Chapter 5 ENVIRONMENTAL QUALITY STANDARDS FOR WATERS

--- STANDARDS RELATED TO CONSERVATION OF LIVING ENVIRONMENT ---

1. Basic Concept for the Legislation

1.1 Background

Under the Basic Environment Law, environmental water quality standards consist of items that deal mainly with the protection of human health and conservation of living environment. For the protection of human health uniform standards were set for all public water bodies, while for the conservation of living environment the standards were set considering the type of water body and its water use.

Public water bodies can be categorized into three kinds that are rivers, Lakes and coastal waters. Each type of water body is further categorized into several groups, based on the water usage, and the standards were fixed for each group.

The classification method was introduced for the conservation of living environment, because the standards should be associated with wide and diverse water usage. In other words, it is considered inappropriate to set a uniform standard for water pollution control. The word "living environment" is defined as wider than usual, because it include properties of natural living things deeply related to human life and its surrounding environment. Domestic and industrial water supply, agriculture and fishery are within the range of the definition.

Therefore, each water category corresponds to various purposes such as conservation of natural environment, water supply, fishery, industrial water, agriculture and water conservation of environment. The categorization and classification were carried out referring exiting standards and establishing standards at the same time, as listed below.

1) Standards for fishery (1965)
2) Drinking water standards (1970)
3) Standards for agricultural water (1970)
4) Standards for industry water (1971)

Six categories for rivers, four categories for lakes, and three categories for coastal waters were set for the standards. Later nitrogen and phosphorus standards were included for lakes and coastal waters to deal with eutrophication problem.

1.2 Standards as an Administrative Goal

The environmental water quality standard is an administrative goal or regulations that express a desirable situation maintained. However it is not simply an ideal vision but the goal which should be attained and maintained by implementing effective measures.

From the viewpoint of living environment, the standards should be satisfied under normal conditions. Under exceptional conditions such as drought, the standards might not be satisfied. Although it is possible to set standards as the maximum allowable limit, and the established standard were taken as desired one to be maintained. Therefore, in case of less pollution, the standards should established not such that causing deterioration of water environment.

1.3 Designation of category of Water Bodies

Water bodies can be classified into different groups according to the water use. The different categories were designated in 1971, since then, these are authorized by prefecture authorities, except 47 interstate water regions, i.e., 37 rivers such as Kitakami river and 10 coastal waters including Tokyo Bay.

Before designation of each category the following points were considered.

* Water Pollution problems
* Present as well as future water usage
* Pollution conditions and the location of pollution source
* Categorization of water body according to the present level of pollution
* Designation of compliance period according to the present status of pollution control technologies.

1.4 Compliance Period

It is defined in Notification Letter no. 126 from environmental agency 1985. Water quality standard is an administrative goal therefore the determined period to achieve the desired level of water quality is needed. But the determined or compliance period should not be considered as established or fixed time, but it should be enforced as early as possible but for the protection of human health. For the conservation of living environment, the compliance period should be defined according to the present level of pollution, population and industrial developments. The normal compliance period should be no further than five years, if in case it is not possible to achieve the desired water quality standards within five years, relaxation of extra 5 years can be provided but the final period should be fixed. Each water body has its own characteristics. Therefore compliance period will have to be individually tailored.

In case of Lake Water quality, if the desired standards would not achieved within 10 years, the government has to set a tentative pollution level for the next five-year period and then the level should be subsequently improved. The water bodies excluding in previous, once the water quality standard were set, the water pollution control should be hastened to achieve better standards. In 1995, more than 40% of polluted water bodies in Japan were applied for certain compliance period.

1.5 Amendment/rechecking of Water Quality Standards

The water quality standards should not rigidly fixed; it can be amended considering following viewpoints.

1. Improvement and amendment in water quality standards based on rational and scientific approaches.
2. Incorporation of additional water quality parameters, according to the additional pollution source, example organochlorines (pesticide) and arsenic and lead for human health.
3. Exclusion of water quality parameters that are banned, such as organophosphorus pesticides were omitted to use, their standards would be excluded.
4. Changes in water use
5. Considering compliance period according to the usage
6. If present standard is at higher level but the specified category was lower, the category should be increased to the higher one. In Japan about 20 years ago, usage of many water bodies were changed, but standards were not amended only until recently, amendment in standards were made for water bodies having inconsistency in present water usage and the designated category of water quality standard. Nitrogen and phosphorus standards were added to prevent coastal water and lakes eutrophication

2. Water quality standards for different water bodies

The water quality items considered are pH, DO, BOD, COD, Coliform groups and N-Hexane Extract. Total Nitrogen and Phosphorus were added to standards to prevent eutrophication in lakes in 1982 and for coastal waters in 1993 respectively.

The following points were considered for selecting the water quality items.

1) Several common water quality items were considered to establish ambient water quality standards. Less common items such as electric conductivity, Total Nitrogen, color, manganese and irons are not considered

2) pH and DO are important parameters for agriculture use of river and lakes waters while Ecoli and COD for coastal waters. Oil has also been added as a standard for coastal waters, because of important significance for fisheries.

3) BOD for rivers and COD for lakes and coastal water were taken as index of organic pollution, COD is selected for lakes and coastal waters instead of BOD, because of following reasons.

* The lack of BOD monitoring data compared to COD (Mn).
* Mostly COD (Mn) data is available at intake of water treatment plants to account the quality of raw water for drinking purpose.
* For coastal water alkali-permanganate method was quite commonly used to monitor the organic pollution, therefore when standards were established, these points were taken into consideration.
* Standard method for BOD analysis for sea and Lake Waters are also not well established. COD is considered more suitable than BOD, as it can account the organic pollution due to phytoplanktons.
* In the closed water bodies such as lakes, because of long retention time, biological degradation of organic matter is also different i.e., much slowly than rivers, therefore five day BOD test was not found suitable, COD is rather proper for organic pollution index.
* Although there is a limited data to correlate COD (Mn) and BOD, as shown in Fig. 5.1, and also no fixed relationship between the two was observed.

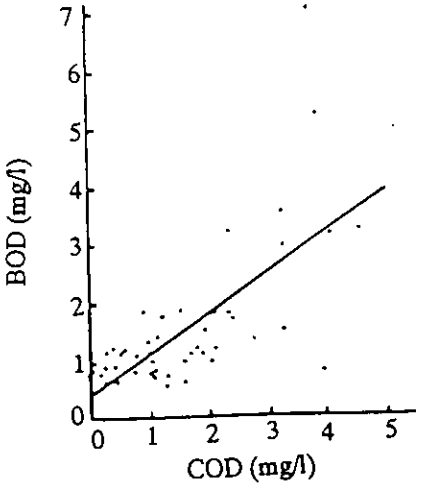

Fig. 5.1 Relationship between BOD and COD_{Mn} for Coastal Waters

2.1 Water Quality Standards for River

Water quality standards for river are listed in Table 5.1. Five important water quality items such as pH and BOD, and six categories from AA to E. Reservoirs of capacity less than 10 million cubic meters have been dealt as a river instead of lake. All standards are defined as the daily average values. The reason for the standard for each item were described as following:

TABLE 5-1 Water quality standards for river related to the conservation of the living environment

Category	Item / Purposes of water use	Standard values				
		pH	BOD	SS	DO	Number of coliform groups
AA	Water supply, class 1 conservation of natural environment, and uses listed in A-E	6.5-8.5	1mg/ℓ or less	25mg/ℓ or less	7.5mg/ℓ or more	50MPN/100ml or less
A	Water supply, class 2 fishery, class 1 bathing and uses listed in B-E	6.5-8.5	2mg/ℓ or less	25mg/ℓ or less	7.5mg/ℓ or more	1000MPN/100ml or less
B	Water supply, class 3 fishery, class 2 and uses listed in C-E	6.5-8.5	3mg/ℓ or less	25mg/ℓ or less	5mg/ℓ or more	5000MPN/100ml or less
C	Fishery, class 3 industrial water, class and uses listed in D-E	6.5-8.5	5mg/ℓ or less	50mg/ℓ or less	5mg/ℓ or more	–
D	Industrial water, class agricultural water and uses listed in E	6.0-8.5	8mg/ℓ or less	100mg/ℓ or less	2mg/ℓ or more	–
E	Industrial water, class conservation of the environment	6.0-8.5	10mg/ℓ or less	Floating Matter such as garbage should not be observed	2mg/ℓ or more	–

(BOD : Biochemical Oxygen Demand, SS : Suspended Solids, DO : Dissolved Oxygen)

Notes : 1.The standard value is based on the daily average value. The same applies to the standard values of lakes and coastal waters.

2.At intake for agriculture, ph shall be between 6. 0 and 7. 5 and DO shall not be less than 5mg/ℓ The same applies to the standard values of lakes.

1) pH

Generally pH of the rivers in Japan is around 7, barring estuaries. As it can be shown in Figure 5.2, at most water intake facilities of more than 5000 m3/days, pH was around 7.0. pH above than 8.5, interferes chlorination in water treatment plant as well as causes corrosion in distribution system. To ensure prevention of corrosion in treatment plant and distribution system pH range 6.5-8.5 is desirable. pH outside the abovementioned range also causes irritation of eyes of swimmer and also retards the growth of plants and marine organisms. Low pH affects the root of rice plant owing to the dissolution of salts, while high pH causes decoloration of leaves. Generally speaking the optimum pH range for proper plant growth should between 6.5-7.5, therefore pH standard at the intake point for agriculture use is set as 6.0-7.5.

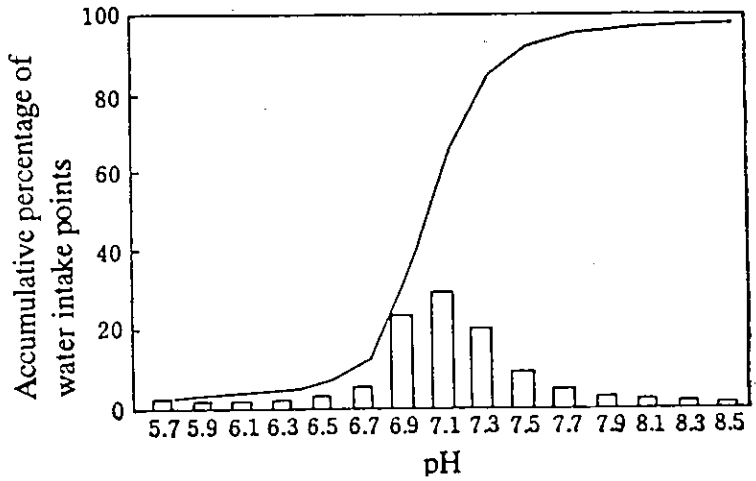

Fig. 5-2 Distribution of pH values at intake points for water supply

2) BOD

The BOD standards have been selected mainly considering the self-purification aspect of the rivers. BOD less than 1 mg/L can be assumed by nonanthropogenic sources and considered for conservation of natural resources. As it is shown in Table 5-2, that about 31.4 %, 29.9% and 13.8% of drinking water sources in Japan have BOD less than 1 mg/L, 2mg/L and 3 mg/L respectively. BOD more than 3 mg/L affects primary sedimentation and filtration processes in conventional water treatment plants, resulting in upgradation to advanced water treatment. Therefore for class 2 and 3, BOD standards are set as 2 and 3 mg/L respectively.

For fisheries class I, BOD would be less than 1 mg/L, as Oligosaprobic fish such as salmon and smelt survive at BOD less than 2 mg/L, For fisheries class II, BOD would be less than 2 mg/L, as Omesoprobic fish such as carp survive at BOD less than 3 mg/L, For fisheries class III, BOD would be less than 3 mg/L, as class III fisheries survive at BOD less than 5 mg/L. For the conservation of environment, of class E, BOD should be less than 10 mg/L to prevent odor caused by the anaerobic decomposition of organic matter.

TABLE 5-2 Potassium Permanganate Consumption value at Surface Water Intake Points For Water supply in 1967

$KMnO_4$ Consumption	0 ~ 4.0mg/l	4.1 ~ 8.0mg/l	8.1 ~ 12.0mg/l	12.1mg/l ~	Total
Estimated BOD	~ 1mg/l	1~2mg/l	2~3mg/l	3mg/l ~	
Number of water intake points (%)	154 (40.2)	150 (39.2)	5 (13.0)	29 (7.6)	383 (100)
Average Intake Water $x10^3m^3/d$ (%)	3409 (31.2)	3267 (29.9)	2731 (25.0)	1511 (13.8)	10913 (100)

Note Assuming that the ratio of BOD to COD_{Mn} is 1 in the BOD range of 1~3mg/l

3) SS

Related to the growth of aquatic organisms, generally SS should be less than 25 mg/L to prevent any harmful effect to the aquatic environment (Table 5-3). SS concentration more than 50 mg/L affect the proper functioning of gills of fish. Turbidity less than 30 NTU, equivalent to 30 mg/L SS required for proper functioning slow sand filtration. Therefore SS standards of 25 mg/L and 50 mg/L were adopted for water supply use and fisheries respectively.

SS are also significant for agriculture water use, as high SS disperse the soil pore size and causes decrease in permeability. From the field results, 3-cm deposition is reported to be permissible, therefore SS standards for agriculture water are restricted to 100 mg/L. From the viewpoint of environmental conservation, no SS limitations were provided, but it should be free of materials such as solid refuse and floating solids that produce undesirable physiological responses to human beings.

TABLE 5-3 Effects of SS on Fisheries

SS	Effects
~25 mg/l	No effects
25~80mg/l	Good enough
80~400mg/l	Poor fishery
400mg/~	Not possible

Report by EIFAC
(European Inland Fisheries Advisory Commission)

4) DO

The DO standards were formulated considering fisheries criteria. The national committee on resources on water pollution control established guidelines in 1958 on DO for water use as shown in Table 5.4. Relatively good water bodies have more than 7.5 mg/L of DO. For fisheries, hatching of salmon and trout requires more than 7mg/L of DO, other organisms also require more than 6 mg/L of DO. In Ohio State, the DO standard for fisheries is 5 mg/L, therefore for fishery class 3 same standard were adopted in Japan.

For agriculture use, DO should be more than 5 mg/L, as DO less than 5 mg/L interferes root growth. For the conservation of environment, DO should be kept more than 2 mg/L to prevent anaerobic conditions that causes bad odors.

TABLE 5-4 Guidelines of water quality classification and water usage
(Council on Resources, 1958)

Class	DO (mg/l)	Water usage
A	7.5 or more	Bathing, Water supply
B	7.5 or more	Bathing, Water supply, Industrial water, Fishery
C	5 or more	Industrial water, Fishery, Agricultural water
Limit	5	
D		Industrial water after treatment with sedimentation and settling, Agricultural water
E		Not suitable for water supply and fishery, Industrial water after advanced treatment, questionable for agricultural water

5) Coliforms

Indicator organism, coliforms itself not harmful for human health, but has been used as an indicator for existence of pathogenic bacteria. For drinking water standard, coliform organisms should be non-existent, and MPN equal to 1/100 ml at the normal expected efficiency of 98% kill during chlorination. Therefore safety limit to control for chlorination is 50 MPN/100mL to disinfect coliforms.

The council on living environment in the Ministry of Health and Welfare reports that removal rate of coliforms is 99%, 95% by slow and rapid sand filter, if the advanced maintenance is available for rapid sand filter it can be increase to 98%. Based on these removal rates, water supply class 2 in which normal operation and management is expected the standard was set as 1000 MPN /100 ml for class 2. For water supply of class 3 in which high level management and operation can be expected, the limit is around 2500-5000, therefore the standard were set as 5000 MPN/100 ml. For bathing 1000 MPN/100 ml was considered as standard.

2.2 Water Quality Standards for Lake

Lake includes natural lakes or artificial reservoir having more than 10 million cum capacity. As shown in Table 5.5, seven water quality items are selected including total nitrogen and phosphorus. There are four categories from AA to C are set for water quality items such as pH and COD. There are five categories for nitrogen and phosphorus. Standard value of five water qualities are defined as daily average value, total nitrogen and phosphorus are defined as annual average. pH and Ecoli standards follow the scientific background as that for river standards. The discussion on total nitrogen and phosphorus standards values is shown in Chapter 6.

TABLE 5-5 Water Quality Standards for Lakes Related to the Conservation of the Living Environment

Lakes (natural lakes and artificial lakes (10 million cubic meters of water or more)

Category \ Item / Purposes of water use	Standard values				
	pH	COD	SS	DO	Number of coliform groups
AA	Water supply, class 1 fishery, class 1 conservation of natural environment, and uses listed in A-C	6.5-8.5	1mg/ℓ or lsee	1mg/ℓ or lsee	7.5mg/ℓ or more	50MPN/100ml or less
A	Water supply, class 2, 3 fishery, class 2 bathing and uses listed in B-C	6.5-8.5	3mg/ℓ or lsee	5mg/ℓ or lsee	7.5mg/ℓ or more	1000MPN/100ml or less
B	Fishery, class 3 industrial water, class agricultural water and uses listed in C	6.5-8.5	5mg/ℓ or lsee	15mg/ℓ or lsee	5mg/ℓ or more	–
C	Industrial water, class conservation of the environment	6.5-8.5	8mg/ℓ or lsee	Floating matter such as garbage shall not be observed	2mg/ℓ or more	–

(COD : Chemical Oxygen Demand, SS : Suspended Solids, DO : Dissolved Oxygen)

Lakes (Cantinued)

Category \ Items / Purpose of water use	Standard values	
	Total nitrogen	Total phosphorus
I	Conservation of natural environment and uses listed in II-V	0.1mg/ℓ or less	0.005mg/ℓ or less
II	Water supply classes 1, 2 and 3 (excluding special types) ; fishery class 1 ; bathing and uses listed in III-V	0.2mg/ℓ or less	0.01mg/ℓ or less
III	Water supply class 3 (special typse) and uses listed in IV-V	0.4mg/ℓ or less	0.03mg/ℓ or less
IV	Fishery class 2 and uses listed in V	0.6mg/ℓ or less	0.05mg/ℓ or less
V	Fishery class 3 ; industrial water conservation of the environment	1mg/ℓ or less	0.1mg/ℓ or less

Notes :

1. Standard values are set in terms of annual averages.
2. Standard values for total nitrogen are applicable to lakes and reservoirs where nitrogen limits phytoplank ton growth.
3. Standard values for total phosphorus are not applicable to agricultural water uses.

1) COD (Mn)

COD (Mn) considered as organic pollution index for phytoplankton growth. COD less than 1 mg/L can assumed to be caused by non-anthropogenic pollution and the condition was found suitable for natural environment conservation. According to the drinking water law, the standard value for KMnO4 consumption is 10 mg/L, that is equivalent to 2.5 mg/L of COD. From the survey conducted by the Ministry of Health and Welfare, it was found out that for most lakes utilized for drinking water source have COD less than 3 mg/L, as shown in Table 5.6.

TABLE 5-6 Potassium Permanganate Consumption at Lake water Intake Points for Water Supply in 1967

$KMnO_4$ Consumption	0 ~ 4.0mg/l	4.1 ~ 8.0mg/l	8.1 ~ 12.0mg/l	12.1mg/l ~
COD_{Mn}	~1.0mg/l	1.1 ~ 2.0mg/l	2.1 ~ 3.0mg/l	3.1mg/l ~
Number of water intake point (%)	29 (42.0)	26 (37.6)	12 (17.3)	2 (2.8)
Average Intake Water $x10^3m^3/d$ (%)	2166 (67.1)	756 (23.4)	273 (8.4)	27 (0.8)
Total Number of Water Intake points= 64 · Total Intake Water = 3,224,400m^3/d				

Data for water supply authorities whose population in service were more than 5000.

Water quality for fishery was categorized into Oligotrophs and eutrophs. In Oligotrophic lakes having very clear water, COD should be less than 1 mg/L required for breeding of oligosaprobic fish such as rainbow trout. In general Oligotrophic and eutrophic lake for oligosaprobic fish such as smelt, COD should be less than 3mg/L. In eutrophic lake where carp habitats, the COD should be less than 5 mg/L according to the water quality standards for fisheries, 1965. To prevent any nuisance during bathing COD should be less than 8 mg/L. For agricultural use, high COD interferes the oxygen transfer to the soil resulting death of rice plant in paddy. Experimental result also shows that COD less than 6 mg/L was desirable for agriculture use. For industrial use and conservation of environment, 8 mg/L of COD was acceptable.

2) SS

Related to the growth of aquatic life. Generally speaking, if transparency (Secchi Depth) is more than 3 meters, the SS concentration is assumed to be less than 1 mg/L. For Oligotrophic and eutrophic lakes the transparency should be less and more than 5 m respectively. According to the OECD criteria, the annual average transparency is 1.5-3 m for eutrophic lake and more than 6 meter for oligotrophic lake. These standard values are determined considering the representative lake in Japan such as Lake Biwa, Lake Suwa, and Lake Imba. Therefore, for the purpose of natural conservation of environment the SS should be less than 1 mg/L. From the viewpoint of environmental conservation, no SS limitations were provided, but it should be free of materials such as solid refuse and floating solids that produce undesirable physiological responses to human beings.

3) DO

DO concentration is generally more than 7.5mg/L in clean lakes. The DO standard for fishery was set as 7.5 mg/L and 6 mg/L for smelt, salmon and carps. The acceptable DO limit for fisheries is 5 mg/L. In some case existing plankton cause lower DO in night, therefore DO limit is 5 mg/L. For the conservation of environment, DO should be kept more than 2 mg/L to anaerobic conditions that causes bad odors.

2.3 Water Quality Standards for Coastal Water Bodies

Seven water quality items were set for coastal water standards as shown in Table 5.7. Main use for coastal water is fisheries. Oil content, total nitrogen and phosphorus were also added for oil pollution and eutrophication control. The three categories A to C is set for general water quality parameters, such as COD. With respect to nitrogen and phosphorus four categories were set, similar to lake daily average values are applied for general water quality items while annual average value is applied for total nitrogen and phosphorus.

TABLE 5-7 Water Quality Standards for Coastal Waters related to the Conservation of the Living Environment

Category	Item / Purposes of water use	Standard values: pH	COD	DO	Number of Coliform Groups	N-hexane Extracts (oil content etc.)
A	Fishery, class 1 ; bathing conservation of the natural environment, and uses listed in B-C	7.8-8.3	2mg/ℓ or less	7.5mg/ℓ or more	1000MPN/100ml or less	Not detectable
B	Fishery, class 2 industrial water and the uses listed in C	7.8-8.3	3mg/ℓ or less	5mg/ℓ or more	–	Not detectable
C	Conservation of the natural environment	7.0-8.3	8mg/ℓ or less	2mg/ℓ or more	–	–

(COD : Chemical Oxygen Demand, DO : Dissolved Oxygen)

Notes :

1. The permissible number of coliform groups for fishery class 1 for the cultivation of oysters shall be 70MPN/100 ml or less.

Category	Items / Purpose of water use	Standard values: Total nitrogen	Total phosphorus
I	Conservation of the natural environment and uses listed in II-IV (excluding fishery classes 2 and 3)	0.2mg/ℓ or less	0.02mg/ℓ or less
II	Fishery class 1, bathing and the uses listed in III-IV (excluding fishery class 3)	0.3mg/ℓ or less	0.03mg/ℓ or less
III	Fishery class 2 and the uses listed in IV (excluding fishery class 3)	0.6mg/ℓ or less	0.05mg/ℓ or less
IV	Fishery class 3, industrial water, and conservation of habltable environments for marine biota	1mg/ℓ or less	0.09mg/ℓ or less

Notes :

1. Standard values are set in terms of annual averages.
2. Standard values are applicable only to marine areas where marine phytoplankton blooms may occur.

1) pH

In general pH of coastal waters varies between 7.8 to 8.3. Standard values for category A and B were determined according to the natural conditions. Within this range aquatic plants and organisms thrive best and also the buffer capacity of coastal water is very high, the pH range of 7-8.3 is acceptable for the conservation of environment.

2) COD

Related to the protection of fisheries due to red tide. Under stagnant water condition if the number of diatoms were found more than several thousand per liters, red tide was clearly

recognized. Algal count less than 1000 /ml, equivalent to 1 mg/L COD is adequate to control red tide. If COD more than 3 mg/L and DO concentration less than 5 mg/L, fish growth was affected. For standard class A, 1 mg/L was subtracted from 3 mg/L to exclude the effect of algae and red tide. Therefore standard was 2 mg/L.

Seaweed culturing needs relatively low COD, based on monitoring COD data using alkali method, less than 3 mg/L COD is needed for proper growth of sea weed and control growth of filamentous bacteria. For industrial use COD should be less than 3 mg/l, if the water has been used for cooling purpose. For the conservation of environment 8 mg/L of COD was set to prevent bad odor caused by anaerobic decomposition.

4) DO

The DO concentration in coastal water is lower than that of rivers and lakes due to high salinity. For fisheries, more than 5 mg/L of DO is desirable, monitoring data, also showed that DO more than 7.5 mg/L was recorded under natural conditions. For the conservation of environment, DO should be kept more than 2 mg/L to prevent anaerobic conditions that causes bad odors.

5) Coliforms

The standard values are set based on the background of river standards. The permissible number of coliform group for fisheries class 1, and for the cultivation of oyster was 70 MPN/100 ml, derived from food and safety law by the ministry of health.

6) N -Hexane Extract

Represents the dissolved oily material in terms of normal hexane. Oil pollution problem in coastal water averts the consumption of fish due to odor problems. Oil film on the water surface interferes recreational bathing and respiration of marine organisms. The research report by STA (Science and Technology Agency) reported the relationship between the petroleum oil concentration and absorbed oil on fish. The limit of concentration to fish absorption is 0.01 to 0.1 mg/L. On the contrary Ministry of International Trade and Industry (MITI) reported 0.2-3 mg/L, data from fishery agency reported 0.002-0.1 mg/L. It can be inferred that even for very low concentration, fisheries was affected, therefore it is necessary to keep the oil concentration as low as possible in coastal waters.

However there was no standard method available for determination of very low oil content. N-Hexane extract method (Japan Industry Method) has been commonly used. Detection limit of this method is 0.5 mg/L for 10-L sample, which is very low, therefore the standard value has been defined as non-detected. The present method cannot be applicable to determine the oil pollution in rivers and lakes, because of the interference of other form of organic matters. Therefore this method is only applicable for the detection of oil in marine waters.

3. Future amendments/ modification

There have been several revisions and amendments carried out, however still arguments are existing to develop the rational standards. The following problems need to be discussed for future modifications:

3.1 Coastal Waters

DO standard was set as 7.5 mg/L for category A, but even under normal condition in summer DO does not satisfy the standard. Since salinity and temperature affected DO concentration, therefore saturation percentage can be applied as the standard value. In stagnant coastal region the DO concentration is affected by photosynthesis, although the water quality was deteriorated, but DO satisfies standard. Therefore upper DO limit should also be set as the standard. The COD standards for category C has been set as 8 mg/L, but it seemed to be relatively high, it can be

possible to include new category between B and C. The standard should be different for coastal waters closed to the land, as exchange of waters is less. Therefore the standards C should be divided into two parts, one for nearby coastal area and the other for the nearby main sea.

The detection limit of N-Hexane method is very high, therefore some other sensitive analytical method needs to be developed that doesn't consume hazardous chemicals.

3.2 Coliform Analytic methods

Coliform counting group has been used as the indicator for fecal pollution, the present analytical method counts total coliform rather than fecal coliform. The monitoring data may not correspond to actual fecal pollution. The water quality standards for bathing already introduced fecal coliform count as an index.

3.3 Organic pollution index

Different water pollution indices were used for different water environment. Like in river BOD has been considered as organic pollution indicator, but for lake and coastal water bodies COD. This causes inconstancy in management of interconnected water environment. Therefore a common indicator needs to be developed for water environment. Although it is necessary to accumulate the monitoring data based on new indicator. COD (Mn) method was adopted only in Japan but COD dichromate is commonly used in other countries. Therefore a precise quantitative relationship needs to be developed between these parameters. For COD (Mn) measurement, if COD concentration is low, acid method was not accurate, as it is mainly developed for high concentration.

References

Japan Environmental Agency (1988), Report on Water Quality Standard-Living Environment (In Japanese)

Japan Environmental Agency (1990), Report on Water Quality Standard-Evaluation of Water Environment in Coastal Waters (In Japanese)

Japan Environmental Agency (1997) Environment in Japan, Heisei 9 year (In Japanese)

Water Quality Bureau of Japan Environmental Agency (1973) Water Pollution Vol. 1, 2 (In Japanese)

Water Quality Bureau of Japan Environmental Agency (1986) Water Quality Conservation in Lakes-Present circumstances and new Policy (In Japanese)

Water Quality Bureau of Japan Environmental Agency (1988) Revised Guidebook for Water Pollution Control Law (In Japanese)

Water Quality Bureau of Japan Environmental Agency (1996) Guidebook for Water Pollution Control Law (In Japanese)

Goda (1975) Water Quality Engineering. Maruzen Publishers (In Japanese) Sugiki (1974) Water Pollution - Phenomena and Pollution Control, Gihodo Pub. (In Japanese)

Japan Chemical Society (1979) Environmental Standards-Scientific Background. Maruzen Pub. (In Japanese)