Industrial Waste Water Treatment System for Water Recycling

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OVERVIEW: Many countries and regions around the world are facing threats of severe water shortages or degradation of the water environment resulting from factors such as explosive population growth, rising living standards brought about by economic progress, and increasing use of industrial water. Using the advanced technologies of water treatment systems, information and control systems, and energy saving systems, Hitachi has been helping protect and improve the world's water environment for about a century. In the future, Hitachi intends to continue utilizing its high levels of both hardware and software technology built up in a variety of water-related fields to work with customers on building water distribution systems.

INTRODUCTION

WITH a small land area and limited resources, Japan has achieved economic growth through the strength of its manufacturing and other industrial operations. However, this resulted in pollution and other environmental problems, and restrictions stipulated by a number of different laws have been placed on the discharge of water by companies involved in industrial activity. Other countries have had similar experiences, with Southeast Asia and other emerging economies, in particular, facing severe water shortages and degradation of their water environments resulting from factors such as increasing use of industrial water and rising living standards brought about by economic progress.

It is against this environmental and social background that Hitachi supplies total solutions for protecting the water environment and making improvements.

This article reviews the water situation in Southeast Asia and other emerging economies, and describes the industrial water treatment systems that Hitachi is offering in response.

CHANGING WATER ENVIRONMENTS IN ASIA

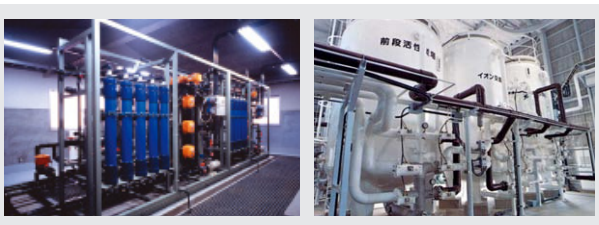
The water-related environmental laws in Japan include the Water Pollution Control Law enacted under The Basic Environment Law. These laws provide the basis for detailed regulatory limits for specific industries or locations, including those specified in the bylaws issued by local governments.

A similar legal framework applies in Southeast Asia, with each nation stipulating quantitative rules for various water discharge criteria. A distinctive feature is that these quantitative rules on water discharges differ between the numerous industrial sites located around the region.

One example is how some industrial sites with centrally managed waste water treatment facilities are permitted to operate to looser standards than the host nation's quantitative rules. This makes it essential to conduct preliminary studies when considering the construction of a plant.

Considering the quality of industrial water supplies, there are also examples of companies installing their own systems for improving water quality to suit the intended end use. In India, meanwhile, top priority is given to irrigation to conserve precious water resources. Measures include the placement of restrictions on use of water for production at industrial and other sites, and also encouragement for water recycling ("zero discharge" practices).

These factors mean that companies operating in Southeast Asia and other emerging economies need to build their own water treatment systems in accordance with local circumstances.



(a) **(b)**

Fig. 1—Membrane-type Drinking Water Treatment System (a) and Ion Exchange Tower.
These photographs show a compact module for a membrane-type drinking water treatment system (a), and the ion exchange tower for use in production of soft drinks (b).

HITACHI WATER TREATMENT SYSTEMS

In Japan and elsewhere, Hitachi has built up extensive experience and know-how in both hardware and software for a diverse range of water-related fields. This section describes the industrial water treatment systems that are included among these technologies.

Water Treatment Equipment

Membrane-type drinking water treatment systems that use membrane filters to purify water to a level acceptable for drinking represent one form of water treatment. Compact and easy to maintain, these systems provide a choice of microfiltration (MF), ultrafiltration (UF), and other types of membranes, as appropriate, based on the water quantity and quality requirements, and can remove suspended solids as well as Escherichia coli (E. coli) and other microorganisms.

Some industrial applications require high-quality purified water. In this case, water purification units fitted with components such as ion exchange towers or reverse osmosis (RO) membranes are used to remove impurities such as electrolytes, colloidal matter, and low- or high-molecular-weight organic material (see Fig. 1).

Waste Water Treatment Equipment

The waste water produced by industrial activity can be broadly divided into organic and inorganic waste water.

Treatment of organic waste water typically involves biological methods based on the use of activated sludge. Another type of biological treatment system that has emerged in recent years is the membrane bioreactor system. Combining activated sludge treatment with an immersed flat membrane to perform highly concentrated activated sludge treatment, this system is suitable for industrial waste water treatment where the requirements are for a high level of treated water quality together with ease of maintenance, space efficiency, and low cost (see Fig. 2).

Another consideration is that many countries have established regulations on the presence of nitrogen in waste water. This is in response to the severe impacts that the discharge of nitrogen in waste water into oceans or lakes can have on ecosystems, such as various types of algal blooms.

The method used to deal with nitrogen in waste water involves first using a nitrification treatment in which a long-duration aerobic treatment process using activated sludge converts ammonium nitrogen into nitrate nitrogen. This is followed by the use of denitrifying bacteria under anaerobic conditions to covert the nitrate nitrogen into nitrogen gas.

To perform this waste water treatment efficiently, Hitachi has developed a comprehensive immobilizing nitrogen removal system. This system enhances the capacity of the nitrification treatment process by using nitrifying pellets (inclusive immobilization supports) in which the microorganisms that form the activated sludge are encapsulated into 3-mm square cubes of agar-like polymer aqueous gel (see Fig. 3).

In addition to boosting the efficiency of nitrogen removal, this system uses only about half as much

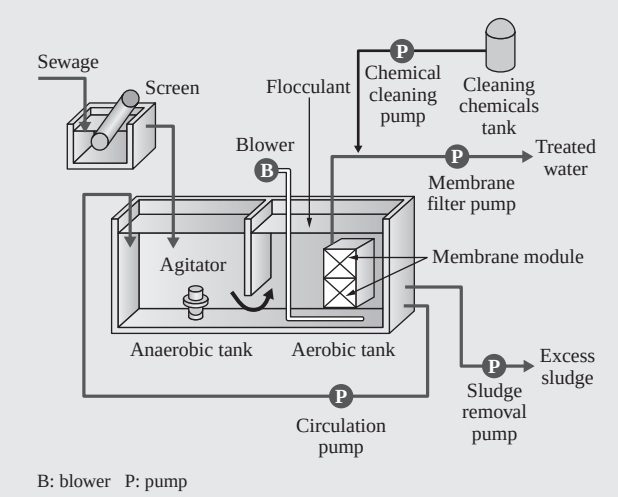


Fig. 2—Membrane Bioreactor System.
The figure shows a simplified flow diagram of a membrane bioreactor system that combines activated sludge treatment and an immersed flat membrane.

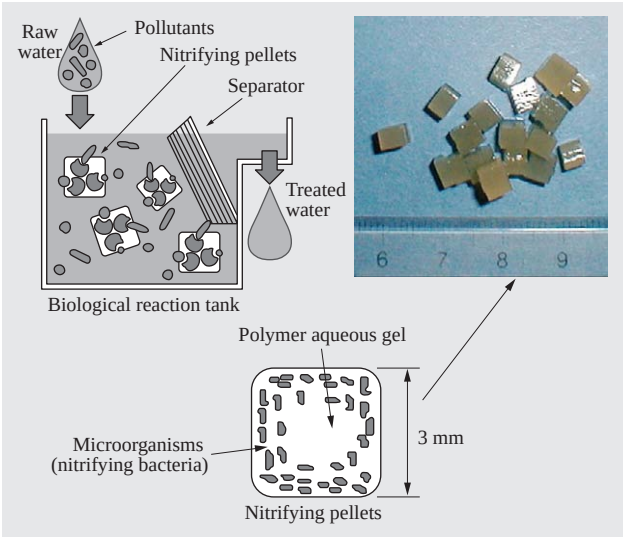


Fig. 3—Comprehensive Immobilizing Nitrogen Removal System.
The figures show the principle of operation of the comprehensive immobilizing nitrogen removal system and the immobilization supports used.

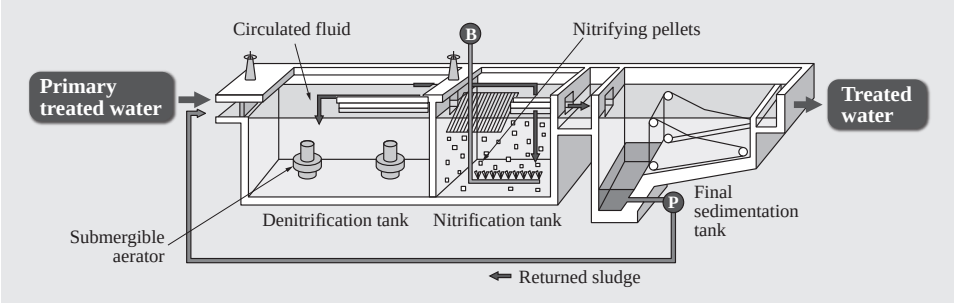


Fig. 4—System Flow Diagram of Comprehensive Immobilizing Nitrogen Removal System.
This shows the standard configuration of a comprehensive immobilizing nitrogen removal system.

space as previous methods. Hitachi has had extensive experience with this technology over many years (see Fig. 4). Hitachi is now developing a system for treating waste water with a high nitrogen concentration that uses inclusive immobilization supports embedded with anaerobic ammonium oxidation (ANAMMOX) bacteria capable of removing nitrogen directly from ammonium nitrogen. Because this inclusive immobilization technology also has the potential for deployment in other applications, Hitachi is proceeding with further research and development, including its use for the removal of other restricted substances.

In the case of inorganic waste water, on the other hand, it is necessary to choose a treatment method that suits the substance to be removed.

One distinctive technology of Hitachi is its advanced fluorine treatment device (see Fig. 5). This device converts the residual fluorine in water treated using flocculation that contains hydrofluoric acid to apatite, and then precipitates it on the surface of a crystallized material. It uses an expanded-layer reactor structure that makes it simpler, easier to maintain, and less costly than existing two-stage coagulation sedimentation devices (see Fig. 6).

Equipment for Water Reuse

Hitachi has for some time been developing systems that combine RO membranes with membrane bioreactor systems, and that are targeted particularly at regions that suffer from water shortages. These systems

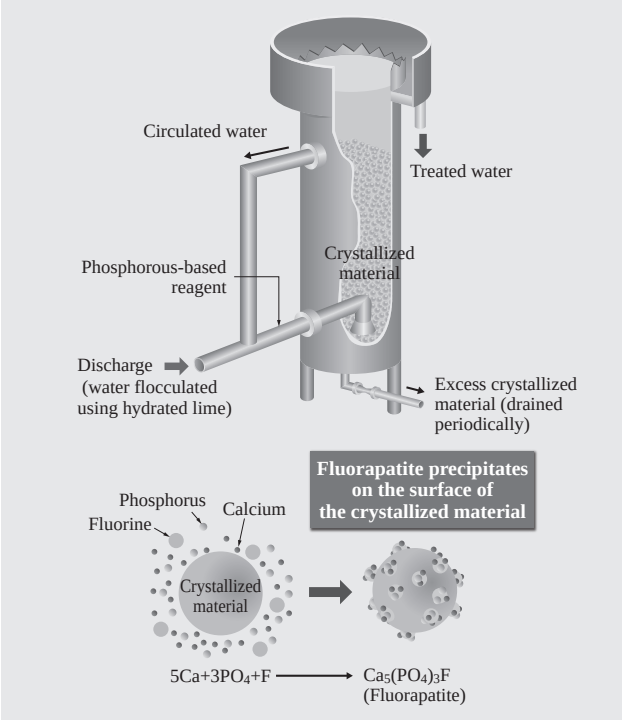


Fig. 5—Principle of Operation of Advanced Fluorine Treatment Device.
The diagram shows the principle of operation of this advanced fluorine treatment technology based on a precipitation reaction.

Fig. 6—Advanced Fluorine Treatment Device.
This advanced fluorine treatment device is based on a precipitation reaction.

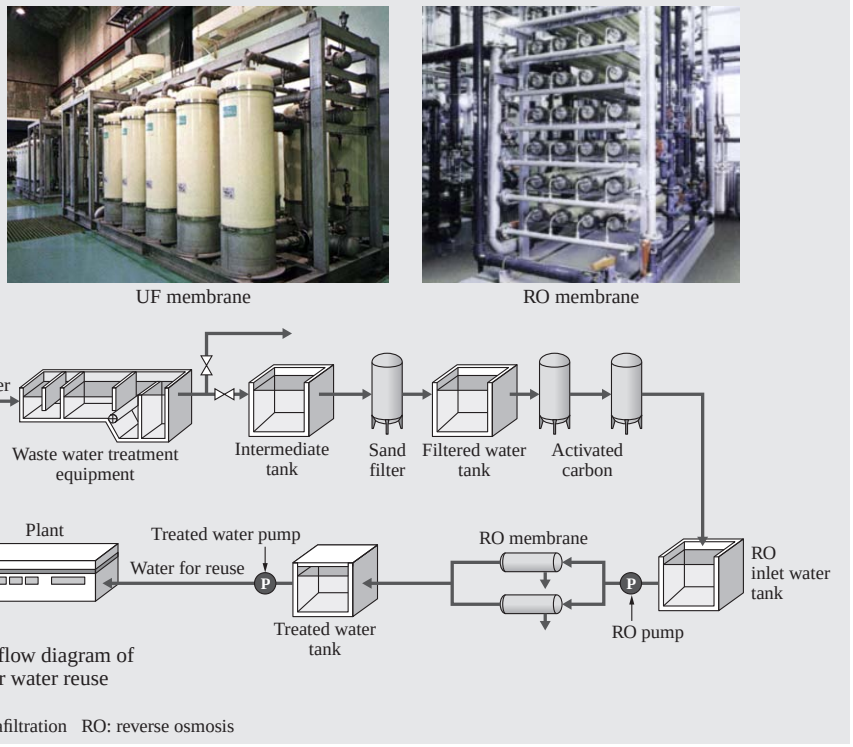


Fig. 7—Example of Equipment for Water Reuse Supplied by Hitachi.
Hitachi supplied this waste water recycling plant that uses RO membranes.

recycle water and supply it as high-purity treated water (see Fig. 7). Hitachi is also investigating systems that recover and reuse rainwater so that it can be provided as a resource for regions with limited water sources. While rainwater is often stored for use in emergencies after its contaminants have been removed, it can also be treated to make it suitable for various uses.

Water recycling systems can be built by using the fresh water and waste water treatment systems described above to treat resources such as waste water and rainwater that have not been reused in the past. As a wide range of potential applications exist for water reuse, extending from general water supplies and the makeup water used in cooling towers to the highly treated water required by factories, Hitachi is seeking to work with customers to build systems that ensure the efficient use of water at production sites and other facilities.

CONCLUSIONS

This article has reviewed the water situation in Southeast Asia and other emerging economies, and described the industrial water treatment systems that Hitachi is offering in response.

While emerging economies set waste water standards equivalent to those in Japan, the regulations differ from nation to nation. This makes it necessary to investigate this issue before embarking on plant construction and make changes as required. Hitachi has technology and experience in a wide range of industrial water treatment systems able to comply with these regulations, as discussed along with examples in this article. These include water treatment using MF, UF, RO, and other types of membranes, organic waste water treatment using nitrifying pellets (inclusive immobilization supports), advanced fluorine treatment based on a precipitation reaction, and systems for water reuse that combine RO membrane equipment with a membrane bioreactor system.

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