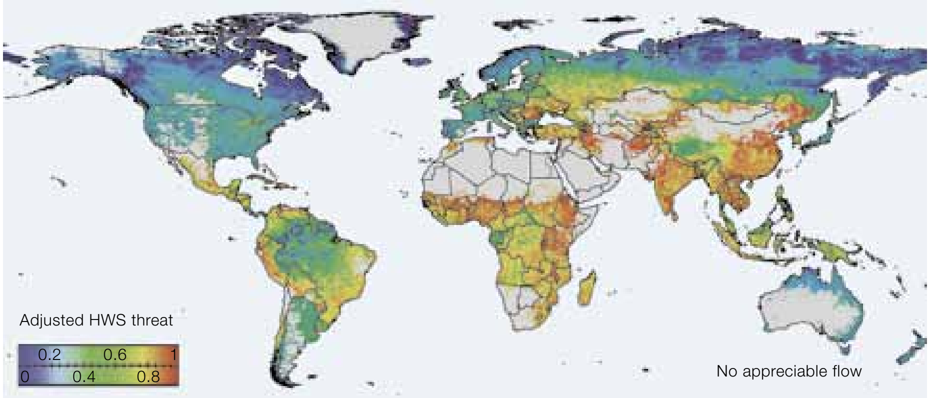
Managing water use responsibly

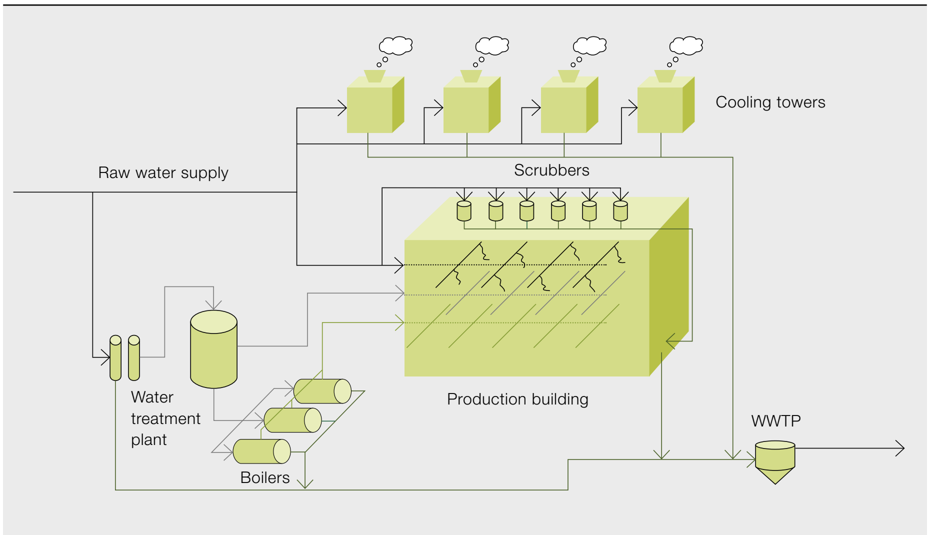
ABB technology helps the process industries achieve sustainable water use

NUNZIO BONAVITA, ROB TERRELL – Tantalizingly, 97.5 percent of the world's vast surface water volume is salt water and, of the remaining 2.5 percent present as fresh water, only 0.6 percent is available for ecosystems and human use [1]. Whereas some areas have an abundance of this most essential of resources, most do not. Further, the UN reports that, over the last century, water use has been growing at more than twice the rate of population increase [2]. This makes it all the more important to exploit this natural resource prudently and to be conscientious in reducing use. Industry, globally, accounts for 20–25 percent of water use, but this rises to some 60 percent in developed countries. It is in industry, therefore, that we should look to improve water management. With its wide range of innovative water management products and approaches, ABB can do much to help – leading the drive towards sustainability and accruing real economic benefits for the water user at the same time.

1 Global water distribution



2 A typical water scheme in an industrial plant



Unfortunately, rain seldom falls in the right place in the right quantities ➔ 1 and transporting water is expensive; it is estimated that California uses seven percent of its electricity just moving water around. Sometimes it is cheaper to look for alternative sources nearby or to purify water locally, but this is no panacea either: the World Business Council for Sustainable Development has estimated, for example, that it costs the same to desalinate 1 m^3 of sea water as it does to pump it over 350 km (horizontally) [3].

Water use and sustainability

According to the World Bank, agriculture accounts for over 70 percent of worldwide water use, with industrial use at 22 percent and domestic at 8 percent. And this consumption is increasing.

Of these users, industry offers the most promising short-term reduction opportunity:

- It is focused in specific locations and supported by measurement and control systems.
- It is contaminant-tolerant, with the possible exception of the food and drink sector.
- It is inherently receptive to high-technology solutions.

The major industrial use of water is for energy transfer, eg heating, cooling or as steam to drive turbines. But it is also used as a reaction medium, as a carrier, for product formulation, for cleaning and so on ➔ 2.

Unfortunately, in most cases these processes are designed and operated in the certain knowledge that water is cheap and plentiful. This practice has developed for a number of reasons: the low cost of water compared to its value and its ready availability; the perceived high cost and complexity of treating water; and the often mistaken belief that water reuse would have a detrimental impact on production.

If the efficient use of water in industry is to be voluntarily adopted, rather than driven by legislation, taxation, pricing policy or supply rationing, water reuse / recycle practices and technologies must be able to address these concerns. The practices must be easy to manage, the technologies used must be non-intrusive and the net present value (NPV) must be positive to compete with other demands for investment.

> Water use has been growing at more than twice the rate of population increase in the last century.

Title picture
Water. With demand rising faster than supply, what can ABB do to help industry manage this most essential of resources?

Water reuse/recycle principles

The ideal factory would reuse all water. This closed-cycle situation, however, can usually only be achieved by using excessive energy to evaporate off excess water, thus generating solids which have to be disposed of.

It is better to view water use reduction as a journey to be taken in steps which are both environmentally and economically sustainable. Water reuse/recycle should be pre-eminent in plant design; retrofitting infrastructure later is usually troublesome and expensive.

Wastewater could, of course, simply be fed back to the start of the process, displacing the fresh water supply. Inevitably though, the water quality would be inadequate without expensive treatment – and such treatment might produce water "too good" for some lower-grade tasks. A more acceptable solution is a distributed water reuse/recycle system where any available "waste" water can be recovered and reused (without treatment) or recycled (reused after essential treatment), thus ensuring that critical duties, ie those requiring specific water qualities, can be protected. This principle is known as Distributed Effluent Treatment (or DET). This results in a number of "water recovery units" being installed at key locations around the plant to improve overall water efficiency without putting the process at risk ➔ 3.

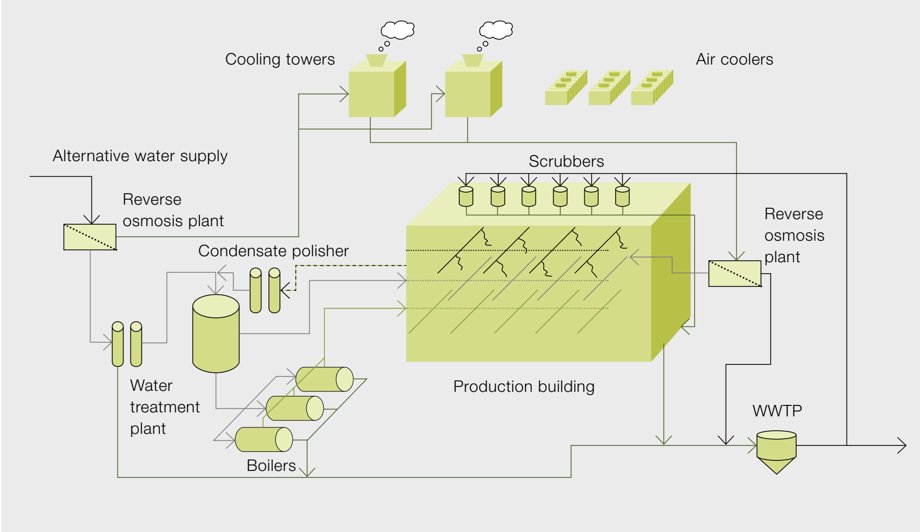
But what is the best way to do this to satisfy the competing demands of cost, water demand, plant operability and environmental compliance?

Suitable treatment technologies

First of all, where possible, the water will be reused for lower grade duties without any treatment. Otherwise, a minimum treatment is performed to make the water suitable for its new duty and, if feasible, to recover raw material for reuse in the process. Examples of suitable technologies include:

- Media filtration units or hydrocyclones to remove suspended solids
- Activated carbon to remove organic contaminants and oxidants such as chlorine
- High efficiency flotation devices to remove free oil
- Membrane filtration including microfiltration and nanofiltration for the removal of fine particles, colloidal material and microbiological organisms
- Membrane processes including nanofiltration and reverse osmosis to remove dissolved salts

3 A typical water scheme in an industrial plant



The critical role of measurement and monitoring

As better water management practices are introduced, contaminants will no longer be lost to drain but will be transferred into a "receiving process" and may create scaling or corrosion problems there. Proper specification and close monitoring of the scheme is therefore essential. This will require the installation of flowmeters and on-line instruments to measure critical contaminants, with the data being collected centrally and processed to allow real time control. Typical measurements required will include pH, conductivity and temperature, but there will also be a need for specific instruments for parameters such as total organic carbon, redox potential and adenosine triphosphate (for the measurement of microbiological activity).

Establishing a reuse/recycle methodology

Before any equipment can be specified, it is critical to understand the total water flow and composition, and the quality required by the receiving duty. Also, as reuse/recycle is introduced it will inevitably influence these. It is therefore essential that any scheme is implemented in a logical, progressive manner, starting at the "clean water" end and progressing through to the "dirty water" end. This

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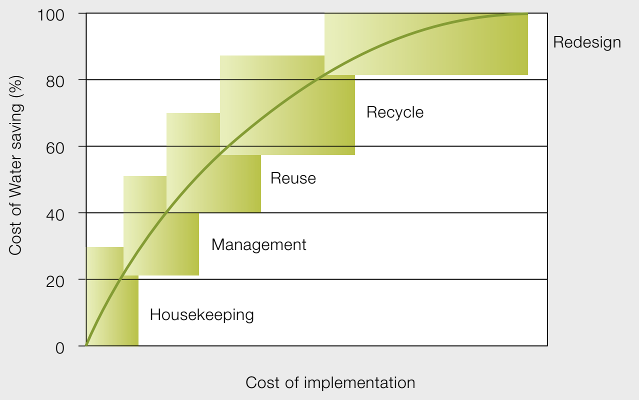
4 Any water reuse/recycle scheme should be developed via a logical hierarchy of activities



Activity	Potential Savings
1. Establish a verifiable water balance	–
2. Housekeeping / waste minimization through a program of tackling leaks and unmanaged water losses	20 to 30 %
3. Improved management of existing water systems, including process water usage and utilities	20 to 30 %
4. Reuse of water into tolerant "lower grade" duties	10 to 20 %
5. Recycle of water after treatment into tolerant "higher grade" duties	10 to 20 %
6. Redesign the system to eliminate the use of water where possible. (Generally only applicable to new systems).	10 to 20 %

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leads to a logical hierarchy of activities from which typical savings can be deduced → 4, although these will depend on the starting point.

The best implementation of a water recycling/conservation policy will be a combination of good management of the existing water systems, direct reuse of water for lower grade duties, where possible, and the introduction of appropriate recycle technologies.

This process needs to be underpinned by a sound and consistent methodology which can predict the impact of changes on the water quality at any point in the network. This is essential to have confidence that the reduction in water consumption will not adversely affect the process or utility operations through corrosion, scale formation, microbiological growth or the build-up of trace contaminants, result in breaches in compliance for discharges from the plant or entail excessive costs.

Will it be economically viable?

Factors other than mere water cost usually decide reuse/recycle projects' viability:
- Increased availability of water for future plant expansion
- Reduced wastewater disposal costs and opportunity for product and raw material recovery
- Meeting discharge consents reliably
- Simpler technology for wastewater treatment
- Greater wastewater treatment plant capacity giving longer residence times and greater operating stability
- Reduced capital for wastewater treatment plant expansion due to lower flow
- Improved company image
- Continued license to operate, etc

Real life examples can bring the real benefits of water reuse/recycle to life.

Real life examples

There is a growing list of reported examples of improved water consumption, including:
- Power utilities using only tertiary treated sewage as make-up
- Large chemical plants and industrial complexes being supplied only with tertiary treated sewage for all their duties
- The pulp and paper industry reducing water consumption by a factor of more than 20 over the last 30 years
- Individual fine chemicals plants reducing their net water consumption by over 60 percent
- The brewing industry as a whole driving its specific water consumption down by over 30 percent through efficiency measures

Drivers for these improvements were, typically, threat of local water shortage, industry peer pressure to be seen to be responsible and environmentally-aware and, and perhaps more significant, simple economic benefit.

How can ABB help? Case studies

ABB has a wide offering of products, solutions and services to help its customers improve their water management practices. The products include top-

5 The El Merk oil and gas fields

quality instrumentation and analyzers able to improve the clarification of raw water or to properly manage a water network safely, as well as state-of-the-art integrated control and electrical systems. Water-specific solutions extend from specialized turn-key ultrafiltration units for pulp and paper plants to EPC contracts for large oil and gas installations. The range may best be illustrated by some examples.

A consultancy case study in steel

A steel plant planned a significant production increase over a period of five years. Although the plant was already an efficient water user compared to its peers, preliminary calculations indicated that there was insufficient water supply available to support this increase. The constraints included future abstraction permits, physical limitations in abstraction, and uncontrolled water usage. A study was carried out by ABB to address three major questions:

– How much extra water was required to achieve a production rate
– What would be the best way to achieve an increase, taking into account cost, timing, reliability and likelihood of success?
– How much production would these measures support and what would need to be done to achieve even higher production rates?

The current water supply, distribution, demand, recycle and discharge on the site were reviewed and the limited information available used to develop a "predicted usage" model to estimate the water demand for different production rates, based on current operating practices. Each aspect of the water system was considered in turn to identify ways in which this water demand could be met or, alternatively, ways in which the demand could be reduced.

The study identified several relatively cheap and simple ways of achieving the first production target through the implementation of a number of minor projects to improve control and remove bottlenecks in the supply and distribution systems.

The study showed that to achieve sustained production rate increases in excess of 30 percent would require major investment to either

– develop the existing river water pumping station, including the distribution system to the site, which would require the renegotiation of the abstraction permit, or
– develop a new major supply to the site

The use of piecemeal improvements, while still required to sustain the increased production rates, would be insufficient to meet the higher water demands reliably. The study further concluded that even the present production rate was not sustainable due to weaknesses in the present pumping and distribution arrangements and seasonal variations in water availability and quality. The impact of seasonal variations would be even greater at higher production rates.

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Oily water case study

New oil wells typically produce three barrels of water per barrel of oil, this rising to as many as 12 barrels as fields become marginal. This problematic and often highly saline water has to be treated appropriately before it can be re-injected, discharged or used for agricultural purposes. The disposal of produced water, as it is called, in the oil and gas sector is a growing challenge. [4]

Between 2000 and 2006 ABB built water de-oiling plants in three different locations in North Africa for a leading oil and gas company before being selected in 2007 to perform both operation and "full service" activities for four water de-oiling plants for a period of five years.

ABB has developed an innovative approach to treat high-salinity, oily water which is recognized in two different patents and which presents some appealing features, including:

– Can be adapted to treat oily water with high salinity
– Is not dependent on the temperature or pH of the wastewater
– Has full flexibility of flow (0 to 100 percent of max inlet water flow)
– Improves energy efficiency by minimizing the number of pumps through the use of gravity flow

Additionally, it has a small footprint (35 by 80 meters), it can be easily managed by local operators and it utilizes chemicals which can be produced on site from easily available, cheap, base ingredients, a feature which is highly advantageous in desert areas. It can be built on skids and transported to site for final installation and commissioning [5].

Compared with existing technologies for treating produced water, the ABB solution has proved more effective, not only in terms of process results but in critical areas like cost, energy efficiency, footprint, speed of installation and ease of operation. The process has exceeded the customer's specifications for hydrocarbon content and suspended solid concentration in the outlet water by 7 and 55 times respectively. This is a huge improvement over current alternative methods, and this treatment method is believed to be the only one that meets the rigorous requirements of proposed European legislation on produced water.

EPC case study

The sheer scale of ABB's involvement in water treatment can gauged from the El Merk oil and gas development in Algeria. Here, the ABB-led consortium comprising Sarpi of Algeria and Petrojet of Egypt is responsible for the off-site facilities. The contract awarded in 2009 has an overall value of 650 MUSD and is one of the largest EPC contracts in ABB's history [6]. ABB is responsible for the design, procurement, transportation, construction, commissioning and start-up of:

- Ten field gathering stations
- Six gas distribution manifolds
- The complete material supply for 120 wells and the hooking up of the first 80 for production in 2012
- The 719 km of pipelines and process piping across all the production fields.

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ABB's scope of supply includes critical water systems for injection into the wells, the flowlines for production, gas lift, dilution water and water supply, the trunk lines for oil and gas condensate, gas injection and water injection, and the process piping. Other equipment supplied by ABB related to water systems includes 20-odd water pumps and filters and 210 km of water pipelines [1].

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Construction, involving up to 6,000 local and foreign personnel is currently underway and first oil should flow in March 2012.

Summary

Most current examples of industrial water management are largely driven by water shortage, but some industry sectors have already demonstrated that such management also has net positive economic benefits. Progress is not technology-limited but is often hindered by water's relative cheapness, a mistaken perception of water's abundance and by lack of understanding of the opportunities.

But a progressive methodology coupled with economic acuity can lead to significant water consumption savings and a positive payback, leaving the enterprise better placed to withstand future pressures and demonstrating a responsible approach to this valuable, limited resource.

ABB already plays a significant role in this market and is well placed to lead the drive towards more sustainable and more responsible industrial water use.

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Footnote

1 For further information on the El Merk project, please see "In the depths of the desert" on pages 20–24 of *ABB Review* 2/2011.

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