Guest Forum

The Situation of the International Standardization for Water Reuse

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Water reuse markets are forecasted to expand rapidly against the background of population growth and urbanization in emerging and developing countries. When using reclaimed water, it is important to evaluate the health of users, as well as safety and reliability at the location of use. Membrane technology is indispensable and is widely used; it is a technology in which Japan is considered to have superiority. Against this background, Technical Committee ISO/TC282 "Water Reuse" was established in June 2013. Japan is currently the secretariat, and the first General Meeting was held in Tokyo in January 2014. This report reviews the status of water reuse and related international standardization.

Introduction

There are definitely water shortages in the world, and reusing water, one of the measures to alleviate these, has become a requirement. Water shortages due to urban development and population increases have become major social problems in every part of the world. In areas with water shortages, some countries are using water reuse as a national strategy, and the importance of this will only increase. Even in Japan, the Basic Act on the Water Cycle has been established as legislation by Diet members, and was put into effect starting on July 1, 2014. The Water Cycle Policy Division, a group that goes across multiple ministries and agencies, was established, and this is one of the developments that indicates that interest in water is increasing. However, in Japan, which has less water stress than some other countries, it seems unlikely that a major market will develop for reusing water. According to Fujie,[1] in Japan, the 5 items listed below will be the significance of reusing water.

1. Solution for uneven distribution of resources
2. Good instrument for promoting major Japanese water-related companies
3. Safe and stable water resources
4. Systems to support advanced industries
5. Water source that preserves the waterfront environment

Number 2. above is an item unique to Japan. Reusing water is a trump card in the water business, which is a growth field, and it can be said that businesses should aim to create a reuse field that utilizes technologies at which Japan is skilled, such as membrane technology, and that this should be implemented globally. Furthermore, international standardization is one method for globally implementing Japan's excellent technology. Actions are being taken to create ISO standards regarding water, and there have been various developments in this area, such as the establishment of the ISO TC282 Water Reuse Specialist Committee in June 2013, for which Japan is the managing country. This paper will discuss the status of water reuse and the related actions being taken in terms of international standardization.

Water reuse market trends

According to research by Global Water Intelligence (GWI),[2] in 2016, the reuse market will become a market that exceeds 800 billion yen, which is approximately 4 times the size it was in 2009. This is shown in Figure 1. If we look at this by region, we can see that there is major expansion and large markets in the Middle East and North Africa. Furthermore, the top 3 countries with the highest capital investment are the US, China, and Saudi Arabia. The capital investment amount in the US is 1 trillion yen, over a period of 8 years after 2009. The capital investment totals for these top 10 countries are predicted to exceed 3 trillion yen over an 8-year period. Figure 2[2] shows the

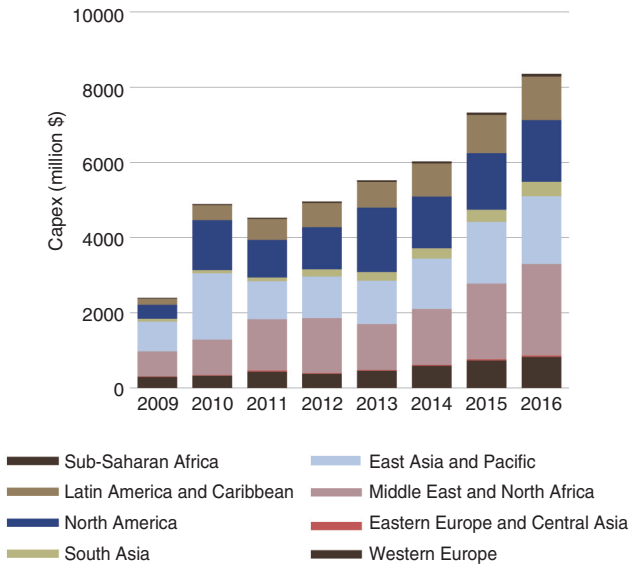

Figure 1 Market Predictions for Reclaimed Water

applications for reclaimed water in the world market. The top category is agricultural applications, which makes up approximately 33%, and industrial applications are the next highest, with approximately 20%. Indirect drinking water and groundwater recharge combined make up approximately 5%, and it is very likely that these applications will expand in the future. For that reason, evaluating the safety of reclaimed water will become important.

Current status of reuse technology

The author will introduce technology related to reuse.

Systems for reclaiming water in the Middle East[3]

There is a pond around the tallest building in the world, "Burj- Khalifa ", in the United Arab Emirates (UAE) in the Middle East, and the water used in this fountain is reclaimed water produced by processing 3,000 m^3/d of residential household waste water in the area using a Membrane Bioreactor-Reverse Osmosis (MBR-RO) system. Figure 3 shows a photo of the MBR equipment in this system. The raw household waste water is directly drawn in from the sewage pipe, and the RO concentrated water and excess sludge is sent back into the sewage pipe. Considering the aspect of residential sanitation in the area, and also that this is an area with an extremely high amount of evaporation, reclaimed water is being used that has been desalinated using RO equipment. Furthermore, some is being used as make-up water for local heating and cooling.

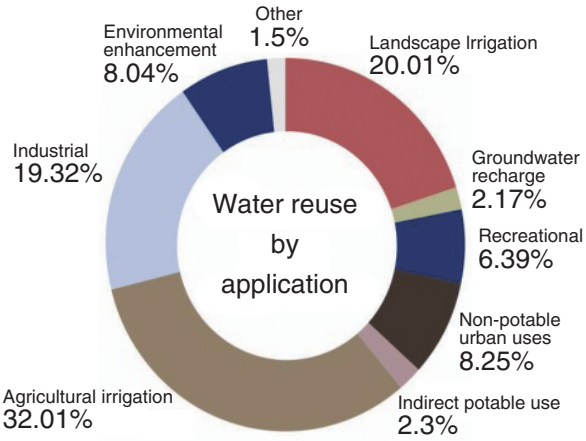

Figure 2 Applications for Reclaimed Water in the World Market

Water reuse business in the UAE[4]

In the emirate of Dubai in the UAE, household waste water has been collected and treated since February 2009, and water reclamation companies are selling treated water as reclaimed water. Figure 4 shows an overview of this business model.

In Dubai, this business model has the social background of the rapid increase in laborers that was due to the urban development rush. At the time, there was only one public sewage treatment plant, and the management network could not keep up with the drastic increase in population, so the laborers' household waste water was being transported by tanker truck to a sewage treatment plant located several dozen kilometers away, and being treated. However, the sewage treatment plant ended up treating an amount of household waste water that exceeded its treatment capacity by a considerable level, and the decrease in the quality of the treated water was a major problem when it was reused. Furthermore, the traffic congestion caused by the tanker trucks was also a social problem. Furthermore, the majority of public water in

Figure 3 MBR Equipment in Burj Khalifa, Dubai

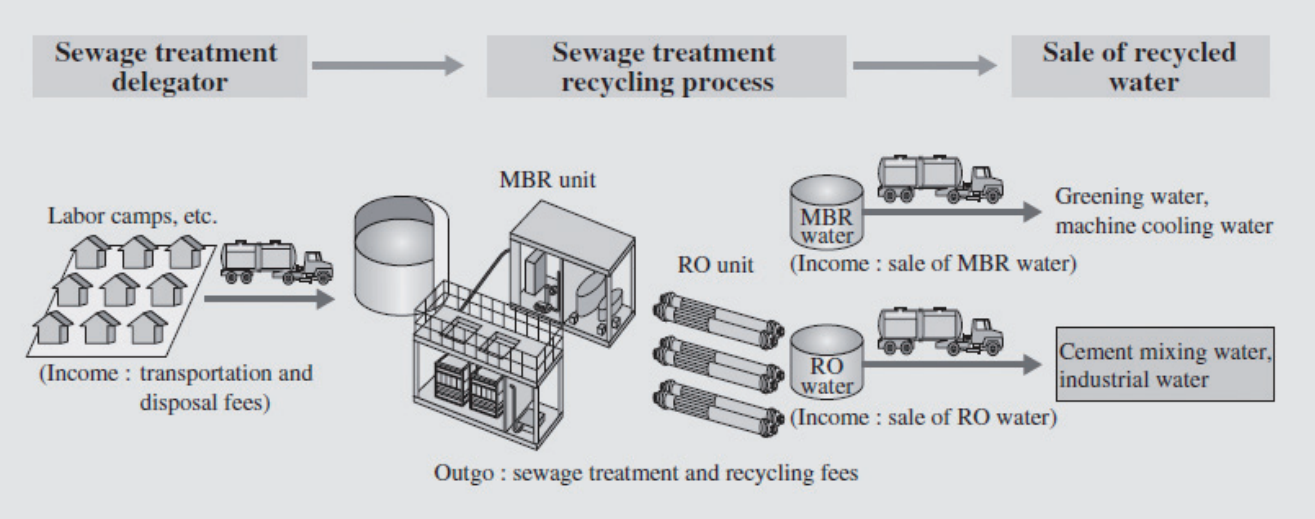

Figure 4 Reclaimed Water Business Model in the UAE

Dubai was covered by seawater desalination facilities, and high water fees were being paid to use the water as industrial water. Based on these factors, if it is possible to collect the laborers' household waste water and charge the treatment cost, then install treatment equipment and treat the water in a location near the discharge source of the household waste water, and if the water can be supplied as industrial water for nearby plants at a lower cost than tap water, the business would be feasible. The treatment equipment combines MBR and RO. Both use membrane technology, which has the features of conserving space and producing good-quality treated water. Treatment equipment is installed in cement plants, the household waste water is collected from nearby neighborhoods, and the treated water is used as industrial water inside the cement plant. Due to the effects of the economic downturn precipitated by the Lehman Brothers bankruptcy in 2008 and the Dubai debt crisis in 2009, since 2010, there has been a rapid decrease in the number of laborers in Dubai, which means that there has been a sharp decline in the household waste water treatment cost by tanker truck. For this reason, reclaimed water businesses at companies have been scaled down, but currently, this business is continuing, with waste water treatment O&M as the main business.

Projects in the emirate of Ras Al Khaimah[5]

In the Al Ghail Industrial Park in Ras Al Khaimah in the UAE, tap water has been transported by tanker trucks, and was used as water for daily use and industrial water. The household waste water was then transported by tanker truck to a sewage treatment plant several dozen kilometers away, and was treated there. As a New Energy and Industrial Technology Development Organization (NEDO) verification project that aims to manage the business and income sources, the cost of disposing of household waste water, and the cost of selling industrial water, MBR equipment (2,000 m^3/d) and RO equipment (1,000 m^3/d) were installed (Figure 5 shows a general view of the equipment), and the household waste water was treated to manufacture industrial water.

Technological developments at the Water Plaza Kitakyushu[6]

Aiming to develop efficient technology for manufacturing industrial water for global water shortages, a verification project was started in FY2009 for a system that combines the energy conservation of a seawater desalination system

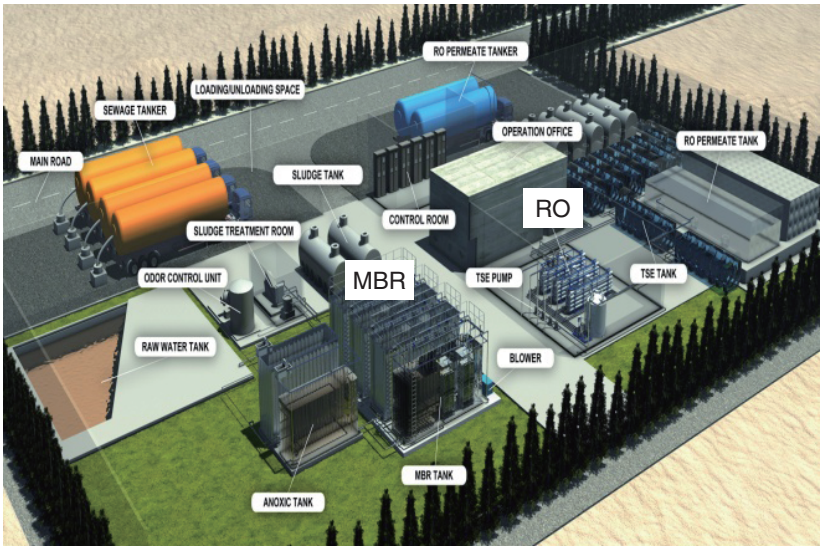

Figure 5 NEDO Verification Facility

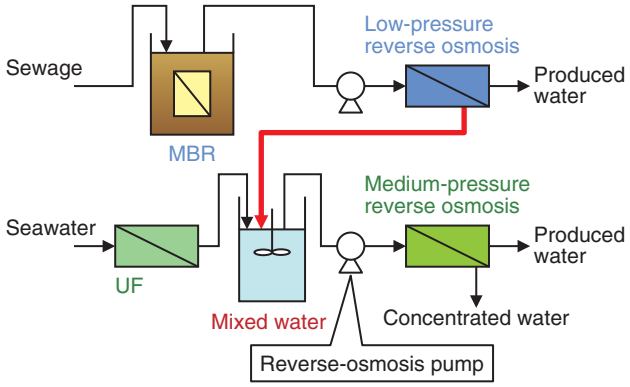

Figure 6 Flow Diagram for Kitakyushu Water Plaza

that uses RO membranes and household waste water treatment. Figure 6 shows the equipment flow. As a water plaza concept, 1,500 m^3/d MBR and RO equipment was installed in the Hiagari Purification Center in the city of Kitakyushu, whose target is to decrease the osmotic pressure of the sea water by mixing the MBR-treated RO concentrated water with seawater and reduce the power used in seawater desalination by 30%. Reclaimed water is used as industrial water for nearby power plants. Furthermore, test bed equipment has been installed, various verifications are being done, and environmental improvements are being made. The water plaza has built a water circulation system that conserves energy and is harmonious with the environment, which contributes to the spreading and promotion of this technology to international society, and as such, the water plaza is positioned as a low-cost, low-power new water generation system that integrates seawater desalination and sewage reuse.

Trends in international water standardization

Developing standards related to the water environment

In October 2011, the ISO Council made an important decision about water standardization. The following 5 things were decided with regard to access to and use of water.[7]

1. In 2012, the Council planned to hold an international workshop with water as the theme
2. With ISO TC224, handle water supply and sewage system resources and services, as well as the recycling of reclaimed sewage water (for example, integrate ISO PC253)
3. Investigate international standards for water conservation, recycling, and seawater desalination
4. In the approach to water management systems, consider the environmental, social, and economical fields
5. Investigate the need for new Water Leak Guidelines

With regard to 1., in 2012 in Kobe, the Japan Standards Association hosted an international workshop that decided the importance of international standards on things such as countermeasures against water leaks, sewage reuse, and sludge treatment. With regard to 2. and 3., in the ISO technical management board in February 2013, Japan, China, and Israel recommended that a specialist committee on water reuse be established. The board received this recommendation and sent the proposal to the various countries, and the vote resulted in the decision that a water reuse specialist committee (ISO TC282) be established in June 2013. Furthermore, France made proposals regarding the recovery, recycling, and disposal of sludge, and these activities started in the fall of 2013, as ISO TC275. Table 1[8] shows the specialist committees on water that have been investigated to this point. ISO TC224 (Service Activities Relating to Drinking Water Supply Systems and Wastewater Systems - Quality Criteria of the Service and Performance Indicators) is a specialist committee that France proposed in 2001, and the ISO 24510 Series was issued in 2007. Furthermore, the ISO 55000 Series international standard on infrastructure asset management that includes the water and sewage aspects investigated in ISO PC251 was also issued in January 2014. In response to these events, in Japan, various review groups were established and are

Table 1 Water-Related Technical Committees

Committee	Description (host country)
TC5	Metallic Pipes and Fittings (China)
TC23/SC18	Irrigation and Drainage Equipment and Systems (Israel)
TC30	Flow Measurement in Pipelines (UK)
TC113	Flow Measurement in open channels (India)
TC138	Plastic Pipes, Fittings, and Valves for Transport of Fluids (Japan)
TC147	Water Quality (Germany)
TC223	Societal Risk Management (Sweden)
TC224	Activities Relating to Drinking Water Supply Systems and Sewage Water Services - Quality Criteria of the Service and Performance Indicators (France)
PC251	Asset Management (UK)
PC253	Treated Sewage Water Reuse for Irrigation (Israel)
TC255	Biogas (China)
TC268	Sustainable Development in Communities [Smart communities] (France)
TC275	Sludge Recovery, Recycling, Treatment, and Disposal (France)
TC282	Water Reuse (Japan, China)

Note: Abbreviation descriptions:
TC: Technical Committee. PC: Project Committee. SC: Subcommittee.

working on related activities, but Japan was not able to take control of the leadership role for establishing international standards.

International standardization of MBR technology[9]

Figure 7 shows the background of the standardization activities for membrane technology and water reuse in Japan. In Japanese membrane-related industries, some have voiced concerns about signs of a decline in Japan's international share of MBR membranes. The Association of Membrane Separation Technology (AMST) has been researching MBR standardization in the NEDO research division for 3 years since FY2009. In FY2009, relevant people in Japan were surveyed, which made it clear that MBR need to be standardized. In FY2010, research was conducted, mostly overseas, which clarified the problems that the MBR technology faces. Based on these results, in FY2011, it became clear that as a direction for specific activities, the standardization of MBR maintenance and management technology will be required in order to differentiate Japanese membranes from overseas membranes, and for the MBR market to expand. Based on the results of this research, in FY2012 and FY2013, the Ministry of Land, Infrastructure, and Transport (MLIT) needed to form a consensus in Japan on MBR standardization, so the work was consigned to the Japan Sewage Treatment Plant Constructors Association (a group of plant engineering companies) and AMST (a group related to membranes), and the administrative work was consigned to the Japan Sewage Works Agency. Then, with the aim of standardizing MBR, assumptions were made about the scope of indicators and requirements, and directions were coordinated for standardizing the first methods for evaluating MBR membrane performance and evaluating MBR system performance. On the other hand, the Standard Certification Policy Section in the Ministry of Economy, Trade, and Industry (METI) called relevant organizations to the MBR international standardization project, as one tool for exporting water infrastructure. AMST and Hokkaido University jointly undertook consignment, aiming for the international standardization of MBR operation, maintenance, and management methods. The results of the MLIT and METI projects are expected to be an ISO TC282 specialist committee. With regard to MBR technology, AMST will be the main organization to make plans and do activities for new proposals for evaluating membrane technology.

Progress status of ISO TC282, Water Reuse

For ISO TC282, which was established in June 2013, it was decided that Israel would be the chairman, and that Japan and China would be the managing countries. Japan was in the position of having a leadership role, and was able to make policy on international standardization in the water reuse field. This review group in Japan decided that a Director for Watershed Management would be established in the MLIT Sewage Division, and the first specialist committee was held in Tokyo on January 23-24, 2014. Ten countries participated in the first ISO TC282 specialist committee, whose aim was to build the structure of the specialist committee. The members deliberated, and the installation of SC1 (irrigation use) put together by Israel was approved. It was decided that the members would vote on whether to establish SC2 (urban use) proposed by China and SC3 (evaluating risks and performance) proposed by Japan. In March 2014, the establishment of various SC was decided based on voting. In this first meeting on ISO TC282, Israel made a

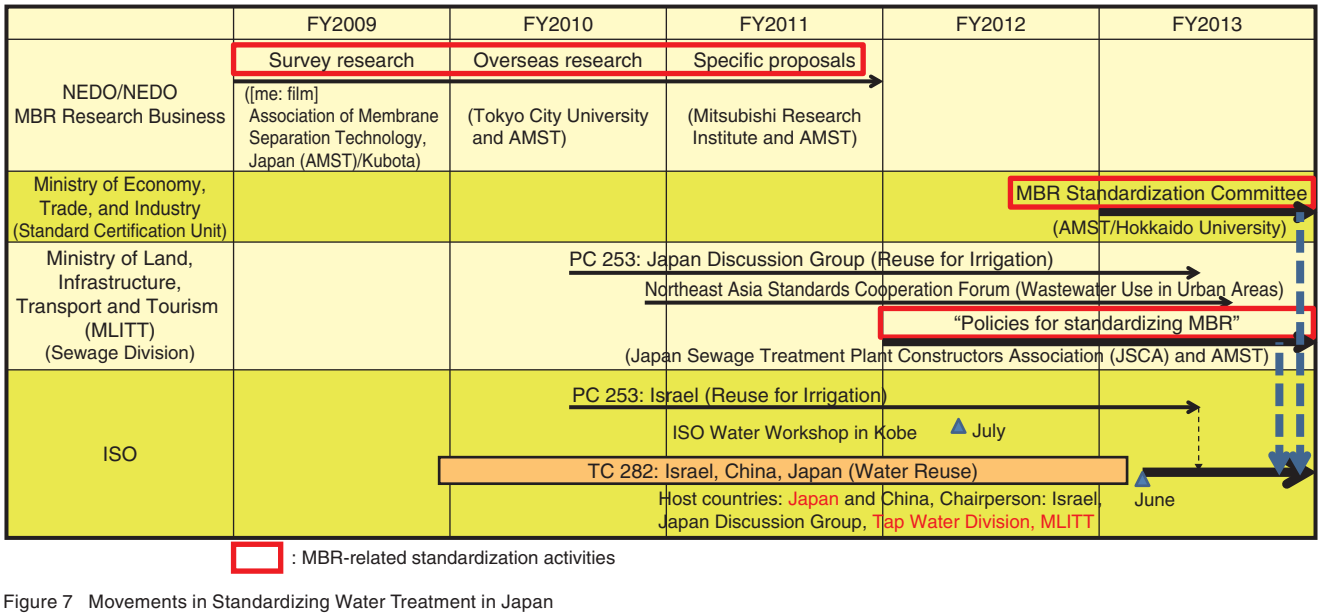

Figure 7 Movements in Standardizing Water Treatment in Japan

proposal in a working group about reusing mining waste water, and it was decided to establish this SC. In these situations, in the future, standards will be proposed for things like applications for reclaimed water and how to evaluate the performance of reclaimed water. Furthermore, starting in May 2014, the Water Generation Promotion Center and Kyoto University jointly undertook consignment of the METI project entitled Foundations for Spreading the International Standardization of Reclaimed Water Manufacturing Systems. This project aims to propose standards for ISO TC282, and drafts for international standards on reclaimed water systems are being created for membrane treatment technology, ultraviolet treatment technology, and ozone treatment technology, and there is a plan to acquire the verification data for evaluating the risks of reclaimed water using Water Plaza Kitakyushu's MBR-RO equipment.

Expectations for improving analysis and evaluation technologies related to water treatment

The technology introduced in the 'Current status of reuse technology' section of this paper was all technology for manufacturing reclaimed water that uses membranes. Membrane technology has to battle membrane fouling (phenomenon in which contamination or dirtiness causes the performance of the membrane to decrease), and there is a need to analyze and evaluate what components are causing the contamination, and whether or not they can be cleaned. Recently, investigations to analyze membrane-fouling substances are using these technologies: three-dimensional excitation fluorescence spectrum (Excitation Emission Matrices, EEM) analysis, the comprehensive analysis technique of the size-exclusion Liquid Chromatograph-Organic Carbon Detector (LC-OCD) method, Dimensional Polyacrylamide Gel Electrophoresis (2D-PAGE), and the Matrix-Assisted Laser Desorption/Ionization (MALDI)-Time of Flight (TOF)/Mass Chromatography methods.[10] There is a review paper about MBR membrane fouling mechanisms and cleaning,[11] and there is a review paper about RO membrane biofouling.[12] Furthermore, when using reclaimed water, it is necessary to evaluate the risks to the health of the people using the water as well as the risks to the ecosystem, and it is important to develop easy ways to analyze and develop evaluation technologies for pathogenic microorganisms, viruses, and microchemicals. In addition, combined use with the Whole Effluent Toxicity (WET) technique, which is an overall technique for evaluating and managing the toxicity and quality of the water using biological responses is an issue. With regard to reclaimed water manufacturing systems, exporting water infrastructure is one of Japan's strategies. To differentiate from other countries' systems and do business in such a way that gives Japanese companies the advantage, monitoring and controlling technical development will be required. For example, with the MBR-RO systems introduced in the 'Current status of reuse technology' section, it is essential that the system for monitoring the water quality of MBR treated water operate in a stable manner to control RO membrane fouling, and currently, this area cannot be said to be sufficient.

Conclusion

Due to the background of global water shortages, the reclaimed water market is expected to expand significantly in the future. Promoting international standardization can be one tool for Japan to implement its reclaimed water technology overseas and for related companies to enter the market. With ISO TC282, a workgroup was launched in the fall of 2014, which is expected to start specific activities. In the future, it will be important for Japanese companies to plan and propose ISO standards themselves, not carry out the ISO standards made by others, and they should begin activities in this direction as business tools for implementing the international standards that are established. Furthermore, with water quality monitoring and control as a set, water treatment plants can fulfill their functions in an optimal way. In order to do this, it will be important for plant engineering companies and analysis and measuring instrument companies to make alliances, and development will need to be undertaken by participating in the national projects and successfully taking advantage of the experience obtained from them.

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