in their maintenance processes, which may also reduce operating and maintenance costs. Introduction of electronic microprocessor based pump efficiency monitoring, combined with water SCADA systems will result in faster return on the investment in a SCADA system.

Implementation of this process involves:

a) Calculating the volume of pumped water as measured and logged by the RTU

b) Monitoring of the "peak power" drawn by the pump during its activation.

c) Monitoring the average energy supplied to that pump during the same period

While a selected water pump is confirmed to be in good condition, the system shall keep the calculated values as a reference for future benchmarking. In case the calculated ratio for a designated pump is out of the expected range, the RTU shall send an alarm to the control center.

Figure 2 bellow shows details of a SCADA system screen showing the key electric parameters and accumulated flow associated with monitored pumps as well as the changing levels in the reservoirs.
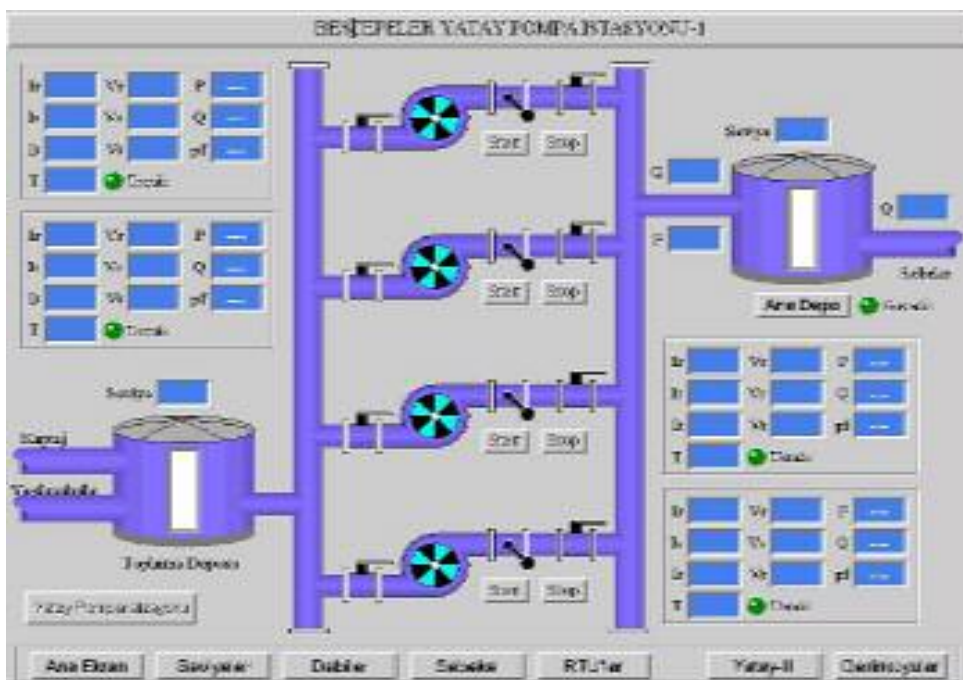

Figure 2. Water pump Efficiency Monitoring

Pressure Reduction Station

Implementing flow monitoring and water pressure control using PRV stations may directly reduce real losses resulting from difficult to locate bursts leakages. It requires installation of flow meters combined with RTUs and communication at strategic points throughout the network, while each meter is recording the flow into a "metered area" with a defined and permanent boundary.

This can be done with a SCADA system by relatively low investments and fairly quickly by introducing zonal monitoring and district metering of water flows.

Use of PRV stations combined with RTUs and data communication provide means for adapting and optimizing the water pressure along the pipeline and prevent further losses through leaky joints and damages during off-peak periods such as nights, weekends (in some districts). These stations require use of hydraulic regulative valves. Solar panels can also be installed in remote sites along the water pipeline, where electric power is not available.

Usually, water system planning by utilities is based on the assumption of growth in both population and demand. The objective is that the system's ability has to cope with peak demand days and hours, for the duration of the system's expected life span. In many instances, the water supply system is adjusted to the daily peak demand hours. Pressure reducers, for example, are calibrated to maintain a consistent pressure at the pressure reduction point, such that it will be sufficient to cope with demand during peak hours. In these cases, there are many periods of operation during which the system is working in a state of over-production, with excess pressure in the system.

Dynamic pressure control that adjusts to changing conditions throughout the day and from season to season, is an efficient tool that contributes greatly to several aspects of the system's operation:

- Reduction of water leakage, resulting in:
  - Efficient use of existing water resources
  - Delaying the need to invest in development of new water sources
- Reduction in number of pipe bursts (up to 50%), resulting in:
  - Reduced water system maintenance costs
  - Extended life span of system pipes and accessories
  - Delaying the need to invest in system renovations
- Increased reliability of water supply, together with higher customer satisfaction
- Optimal match between infrastructure size and water supply demand, with reduced investment in infrastructure
- Reduction in energy consumption for operation of water supply installations

The primary role of PRV stations as shown in Figure 3 bellow is performing dynamic pressure control and it is installed at critical points at the entrance to supply zones. The aim of water pressure control is to achieve uninterrupted pressure regulation such that excess pressure will not be created at critical junction in the system, while minimum pressure is maintained constant.
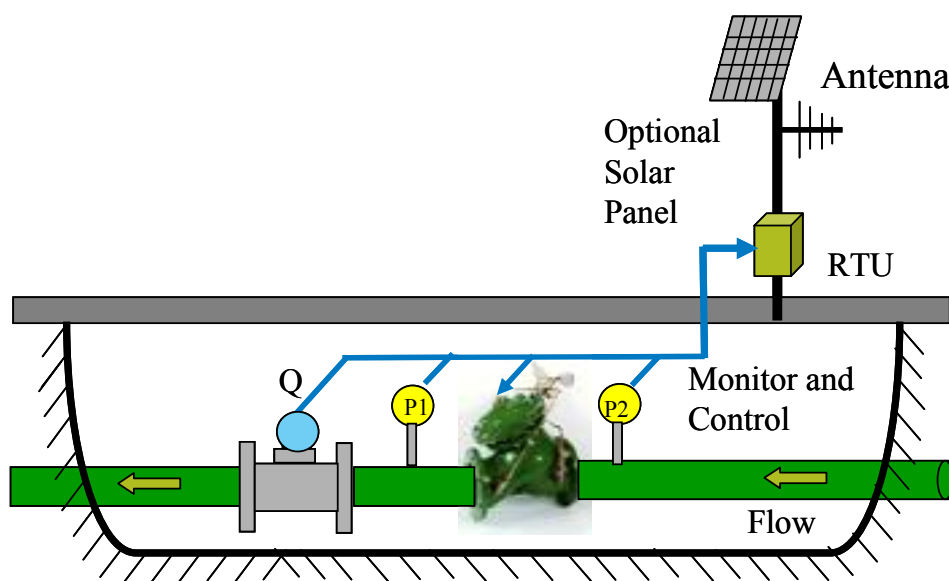

Figure 3. Pressure Reduction Valve Station

Investment Considerations and Calculations

While considering investment, the first step towards determining the cost / benefit ratio and the Return on Investment (ROI) figures is to analyze the real cost components resulted from owning and operating a SCADA system. The annual cost is typically composed of three main components:

- *Capital cost.* This calculation is based on the interest rate of the capital, initially invested in the system, and also includes future investments in improvements and upgrades.

- *Annual depreciation.* This cost is related to the equipment, which was purchased to run the system, and the calculation is based on the expected lifetime of such equipment (e.g. 15 years).

- *Operating costs.* This figure includes all the ongoing expenses for salaries allocated for the dedicated manpower, training of operators, field transportation, maintenance costs, etc., which can be attributed to the SCADA system operation.

- *Supply Reliability.* This factor combines both financial and operating benefits and is as important as the purely financial factors. It leads to saving of water and boosting customer satisfaction.

Today utilities want to enhance the level of service and operate their water network in more efficient, convenient, advanced and modern way. A request to improve grade of service may for example be dictated by local country legislation, which is directed towards the "utility watchdogs" and/or the city mayor. They may be interested in boosting the public confidence and customer satisfaction, and demonstrating to the public that actual savings are being pursued.

Utilities often make decisions to purchase their system in a step-by-step fashion. This approach makes sense, since modular SCADA systems can be built with a lower initial budget and allows better definitions of the current and future needs prior to starting a significant expansion program.

SCADA Cost Contributors

Integrating and operating a SCADA system involve the use of computer hardware, instrumentation and sensors, electrical control panels, software programming, data communication, equipment and infrastructure, consulting fees, and system installation and commissioning. Careful selection of these components may help making the system expandable, upgradeable and also affordable.

- *Hardware Instrumentation.* Although investment in computer hardware is not the most critical neither the expensive part, it is considered the "heart & soul" of the system. The reason is that people consider the computer hardware as the "main thing" that makes the system working.

- *Computer Operating System and Application Program.* Master Control Center (MCC) software maintenance program is required, since their vendors from time to time tend to release enhanced versions, which are incompatible with other programs that must be integrated to the system.

- *Communication Infrastructure.* The data communication data network used for the SCADA can be viewed as the "nerves" of the system, conveying information to the "brain". Therefore, selecting a suitable and reliable type of communication medium and data protocol are mandatory.

- *Field Instrumentation.* These devices are often provided "built-in" with the equipment to be monitored or controlled. Sensors and controls linked to RTUs must be reliable and accordingly accurate in order to make the SCADA system functioning properly.

- *System Installation and Commissioning.* Professional installation of SCADA system components with "easy maintenance" in mind is as important as any other step when integrating the system. This work can be performed by the utility or by an outside system integration firm.

- *System Maintenance Costs*. These include the costs of all repairs and preventive maintenance. The overall figure can be broken down into several segments of the installed system. Maintenance of the communication equipment shall be considered as well.

- *Operators and Technicians***:** In order to operate these systems, utilities must employ well trained operators who work probably in 3 shifts. This cost is of course associated with periodic travel to remote sites for reviewing the condition of remote sites.

- *Other Cost Factors:* Field installations as well and sensors must be tested and calibrated periodically. One major advantage of smart RTUs is that they that allow you to perform these functions remotely using software managed calibration methods.

Summary and Conclusions

Use of SCADA for management of water networks results in many intangible benefits, which are as important as the financial improvements. If only the quantifiable benefits are taken into consideration, investment is such system might not in all cases justify the expenditure. However, if also non-quantifiable benefits are included, SCADA systems more than justify the investment. Examples of such non-quantifiable benefits are: fewer interruptions of supplies simplified handling of the water infrastructure, more satisfied operators, improved level of service and enhanced customer satisfaction.

Reliable supply of high quality water to urban, rural and agricultural customers can only be assured with the use of a SCADA system combined with remote monitoring and automated control.

Thanks to integration of these solutions, experienced SCADA operator can reduce the time from the event occurrence to the start of implementing corrective actions, and allow further improve operating reliability, help reduce operating costs while modernizing the water distribution network.

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