Chapter 9 TRANSACTIONS FOR WATER POLLUTION CONTROL AND RESULTS

1. Effluent Pollution Control and Standards

1.1 Enforcement system

In general, measures taken by the national and prefectural governments to control water pollution and to maintain the water quality of water bodies within the set standards include strict regulation of discharges, expansion and improvement of sewerage systems and treatment facilities, river flow improvement and dredging, and environmental impact assessment of new projects and facilities. A typical river water management practice at the prefectural level will be presented later using the experience of Kanagawa Prefecture and Shiga Prefecture.

The Japan's administration of water quality management is handled by the Environment Agency which was established in 1971 as a ministry. The Director General of the Agency is a Minister of State who is a member of the Cabinet. The Agency is responsible for the coordination and promotion of the protection of the environment as well as the implementation of pollution control. In the field of water quality management, the main role of the Agency is as follows: enforcement of the Water Pollution Control Law and some other laws relating to water quality management; establishment and amendment of the standards including the Environmental Water Quality Standards and the nationwide Effluent Quality Standards; and the promotion of research for water pollution control.

Some ministries of the national government also have responsibilities related to water quality management. The Ministry of Health and Welfare is responsible for waste disposal and night soil treatment as well as for the protection of the drinking water system. The Ministry of International Trade and Industry is responsible for research on environmental conservation and technology and the promotion of various environment-friendly industries. The Ministry of Transport is in charge of the prevention of marine pollution by shipping. The Ministry of Construction is responsible for the sewerage system and for flood control and river flow management systems. Other ministries with responsibilities related to water quality management are the Ministry of Agriculture, Forestry and Fisheries and the Ministry of Foreign Affairs.

Prefectural governments are also playing very important roles in environmental water quality management. Their responsibilities include establishing more stringent standards, as mentioned earlier; inspection of specified factories and regulating the effluents discharged by those firms; and establishing and implementing the environmental water quality monitoring program in their localities.

Aside from prefectural governments, city governments in 71 cities specified in the Water Pollution Control Law as "designated cities" are empowered to inspect and regulate the effluent discharges of factories in their respective areas. To illustrate the water quality management practices of Japan's prefectural governments, the experience in Kanagawa Prefecture is included in this chapter.

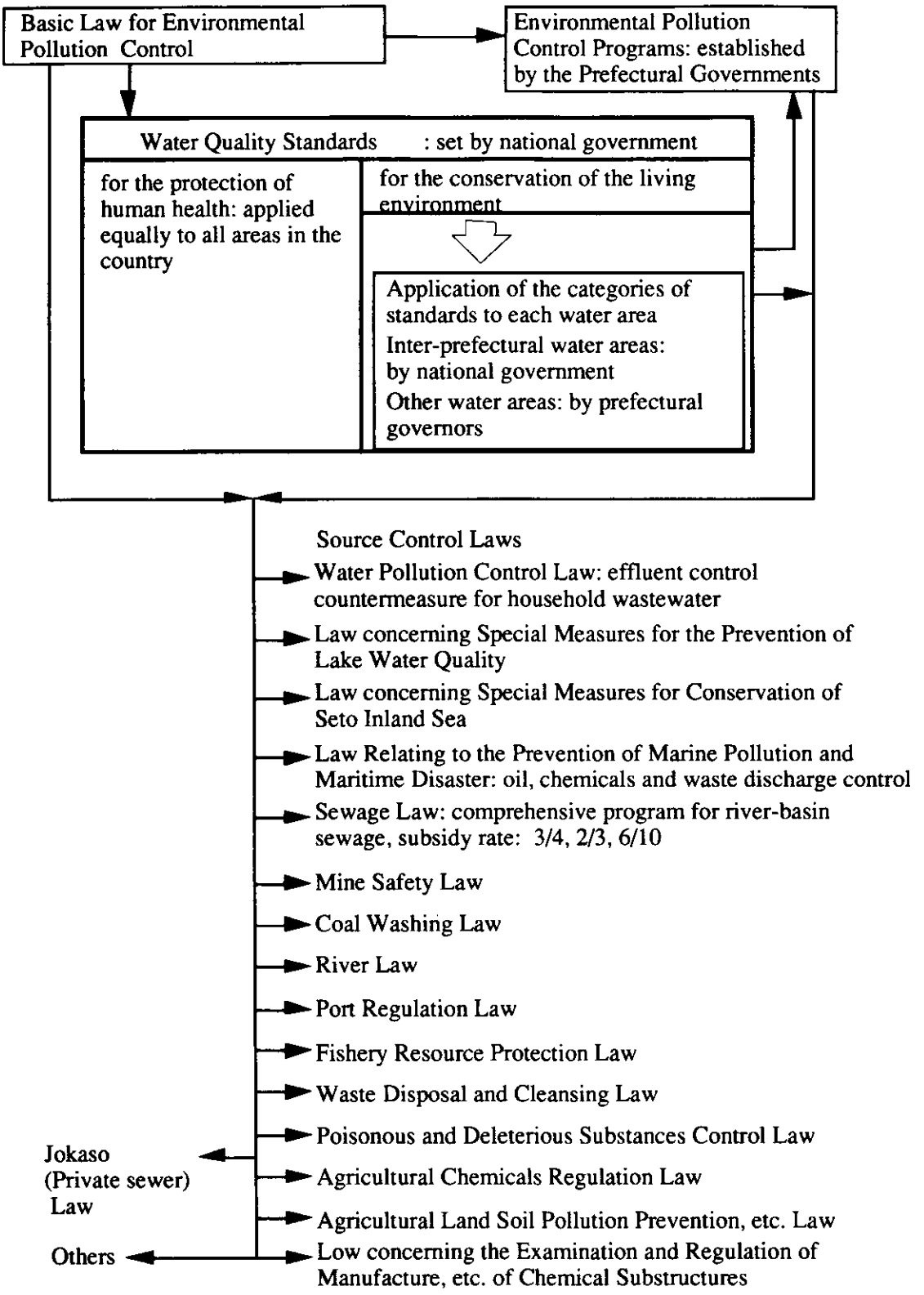

Fig.9-1 Legal System for Water Quality Management.

1.2 Designation of specified factories and establishments

Effluent wastewaters from factories and establishments are widely regulated regardless of kind of industries. Factories and establishments those discharge wastewater into public water areas are designated as "specified factories" based upon the criteria shown in Table 9-1. The effluent from those specified factories are strictly regulated by applying the effluent water quality standard set up by the central government or by more stringent standard set up by local government based upon the Water Pollution Control Law.

Table 9-1 Designation of Specified Factories

Date Specified	Specified Factories
Oct.1 '72	Livestock facilities except smaller than 50 m2 for pig, 200 m2 for cow and 500m^2 for house
Dec.1 '74	1.Spinning facilities, textile and fiber processing facilities for desizing 2.Kitchen, laundering facilities and bath of Japanese style inn 3.Cleaning facilities and quenching in research institute, experimental stations
Jan.3 '86	Vocational training school
June 1'86	Facilities for water works and industrial water works with sedimentation and filtration. Capacity of which is larger than 10000m^3/day Wholesale market dealing aquatic products.
May 5 '79	Kitchen, laundering facilities and bath of hospital with beds more than 300 Incineration facilities of Municipal wastes treatment plant
Jan.1 '82	Frozen food processing factories with washing, cooking and unpacking. Cigarette factories with washing and deodorization by water washing Sawmill and wood chipping with glue washing facilities Plywood processing factories with wet barker and washing facilities New paper, publishing, printing, plate makers with automatic film developing facility and automatic printing facility. Tire and tube manufactures, rubber horse manufactures, industrial rubber product manufactures, reforming tire manufactures with vulcanization process Latex forming facility with washing for medical and sanitary rubber products, rubber gloves, rubber band, etc. Automatic bottle washing facilities for reuse Car washing facility in auto shop Industrial wastes treatment and disposal facilities
July 1 '82	Wholesale market in regional cities with floor area larger than 1000 m^2

1.3 Effluent water quality standard

Effluent standards are set in terms of permissible concentration of each harmful or environment polluting substance for protecting human health and each parameter for preserving the living environment. Effluent standards are classified into common national standards set up by the central government and the more stringent effluent standards set up by the local government, i.e. Prefecture. The national effluent standards, which is common nation-widely, shall be set by the Prime Minister's Office Order as shown in Table 9-2.

Table 9-2 National Effluent Standards for Rivers (mg/L or less)

a) Standards related to the preservation of the living environment

(mg/L or less except pH)

Parameters	Standard Values
pH	5.8 - 8.6 5.0 - 9.0 (for estuaries)
BOD, COD*	160 (daily average: 120)
SS	200 (daily average: 150)
n-Hexane extract	5.0 (mineral oil) 30 (animal fat and vegetable oil)
Phenols	5.0
Cu	3.0
Zn	5.0
Dissolved iron	10.0
Dissolved manganese	10.0
Cr	2.0
F	15.0
Number of coliform groups	3,000/mL (daily average)
Nitrogen	120 (daily average: 60)
Phosphorus	16 (daily average: 8)

* COD is applied to lakes and estuaries

b) Standards related to the protection of human health (mg/L or less)

Parameters	Standard Criteria
Cd and compounds	0.1
CN and compounds	1.0
Organic phosphorus (Parathion, Methylparathion, Methyl dimethion and EPN)	1.0
Pb and compounds	0.1
Cr (VI) and compounds	0.5
As and compounds	0.1
Hg (total)	0.005
Hg (alkyl)	ND.
PCBs	0.003
Trichloroethylene	0.3
Tetrachloroethylene	0.1
Dichloromethane	0.2
Carbon tetrachloride	0.02
1,2-dichloroethane	0.04
1,1-dicloroethylene	0.2
cis-1,2-dichloroethylene	0.4
1,1,1-trichloroethane	3
1,1,2-trichloroethane	0.06
1,3-dichloropropene	0.02
Thiuram	0.06
Simazine	0.03
Thiobencarb	0.2
Benzene	0.1
Selenium and compounds	0.1

For Public water areas where it is reorganized that the national effluent standards are insufficient for protecting human health to preserve the environment water quality for Cabinet Order effluent water quality and/or for preserving the living environment to attain the environmental quality standards of water, the water pollution control law provides that the more stringent effluent standards may be decided by enacting necessary prefectural regulations in accordance with the national standards. Examples of more stringent effluent water quality standard set up by Kanagawa Prefecture and by Shiga Prefecture are shown in Table 9-3.

Table 9-3 More Stringent Effluent Water Quality Standards by Local governments (Kanagawa Prefecture and Shiga Prefecture).

Parameters	Kanagawa Prefecture			Shiga prefecture
	"A" area	"B" area	Sea	
Cd & its compounds	ND	/	/	0.01
CN compounds	-	/	/	0.1
Organic phosphorus compounds	ND	0.2	0.2	ND
Pb and its compounds	0.05	/	/	0.1
Cr (VI)	0.05	/	/	0.05
As and its compounds	0.01	/	/	0.05
Hg (total)	/	/	/	0.005
Hg (alkyl) compounds	/	/	/	ND
PCBs	/	/	/	0.003
pH	/	/	5.8 ~ 8.6	6.0~8.5
BOD	15 (10)	25 (20)	/	70~100* 50~80#
COD	15 (10)	25 (20)	25 (20)	70~120* 50~80#
SS	35 (20)	70 (40)	70 (40)	90* 70#
n-Hexane extracts (mineral oil)	3	/	/	5
do. (animal fat & vegetable oil)	3	5	5	20
Phenols	0.005	0.5	0.5	1
Cu	1	1	1	1
Zn	1	1	1	1
Dissolved iron	0.3	3	3	10
Dissolved manganese	0.3	1	1	10
Cr	0.1	/	/	0.1
Fl	0.8	/	/	8
Number of coliform group (/ml)	/	/	/	3000
(Ni)	0.3	1	1	/

ND: Not detectable, - : Prohibited to discharge by other Kanagawa Prefectural Ordinances

( ) : Daily average (Ni): Regulated by other Kanagawa Prefectural Ordinances

*Wastewatar: 30~50m^3/day. #Wastewatar > 50m^3/day

Kanagawa Prefecture is located immediately to the south of Tokyo and is part of the national capital region. It is one of the smallest of Japan's 47 prefectures but has the third largest population, centered in Japan's third largest city, Yokohama. Kanagawa has three international ports and thousands of industries, especially the so-called high-tech ones, located

within its boundaries. Kanagawa was among the first prefectures to handle industrial pollution control. Environmental Research Center (ERC) was established by the prefectural government. The ERC is entrusted with tasks related to water quality management such as monitoring of water bodies, inspection and regulation of industrial effluents, research to improve or enhance pollution control measures and others.

Shiga prefecture, located immediately to the north-east of Kyoto and Osaka Prefectures, centered in Japan's biggest lake, Biwa Lake. The lake supplies the industrial and drinking waters to Osaka and Kyoto Prefectures, whereas the quality of water in it has been deteriorated lately due to the urbanization and the industrialization in the surrounding area. Water pollution is one of the serious problems in each prefecture.

2. Countermeasures to Preserve Sound Water Environment

The government of Kanagawa had enacted a Prefectural Ordinance to Prevent Pollution, a Effluent Concentration Regulations Ordinance and a Areawide Total Pollution Load Regulation Ordinance. Its Effluent Standards are more stringent than the national standards (compare Tables 9-2 with 9-3). The prefectural government, through the Environment Research Center (ERC) of Kanagawa Prefecture, has also established a regular monitoring program of all public waters, including groundwater, in the prefecture. Monitoring points, monitoring parameters and monitoring frequencies are given in Table 9-4 and 9-5.

Table 9-4 Monitoring Parameters.

Categories	Parameters
Human health	Cd, CN, Pb, Cr (VI), As, Hg (total), Hg (alkyl), PCBs, Trichloroethylene, Tetrachloroethylene, Dichloromethane, Carbon tetrachloride, 1,2-Dichloroethane, 1,1-Dichloroethylene, Cis-1,2-Dichloroethylene, 1,1,1-Trichloroethane, 1,1,2-Trichloroethane, 1,3-Dichloropropene, Thiuram, Simazine, Thiobencarb, Benzene, Selenium and compounds,
Living environment	pH, BOD, COD_{Mn}, SS, DO, Number of Coliforms, n-Hexane extracts, Total nitrogen, Total phosphorus
Special items	Phenols, Copper, Zinc, Dissolved ion, Dissolved manganese, Chromium, Fluorine, Nickel, ENP
Other items	Ammoniacal nitrogen, Nitrite, Nitrate, Phosphorus, Chloric ion, Salts, 1,1,1-Trichloroethane, Anionic surfactant, Chlorophyl a
Physical items	Weather, Weather of previous day, Water depth, Sampling depth, Water flow rate, Flow, Atmospheric temperature

Table 9-5 Monitoring Frequency of Water Quality in Rivers, Lakes and Seas Implemented in Kanagawa Prefecture.

Site	Frequencies
River	4 times a day at 6 hourly intervals each month and 48 times (12 days) a year
Lake and Sea	Once a day from the upper and the lower layers of water each month and 12 times a year

Pollution control measures undertaken by Kanagawa prefectural government are as follows:

1)regulating factories based on laws and ordinances;
2)maintenance and construction of additional sewerage and sewage treatment systems;
3)aeration of Sagami Lake;
4)water quality purification in waterways; and control of pollution from new high-tech industries.

Reports which indicate pollution control plans and measures are required for all factories and establishments discharging effluents into public water bodies. Such reports are examined, and the establishments inspected by the government through the ERC, before operating approval is given. Administrative disposition or guidance has been used to correct pollution problems by those establishments found violating the set standards for effluents.

To support the governmental system of environmental guidance and regulation of industries, the government has instituted a system of Pollution Control Officers (PCO) in all designated industries. The PCOs have been given the task of supervising the control of pollutants in the plants, more specifically to ensure that effluents released to water bodies are within the set standards. To become a PCO, one has to pass a qualifying examination administered by the Ministry of International Trade and Industry. There are several levels of PCOs ranging from supervisors to managers of different staff which are designated by the firms, especially in large establishments, to handle pollution control. The prefectural government institutes educational meetings yearly or more frequently for lower-level PCOs, to update their knowledge and skill in pollution control.

The prefectural government has been constructing and maintaining sewerage systems, treatment plants and special tanks for night soil and household wastewater to control pollution from domestic sources. To date, 79.4% of the population is served by a sewerage system. The cities of Yokohama and Kawasaki are almost completely sewered.

The government of Kanagawa, through the ERC, has also started studying and monitoring chemical pollutants from high-tech industrial firms such as those engaged in electronics, new materials technology and biotechnology. The government has given guidance and information on the safe use of some chemicals used in these plants. The monitoring of some chemical substances, such as tetrachloroethylene which penetrates the soil and accumulates in the groundwater, had also been conducted by the ERC. Research on how the pollutants are produced and proper disposal procedures is conducted on these chemical pollutants.

The efforts of the prefectural government in Kanagawa have produced positive results. The water quality of public water bodies in this area has been improving. The health of the people has been protected and the living environment has been conserved.

3.Countermeasures Taken in Industries

Figure 9-2 shows the combination of production process and wastewater treatment process. The top figure shows the conventional, i.e., previous type combination, where the wastewaters from each unit production process are mixed and treated with together. Additional and complicated treatment processes could be required to meet the more stringent regulation applied to the effluent. No advantage is available to introduce such wastewater treatment process for the production side since productivity is not improved by the introduction of such treatment process. The bottom figure shows the production process combined with on-site wastewater treatment and recycle system. Pollutants discharged from each unit process will be easily removed by the corresponding and simple treatment process and the effluent can be recycled for the same unit process. The amount of industrial water required for the production can be reduced by the reuse of treated wastewater. Moreover the wastewater treatment process can be simplified by incorporating the on-site treatment because the wastewaters are treated separately without mixing.

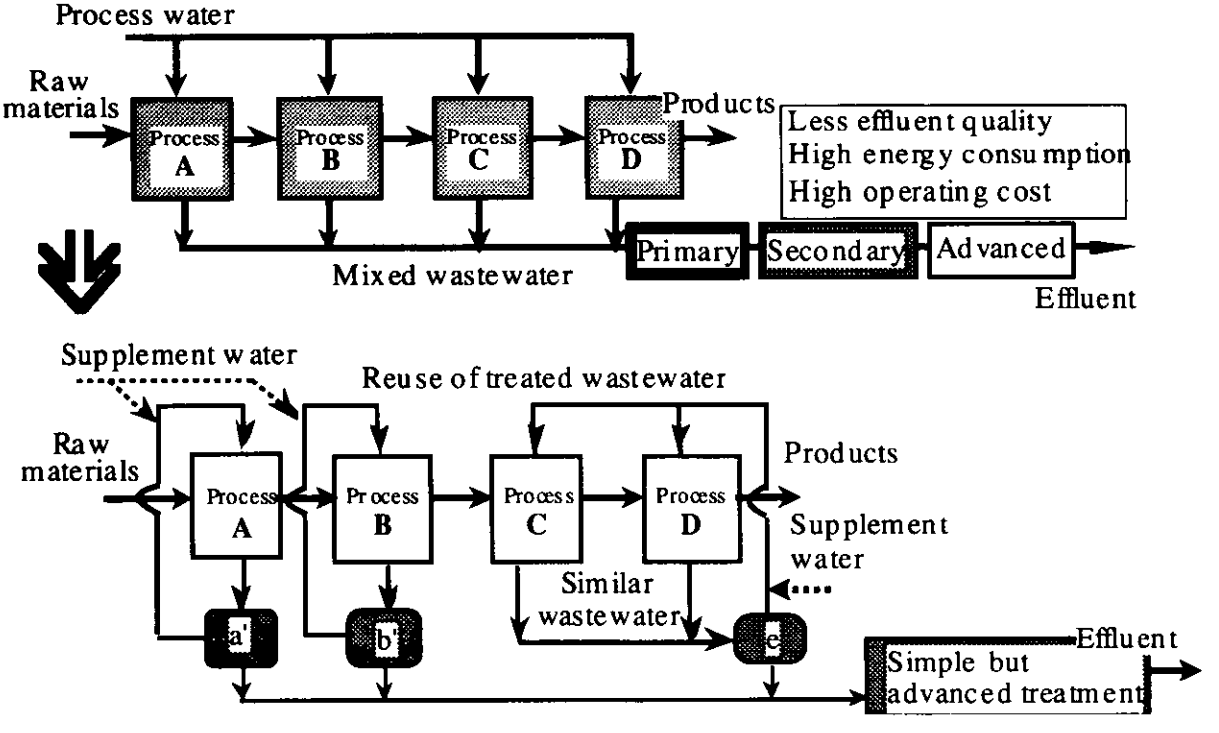

Fig.9-2 Onsite wastewater treatment and recycle system

Table 9-6 shows an example in the reduction of wastewater discharged from polymerization process. The counter measures have taken to reduce the wastewaters from the process are summarized in the table. The amount of wastewater from the polymerization process was drastically reduced by the introduction of onsite wastewater treatment process with recycle.

Table 9-6 Reduction of the wastewaters from polymerization process

Month & Year	Jan. 1965	Jan 1973	Nov. 1973	Feb. 1974
Wastewater (m^3/t-polymer)	36.2	17.0	8.8	0.2
Counter measure	(A)	(B)	(C)	

(A)Increase in polymer concentration in liquid, (B)Wastewater recycle from separation process, (C)Wastewater recycle from catalyst washing and polymer drying processes.

Information on the constituents of raw and supplemental materials in the production process and the constituents in the wastewaters are very much useful to improve the production process. Wastewater discharge was reduced by introducing counter current washing system as shown in Fig.9-3. Note that the fresh washing water is supplied counter currently to the products.

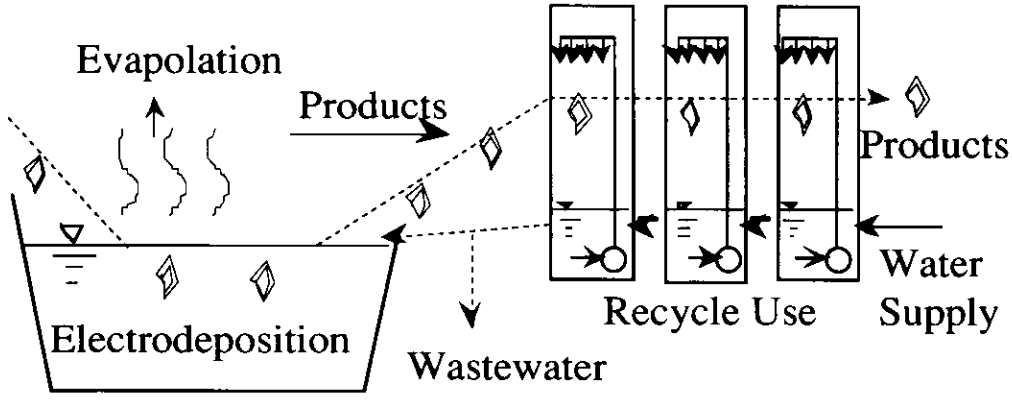

Fig.9-3 Counter current washing system for reduction of washing water

Production process should be replaced with an alternative process to reduce or to eliminate the pollutants discharge. Electrolysis using mercury electrode to produce sodium hydroxide and chlorine from sodium chloride was replaced that with the electrolysis using ion exchange membrane to eliminate the wastewater containing toxic mercury. Wastewaters from polymerization process can be eliminated by replacing the liquid phase polymerization with the gas phase or bulk polymerization processes.

Any materials including raw and sub-materials (supplemental materials for production) used in production processes should be totally managed appropriately to know the input and the output in the factory. Total management system of materials should be introduced to reduce the excess use of materials and to know the effluent discharge, i.e., the wastes, from the production process. Then we can expect the amount of wastes from the process in the forms of gas, liquid and solid by subtracting the mass of products from the input. Once such total management system is introduced, it is easy to know the constituents and the concentration of pollutants in the wastewater, exhaust gas and in the solid wastes. In case some materials are difficult to treat, those should be removed from the input readily. Pre-evaluation system of materials and supplements used in factories should be preliminary evaluated from view point of environmental pollution loading before using.

4. Effect of Countermeasures for Water Quality Management in Japan

4.1 Sewerage system and household treatment tank

Figure 9-4 shows the diffusion of sewerage system and household treatment tank (Jokaso) for municipal wastewater treatments.More than 50 % domestic wastewater is accepted by municipal plant with secondary or more advanced treatment system. The household treatment tank shears about 30 % domestic wastewater to treat. Night soil collected from the privy is treated by treatment plant with advanced system exclusively used for night soil.

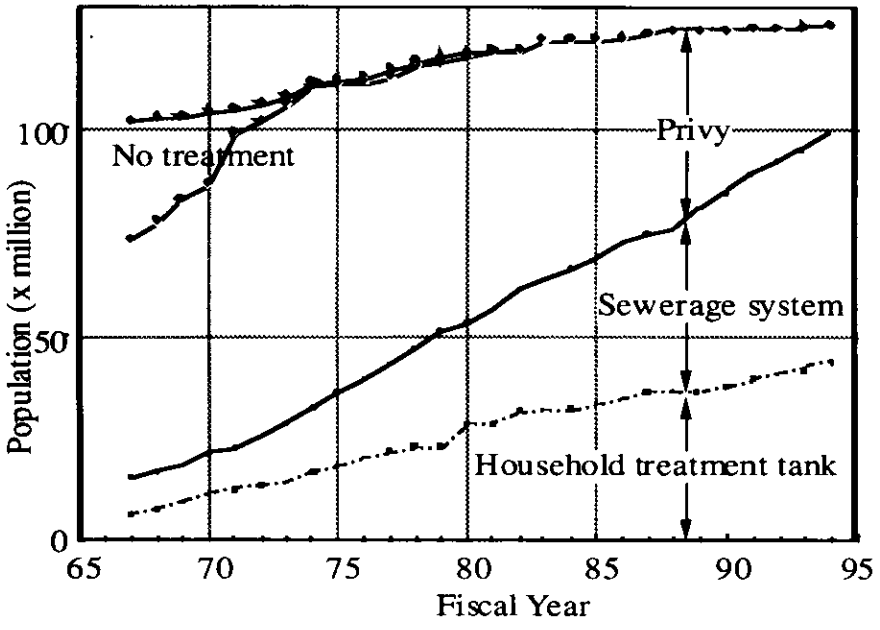

Fig.9-4 Diffusion of sewerage system and household treatment tank for domestic wastewater treatment.

4.2 Reduction of Industrial Wastewater with Recycle Use

The more stringent water pollution control regulation and two times energy crises brought about the reduction of water usage in factories for production. Figures 9-5 and 9-6 show the required amount of water for the production of commodities in Japan for past 25 years. Required water for production was reduced to one-third for the past 25 years. Appreciable reductions can be seen in the pulp and food industries.

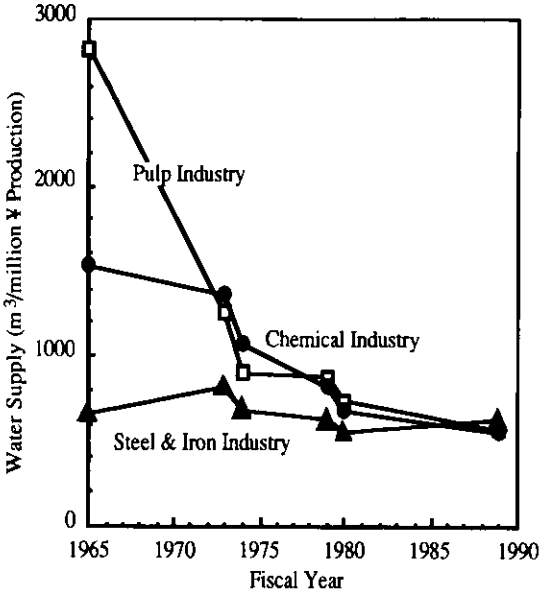

Fig.9-5 Water use in production processes

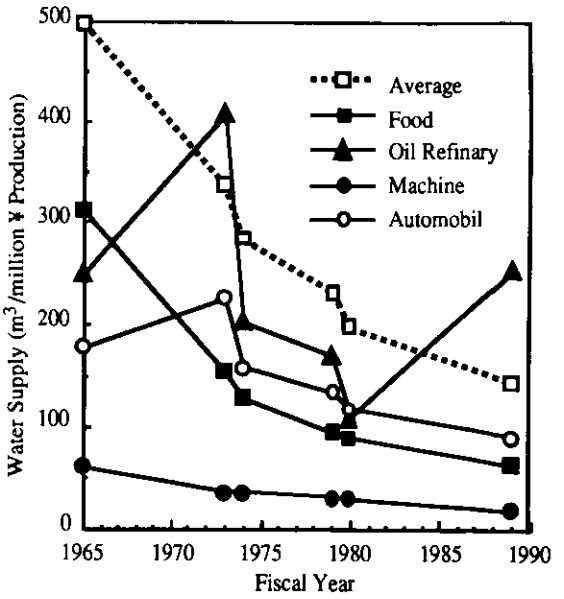

Fig.9-6 Water use in production processes

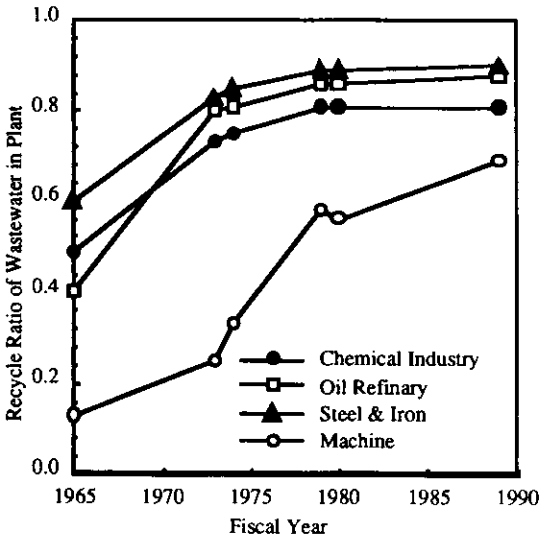

Fig.9-7 Recycle ratio of wastewater in plant

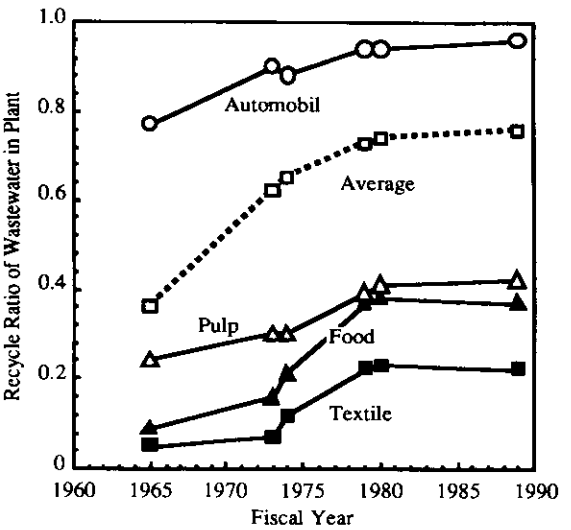

Fig.9-8 Recycle ratio of wastewater in plant

Figures 9-7 and 9-8 show the recycle ratio of wastewater to the production process after appropriate treatment in the plant. The recycle ratios in steel and iron industries, oil refinery plants, chemical industries and automobile industries are as high as 80% through 90%. The recycle ratio, however, in pulp, food and textile industries are still low compared to the average recycle ratio in Japan, i.e. 75% in 1990. Appreciable increase in the recycle rations has been attained through two times oil crises, i.e. 1973 and 1979 as shown in Figs.9-3 through 9-6. The oil crisis brought about the conservation of energy and the increase in the recycle ratio of wastewater in plants as well.

Figure 9-9 shows the water consumption by industries in Japan. More than 100 million m3 of water is used for the production. Large part is occupied by steel and iron industries, chemical industries and pulp and paper industries.

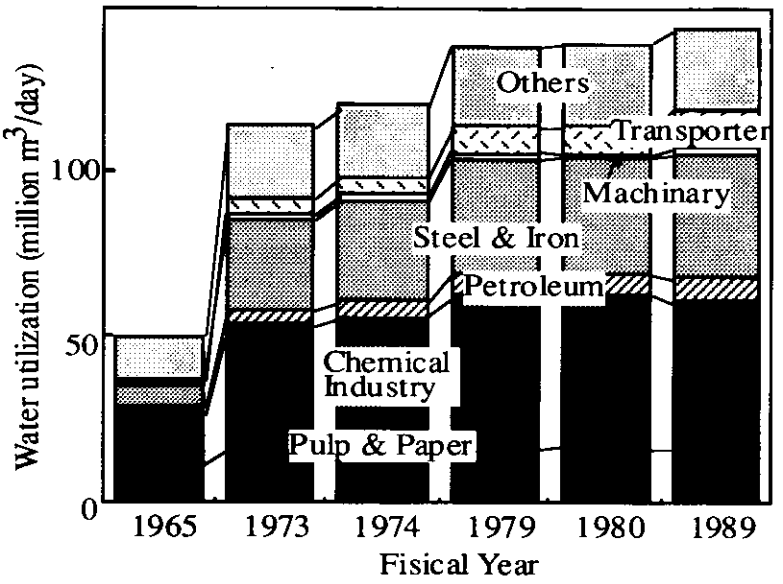

Fig.9-9 Water utilization by industries in Japan

4.3 Compliance to the Environment Quality Standards for Water Area

Due to the countermeasure for the management of water quality in the rivers, recently, there has been a general improvement in terms of controlling water pollution and raising the water quality of rivers and other water bodies in Japan. In particular, the levels of toxic substances, such as cadmium and cyanide, have decreased remarkably in water bodies (see Fig.9-10). The improvement of river water quality in terms of a reduction of organic waste pollutants is also seen in rivers. The compliance ratio with respect to environmental quality standards for BOD and COD in various aquatic environments is increasing as seen in Fig.9-11.

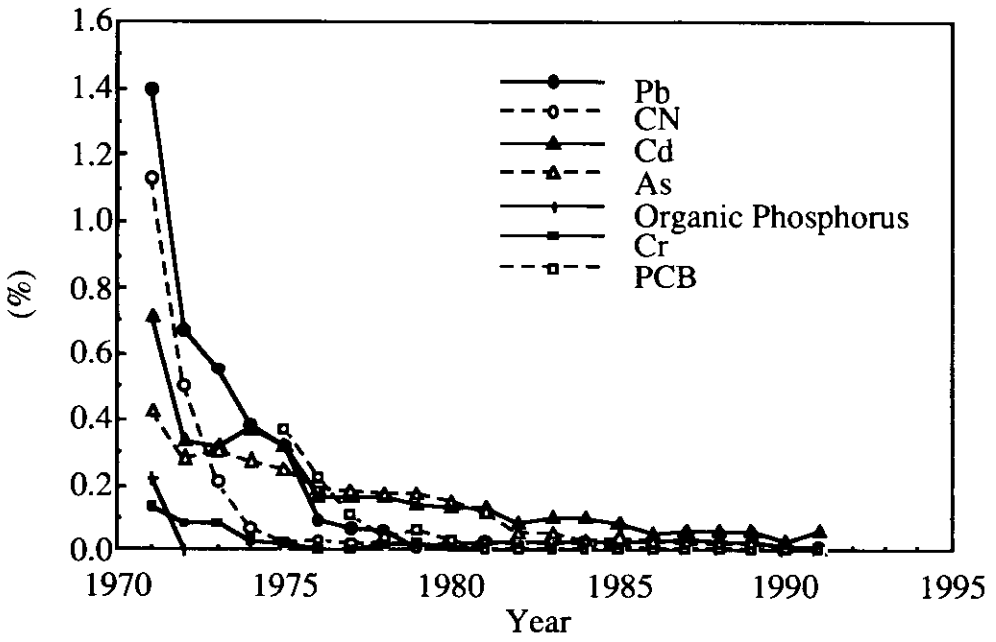

Fig.9-10 Non-compliance Ratio to the Water Quality Standards of Toxic Substances.

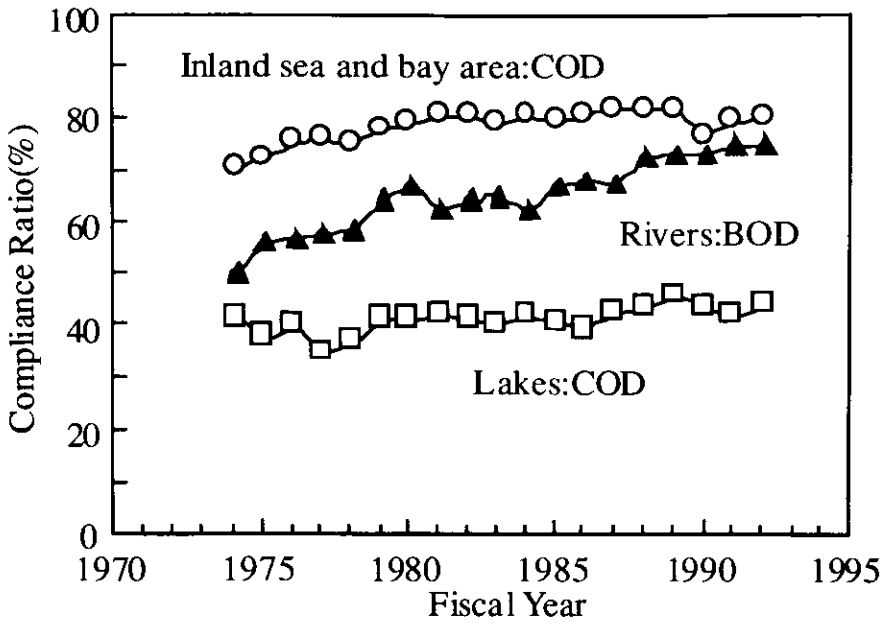

Fig.9-11 Compliance ration to the water quality standards of BOD in rivers and COD in lakes and bays.