

Review

Environmental Analysis Activities in China

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Since the 1980's, China's heavy industry and chemical industrial infrastructure has been expanding as a result of nationwide economic growth and it has resulted in serious environmental pollution. As one of the measures for environmental protection, the need for environmental measurement has rapidly increased. Against such a background, HORIBA is actively deploying co-operative operations and businesses with China and is promoting environmental measurement projects over the whole of mainland China in such fields as monitoring air pollutants emission or of discharged water, water or air pollution monitoring. Particularly, the company is driving development of products and systems that can address needs relating to protection of the local environment and provide measurement in preparation for expansion of environmentally conscious businesses.

Economic Development in China

Since the reform and liberalization in 1978, China has been maintaining economic growth at a rate of about 10% of GDP increase per year over past 20 years. Especially, economic growth of coastal areas is rapid and it is well known that the 2008 Beijing Olympics and the 2010 Shanghai Expo are attracting the world's attention. In coastal areas of China, big economic blocs such as Chu Kiang River delta including Guangzhou, Shenzhen and Hong Kong are well known. Then there is the Yangtze River delta centered on Shanghai and the Bo Hai rim economic blocs that are forming. The sum of intraregional gross production of these major economic blocs comprises about 35% of China's total GDP^[1]. China's major companies are mostly energy related industries, such as oil, as well as iron and steel production, transportation and distribution industries. Since the heavy industrial and chemical industrial infrastructure has been constructed, there has recently been a rapid increase in energy consumption.

At present, the urbanization ratio of China is about 30%. As a process of modernization, it is expected that high-speed growth will continue for the next 20 years until the urbanization ratio reaches 70% which is the value of the US or Japan.

Environmental State of China

Along with economic growth, China is addressing environmental preservation problems as its basic national policy. For example, the investment in environmental pollution countermeasures of 2002 was 136.34 billion Yuan (1.9 trillion Yen) that is 1.33% of GDP an increase of 13.5% over 2001, which was one of the highest values among the developing countries in the world. The environmental industry of China is continuing to achieve a growth rate higher than 15% per year. However, environmental policy has not been sufficient to address the problems of increased environmental pollution caused by rapid economic growth. Especially, in the last 20 years, environmental pollution problems such as water contamination, atmospheric pollution, and hazardous solid waste have become more and more serious with the term of each local government. As the result, undesirable phenomena are occurring such as desert expansion or degeneration of ecological systems over the broad area of the Chinese mainland. Although political countermeasures have been well arranged to a considerable degree, actual activities have only just begun^[2].

Water Environment

At present, in China, since the processing capacity of domestic waste water discharged from factories and households is low, water contamination is occurring over the majority of rivers, lakes and sea coasts. Such phenomena as the death of water creatures in rivers, damage to fish farms or eutrophication of lakes and adjacent sea are seen everywhere. As shown from the fact that 50% of underground water in urban areas is contaminated, problems of water shortages are becoming more serious. Among seven major river systems, degree of contamination is very serious in the Huai river, Hai river, and Liao river, and especially, along the Huai river water system, there are such a serious conditions that people can barely obtain drinking water^[3]. In the Chinese Government's 10th five year plan (2001 to 2005), protection from water contamination in rivers, lakes and sea coasts is specially focused on, and also in the 11th five year plan (2006 to 2010), the same political measures are expected to be continued. But, in order to fundamentally improve water quality, great effort should be expended in the long term by regional government, industrial society, agricultural workers working in river basins, and so on.

Atmospheric Environment

Coal is a major energy resource providing over 50% of the energy consumed in China. But, SO₂ gas emissions are the largest in the world exceeding the emissions of the USA. As a result, acid deposition phenomena are seen over a broad area. Accompanying relocation of factories from urban areas to suburbs, contributions of fixed emission sources to atmospheric pollution is decreasing in urban areas. At the same time it has been found that the contribution of exhaust gases from vehicles to atmospheric air is a major cause of environmental pollution in several big cities as the result of recent moves toward an automobile society.

About Solid Waste

In China, since processing facilities of solid wastes such as domestic garbage, industrial waste, and polluted sludge is insufficient and they are left unattended in suburb areas, phenomena such as soil pollution and underground water contamination are seen over a wide area. At present, landfilling is mostly used as the main method of treating solid wastes in China. But, recently, in coastal areas where economic growth is rapid, many incineration plants for domestic garbage and industrial waste have been constructed and also refuse incineration power plants have been constructed in several big cities to address the shortage of electric power.

Status of Environmental Monitoring in China

At present, there are 82 government-constructed automatic monitoring facilities in rivers, dams, and lakes in major water systems. Monitored environmental status obtained from these automatic monitoring stations is published weekly in newspapers^[4]. Being actively promoted is continuous monitoring of discharged water from industry, to measure such parameters as COD^{*1}, pH, rate of discharge, etc. Although several thousand COD meters have been installed nationwide, there have been many instruments that cannot operate stably because of quality problems and insufficient systems of maintenance. As a measuring method, the shift to the TOC method^{*2} and UV method^{*3} is progressing.

*1: COD means Chemical Oxygen Demand that shows the amount of oxidizing reagent consumed by converting to an equivalent amount of oxygen when reducing organic materials in water.

*2: TOC means Total Organic Carbon that is a method to measure the amount of organic carbon in water by using oxidization to convert it to CO₂.

*3: UV method is a measurement method using absorption of ultraviolet light.

In 2002, automatic ambient air monitoring stations started operation in 474 places in 179 cities and a nationwide survey on acid deposition was carried out^[5]. As for continuous monitoring of emitted gas from fixed sources such as thermal power plants, although there are many plants that use a simple monitoring system, there are still not so many companies that have installed a Continuous Emission Monitoring

Systems (CEMS). It is expected that companies that install both the desulfurization system and CEMS will increase in the future.

Attention to acid deposition has become high and China is now engaged in acid deposition monitoring as part of the Acid Deposition Monitoring Network in East Asia (EANET). China is monitoring the amount and impact of acid deposition at nine sites in four cities of Chongqing, Xian, Xiamen and Zhuhai. Nationwide research on acid deposition is also being carried out.

In order to address various environmental problems, environmental monitoring centers of national government, province and regional governments, directly controlled cities, and municipalities are intensively promoting installations of laboratory equipment and cultivating human resources.

Working on Environmental Business in China

Recently, HORIBA has been developing its business across a broad range of environmental measurement fields in China.

Participation and Co-operation with Activities of JETA (Japan Environmental Technology Association)

Recently, JETA has been working on international co-operation activities. Especially in areas of information exchange and co-operation in the field of environmental measurement technologies with China, many successful results have been obtained. As a JETA member, HORIBA is actively participating and co-operating in JETA's activities.

A delegation lead by the Chairman of JETA, Kozo Ishida who is a vice-president of HORIBA has visited China several times to discuss and exchange opinions relating to environmental preservation and measurement issues. Also to discuss future co-operation and the direction of environmental business development with Mr. Qu Geping who is a deputy doyen of the All-China Environment Federation and President of the China Environmental Protection Foundation (previously minister of State Environmental Protection Administration of China), Mr. Wang Xinfang, who is the Deputy Minister of State Environmental Protection Administration of the P. R. China, Mr. Wan Bentai, who is Director of the China National Environmental Monitoring Center, and Han Wei, who is the Deputy Chairman of the China Environmental Protection Industry Association.

As a result the Japan and China Symposium on limiting and measuring of dioxin in hazardous waste incineration processes was held at Beijing in August 2004, jointly hosted by the Ministry of Environment of Japan and State Environmental Protection Administration of the P. R. China (SEPA) and in co-operation with the China National Environmental Monitoring Center (CNEMC), Japan Industrial Waste Treatment Promotion Center (JW), Japan Environmental Sanitary Facilities Industrial Association (JEFMA) and JETA^[6]. The author reported a paper entitled "Reduction of dioxin emission by controlling CO₂/O₂ concentration of incineration processing" and introduced experiences in Japan of a continuous measurement system related to reduction of dioxin emissions by controlling the CO₂/O₂ concentration. In September 2004 the 1st Japan and China Environmental Measurement Technology Symposium was held at Dalian by a joint hosting of JETA and CNEMC. At this symposium, HORIBA reported exhaust gas monitoring technology from fixed emission sources and also water contamination monitoring technology. In December 2004 the "Japan and China water quality continuous measurement technology seminar" was held at Shigenseng of Guangdong province by a joint hosting of JETA and CNEMC. HORIBA summarized and reported research results from China on COD measurement using a UV method.

HORIBA has been dispatching a researcher to Acid Deposition and Oxidant Research Center (ADORC) that is also a network center of Acid Deposition Monitoring

Network in East Asia (EANET) since trials started in April 1998. At present, the 3rd dispatched researcher is actively working at the ecological impact research department of ADORC. Also, the author has visited Beijing, Chongqing, Xian, Amoy and Zhuhai that are participating cities to EANET as its operation in China to conduct a field survey as well as to exchange information and to execute technical assistance, through which the author could contract a good friendship with SEPA and CNEMC people.

Emission Gas and Ambient Air Measurement Systems

HORIBA's emission gas measurement equipment (for fixed and mobile emission sources) and ambient air measurement equipment have been introduced to the Japan and China Friendship Environmental Preservation Center as a symbol of co-operative work between them and has been in use for some time. HORIBA has been offering free after-service for this equipment as part of co-operative work and has been highly appreciated and valued by CNEMC.

In China, as a countermeasure against air pollution, needs for emission gas monitoring from fixed emission sources such as thermal power plants is increasing. To address these needs, HORIBA obtained a certification from the China Measurement Law for stack gas measurement equipment in 2001. HORIBA has developed the ENDA-600ZG series of CEMS that is possible to be compatible with Chinese standard. Together with an engineering company in Beijing, installed it in the Huangdao power plant in Qingdao city in September 2002, and received a certification from SEPA certification center. Further in March 2003, HORIBA received a certification issued from the China Environmental Protection Industry Association. In spring of 2003, HORIBA received an order from the Chongqing city fixed emission source gas monitoring system as part of a yen-credit project. At present, 25 installations of this system are working at sites such as the thermal power plants of Chongqing city, etc. In addition, HORIBA is selling 100 sets of stack gas measurement equipment per year in co-operation with local engineering companies of Beijing. Figure 1 shows a 300 MW thermal power plant of Zao Zhuang City in Shandong Province to which an ENDA-600ZG series has been installed.

In China's electrical power industry, also CEMS using a dilution method is widely used. The ambient air measurement equipment that HORIBA is supplying to local engineering companies in China has been widely adopted by many companies as a dilution-method CEMS because of its high performance and quality.

At present, electrochemical type sensors are mostly provided in the portable stack gas analyzer market in China. But, since HORIBA's portable stack gas analyzer PG-250 features a continuous measurement capability, stability and high accuracy, certifications from the China Measurement Law and China Environmental Protection Industry Association were obtained to address the demands from the market. Excellence of this product was also recognized by the China Environmental Protection Office's Certification Center and the products were introduced to this center. We are expecting that this product will be rapidly introduced into the market.

HORIBA is actively developing the market in the filed of ambient air monitoring. In collaboration with regional Chinese companies, HORIBA is developing an automatic environmental air pollution monitoring system that can address the regional needs to expand this market. Required for the acid deposition problem is automatic measurement equipment to measure concentrations of acidic gases and PM₁₀^{*4} for dry deposition. Since HORIBA has rich experience and data in this field also, we will surely be able to contribute to solving China's acid deposition issue.

Movement of China toward an automobile society has greatly influenced atmospheric air in big cities. The author presented a report about the purpose, role and system construction of automobile emission gas measurement station at "National meeting on automobile emission gas measurement in important cities" held in 2004 sponsored by SEPA and got a great attention of many attendants. HORIBA believes that the company will be able to contribute for improving the air pollution issue in big cities of China utilizing its abundant know-how about this field.

*4: Particulate matter having a diameter less than 10 μm.



Figure 1 300 MW Thermal Power Plant of Zao Zhuang City in Shandong Province (ENDA-600ZG series has been installed)

Water Quality Monitoring Field

Before filling Sanxia Dam, the world's largest dam with water, CNEMC measured the water quality of the Sanxia dam water system using the U-10 portable water quality checker. We were highly praised for our speed of providing equipment and the stable and accurate data acquisition capability of the product. In the field of COD, continuous measurement of industrial wastewater, COD_{Cr} method⁵ has been adopted as an officially recognized method in China. However, although many continuous measurement devices using the COD_{Cr} method have been installed, there are not many devices that are normally operating in the field.

In Japan, the COD_{Mn} method⁶, UV method, TOC method and TOD method⁷ have been adopted for continuous measurement of COD values. Especially, since the UV method has such benefits as simple, easy maintenance and low maintenance cost, it has been adopted in about 80% of COD meters⁷. Utilizing our experiences and know-how in Japan, we have carried out research and dissemination activities to contribute to environmental preservation in China. JETA has participated in two-years' joint research in a comparison survey on the environmental water quality of Chu Kiang river basin, Guangzhou city sewage disposal plant and 4 industries' discharged water in co-operation with South China Environmental Science Research Institute and Guangzhou city Pan Yu district Environmental Monitoring Station. HORIBA dispatched two professionals and executed comparison surveys between the UV method COD meter OPSA-120 and the COD_{Cr} analyzer to confirm availability of the UV method in China. We obtained a good correlation between water samples from the Chu Kiang river and five kinds of discharged water from industry⁸.

In addition, as a part of comparison survey between CNEMC's UV method and the COD_{Cr} method, an engineering company from Shenzhen installed an OPSA-120 at the water outlets of sewage disposal plants of about 10 companies including dye works, a food company and PCB company, etc. While the Shenzhen City Environmental Monitoring Center executed several months of comparison surveys between COD values obtained by the COD_{Cr} method and UV method. The result of this survey was fairly good and showed a good correlation. Also high stability of the installed equipment was endorsed⁹. Since the operation of the UV method is very stable, it was highly evaluated at the meeting on wastewater quality monitoring held by Guangdong province's environmental continuous monitoring project.

In Summer 2003, HORIBA installed an OPSA-120 system which uses the UV method at the sewage disposal plant of a food company in Yunnan district together with local engineering company in collaboration with the Yunnan Environmental Monitoring Center and obtained a good correlation with the result of the COD_{Cr} method. At present, it is still working stably two years after its installation. This result has been highly endorsed by Yunnan District's Environmental Protection Bureau and quotation requests about this system from companies in Yunnan district are increasing. At present, in the market for this type of COD continuous measurement equipment, HORIBA's OPSA-120 system is occupying over 50%.

HORIBA's OPSA-120 has also been installed as the continuous measurement station of environmental water quality at the Shenzhen river site. Water from Shenzhen river is blackish, dirty and bad-smelling, so many measurement errors have occurred when using other measurement equipment, while HORIBA's system is stably providing the data. From this achievement, we are expecting the future expansion of this type of COD analyzer market.

In August 2004, an engineering company in Shenzhen installed an automatic measurement station (Figure 2) consisting of HORIBA's water quality monitoring equipment, TPNA-300 (Monitoring total Nitrogen and total Phosphorus), UV method type OPSA-120, and multiple water quality checker U-20 series at the Shenzhen city's dam site. This system is stably providing good data. In future, the system will become a good model of an automatic water quality monitoring station and its use is expected to spread to other districts.



Figure 2 Automatic Measurement Station of Environmental Water Quality at the Shenzhen City's Dam Site in Guangdong Province

- *5: COD_{Cr} measurement method using potassium bichromate as oxidizing reagent.
- *6: COD_{Mn} measurement method using potassium permanganate as oxidizing reagent.
- *7: TOD means Total Oxygen Demand that is a method for measuring total amount of oxygen consumed when organic substance in sample is combusted and oxidized.

Conclusion

So far, many delegates and related people from various districts including the Chinese government, Beijing city, Guangdong Province, Chongqing city, Shandong Province, etc. have visited HORIBA to exchange opinions and to discuss utilization of HORIBA group's environmental measurement technologies. We have recognized that co-operation with local engineering companies and agents is an indispensable factor in developing HORIBA's environmental business in China. Because it is necessary to understand the local conditions and status as well as to reserve an executive ability on site. With the factor, the Win/Win system can be established.

At present, it is clear that the scale of environmental market will further expand with economic development. China is targeting to build a recycling-oriented society. HORIBA is also researching on technological approaches toward environmental monitoring systems that will be used in the recycling-oriented society of the future. We would like to co-operate with and contribute to environmental businesses in China, based on a deep understanding of the whole status, needs and direction of development of China's environmental preservation activity.

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