centrated wastewater is transported to the treatment facility. At the facility, the concentrated wastewater goes through coagulation and sedimentation process and then undergoes the activated sludge treatment process. Any sludge separated is incinerated and the ashes are placed in a pit. Diluted wastewater separated at each factory goes through the neutralization process within the factory and is discharged into rivers. At the rivers where diluted water is discharged into, the aforesaid automatic measuring and recording device for COD and wastewater is installed.

The flowchart for the whole process materialized at Nishiwaki Treatment Facility (Centralt treatment facilitiy) is given in Figure 2.1.2. The facility is operated by the staff of the Cooperative.

The flowchart for the whole process practiced at the wastewater treatment workshop located in each company outside the city is shown in Flowchart 2.1.3. Each workshop has its own method of process similar to one another.

Nishiwaki Treatment Facility has capacity to treat wastewater up to 2,780m^3 per day; however, the most recent amount of wastewater treated is 2,200m^3 per day.

(2) Quality of wastewater and treated water

The quality of wastewater and treated water is shown in Table2.1.2.

"The Regulations on Special Measures for the Preservation of the Environment of Seto-naikai" provide that the concentration control value for COD shall be 70mg per liter and the areawide total pollution load control value shall be:

The table proves that at present there is more room for both concentration and pollution weight to grow.

2.2 Fukui Prefecture Dyeing Industrial Cooperative, Tookoo Treatment Plant

2.2.1 Outline of the Cooperative

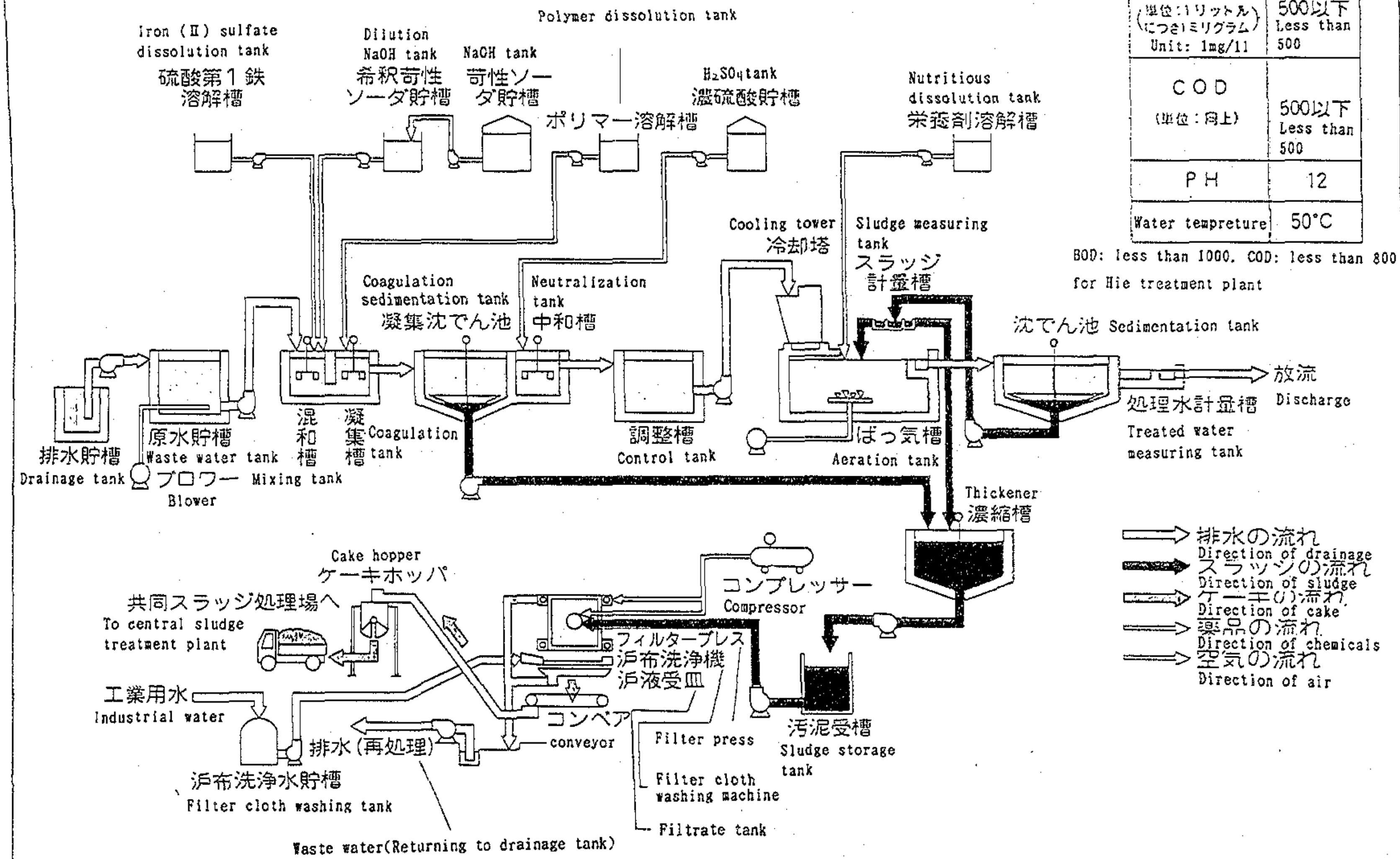
FLOW SHEET

フローシート

Quality of waste water
㊟原水水質

BOD (単位：1リットルにつきミリグラム) Unit: 1mg/1l	500以下 Less than 500
COD (単位：同上)	500以下 Less than 500
PH	12
Water tempreture	50°C

BOD: less than 1000, COD: less than 800 for Hie treatment plant



Note: For Hie treatment plant(Niitaka dyeing cooperation), activated sludge treatment is performed.

(注)比延処理場(新高染工株式会社)については活性汚泥処理のみです

Figure 2.1.2 Nishiwaki waste water treatment plant

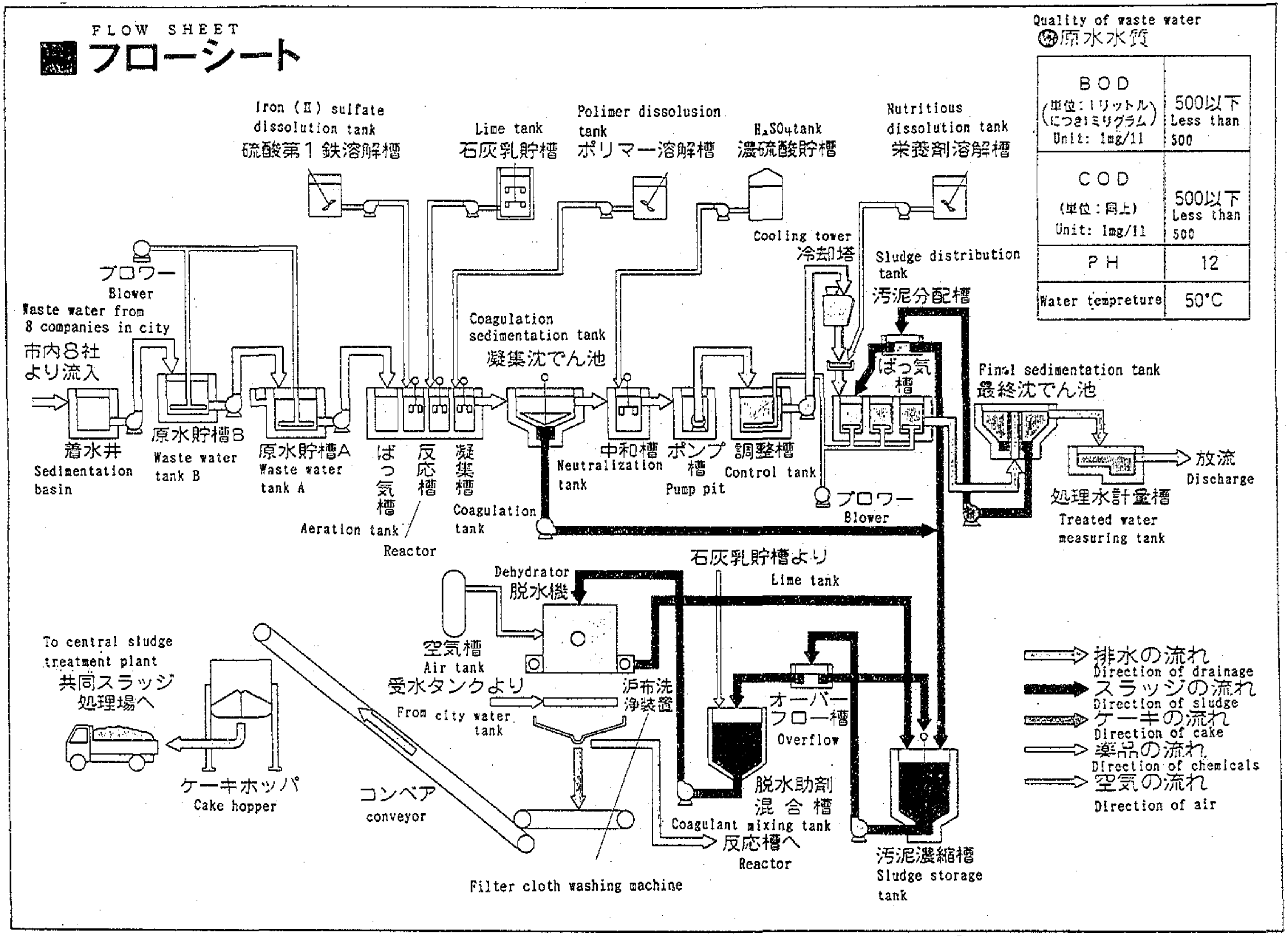


Figure 2.1.3 Gunbu district waste water treatment plant

Table 2.1.2 Quality of wastewater and treated water

(Hyogo pref. textile dyeing industrial enterprise cooperative)

	pH	SS	COD	BOD
Waste water	10 - 11	20 - 30	400	300
Treated water	7.5~8.0	5	50	5
Total amount	-	-	110kg/day	-

Note: 1. Unit used for quality of water is [mg/l], except one for pH.

2. Total amount is calculated with multiplication of treated water and 2200m/day.

Fukui Prefecture Dyeing Industrial Cooperative consists of five (5) dyeing factories situated in an industrial estate in Sabae City, Fukui Prefecture.

Originally, this are was a district chiefly for the dyeing of silk fabrics; however, the dyeing of synthetic fibers has been the main industrial practice for the last thirty (30) years. All the companies belonging to the Cooperative are dedicated to the dyeing of synthetic fabrics.

Any wastewater produced by the cooperative member companies is collected and treated jointly by all the member firms.

A brief of the factories associated with the Cooperative is given in Table 2.2.1.

2.2.2 Service Water and Wastewater

This area is supplied with industrial water, and, every office uses industrial water. Large-scale offices, however, are obliged to pump up water from their own wells because the amount of water available is insufficient. underground water is of poor quality, and, thus, is used after the removal of iron substances.

Joint wastewater treatment work has been performed according to plan ever since the Cooperative's complex was completed.

2.2.3 Cooperative Treatment of Wastewater

(1) Management

The central wastewater treatment facilities described above are all communal facilities for the treatment of industrial wastewater operated by privately-owned corporations. Criteria for dischargeable wastewater conform to the same regulations as those for private corporations. Nevertheless, the treatment facility at Fukui Prefecture Dyeing Industrial Cooperative is established as a sewage treatment plant for specially designated public drains, similar to the case with "Bisai Special Public Sewage Treatment Plant" described in 2.3. below. (As for "Spe-

Table 2.2.1 Outline of work shops
(Fukui pref. dyeing industrial enterprise cooperative)

No	Capital of the enterprise (¥1,000)	Number of employees	Amount of drainage (m /day)
1	200,000	450	7,000
2	100,000	150	1,200
3	45,000	80	1,050
4	–	25	50
5	–	–	120
Total			9,420

Notice: (-) in column of "capital of enterprise" and "number of employees" are unknown data.

cially Designated Public Drainage" is explained hereinafter in "2.3. Bisai Special Public Sewage Treatment Plant.")

According to the "prefectural regulations," numerical-value-wise, criteria for dischargeable wastewater for sewge treatment plants are severer than those for dyeing factories; however, the same criteria apply to this treatment plant under regional circumstances.

This wastewater treatment plant is under the control of Sabae City's municipal sewage section. The maintenance and operation of the plant, however, is taken charge of by the cooperative staff.

(2) Capacity of treatment

This wastewater terminal facility has capacity to process 12,000m^3 of wastewater per day. The actual amount of wastewater treated at present is 10,000m^3 per day which is the entire quantity of the five (5) companies' wastewater.

(3) Method of treatment

Wastewater produced by the aforementioned five (5) different factories is collected and goes through a biological removal process and coagulation process and then is discharged into rivers.

Biological removal is based on a contact aeration method, that is to say, filling up an aeration tank with some one-centimeter-in-diameter particles (pieces of stones), and coagulation process is a packaged method for coagulation and sedimentation using PAC and polymer coagulant.

Deposited sludge undergoes the dehydration process using a belt press within the treatment plant. The amount of sludge generated is five (5) tons or thereabouts per day.

(4) Quality of wastewater and treated water

The quality of wastewater and treated water is shown in Table 2.2.2.

2.3 Bisai Special Public Sewage Treatment Plant

2.3.1 Outline

Public drainage is designed to treat sewage collected from towns and cities while specially designated public drainage is used for the treatment of wastewater collected chiefly from factories. To avoid contamination, the operation and management of the sewage treatment plant should be taken charge of by the cooperative members in principle.

Bisai district is proud of its largest production of woolen fabrics, and two hundred (200) companies specializing in textile, dyeing and related business spreading over this district. Most of these companies are small- or medium -sized enterprises, which had been attributable to the poor wastewater treatment performance, resulting in contaminated rivers in the vicinity.

In 1961, a sewage control association was finally organized comprising two (2) cities including Bisai City and one (1) town. In 1970, treatment facilities including the sewage treatment plants were completed and therewith the specially designated public drainage system materialized.

120 offices are covered by the Bisai Special Public Sewage Treatment Plant, and the pipes extend 58 kilometers away, and the water catchment space area is 2,600 hectares.

2.3.2 Sewage Treatment Terminal

A profile of the sewage treatment plant is as follows:

Location: Hagiwara-cho, Ichinomiya City, Aichi Prefecture
Treatment Capacity: 100,000m^3/day
Number of Factories in Treatment Business: About 120
Method of Treatment: Activated sludge method

Table 2.2.2 Quality of waste water and treated water

(Fukui pref. dyeing industrial enterprise cooperative)

	pH	SS	COD	BOD	Transparency
Waste water	10 - 11	60 - 70	180	300	-
Treated water	7.0	10	50	30	More than 30cm
Targeted figures of the treated water	5.8 - 8.6	15	-	40	More than 30cm

Note: Unit used for quality of water are all [mg/l] except pH and transpareancy.

Sludge Treatment: Dehydration and incineration of sludge (multiple-hearth furnace)

The whole treatment process is shown in Figure 2.3.1. The layout of devices installed is shown in Figure 2.3.2.

2.3.3 Water Quality

The quality of wastewater and treated water is shown in Table 2.3.1.

*** *** *** *** *** *** ***

FLOW DIAGRAM OF SEWAGE TREATMENT PLANT

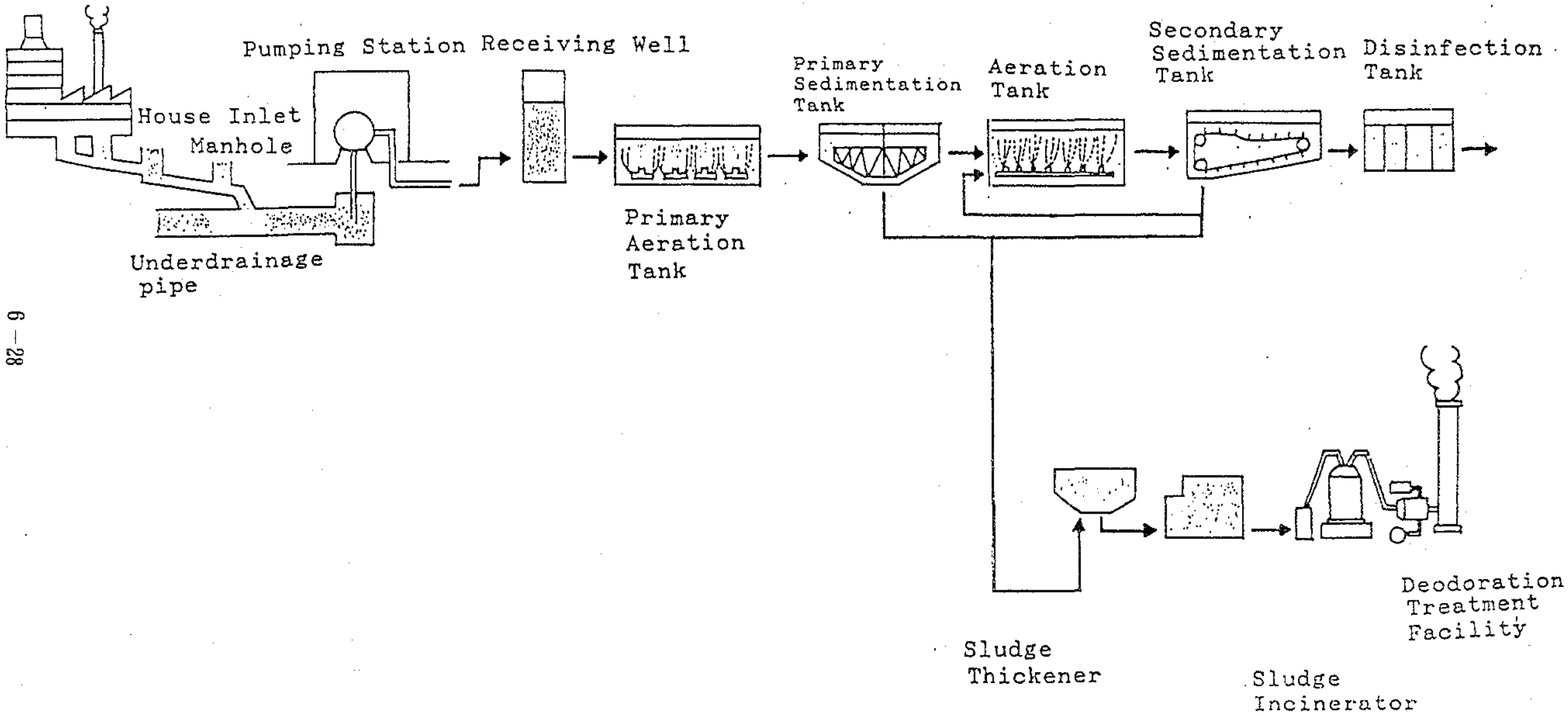


Figure 2.3.1 Flow sheet of treatment (Ozai district special public sewage)

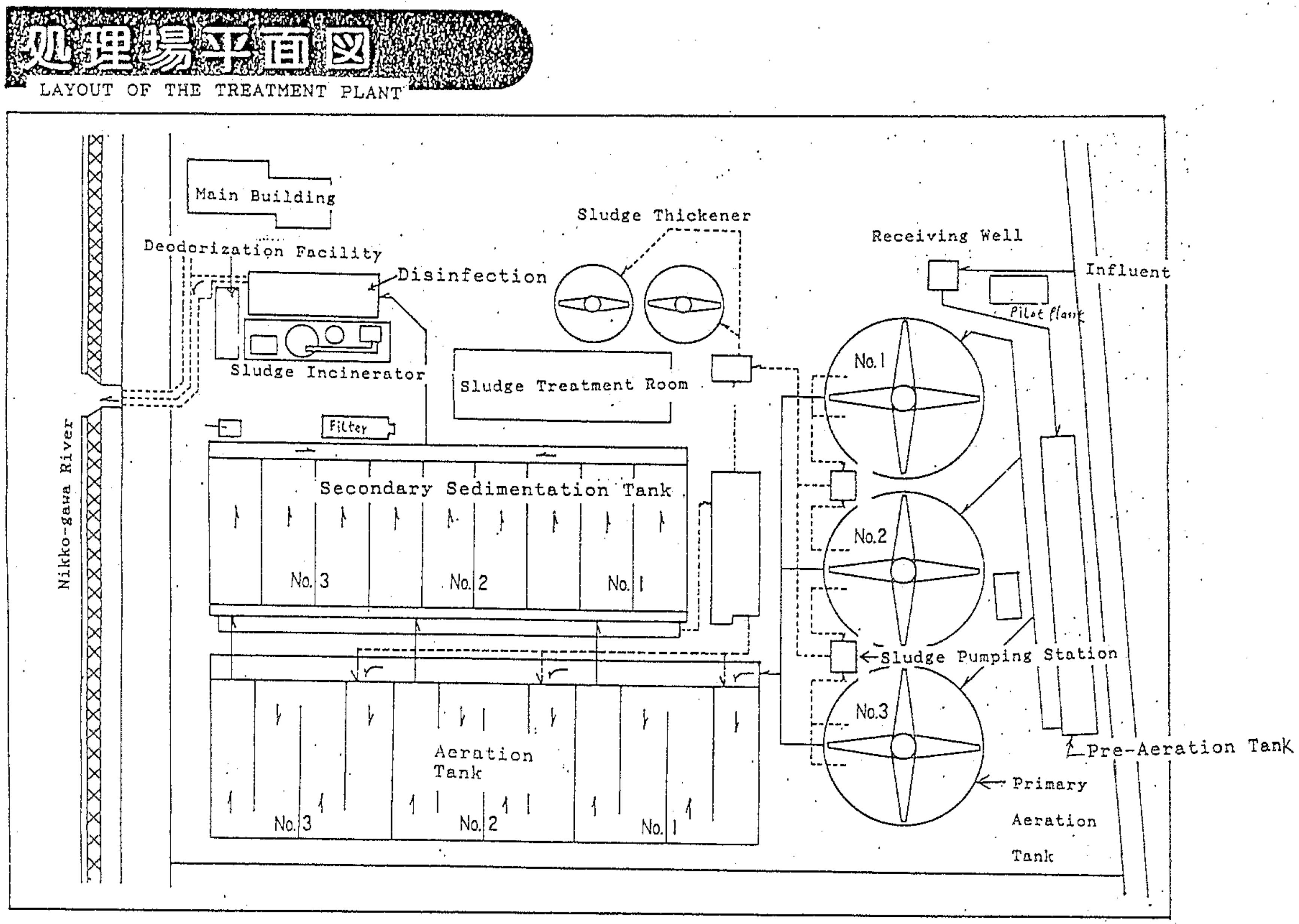


Figure 2.3.2 Layout of waste water treatment facilities(Ozai district special public sewage)

Table 2.3.1 Quality of waste water and treated water

(Bisai district special public sewerage)

	pH	SS	COD	BOD	Transparency
Waste water	8 - 9	100	160	160	5cm
Treated water	7.0	25	65	8	15cm
Effluent standard	5.8 - 8.6	70	-	20	-

Note: Unit used for quality of water is [mg/l], except one for transparency.

VII. Appendixes

Appendix 1: Survey for the Introduction of the Optimum System

1. Outline

The figure below shows the procedure for conducting a survey in order to introduce the optimum system of wastewater treatment/reclamation into a factory or an industrial estate. The procedure is described in the following steps.

Fig. Survey Procedure for the Introduction of the Optimum System

Step 1: Understanding the background and object
↓
Step 2: Survey of the actual state of the usage of industrial water
↓
Step 3: Study of measures for reducing thequantity of waste water
↓
Step 4: Study of the wastewater treatment system
↓
Step 5: Study of the wastewater reclamation system
↓
Step 6: Implementation of conceptional designing
↓
Step 7: Study of economic aspects
↓
Step 8: Evaluation of the systems

To conduct the survey in the right direction, it is important to clarify the background and object of introducing the optimum system. In general, the background and object may be one or more of the following matters.

(1) Improvement of the existing waste water treatment system

If, for example, effluent standards become stricter or the amount of wastewater becomes greater, some measures must be taken to improve the system.

(2) Establishment of a new wastewater treatment system

The wastewater treatment system may be newly constructed.

(3) Reduction of the use of water or discharge of waste water

There are some objectives for this items. For example, the water supply may not catch up with the increase of manufacturing activities, the water supply may decrease owing to a drought, the pumping of water may have to be reduced because of subsidence, or environmental protection may make it necessary to limit the discharge of wastewater.

(4) Necessity of planning in case the amount of water use or discharge is limited

In the area where a factory or an industrial estate is newly constructed, there may be certain restriction on the use of water (or discharge of wastewater). In such a case, the planning for water use/discharge must be established pursuant to the restriction.

3. Step 2: Survey of the actual state of usage of industrial water

In introducing the optimum system, it is of utmost importance to understand how industrial water is used in the factory or the industrial estate. Even state-of-the-art technology may not work if the target is not clearly defined. To understand the actual state, such methods as (1) questionnaires (2) visiting survey (3) water quantity measurement and (4) water quality measurement may be employed, each of which is explained in the following.

(1) Questionnaires

Questionnaires provide the basis of the survey and relatively easy to carry out. The questionnaires used in our survey (for plating factories and dyeing factories) are shown in "2. Reference Materials".

(2) Visiting survey

The visiting survey makes it possible to reconfirm the answers to questionnaires and, more importantly, cover those matters which were not included in the questionnaires. Information directly obtained from the staff of a factory is more valuable than the information on paper.

(3) Water quantity measurement

In order to achieve a water balance in the whole factory, it is necessary to know the amount of water used in each section of the factory. Since the use of water varies from time to time, long term data should be obtaind. If no long-term data is available, measurements should be taken by choosing certain points. This being the case, fluctuations over time should be taken into account in interpreting the results of the measurements.

(4) Water quality measurement

In order to plan the wastewater treatment and water reclamation systems, it is necessary to know the qualities of supply water and waste water. While the qualities of supply water are uniform for the most part, those of wastewater vary greatly from time to time. So, as is the case for the water quantity measurement, long-term data should be used. If no long-term data is available and hence measurements are taken, fluctuations over time should be taken into account.

4. Step 3: Study of measures for reducing the quantity of waste-water

On the basis of the survey of the actual use of industrial water, measures should be established to reduce the amount of waste water. Possible measures are described in "3.2 Measures for reducing the waste water quantity" in "II. Plating Industrial Estate" and "III. Dyeing Industrial Estate".

5. Step 4: Study of the wastewater treatment system

On the basis of the conditions (quntity, quality, etc.) resulting from the measures to reduce the amount of waste water, the optimum waste water treatment system should be planned. The method for the planning is shown in 3.3 of "II. Plating Industrial Estate" and "III. Dyeing Industrial Estate". Also, the guidelines stated there include basic considerations for planning the waste water treatment system.

6. Step 5: Study of the wastewater reclamation system

Where the reclamation system is required, the optimum system should be planned in the manner similar to Step 4 above. The method for the planning is shown in 3.4 of "II. Plating Industrial Estate" and "III. Dyeing Industrial Estate". Also, the guidelines stated there include basic considerations for planning the waste water reclamation system.

7. Step 6: Implementation of conceptional designing

The optimum system having been selected, its conception should be designed. The examples are shown in 3.5 of "II. Plating Industrial Estate" and "III. Dyeing Industrial Estate".

8. Step 7: Study of economic aspects

On the basis of the conceptional design, construction costs, running costs and other economic factors should be studied. Examples are shown in 3.6 of "II. Plating Industrial Estate" and "III. Dyeing Industrial Estate".

9. Step 8: Evaluation of the systems

Mmethods of system evaluation differ according to the aim of each system. Since the technical evaluations are mostly made in the Step 4 and 5, the main task at this stage will be the economic evaluation. Examples of financial/economic analysis are shown in 4 of "II. Plating Industrial Estate" and "III. Dyeing Industrial Estate".

When the central wastewater treatment plant is an independent business entity, it is not hard to apply financial analysis. However, as shown in the examples, economic analysis for pollution prevention systems is very difficult because there are no established methods. If the financial analysis shows the soundness of the proposed system, it may be regarded as a good system.

10. Organizational Aspects of the Survey

To conduct a survey of this kind, the following organizaions and experts are needed.

(1) Staff for arranging and summarising the survey

The task of such staff is to plan the survey and lead its implementation. The staff may not be specialized in some particular field, but must have wide-ranging knowledge about manufacturing processes, use of industrial water, wastewater treatment and the like.

(2) Experts for manufacturing processes and the use of industrial water

Such experts engage themselves in Sstep 2 (i.e. survey of the actual state of usage of industrial water) and Step 3 (i.e. study of measures for reducing the quntity of wastewater). These steps require a specialized knowledge of each manufacturing process and the use of water in it.

(3) Experts (or a specialized company) for wastewater treatment technology

The task of such experts (or a specialized company) is to carry out Step 4 - 7, which make up the main part of the survey. Since these steps require a large amount of work, organizational capacity must also be large.

(4) Experts for financial and economic analysis

As mentioned above, the task of Step 8 is mainly economic analysis, and hence such experts are needed.

(5) Remarks

As for Step 2 (3) (i.e. water quantity measurement), although it is desirable for experienced persons to carry it out, this can be done by inexperienced persons if they are given some training.

As for Step 2 (4) (i.e. water quality measurement), it is more practical to subcontract the task to a specialized company, so no experts in this field are required in the survey.

Among the experts listed above, those mentioned in (3) and (4) are relatively easy to find, but the fact that those mentioned in (1) and (2) may not be so readily available, which should be taken into account in preparing the survey.

Appendix 2 Reference Materials

(1) Questionnaire for Plating Works

(2) Questionnaire for Dyeing Works

(3) Study of Wastewater Treatment for Plating Works - prepared by Mr. Kyoo-ok Cho, President of Sam Dong Industrial Co., Ltd.

(4) Daily Working Report of Central Wastewater Treatment Plant in Dyeing Industrial Estate (Example)

(5) New Technologies Using Bacteria Enzymes for the Dyeing Waste water Treatment

(6) Financial Sources for Development of Wastewater Treatment Facilities in Japan

(7) Tax Incentives in Japan

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CONFIDENTIAL
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(Plating Works)

C#: ____________

F#: ____________

QUESTIONNAIRE

FOR

THE STUDY

ON

INDUSTRIAL WASTE WATER TREATMENT

AND

RECYCLING PROJECT

IN

THE REPUBLIC OF KOREA

(DRAFT)

MARCH 1991

KOREA INSTITUTE OF SCIENCE AND TECHNOLOGY

AND

JAPAN INTERNATIONAL COOPERATION AGENCY

F#: ______

1. Outlines of Company and Factory

1.1 Company

A. Name: ______________________________

B. Capital: ____________ Thousand Won

1.2 Factory

A. Name: ______________________________

B. Address: ______________________________

C. Telephone: ____________

D. Annual Amount of Shipment *1: ____________ Million Won

E. Total Area of Factory *2: ________ m^2

F. Total Area of Building: ________ m^2

G. Total Number of Workers: ________

H. Average Daily Working Hour *3: _____ (_____) hours/day

I. Annual Working Day *4: _____ (_____) days/year

J. Product Shipment

Name of Main Product	
Annual Quantity of Production in 1990 ( ) *5	
Annual Quantity of Shipment (mil W)	

K. Special Notes on Operation and Others in 1990:

____

____

____

____

F#: ______

1.3 Person to Contact related to this Study

Name: ______________________

Title: ____

____

- -

Notes:

*1: Please fill in actual quantity of shipment from January to December in 1990

If difficult, please fill in quantity of shipment in recent one year.

*2: Please fill in total area including plant, dormitory and company house.

*3 and *4: Please fill in date in 1990.
If operation in 1990 was different from normal year, please fill in data in normal year in ( ).

*5: Please fill in unit such as unit, ton, kg, m^2, m^3 and others.

2. Kind of plating

Please itemige your plating process and products according to the folling list and mark ◎ to the main one and ○ to the secondary one.

Kind / Articles	Zinc			Copper					Nickel			chromium			silver	gold	others
	cyanide bath	non cyanide bath	others	cyanide bath	sulfric acid bath	diphos-phate bath	non elect-rolytic bath	others	Sulfric acid bath	non elect-rolytic bath	others	chromium bath	hard chromium bath	others			
Car parts																	
Bicycle parts																	
Precision machine parts																	
Machine parts																	
Official machine parts																	
Electronic machine parts																	
Electric machine parts																	
Building materials																	
Accessaries																	
Miscellanous goods																	

3. Materials for plating

Please write ① materials, ② shape, ③ surface area of products, ④ producting capacity in accordance with following classifiation.

Classification of Plating	①	②	③	④

4. Chemicals

Please write main ingredients of the chmicals using now.

main ingredients of chemicals

Chemicals	Main ingredients	Concentration or Content	Note
(example) bright dip	sulfic acid	6 (l)	supply according to consumption
	nitric acid	4 (l)	
	hydrochloric acid	3. 5 (l)	supply according to consumption
zinc plating	zinc cyanide	40 (kg/m³)	control by R rate(2/W)
	sodium cyanide	73 (kg/m³)	control by M rate(2/W)
	caustic soda	12 (kg/m³)	control by R rate(2/W)

5. Specification of main machines and equipments, and outline of plant layout

Please write specification and role of main equipment, and in layout drawing please show water piping (fresh water, waste water etc.). You may show us copies of item, if you have existing layout drawings.

No.	Name	Quantity	Specification	Note
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				

(layout)

6. Production process blockdiagram and place of waste water occurence

Please draw blockdiagram of your production process and indicate the place of water use (industrial water, well water etc.) and waste water occurence in blockdiagram. And please write pretreatment of water, and recycling system whitch operating now, referring to "Example" . You may show us copies of them if you have existing drawing.

(凡例)

——→ water

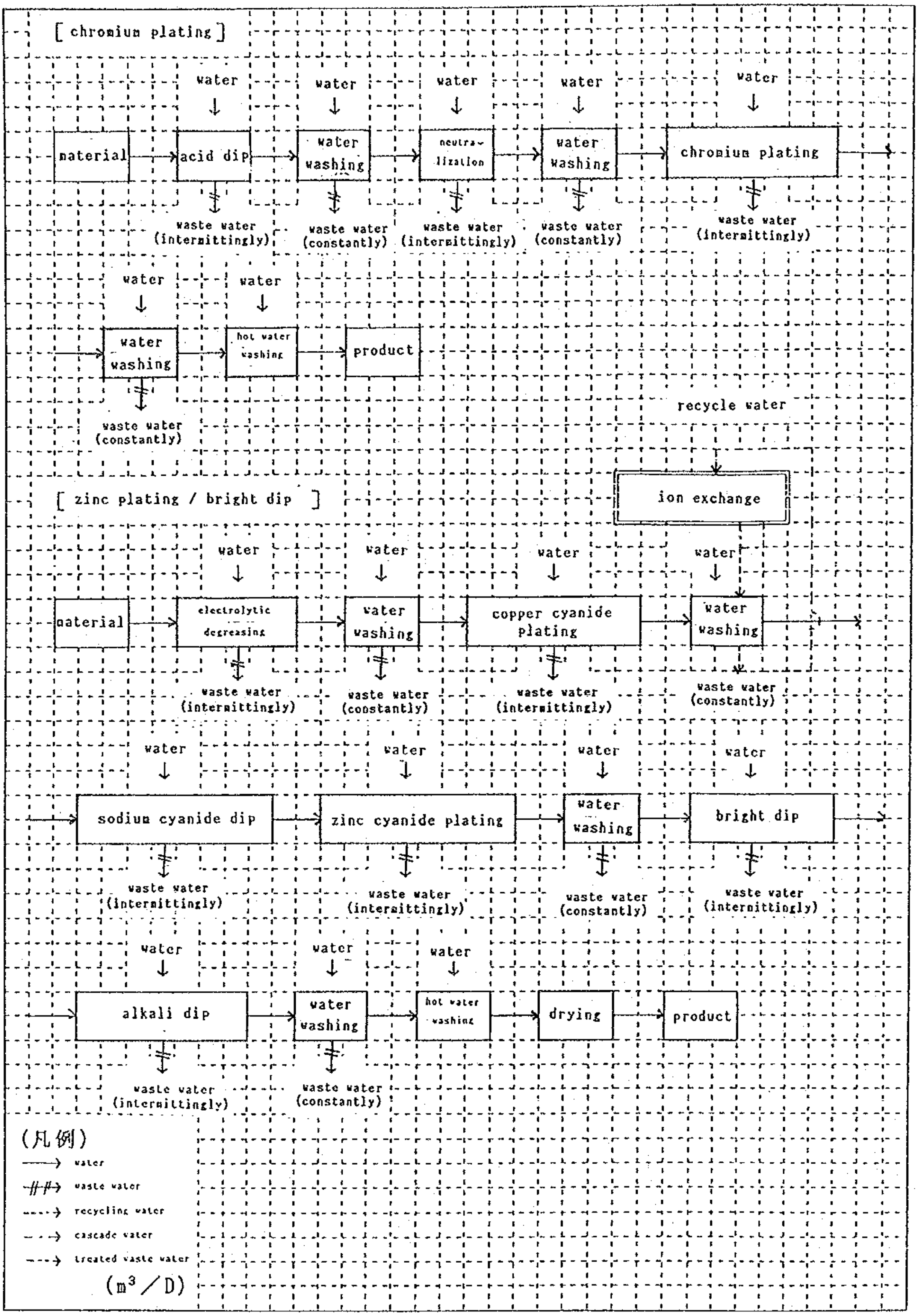
-//-//→ waste water

-----→ recycling water

—‐—→ cascade water

—‐‐→ treated waste water

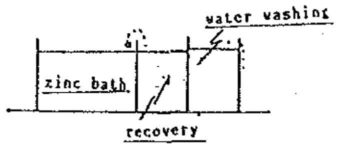
(m^3／D)


[chromium plating]
water
material
acid dip
water washing
neutralization
water washing
chromium plating
waste water (intermittingly)
waste water (constantly)
waste water (intermittingly)
waste water (constantly)
waste water (intermittingly)
water washing
hot water washing
product
waste water (constantly)
recycle water
ion exchange
[zinc plating / bright dip]
material
electrolytic degreasing
water washing
copper cyanide plating
water washing
waste water (intermittingly)
waste water (constantly)
waste water (intermittingly)
waste water (constantly)
sodium cyanide dip
zinc cyanide plating
water washing
bright dip
waste water (intermittingly)
waste water (intermittingly)
waste water (constantly)
waste water (intermittingly)
alkali dip
water washing
hot water washing
drying
product
waste water (intermittingly)
waste water (constantly)
(凡例)
water
waste water
recycling water
cascade water
treated waste water
(m³／D)

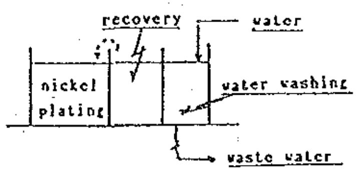
7. Method of water washing

Please mark ◎ to the method of water washing (include effective use of water) adopting now at the corresponding method. And put using place in parenthesis

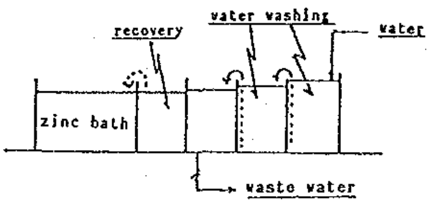
(1)Batch system (　　　　　)



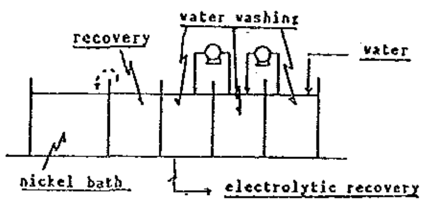
(2)Single stage system (　　　　　　　)



(3)Countercurrent multistage system (　　　　　　　)

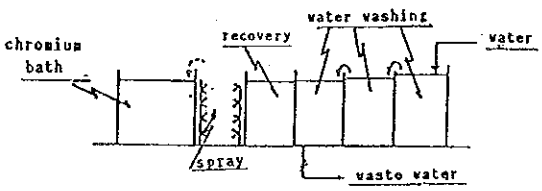


(4)Batchwise countercurrent multistage system (　　　　　　　　　　　)



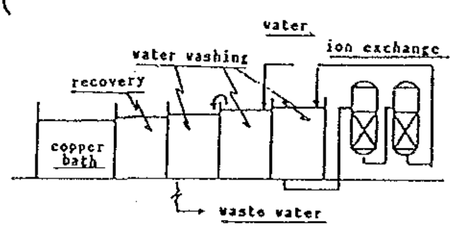
(5)Countercurrent multistage added spray system

(　　　　　　　　　　　)

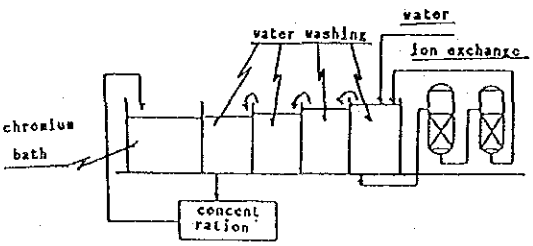


(6)Countecurrent multistage added ion exchange system

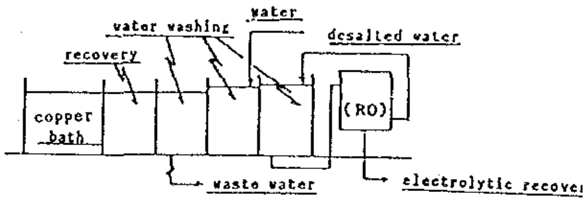
(　　　　　　　　　　　　　　　)



(7)Ion exchange added concentrating recovery system (　　　　　)



(8)Countercurrent multistage added reverse osmosis system (　　　　)



(9)Others (　　　　　　)

8. Present situation of industrial water and waste water

Please mark ○ at the number of coresponding item, and write explanation in parenthsis if necessary.

1) Stream source: 1. shortage 2. proper 3. enough

→ reason :
- 1. shortage of stream source → 1.1 steadily / 1.2 seasonal / 1.3 sometimes
- 2. rapidly increase of water use
- 3. others (   )

2) Quality: 1. no problem 2. problem remains → 2.1 steadily / 2.2 seasonal / 2.3 sometimes

→ water quality presend a problem
- 1. SS or turbidity 2. COD or BOD
- 3. hardness 4. chlorine ion
- 5. Fe 6. Si 7. others (   )

3) Reuse:

① Bring into operation: (or intending) Reason
- 1. stream source insufficient
- 2. high cost of water
- 3. high cost of waste water treatment
- 4. energy saving
- 5. economical
- 6. others

② Not bring into operation: Reason
- 1. enough stream source
- 2. low cost of water
- 3. low cost of waste water treatment
- 4. energy saving
- 5. economical
- 6. others

9. Other opinion on water supply and waste water treatment.

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CONFIDENTIAL
============

(Dyeing Works)

C#: ____________

F#: ____________

QUESTIONNAIRE

FOR

THE STUDY

ON

INDUSTRIAL WASTE WATER TREATMENT

AND

RECYCLING PROJECT

IN

THE REPUBLIC OF KOREA

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MARCH 1991

KOREA INSTITUTE OF SCIENCE AND TECHNOLOGY

AND

JAPAN INTERNATIONAL COOPERATION AGENCY

F#: ______

1. Outlines of Company and Factory

1.1 Company

A. Name: ______

B. Capital: ______ Thousand Won

1.2 Factory

A. Name: ______

B. Address: ______

C. Telephone: ______

D. Annual Amount of Shipment *1: ______ Million Won

E. Total Area of Factory *2: ______ m^2

F. Total Area of Building: ______ m^2

G. Total Number of Workers: ______

H. Average Daily Working Hour *3: ______ (______) hours/day

I. Annual Working Day *4: ______ (______) days/year

J. Product Shipment

Name of Main Product	
Annual Quantity of Production in 1990 ( ) *5	
Annual Quantity of Shipment (mil W)	

K. Special Notes on Operation and Others in 1990:

______

______

______

______

F#: ______

1.3 Person to Contact related to this Study

Name: ____________________

Title: ____

____

- -

Notes:

*1: Please fill in actual quantity of shipment from January to December in 1990

If difficult, please fill in quantity of shipment in recent one year.

*2: Please fill in total area including plant, dormitory and company house.

*3 and *4: Please fill in date in 1990.
If operation in 1990 was different from normal year, please fill in data in normal year in (   ).

*5: Please fill in unit such as unit, ton, kg, m^2, m^3 and others.

2. Outline of dyeing process

Please check the sheet at applicable material and form.
Entry example (case of applicable) : ⊘

Please check the process. If there is not an applicable process, please complete the flow sheet, or please draw a new flow sheet.

Mark	Material	Form	Process name and process number
A	○ cotton	○ raw fiber ○ raw yarn ○ textile	○ A-1 desizing → ○ A-2 scouring → ○ A-3 bleaching → ○ A-4 marcerizing → ○ A-5 dyeing / ○ A-6 printing → ○ A-7 finishing
B	○ wool	○ raw fiber ○ raw yarn ○ textile	○ B-1 washing → ○ B-2 milling → ○ B-3 bleaching → ○ B-4 dyeing / ○ B-5 printing → ○ B-6 crabbing → ○ B-7 finishing
C	○ synthetic fiber (kind:)	○ raw fiber ○ raw yarn ○ textile	○ C-1 desizing → ○ C-2 scouring → ○ C-3 bleaching → ○ C-4 dyeing / ○ C-5 printing → ○ C-6 finishing
D	○ silk	○ raw fiber ○ raw yarn ○ textile	○ D-1 desizing → ○ D-2 raw scouring → ○ D-3 water washing → ○ D-4 main scouring → ○ D-5 hot water washing → ○ D-6 water washing
E	○	○ raw fiber ○ raw yarn ○ textile	
F	○	○ raw fiber ○ raw yarn ○ textile	

3. Quantity and kind of raw materials, chemicals, and auxiliaries.

(Please entry "Δ" at the notes if you will use.)

1) Raw material

Kind	Form		Quantity (ton/month)	Notes
○ cotton	○	raw fiber		
	○	raw yarn		
	○	textile		
○ wool	○	raw fiber		
	○	raw yarn		
	○	textile		
○	○	raw fiber		
	○	raw yarn		
	○	textile		
○	○	raw fiber		
	○	raw yarn		
	○	textile		
○	○	raw fiber		
	○	raw yarn		
	○	textile		
○	○	raw fiber		
	○	raw yarn		
	○	textile		
○	○	raw fiber		
	○	raw yarn		
	○	textile		
○	○	raw fiber		
	○	raw yarn		
	○	textile		
○	○	raw fiber		
	○	raw yarn		
	○	textile		
○	○	raw fiber		
	○	raw yarn		
	○	textile		
○	○	raw fiber		
	○	raw yarn		
	○	textile		

2) Chemicals•Auxiliaries

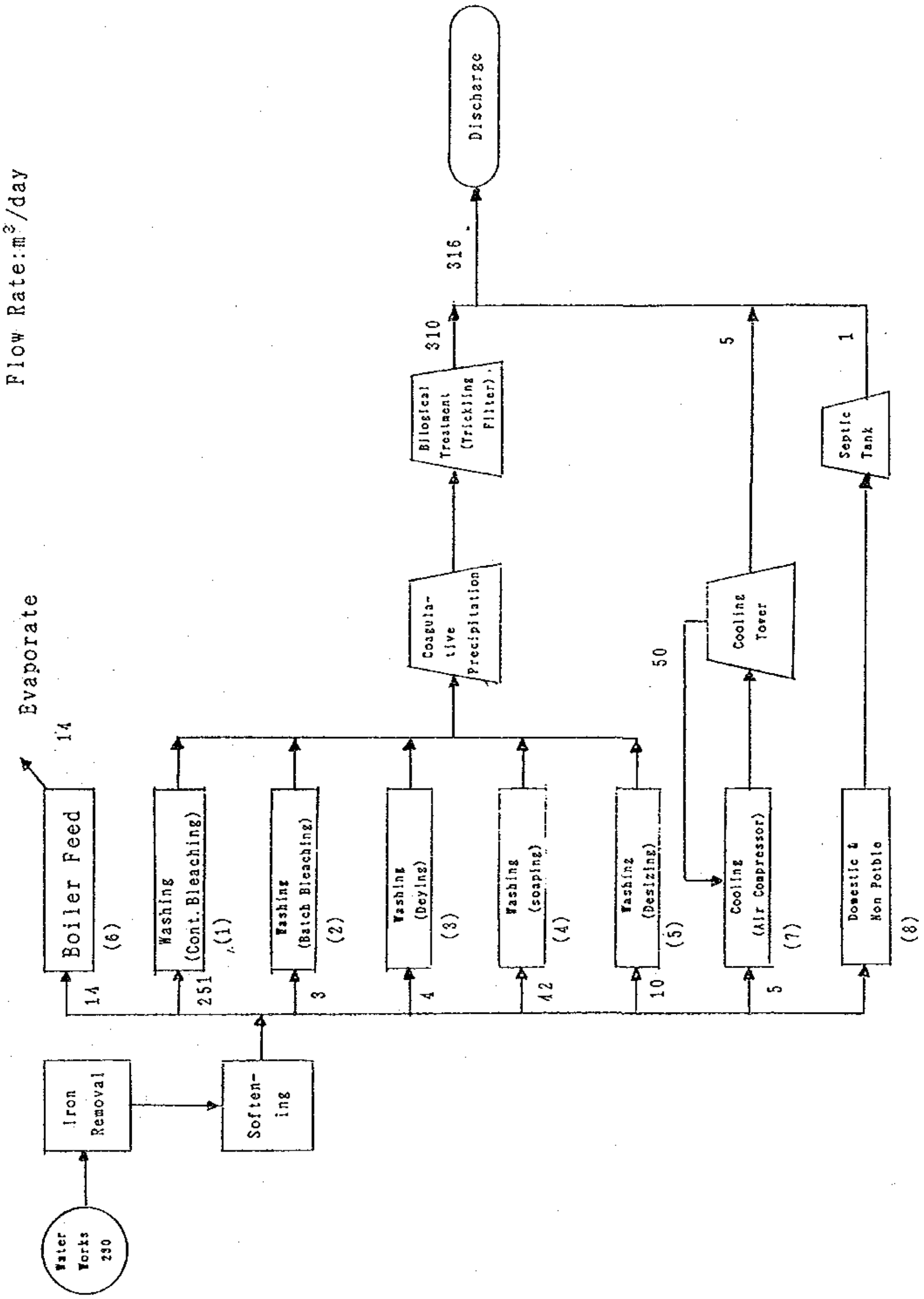
Name	Principal ingredients component	Quantity	Concentration	Process number	Notes
caustic soda					
surfactant					
bleaching agent					

Notes : Please entry the same process number as the process number of "2. Outline of dyeing process"

Example : A-3

4. Flow Diagram of Water Supply and Waste Discharge

Please draw flow diagram referring to a sample that is shown below.



5. Quantity of Consumed Water Classified to Use (/)
(Please refer to a sample in next page.)

Place	Use	No.	Process or Equipment	Water Quantity in Operating Day (m^3/d) Cl. to Source 1)					Op Hr (h/d)	Op Dy (d/y)	CW Temp at Outlet (°C) 6)	Specification of Equipment and Operating Method	Remarks
				WW 2)	WE 3)	RW 4)	REW5)	Total					
Total													

Note: 1) Please fill in annual average quantity of operating day.
Please fill in additionally peak quantity in ( ), if seasonal change is high.
2) WW = Water Works; 3) WE = Well Water; 4) RW = River Water; REW = Recycling Water
6) CW = Cooling Water

5. Quantity of Consumed Water Classified to Use (1/1) (Sample)

Place	Use	No.	Process or Equipment	Water Quantity in Operating Day (m^3/d) Cl. to Source 1)					Op Hr (h/d)	Op Dy (d/y)	CW Temp at Outlet (°C) 6)	Specification of Equipment and Operating Method	Remarks
				WW 2)	WE 3)	RW 4)	REW5)	Total					
Plant	Washing	1	Continuous bleaching	251				251	7	291			1 unit
	"	2	Batch bleaching	3				3	4	"			Wins type 1 unit
	"	3	Dyeing	4				4	7	"			Overmyer type, 4 units
	"	4	Soaping	42				42	7	"			2 units
	"	5	Desizing	10				10	6	"			Wins type, 1 unit
Boiler House	Boiler Feed	6	Boiler	14				14	9	"			Max Capacity 4 tons/hr
	Cooling	7	Air Compressor	5			50	55	9	"	35	Motor 5.0 kW	Recycling use 42°C to 35°C
Office	Domestic & non-pot	8	Drinking, Toilet, etc.	1				1	9	"			
Total				330			50	380					

Note: 1) Please fill in annual average quantity of operating day.
Please fill in additionally peak quantity in ( ), if seasonal change is high.
2) WW = Water Works; 3) WE = Well Water; 4) RW = River Water; REW = Recycling Water
6) CW = Cooling Water

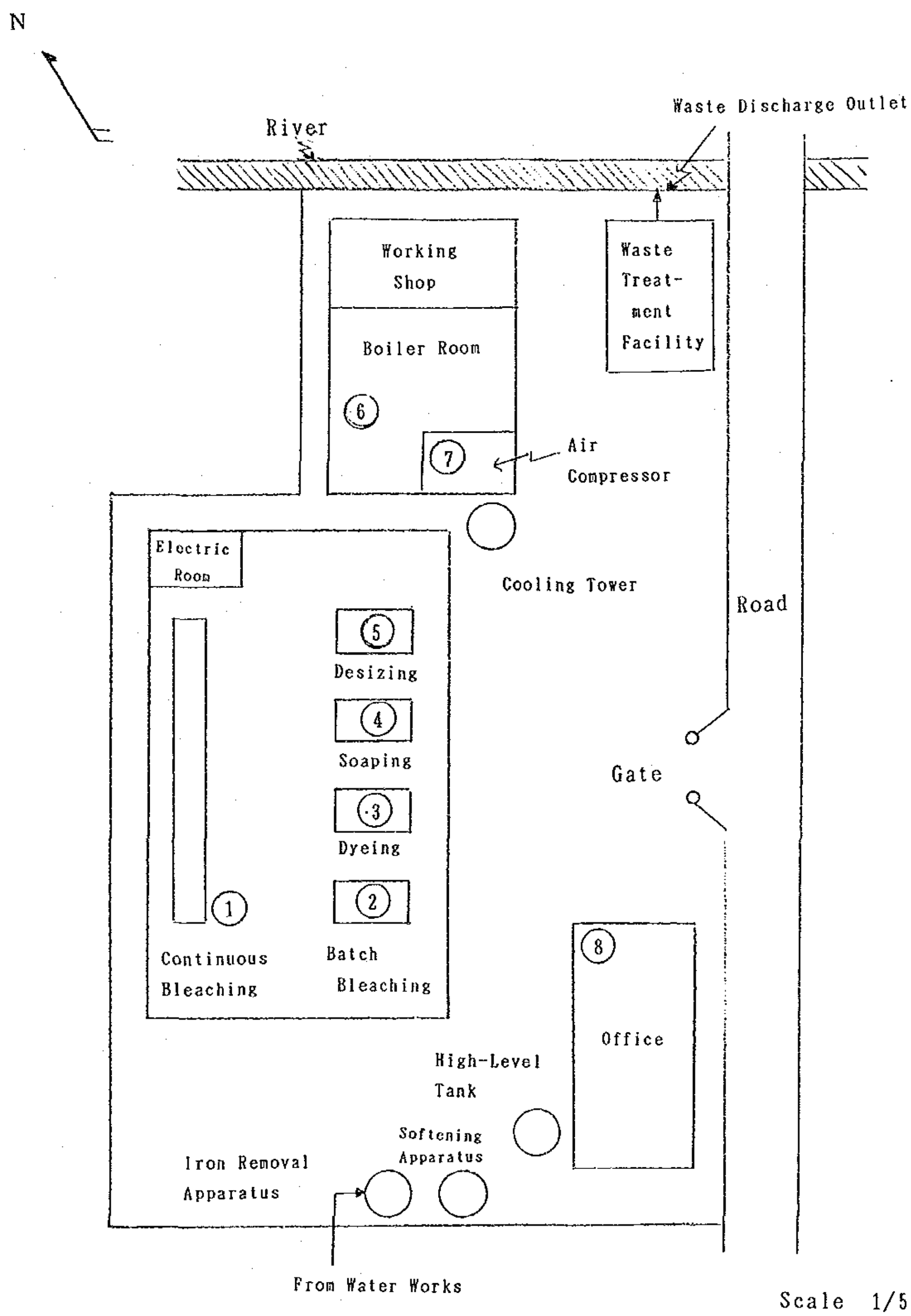
6. Drawing of Factory Layout

Please draw drawing of your factory layout that shows places where water is used, referring to page 10.

If you have drawing, please indicate places where water is used.

Please use same number as the Item 5.

Drawing of Factory Layout



Scale 1/500

7. Quality of Fresh Water

If you have analysis data of fresh water, please complete the table below:

Water Source (please check following items)

1. Water Works   2. Well   3. River   4. Others

Items		Raw Water	After Treatment
Temperature	(°C)		
Turbidity	(°)		
pH	(-)		
COD by Mn or Cr	(mg/l)		
Alkalinity	(mg/l)		
Total Hardness	(mg/l)		
Chroline Ion	(mg/l)		
Total Iron	(mg/l)		
Evaporation Residue	(mg/l)		
Electric Conductivity	(μS/cm)		

8. Quality of Waste Water

Items / Kind	Temp. (°C)	pH	BOD (mg/l)	COD *3 Mn or CR (mg/l)	SS (mg/l)	Oil (mg/l)	Electric Conduct. (μS/cm)	Color *4	Heavy Metals (mg/l)	Other Pollutant (mg/l)	Remarks
Total Effluent No.1 *1											
No.2											
Process Effluent No. *2											
No.											
No.											
No.											
No.											

Note:
*1: Please fill in the quality of total effluents from the factory.
*2: Please fill in the quality of waste water from each process.
In this item, please use same number as item 2 of page 3.
*3: Please make sure and check the COD Mn or Cr.
*4: Please fill in the color referring examples -- blue, light blue, red, gray, colorless, etc.

9. Waste Water Treatment and Recycling (1/)

Facility No.	1		2	
Object of Treatment (Please circle 1 or 2.) (Please fill in 3, if otherwise.)	1. Waste Discharge 2. Water Recycling 3.		1. Waste Discharge 2. Water Recycling 3.	
Treatment Process *1				
Maximum Capacity (m^3/d)				
Treatment Capacity (m^3/d)				
Date of Installation				
Water Quality	Influent	Effluent	Influent	Effluent
Temperature (°C)				
pH				
BOD (mg/l)				
COD Mn or Cr (mg/l)				
SS (mg/l)				
Oil (mg/l)				
Electric Conductivity (μS/cm)				
Color				
Heavy Metals (mg/l)				
Other Pollutant (mg/l)				
Remarks				
Flow in from *2				
Flow out to *3				

Note: *1: e.g. Coagulation and Sedimentation, Floatation, Activate Sludge, etc. and these combinations.
*2: Please use same number as Item 2 of page 3.
*3: e.g. Sewage system, River, etc.

9. Waste Water Treatment and Recycling (2/)

Facility No.	3		4	
Object of Treatment (Please circle 1 or 2.) (Please fill in 3, if otherwise.)	1. Waste Discharge 2. Water Recycling 3.		1. Waste Discharge 2. Water Recycling 3.	
Treatment Process *1				
Maximum Capacity (m^3/d)				
Treatment Capacity (m^3/d)				
Date of Installation				
Water Quality	Influent	Effluent	Influent	Effluent
Temperature (°C)				
pH				
BOD (mg/l)				
COD Mn or Cr (mg/l)				
SS (mg/l)				
Oil (mg/l)				
Electric Conductivity (μS/cm)				
Color				
Heavy Metals (mg/l)				
Other Pollutant (mg/l)				
Remarks				
Flow in from *2				
Flow out to *3				

Note: *1: e.g. Coagulation and Sedimentation, Floatation, Activate Sludge, etc. and these combinations.
*2: Please use same number as Item 2 of page 3.
*3: e.g. Sewage system, River, etc.

〈主題發表〉

鍍金廢水處理方法研究

三東産業株式會社
代表理事 曺 圭 玉

目　　次

I. 서 론

1. 개 요

도금폐수를 적정하게 처리하기 위하여는 먼저 발생원을 면밀히 검토하여 방지시설을 설계하여야 할 것이며 일반적으로 도금폐수는 분류처리 하는것이 상식화 되어 있으나 발생원에서부터 원천적으로 폐수의 분류가 곤란하여 실제상황에서는 많은 문제점이 발생되어 이를 검토·분석하여 다음과 같은 실험결과를 구하였다.

2. 오염물질 발생원

오염물질의 발생은 산(알카리) 작업에서부터 각 공정에서 오염물질이 발생하며 공정상에서 용액이 재순환 하지만 결국은 배출되며 이 배출되는 오염물질은 주기적으로 발생하며 적은양이 배출되나 그 농도가 매우 높은 것이 특징이며 도금후 발생되는 세척수는 도금체에 묻어있는 이물질을 제거하기 위하여 세척하므로 이 세척수에서도 오염물질이 발생함.

3. 공정설명 및 발생되는 오염물질의 종류

(1) 일반도금

가. 산(알카리)처리 : 산처리는 금속표면에 생성된 녹, 스케일 등 제거. 알카리처리는 동, 식물성 유지나 비누, 글리셀린 제거에 사용되며 주오염물질로는 SS, N-H등.

나. 청화(유산)동도금 : 유산동도금과 같은 산성도금은 고전류 밀도를 사용할 수 있기 때문에 철강이나 아연다이캐스트 소재위에 직접 도금할 수 없으며 청화동도

금과 같은 알카리성도금은 균일전착성이 우수하며 철강, 아연다이캐스트 소재위에 직접 도금할 수 있으며 주오염물질로는 Cu, CN등.

다. 니켈도금 : 부식방지와 장식의 목적으로 사용되며 최종 크롬도금을 행하는 하지도금에 사용되며 니켈도금은 색깔이 좋고 변색되지 않으며 경도, 기계적 성질이 우수하며 주오염물질로는 Ni, CN등.

라. 크롬도금 : 외관이 좋고 공기에 변색, 부식되지 않으므로 광범위하게 사용되며 주오염물질로는 Cr^{+3}, T-Cr등.

(2) 아연도금

가. 초음파 : 초음파 처리는 16 Kc/sec 이상의 주파수를 가진 초음파를 사용하며 액체중 팽창, 압축, 진동의 반복으로 기름이나 기타 오염물질을 제거하며 주오염물질은 SS, N-H등.

나. 산처리 : 산처리는 금속표면에 생성된 녹, 스케일 등 제거에 사용되며 주오염물질로는 SS, N-H등.

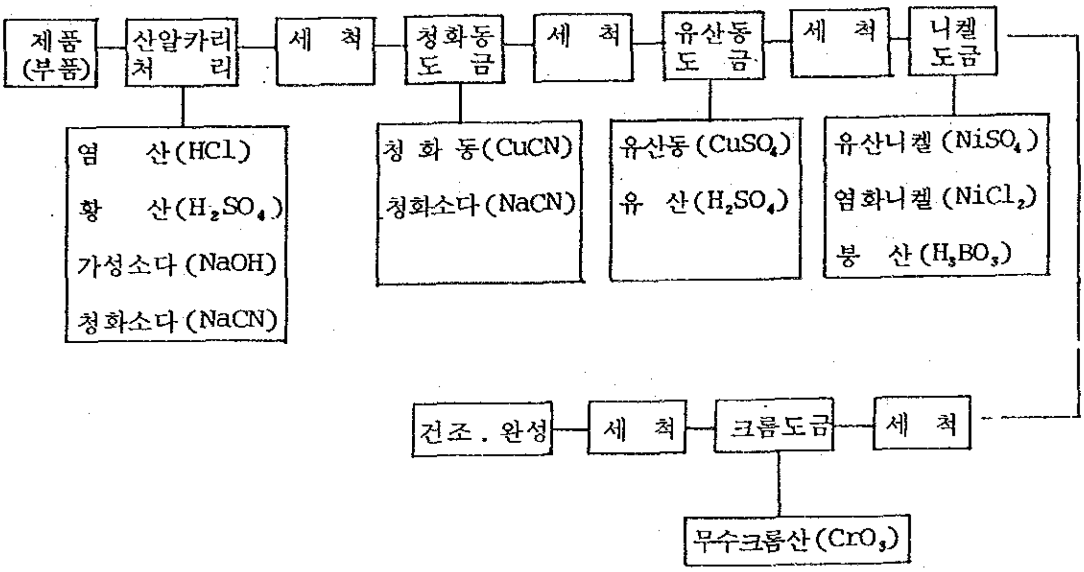
다. 아연도금 : 아연도금은 철에 비해 전극 전위가 낮기 때문에 부식방지에 가장 적합하며 주오염물질로는 Zn, CN등.

라. 크롬도금 : 외관이 좋고 공기에 변색, 부식되지 않으므로 광범위하게 사용되며 주오염물질로는 Cr^{+3}, T-Cr등.

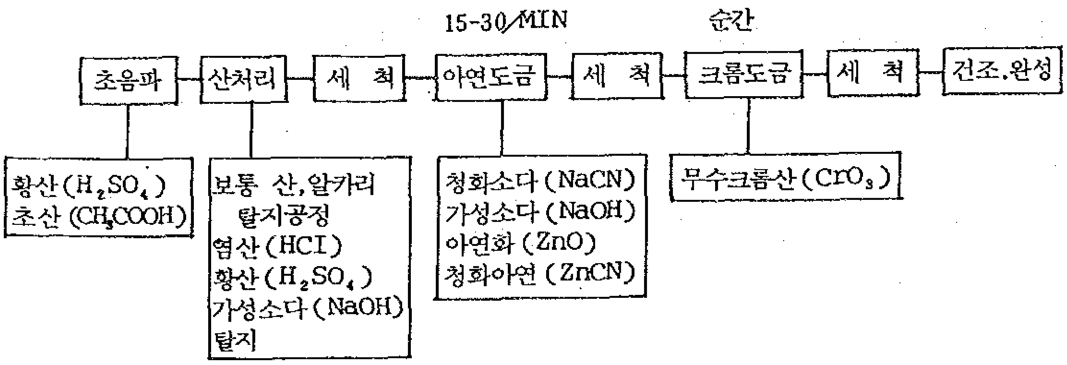
Ⅱ. 도금생산공정

1. 일반도금

다음은 도금 방법상 공정을 요약한 것이며 작업조건 또는 제품의 특성에 따라 일부공정이 변경, 가감될 수 있다.



2. 아연도금



도금업소별 생산 및 운영비 내역

(단위 : kg/day)

도금종류	용 도	제 품 생산량	단가/kg	생산총액 (25/D)	재료비	인건비	전기료	관리비	폐수비	폐수처리비 비 율	이 윤	폐수발생량 (월:25day)
					운 영 비 계/원							
아연도금	건축자재	3200 /kg	100	8,000,000	1,000,000	4,000,000	500,000	800,000	2,050,000	24.5%	- 350,000	140M3/월
						8,350,000						
플라스틱 도 금	플라스틱 제 품	200 /kg	3,600	18,000,000	2,000,000	9,000,000	700,000	1,500,000	2,900,000	18.0%	1,900,000	192M3/월
						16,100,000						
귀 금 속 도 금	악세사리	10000 /EA	140 /EA	35,000,000	17,500,000	12,000,000	800,000	1,000,000	2,100,000	6.3%	1,600,000	196M3/월
						33,400,000						
일반도금	전자부품	650 /kg	1,000	16,250,000	4,000,000	5,000,000	800,000	1,500,000	3,300,000	22.6%	1,500,000	230M3/월
						14,600,000						

※ 아연도금의 경우 정상 운영시 적자운영이 되므로 기업주 스스로 생산노역에 참여 적자를 감소시키고 있음.

※ 본 기록은 삼동산업㈜ 입주업체 참조.

Ⅲ. 도금폐수처리 실험 및 고찰

1. 일반적인 도금폐수처리

가. 도금 폐수 성상

〈표3－1〉

(단위 : ppm)

	PH	COD	SS	Cu	Cr	CN	Zn	Fe
산・알카리	1	180-240	170	150-200	80	40	20	400
CN 계	7.4	120-400	175	50-120	46-60	700-1400	700	200
Cr 계	1.5	130-200	160	250-400	600-1200	60	25	90

상기 〈표3－1〉내용과 같이 완벽하게 분류되어야 할 성격의 폐수에 -이온 과 +이온을 가진 오염물질이 복합, 혼합되어 발생된다.

선진 부유국가에서는 생산라인에서부터 분류가 가능토록 배출시설 자체에서부터 자동화가 되어 있으나 우리의 실정에서는 몇십년전부터 내려오는 재래식 공법으로 도금업이 행하여 지고 있어 제품의 생산과정에서 부터 폐수의 분류가 어려운 실정이다.

※ 본 데이타는 위탁 폐수 및 공동처리장의 폐수를 혼합한 것으로 일반 자가업소와는 차이점이 있을 수 있음.

나. 도금 폐수 처리공정

도금폐수는 수산화물 침전법이 대중을 이루며 방지시설은 일반적으로

CN Storage — P.H Control — 1st, 2nd Oxidation

Cr Storage — P.H Control — Reduction — Neutralization

Acid·Alkali Storage — P.H Control

Reaction — Flocculation — Sedimentation

Active carbon Filter — Effluent의 계통을 거쳐 방류되고 있다. 그러나 도금폐수는 완전분리가 어려우며 각종의 약품사용으로 처리 방해요인이 발생하여 한순간이라도 불완전 운전을 할시는 3차 처리 시스템을 거치지 않는한 절대 적정처리가 되지 않는다.

이를 파악한 일부 업체에서는

CN Oxidation — Cr Reduction — Neutralization

Reaction — Flocculation — Sedimentation

Active carbon Filter 라는 과정으로 복합처리하고 있는데 이론적인 처리방식은 가능하나 허용기준이내 처리는 어려운 실정이다.

현재 보편적으로 NaClo에 의한 알카리염소법 (CN), $NaHSO_3$에 의한 환원법 (Cr^{+6}) 등으로 90-99 %정도 처리가능하나, 일반적인 처리약품인 NaClO의 경우 약품조에서 산화가 강력하게 발생되어 염소의 %가 현저하게 감소되는 것을 주의하여야 할 것이다. 이로인한 체류시간, 약품투여, 혼합상태 등의 요인으로 처리효율이 저하될 수 있으며 최종적으로 방류수에 존재하는 착이온 상태 (약 1 − 5 %) 의 중금속은 상기 처리공정으로는 불가능하다.

다. 처리효과

〈표3－2〉 (단위 : ppm)

	원 수	처 리 수	처 리 효 율	배출허용기준
CN	980	8.6	99.1 %	1 ppm
Cu	276	11	96.0 %	3 ppm
Cr	880	7.1	99.2 %	2 ppm

상기 처리효율표를 검토해볼때 우리의 현 처리방식으로서는 최고의 처리효율은 얻을. 수 있으나 원수의 고농도로 인하여 배출허용기준이내 처리하기란 매우 어려운 실정이다.

〈표3－2〉와 같이 처리수의 잔유농도는 거의가 킬레이숀화한 물질이라고 보아도 무난할 것이다. 결국 도금폐수의 적정처리는 착이온 상태의 중금속 처리가 관건이며 지금까지 기대했던 여러 전문가들의 새로운 처리약품 및 O_3에 의한 Chelate파괴 및 페어라이트공법등의 새로운 처리공법을 찾아 우리나라의 도금폐수를 미국에까지 운반하여 갖가지 실험검토를 하여 보았으나 처리 cost및 기타 제반여건이 우리에게는 합당치 못하였다.

지금까지 본인이 많은 시간과 경비를 투자해가며 얻은 결론은 궁여지책에 지나지 않지만 Chelate Resin에 의한 처리방법밖에 없다고 판단되어 이를 집중 연구하여 다음과 같은 실험결과를 구할 수 있었다.

2. 도금폐수의 고도처리

도금폐수를 수산화물 침전법에 의한 처리공정에 O_3을 활용하는 방식과 Resin에 의한 처리방법을 채택하여 실험 분석하여본 결과 O_3에 의한 착이온 제거방식은 우리현실에 부적합한 결론을 얻을 수 있었고 Resin에 의한 처리방식에서는 매우 양호한 효과를 구하였다.

Resin에 의한 처리공정은 다음과 같이 복합처리 및 분류처리 2가지

공정을 채택 실험에 임하였다.

(공정A) (복합처리)

CN 1st, 2nd Oxidation — Cr Reduction —
— Neutralization — Reaction — Flocculation —
— Sedimentation — Anthracite — Active carbon —
— R – OH Resin — Chelate Resin — 방류

(공정B) (분류처리)

CN 1st, 2nd Oxidation —
Cr Reduction — — Neutralization —
— Reaction — Flocculation — Sedimentation —
— Anthracite — Active carbon — R – OH Resin —
— Chelate Resin — 방류

O_3 (오존) 발생기 COD실험

(단위 : ppm)

구분 \ 항목	COD	SS
중금속폐수	190 ／시료	220 ／시료
3 hr	132 (30.5 %)	196 (11.0 %)
7 hr	118 (38.0 %)	188 (14.5 %)

o 오존발생기 : U.S.A GSP제품

o 오존투입량은 G.S.P측에서 hr당 2㎥ 적정용량으로 제작되어 본 실험에 임하였으며 이론적 O_3 투입량 산출제시는 정확한 자료를 구입치 못하였음.

(단위 : ppm)

구 분 \ 항 목	COD	SS
중금속폐수 (도금)	460 /시료	550 /시료
3 hr	306 (33.5 %)	478 (13.0 %)
7 hr	276 (40.0 %)	445 (19.0 %)

O_3 발생기실험

(단위 : ppm)

구분 \ 항목	CN		Cu	
시간 \ 시료	8.6	5.0	11	5.0
30min	8.2	4.8	10.5	4.8
	(4.7 %)	(4.0 %)	(4.5 %)	(4.0 %)
1 hr	6.2	3.5	10.2	4.6
	(27.9 %)	(30.0 %)	(7.3 %)	(8.0 %)
2 hr	5.7	3.3	10	4.6
	(33.7 %)	(34.0 %)	(9.1 %)	(8.0 %)
3 hr	5.3	3.0	10	4.6
	(38.4 %)	(40.0 %)	(9.1 %)	(8.0 %)

※ O_3 발생기로 처리한 결과 −Ion은 기대에 미치지는 못하나 처리효율은 증가하였고 +Ion은 거의 효율의 변화를 찾을 수 없었다.
결론적으로 O_3 처리방식은 우리현실에 적합치 못하였다.

3 차처리 (Resin) 효율실험

(단위 : ppm)

구분 \ 항목	Cu		CN		Cr	
	1 차	2 차	1 차	2 차	1 차	2 차
시 료	2.6	1.95	1.6	1.09	2.0	3.0
IRC-718	0.5 (80.8 %)	0.67 (65.6 %)	1.4 (12.5 %)	0.73 (33.0 %)	불검출 (100 %)	0.12 (96 %)
IR-122	1.0 (61.5 %)	1.45 (25.6 %)	1.6	0.92 (15.6 %)	1.0 (50 %)	1.8 (40 %)
WA-30	0.2 (92.3 %)	0.48 (75.4 %)	0.06 (96.3 %)	0.16 (85.3 %)	0.5 (75 %)	1.14 (62 %)
CR-20	0.2 (92.3 %)	0.29 (85.1 %)	불검출 (100 %)	불검출 (100 %)	0.64 (68 %)	1.2 (60 %)
P V B	0.9 (65.4 %)	0.9 (53.8 %)	1.6	0.65 (40.4 %)	0.76 (62 %)	1.2 (60 %)

시료 : 화학식 수산화물 침전법에 의한 최종 방류수 (분류처리)

Resin과 Active Carbon의 효율비교

(단위 : ppm)

항목 \ 구분	$R\text{-}OH^-$ Resin			Chelate Resin			Active Carbon		
	통과전	통과후	효 율	통과전	통과후	효 율	통과전	통과후	효 율
Cu	14.25	9.2	35.4 %	17.81	2.75	84.6 %	7.3	7.1	2.7 %
Cr	3.5	2.28	35.0 %	38.3	0.65	98.3 %	15.7	14.2	9.6 %
CN	17.5	0.38	97.8 %	14.5	0.57	96.1 %	12.4	11.5	7.2 %

※ R-OH Resin및 Chelate Resin의 모델번호는 당사의 여러가지 사정으로 생략하였음.

Ⅳ. 실 험 결 과

1) 오존처리

상기 실험기록과 같이 O_3를 이용한 처리방식은 CN및 COD 부분에서는 얼마간의 제거효율을 얻을 수 있었으나 중요한 중금속 부분에서는 거의 처리효율을 구할 수 없었다.

부득이 오존처리를 하고저 하는 경우에는 착화합물질중에서 $^-$Ion을 먼저 O_3으로 제거하여주고 별도의 처리공정을 통하여 중금속을 제거해야 할 것이다.

이는 설치비용 및 운영비 처리효율등에 많은 문제점이 내포되어 있으므로 심사숙고하여 결정하여야 할 것이다.

2) Resin공정 A

복합처리방식에서는 해당분야에서 가장 문제가 되어온 $^-$Ion 및 $^+$Ion의 분류집수되는 과정이 생략되므로 이의 해결이 이루어지면서 Storage Tank의 단일화가 이루어져 이의 설치비 및 생산과정의 발생원에 대한 염려는 필요없으나 반복되는 처리과정과 이로인한 약품의 과다투입으로 Sludge 발생량이 현격히 증가될 수 밖에 없으며 처리단가는 상승되나 처리시간 연장 및 침전장해로 인한 처리효율은 떨어져 COD는 기존방식보다 오히려 증가되는 현상이 나타났다.

3) Resin공정 B

CN계와 Cr계의 완벽한 분류상태에서는 부분적으로 재이용도 가능한 처리수를 얻을 수 있었다.

또한 처리시간 단축, 처리비용절감등 많은 문제점이 원활히 이루어지나 도금공장에서만은 생산공정 자체내에서 자연발생적인 결합으로 완벽한 분류는 거의 불가능하다고밖에 볼 수 없다.

이러한 문제점에도 불구하고 본 과정이 현실에 가장 효율적이라 판단되어 본인이 운영하고 있는 삼동산업 인천공장에서는 이미 Ion Exchange Resin과 Chelate Resin을 외국에 발주하여 지난 9월 30일 본 시설을 설치완료하여 많은 효과를 얻고 있으나 Resin의 설치비용이 우리나라에서 현재 행하여지고 있는 기존 방지시설에 50-70%이상 추가비용이 투자되어야 하는것도 우리는 깊게 검토해야 할 것이다.

또한 Chelate Resin은 종류가 매우 다양하며 오염상태가 매우 빨라 막대한 비용이 투자된 시설을 잘못관리하면 활용치 못할 수 있게 되므로 관리자는 세심한 주의를 하여야 할 것이며 이의 대처방안으로 1일 1회 이상의 역세척과 재생을 시켜주어 Resin의 수명을 연장시켜 주는것을 잊지 말아야 할 것이다.

자가측정기록부 (수질)

1992 년10 월 4일 일요일 날씨 : 맑음

결제	담 당	계 장	과 장	부 장	상무이사	이사장

구분 / 처리관계		11) 처리전 평균	11) 처리전 최대	12)처리후 평균	12)처리후 최대
1) 폐수량 ㎥/일		9,160		12,970	
수질	2) 외관				
	3) 수수이온농도 (PH)				
	4) 생물학적 산소 요구량 (BOD)				
	5) 화학적 산소 요구량 (COD)				
	6) 부유물질량 (SS)				
	7) 색도				
	8) N — 헥산				

9) 사용약품	약품	사용량		사용처	사용방법
	H_2SO_4 :	90 PPM	0.83 TON	중화조	
	P.M.C :	PPM	TON	PH조정조	
	NaOH :	PPM	TON	PH조정조	
	유기산화제 :	PPM	TON	PH조정조	
	HYDRO-S :	PPM	KG	방류조	
	중금속처리제 :	PPM	KG	원수조	
	영양제 :	PPM	KG	중화조	
	워터크린 :	147 PPM	1.35 TON	중화조	

10) 조업내용	조업시간	용수 사용량/일	냉각수 사용량	재이용수량
	24 시간/일	90 ㎥/일	㎥/일	㎥/일

11) 방지시설	이상유무	운영상황(처리방법약술)

방 지 시 설 운 영 일 지

결	담 당	계 장	과 장	부 장	상무이사
재	(stamp)	(stamp)	(stamp)		

199 92 년 10 월 4 일 일 요일 날씨 : 맑음 온도 : 19 °C

1. 방지시설 가동시간대 및 근무자 직·성명

10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	1	2	3	4	5	6	7	8	9

〈야간근무자〉 〈주간근무자〉

직위	성 명	직위	성 명	직위	성 명	직위	성 명	직위	성 명
	이 정 민	주임	박 철 호						
	신 창 현								
	김 시 훈								
	하 태 건								
	이 종 윤								

2. 용수사용량 및 폐수배출량

항목 / 구분	금 일 지 침 (㎥)	사 용 량 (㎥ / 일)		
폐 수 발 생 량	137,280	9,160		
폐 수 배 출 량	134,510	12,970		
용 수 사 용 량		90	누계	390 ㎥

3. 전력 사용량

금 일 지 침(㎾)	사 용 량(KWH)	금일폐수 1 ㎥당소모전력량	정 전 관 계(시간)
		KWI / ㎥	

4. 슬럿지 처리실적 (위탁처리 업소명 : 한국환경개발(주))

발 생 량	반 출 량	잔 량	누 계	보관상태 (방법)
TON	TON	TON	TON	CONTAINER BOX

5. 약 품 현 황

약 품 명	주입농도 (mg / ℓ)	주 입 량	입 고 량	잔 량	사용량누계	비 고
응 집 제		TON	TON	175.96 TON	27.81 TON	
가 성 소 다		TON	TON	5.85 TON	6.00 TON	
H_2SO_4	90	0.83 TON	TON	43.28 TON	34.13 TON	
워 터 크 린	147	1.35 TON	TON	22.43 TON	7.54 TON	
소 포 제	109	1.00 TON	TON	1.51 TON	4.00 TON	
YANG FLOC 700		TON	TON	14.36 TON	4.28 TON	
CATION		40 kg	kg	2,430 kg	240 kg	
영 양 제		kg	kg	2,380 kg	1,200 kg	
HLC		kg	kg	1,800 kg	750 kg	
종 균 제		kg	kg	1,900 kg	300 kg	
HYDRO SULFITE		kg	kg	950 kg	300 kg	
POLYMER		kg	kg	kg	kg	

6. 수질측정 사항

항목 / 구분	PH	COD	BOD	SS	N－H	
원 폐 수						
방 류 수						

7. COD, PH 자동측정기 시간별 현황

시간 / 항목	9 : 00	13 : 00	17 : 00	21 : 00	01 : 00	05 : 00
COD						
PH						

8. 방지시설 고장유무

고장시설명	고 장 시 간	고 장 상 태	조 치 사 항	기 타

PROCESS CHECK LIST

199 2년 7월 28일 화요일 날씨: 맑음 온도: 29℃

결재	담당	계장	대리	과장	부장
	(stamp)	(stamp)	(stamp)	(stamp)	(stamp)

원수조

유량	61.470 ㎥
PH	11^{33}
COD	250^{0}
SS	125^{9}
BOD	264^{2}
H₂SO₄ 주입량	
PPM	
(. TON)	
영양제주입량	
9 PPM	
(600 kg)	
안정조	
PH	10^{98}
COD	410^{0}
SS	223^{1}

PH 조정조

유량	26.800 ㎥
NaOH 주입량	
. PPM	
(. TON)	
응집제주입량	
. PPM	
(. TON)	
polymer주입량	
. PPM	
(. kg)	
1 차침전조	
PH	
COD	
제거율	%
SS	
제거율	%

중화조

H_2SO_4 주입량
311 PPM
(19^{16} TON)
신설폭기조유입 유량
№3 : 16335㎥
№4 : 18335㎥

폭기조

		DO(mg/ℓ)	Temp(℃)	MLSS(mg/ℓ)	SV_{30}(%)	SVI	반송MLSS	반송비	용적부하	F/M 비	SRT
№1	#						4116^{1}	47^{9}			
	#3			1329^{6}	16	120^{3}					
№2	#						3444^{0}	51^{1}			
	#3			1165^{1}	18	154^{4}					
№3	#						7008^{3}	31^{1}			
	#3			1663^{1}	10	60^{1}					
№4	#						3095^{2}				
	#3			1600^{0}	9	56^{2}					

2 차 침 전 조

	PH	COD	기타
№1	7^{87}	77^{0}	<SS> 8^{0}
№2	7^{92}	71^{4}	6^{2}
№3	7^{80}	175^{0}	36^{8}
№4	7^{77}	190^{0}	45^{7}

방류조

유량	60.240
PH	7^{80}
COD	88^{2}
제거율	64^{8} %
SS	8^{0}
제거율	93^{6} %
BOD	15^{3}
제거율	94^{2} %

농축탈수기

농축함수율
%
Cation 사용량
. kg
Cake 발생량
. TON
Cake 반출량
. TON
Cake 잔량
2,376 TON

기타

	<기존중화조>	<신설중화조>
PH :	7^{60}	7^{93}
COD :	280^{0}	320^{0}
SS :	75^{5}	83^{3}

(5) New Technologies using Bacteria Enzymes for the Dyeing Wastewater Treatment

In Japan, regarding the treatment of wastewater from dyeing and dyestuff factories, BOD and COD removing technologies were long-established. In recent years, however, social interest in removing the wastewater color has increased, and in some local bodies, movements toward setting up ordinances regulating the degree of coloring of the wastewater have appeared. Now, advanced treatment technologies even for decolorization are being sought.

On the other hand, in the Asian countries, governmental regulations regarding the wastewater treatment have become stricter. *In addition to decolorization not to speak of*, COD removal also is now a serious problem in the operation of dyeing and dyestuff factories. Some dyestuff and its intermediates, which have ceased to be produced in Japan, are held as products in not a few factories, because wastewater treatment technologies have little been accumulated there, and if they were to be used, then the resulting wastewater would require its treatment and this would produce problems. It is a very difficult work to establish the method of dissolving the resulting nonbiodegradable COD to at a reasonable cost.

Japanese Chemical Company S has been engaged in the wastewater treatment for dyeing and dyestuff factories in Japan and in Korea for a long time. In facing these problems, the company has accumulated total dyeing and dyestuff factory wastewater treatment technologies such as for reducing the degree of color and COD by using Bacteria Enzymes, HIPOLKA, in the activated sludge treatment, and for developing the decoloring effect by improving the chemicals used and operating methods in the flocculation and sedimentation treatment (with the pressured flotation).

Depending on the dyestuff being used, the methodology to be adopted differs in the particular cases. At this point, advanced treatment technologies using Bacteria Enzymes for dyeing and dyestuff factory wastewaters will be outlined as a general description.

1. General Treatment Methods for Dyeing and Dyestuff Factory Wastewater

Fig.1 shows a typical flow diagram for dyeing and dyestuff factory wastewater treatment. In general, the wastewater meets the relationship of BOD/COD < 1 in many cases, and therefore, the flocculation and sedimentation treatment (with pressured flotation) using Fe salts, Al salts, etc. is applied. In this process, COD, SS and coloring are roughly removed until the relationship of BOD/COD > 1 (preferably above 1.5)is met, and then the activated sludge treatment is done. This process is intended to remove BOD, but biodegradable COD is also removed. If the facility design and the operation are done properly, and both BOD and COD are reduced to 20-50 mg/l at this point, then it will be relatively easy to treat the effluent subsequently by activated carbon adsorption, etc. up to such a water quality suited for

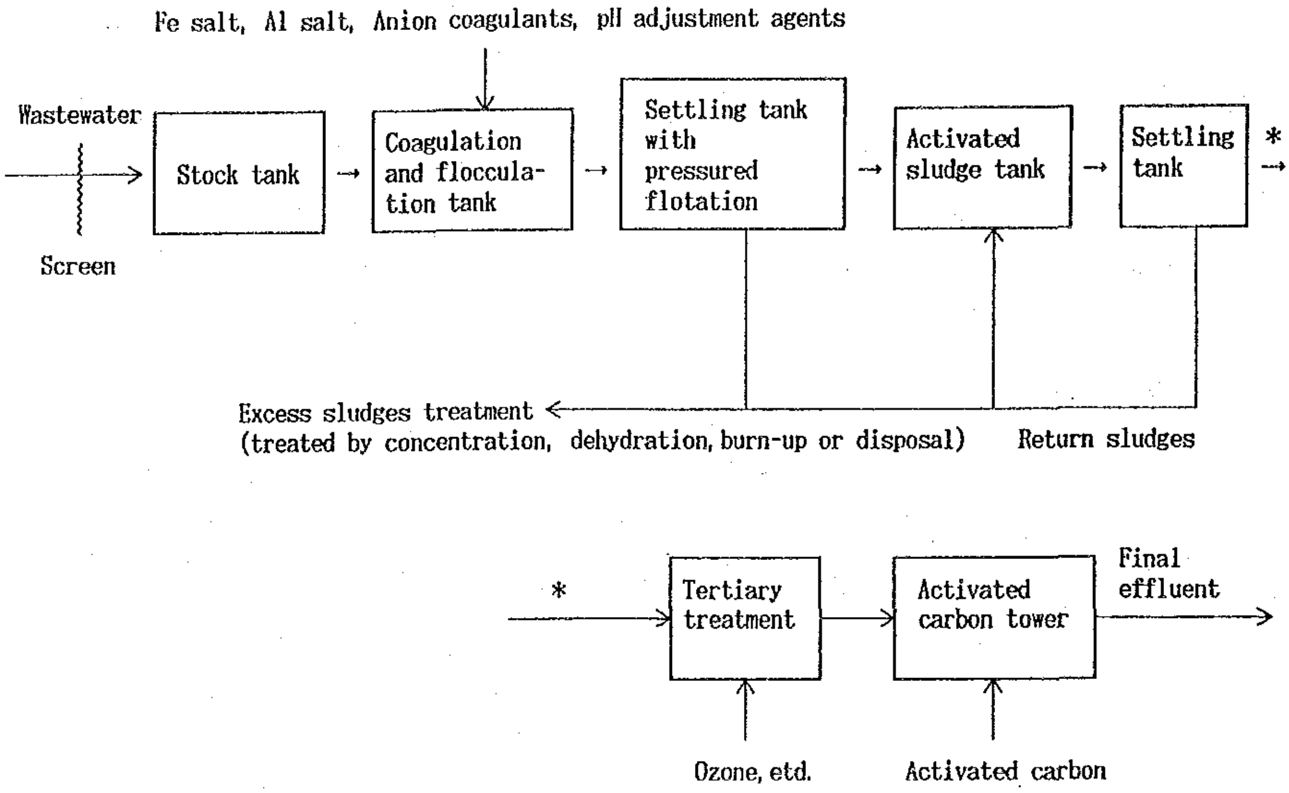


Fig. 1. Flow diagram of dyeing and dyestuff factory wastewater treatment process

final discharge. If the COD content and the degree of color are so high that the activated carbon treatment economically done is insufficient to obtain the condition suited for final discharge, it is necessary to carry out oxidation or other physico-chemical treatment as a tertiary treatment.

2. Reduction of the Degree of Color and Removal of nonbiodegradable COD in the Activated Sludge Treatment

In general, it is said that it is difficult to reduce the degree of color and remove nonbiodegradable COD in the activated sludge treatment. In fact, it seems that the degree of color is hardly reduced in the activated sludge treatment when it is carried out in the normal way. In some cases, the degree of color is increased by the activated sludge treatment slightly as compared with that of the effluent of the flocculation and sedimentation treatment applied as a pre-treatment. Thus, it can hardly be expected to reduce the degree of color in the activated sludge treatment when it is operated normally. However, if bacteria which have excellent nonbiodegradable COD removing performance, such as Bacteria Enzymes HIPOLKA, are used under the suitable conditions for their activities, then it is possible to reduce the degree of color and remove nonbiodegradable COD in the activated sludge treatment (the removal efficiency up to 50 % being confirmed). Table 1 shows a case where the degree of color is reduced and the COD removal efficiency is improved in the

Table 1. The comparison of field data with use of HIPOLKA at a dyestuff factory in Korea.

1. Before using HIPOLKA

Date	Inflow			Outflow			MLSS (mg/L)
	BOD (mg/L)	COD (mg/L)	Degree of color	BOD (mg/L)	COD (mg/L)	Degree of color	
June 1	1,320	1,110	1,100	82 (94)	420 (62)	1,200 (- 9)	5,840
June 4	1,430	1,150	900	63 (96)	440 (62)	1,100 (-22)	5,880
June 7	1,300	1,120	1,400	90 (93)	440 (61)	1,200 (14)	5,840
June 10	1,300	1,110	1,200	74 (94)	430 (61)	1,100 (8)	6,510
June 13	1,220	1,010	1,100	100 (92)	430 (57)	1,200 (- 9)	6,230

NOTE :The mark ( ), means the removal efficiency (unit : %).

2. After 1 month with use of HIPOLKA

Date	Inflow			Outflow			MLSS (mg/L)
	BOD (mg/L)	COD (mg/L)	Degree of color	BOD (mg/L)	COD (mg/L)	Degree of color	
July 16	1,420	1,030	1,300	55 (96)	330 (68)	800 (38)	6,110
July 19	1,480	1,140	1,100	47 (97)	290 (75)	700 (36)	6,230
July 22	1,360	1,120	1,100	38 (97)	310 (72)	700 (36)	6,850
July 25	1,400	1,080	1,400	41 (97)	300 (72)	800 (43)	6,460
July 28	1,480	1,150	1,300	36 (98)	280 (76)	700 (46)	6,290

NOTE :The mark ( ), means the removal efficiency (unit : %).

* Conditions of wasterwater treatment process for both 1 and 2 :

Activated sludge tank volume: 3,000 m^3 Wastewater volume : 1,000 m^3/day
BOD load: 0.45 kg/m^3/day on the average BOD/COD : 1.2 on the average
The temperature of the activated sludge tank water: 28±5 ℃
Inflowing wastewater of the activated sludge tank is treated in flocculation and sedimentation treatment process.
Sampling location : the activated sludge tank

Dosages of HIPOLKA
Initial treatment : Apply 600 kg into the activated sludge tank.
Weelky treatment : 50 kg/week will be required 1 month after initial treatment.

activated sludge treatment using Bacteria Enzymes HIPOLKA.

Based on the experience so far obtained, the conditions for decolorization and COD removal by using HIPOLKA can be summarized as follows.

* The retention time for the wastewater in the activated sludge tank should be at least 1 day. (The removal capacity of COD by HIPOLKA trends to be developed on the longer retention time.)
* MLSS should be controlled to be a level as high as possible (above 5000 mg/l) because the COD load with a lower level trends to make the removal efficiency of COD increase.
* The demand of oxygen (D.O.) and the pH is based on the conditions of the activated sludge treatment under the normal operations.
* The concentration of inorganic salt in the wastewater is high at some dyestuff factories by case. In such cases, dilution water should be applied to reduce the inorganic salt concentration (a guide value being less than 1 %).

If these conditions are satisfied, Bacteria Enzymes HIPOLKA may function effectively, contributing to reducing the degree of color and nonbiodegradable COD.

As described before, the degree of color is sometimes increased by the activated sludge treatment slightly as compared with that of the effluent of the flocculation and sedimentation process or the like applied as a pre-treatment (especially, when the flocculation and sedimentation treatment is done using Fe^{2+} salt, etc.) This leads to an increased running cost of the tertiary treatment which is applied to reduce the degree of color finally. It is a major demerit. In general, by the flocculation and sedimentation treatment, COD is mainly removed and BOD reduction is not significant. Table 2 shows the treatment effect evaluated in terms of the total weight of BOD and COD removed in the activated sludge treatment when the wastewater is treated first directly by the activated sludge and subsequently by the agglutinative precipitate sedimentation, as compared when the activated sludge treatment is applied after the flocculation and sedimentation process. The figures shown are approximate and not significantly different. If any inhibitor to the activated sludge exists in the wastewater, it is not preferable to treat the wastewater directly by the activated sludge. However, the effect can be evaluated previously by testing in the laboratory, and if there is no problem, then the activated sludge treatment may be done first.

By comparison with the wastewater treatment processes between No.1, 2 and 3 in Table 2., it is seen that No. 3 has the smallest degree of color, and therefore, unless the performance on BOD and COD removal with the activated sludge treatment is affected, it is advantageous to adopt 3.

In general, dyestuff factory wastewater have high BOD and COD concentrations, and in many cases, contain much inorganic salts and other substances which interfere with the activated sludge

Table 2. The comparison with the wastewater treatment processes at a dyeing factory in Japan.

	Inflow			Outflow		
	BOD (mg/L)	COD (mg/L)	Degree of color	BOD (mg/L)	COD (mg/L)	Degree of color
Flocculation and sedimentaion treatment	1,360	1,620	1,400	1,140	810	560
Activated sludge treatment	1,140	810	560	180	450	890

1. Processes : Wastewater → Flocculation and Sedimentation treatment→ Activated sludge treatment
   BOD load in the activated sludge tank : 0.57 kg/m^3/day
   Dosages of HIPOLKA : None

	Inflow			Outflow		
	BOD (mg/L)	COD (mg/L)	Degree of color	BOD (mg/L)	COD (mg/L)	Degree of color
Flocculation and sedimentaion treatment	1,360	1,620	1,400	410	930	1,400
Activated sludge treatment	410	930	1,400	310	470	560

2. Processes : Wastewater → Activated sludge treatment → Flocculation and Sedimentation treatment
   BOD load in the activated sludge tank : 0.68 kg/m^3/day
   Dosages of HIPOLKA : None

	Inflow			Outflow		
	BOD (mg/L)	COD (mg/L)	Degree of color	BOD (mg/L)	COD (mg/L)	Degree of color
Flocculation and sedimentaion treatment	1,360	1,620	1,400	320	720	1,100
Activated sludge treatment	320	720	1,100	250	360	140

3. Processes : Wastewater → Activated sludge treatment → Flocculation and Sedimentaion treatment
   BOD load in the activated sludge tank : 0.68 kg/m^3/day
   Dosages of HIPOLKA
   Initial treatment : Apply 200 ppm per volume of the activated sludge tank into the activated sludge tank.
   Weekly maintenance : Apply 25 ppm per volume of the activated sludge tank into the activated sludge tank 1 month after initial treatment.

treatment. Therefore, for the dyestuff factory wastewaters, it is difficult to adopt the methods mentioned above. For the dyeing factory wastewaters, the process shown in Table 2-2. can be adopted in many cases because the influence on any water quality item other than the degree of color is negligible. In any case, this point should be judged after adequate testing has been done.

3. Reduction of the Degree of Color in the Flocculation and sedimentation Treatment

In general, the wastewater of dyeing and dyestuff factory in the flocculation and sedimentation treatment with pressured flotation is treated with a combination of inorganic coagulants shown in Table 3, pH adjustment agents (NaOH, CaO, etc.) and high molecular coagulants for accelerating the sludge settlement (anionic, nonionic, etc.) In every case, a jar test should be done to select the coagulants best suited for the wastewater. In general, Fe^{2+} salt is more effective for decolorization, and Fe^{3+} salt is more effective for COD removal, and both should be used selectively. (For each of them, there is some know-how about the conditions of flocculation such as the amount to be added, the most suitable pH range for coagulation.)

The following inorganic coagulants are acidic, and when any of them is added, pH tends to be decreased, and therefore, an alkali agent is required to adjust pH in many cases. As the

Table 3. Properties of inorganic coagulants used in the flocculation and sedimentation treatment.

Chemical name	Molecular formular	pH range	Removal capacity on COD	Decoloring capacity
Iron (II) sulfide	$FeSo_4 \cdot 7H_2O$	8～14	○	◎
Iron (III)sulfide	$Fe_2(SO_4)_3$	3～14	◎	○
Iron (II) chloride	$FeCl_2 \cdot 4H_2O$	8～14	○	◎
Iron (III)chloride	$FeCl_3 \cdot 6H_2O$	3～14	◎	○
Aluminum sulfate	$Al_2(SO_4)_3 \cdot 18H_2O$	6～ 9	○	△
Poly aluminum chloride	PAC	6～ 9	○	△

NOTE : The capacity ranking ; ◎>○>△ .

alkali for this purpose, NaOH is markedly advantageous if even the sludge disposal cost is taken into consideration. However, if it is desired to reduce the degree of color to any degree in this process, compounds of bivalent alkaline earth metals such as CaO, $Ca(OH)2$ and MgO should be selected because they have some power of decolorization. Table 4 shows alkalis used for this purpose and their features.

The method to reduce the degree of color further in this process is to use a decoloring agent, POWERFLOCK M-51 (PF M-51). PF M-51 is a strong cationic high molecular coagulant. It is added in a quantity (10-100 ppm) together with inorganic coagulants in the flocculation and sedimentation tank. PF M-51 allows the coloring components to be flocculated promptly to decolorize the wastewater, while it is settled as sludges. Table 5 shows the results of the removal of color using PF M-15 by jar testing.

4. Tertiary Treatment for Decolorization and COD Removal

In nearly all cases, the wastewater can be treated enough for the final discharge by a combination of treatment methods so far described. However, where the pollutant loading on the treatment facilities is always high as in the case of dyestuff factories, or in any local area where strict regulation standards are set up regarding the degree of coloring and advanced treatment for

Table 4. Properties of alkali agents used in the flocculation and sedimentation treatment process.

Chemical name	Advantages	Disadvantages
Sodium Chloride (NaOH)	Reaction time is short. Sludge volume is small.	No synergism on decoloring.
Slaked lime ($Ca(OH)_2$) Quick lime (CaO)	Synergism on decoloring can be excepted.	Reaction time is long. Sludge volume is large.

Table 5. The performance of PF M-51 on the removal of color from colored wastewater.

Variable	Class 1	Class 2
$FeCl_2$ dosage, g/m^3	2,000	2,000
PF M-51 dosage, g/m^3	none	50
Results		
COD, mg/L	1,850	1,670
Coloring degree	560	280
Suldges volume, g/m^3	7,000	7,400

NOTE : The sludges volume refers to the quantity of sludge containing 75 % moisture per m^3 in wastewater.

* Testing conditions :
  Samples : Colored wastewater from the dyeing process at a spinning mill in Japan
  Inorganic coagulant : $FeCl_2$ (Lquid)
  Alkali agent : Waste NaOH
  COD of samples : 2,550 m/L
  pH range for Flocculation : 10
  Coagulants : Anionic high molecular agents (1 ppm added)
  Degree of color of samples : 1,400

decolorization is specified, tertiary treatment is sometimes required.

For this tertiary treatment of dyeing and dyestuff factory wastewaters to reduce the degree of color and COD, ozone oxidation, electrolytic oxidation and activated carbon treatment have been well known. Each of them is an effective treatment means, but has some problems. Ozone oxidation and electrolytic oxidation require much equipment cost. Activated carbon treatment requires much running cost because the life of activated carbon is shortened if the COD content and the degree of coloring are high.

Introduced below is a method of tertiary treatment using hydrogen peroxide which can be implemented relatively easily in the existing agglutinative precipitate sedimentation facilities (See Fig. 2. and Table 6.).

* Features

This treatment method uses oxidation by OH radicals which are produced when H2O2 is added in the presence of Fe2+. It has a high reaction rate and can be applied in the existing agglutinative precipitate sedimentation (pressured flotation) facilities, and therefore, the equipment cost is small, The oxidized Fe3+ acts as a coagulant. Thus, it can be expected that decolorization and COD removal have synergism in the flocculation and sedimentation process. If, before this process, decolorization or COD removal has been done to some degree, the quantity of hydrogen peroxide to be added can be reduced and so, this treat-

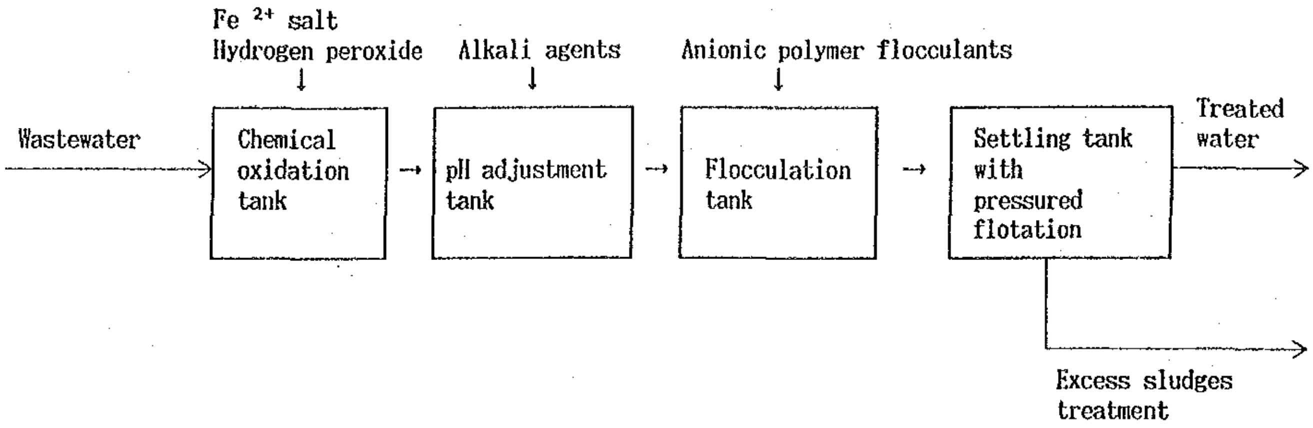


Fig. 2. Flow diagram for tertiary treatment

Table 6. The performance of tertiary treatment on the removal of color and COD

Constituent	Before tertiary treatment	After tertiary treatment
COD, mg/L	720	60
Degree of color	1,100	60
Suldges volume, g/m^3	none	6,820

NOTE : The sludges volume refers to the quantity of sludge containing 75 % moisture per m3 in wastewater.

* Testing conditions :
  Samples : Colored wastewater from the activated sludge treatment process at a dyeing company in Japan.
  H_2O_2 dosage : 350 g/m^3 $FeCl_2$ dasage : 1,600 g/m^3

ment method is economical even in the aspect of running cost.

5. Examples of Dyestuff Factory Wastewater Treatment using HIPOLKA

Finally, two examples of wastewater treatment adopting the technologies described above in Korea and Japan are shown in Fig. 3,4 and Table 7,8.

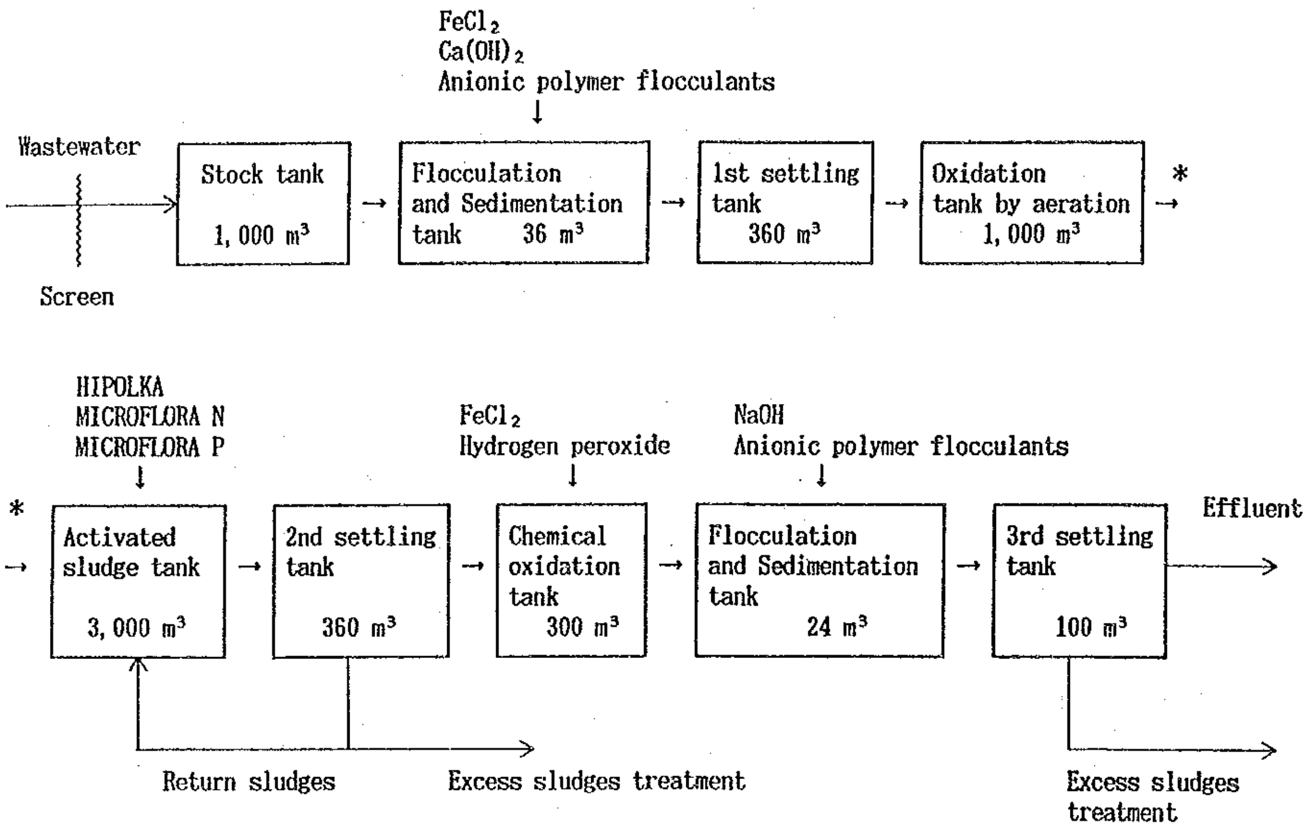


Fig. 3. Flow diagram of wastewater treatment at a dyestuff factory in Korea

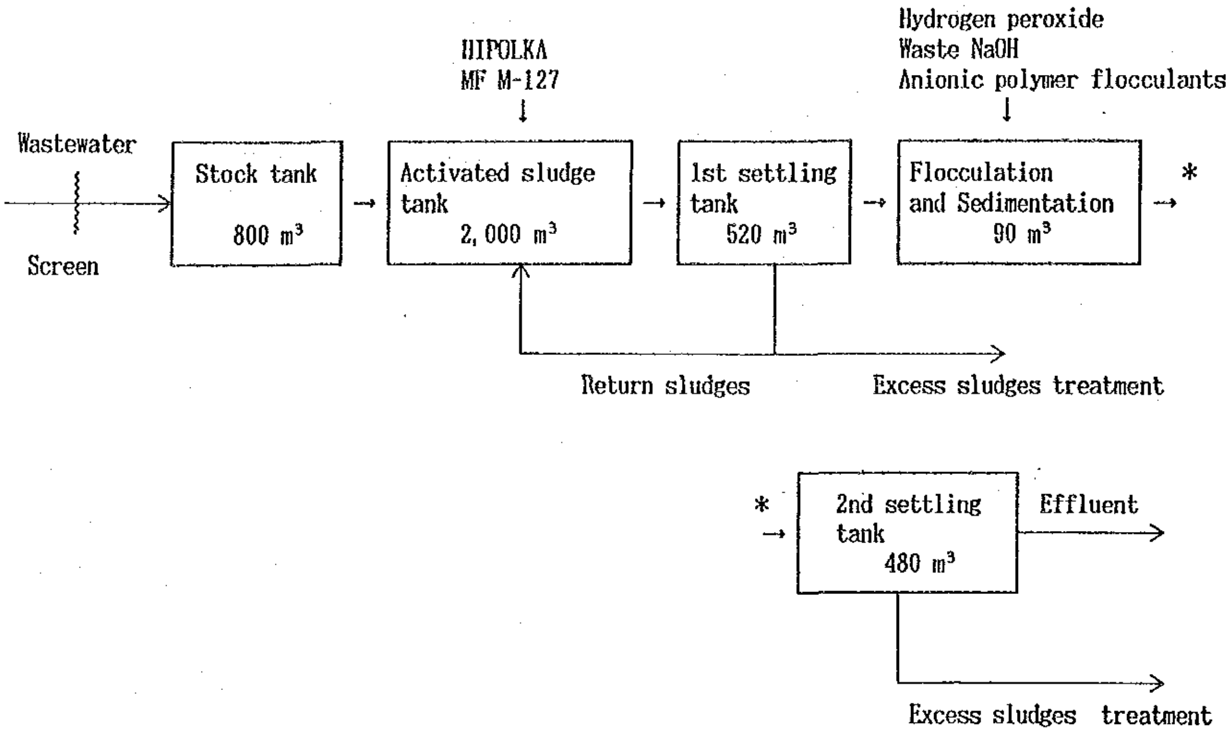


Fig. 4. Flow diagram of wastewater treatment at a fiber dyeing factory in Japan

Table 7. The field data of wastewater treatment at a dyestuff factory in Korea

Constituent	Sampling location in the treatment process				
	Stock tank	Flocculation and sedimentation tank	Oxidation tank by aeration	Activated sludge tank	Effluent to the sea
COD, mg/L	4,120	1,830	1,100	310	92
BOD, mg/L	2,200	1,780	1,450	43	16
Degree of color	7,800	1,100	1,300	740	110

* Dosages of Chemical used in the activated sludge tank

Bacteria enzyme, HIPOLKA : 600 kg for initial seeding, 1 month later 50 kg for weelky maintenace.
Nitrogen nutrient, MICROFLORA N : 40 kg per day
Phosphorus nutrient, MICROFLORA P : 100 kg per day
Accelerator for settling sludge, POWERFLOCK M-127 : 20 kg per day

Table 8. The field data of wastewater treatment at a fiber dyeing factory in Japan

Constituent	Sampling location in the treatment process		
	Stock tank	Activated sludge tank	Effluent to the river
COD, mg/L	1,210	430	68
BOD, mg/L	1,050	160	53
Degree of color	1,100	720	40

* Dosages of Chemical used in the activated sludge tank
  Bacteria enzyme, HIPOLKA : 300 kg for initial seeding, 1 month later 25 kg for weelky maintenace
  Accelerator for settling sludge, POWERFLOCK M-127 : 20 kg per day

(6) Financial Sources for Development of Wastewater Treatment Facilities in Japan

As of April, 1993

Institution	Qualified Enterprises	Eligible Facilities	Financal Conditions			
			Amount (million yen)	Interest(%/year)	Repayment period	Maximum Ratio of Loan
Japan Finance Corporation for Small Business	Medium-small scaled co. Paid capital Less than 100 million yen and Less than 300 employees	Wasterwater treatment facilities	Within 600	4.9% for the first three years, 5.4% after the fourth year	Within 15 years, 2 year's grace period	No limitation
People's Finance Corporation	Medium-small scaled co. Paid capital Less than 10 million yen and Less than 100 employees	-ditto-	Within 60	-ditto-	-ditto-	-ditto-
Local Governments	Medium-small scaled co. Paid capital Less than 100 million yen and Less than 300 employees	Facilities for effective use of industrial water, Wastewater treatment facilities	0.5-30	No interest	4 years, One year grace period	Within 50% of the cost of facilities
Japan Development Bank	Large scaled co. Paid capital more than 100million yen and more than 300 employees	-ditto-	No limitation	5.4%	10 years	Within 40% of the cost of facilities
Japan Environment Corporation For the cooperative environment protection facilities	Medium-small scaled co. and local govemments	Wastewater treatment facilities	-ditto-	4.3%	Within 15 years, 2 year's grace period	Within 80% of the cost of facilities
	Large scaled co.			4.5% of the first three years, 4.7% after the fourth year		Within 70% of the cost of facilities
For the individual environment protection facilities	Medium-small scaled co. and local govemments	-ditto-	-ditto-	4.3%	Within 15 years, 2 year's grace period	Within 80% of the cost of facilities
	Large scaled co.			4.7%		Within 50% of the cost of facilities
Japan Small Business Corporation	Cooperatives for the Medium-small scaled co.	-ditto-	-ditto-	No interest	Within 20 years, 3 year's grace period	Within 80% of the cost of facilities

(7) Tax Incentives for Development of the Waterwaste Treatment Facilities in Japan

As of April, 1993

Name of program	Eligible Facilities	Contents
1. Ad hoc (Accelerated) Depreciation	Wastewater Treatment Facilities	It is allowed to depreciate 18% of the total cost of the facilities in the first year.
2. Reduction of the legal durable years for depreciation	-ditto-	It is allowed to reduce its legal durable years for machine and equipment from 10-15 years in general to 7 years.
3. Exemption of the Municipal Property Tax	-ditto-	The municipal property tax for the now or innovated eligible facilities will be exempted.
4. Ad hoc Depreciation or reduction of the Municipal Property Tax	Energy Concervation Type Wastewater Treatment Facilities, e.g., Anaerobic Wastewater Treatment Facilities and so on	It is allowed to depreciate 30% of the total cost of facilities in the first year or 7% of the cost of facilities will be exempted from the taxable amount of the prperty tax in the first year. This program, however, is not simultaneously applicable to the first program.

JICA