Conservation: the chief aim of water management in the 21st century

With its growing population and expanding cities, our world faces pressure on water resources as never before. "Sustainability" is a buzzword, but in water management its meaning is clear: learning to do more with less water and less of the energy required to manage and transport it. Water systems throughout the world are plagued with excessive leakage and inadequate treatment facilities. Many industries need to be reconfigured to make less use of water or eliminate its use altogether. This article surveys some of the applications and industries where water management is required and examines new developments in valves for water service. (Desalination will be discussed in a forthcoming article.)

By James Chater

Sulzer water transport pumps in Burgos, Spain.

Wrong and right

As I write, the ravages of climate destabilization (presumably caused by El Niño, global warming or a combination of both) are reaping their deadly toll: flash floods in the south of France, a typhoon in South China, and forest fires in California due to the long drought.

As if this weren't enough, politics and war have combined to make a bad situation worse. The refugee crisis is causing a water shortage in Jordan, while ISIS is building dams that deprive areas of Iraq and Syria of water. Meanwhile these two countries are at odds with Turkey, who they say is damming too much water. Water shortages threaten to intensify the chaos in the Middle East.

Apart from these disasters, the underlying gravity of the situation is clear from any number of worrying statistics (see box). And it is not only surface water that is in short supply. Now that the water near the surface is running dry, populations are tapping into the world's final reserves. A NASA report claims that one-third of all underground aquifers are being depleted, and that no one knows how long the remaining water will last (1).

All these disasters and emergencies have one element in common: the wrong water (too much, too little or too polluted) in the wrong place at the wrong time. The most urgent task of water management consists in redressing this imbalance as far as humanly possible: the right water in the right place at the right time.

Did you know?

World water demand will quintuple by 2050.

Every year, dirty water claims about 2.2 million lives.

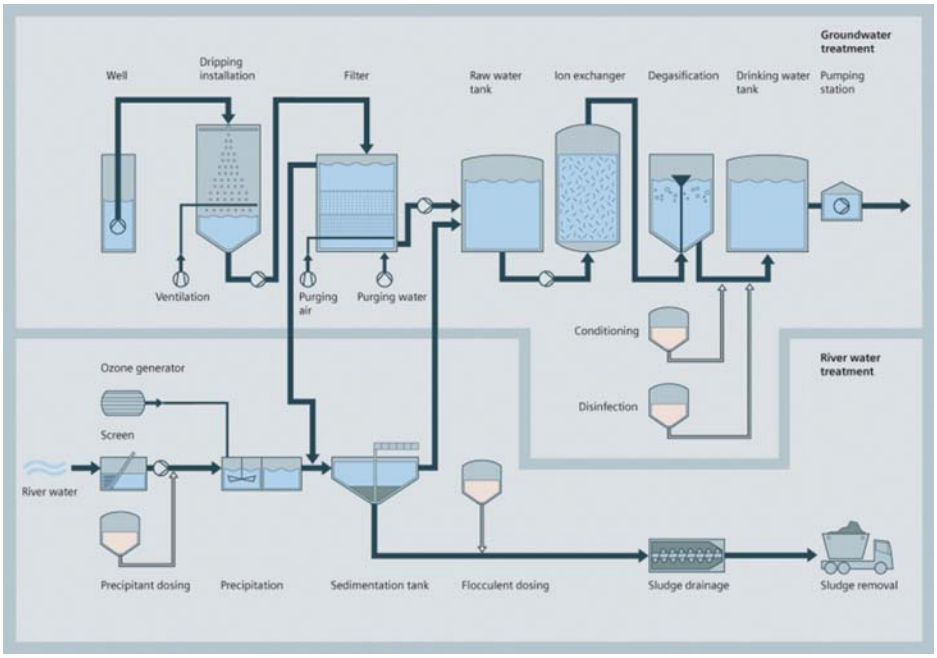
China has about the same amount of water as Canada, but has 40 times more people.

In the United States, water used in shale oil and gas fracking makes up less than 1% of total industrial water use.

According to Sydney Water, switching from a single-flush toilet to a dual-flush can save about 25,000 litres of water a year.

London's water pipes leak 680 million litres a day, or 40% of their supply.

The US loses 26 billion litres a day



Flow chart for drinking water preparation system. Image: Siemens.

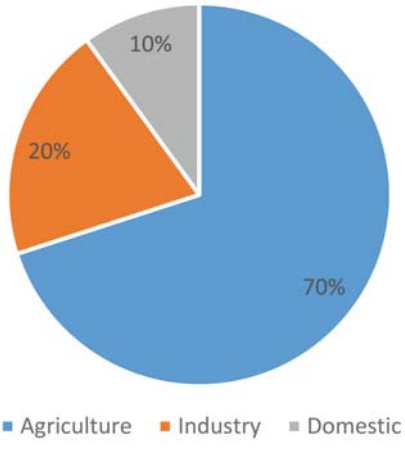
Water management round the world

Among the world's most drought-afflicted countries are the two largest economies, China and the United States. China's huge population and intensive industrialization have together caused a high level of pollution in air, soil and water. In April this year the government published its "Action Plan for Water Pollution Prevention", detailing a number of measures to be taken by 2020 and 2030: rivers, coastal water and groundwater to be cleaned up, water sources to be protected, the quality of urban drinking water to be improved; several polluting factories and plants are being closed.

In certain areas of the United States, water shortages are arising from extremes of climate (drought and floods) combined with decades of neglect of the country's infrastructure: some of the water pipes date from the time of the Civil War and are made of wood. According to ASCE, the United States needs to spend at least USD 1 trillion over the next 25 years to overhaul its water infrastructure (2). The situation in California has got so bad that a plan was made to ship freshwater from Alaska to the drought-stricken state. Alaska Bulk Water wanted to do this during the summer, but was unable to because of logistical problems. Several cities, especially in the south, have been struggling with water scarcity for decades, and residents in desert areas are having to change their behaviour, for example by replacing their lush lawns with cacti. In one of the driest areas, the Sacramento basin in California, a wastewater treatment plant is being upgraded in Elk Grove. The two-fold purpose is to improve water treatment to meet new regulations and to improve the quality of the water discharged into the Sacramento river. The project, which got under way in May 2015, is scheduled for completion between 2021 and 2023. Similar projects are under way in other wealthy but drought-stricken countries: Singapore, China, and the UAE.

Conservation

Water management falls into various interrelated activities: water treatment, especially of drinking water (including desalination) and of wastewater, water conservation (including recycling and re-use), water replenishment, water transport and flood control. Several



Percentage of water use per application sector

PepsiCo reduced fresh water consumption by up to 70% using Siemens' integrated re-use solution. Siemens' MemPulse membrane bioreactor (MBR) system will separate and treat liquids and solids.

projects illustrate how all these different activities are united by one concern: conservation of both water and energy. In Sydney the world's largest recycling plant is taking shape, which will save up to 1 million litres of water a day. Sewage and wastewater will be collected and treated before being recycled for various purposes such as toilets, cold water clothes washing and car washing, all functions that in the past have consumed too much drinking water. In this way, drinking water can be saved, as also happened at Covanta's Delaware Valley energy-from-waste plant, where 1.3 million gallons per day was saved from local water supplies by installing GE's water re-use technology.
In Sunderland, UK, recycled rain water is being used to flush toilets in factories, proving that the British climate is good for something after all!
In Bucharest an old water network was upgraded by Grundfos with a network of interconnected "smart" pumps. The number of pumps operating depended on the fluctuating needs of consumers, which resulted in less running water, therefore fewer leakages and lower energy consumption. Energy savings were also achieved in a new plant in Singapore, where the wastewater's own sludge helped to clean it. As the water is pumped towards a grate, the grate is silted with sludge, which acts as a small-meshed filter letting through only clean water.
Because of more stringent environmental restrictions, it is no longer possible in many countries to dump untreated industrial water or sewerage back into the environment. One solution is more sophisticated treatment technologies, such as an ultrafiltration membrane bioreactor (MBR) supplied by GE to a wastewater treatment plant in Brussels. After the water has been treated, it can be re-used, as happens at the Huai Fang re-use water treatment plant in Beijing, built by Suez Environnement. Other forms of recycling are possible: for instance, in the United States Veolia worked with the Sewerage & Water Board to use sanitized wastewater biosolids in wetlands, with the result that urban swampland was turned into a cypress forest. Some new water projects aim to be energy-neutral by using PV panels, hot water solar heaters and heat recovery systems. This is true not only of remote locations in Australia but also such ambitious projects as Veolia's upgrade of SIAAP's wastewater pretreatment plant near Paris.

Unexpected uses of water

Water's role in most industries is well understood. Here are a two less well-known ways that water is used:

- Ballast water treatment. Ships often discharge ballast water in an environment very different from where the intake occurred. As a result, eco-systems are being disrupted by the introduction of foreign species. Therefore ballast water systems are required to treat the water before discharge. This requires filtration and medium-pressure UV disinfection.

- Ultra-pure water. This is required in several industries, including semiconductor manufacture. In this water ions, salts and minerals are kept to a minimum. Large quantities of high-quality water are need to manufacture the cells used in photovoltaic systems.

Suez Environnement's water purification plant in the Ehn basin, Meistratzheim, France. Photo © J. Boccon-Gibod.

Water at work

Apart from water for domestic use, water management is a vital component of several industries. And here too, water conservation is a paramount concern. Stronger regulations are forcing companies to recover all their wastewater. ZLD (zero liquid discharge), estimated to be worth USD 200 million a year, is a growing market. It started out in power plants and is spreading to other industries such as mining, coal processing and petrochemical. An ambitious example is the Kenya water treatment plant in the Surat coal basin of southern Queensland, which treats the produced water of coal seam gas with ultrafiltration, ion exchange, reverse osmosis (RO) and brine concentration technologies.

Wastewater or produced water treatment forms part of most industries, including chemicals, oil & gas, steel making, pulp & paper, food & drink, and power generation. Water is used in other ways, for instance as cooling in power stations and in the steam generation tubing of nuclear power stations, which require high-nickel alloys to withstand the heat and pressure.

The way water is used in energy production is especially instructive, as water and energy are interdependent: water is boiled to create energy (especially in PWR reactors), while water treatment and transport depend on energy. The close connection between the two is underlined by several projects where wastewater is not only being recovered, but the waste element is being recycled to generate power. France's Suez Environnement has developed a process that converts wastewater into liquefied biogas (biomethane) using membrane technology. This technology has been tested at Arvéa in La Roche-sur-Foron (Valenton, France) and will be used at plant under construction in Strasbourg. In New Orleans, GE's anaerobic membrane bioreactor technology and PurposeEnergy's Tribrid-Bioreactor™ (an anaerobic digester) will be combined to convert food & drink waste into clean water and energy.

4D-printed valves

In 4D printing, time becomes the fourth dimension. In Australia, a team led by Professor in het Panhuis at the University of Wollongong has just built an autonomous valve that opens in warm water and closes in cold water. It is made of four types of polymers fabricated at the same tie using a 3D printer. A series of actuators inside the valve respond to hot or cold water to open and close the valve (3).

Sydney Water's North Head water treatment plant, Australia.

Valves

Valves and pumps are used in various applications at several stages of water management processes. Wherever pumps are used, valves are needed to check the pressure and control the flow. For instance, at the Iron Bridge Water Pollution Control Facility, a wastewater treatment plant in Orlando, Texas, two knife gate valves inside the master pump station allow inflowing water to be diverted between two large wet wells located in the pump station. Supplied by Lined Valve, the valves are made from 316 stainless steel to handle the high pressures and corrosive conditions. More valve makers are making products available in stainless steel. Traditionally, the most favoured materials was mild austenitic stainless steel, especially 316. Duplex stainless steel has traditionally been viewed as difficult to cast, but there are signs of valve makers are gradually beginning to appreciate the value of duplex grades in corrosive and erosive conditions. For instance, GEMÜ has expanded its Victoria® series to include the GEMÜ C480, which has a disc made of super duplex stainless steel. It is designed for use in water treatment, seawater desalination and power plants. Super duplex played a role in a recent order received by Mitech from Umgeni Water for 42 butterfly valves for water storage and purification. They were made of a WCB carbon steel body and duplex stainless steel shafts and disks to cope with the chlorine content in the water.

Conclusion

Water has been called the "oil of the 21st century". True, the gap between supply and demand is worrying. However, as water gets scarcer, water companies get smarter (as do oil and gas companies). Demand for water is driving technological developments and, in doing so, offers plenty of opportunities for materials and instrument suppliers. There is only one caveat: most of the important projects are happening in prosperous countries with a strong industrial base: USA, China, the Middle East, Europe, Singapore and Australia. However, the needs of poorer countries are as great, if not greater, but will they be able to afford the sophisticated technologies? Here is a humanitarian issue that needs to be addressed.

References

(1) www.nasa.gov/jpl/grace/study-third-of-big-groundwater-basins-in-distress.
(2) Eric Fry, "It's Time to Clean Up!", Non-Dollar Report, 19 September 2015.
(3) http://phys.org/news/2015-04-3d-year-4d.html.