ANNEX 6

ENVIRONMENTAL QUALITY STANDARDS

ANNEX 6 ENVIRONMENTAL QUALITY STANDARDS

6.1 Environmental Quality Standards for Air Pollutants

6.2 Environmental Quality Standards for Air, Water and Noise Pollution

Annex 6-1(1) ENVIRONMENTAL QUALITY STANDARDS FOR AIR POLLUTION (COUNTRY-WISE)

		Japan	Brazil		Bulgaria	Peru	Poland	Malaysia	South Africa	Mexico	Romania	Russia
			1st Stan'd	2nd Stan'd								
Sulfur Dioxide	Annual average	(0.018)	0.028	0.014	-	0.060	0.011	-	0.028	-	0.021	-
	Monthly avera.	-	-	-	-	-	-	-	-	-	-	-
	24hr av.of 1hr*	0.04	0.13	0.03	0.02	0.30	0.07	0.04	0.09	0.12	0.09	0.05
SO_2 [ppm]	1 hr. value	0.1	-	-	0.17	-	-	0.13	0.27	-	-	-
	30 min. value	-	-	-	-	-	0.21	-	-	-	0.26	-
	10 min. value	-	-	-	-	-	-	0.19	-	-	-	-
Nitrogen	Annual average	(0.02~0.03)	0.053	0.053	-	-	0.027	-	0.144	-	0.021	-
NO_2 [ppm]	24hr av.of 1hr*	0.04~0.06	-	-	0.02	0.11	0.08	-	0.29	-	0.05	-
	1 hr. value	(0.1~0.2)	0.17	0.10	0.05	-	0.27	0.17	0.57	0.21	0.16	-
Nitrogen	Annual average	-	-	-	-	-	0	-	-	-	-	-
Monoxide	24hr av.of 1hr*	10	-	-	3	-	1	-	-	-	2	1
	8 hr. value	20	9	9	-	17	-	9	-	13	-	-
CO [ppm]	1 hr value	-	35	35	4	35	-	30	-	-	-	-
	30 min. value	-	-	-	-	(2hr val.↑)	4	-	-	-	5	-
	15 min. value	-	-	-	-	-	-	-	-	-	-	-
Photo-chemical	Target subs.**		Ozone		Ozone		Ozone	Ozone			Ozone	
	Annual average	-	-	-	-	-	-	-	-	-	-	-
Oxidant	24hr av.of 1hr*	-	-	-	0.015	-	0.015	-	0.050	-	0.015	-
	8 hr. value	-	-	-	-	0.10	-	0.06	0.12	-	-	-
OX [ppm]	1 hr. value	0.06	0.08	0.08	0.08	-	-	0.10	-	0.11	-	-
	30 min. value	-	-	-	-	0.20	0.05	-	-	-	0.05	-
Suspended	10umCut	100%	50%	50%	-	-	-	50%	-	-	-	-
Particulate	Annual average	-	0.05	0.05	-	-	-	0.05	-	-	-	-
Matter	24hr av.of 1hr*	0.1	0.15	0.15	-	-	-	0.15	-	-	-	-
SPM[mg/m³]	1 hr. value	0.2	-	-	-	-	-	-	-	-	-	-
Other Substances			TSP, smoke	TSP, smoke	TSP	TSP, As, Pb, smoke	TSP	TSP, Pb, soot & smoke	Pb, TSP, smoke	TSP	smoke, TSP, other 25 substances	Total 360 substances incl. TSP.
Definitions and Remarks		Desirable standards for maintaining protection of human health. National policy target. Evaluation for annual average is to be made excluding highest 2% or 98% values.	Except for annual average, no appearance more than one time in a year.			24 hour average of hourly value for SO_2 and TSP. No appearance more than one time in a year for 30 minute value of O, and As. For As, reference value.	NO_2 is stipulated for 30 minute value for NO_2 and annual average for CO, but described in a column of hourly value and monthly average respectively.			For O, standard of Mexico City.	NO_2 is stipulated for 30 minute value, but described in a column of hourly value.	NO_2 is stipulated for 30 minute value, but described in a column of hourly value.

Notes : 1. The simpler comparison cannot be made due to the difference of methodology for projecting values.
2. The values in the parentheses in the column of Japan do not mean the environmental quality standard, but the values on which the standards are projected.
3. The values of suspended particulates by high volume air sampler are indicated as Total Suspended Particulates.
4. In the case that the units are different from the units being used in Japan, they are converted to the units prevalent in Japan.
5. * : 24 hour average of one hour value 6. ** : Target substances

Source: World Air Pollution Standards and Risk Assessment Today and Tomorrow (1993)

Annex 6-1(2) ENVIRONMENTAL QUALITY STANDARDS FOR AIR POLLUTION (COUNTRY-WISE)

		Japan	WHO	EC : UK, France Italy, Belgium	U.S.A.		Argentina	Israel
					1st Standard	2nd Standard		
Sulfur Dioxide	Annual average	(0.018)	0.017	0.014~0.021	0.030	-	-	0.021
	Monthly avera.	-	-	-	-	-	0.2	-
	24hr av.of 1h*	0.04	0.04	0.035~0.053	0.14	(3hr value↓)	(3hr val.↑)	0.10
SO_2[ppm]	1 hr. value	0.1	0.12	-	-	0.05	-	-
	30 min. value	-	-	-	-	-	-	0.26
	10 min. value	-	0.17	-	-	-	-	-
Nitrogen NO_2[ppm]	Annual average	(0.02~0.03)	-	0.027	0.053	0.053	-	-
	24hr av.of 1h*	0.04~0.06	0.08	0.07	-	-	-	-
	1 hr. value	(0.1~0.2)	0.21	-	-	-	-	-
Nitrogen Monoxide	Annual average	-	-	-	-	-	-	-
	24hr av.of 1h*	10	-	-	-	-	-	-
	8 hr. value	20	9	-	9	-	10	10
CO[ppm]	1 hr value	-	26	-	35	-	50	52
	30 min. value	-	52	-	-	-	-	-
	15 min. value	-	87	-	-	-	-	-
Photo-chemical Oxidant	Target subs.**		Ozone	-	Ozone	Ozone		Ozone
	Annual average	-	-	-	-	-	-	-
	24hr av.of 1h*	-	-	-	-	-	-	0.033
	8 hr. value	-	0.05~0.06	-	-	-	-	-
OX [ppm]	1 hr. value	0.06	0.075~0.1	-	0.12	0.12	0.10	-
	30 min. value	-	-	-	-	-	-	0.12
Suspended Particulate Matter SPM[mg/m³]	10umCut	100%	50%	-	50%	50%	-	-
	Annual average	-	-	-	0.05	0.05	-	-
	24hr av.of 1h*	0.1	0.07	-	0.15	0.15	-	-
	1 hr. value	0.2	-	-	-	-	-	-
Other Substances			24 substances including Cd, Trichloroethylene	SP by black smoke method	Pb	Pb	NOx, TSP, soot and smoke	H_2S, NOx, TSP, Pb, soot & smoke
Definitions and Remarks		Desirable standards for maintaining protection of human health. National policy target. Evaluation for annual average is to be made excluding highest 2% or 98% values.	The values for supplying guidance or backgruond data for governments which plan to establish the standards of risk administration. The values are considered not to badly affect human health. Almost of above values are projected by the office of European area.	The values are used as guidelines. NO_2 is stipulated as a median of one hour value and 98% value. The former is described in a column of annual average and the latter in a column of daily average.	The standards which include suitable safety allowance for protecting public health.	The standards which protect welfare of public people from hazardous effects anticipated with relation to air pollution.	Maximum allowable limits.	As for ozone, scheduled to replace 24 hour value with 4 to 6 hour values.
					Stipulated not exceeding more than one time in a year except the standards of annual averages.			

Notes : 1. The simpler comparison cannot be made due to the difference of methodology for projecting values.
2. The values in the parentheses in the column of Japan do not mean the environmental quality standard, but the values on which the standards are projected.
3. The values of suspended particulates by high volume air sampler are indicated as Total Suspended Particulates.
4. In the case that the units are different from the units being used in Japan, they are converted to the units prevalent in Japan.
5. * : 24 hour average of one hour value 6. ** : Target substances

Annex 6-1(3) ENVIRONMENTAL QUALITY STANDARDS FOR AIR POLLUTION (COUNTRY-WISE)

		Japan	Indonesia	Egypt	Australia	The Netherlands	Canada		
							desirable	acceptable	tolerable
Sulfur Dioxide	Annual average	(0.018)	-	-	0.020	-	0.010	0.021	-
	Monthly avera.	-	-	-	-	-	-	-	-
	24hr av.of 1h*	0.04	-	0.07	-	0.03	0.05	0.10	0.28
SO_2[ppm]	1 hr. value	0.1	0.10	-	-	-	0.16	0.31	-
	30 min. value	-	-	-	-	-	-	-	-
	10 min. value	-	-	-	-	-	-	-	-
Nitrogen	Annual average	(0.02~0.03)	-	-	-	-	0.032	0.053	-
NO_2[ppm]	24hr av.of 1h*	0.04~0.06	-	0.10	-	-	-	0.11	0.16
	1 hr. value	(0.1~0.2)	-	-	0.16	0.04	-	0.21	0.53
Nitrogen Monoxide	Annual average	-	-	-	-	-	-	-	-
	24hr av.of 1h*	10	-	3	-	-	-	-	-
	8 hr. value	20	20	-	9	-	5	13	17
CO [ppm]	1 hr value	-	-	-	-	-	13	31	-
	30 min. value	-	-	-	-	-	-	-	-
	15 min. value	-	-	-	-	-	-	-	-
Photo-chemical Oxidant	Target subs.**								
	Annual average	-	-	-	-	-	-	0.015	-
	24hr av.of 1h*	-	-	-	-	-	0.015	0.025	-
	8 hr. value	-	-	-	-	-	-	-	-
OX [ppm]	1 hr. value	0.06	0.10	-	0.12	-	0.05	0.08	0.15
	30 min. value	-	-	-	-	-	-	-	-
Suspended Particulate Matter	10umCut	100%	-	-	-	-	-		-
	Annual average	-	-	-	-	-	-	-	-
	24hr av.of 1h*	0.1	-	-	-	-	-	-	-
SPM[mg/m³]	1 hr. value	0.2	-	-	-	-	-	-	-
Other Substances			TSP, NOx HC, NH_3 H_2S, Pb		Pb, TSP	Benzene	TSP	TSP	TSP
Definitions and Remarks		Desirable standards for maintaining protection of human health. National policy target. Evaluation for annual average is to be made excluding highest 2% or 98% values.			Long term targets for maximum allowable limits. Stipulated not exceeding one time in a month as for one hour value, and one time in a year as for 8 hour value.	The values are used as guidelines. Stipulated 50, 95, 98% values of 24 hour value as for SO_2, and 50, 98% values of one hour value as for NO_2. The both values in the table indicate 98% values.	The long term target, on which the national assembly will formulate environmental protection policy for not polluted area.	The standards for adequately protecting soil, water, plants, substances, animals, view range and individual confort and welfare.	The standards for requiring immediate actions for decreasing pollutants in order to protect ambient air from getting worse to the degree which ultimately cause serious risks on general style of life and/or public hygiene.

Notes : 1. The simpler comparison cannot be made due to the difference of methodology for projecting values.
2. The values in the parentheses in the column of Japan do not mean the environmental quality standard, but the values on which the standards are projected.
3. The values of suspended particulates by high volume air sampler are indicated as Total Suspended Particulates.
4. In the case that the units are different from the units being used in Japan, they are converted to the units prevalent in Japan.
5. * : 24 hour average of one hour value 6. ** : Target substances

Annex 6-1(4) ENVIRONMENTAL QUALITY STANDARDS FOR AIR POLLUTION (COUNTRY-WISE)

		Japan	Korea	Kuwait	Colombia	Saudi Arabia	Thailand	Taiwan	China		
									Class I	Class II	Class III
Sulfur Dioxide	Annual average	(0.018)	0.050	0.030	0.030	0.030	0.035	0.030	-	-	-
	Monthly avera.	-	-	-	-	-	-	-	-	-	-
	24hr av.of 1h*	0.04	0.15	0.06	0.12	0.15	0.10	0.10	0.02	0.05	0.09
SO_2 [ppm]	1 hr. value	0.1	-	0.17	-	0.31	-	0.25	0.05	0.17	0.24
	30 min. value	-	-	-	-	-	-	-	-	-	-
	10 min. value	-	-	-	-	-	-	-	-	-	-
Nitrogen	Annual average	(0.02~0.03)	0.050	-	0.050	0.050	-	0.050	-	-	-
NO_2 [ppm]	24hr av.of 1h*	0.04~0.06	-	0.05	-	-	-	-	0.03	0.05	0.08
	1 hr. value	(0.1~0.2)	0.15	-	-	0.35	0.17	0.25	0.05	0.08	0.16
Nitrogen	Annual average	-	8	-	-	-	-	-	-	-	-
Monoxide	24hr av.of 1h*	10	-	8	-	-	-	-	3	3	5
	8 hr. value	20	20	10	12	9	17	9	-	-	-
CO [ppm]	1 hr value	-	-	35	-	35	44	35	9	9	17
	30 min. value	-	-	-	-	-	-	-	-	-	-
	15 min. value	-	-	-	-	-	-	-	-	-	-
Photo-chemical	Target subs.**			Ozone		Ozone		Ozone	Ozone	Ozone	Ozone
	Annual average	-	0.020	-	-	-	-	-	-	-	-
Oxidant	24hr av.of 1h*	-	-	-	-	-	-	0.06	-	-	-
	8 hr. value	-	-	-	-	-	-	-	-	-	-
OX [ppm]	1 hr. value	0.06	0.10	0.08	0.08	0.15	0.09	0.12	0.06	0.080	0.100
	30 min. value	-	-	-	-	-	-	-	-	-	-
Suspended	10umCut	100%	-	-	-	-	-	50%			
Particulate	Annual average	-	-	-	-	-	-	0.065	-	-	-
Matter	24hr av.of 1h*	0.1	-	-	-	-	-	0.125	-	-	-
SPM[mg/m³]	1 hr. value	0.2	-	-	-	-	-	-	-	-	-
Other Substances			TSP, HC	TSP, H_2S, NH_3, Cl_2, NMHC, Pb	TSP	TSP, F_2	TSP	TSP, Pb	NOx, TSP	NOx, TSP	NOx, TSP
Definitions and Remarks		Desirable standards for maintaining protection of human health. National policy target. Evaluation for annual average is to be made excluding highest 2% or 98% values.	Stipulated not to appear more than 3 times in a year except annual monthly average values.	Stipulated not to appear more than one time in a year as for 24 hour value of SO_2 and TSP, and not more than 2 times in 30 days at any place as for one hour value of SO_2.		Stipulated not to appear more than one time in a year as for CO and ozone, and not more than 2 times in a month as for H_2S and 24 hour value of SO_2.			Area for sight-seeing and historical ruins.	Area for habitation	Area for industries and traffic congestion

Notes : 1. The simpler comparison cannot be made due to the difference of methodology for projecting values.
2. The values in the parentheses in the column of Japan do not mean the environmental quality standard, but the values on which the standards are projected.
3. The values of suspended particulates by high volume air sampler are indicated as Total Suspended Particulates.
4. In the case that the units are different from the units being used in Japan, they are converted to the units prevalent in Japan.
5. * : 24 hour average of one hour value 6. ** : Target substances

Annex 6-1(5) ENVIRONMENTAL QUALITY STANDARDS FOR AIR POLLUTION (COUNTRY-WISE)

		Japan	Germany	Turkey	New Zealand	Hungry	The Philippines	Finland
Sulfur Dioxide	Annual average	(0.018)	0.050	0.021	(3mo val.↓)	0.024	-	0.014
	Monthly avera.	-	-	-	0.02	-	-	-
	24hr av.of 1h*	0.04	-	0.05	0.04	0.05	0.13	0.07
SO_2[ppm]	1 hr. value	0.1	-	0.16	-	-	0.30	0.17
	30 min. value	-	0.15	-	-	0.17	-	-
	10 min. value	-	-	-	-	-	-	-
Nitrogen	Annual average	(0.02~0.03)	0.040	-	-	0.037	-	-
NO_2[ppm]	24hr av.of 1h*	0.04~0.06	(30mi value↓)	-	0.05	0.05	-	0.08
	1 hr. value	(0.1~0.2)	0.11	-	-	0.05	0.10	0.16
Nitrogen	Annual average	-	-	-	-	2	-	-
Monoxide	24hr av.of 1h*	10	-	9	-	4	-	-
	8 hr. value	20	9	-	9	-	9	9
CO[ppm]	1 hr value	-	26	-	35	-	74	26
	30 min. value	-	-	-	-	9	-	-
	15 min. value	-	-	-	-	-	-	-
Photo-chemical	Target subs.**		Ozone	Ozone		Ozone		
	Annual average	-	-	-	-	-	-	-
Oxidant	24hr av.of 1h*	-	-	-	-	0.050	-	-
	8 hr. value	-	-	-	0.03	-	-	-
OX [ppm]	1 hr. value	0.06	-	0.12	0.06	-	0.06	-
	30 min. value	-	-	-	-	0.10	-	-
Suspended	10umCut	100%	50%	-	-	-	-	-
Particulate	Annual average	-	0.1	-	-	-	-	-
Matter	24hr av.of 1h*	0.1	(30mi value↓)	-	-	-	-	-
SPM[mg/m³]	1 hr. value	0.2	0.2	-	-	-	-	-
Other Substances			TSP, NO, Pb	smoke	smoke, TSP, inorganic Pb, F_2, NMHC, H_2S	TSP, smoke	TSP	TSP, Sulfuric acid
Definitions and Remarks		Desirable standards for maintaining protection of human health. National policy target. Evaluation for annual average is to be made excluding highest 2% or 98% values.	One of key approval conditions for installation and operation of predetermined facilities. Neighboring inhabitant cannot request prohibition of operation for the once approved facilities due to immersion of environmental pollutants.			Stipulated 30 minute value as for NO_2 and annual average value as for CO, which are described in a column of one hour value and monthly average value.		Projected 24 hour values by 98% annual value, and one hour value by 99% 30 day value except CO. As for SO_2, separate standards are stipulated except towns and big villages.

Notes : 1. The simpler comparison cannot be made due to the difference of methodology for projecting values.
2. The values in the parentheses in the column of Japan do not mean the environmental quality standard, but the values on which the standards are projected.
3. The values of suspended particulates by high volume air sampler are indicated as Total Suspended Particulates.
4. In the case that the units are different from the units being used in Japan, they are converted to the units prevalent in Japan.
5. * : 24 hour average of one hour value 6. ** : Target substances

Annex 6-2 ENVIRONMENTAL QUALITY STANDARDS FOR AIR,WATER AND NOISE POLLUTION

1.1 Environmental quality standards regarding air pollution

Substance	Sulfur dioxide	Carbon monoxide	Suspended Particulate Matter	Photo-chemical oxidant
Environmental conditions	Daily average of hourly values shall be below 0.04 ppm, and one hour value shall be below 0.1 ppm.	Daily average of hourly values shall be below 10 ppm, and eight-hour mean value shall be below 20 ppm.	Daily average of hourly values shall be below 0.10 mg/m^3, and one hour value shall be below 0.20 mg/m^3.	Hourly value shall be below 0.06 ppm.
Measuring methods	Conductometric method	Non-dispersive infrared analyzer method	Weight concentration measuring methods based on filtration collection or light scattering method, or Piezo-electric microbalance method or β-ray attenuation method yielding values having a linear relation with the values of the above method.	Absorptiometry using neutral potassium iodide solution, or coulometry.

Notes : 1. Suspended Particulate Matter means airborne particles of 10 microns or less in diameter.
2. Photo-chemical oxidants are oxidizing substances such as ozone and peroxyacetyl nitrate produced by photo-chemical reactions (only those capable of isolating iodine from neutral potassium iodide, excluding nitrogen dioxide).

1.2 Environmental quality standard for nitrogen dioxide

(1) The environmental quality standard for nitrogen dioxide shall be as follows:
The daily average of hourly values shall be within or lower than the range between 0.04 ppm and 0.06 ppm.

(2) The environmental quality standard mentioned in (1). shall be based on the measured value obtained by the absorptiometry using Saltzman reagent at a place where it is considered to be able to ascertain accurately the state of air pollution by nitrogen dioxide.

(3) The environmental quality standard mentioned in (1). shall not apply to exclusive industrial districts, roads or other regions or places where the general public do not usually live.

2.1 Environmental quality standards regarding water pollution

2.1.1 Environmental quality standards regarding the protection of the human health (The Environment Agency Notification No. 16, 1993)

Item	Standard value
Cadmium	0.01 mg/l or less
Total cyanide	Not detectable
Lead	0.01 mg/l or less
Chromium (hexavalent)	0.05 mg/l or less
Arsenic	0.01 mg/l or less
Total mercury	0.0005 mg/l or less
Alkyl mercury	Not detectable
PCB	Not detectable
Trichloroethylene	0.03 mg/l or less
Tetrachloroethylene	0.01 mg/l or less
Carbon tetrachloride	0.002 mg/l or less
Dichloromethane.	0.02 mg/l or less
1,2-Dichloroethane	0.004 mg/l or less
1,1,1-Trichloroethane	1 mg/l or less
1,1,2-Trichloroethane	0.006 mg/l or less
1,1-Dichloroethylene	0.02 mg/l or less
cis-1,2-Dichloroethylene	0.04 mg/l or less
1,3-Dichloropropene (D-D)	0.002 mg/l or less
Thiram (TMTD) (bis (dimethylthiocarbamoyl) disulfide)	0.006 mg/l or less
Simazine (CAT) (2-chloro-4,6 bis (ethylamino)-1,3,5-triazine)	0.003 mg/l or less
Thiobencarb (S-p-chlorobenzyl diethylthiocarbamate)	0.02 mg/l or less
Benzene	0.01 mg/l or less
Selenium	0.01 mg/l or less

Environmental quality standards (the Environment Agency Notification No. 59, 1971) was amended by the notification No. 16 on March 8, 1993 which will be followed by the establishment of waste effluent standards soon to be revised.

2.1.2 Environmental quality standards regarding the protection of the human health (The Environment Agency Notification No. 59, 1971)

Item	Standard value[1]
Cadmium	0.01 mg/l or less
Cyanide	Not detectable
Organic phosphorus[2]	Not detectable
Lead	0.1 mg/l or less
Chromium (hexavalent)	0.05 mg/l or less
Arsenic	0.05 mg/l or less
Total mercury	0.0005 mg/l or less
Alkyl mercury	Not detectable
PCB	Not detectable

1. Maximum values. But with regard to Total mercury, standard value is based on the yearly average value.
2. Organic phoshorus includes Parathion, Methyl Parathion, Methyl Demeton and EPN.
3. "Not detectable" means that the substance is below the level detectable by the specified method.
4. The standard for Total mercury is 0.001 mg/l or less in case it is obvious that pollution in rivers is caused by natural factors.

2.2 Environmental quality standards regarding the prevention of the living environment

2.2.1 Rivers (excluding lakes)

Category	Item / Purposes of water use	Standard values[1] pH	Biochemical Oxygen Demand (BOD)	Suspended Solids (SS)	Dissolved Oxygen (DO)	Number of Coliform Groups
AA	Water supply class 1, conservation of natural environment and uses listed in A-E.	6.5 - 8.5	1 mg/l or less	25 mg/l or less	7.5 mg/l or more	50 MPN/100ml or less
A	Water supply class 2, Fishery class 1, bathing and uses listed in B-E.	6.5 - 8.5	2 mg/l or less	25 mg/l or less	7.5 mg/l or more	1,000 MPN/100ml or less
B	Water supply class 3, Fishery class 2, and uses listed in C-E.	6.5 - 8.5	3 mg/l or less	25 mg/l or less	5 mg/l or more	5,000 MPN/100ml or less
C	Fishery class 3, Industrial water class 1, and uses listed in D-E.	6.5 - 8.5	5 mg/l or less	50 mg/l or less	5 mg/l or more	
D	Industrial water class 2, Agricultural water[2], and uses listed in E.	6.0 - 8.5	8 mg/l or less	100 mg/l or less	2 mg/l or more	
E	Industrial water class 3, Agricultural water[2], conservation of the environment.	6.0 - 8.5	10 mg/l or less	Floating matter such as garbage should not be observed.	2 mg/l or more	

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 the intake for agriculture, pH shall be between 6.0 and 7.5, and dissolved oxygen shall not be less than 5 ppm. The same applies to the standard values of lakes.
3. Conservation of natural environment: Conservation of scenic spots and other natural resources.
4. Water supply class 1: Water treated by simple cleaning operation, such as filteration.
Water supply class 2: Water treated by normal cleaning operation, such as sedimentation and filteration.
Water supply class 3: Water treated through a highly sophisticated cleaning operation including pretreatment.
5. Fishery class 1: For aquatic life, such as Yamame (Oncorhynchus masou) and Japanese char (Salvelinus pluvius) inhabiting oligosaprobic water, and those of Fishery class 2 and 3.
Fishery class 2: For aquatic life, such as fish of the salmon family (Salmonidae) and sweetfish (Plecoglossus altivelis) inhabiting oligosaprobic water, and those of the Fishery class 3.
Fishery class 3: For aquatic life, such as carp (Cyprinus carpio) and crucian carp (Carassius auratus) inhabiting, β-mesosaprobic water.
6. Industrial water class 1: Water given normal cleaning treatment, such as sedimentation.
Industrial water class 2: Water given sophisticated treatment by chemicals.
Industrial water class 3: Water given special cleaning treatment.
7. Conservation of the environment: Up to the limits at which no unpleasantness is caused to people in their daily life including a walk by the riverside, etc.

2.2.2 Lakes (natural lakes, reservoirs, marshes and artificial lakes with more than 10 million cubic meters of water)

i)

Category	Item / Purposes of water use	Standard values[1]				
		pH	Chemical Oxygen Demand (COD)	Suspended Solids (SS)	Dissolved Oxygen (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	1 mg/l or less	1 mg/l or less	7.5 mg/l or more	50 MPN/100ml or less
A	Water supply class 2 and 3, Fishery class 2, bathing and uses listed in B - C.	6.5 - 8.5	3 mg/l or less	5 mg/l or less	7.5 mg/l or more	1,000 MPN/100ml or less
B	Fishery class 3, Industrial water class 1, Agricultural water and uses listed in C.	6.5 - 8.5	5 mg/l or less	15 mg/l or less	5 mg/l or more	
C	Industrial water class 3, conservation of the environment.	6.0 - 8.5	8 mg/l or less	Floating matter such as garbage should not be observed.	2 mg/l or more	

Notes : 1. With regard to Fishery class 1, 2, and 3, the standard value for Suspended Solids shall not be applied for the time being.
2. See notes for rivers.
3. Fishery class 1: For aquatic life, such as kokanee salmon (Oncorhynchus nerka) inhabiting oligosaprobic lake type waters, and for those of fishery class 2 and 3.
Fishery class 2: For aquatic life, such as fish of the salmon group (Salmonidae) and sweetfish (Plecoglossus altivelis) inhabiting oligosaprobic lake type waters, and for those of the Fishery class 3.
Fishery class 3: For those aquatic lives, such as carp (Cyprinus carpio) and crucian carp (Carassius auratus) inhabiting eutrophic lake type waters.
4. Industrial water class 1: Water given normal treatment such as sedimentation.
Industrial water class 2: Water given sophisticated treatment such as chemical injection or special treatment.
5. Conservation of the environment: Up to the limit at which no unpleasantness is caused to the people in their daily lives including a walk along the shore.

ii)

Category	Item / Purposes of water use	Standard values	
		Total nitrogen[2]	Total phosphorus[3]
I	Conservation of natural environment and uses listed in II-V.	0.1 mg/l or less	0.005 mg/l or less
II	Water supply classes 1, 2 and 3 (excluding special types) Fishery class 1, bathing and uses listed in III-V.	0.2 mg/l or less	0.01 mg/l or less
III	Water supply class 3 (special types), and uses listed in III-V.	0.4 mg/l or less	0.03 mg/l or less
IV	Fishery class 2, and uses listed in V.	0.6 mg/l or less	0.05 mg/l or less
V	Fishery class 3, Industrial water, Agricultural water, conservation of the living environment.	1 mg/l or less	0.1 mg/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 is a causal factor of the growth of phytoplankton.
3. Standard values for Total phosphorus are not applicable to agricultural water uses.
4. Conservation of natural environment: Conservation of scenic points and other natural resources.
5. Water supply class 1: Water treated by simple cleaning operation, such as filteration.
Water supply class 2: Water treated by normal cleaning operation, such as sedimentation and filteration.
Water supply class 3: Water treated through a highly sophisticated cleaning operation including pretreatment. ("special types" mean water treatments by special cleaning operation in which removal of smelling substances is possible).
6. Fishery class 1: For aquatic life, such as fish of the salmon group (Salmonidae) and sweetfish (Plecoglossus altivelis), and for those of Fishery class 2 and 3.
Fishery class 2: For aquatic life, such as smelt and those of Fishery class 3.
Fishery class 3: For aquatic life, such as carp (Cyprinus carpio) and crucian carp (Carassius auratus).
7. Conservation of the environment: Up to the limits at which no unpleasantness is caused to the people in their daily lives including a walk along the shore.

2.2.3 Coastal waters

Category	Item / Purposes of water use	Standard values[1] pH	Chemical Oxygen Demand (COD)	Dissolved Oxygen (DO)	Number of Coliform Groups	N-hexane extracts
A	Fishery class 1, bathing, conservation of natural environment, and uses listed in B-C.	7.8 - 8.3	2 mg/l or less	7.5 mg/l or more	1,000 MPN/100ml or less	Not detectable
B	Fishery class 2, Industrial water and uses listed in C.	7.8 - 8.3	3 mg/l or less	5 mg/l or more	-	Not detectable
C	Conservation of the environment	7.0 - 8.3	8 mg/l or less	2 mg/l or more	-	-

Notes : 1. With regard to the water quality of fishery, class 1 for cultivation of oysters, number of coliform groups shall be less than 70 MPN/100ml.
2. Conservation of natural environment: Conservation of scenic points and other natural resources.
3. Fishery class 1 : For aquatic life, such as red sea bream (Chrysophrys major), yellow tail (Seriola quinqueradiata), seaweed (Undaria pinnatifida) and for those of Fishery class 2.
Fishery class 2 : For aquatic life, such as gray mullet (Mugil cephalus), laver (Porphyra tenera), etc.
4. Conservation of the environment: Up to the limits at which no unpleasantness is caused to the people in their daily lives including a walk along the shore.

3.1 Environmental quality standards for noise

Environmental quality standard values for each type of area and time category shall be as listed in the following table.

Area type	Time category: Day time	Morning, evening	Night time	Applicable areas
AA	45 dB(A)	40 dB(A)	35 dB(A)	Areas designated for each classification of land areas by a prefectural governor based on the provision of Article 2 of the Cabinet Order relating to the Delegation of Authority to Designated Water and Land Areas for Environmental Quality Standards (Cabinet Order No. 159, 1971).
A	50 dB(A)	45 dB(A)	40 dB(A)	
B	60 dB(A)	55 dB(A)	50 dB(A)	

Notes : 1. Areas coming within the AA category are areas where quiet is specially required such as where there is a concentration of convalescent facilities.
2. Areas coming within the A category areas which are used mainly for residential purpose.
3. Areas coming within the B category are areas where are used considerably for residential purposes and which are also used for commercial and industrial purposes.

However, with regard to environmental quality standards for the areas of the following table (hereinafter referred to as "areas facing roads") the values hereinbelow shall be applied instead of the values in the table above.

Area category	Time category: Day time	Morning, evening	Night time
"A" areas facing roads with 2 lanes.	55 dB(A)	50 dB(A)	45 dB(A)
"A" areas facing roads with more than 2 lanes.	60 dB(A)	55 dB(A)	50 dB(A)
"B" areas facing roads with not more than 2 lanes.	65 dB(A)	60 dB(A)	55 dB(A)
"B" areas facing roads with more than 2 lanes.	65 dB(A)	65 dB(A)	60 dB(A)

Notes : "Lane" refers to a longitudinal strip of road with uniform width requisite to allow a single line of cars to travel there along safely and without hindrance.

ANNEX 7

BOILER FEED WATER TREATMENT SYSTEM

ANNEX 7 BOILER FEED WATER TREATMENT SYSTEM

1. GENERAL

In this Annex, the description is made for the boiler feed water treatment systems (hereinafter called as demineralizing system) which are designed by the modern technology and able to expect very high water production and regeneration efficiency.

2. DOUBLE FLUIDIZED BED TYPE DEMINERALIZING SYSTEM

The description of this system is based on the technical document of vendor concerned. It is therefore advised that the proper techniques of said vendor are included in this description.
In order to readily understand this system, the description is divided into two(2) sections as follow:
2.1 Fluidized Bed Type Demineralizing System
2.2 Double Fluidized Bed Type Demineralizing System

2.1 Fluidized Bed Type Demineralizing System

2.1.1 Outline of system

This system is 2-bed 1-degasifier demineralizing system consisting of a cation exchanging unit, a degasifier (decarbonator), and an anion exchange unit. Raw water flows through the three units in the stated sequence, and in the process is converted to highly demineralized water as shown in Figure 1. Regeneration and washing operations are carried out in a downward flow through fixed beds, while in the demineralizing process, the flow is upward, with the lower 25 to 75% of the resin in a fluidized state and the rest forming a compact bed at the top of resin bed as shown in Figure 2.

Figure 1 FLOW SHEET OF FLUIDIZED DEMINERALIZING SYSTEM

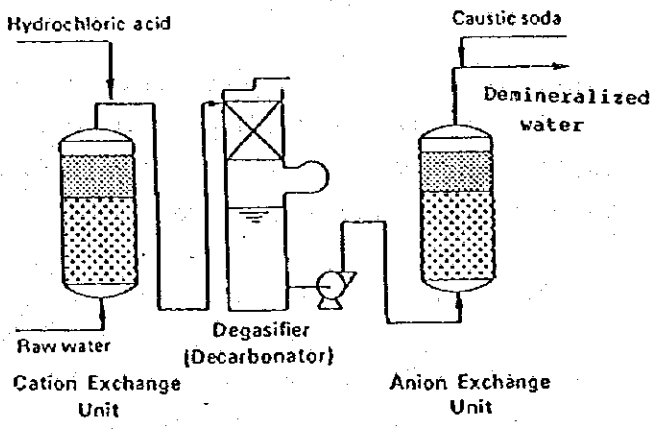
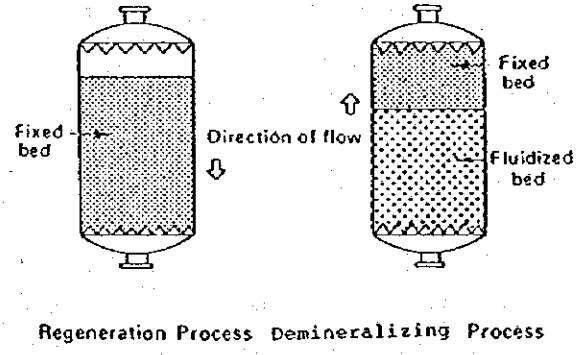


Figure 2 PRINCIPLE OF FLUIDIZED DEMINERALIZING SYSTEM



2.1.2 Functions and features of system

(1) produces high-purity demineralized water

In conventional systems with co-current regeneration, if a low level of regeneration is employed, the resin remains unregenerated in the lower portion of the bed.
When the next demineralizing cycle is started, a few hydrogen ions are released in the upper portion of the bed and are exchanged for the residual ions at the bottom of the bed, thus causing some leakage. This leakage is usually sodium, since this ion is most easily exchanged for hydrogen ions. If the free mineral acidity generated

by ion exchange is high enough, magnesium and even calcium may also leak from the unit. Therefore, conventional systems require a high level of regeneration in order that the entire volume of resin may be completely regenerated. This system uses countercurrent regeneration, viz., regeneration is performed with a downflow and demineralization with an upflow. This means that, at the start of upflow service, there is virtually no leakage of cations because all of the exchange occurs at the inlet rather than the outlet end of the unit. Thus, treated water of high purity is continuously produced.
This system can operate at a relatively low level of regeneration and its performance is not affected by the ion concentration or composition of the raw water.

Figure 3 STATES OF RESIN BED IN REGENERATION AND DEMINERALIZING PROCESS

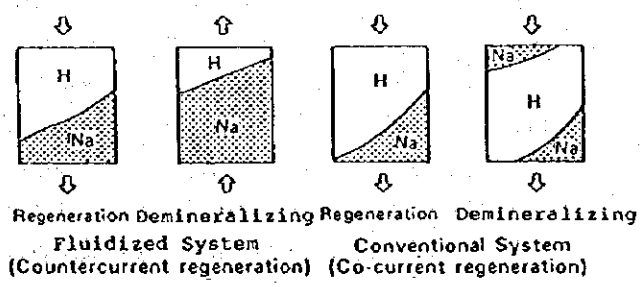
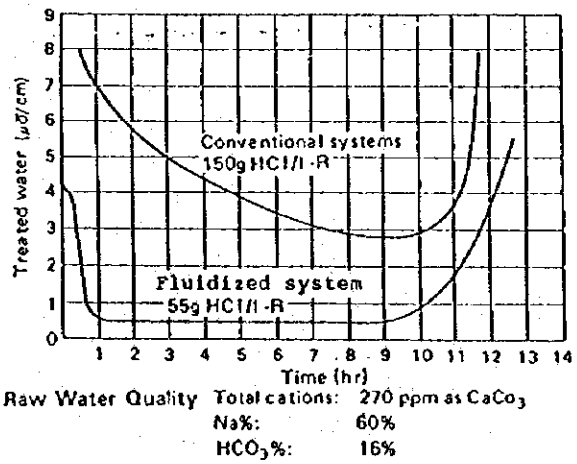


Figure 4 PURITY TREATED WATER



(2) Large savings in regenerant

1) Low level or regeneration

Since countercurrent regeneration is used, high-purity treated water is obtained at a relatively low level of regeneration. Therefore, regeneration efficiency is greatly enhanced.

Figure 5 shows the relationship between regeneration level and the capacity at the breakthrough point of an ion exchange resin. It can be seen that exchange capacity does not increase much even though the regeneration level is raised. In other words, the lower the regeneration level, the higher is the ratio of exchange capacity to a given weight of regenerant, which means the higher the regeneration efficiency.

2) Countercurrent regeneration

The state of a cation exchange resin bed at the breakthrough point of the demineralization is illustrated in Figure 6. It can be seen that ions are adsorbed by the resin in the order of greater selectivity, i.c., starting from the bottom, first calcium, then sodium, and finally hydrogen, there by forming an adsorption zone. During regeneration, i.e., from the top, the hydrogen ion displaces the sodium ion, which in its turn displaces the calcium ion, in what is known as a hookup effect. This hookup effect gives a more complete regeneration and helps boost regeneration efficiency. This is obvious from Figure 7.

Figure 5 REGENERATION LEVEL VS. ION EXCHANGE CAPACITY

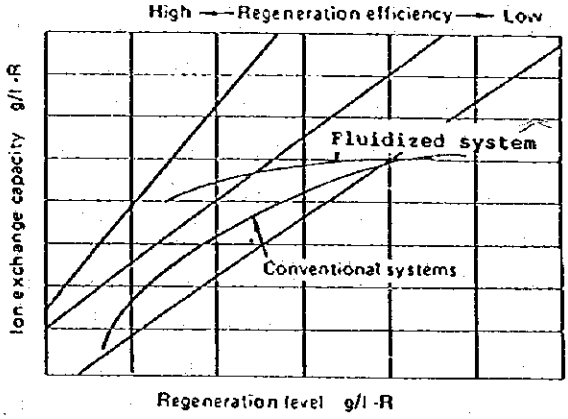


Figure 6 STATE OF RESIN BED ADSORPTION ZONE AT DEMINERALIZING AND REGENERATION

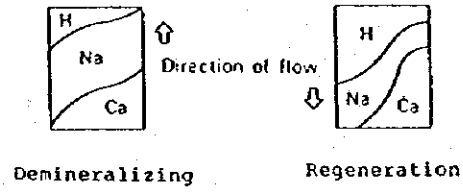
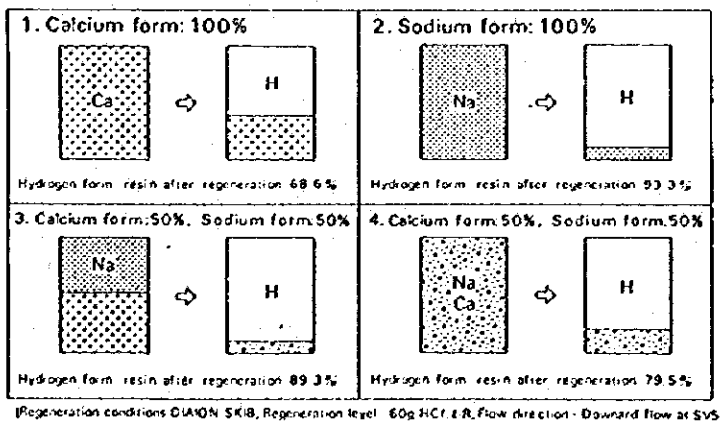


Figure 7 COMPOSITION OF DIAION SKIB RESIN AND UTILIZATION OF REGENERANT



3) Thorough utilization of resin

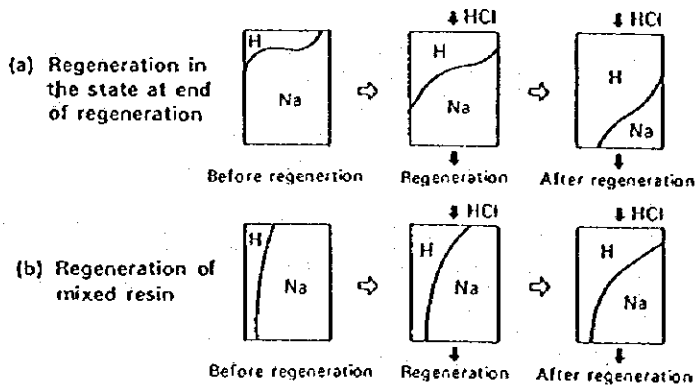
In conventional systems, in which both service and regeneration flow are downward, a considerable amount of resin remains unused in the lower portion of the bed at completion of the demineralizing cycle. In the regeneration step, the unused resin is contaminated with downwardly displaced regenerant wastes.

Since this system uses an upward service flow, the unused resin remains in the upper portion as shown in Figure 8(a). And because the regenerant flows downward and passes through the unused resin zone without regenerating, the regenerant power is concentrated fully on the exhausted resin. This means the effective regeneration level is raised relative to the conventional systems.

In this system, the entire resin bed is pushed against the upper distributor during service flow. The freeboard space in the resin bed is limited so as not to cause a mixture of exhausted and unused resin during settling resin.

This physical set-up does not allow in-place washing, so backwashing to remove accumulated matters on the resin is done in a separate tank. Since the unused resin becomes mixed with the exhausted resin, the amount of regenerant required is twice that used in the normal regeneration steps.

Figure 8 ADSORPTION ZONE IN REGENERATION PROCESS



However, this external backwashing of the resin is required at a frequency of only once every 30 to 40 cycles for the cation exchange unit and once every year or so for the anion exchange unit. This permits us to take good advantage of the economical operation resulting from the countercurrent regeneration steps.

(3) Small pressure drop in demineralizing process

Pressure drop during the demineralizing process is minimal because about 25 to 75% of the ion exchange resin is in a fluidized state.

(4) Little water needed for washing

Whereas conventional systems require wash water in an amount equivalent to 8 to 12 times the volume of resin, this system uses only 2 or 3 times as much as the resin volume.

(5) Quick regeneration

Regeneration is completed in about an hour, compared to approximately four hours for conventional systems.

(6) Simple and compact equipment

Regeneration, as in conventional systems, is performed in a downward flow. Therefore, no special device is required for preventing fluidization in the demineralizing process. This simplifies the equipment. Moreover, since it comes in a compact 2-bed 1-degasifier arrangement, this system takes a very small space for installation.

Figure 9 FLOW RATE VS. PRESSURE DROP IN CATION EXCHANGE RESIN

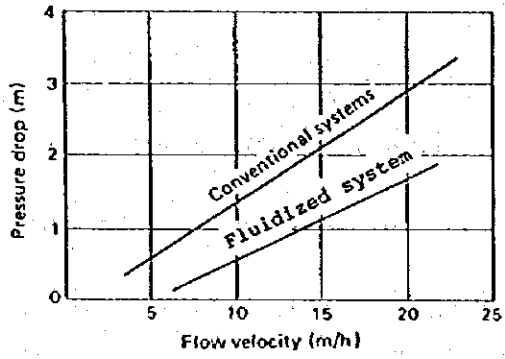
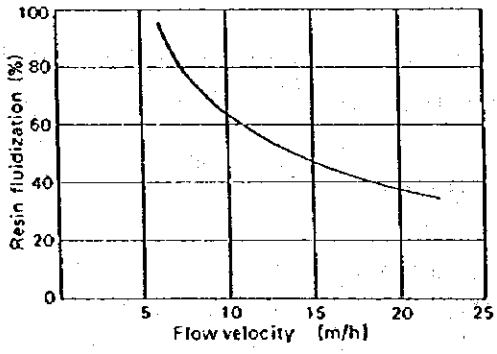
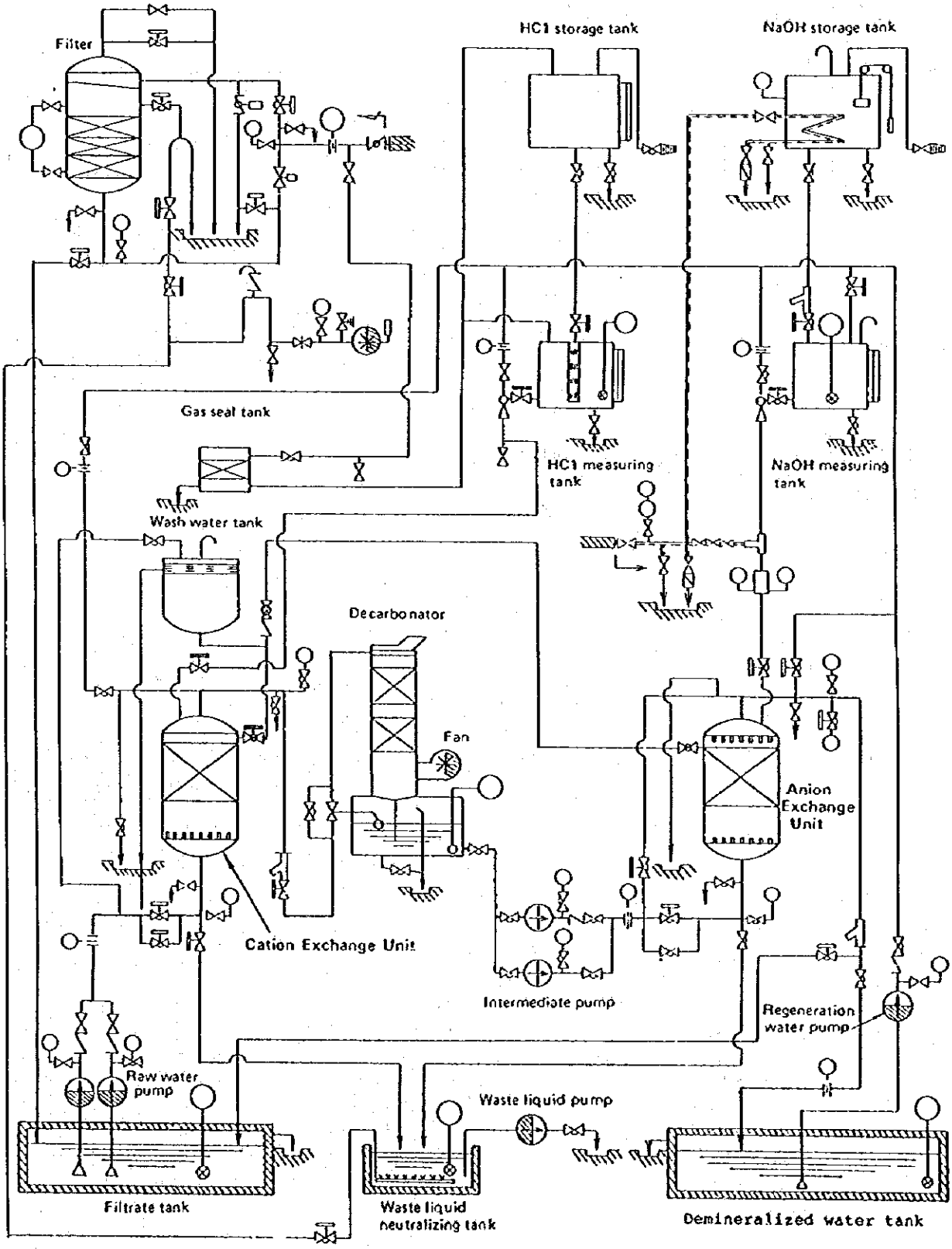


Figure 10 FLOW RATE VS. RESIN FLUIDIZATION RATE IN CATION EXCHANGE RESIN



FLOWSHEET OF FLUIDIZED DEMINERALIZING SYSTEM



EXAMPLE OF PRACTICAL USE OF FLUIDIZED BED TYPE DEMINERALIZING SYSTEM

Table 1 presents the performances of two commercial units in operation, with regard to raw water analysis and treated water quality:

	Example 1	Example 2
Raw water	Total cations ..... 326ppm as $CaCO_3$ Ca + Mg ..... 220ppm as $CaCO_3$ Na + K ..... 100ppm as $CaCO_3$ HCO_3 ..... 230ppm as $CaCO_3$ SO_4 ..... 70ppm as $CaCO_3$ Cl ..... 26ppm as $CaCO_3$ SiO_2 ..... 17ppm as $CaCO_3$	Total cations ..... 113ppm as $CaCO_3$ Ca + Mg ..... 90ppm as $CaCO_3$ Na + K ..... 23ppm as $CaCO_3$ HCO_3 ..... 50ppm as $CaCO_3$ Cl + SO_4 ..... 63ppm as $CaCO_3$ SiO_2 ..... 10ppm as $CaCO_3$
Treted water	Breakthrough point conductivity Below 5μU/cm Mean conductivity ..... Below 1μU/cm Silica ..... Below 0.02ppm as SiO_2	Breakthrough point ..... Below 5μU/cm Mean silica concentration..... Below 1μU/cm Silica concentration ..... Below 0.1ppm as SiO_2 Mean silica concentration..... Below 0.06ppm as SiO_2

Table 1 Analyses of Treated Water and Raw Water

COMPARISONS OF ECONOMICS

Example 1

• Design Standards

Total cation in raw water ..... 275ppm as $CaCO_3$
Treatment capacity ..... 500m^3/cycle
Quality of treated water : Conductivity ..... Below 5μU/cm
Silica ..... Below 0.1 ppm

• Economic Comparisons

	Conventional 2-bed 1-degasifier systems	Fluidized system
Treated water quality	Below 15μU/cm Below 0.1ppm as SiO_2	Below 5μU/cm Below 0.1ppm as SiO_2
Regenerant requirements	35% HCl 1,350kg/C 45% NaOH 780kg/C	35% HCl 440kg/C 45% NaOH 380kg/C
Approximate capital cost	¥30,000,000	¥33,000,000
Running cost	¥63/m^3 treated water	¥23.6/m^3 treated water

Example 2

• Design Standards

Total cation in raw water ..... 83ppm as $CaCO_3$
Treatment capacity ..... 4,000m^3/day
Qualityof treated water : Conductivity ..... Below 3μU/cm
Silica ..... Below 0.1 ppm

• Regenerant Requirements

	Conventional 2-bed 1-degasifier systems	Fluidized system
35% HCl 45%NaOH	2,170kg/day 1,250kg/day	1,090kg/day 690kg/day

2.2 Double Fluidized Bed Type Demineralizing System

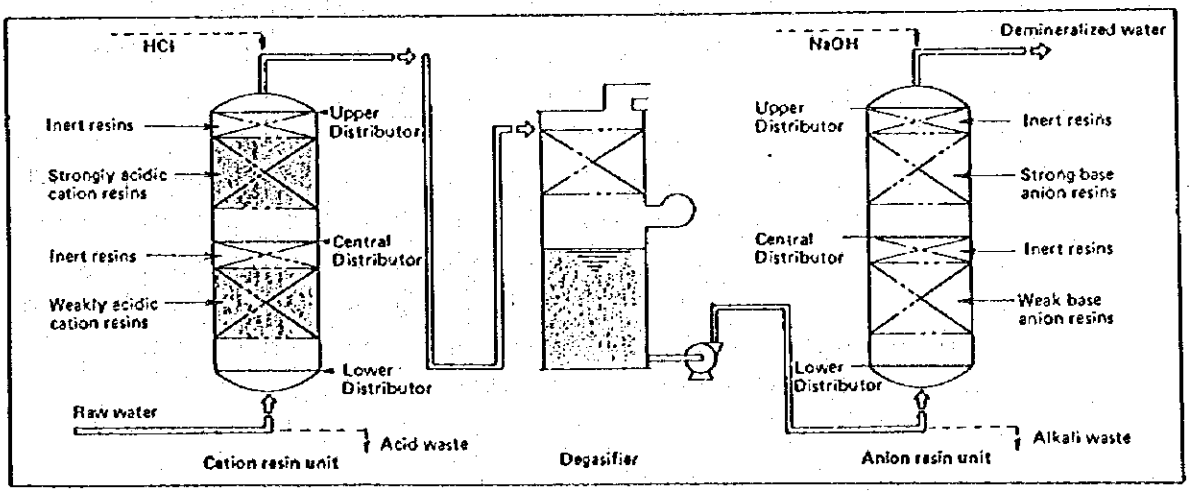
2.2.1 General

Lately, the application technology of ion exchange resins is making a rapid development. However, the demineralizing system exhibiting a higher regeneration efficiency has long been desired when viewed from the point of resource-saving and pollution control.
The double fluidized bed type demineralizing system well meet such requirements, and offer 100 percent regeneration efficiency which has not been accomplished with a conventional demineralizing system.

2.2.2 Outline of system

This system is, as illustrated in the diagram, of 2-bed 1-degasifier type demineralizing system consisting of a cation exchange unit, a degasifier and an anion exchange unit. Raw water flows through the three units in the stated sequence; the cation exchange unit, the degasifier and the anion exchange unit. A distinctive feature of the system is that each exchange unit contains two kinds of ion exchange resins-one strong, the other weak. The cation exchange unit is filled with strongly acidic and weakly acidic cation resins, and with strong base and weak base anion exchange resins in the anion exchange unit. The resins are divided by a central distributor placed between the two compartments.

FLOW DIAGRAM OF FLUIDIZED BED TYPE DEMINERALIZING SYSTEM



2.2.3 Service run and regeneration

(1) Cation exchange unit

Raw water flows from the bottom of the cation exchange unit and contacts first with the weakly acidic resin layer located in the lower compartment, in which the hard composition combined with bicarbonate radical (temporary hardness) will be effectively exchanged while the parmanent hardness and monovalent ions like sodium are exchanged by the strongly acidic exchange resins in the upper compartment. The water flows from the top of the exchange unit.

(2) Anion exchange unit

Acidic water degasified through degasifier flows from the bottom of the anion exchange unit, in which a mineral acidity will be exchanged through the contact with the weak base resins. Residual carbonate and silica will react with the strong base resins and the removal can be accomplished. The demineralized effluent flows the top of the exchange unit.

2.2.4 Regeneration

(1) Regeneration for cation resin unit

Hydrochloric acid (or sulfuric acid) introduced from the top of the cation resin unit is used first for regeneration of the strongly acidic exchange resins in the upper compartment and the regeneration waste water containing still effective hydrochloric acid is used again for the regeneration of the weakly acidic exchange resins in the lower compartment. As stated, the regeneration waste water from the regeneration of the strongly acidic exchange resins is used for the regeneration of the weakly acidic exchange resins. Thus, almost none of the acid may remain in the regeneration waste water.

(2) Regeneration for anion exchange unit

Sodium hydroxide fed from the top of the anion resin unit will be used for regeneration of the strong base resins in the upper compartment, then be used for regeneration of the weak base resins in the lower compartment. Therefore, the regeneration efficiency and the regeneration waste water characteristics could be similer to that of the cation resin unit.

2.2.5 Feature of system

(1) High regeneration efficiency and lower running cost

Nearly 100 percent regeneration efficiency shall be established since the regeneration waste water from the regeneration step of the strongly acidic exchange resins and the strong base exchange resins are used again for the regeneration of the weakly acidic exchange resins and the weak base exchange resins, respectively. As a result, the running cost can be reduced to a half or a quarter when compared with that of 2-bed 1-degasifier demineralizer.

(2) Easy treatment of regeneration waste water

Since the regenerant is used up almost completely in the regeneration step of the ion exchange resins, the regeneration waste water contains almost none of free acid and alkaline. Thus, the regeneration waste water can be treated very easily.

(3) High-purity water production

Since the effluent is finally polished by the completely regenerated ion exchange resins contained in each upper layer of anion and cation resins, the highly purified water can be obtained.

(4) No pressure loss during service run

Pressure loss will be minimal because each ion exchange resin bed is in a fluidized state during the service run.

(5) Little water needed for washing

The water needed for washing is as little as a third or a quarter when compared with that of 2-bed 1-degasifier system.

(6) Shorter outage time for regeneration

Only one hour and a half will be required for regeneration.

2.2.6 Operating results of double fluidized

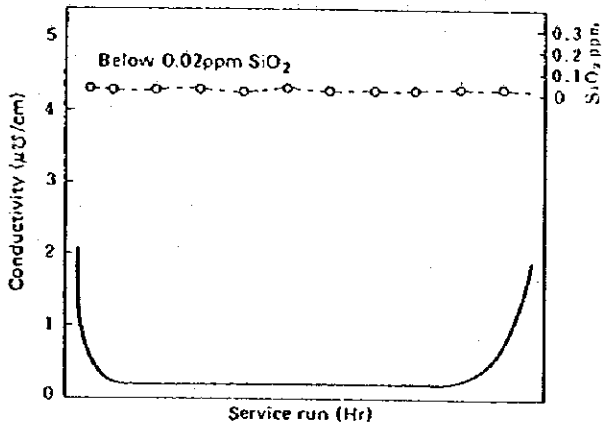
Bed type demineralizing system

*Capacity: $1000m^3$/day (2-cycle/day)

*Influent

			HCO_3	160ppm as	$CaCO_3$
			$Cl+SO_4$	160ppm as	$CaCO_3$
Ca+Mg	140ppm as	$CaCO_3$	SiO_2	5ppm as	$CaCO_3$
Na+K	180ppm as	$CaCO_3$	CO_2	5ppm as	$CaCP_3$
T.C.	320ppm as	$CaCO_3$	T.A.	330ppm as	$CaCO_3$
		Na+K%	56%		
		HCO_3%	50%		

- Effluent



- Regeneration

Step	Regenerant injection	Slow rinse	Rinse	Regeneration time
Hour	20 min.	50 min.	15 min.	85 min.

- Regeneration efficiency

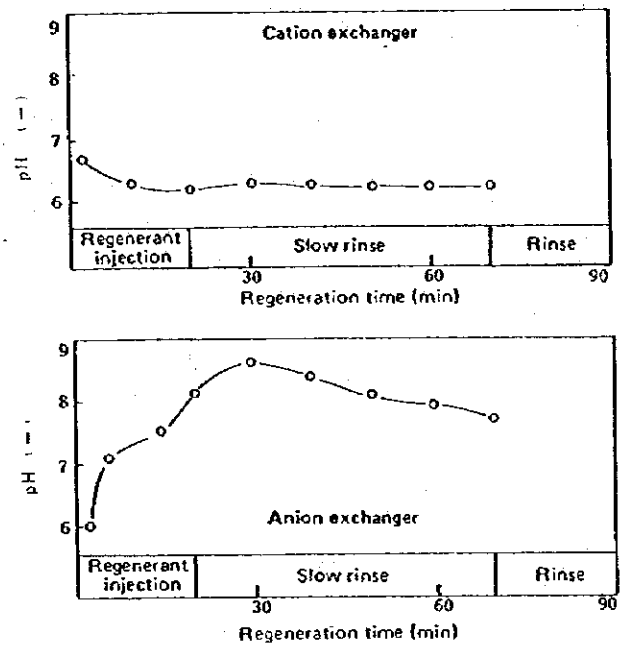
Cation exchanger

Regenerant 35%HCl	427kg/cycle (4.09keq/cycle)
Deionization 320ppm x 640m^3/c	205kg$CaCO_3$/cycle (4.1keq/cycle)
Regeneration efficiency	100%

Anion exchanger

Regenerant 45%NaOH	327kg/cycle (3.68keq/cycle)
Deionization 330ppm x 640m^3/c	211kg$CaCO_3$/cycle (4.22keq/cycle)
Regeneration efficiency	114.7%

- pH value in the regeneration waste water



2.2.7 Comparisons of chemical requirements

Comparisons of chemical requirements

- Design standard

Influent	T.C.	133ppm as $CaCO_3$	Operating Capacity	2000m^3/day
	D.T.A.	140ppm as $CaCO_3$	Effluent: Conductivity	5μU/cm
	Na%	25%	SiO_2	0.1ppm
	MTO Alkalinity	42%		

- Chemical requirements

	Unit price	2-bed 1-degasifier demineralizer		Double Fluidized Demineralized	
Regenerant 35%HCl	¥20/kg	1740kg/cycle	¥34,800/cycle	555kg/cycle	¥11,100/cycle
45%NaOH	¥45/kg	1780kg/cycle	¥80,100/cycle	498kg/cycle	¥22,410/cycle
Neutralizing 35%HCl	¥20/kg	496kg/cycle	¥ 9,900/cycle	–	–
Per one cycle			¥124,820/cycle		¥33,510/cycle
Annual outlay			¥41,191,00/year		¥11,059,000/year

Basis: 330 days of operation a year.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