Wastewater Treatment Technology [№1－41]

Training Course

Introduction of Organic Waste & Inorganic Waste Water Treatment System.

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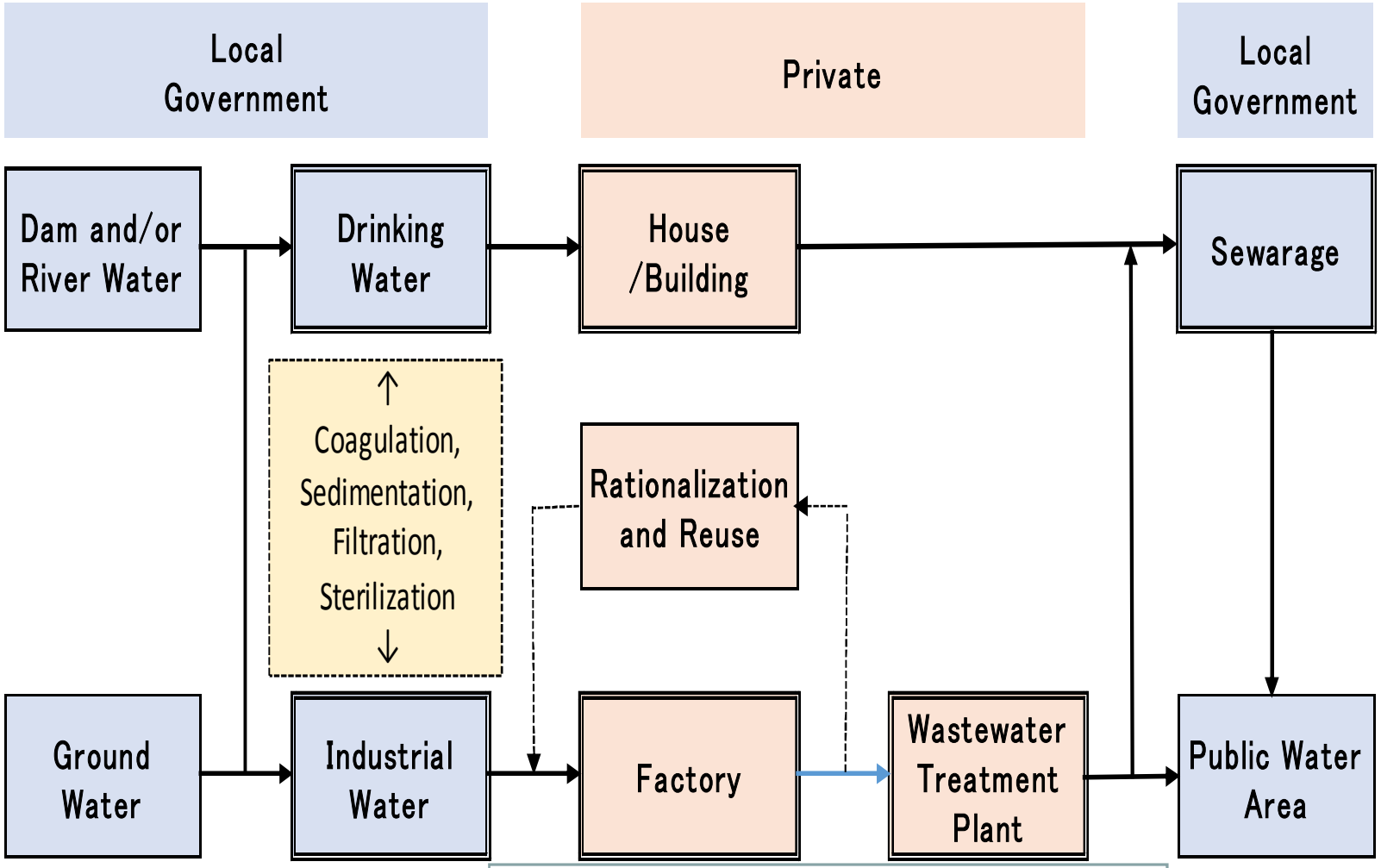
Contents

§ 1. Water & Wastewater Flow in Japan



PCM manager has to be assigned

§ 2. Biological Treatment System

The following biological treatment systems are for Organic waste water..

(1) Anaerobic Biological Treatment Digestion)

→ BOD is decomposed by anaerobic bacteria such as

methane bacteria.

Methane Bacteria

Reaction $CH_3COOH \rightarrow CO_2 + CH_4$

(Acetic Acid) (Carbon Dioxide Gas) (Methane Gas)

Filature: High BOD Concentration such as Human Waste.

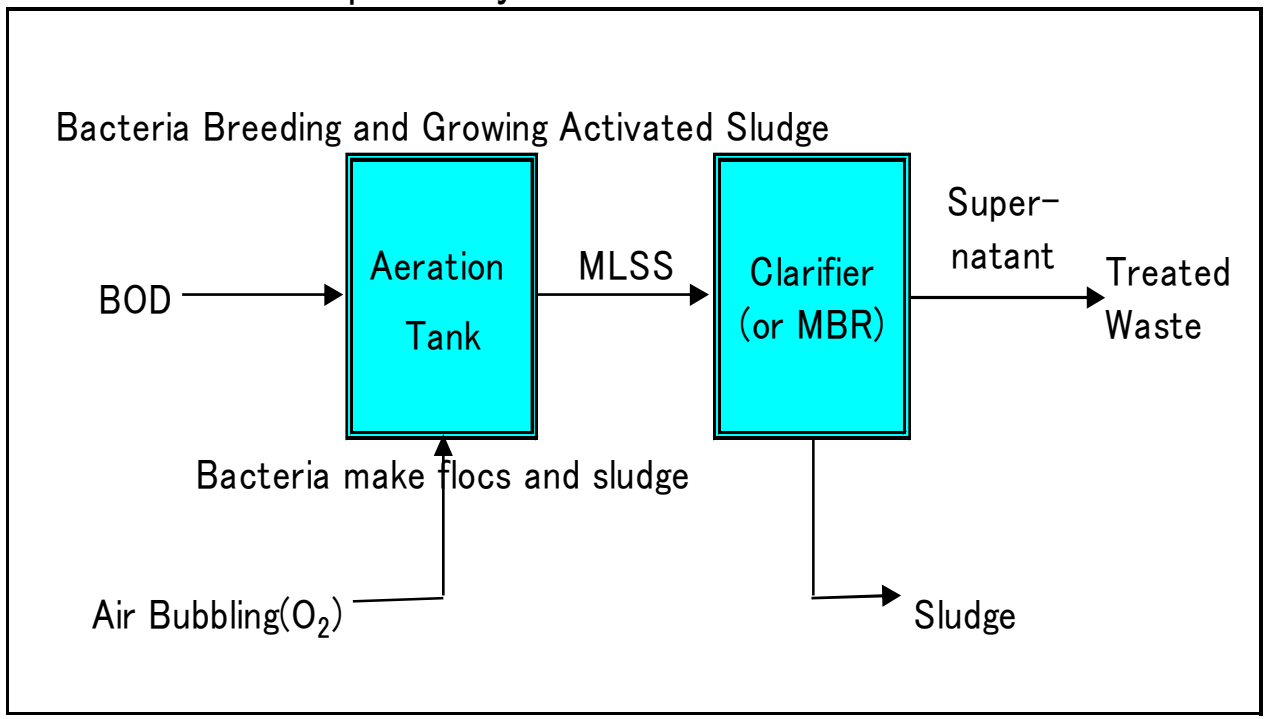
Retention Time needs long(30～60days)

Digestion gas can be utilized for energy resources.

The produced sludge is smaller than aerobicic biological method.

(2) Aerobic Biological Treatment(Activated Sludge System)

→ BOD is decomposed by aerobic bacteria as follows.



Standard Activated Sludge Method
Step Aeration Method
Oxi-contact Method
Re-aeration Method
Oxidation Ditch

} Variation of Activated Sludge System

(3) Kind of Activated Sludge System and Comparison of Parameters

Treatment Method	BOD Load		MLSS Concentration	Aeration (Times/ Influent)	Pretension Time
	kg/MLSS	kg/m^3	ppm		Hrs
Conventional Activated Sludge	0.2-0.4	0.3-0.8	1500-2000	3 - 7	6 - 8
Step Aeration	0.2-0.4	0.4-1.4	1000-1500	3 - 8	4 - 5
Re-aeration Method	0.2-0.2	0.8-1.4	2000-8000	> 12	> 5
Long Areation Method	0.03-0.05	0.15-0.25	3000-6000	> 15	16 - 24
Oxidation Ditch	0.03-0.05	0.1-0.2	3000-4000	—	24 - 48

Index of Organic Waste Water

① COD Chemical Oxygen Demand)

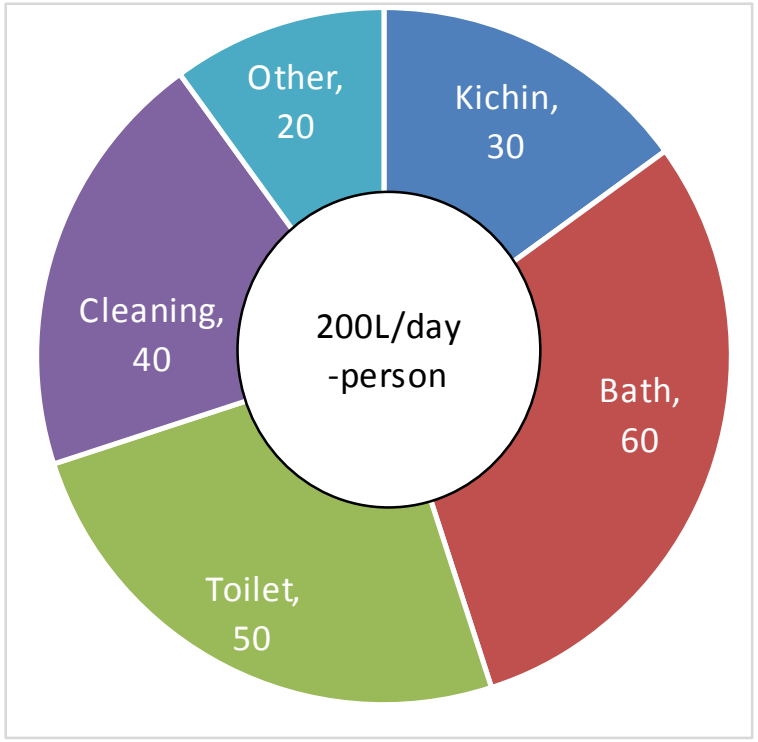
⇒ Consumed Dissolved Oxygen Quantities by composition of Organics at 100℃, with H_2SO_4 and indicated as mg O/l(ppm)

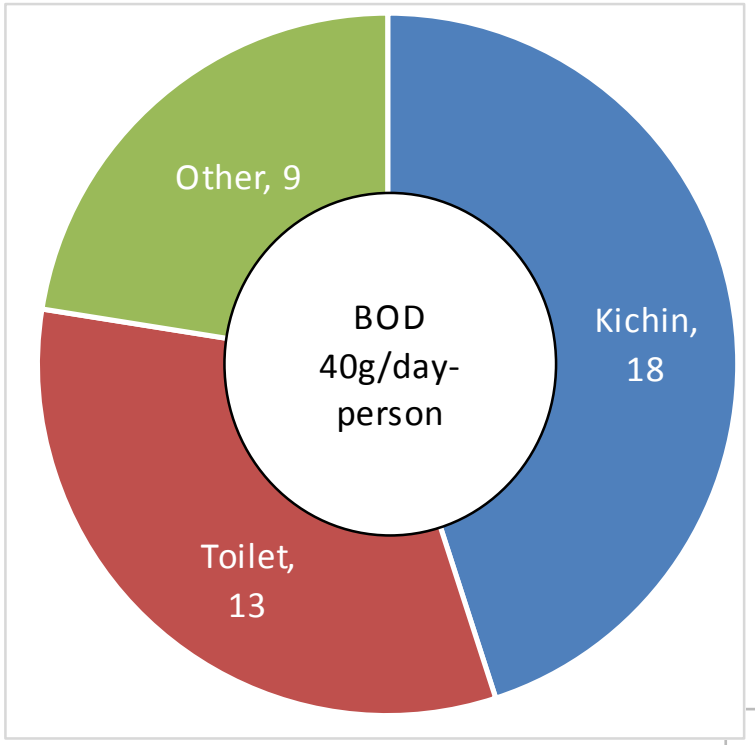
② BOD(Biochemical Oxygen Demand)

⇒ Consumed Dissolved Oxygen by composition of Organics During bacteria incubation at 35℃, 5 days and indicated as mg O/l(ppm)

＜ 10ppm	BOD ＞ COD
10～100ppm	BOD = COD
＞ 100ppm	BOD ＜ COD

(4) Domestic Drainage to Sewage in Japan





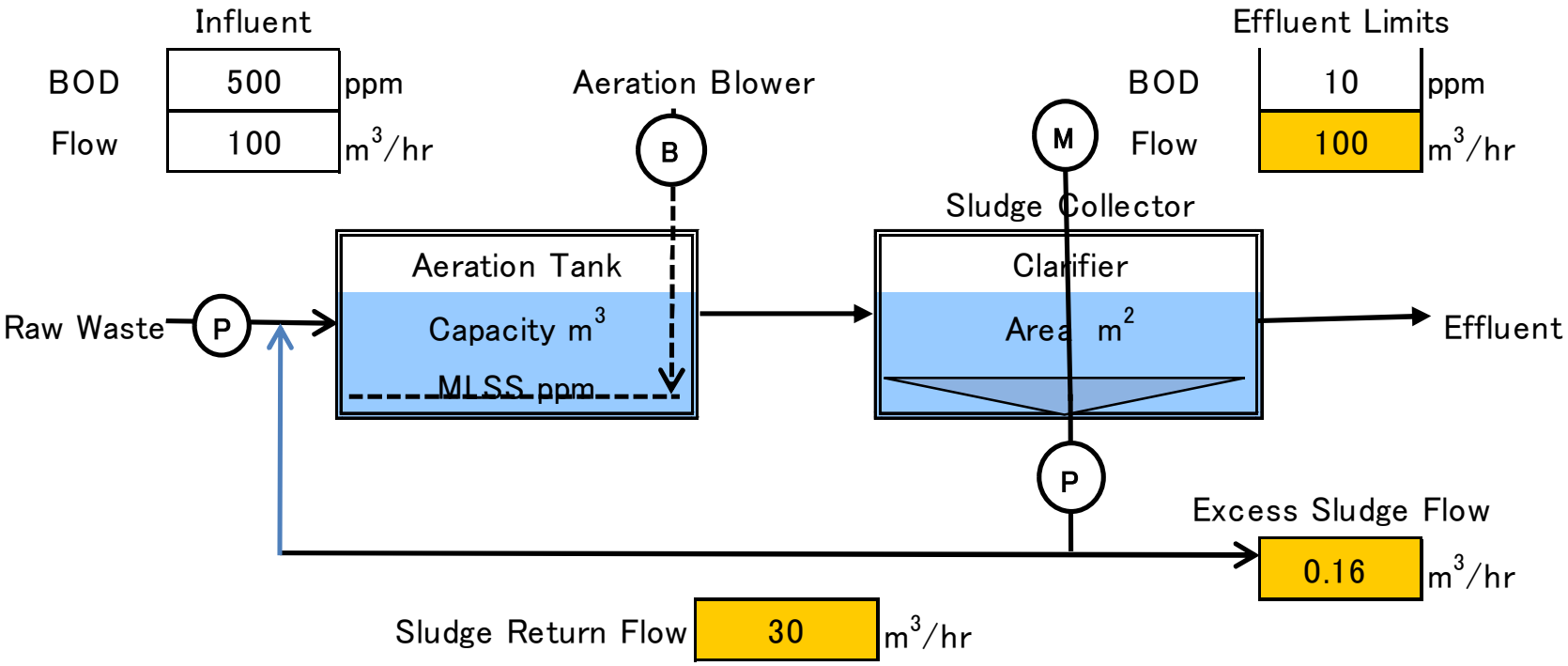
Water Quality for Sewage(Tokyo Bureau of Sewerage)

Domestic Dranage	Discharge	Limits
BOD 148ppm(Ave)	BOD < 3ppm	BOD < 25ppm

Environmental Condition

BOD	< 5ppm	< 3ppm
Kind of Fish	Carp, Crucian carp	Salmon, Ayu

(5) Block Flow and Mass Balance of Activated Sludge System



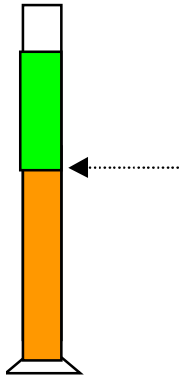
Parameter of Activated Sludge System Operation

				Recommending Values
① BOD of Influent		1200	kg-BOD/d	=m^3/hXBODppmX24
② BOD Load	Sludge Load	0.2	kg/MLSS	=kg-BOD/d/MLSSKg
	Volume Load	0.6	kg/m^3	=kg-BOD/d/m^3
③ Aeration Tank Capacity		2,000	m^3	
④ MLSS(Mixed Liquor SS)		2,500	ppm	1000～2000ppm
⑤ Aeration Time		20.0	hrs	=m^3/m^3/h
⑥ DO Conc. in Aeration Tank		2～5	ppm	
⑦ 30minutes SV(Sludge Volume)		50	%	
⑧ SVI(Sludge Volume Index)		200	70～250	=SVX10000/MLSSppm
⑨ Water Area of Clarifier		150	m^2	
⑩ Linear Velocity(LV) in Clarifier		0.7	m/hr	To be below 0.8m/hr
⑪ Sludge Return Rate		30	%	20～80% of Influent
⑫ Sludge Concentration		0.8	%	flow
⑬ BOD→Sludge Convert Ratio		40	%	
⑭ Excess Sludge Quantity(DS)		480	kg-DS/d	=kg-BOD/dX%/100

⑮ Nutrient Ratio BOD : N : P Ratio is to be as 100 : 5 : 1

For improving nutrient ratio, nutrient is to be dosed such as ammonium sulfate.

Measuring Cylinder



(6) Description of Activated Sludge System(1/2)

The following shows the examples of troubles which often occurs in the activated sludge treatment system.

Bulking occurs

Due to factors such as the following, fungi such as occurs in the activated sludge process in general, SVI value may increases and occurs caused by higher SVI value than 300, it's called "bulking." .

① In case of BOD High Load ai ⇒ To Reduce BOD Load.

② pH Adjustment ⇒ pH becomes lower due to aeration because CO_2 is dissolved by aeration.
To maintain slightly alkaline side. Bu NaOH dosing.

③ Over Aeration ⇒ Miniaturization of Flocs
N_2-gas increase and flocs are easy to float up.

④ Aeration Shortage ⇒ The treated BOD becomes worth.
To maintain DO 1～5ppm in the aeration tank.

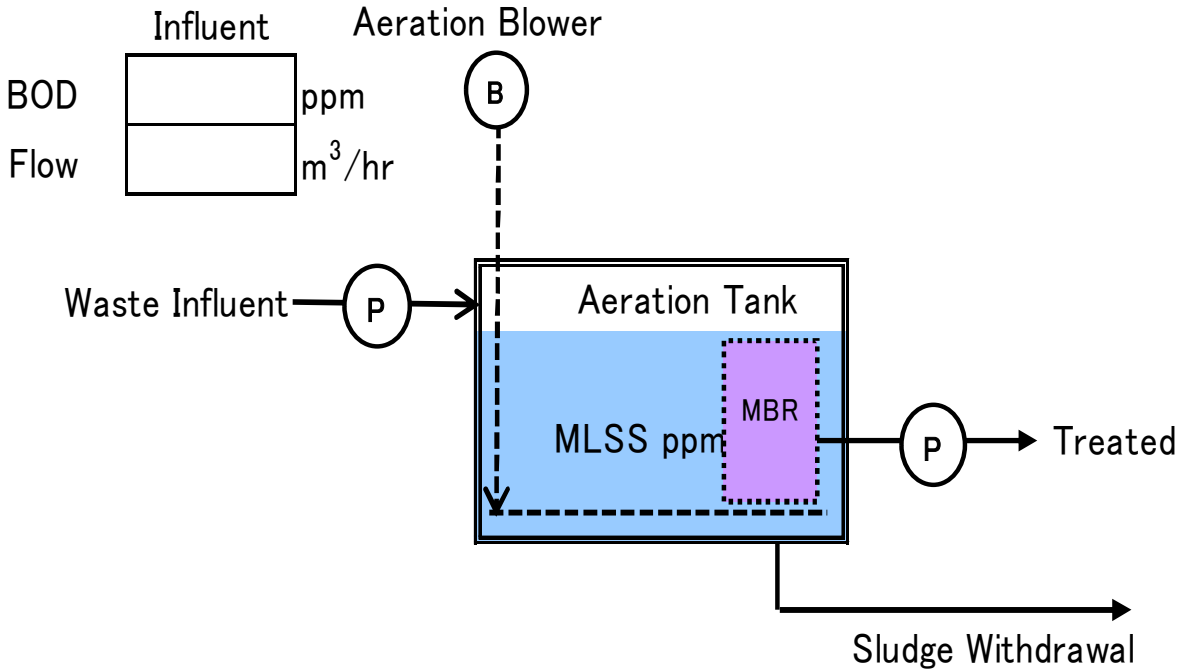
⑤ Persistent Chemicals are contained ⇒ Persistent Chemicals=COD-BOD in the influent waste.

⑥ Unless N, P are contained in the influen⇒ Nutrient has to be dosed.

⑦ If the activated sludge becomes anaerobic condition, fermentation occurs and deadly, poison and bad smell gas such as H_2S are produced, especially, the clearance between sludge collector and bottom, the sludge will be fermentated and scum is produced in the clarifier, and goes to treated water .

⑧ If influent waste contains oxidation reagents such as H_2O_2, NaClO etc., bacteria may be killed, it is necessary to dose reduction reagent such as Na_2SO_3etc for neutralization.

(7) Advanced Technology(MBR) of Activated Sludge System



§ 3 Nitrification, Denitrification System

In case of high T-N , T-P content waste(Eutrophication of water), It is necessary to remove it because of 「Wealth of Nutrients」 causes and affect to living environment. especially in Tokyo Bay, Ise Bay and Setonaikai area, waste discharge of this type is strictly limited by Japanese law. P can be removed by coagulation method, however, T-N has to be removed by employing nitrification and denitrificationsystem.

Note; NH_4-N + NO_3-N + NO_2-N = T-N(Total Nitrogen)

(1) N-waste Treatment Method

In this system, NH_4^+ is converted to NO_3^- (Nitrification) and decomposed to N_2(Denit -rification) aerobic biological method and T-N contained N-waste can be reduced.

Explanation of Nitrification Process

Chemical Reaction of Nitrification	$NH_4^+ + 3/2H_2O \rightarrow NO_2^- + 2H^+ + H_2O$
	$NH_4^+ + 2O_2 \rightarrow NO_2^- + 2H^+ + H_2O$
	$NO_2^- + 1/2O_2 \rightarrow NO_3^-$

The above reaction proceeds by breeding and growing of Nitrosomonas, Nitrosococus and nitrobactor bacteria which are mineral nutrition fungus type.

Factor of Nitrification Reaction	① Tem	The nitrification process proceeds at 20～30℃
	② pH	In nitrification, 2 moles of H+ are produced against ammonia
		1 mole,therefore, NaOH dosing is needed to maintain pH.
	③ DO	If DO becomes lower than 2～3ppm, nitrification bacteria
		activity also becomes lower.
	④ Sludge Age	5～7days…Nitrification reaction is smaller than common waste.
Reaction of Denitrification		$2NO_2^- + CH_3OH \rightarrow CO_2 + N_2 + 2OH + 7H_2O$
		$6NO_3^- + 5CH_3OH \rightarrow 3N_2 + 6OH + 7H_2O$

Needed Methanol Quantity for Denitrification Reaction

Methanol Dosing Quantity has to be applied to (McCarty) $Cm=2.47NO_3+1.53NO_2+0.87DO$)

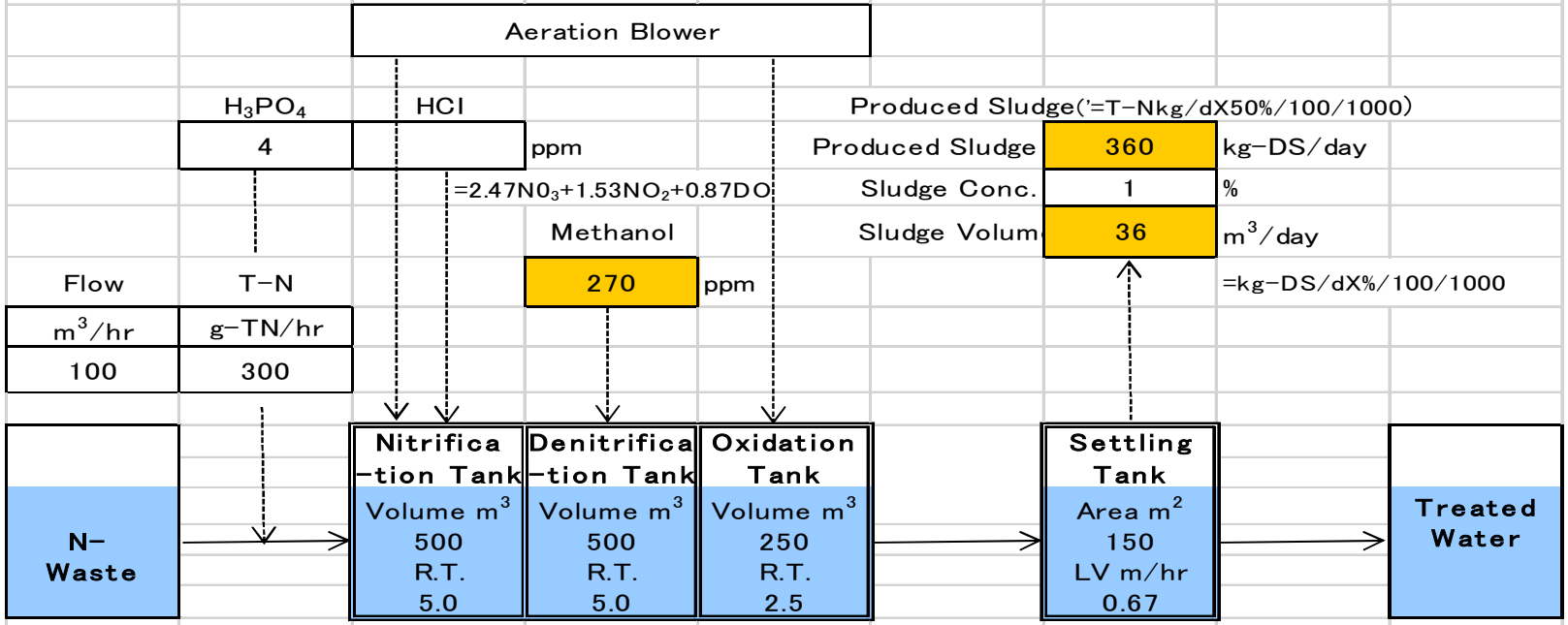
Example ⇒

NO_3-N	NO_2-N	DO	Methanol Dosing Quantity	
108	0	4	⇒	270 ppm

The methanol of 2.5times of influent T-N has to be dosed.

Expected Sludge Volu ⇒50% of Influent T-N becomes sludge.

(2) Block Flow and Mass Balance



(3) Operational Condition and Parameters

Monitoring Item	Nitrification Tank Outlet	Denitrification Tank Outlet	Oxidation Tank Outlet
pH	7 ～ 8	7 ～ 8	7 ～ 8
Dissolved Oxigen(DO)	> 4 ppm		> 4 ppm
Ammonia Nitrogen(NH_4-N)	< 0 ppm	< 0 ppm	< 0 ppm
Nitrite Nitrogen(NO_2-N)	< 10 ppm	< 0ppm	< 0 ppm
Nitrate Nitrogen(NO_3-N)		< 0 ppm	< 0 ppm

Note: If COD becomes higher caused by the excess(remained) methanol in the oxidation tank, and it can be reduced by air bubbling.

§ 4. Inorganic Waste Water Treatment System

The following substances are show typical hazardous of inorganics.

Inorganics		Hazardous	Removal Method	Discharge Limits	
F^-	Fluorine	Deadly Poison	Coagulation & Sedimentation	< 8-15	mg/l
Pb^{2+}	Lead	Deadly Poison	Coagulation & Sedimentation	< 0.1	mg/l
Cd^{2+}	Cadmium	Deadly Poison	Coagulation & Sedimentation	< 0.1	mg/l
Ar^-	Arsenic	Deadly Poison	Coagulation & Sedimentation	< 0.1	mg/l
CN^-	Cyanide	Deadly Poison	Decoposition by Oxidation	< 1	mg/l
Cr^{6+}	Hexavalent Chromium	Deadly Poison	$Cr^{6+} \Rightarrow Cr^{3+}$ by Reductioon	< 0.5	mg/l
Cr^{3+}	Trivalent Chromium		Coagulation & Sedimentation		
Ni^{2+}	Nikel		Coagulation & Sedimentation		
Cu^{2+}	Copper		Coagulation & Sedimentation		
Zn^{2+}	Zinc		Coagulation & Sedimentation		

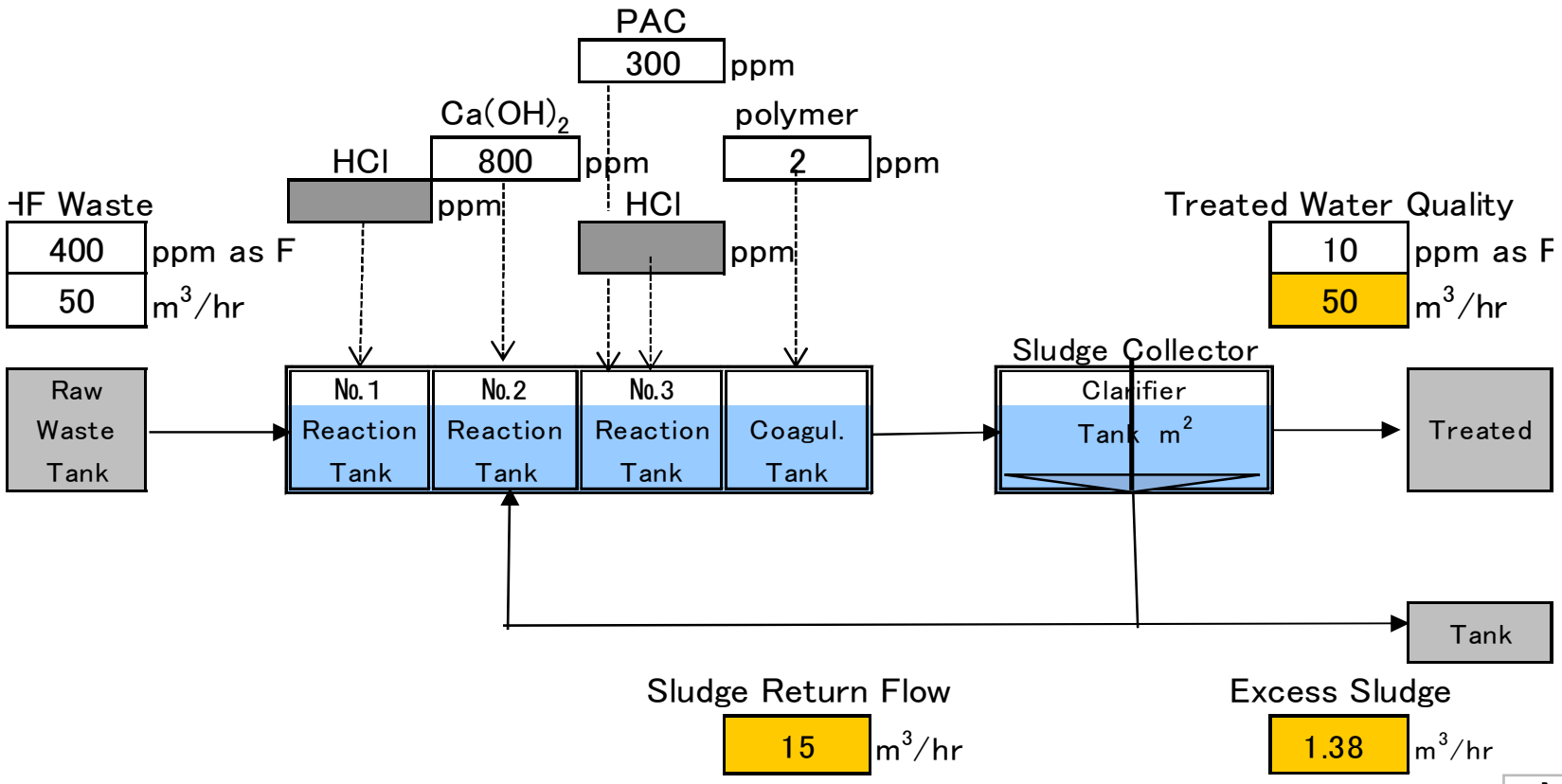
The above substances waste have to separately be received and individually treated.

(1) F−Waste Treatment System for Fluoride Removal

The waste contained F^- ion (Hazardous substance) is to be removed as the following Method Lime and Coagulant are dosed to the fluoride waster while adjusting pH, and CaF_2 flocs are produced in the water. as reaction formula..formula..the following chemical reaction.

Chemical Reaction: $2HF + Ca(OH)_2 \Rightarrow CaF_2 + 2H_2O$

(2) Block Flow



(3) Operational Condition and Parameters

① No.1 Reaction Tank pH	6.0-7.0		
② No.2 Reaction Tank pH	6.5-7.5		
③ No.3 Reaction Tank pH	6.5-7.0		
④ 10% $Ca(OH)_2$	400	l/hr	Lime Solution makes scales in the pipe.
⑤ PAC(10% A_2O_3)	15	l/hr	
⑥ 0.1% Polymer	100	l/hr	
⑦ Sedimentation Tank Area	50	m^2	
⑧ Sedimentation Tank (LV)	1.0	m/hr	To be LV < 3m/hr
⑨ Sludge Return Rate	30	%	
⑩ Sludge Conc.	3.0	%	
⑪ Produced CaF_2Sludge	936	kg-DS/day	$=m^3/h$XFppmX24X78/20/2X24/1000
⑫ Produced $Al(OH)_3$Sludge	55	kg-DS/day	$=m^3/h$XPACppmX0.1X78X2/102X24/100(
⑬ Excess Sludge(DS)Volume	991	kg-DS/day	=⑪+⑫

§ 5 Dehydration of F-Waste Sludge

An excess sludge of F waste treatment usually dehydrates as sludge cake by filter press and transfers for disposal.

Sludge Flow	1.38	m^3/hr	Sludge Cake	2,478	kg/day
Sludge Conc.	3.0	%	Cake Moisture	60	%
			Operation Cycle	1.71	Batches/day

Filtrate Area	30	m^2	
Filtrate Volume	580	l	←from Filter Press Specification
Cake Thickness	18	mm	
Cake Moisture <	55～75	%	

An air bubbling has usually to be done to privet sludge fermentation in the sludge storage tank.

The following shows typical operation diagram of filter press.

Typical Operation Diagram of Filter Press

Process	Duration
Stand By	—
Filtration	60 minutes
Squise	20 minutes
Open Flame	10 minutes
Filter Cloth Rinse	20 minutes
Close Flame	10 minutes

§ 6. Removal of Heavy Metal Ions

1, Pb···Lead Removal

The waste which contains Pb^{2+} ion (Hazardous substance) is to be removed by the following Method and $Pb(OH)_2$, coagulant(Ferric Chloride···$FeCl_3$) and polymer are dosed to the Pb waste while pH adjusting, flocs are produced in the water.as the following chemicals reaction formula.

$$Pb^{+2} + 2OH^{-} \rightarrow Pb(OH)_2$$

2. Other Heavy Metal Ions

The following heavy metals Hazardous substances) can also be removed by the same [Alkaline Coagulation] method.

$$Pb^{+2} + 2OH^{-} \rightarrow Pb(OH)_2$$
$$Ni^{+2} + 2OH^{-} \rightarrow Ni(OH)_2$$
$$Cu^{+2} + 2OH^{-} \rightarrow Cu(OH)_2$$
$$Zn^{+2} + 2OH^{-} \rightarrow Zn(OH)_2$$
$$Cd^{+2} + 2OH^{-} \rightarrow Cd(OH)_2$$
$$Cr^{+3} + 3OH^{-} \rightarrow Cr(OH)_3$$

The Alkaline Coagulation/Sedimentation Methods are usually employed for removal of heavy metals waste and fee following points are very important for it.

Heavy Metals	Coagulation pH	pH = 9.0		pH = 10		pH > 10.5
Cr^{3+} (Chromium)	8.0 ~ 9.0					
Pb^{2+} (Lead)	9.0 ~ 9.5	2.5ppm Pb^{2+}	0.21ppm $HPbO_2^-$	0.025ppm Pb^{2+}	2.1ppm $HPbO_2^-$	$HPbO_2^-$ Increase
Cd^{2+} (Cadmium)	> 10.0	44ppm		0.44ppm		0.04ppm
Ni^{2+} (Nickel)	> 10.0					
Cu^{2+} (Copper)	9.0 ~ 10.0					
Zn^{2+} (Zinc)	> 10.0					

Additional Tools for Other Produced Sludge Volume Calculation.

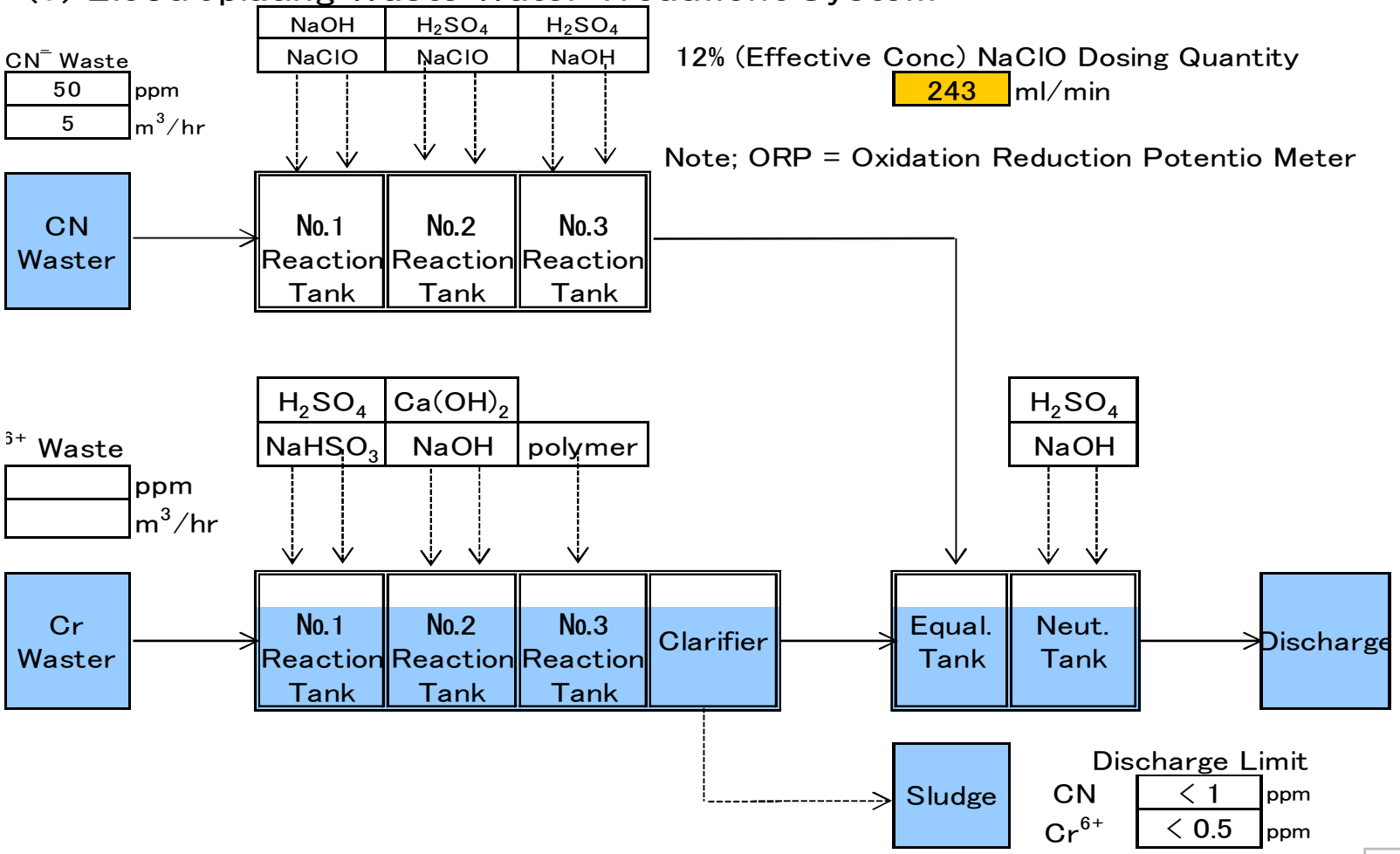
Flow Rate m^3/hr	Dosing Chemicals	Concentration (ppm)	Produced Sludge	Produced Sludge Quant'sk g-DS/d	Calculation
100	PAC	200	$Al(OH)_3$	73	$=m^3/hXPACppmX0.1X78X2/102X24/1000$
	$FeCl_3$		$Fe(OH)_3$	319	$=m^3/hXFeCl_3ppmX107/161X24/1000$
	F^-		CaF_2	936	$=m^3/hXFppmX78/20/2X24/1000$
	Pb^{2+}		$Pb(OH)_2$	559	$=m^3/hXPbppmX241/207X24/1000$
	Ni^{2+}		$Ni(OH)_2$	757	$=m^3/hXNippmX93/59X24/1000$
	Cu^{2+}		$Cu(OH)_2$	735	$=m^3/hXCuppmX98/64X24/1000$
	Zn^{2+}		$Zn(OH)_2$	731	$=m^3/hXZnppmX99/65X24/1000$
	Cr^{3+}		$Cr(OH)_3$	951	$=m^3/hXCrppmX103/52X24/1000$

Note: PAC(Poly Aluminum Chloride)…Coagulant

3. Hexavalent Chlomium(Cr^{6+}), Cyanide(CN^-) Waste Treatment System

The electroplateing waste usually contains CN^- and Cr^{6+} and these are quite strong toxic substances, and has to strictly decompose/remove to lower than the discharge limits before these waste discharge..

(1) Electroplating Waste Water Treatment System



(2) Cyanide ･･･CN Waste

① If pH becomes acid side in CN waste, deadly poison gas will come out, therefore, pH has to be maintained to alkaline side.･･･Strict Precautions

② CN can be decomposed by the following 2 stage chemical reactions in Alkaline-Chlorine Method of CN-waste.

1st Stage Reaction $NaCN + NaClO \rightarrow NaCNO + NaCl$ (Reaction Time > 10minutes)

pH Meter	･･･ pH = 10.5 ･･･ To be maintained by dosing NaOH solution.
ORP Meter	･･･ ORP 300～350mV ･････ To be maintained by dosing oxidation reagent(Cl_2).

2nd Stage Reaction $2NaCNO + 3NaClO \rightarrow N_2 + 3NaCl + 2NaHCO_3$

(Reaction Time > 30minutes)

pH Meter	･･･ pH = 7.5 ･･･ To be maintained by dosing HCl solution.
ORP Meter	･･･ ORP 600～650mV ･･･ To be maintained by dosing oxidation reagent(Cl_2).

1st + 2nd Reaction

$2NaCN + 5NaClO + 2H_2O \rightarrow N_2 + 5NaCl + 2NaHCO_3$ となる。

Therefore, in order to decomposition of CN 1gr, it is necessary to dose 6.63gr of effective chlorine.

[$5Cl_2$ / 2CN = 71 / 26 X 2= 6.63 gars] ･･･ 7times ･･･。

12% (effective Cl_2 concentration) NaClO Dosing Quantity･･･ 243 ml/min

② If heavy metals such as Fe are contained in CN waste, it is difficult to decompose CN by making a satiable cyano complex, and in such case, "Prussian Blue Method" by adding excess Fe, and sedimentation method) is recommended.

(3) Hexavalent Chromium…Cr^{6+}Waste Water Treatment

① Chromium…There are 2 kinds as trivalent chromium(Cr^{3+}) and hexavalent chromium (C^{6+}). both discharge limits are very strict.

② Hexavalent Chromium…Cr^{6+}complex are make as CrO_3. red color and acidic substanc

③ Removal of Hexavalent Chromium…C^{r6} is usually converted to trivalent chromium by adding reduction reagent, [$Cr^{6+} \Rightarrow Cr^{3+}$] and make chromium hydroxide Cr(OH)3 flocs by adding coagulant($FeCl_3$ + polymer) and sedimentation alkaline coagulation/ sedimentation method).

Reduction Reagent	Chemical Reaction	CrO_3 1kg 還元するに要する還元 eduction Chemica	H_2SO_4
Fe	$2H_2CrO_4+2Fe+6H_2SO_4\rightarrow$	0.56kg	
	$Cr_2(SO_4)_3+3Fe(SO_4)_3+8H_2O$		2.94kg
$FeSO_4\cdot 7H_2O$	$2H_2CrO_4++6FeSO_4+6H_2SO_4\rightarrow$	8.34kg	
	$Cr_2(SO_4)_3+3Fe(SO_4)_3+8H_2O$		2.94kg
Na_2SO_3	$2H_2CrO_4+3Na_2SO_3+6H_2SO_4\rightarrow$	1.89kg	
	$Cr_2(SO_4)_3+3Na_2(SO_4)_3+8H_2O$		1.47kg
$NaHSO_3$	$4H_2CrO_4+6NaHSO_3+3H_2SO_4\rightarrow$	1.56kg	
	$2Cr_2(SO_4)_3+3Na_2SO_4+8H_2O$		0.74kg
SO_2	$2H_2CrO_4+3SO_2\rightarrow$	0.96kg	
	$Cr_2(SO_4)_3+8H_2O$		—

§ 7. Oil Removal

1. Oil Separator

The Oil contained in Oily waste can be removed by the following flotation system.

(1) API(American Petroleum Institute)

(2) PPI(Parallel Plate Interceptor)

(3) CPI(Corrugated Plate Interceptor)

These method due to the following Stoke's Formula.

$$U_t = \frac{g\ (\rho_w - \rho_o)\ d^2}{18\ \mu}$$

U_t = Up flow Velocity of Oil Dropet(cm/s)

ρ_w, ρ_o = Decity of Oil Dropet and Water(g/cm^3)

d = Diameter of Oil Dropet(cm)

g = Acceleration of Gravity(cm/s^2)

μ = Water Viscosity(g/cm.s)

Calculation Example

$$U_t = \frac{980}{18 \times 0.01} \times (1.0-0.9) \times 0.015^2 = 0.12 cm/s$$

API Oil Separator

According to API design manual,

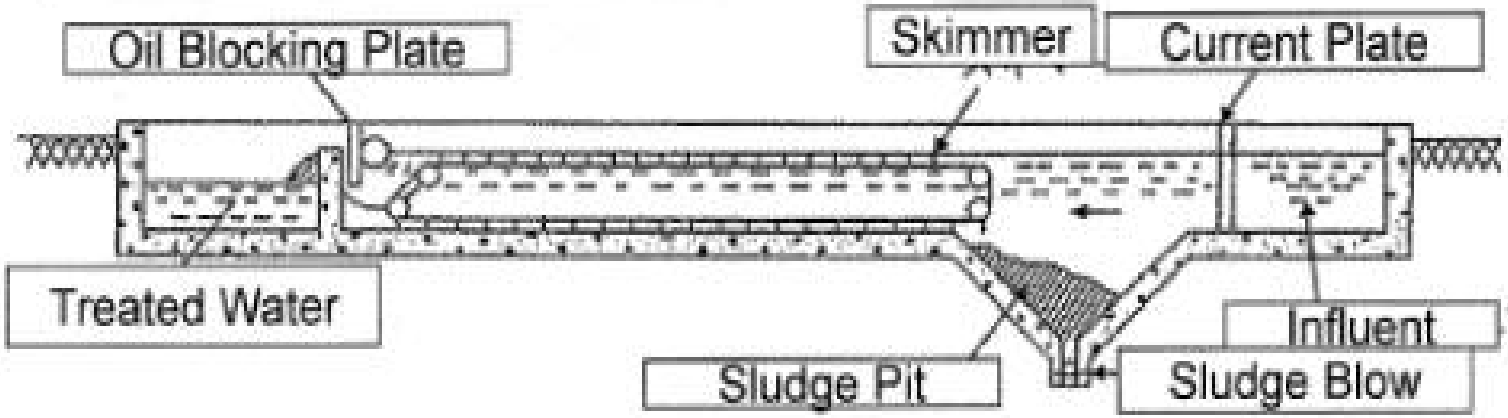
In case of W(Width) = 1.8~6.1m, H(Depth) = 1.9~2.4m, to be designed as H / W = 0.3~0.5 and averaged V(velocity) in tank is to be maintained as below 0.9m/min.

The tank L(Length) is also as following formula.

$$L = VH / Ut \times fs \times ft$$

fs = Short Pas factor (1.2)

ft = Turbulence Factor(1.45~1.07) ←Due to V/Ut



2. Dissolved Air Flotation(DAF) System

(1) Chemical Dosing

The following ①, ②, ③ and ④ chemicals are generally dosed to water pre-treatment system.

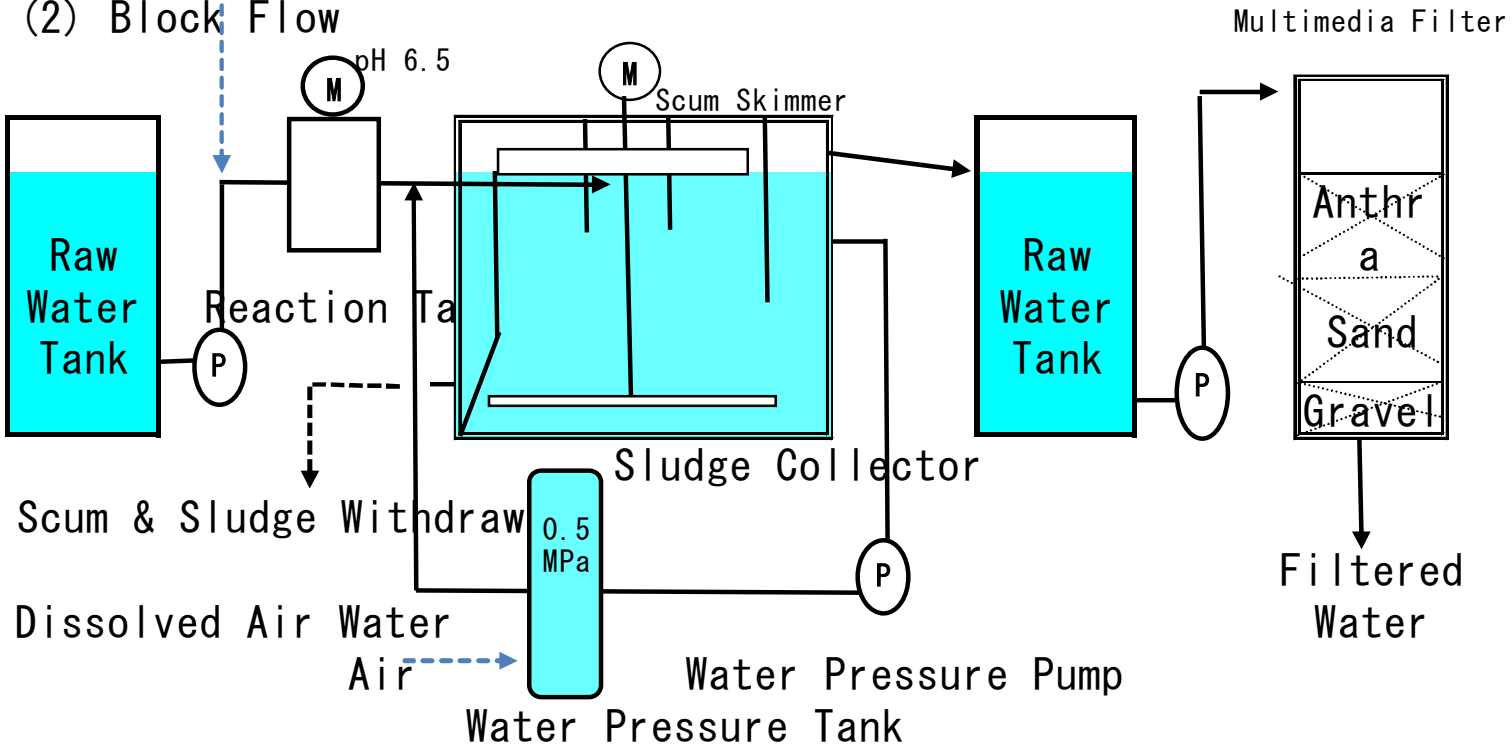
① NaClO(Sodium Hypochlorite) for killing bacteria and Decomposing organics.

② Chloric Acid(HCl) for pH Adjustment

③ PAC($[Al_2(OH)_nCl_{6-n}]_m$ Poly Aluminum Chloride) Coagulant for making flocs($A;(OH)_3$

④ Polymer(Poly Electrolyte) for Coagulation Aid

(2) Block Flow



§ 8. Waste Discharge Limits

1. Discharge Limits of Hazardous Substances Uniform standard limits)

According to (Article No. 54 Prime Minister's Office Ordinance 1993) effluent standards related to the Water Pollution Control Law)

Kind of Hazardous Substances	Discharge Limits			
Cadmium Compounds	< 0.1	mg/l	0.1	mg/l
Cyanide and Cyanide Compounds	< 1	mg/l	1	mg/l
Organic Phosphorus Compounds	< 1	mg/l	1	mg/l
Lead and Lead Compound	< 0.1	mg/l	0.1	mg/l
Hexavalent Chromium Compounds	< 0.5	mg/l	0.5	mg/l
Arsenic and Arsenic Compounds	< 0.1	mg/l	0.1	mg/l
Mercury Compounds of Alkyl Mercury Compounds and Other Mercury	< 0.05	mg/l	0.05	mg/l
Alkyl Mercury Compound	To be N.D.		To be N.D.	
PCB	< 0.003	mg/l	0.003	mg/l
Trichloroethylene	< 0.3	mg/l	0.3	mg/l
Tetra Chlorethylene	< 0.1	mg/l	0.1	mg/l
Di-chloro Ethylene	< 0.2	mg/l	—	
Carbon Tetrachloride	< 0.02	mg/l	(0.03	mg/l)
1. 2-Di-chloro Ethylene	< 0.01	mg/l	—	
1. 1-Di-chloro Ethylene	< 0.2	mg/l	—	
Sys-1. 2-Di-chloro Ethylene	< 0.4	mg/l	—	
1. 1. Trichloroethylene	< 3	mg/l	(3	mg/l)
1. 1. 2-Trichlorethylene	< 0.06	mg/l	—	
1. 3-Trichlorethylene	< 0.02	mg/l	—	
Theorem	< 0.06	mg/l	—	
Simonize	< 0.02	mg/l	—	
Thiobencarb	< 0.2	mg/l	—	
Benzene	< 0.1	mg/l	—	
Selene and Selene Compound	< 0.1	mg/l	—	
Boron and Boron Compound	< 10 < 230	mg/l mg/l	Other Area Sea Area	
Fluorine and Fluorine Compound	< 8 < 15	mg/l mg/l	Other Area Sea Area	
Ammonium, Nitrite, Nitrate Compounds	< 100	mg/l	—	

2. Sewer Discharge Limits of the Technical Standards

(Sewerage Order for Enforcement of the Act 1959)

Item	Allowable Limits
pH	＞5.8 ＜8.6
Coli form Group	＜3000 Peices/cm^2
Biological Oxygen Demand(BOD)	10 ～ 15 mg/l
Suspended Solid(SS)	＜40 mg/l
Nitrogen content	10 ～ 20 mg/l
Phosphorus Content,	0.5 ～ 3 mg/l
The number to comply with the plan effluent quality Sewer construction Ordinance (№35 Sewer Enforcement Order)	

3. Total Volume Control and Drainage Regulations

	Discharge Limits	Total Control Discharge Limits
Purpose	Creating Environmental Standards	Creating environmental standards in wide-area closed system water is particularly significant pollution
Applied Area	Japanese Whole Area	Specified water area(Tokyo Bay, Ise Bay and Setonaikai Area)
Method of Limitation	Limits are to be regulated at each by each discharge points	Discharge quantities are to be regulated at each by eac facilities.
Limits	(Additional Standards) (In case of COD, 100 mg/l)	Limits by COD Values. $L = C \times Q \times 10^{-3}$ L: Permissible Lord (kg-COD/d) C: Regulated Limits at products category by governor. (mg/l) Q: Applied Waste Quantity(m^3/d)
Improvement Order at new project.	Application to Governor (It may be subject to change the plan by the governor order in some case.)	It may be odder to re-set more strict discharge limits than existing above tem C values.

§ 9. Environmental Standards

1. Environmental Quality Standards

for Water Pollution···Environmental Standards for Protection of Human Health
Article 16 Environmental Standards Act, "Environmental Standards" Setting

Item	Standard
Cadmium and Cadmium Compounds	< 0.01 mg/l
Cyanide and Cyanide Compounds	Non Detect
Lead	< 0.01 mg/l
Hexavalent Chromium	< 0.05 mg/l
Arsenic	< 0.01 mg/l
Total Mercury	< 0.0005 mg/l
Alkyl mercury Compounds	Non Detect
PCB	Non Detect
Di-chloromethane	< 0.02 mg/l
Di-chloral Ethylene	< 0.002 mg/l
Carbon Tetrachloride	< 0.004 mg/l
1. 2-Di-chloro Ethylene	< 0.02 mg/l
1. 1-Di-chloro Ethylene	< 0.04 mg/l
Sys-1. 2-Di-chloro Ethylene	< 1 mg/l
1. 1. Trichloroethylene	< 0.006 mg/l
1. 1. 2-Trichlorethylene	< 0.03 mg/l
1. 3-Trichlorethylene	< 0.01 mg/l
Theorem	< 0.002 mg/l
Simonize	< 0.006 mg/l
Chiobenkarupu	< 0.003 mg/l
Benzene	< 0.02 mg/l
Benzene	< 0.01 mg/l
Selene	< 0.01 mg/l
Nitrate Nitrogen and Nitrite Nitrogen	< 10 mg/l
Fluorine	< 0.2 mg/l
Boron	< 1 mg/l

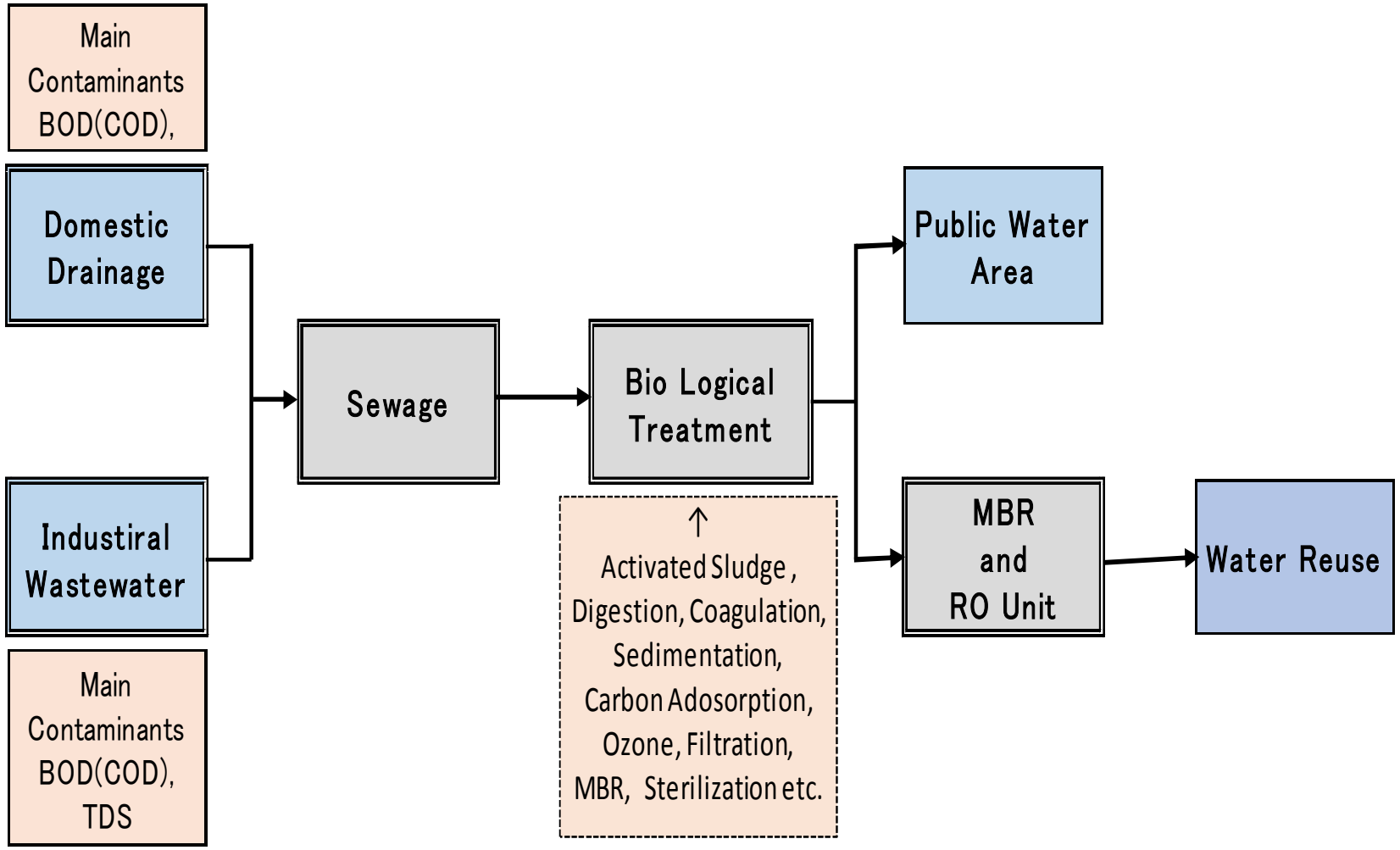
1 Standard Values are to be shown as Annual Averaged.

2 The above discharge limits of Florien and Boron are not applied in Sea Area.

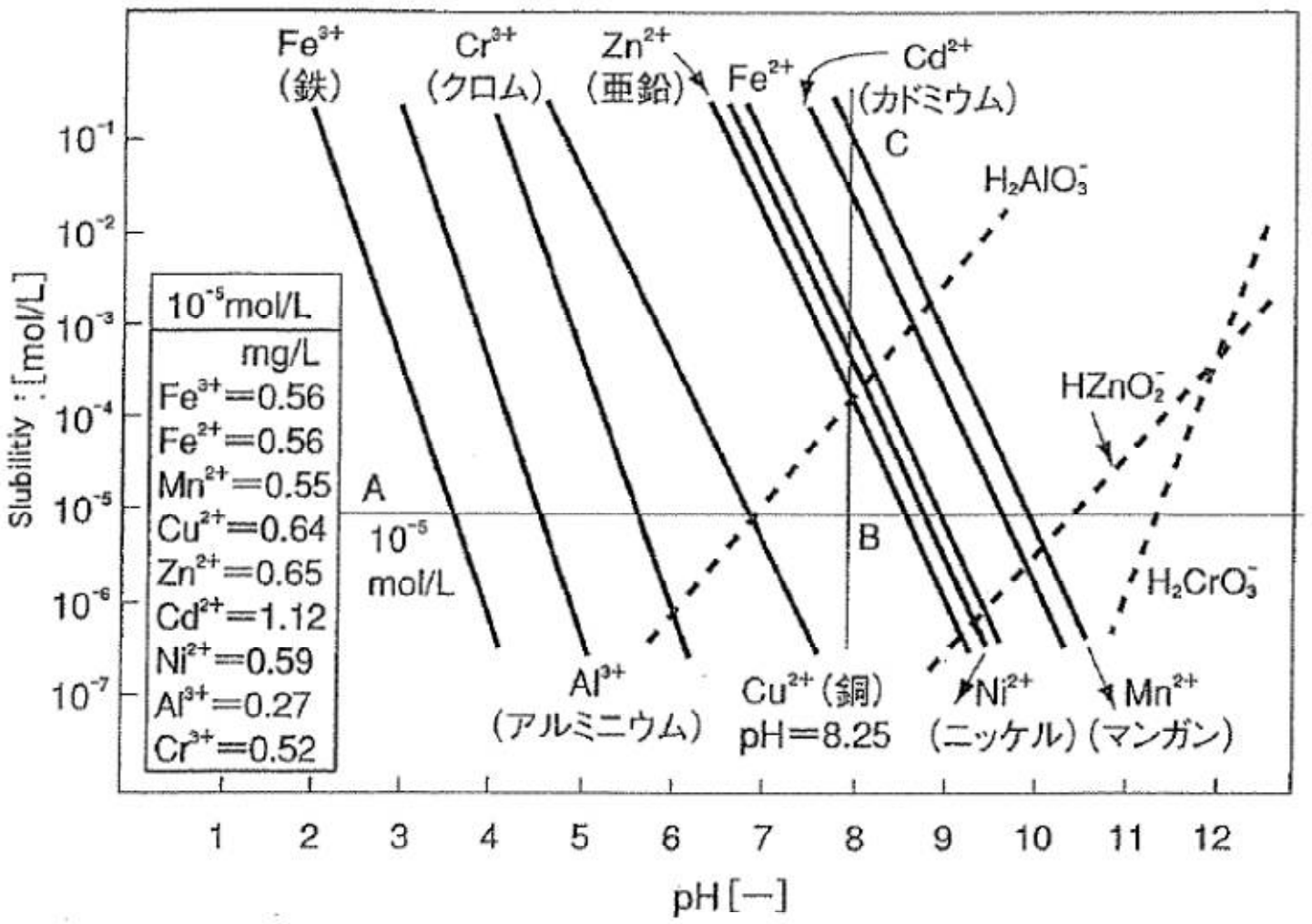
2. Emission Standards in accordance with Living Environment

Item	Discharge Limits	
Hydrogen Ion Concentration = pH	Other Place	> 5.8 < 8.6
	Sea Area	> 5.8 < 9.0
Biochemical Oxygen Demand = BOD		< 160 mg/l
	(Day Averaged	< 120 mg/l)
Chemical Oxygen Demand = COD		< 160 mg/l
	(Day Averaged	< 120 mg/l)
Suspended Solid = SS		< 200 mg/l
	(Day Averaged	< 150 mg/l)
Mineral Oil Content	< 5 mg/l	
Plant type Oil Content	< 30 mg/l	
Phenol Contend	< 5 mg/l	
Copper	< 3 mg/l	
Zinc	< 5 mg/l	
Soluble Iron Content	< 10 mg/l	
Manganese	< 10 mg/l	
Chromium Content	< 2 mg/l	
Fluorine Content	< 15 mg/l	
Escherichia Coli Group	(Day Averaged	< 3000 pcs/cm^2
Nitrogen Content	< 120 mg/l	
	(Day Averaged	< 60 mg/l)
Phosphorus Content	< 16 mg/l	
	(Day Averaged	< 8 mg/l)

§ 10. Sewage Treatment and Water Regeneration

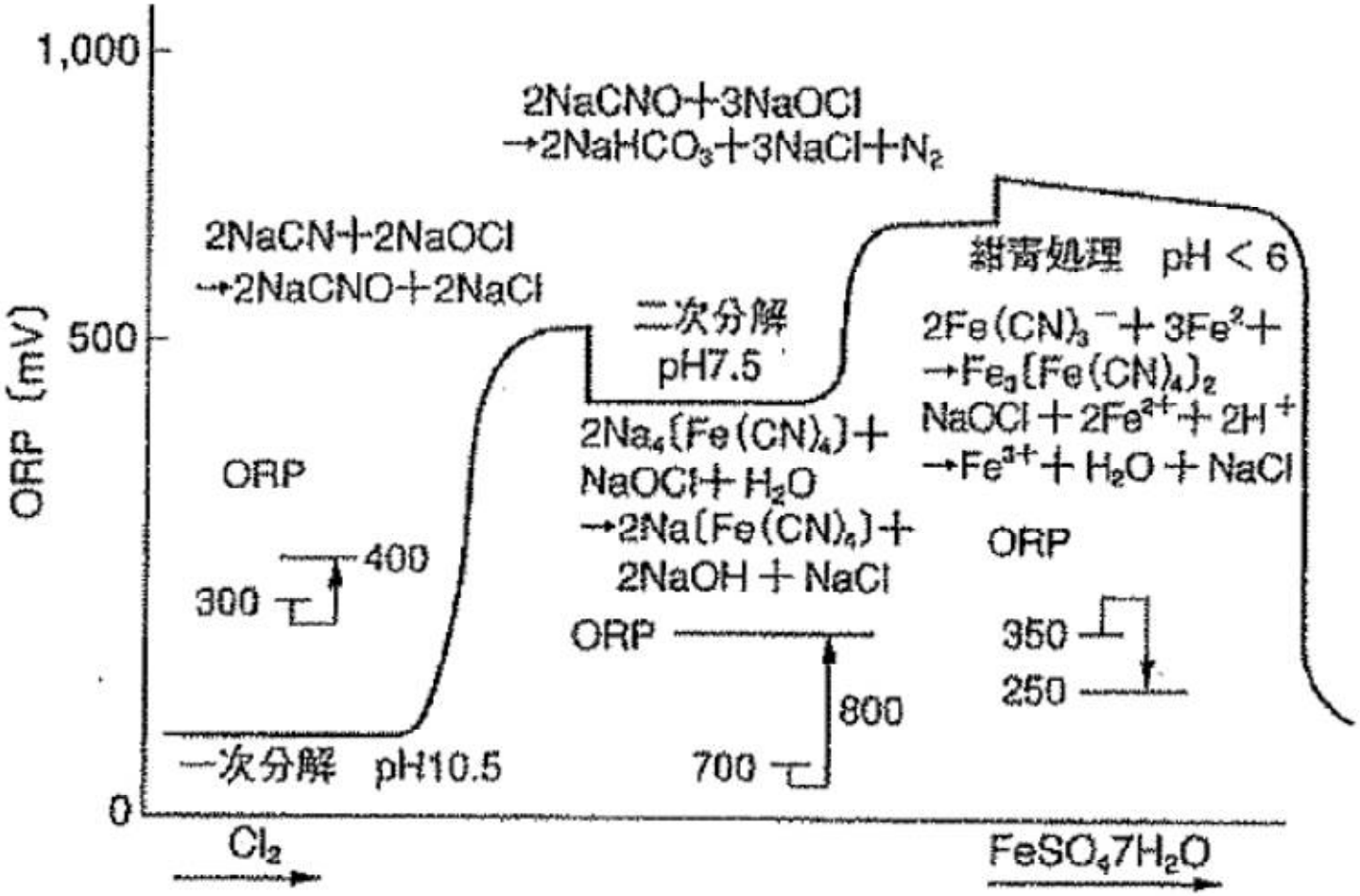


§ 11. Additional Data 1/4



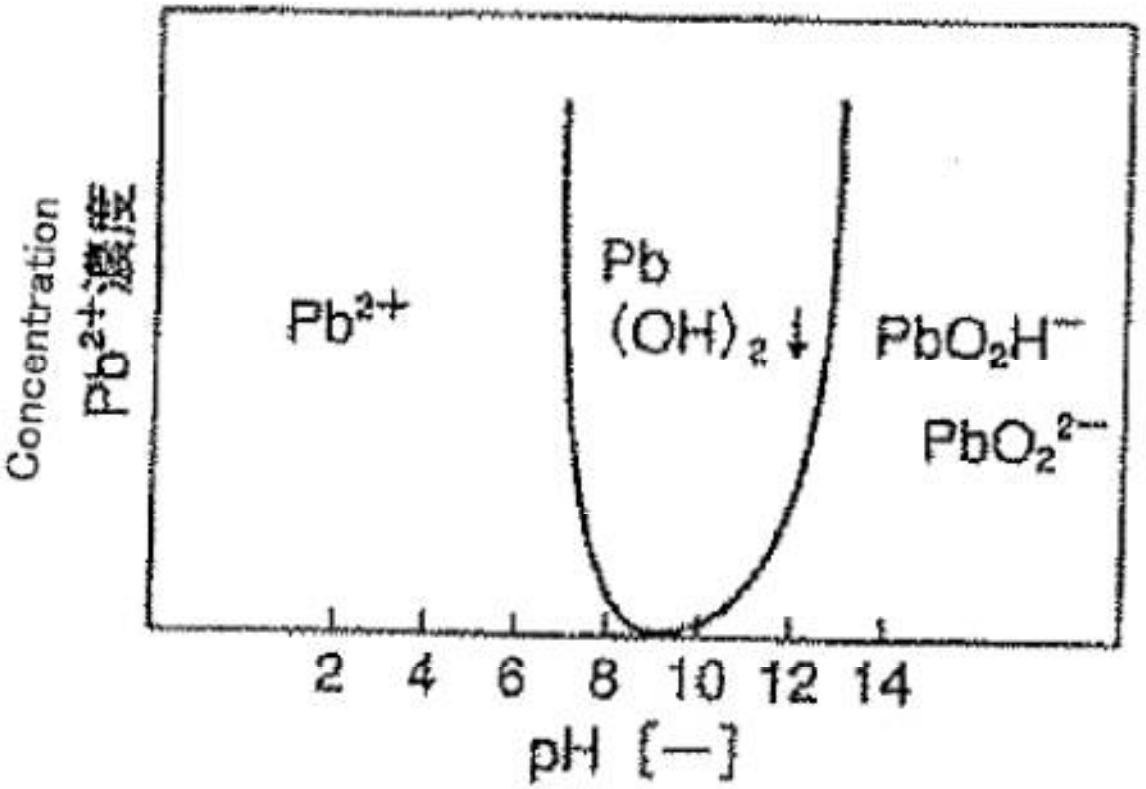
Relation between pH and Metal Ion Solubility

Additional Data 2/4



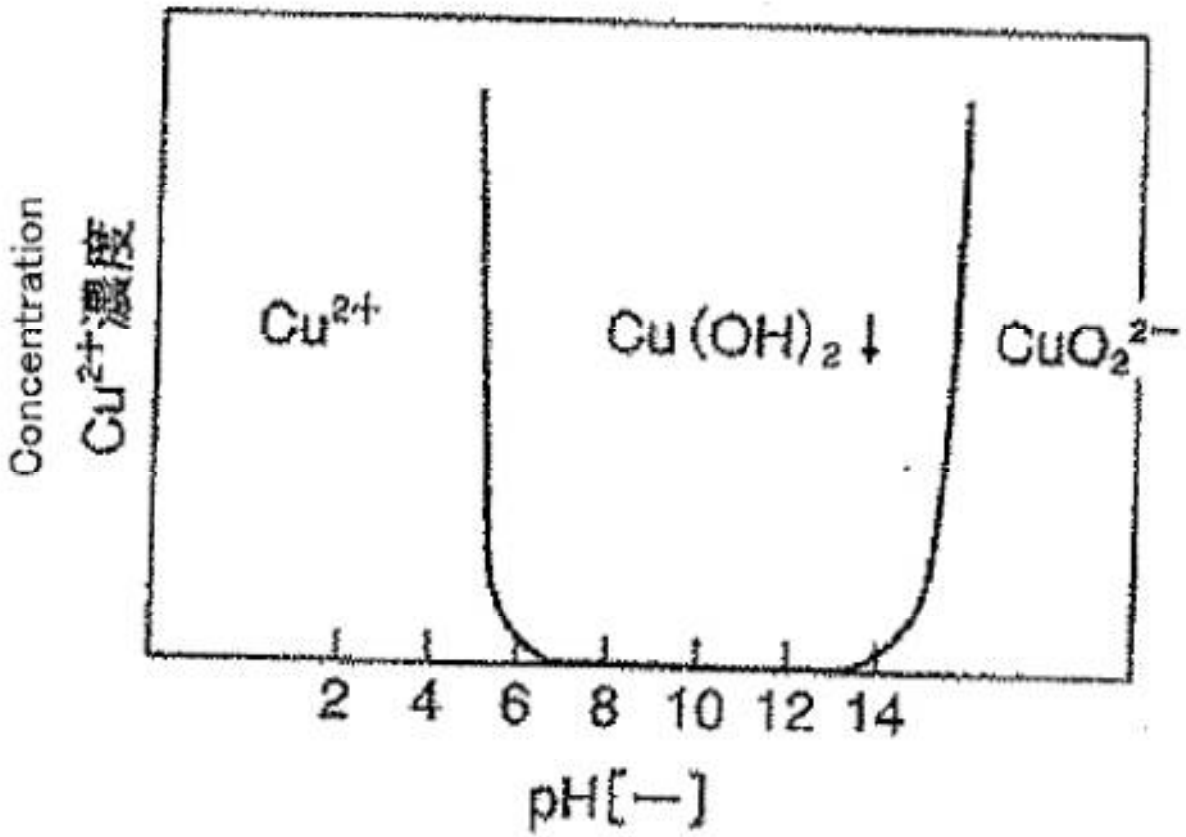
CN Waste Treatment by Alkaline-Chlorine Method

Additional Data 3/4



Relation between pH and Pb Solubility

Additional Data 4/4



Relation between pH and Cu Solubility

Thank you for your attention !