Kitakyushu Initiative Seminar on Urban Air Quality Management

"Urban Air Quality Management – Experiences of Kitakyushu"

Environment Bureau, City of Kitakyushu
Kenichi Shimohara

1. Outline of Kitakyushu

The City of Kitakyushu, formed in 1963 with the merger of five cities (Moji, Kokura, Yahata, Wakamatsu, and Tobata), is located halfway between Tokyo and Shanghai and has an area of 484km^2 (32.5km east-west, 33.5km north-south).

These former five cities have developed as one of the most eminent heavy chemical industrial areas in Japan in cooperation with one other, overcoming the destruction inflicted on the city during World War II and the energy conversion from coal to oil with the change in its industrial structure. In recent years, Kitakyushu has proceeded to promote urban planning to utilize the conversion from secondary industries to tertiary industries and its location close to other Asian countries.

The city's population increased from 1920 to 1960, peaking in 1980 at 1,065,000. The current population has since stabilised. In October 2000, the population of Kitakyushu was 1,010,000, with a density of 2,090 persons per km^2.

General production in Kitakyushu has increased 5.5 times since 1970. In 1970, general production amounted to JPN 656 billion; in 1999, JPY 3.6178 trillion (JPN 511.8370 trillion nationwide). Looking at the industrial structure of Kitakyushu from the amount of revenue generated by general production, the weight of the tertiary industry is largest at 61.8% in 1999 (66.4% nationwide), followed by the secondary industry at 37.3% (32% nationwide), and the primary industry at 0.9% (1.6% nationwide).

Shipment of products in 2000 amounted to JPY 1.8617 trillion; predominant industries include steel, manufacturing of electronic machinery/appliances and general machinery/appliances, chemical, and manufacturing of metal goods.

Although steel remains as a primary industry, the importance of material industries has decreased. However, the importance of high-tech industries such as general or precision instruments, which are expensive and require high processing skill, has been increasing.

Kitakyushu City consists of 27 departments; the environmental department controls and regulates air pollution. The annual revenue of the city in 2001 amounted to 1.0449 trillion; the budget of the environmental department was 20.5 billion. In the total budget, 129 million was budgeted for air pollution management and regulation (excluding personnel costs).

The condition of air pollution in Kitakyushu City in 2001 is outlined as follows:

(1) General environmental air pollution measurement stations (14)

The amount of sulfur dioxide (SOx), carbon nitrogen dioxide (NO_2), and carbon monoxide (CO) were within the environmental standard at every measurement station. However during the spring, all stations did not conform to the standards because of the high amount of suspended particulate matter (SPM) due to yellow sand. Photochemical oxidants, which must be assessed regularly (short-term assessment) at proper assessment times (05:00-20:00), were 0.1%-7.2% at each measurement station.

(2) Roadside measurement stations (5)

NO_2 was within the environmental standard at three measurement stations; CO was within the environmental standard at every measurement bureau. SPM was higher than the environmental standard at every measurement station due to yellow sand.

(3) 4 materials, i.e. benzene

Benzene was measured at four stations, and was within the standard at three stations. The amount of trichloroethylene and tetracholoroethylene was also within the environmental standard at all four measurement stations. The amount of dichloromethane, for which the

city recently set a standard, was also within the environmental standard at all four measurement stations.

Air regulations are based on various laws and ordinances, such as the Air Pollution Control Law, Polychlorinated-dibenzopdiozins (PCDDs) Countermeasure Law, and the Kitakyushu City Pollution Control Ordinance, among others.

The authority of the prefectural governor of Fukuoka with regard to the Air Pollution Control Law was transferred to the mayor of Kitakyushu City. It is the only case in Japan that the authority to announce warnings was entrusted to the mayor of a city, thereby facilitating quick and effective actions for warnings since the regional situation can be easily considered. Additionally, Kitakyushu City is actively working to set up monitoring systems such as air pollution monitoring systems.

2. Actions of Sectors

(1) Environmental protection actions of businesses

After World War II, the restoration of industries progressed, with large industrial areas at the center. The Kitakyushu Heavy Chemical Industry Area, where steel, chemical, ceramic, and electronic enterprises were located, developed rapidly from 1955 to 1965, and the heavy emissions from factories, otherwise known as "seven color smoke", was considered a symbol of prosperity. However, together with this prosperity, air pollution such as dust, soot and dust smoke, SOx, and offensive odors, became serious in various areas. In particular, the conversion of fuel from coal to oil caused extensive environmental problems with regard to SOx emissions. Furthermore, the rapid increase in population, concentration of industries, and advance of a consumer lifestyle brought about overcrowding, and traffic noise and automobile exhaust fumes became a problem.

A few enterprises tried to install dust and soot collectors before the pollution laws were enacted, but the objective was pollution control measures for the working environment such as the protection of the manufacturing machines and improvement of labor sanitation.

However, as the government and the municipalities began to enforce pollution control laws, environmental pollution began to be recognized as a social vice. After the enterprises lost pollution trials, they were required to compensate the victims, so the production activities of the enterprises became difficult. This position rapidly affected the enterprises' attitudes toward pollution problems, and they began to work actively to implement environmental pollution control measures.

Since the middle of the 1960s, the investment for air pollution control equipment rapidly increased. At the beginning, enterprises focused on the collection of dust and soot, the desulfurization of heavy oil, and increase of effective stack height. At that time, flue gas desulfurization equipment was not popular, so the diffusion from high stacks was the only way to control SOx within the environmental standard, with the exception of using low-sulfur fuel. However, there was criticism that this method only diffused smoke and soot into the atmosphere but did not reduce them.

During the 1970s, the installation of flue gas desulfurization equipment was considered because it became obvious that it was not enough to reduce sulfur content in heavy oil using the technology at the time. In those days, a large amount of money was required to develop and install large-scale desulfurization equipment, and only small-scale equipment was in use. Concerned about the bad influence on the Japanese economy, the industrial sector was reluctant to develop desulfurization equipment. However, there were limits in heavy oil desulfurization technology, therefore, in order to achieve the environmental standard, the installation of flue gas desulfurization equipment was introduced.

The introduction of flue gas desulfurization technology began to spread rapidly around 1975. Currently, there are approximately 2000 flue gas desulfurization equipment are in operation. It is highly viewed as one of the main technologies to overcome serious air pollution problems in Japan.

Flue gas desulfurization equipment is expensive and requires much electricity to operate.

A major issue is what should be used as reaction material and methods to use by-products. There is a lot of limestone in Japan therefore this was used as the reaction material. Collected gypsum was used as gypsum boards or materials in cement.

Around 1975, the air pollution due to nitrogen oxides (NOx), which is created with burning of fuel, became a serious problem and began to be strictly regulated all over the world. Then, the technology to contain NOx was researched comprehensively. Businesses promoted the use of fine quality fuel, improvements in the method of burning, and adoption of low-NOx burners or flue gas desulfurization techniques.

After the first oil shock in 1973, Japanese environmental pollution control measures were greatly changed. To deal with the rise of energy costs, the enterprises actively carried out the consolidation of various aspects such as equipment and technologies, and operations. After the second oil shock in 1979, energy saving measures, which mainly consisted of heat recovery, were promoted.

Energy saving measures greatly contributed to the reduction of costs and air pollution with improvements in productivity and quality. Thus the environmental measures by the enterprises shifted its importance from "End of Pipe Method," which is the method to remove discharged pollutants, such as dust and soot collection or desulfurization, to a method to improve manufacturing processes by economizing resources and energy. Today, Japanese energy saving technology is one of the most effective in the world.

In spite of the enormous amount of investment, the economic growth of Japan did not slow down; rather, because of investments for environmental measures, technology innovation was promoted, quality improved, and costs were reduced. Following this, the environmental pollution control equipment industry was established.

The enterprises developed various environmental pollution control technologies and tried to conform to the strict emission standard through environmental pollution control measures. It is important to note that the technological bases for environmental pollution control measures were formed by organizing technical experts within the enterprises such as heat managers or pollution control managers. In 1971, the laws about pollution control organizations were approved. Each enterprise formed pollution control organizations, set pollution control rules, and held discussions and improved pollution control technology. Efficient environmental controls were possible when the environmental managing organizations and technologies were evenly balanced.

The following are examples of the environmental pollution measures taken by enterprises.

① Treatment of converter gas (OG Method)

In 1970, the discharge amount of SOx from "S" Iron Mill was 27,575 ton/year, but in 1990, was reduced to 607 ton/year. The effect of fuel conversion and energy and resource saving was 89%, and the effect of emission gas treatment facilities was 11%. It is clear that the effect of fuel conversion, improvement of production facilities and processes, and energy and resource saving was higher than that of End of Pipe Method.

The introduction of these low-pollution production technologies (Cleaner Production or "CP" technology) was promoted in many factories in Kitakyushu City. In particular, the method to treat fuel gas from LD converters under non-burning conditions (OG Method) was developed in Kitakyushu City, and has been adopted all over the world.

Emission gas is produced when oxidation-reduction reactions occur in LD converters that are used in the steel making process and consist mainly of CO. Once, this gas was burned completely by supplying approached air or secondary air, and collected heat from a boiler tube passed through a wet type dust collector, and was dispersed into the air. Because this gas had a high temperature and high speed, it often caused abrasions in boiler

tubes and problems in wet type soot and dust collectors, leading to an adverse effect on the environmental effect.

Therefore, "S" Iron Mill developed a method to control fuel gas from LD converters under non-burning conditions (OG Method) rather than a large waste heat boiler. OG Method is an abbreviation of "Oxygen Converter Gas Recovery System"; it is a method to collect emission gas generated thorough the steel smelting process in oxygen converters without being burned and conversion of the emission gas into fuel gas. The merits of the OG Method are that the temperature of the emission gas is low and that the grain size of the dust is comparatively large enough to collect easily.

The OG Method could reduce the amount of discharged dust and improve the environment, while also contributing to energy saving by recycling collected gas as fuel.

② Introduction of natural gas for electric and steel industries

The power plants of the electric power companies had used coal from the neighboring Chikuho coalfield to supply the electrical demands of the Kitakyushu industrial area. However, from 1958 co-combustion of coal and heavy oil was promoted during the energy revolution. In 1973, this was switched to single fuel combustion of heavy oil with the reinforcement of environmental pollution control measures.

With the effects of Oil Shock in 1973, the introduction of liquefied natural gas (LNG) was planned to diversify fuel.

Electric companies and iron mills planned to build more LNG power plants, and the government favorably promoted this trend, due to the fact that the introduction of LNG could cut down the amount of SOx to zero and the government was looking to reduce SOx by the regulation of total emissions. However, the government was concerned that constructing more power plants with single fuel combustion of LNG would become an obstacle to achieve the environmental standard of NOx. Therefore, efforts were concentrated in reducing NOx; the enterprises installed flue gas denitrufication equipment, and Kitakyushu City established guidelines for NOx. From 1977 to 1983, 6 groups of power plants were constructed.

In Kitakyushu City, the amount of discharged SOx was greatly reduced, and the amount of discharged NOx could be controlled.

(2) Automobile pollution countermeasures

Related organizations and departments cooperate to carry out various measures such as automobile measures (improvement of automobile structures, promotion of low-pollution vehicles), automobile traffic measures (traffic distribution measures, physical distribution measures), and roadside measures (proper utilization of roadsides, obstacle preventive measures). These measures are based on the "Kitakyushu Basic Plan for Automobile Pollution Countermeasures" established in 1990.

Because of the increase of the number of diesel vehicles, there are some areas around highways where the amount of NOx and SPM is higher than the environmental standard; this means that air pollution from automobiles has not yet been solved. Recently, carbon dioxide (CO_2) discharged from automobiles is regarded as a factor in global warming, and CO_2 measures are needed very soon.

In 2002, city government organized "Kitakyushu Automobile Pollution Control Measurement Promoting Conference" and developed a system to promote automobile pollution control, together with citizens and private enterprises.

Through "Kitakyushu City Automobile Pollution Control Measures Third Mid-term Plan" enacted in 1989, Kitakyushu City tries to implement the attainable measures and promote the usage of low-pollution vehicles such as natural gas vehicles or electric vehicles.

3. Capacity development of the local government in urban air quality management

(1) Improvement plan by wind tunnel test and conclusion agreement on environmental pollution control program

From 1960, the plan to double the nation's income began, and the Japanese economy made rapid progress. Community development was promoted to address the gaps in various areas, but air pollution that used to be local and scattered, extended and became more serious throughout around Japan, because the laws to regulate environmental pollution had not been implemented at that time. Then, environmental pollutions became very important national problems to solve.

In Kitakyushu, dust fall in the Shiroyama Area (located between industrial areas (80 ton/km^2/month in 1965)) and SO_2 emissions rapidly became major social problems. In 1960, there were 24 complaints and petitions about environmental pollution, however in 1964 and 1970, complaints numbered 168 and 386, respectively. This means that with the intensification of environmental pollution, people's concerns about environmental pollution grew.

People residing around the Shiroyama Area, which was surrounded by the large-scale factories of the ceramic, chemical, and steel industries, were affected by dust fall or offensive odors.

Around Nakabaru and Sanroku Areas, which were located close to large-scale factories, an anti-pollution movement started by a local women's group which had suffered from the dust fall from power plants and smoke and soot from chemical factories began in 1950. Under the slogan, "We want our blue skies back", the women's group petitioned the government and called for enterprises to improve the environment, based on their own investigations and tests.

Then, Kitakyushu City became one of the target areas an industrial pollution general feasibility study conducted by the Ministry of International Trade and Industry in 1969. Investigations and studies were carried out by the Ministry of International Trade and Industry, Fukuoka Prefecture, target enterprises (those that used more than 5 kl/day of heavy oil, major 54 factories), and Kitakyushu City. Through these investigations, field surveys to prevent pollution before it occurs and scientific forecasts of future pollution conditions were developed to improve the enterprises' attitudes towards environmental pollutions. Reasons why Kitakyushu City was selected were that air pollution was already serious in the city and development projects were planned in the Hibikinada Area, located in the northern part of the city.

How much does the air that we breathe every day contain the smoke from each factory? Clarifying this problem was the most immediate and important to consider air pollution control measures, so Kitakyushu City implemented the latest scientific method - the wind tunnel test. In this method, the models of the geographical features and the buildings were reduced to a 1/2500 model, geographic features and building effects on the diffusion of the smoke was examined, and the diffusion condition of each chimney was measured. From this data, the total polymerized concentration pollutant was estimated.

The results of these wind tunnel tests showed that the contributed concentration was high because of large number of low chimneys; therefore, it became clear that if these chimneys were concentrated and heightened, pollution would improve greatly. Kitakyushu City then guided enterprises to develop improvement plans to achieve environmental standards with the goal that the maximum all polymerized landing concentration would be within 0.2ppm.

In 1973, Kitakyushu City, which had an objective to achieve environmental standards, concluded the "Agreement on Environmental Pollution Control on SOx" with 54 major factories to ensure that the factories would conduct improvement plans. Although there was criticism at that time that the increase of effective stack height only scatters pollution over a wider area, as a result this action contributed to air pollution control measures in Kitakyushu

City.

Until the enterprises concluded the agreement, they were apprehensive about the reinforcement of regulations by the government. Since smog warnings were announced, social eyes such as the mass media became strict; therefore, the agreement would be a merit for the enterprises to build more factories.

Because each enterprise kept the maximum landing concentration per industry, impartiality among enterprises was maintained, and enterprises could have choices in pollution control. Since the enterprises considered the attainability of their plans, the government expected that their plans were conducted smoothly. Also, as the diffused condition of atmospheric pollutant and the polluted condition were demonstrated concretely by the wind tunnel tests, the persuasiveness for the necessity to invest in environmental pollution control was reinforced, and had a major influence on the decision making process in each enterprise.

The general industrial pollution investigation using the wind tunnel tests was the first environmental assessment in Kitakyushu City to estimate the influences by new enterprises before the problem occurred and was a pioneer of environmental assessments in Japan.

(2) SOx Reduction through Special Weather Information

① Establishment of the Air Pollution Monitoring Center

From the 1960s, environmental pollution became severe; in particular air pollution was severe around Dokai Bay where many factories were located. At first, observation stations were established in Yahata and Tobata in 1964, and measurement instruments were set in public health centers.

In 1970, the air pollution monitoring center was established for a concentrated observation using telemeters and for quick actions in emergency cases. The center functions were enriched with the improvements of a measurement network and a new system was introduced in 1993.

② Transference of authority to City Mayor regarding smog warnings

Prefectural governors usually have the authority to issue smog warnings and alerts, but this authority was transferred to the mayor of Kitakyushu City in 1970. This was the only case in Japan. In Kitakyushu City, a total of 27 warnings and alerts were issued for SOx (smog warning (18 times) and alerts (9 times)), which was a main factor of air pollution at that time.

Smog warnings:	17 times in 1970, once in 1971
Smog alerts:	9 times in 1970

When the warnings and alerts based on Air Pollution Control Law were issued, the city ordered factories to reduce the amount of discharged dust and soot (20%-50%). However, once the concentration of air pollution became high, it tended to continue for a long time even though the factories reduced the amount of discharged dust, and it was difficult to see the effect of the reduction immediately. The government as well as the enterprises understood that air pollution should be treated immediately to prevent air pollution because it impacted on people's health and also disturbed the production activities of the enterprises. Furthermore, it took long time to lift the warnings and alerts in order to ascertain the improvement of smog conditions. If that type of situation continued for a long time, the factories would be severely affected.

③ Foundation of special weather information report system

Kitakyushu City developed an original system to report special weather information to the enterprises beforehand to promote earlier actions for pollution control when smog conditions were expected because of specific weather conditions, such as occurrence of sub-inversion layer.

Compared to the standard 0.15ppm of SOx warnings, under the special weather conditions,

the warnings were announced at 0.07ppm (one-half of the usual standard).

Kitakyushu City reported special weather conditions to the factories and requested a voluntary reduction of 20% of discharged dust, so the smog was reduced before it became serious. Also there was a merit that the factories could shorten the time to reduce production activities.

From 1971 to 1974, the special weather information was reported 95 times (1971—34 times, 1972—37 times, 1973—23 times, 1974—once).

In 1997, a warning regarding photochemical oxidants was announced once.

Although the reduction request based on special weather information was not compelling, it was an agreement between the government and the enterprises following comprehensive discussions. Because the city mayor had the authority to announce the warnings and alerts, requests for reduction worked effectively. This also supported the system in which Kitakyushu City checked the conditions of flue gas desulfurization equipment in the factories and confirmed the implementation process.

In these ways, the Air Pollution Monitoring Center, which observes the conditions of air pollution, has contributed to the improvement of air pollution by using a system to report warnings and alerts to large-scale target factories (approximately 30 factories) and request the reduction of the amount of discharged dust in cases of emergency.

4. Conclusion

Once Kitakyushu City suffered from serious pollution as a result of high economic growth, but cooperation with citizens, enterprises, research institutes and the local government have contributed to the solutions for air pollution, as well as the collection of valuable technologies and experiences.

Now Kitakyushu promotes international environmental cooperation utilizing these achievements, and has developed technologies and trained people through its own process of overcoming pollution. In particular, Kitakyushu City implements international cooperation activities such as acceptance of trainees from developing countries, dispatching of experts, organization of international meetings, and joint enterprises. The city accepted 1,208 trainees from 79 different countries as of 2001, and supports and contributes to environmental improvement in Dalian Model Environmental Zone in China.

At the Johannesburg Summit 2002, Kitakyushu City was recognized as a "World's Environmental Model City." Regarding it as a successful result, we want to work actively for the network cooperation among cities in the proper field for each city to promote Kitakyushu Initiative.

References:

1) "Kitakyushu Statistical Yearbook, Fiscal Year 2001", City of Kitakyushu (2002)
2) "Japan Statistical Yearbook, 51st Edition", Statistic Bureau, Ministry of Public Management, Home Affairs, Post and Telecommunications (2002)
3) "Kitakyushu's Environment (Environment White Paper), Fiscal Year 2002", Environment Bureau, City of Kitakyushu (2002)
4) "Steps of Pollution Administration: 10 years following the establishment of pollution control stations", Air Pollution Countermeasures Bureau, City of Kitakyushu (1981)
5) "Japan's Experience in Urban Environmental Management: Case Studies, Kitakyushu Report", MEIP Kitakyushu Committee (1993)
6) "Pollution Countermeasures of the City of Kitakyushu, Japan", City of Kitakyushu (1999)