Water Environment Solutions for Sustainable Development of Social Infrastructure

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OVERVIEW: Fresh water suitable for drinking and other uses in daily life is unevenly distributed across the planet, estimated to make only about 0.01% of the Earth's total water. Water shortages are becoming more severe around the world as populations increase and become more urban. In Japan, meanwhile, the aging of water and sewage infrastructure and the dwindling numbers of technical personnel have become pressing issues. In response, Hitachi is promoting its intelligent water system concept that seeks to optimize water services at the city or regional level by converging information and control systems with water treatment facilities and other distribution infrastructure to overcome the challenges posed by water infrastructure in Japan and throughout the world. In doing so, it is seeking to consolidate the products it offers in each of the fields that play a role in these services, including business operations, water supply management, flood control, water treatment control, and water treatment equipment.

INTRODUCTION

MODERN society is underpinned by a wide range of social infrastructure, including electric power, communications, transportation, education, water supply, and sewage. As an essential requirement for life, water has a particularly important role. The 21st century has been called the "water century," and there is a need to maintain a healthy water cycle and ensure that everyone has safe and secure access to water.

Hitachi has been supplying products, systems, and services that contribute to various water-related fields for nearly a century, including the protection of water resources, flood control, water supply, sewage, wastewater treatment, and water recycling.

This article provides an update on developments in the water industry in Japan and elsewhere, and describes Hitachi's activities associated with its promotion of the intelligent water system concept, particularly in relation to information and control technology.

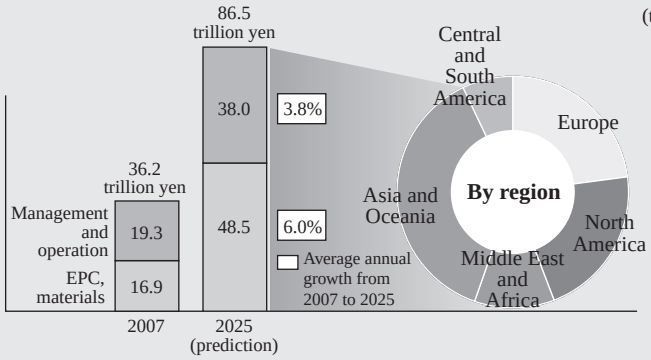
WATER INDUSTRY DEVELOPMENTS

Developments and Issues in Water Industry outside Japan

Many regions of the world suffer from water shortages. Fresh water suitable for drinking and other uses in daily life is unevenly distributed, and estimated to make up only about 0.01% of all the Earth's water. Equatorial and tropical regions in particular often suffer from water shortages, either in absolute terms due to low rainfall, or due to economic factors that limit access to safe water supplies.

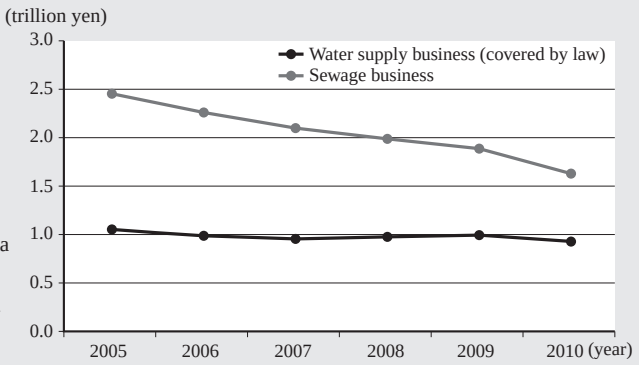
The World Health Organization estimated that approximately 800 million people globally lacked access to wells or other safe water supplies in 2010. Similarly, the number of people lacking access to sewage systems or other basic sanitation was put at approximately 2.5 billion[(1)]. How to improve these figures and meet the growth in demand for water poses a challenge. The reasons for this growing demand include population growth, urbanization and other forms of population concentration, and rising living standards. It has been predicted that water requirements in 2025 will have increased by 30% compared to 2000[(2)].

Against this background, it is anticipated that the global market for water services will increase from 36.2 trillion yen in 2007 to 86.5 trillion yen in 2025, with Asia and the Middle East accounting for a growing proportion of this total [see Fig. 1(a)]. The overall market can be broadly divided into volume markets offering large scale, and rapidly rising growth markets. The volume markets are becoming increasingly competitive, with European "water majors" (large water companies) already operating comprehensive water businesses, and also local companies entering the market. The growth markets, meanwhile, offer business opportunities for Japanese



Source: Report of Study Group for International Development of the Water Business, Ministry of Economy, Trade and Industry

(a) Market outlook for international water business



Source: Japan Water Research Center, Suido HotNews Issue 319

(b) Investment in Japan in water supply and sewage construction

EPC: engineering procurement, and construction

Fig. 1—International and Japanese Markets for Water Infrastructure.
Growth is anticipated in the emerging economies. In Japan, meanwhile, the amount of aging infrastructure in need of upgrading is on the rise while capital investment continues to decline.

companies with expertise in water treatment and other technologies for boosting efficiency, and Hitachi is proceeding with the deployment of its water industry solutions.

Developments and Issues in Water Industry in Japan

Japan is rich in water resources, with 97.5% of the population being connected to water supplies (as of the end of FY2010)[3] and 75.8% to sewage services (as of the end of FY2011)[4]*.

While the water infrastructure is safe, secure, and efficient, how to deal with the aging of infrastructure and the handing on of know-how have become pressing issues. The water treatment facilities, networks of water pipes, and various other infrastructure built in large quantities during the post-war era of rapid growth are now increasingly exceeding their design life and are in need of updating. Outside the major cities, however, the water distribution and sewage businesses run by local governments suffer from a lack of management resources. Meanwhile, trends such as the aging population, falling birthrate, and changing lifestyles are reducing water demand and constraining their income. Also, capital investment in water and sewage operations has been falling in recent years [see Fig. 1(b)]. The Great East Japan Earthquake in March 2011 did considerable damage to water supply and sewage infrastructure, some of which are still being repaired.

A variety of initiatives are underway to overcome these challenges, including consolidating business activities and operating over wider areas, planned upgrades to infrastructure, and public-private partnerships. Hitachi has supplied a large amount of water supply and sewage equipment in Japan, as well as maintenance, administration, and other services. Hitachi intends to continue this work to help maintain a healthy water environment and achieve the sustainable development of water infrastructure.

HITACHI'S WATER INDUSTRY SOLUTIONS

Intelligent Water System Concept

Hitachi supplies solutions to the water industry that help resolve the various issues it faces, including products and systems for mechanical, electrical, information, and control applications together with services that handle certain aspects of water supply and sewage business operations. The basic philosophy behind these activities is what Hitachi calls the "intelligent water system."

Rather than working at the level of individual treatment plants or other infrastructure, this approach aims to optimize overall operation by making effective use of limited water resources across entire cities or regions. Specifically, Hitachi's objectives include the efficient management of water resources, energy

* The figures for the end of FY2011 exclude Iwate and Fukushima Prefectures because the survey could not be conducted due to the Great East Japan Earthquake.

savings, and protection of the environment through both the convergence of information and control systems and the wide-area coordination of water treatment, distribution, and other infrastructure (see Fig. 2).

The water business is heavily dependent on the natural environment as a source of water, and is characterized by the diverse needs of both operators and consumers. It is necessary to supply appropriate systems and services that take account of the circumstances in the country or region concerned, such as its culture, laws, economics, public sanitation, and energy market. For this reason, a wide range of problem solving techniques are required among the elements that make up the intelligent water system.

Components of Intelligent Water System

Hitachi is working on linking together the technologies, systems, services, and other components that make up an intelligent water system. Table 1 lists some of these components. Hitachi is investigating the functions and other developments needed in five different fields. These are: (1) business management to support the planning and operation of water businesses, (2) water supply management to support operational planning of the intake, treatment, and distribution of water, and also sewage treatment and water recycling, (3) flood control, including flood prediction and rain water run-off, (4) water treatment control, including the electrical equipment, information, and control used at water treatment and sewage plants, and (5) water treatment equipment, including the plant and machinery used for water treatment.

Hitachi is combining these different fields to provide a range of options that covers everything from planning to design, construction, and operation, and is helping overcome the challenges facing the water industry by offering solutions that suit the requirements of the area being serviced.

TECHNOLOGIES USED IN INTELLIGENT WATER SYSTEM

This section looks at examples of water supply management and water treatment control, two core components of the intelligent water system.

(1) Water supply management planning and water distribution control system

Two water distribution solutions commercialized by Hitachi are a water supply management (planning) system and water distribution control system. Their benefits include helping provide a reliable water supply, cut operating costs, and reduce the load on the environment.

The water supply management (planning) system helps determine operational parameters, including the daily volume of water to treat and distribute, based on information such as the weather, turbidity of intake water, equipment status, and water demand. A particular feature of the system is that it uses multi-variable optimization to formulate a superior overall

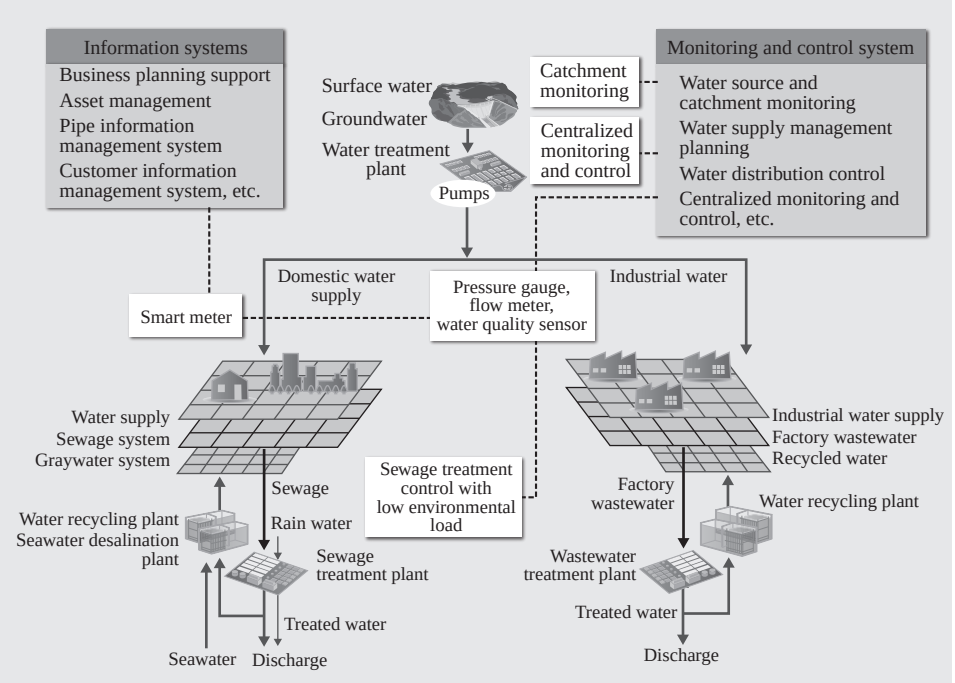


Fig. 2—Example Intelligent Water System.
Water use within a region can be optimized by the interoperation of water treatment systems with information and control systems.

TABLE 1. Components of Intelligent Water System
Hitachi is working to implement the intelligent water system concept by linking together the various different technologies, systems, and services.

Field	Example systems or services	Example benefits
Business management	• System planning engineering • Operational planning support system • EAM • Pipe drawing management • Customer information management • Billing management	• Greater business efficiency • Smoothing of investment • Service improvements
Water supply management	• River basin simulation • Water supply management (plan) • Water distribution control	• Reliable water supply • Reduced load on environment
Flood control	• Flood simulation • Rain water and runoff	• Public safety
Water treatment control	• Monitoring and control • Water quality management • Operational outsourcing service	• Greater reliability and efficiency
Water treatment equipment	• Water treatment equipment • Sewage treatment equipment • Wastewater treatment equipment • Membrane-based water treatment equipment • Seawater desalination equipment	• Greater reliability and efficiency

EAM: enterprise asset management

plan despite conflicting objectives such as reliability and reducing the load on the environment.

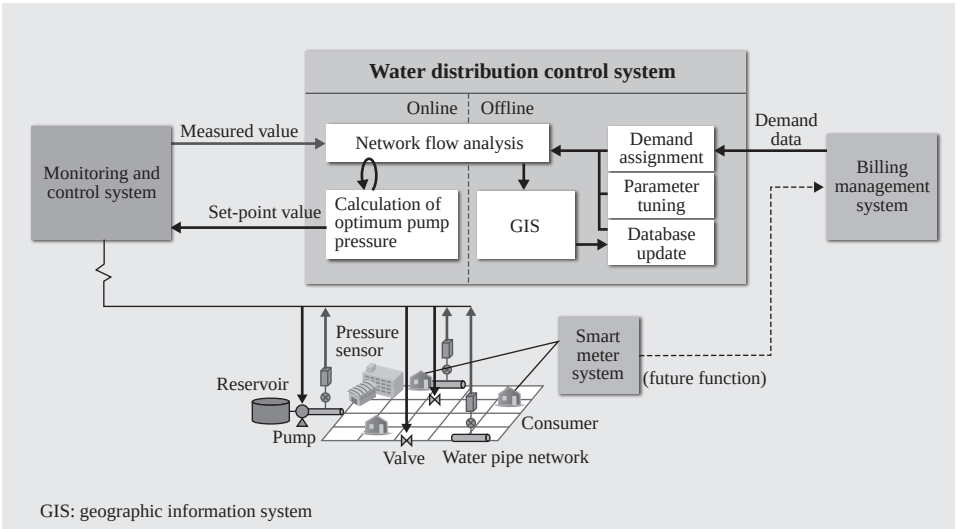
The water distribution control system uses data from water pressure sensors installed along mainline pipes to analyze flow rates and pressures across the entire pipe network, online and in realtime, and also to control valve settings and pump discharge pressures at reservoirs in the distribution system. Not only does this provide up-to-date information on the distribution of water pressures across the entire system, the realtime availability of this information to the control system allows detailed control of the water pressure distribution in response to fluctuations in demand. By keeping water pressures at an appropriate level (minimum required pressure), the benefits of the system also include reducing leakage and pump power consumption (see Fig. 3). Installations in Japan have achieved savings of about 10%.

These systems have already been installed at water distribution businesses in Japan, where they are helping save energy and improve operational efficiency.

(2) River basin simulation

Technologies for assessing and predicting the condition of rivers, groundwater, and other water sources deliver benefits in applications such as catchment disaster management and for helping with various planning tasks and infrastructure operation.

Hitachi has implemented practical river flow simulations that can model water quality problems in the headwaters of river systems to estimate factors such as when and in what concentrations contaminants will reach downstream locations, and that use this information to aid decision making on whether measures such as halting water intake are needed. The system incorporates two separate simulators for realtime and detailed predictions respectively, and also a database of past incidents to help respond quickly when similar problems recur.



GIS: geographic information system

Fig. 3—Overview of Water Distribution Control System. The system uses sensors for continuous monitoring of pressures in the water pipe network, and simulates the water pressure distribution across the entire network. The calculation results are utilized in automatic control of pump operation in close to realtime.

Other current developments include a water pollution trend prediction system that helps with the planning of infrastructural work by predicting medium- and long-term trends in water pollution across an entire catchment, and a water circulation simulation that uses integrated models that consider both ground and surface water to help predict groundwater flows and the distribution of water resources.

(3) Water treatment control technology

To offer a wide range of solutions at the city or regional level that integrate water treatment plants with information and control systems, the operational control techniques for water treatment plants also need to do what they can to improve reliability and efficiency.

Water treatment plants that take water from rivers (surface water) sometimes use manual interventions to cope with the sudden changes in water turbidity that occur after rainfall, such as adding coagulant or decreasing water intake. Hitachi has developed and tested a new control technique for determining the appropriate rate of coagulant injection needed to deal with sudden changes in water turbidity (see Fig. 4). Adding the right amount of coagulant not only reduces the load on the environment, by expanding the range of turbidity levels that can be controlled, it also helps ensure a safe and secure water supply despite the dwindling numbers of experienced plant operators and the contracting out of treatment plant operation to third parties.

In the case of sewage treatment, Hitachi is also developing sewage treatment control technologies that reduce the load on the environment, not only by minimizing the emission of greenhouse gases due to the power consumed by pumps and blowers in the water treatment process, but also by reducing nitrous oxide (N_2O) emissions. Operational control technologies can reduce the load on the environment without needing to make major upgrades to the treatment plant.

CONCLUSIONS

This article has provided an update on developments in the water industry, and described Hitachi's activities associated with its promotion of the intelligent water system concept, particularly in relation to information and control technology.

The intelligent water system concept focuses on water and seeks to achieve the system-wide optimization of water, information, and energy flows at the city or regional level. It is closely related to Hitachi's construction activities in the field of smart cities, where its aim is to achieve a well-balanced relationship between people and the Earth.

Hitachi is working on initiatives that are linked to common issues for urban infrastructure, including the adoption of smart meters that provide a detailed breakdown of demand, the convergence of information and control systems, and international standardization in the field of smart cities.

By proposing new ways of doing things, Hitachi intends to continue making a contribution to the sustainable development of water infrastructure, and to maintaining a healthy water environment in Japan and the rest of the world.

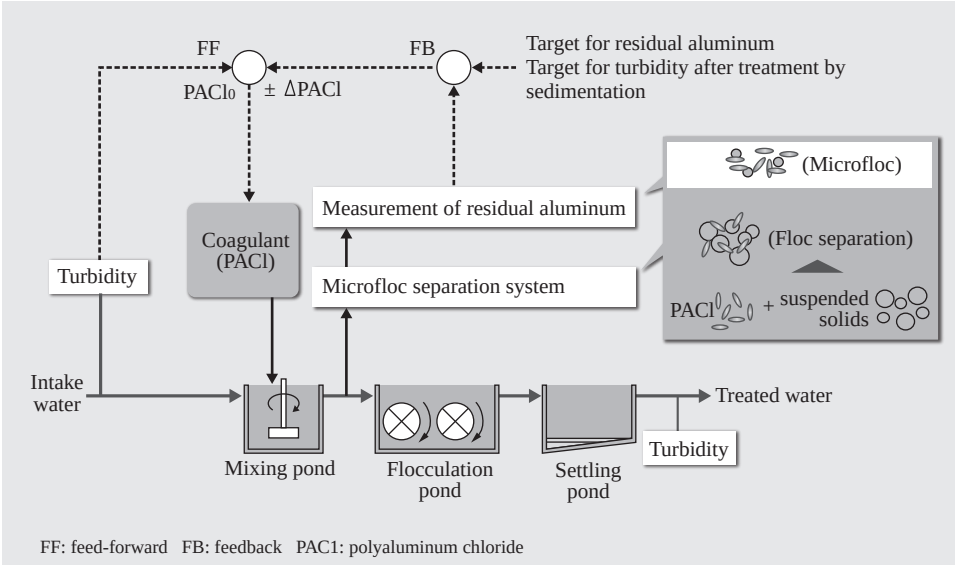


Fig. 4—Control System for Addition of Water Treatment Chemicals in Response to High Turbidity.
Based on the turbidity of the intake water and the level of aluminum in the treated water, the system calculates the appropriate rate of coagulant injection needed to deal with sudden changes in water turbidity.

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