5.3 Textile Industry

5.3.1 Code No. of Factory: T-01

(1.) Outline of Factory

Capital (M₿): 600

Annual Amount of Shipment (M₿): -

Total Area (m^2): 144,000

Total No. of Employees: 4,530

Main Products: Fiber, Yarn, Raw Cloth, Finished Cloth and Dyed Cloth

(2.) Present Situation of the Use of Industrial Water

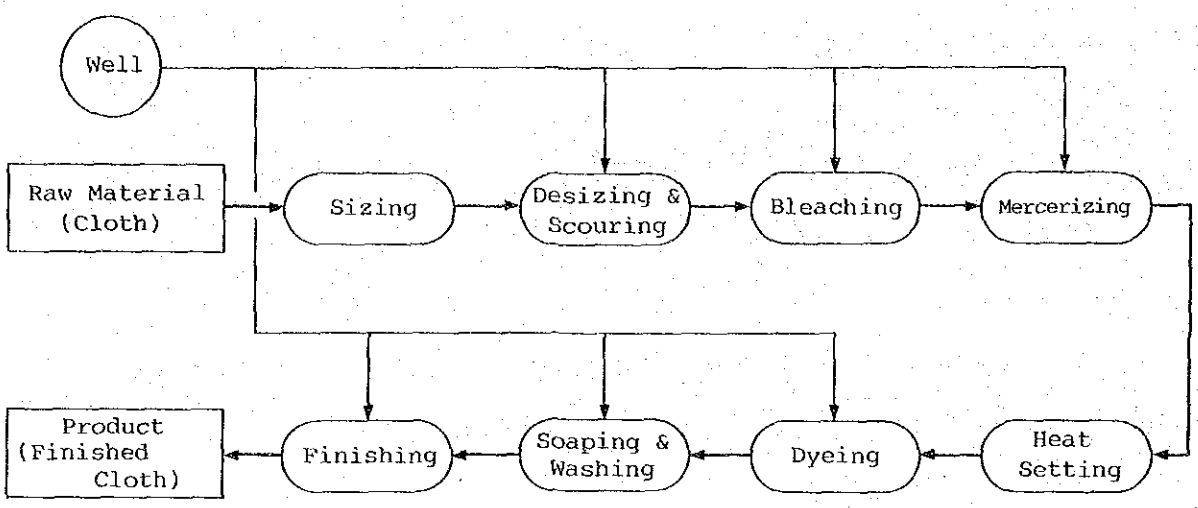
(2.1) Water Consumption

Unit: m^3/d

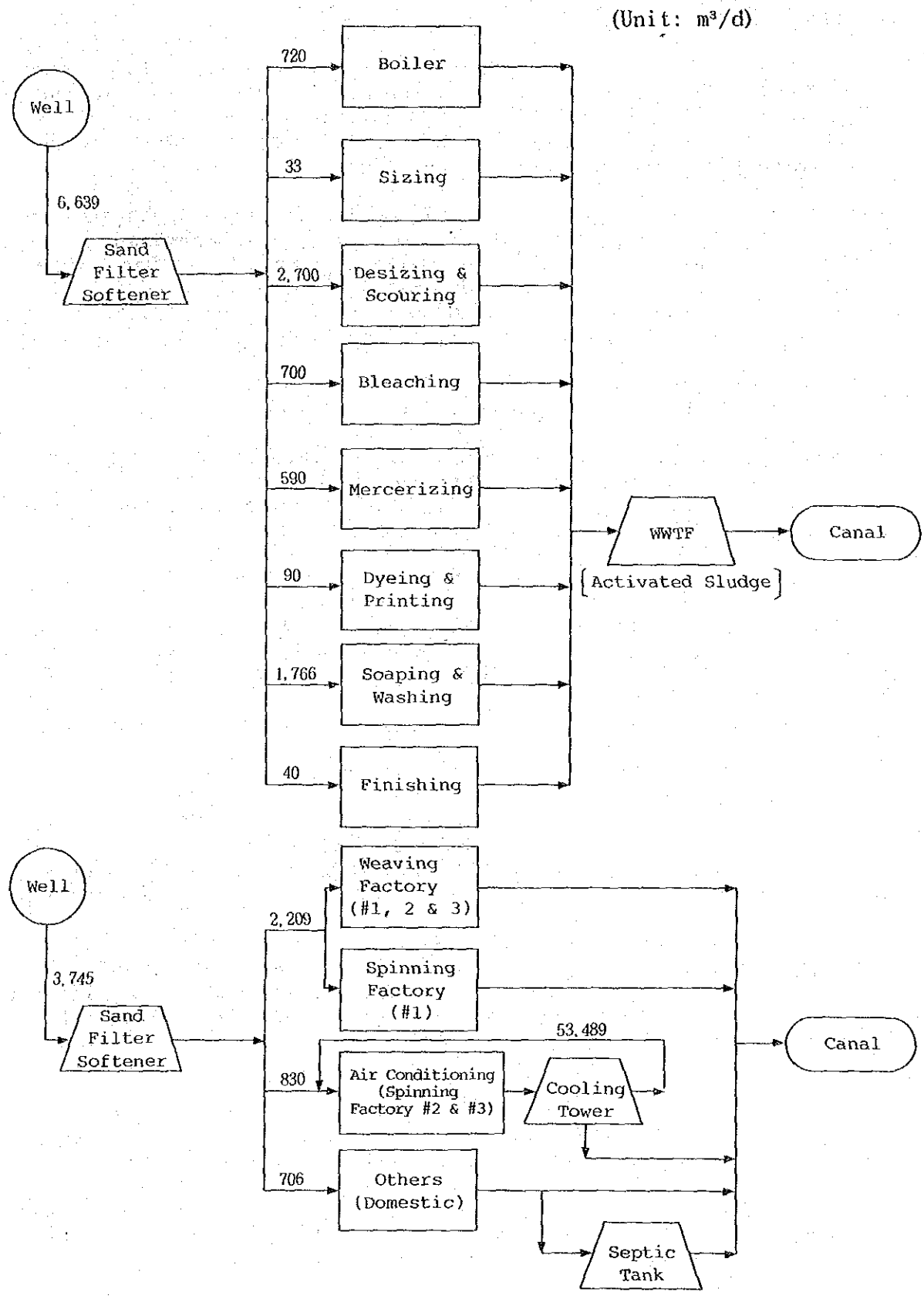
Use \ Source	Well Water	MWA	Others	Sub Total	Recover-ed Water	Total
Boiler	720			720		720
Material						
Processing & Washing	8,128			8,128		8,128
Cooling						
Air Conditioning	830			830	53,489	54,319
Others	706			706		706
Sub Total	10,384			10,384	53,489	63,873
Outside						
Total	10,384			10,384	53,489	63,873

Recovery Rate (%): 83.7

(2.2) Process Diagram of Production Line



(2, 3) Flow Diagram of Water Supply and Waste Water Discharge



Legend: WWTF = Waste Water Treatment Facility

(2.4) Explanation of Present Situation

(2.4.1) Sources and Uses

In this factory, water is supplied only from wells. There are five wells (No. 1, 2, 3, 4, 6) in the middle area of the factory and three wells (No. 5, 7, 8) on the northwest side. Each well is either 210 m or 234 m deep. The No. 1 and No. 4 are standby wells that are normally out of operation.

From three wells in the middle area of the factory, 6,639 m^3/d of water is pumped up mainly for the use of dyeing department. On the other hand, 3,715 m^3/d of water is pumped up from three wells on the northwest side mainly for the use of the spinning/weaving department and the dormitory for employee. In total, 10,384 m^3/d of water is pumped up.

Water for domestic use amounts to 706 m^3/d, which is not particularly high for 4,533 employees.

Around 830 m^3/d of make-up water is used for cooling of the air conditioner in the spinning/weaving department. Currently six cooling towers (three towers with 1,000 RT each and other three with 800 RT each) are in operation.

On the experimental assumptions, the water recycling through cooling towers is estimated at 53,489 m^3/d. This figure is roughly equal with another estimation 54,171 m^3/d based on the pipe diameters. The degree of concentration of recycled water is estimated at about 1.5.

The comparison data on daily consumption of well water are shown in Table T-01

(2.4.2) Water Treatment

The quality of mixed water from No. 2, No. 3 and No. 6 wells is 705 $\mu S/cm$ of electrical conductivity and 84 mg/lit of total hardness. This water is used after being treated by sand filter and softener.

Similarly, the quality of mixed water from No. 5, No. 7 and No. 8 wells is 645 $\mu S/cm$ of electrical conductivity and 78 mg/lit of total hardness. This water is treated by sand filter and softener before being used.

(2.4.3) Waste Water Treatment

Waste water from the dyeing department is discharged into a canal after pH adjustment and activated sludge treatment.

Waste water from the spinning and weaving departments and domestic use is directly discharged into a canal. Toilet washing water goes through the septic tank before being discharged into a canal.

Table T-01 : Daily Consumption of Well Water

(Unit: m^3/d)

Item \ Use	Dyeing Dept.	Spinning & Weaving Dept. & Domestic Use	Total
Measured Value *	11,616	4,973	16,589
Figure on the Answered Questionnaire (Average of 1986)	6,639	3,745	10,384
Same as Above (Sept. 1986)			10,072
Factory's data (from 1st to 15th of Sept. 1986)	7,015		

* Measured value represents only those at a certain point of time. For this study, taking the temporary fluctuations of water consumption (especially for batch-type machine and domestic use) into consideration, the figure described on answered questionnaire is adopted as basis.

(3.) Plans of Effective Use of Industrial Water

(3.1) General

In the dyeing department, the use of water is adequately controlled by monitoring the consumption in terms of water/production ratio (i.e. m^3/100 yard production).

The counter-current washing method is adopted for the main continuous processes (bleaching, dyeing and finishing).

Since batchwise dyeing machines are mostly of a jet type, the liquor ratio is estimated fairly low.

In the spinning/weaving department, most of water is used for air conditioning. Judging from the capacity of the air conditioning system, the quantity of water consumption seems to be excessive.

Therefore, it is necessary to perform detailed survey on the use of water in this department, including the domestic use (for example, the water consumption in the dormitory for single employees).

Since the degree of concentration of cooling water for the air conditioning is still low, water may be further saved by raising it.

To make the use of water more effective, reclamation of waste water should be studied. The technical feasibility of this water saving method has been proven in Japan.

(3.2) Details

a. Raising of degree of concentration through improvement of operation control of cooling tower

By raising the degree of concentration of cooling water up to 2.5 (on average), the daily supply of make-up water could be reduced from the present level of 830 m^3/d to 430 m^3/d. Thus, the quantity of water saving would be 370 m^3/d.

b. Advanced treatment of waste water for re-use in washing process

By applying advanced treatment, waste water might be re-used for washing in pretreatment process of dyeing that do not have much influence on product qualities (especially, colors). The outline of the re-use of waste water is as follows.

(i) Raw water: Discharged waste water
(ii) Volume to be reclaimed : 2,000 m^3/d (approximately 30% of the washing water to be used for dyeing processes)
(iii) Use : Washing for pretreatment process of dyeing
(iv) Treatment process: Coagulation/sedimentation, sand filtration and activated carbon adsorption

(4.) Cost Estimation

Number	1	2
Method for Effective Use Method Item	Improvement of operation control Improvement of operation and maintenance of cooling tower to raise degree of concentration	Reclamation of waste water Advanced treatment of waste water for re-use in washing process
Water Saving Use Qt. (m^3/d)	Air conditioning 370	Washing 2,000
Apparatus for Effective Use Apparatus Cost (10^3฿)		Sedimentation/coagulation tank, sand filter x 2, activated carbon adsorber x 4, dehydrator, pump x 3, electric instrument & piping 40,000
Unit Cost (฿/m^3) Fixed Operating Total	 - 0.5 0.5	 7.3 5.8 13.1

Total Water Saving (m^3/d): 2,370

Total Initial Cost (10^3฿): 40,000

Total Unit Cost (฿/m^3): 11.1

Note: Qt. = Quantity

5.3.2 Code No. of Factory: T-02

(1.) Outline of Factory

Capital (M₿): 2

Annual Amount of Shipment: 6,000 yards/d

Total Area (m²): 19,200

Total No. of Employees: 100 (Peak 170)

Main Products: Dyeing of Cloth

(2.) Present Situation of the Use of Industrial Water

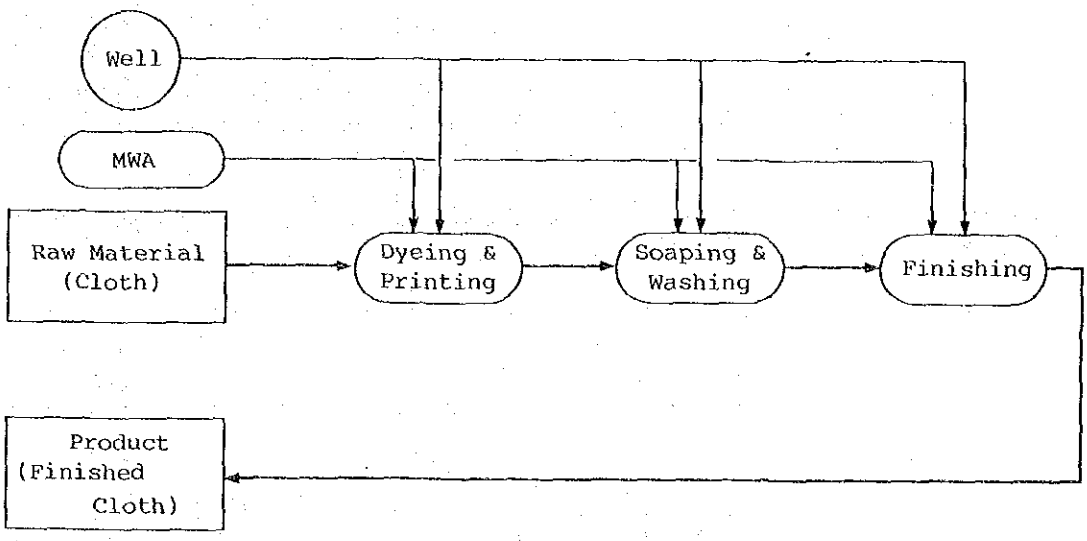
(2.1) Water Consumption

Unit: m³/d

Use \ Source	Well Water	MWA	Others	Sub Total	Recover-ed Water	Total
Boiler		32		32		32
Material						
Processing & Washing	99	6		105		105
Cooling	14			14		14
Air Conditioning						
Others		15		15		15
Sub Total	113	53		166		166
Outside						
Total	113	53		166		166

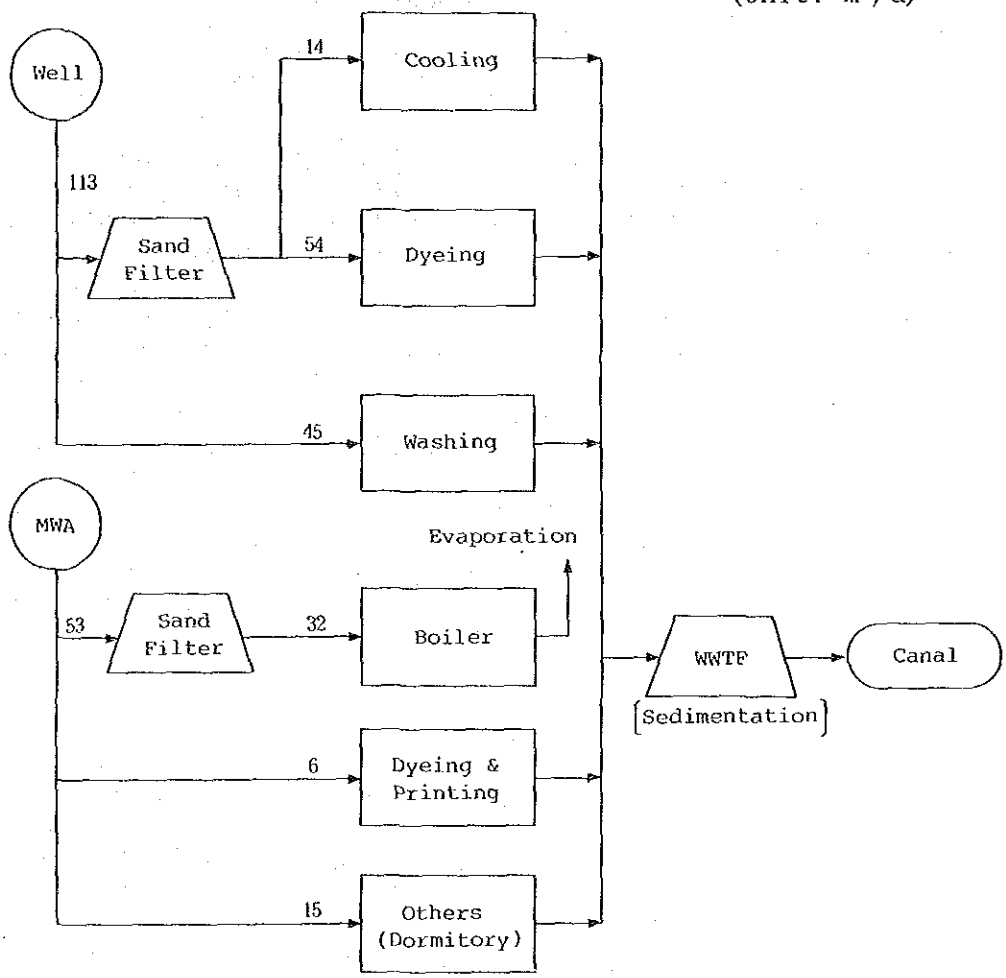
Recovery Rate (%): 0.0

(2.2) Process Diagram of Production Line



(2.3) Flow Diagram of Water Supply and Waste Water Discharge

(Unit: m^3/d)



Legend: WWTF = Waste Water Treatment Facility

(2.4) Explanation of Present Situation

(2.4.1) Sources and Uses

Well water and MWA water is used in this factory. The consumption of well water and MWA water is 113 m^3/d and 53 m^3/d respectively, thus the total quantity is 166 m^3/d.

The well is situated in the central area of the factory. It is 60 m deep, and has no flow meter.

Since the total hardness of well water is rather high (500 mg/lit, according to the factory's explanation), the factory has decided to change well water to MWA water (total hardness is 116 mg/lit) for dyeing and printing department As a matter of fact, however, well water is still partly used.

While well water is used for processing, MWA water is used for the boiler and the employees' dormitory as well as for a certain part of processing.

The water consumption in the employees' dormitory is 15 m^3/d, which is not a large quantity considering the fact that it accommodates 90 persons.

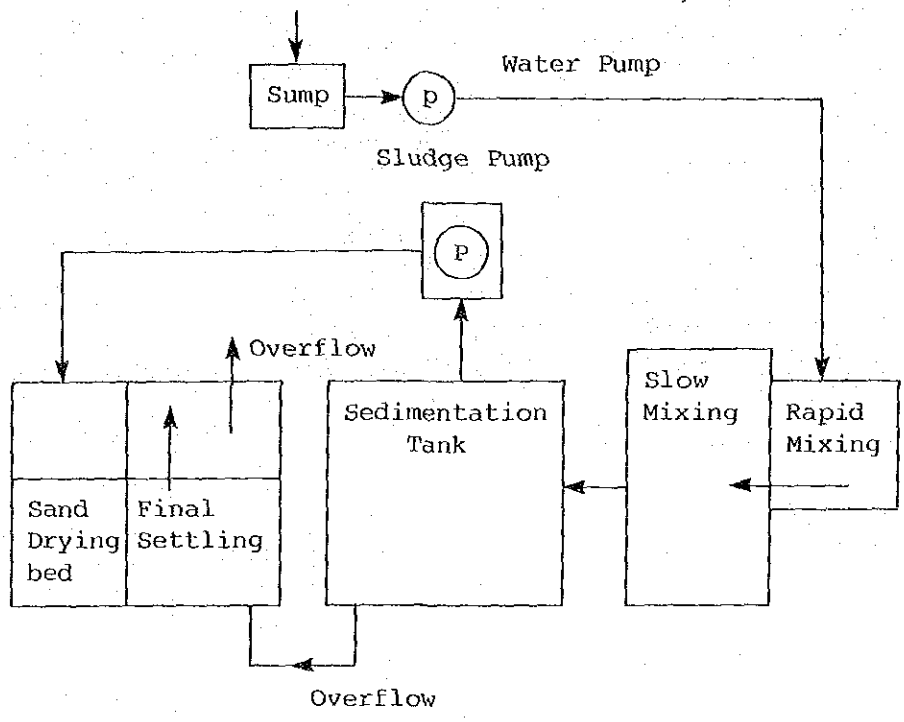
(2.4.2) Water Treatment

The quality of well water of this factory is 1,786 μS/cm of electrical conductivity and 19 mg/lit of turbidity. Water for dyeing, printing and cooling are supplied through sand filter, but no treatment is applied for the washing process.

The quality of water supplied from MWA is 750 μS/cm of electrical conductivity and 116 mg/lit of total hardness. MWA water is fed to the boiler after being treated by sand filter, whereas no treatment is applied for other uses (i.e. for processing and the dormitory).

(2. 4. 3) Waste Water Treatment

Waste water treatment facility of this factory is as follows.



(3.) Plans of Effective Use of Industrial Water

(3. 1) General

Since most of the batchwise dyeing machines of this factory are of water saving jet type, there seems to be little room for further improvement on process water.

To use the effluent of cooling water for washing through cascade system is desirable, but it is difficult to realize this because of the differences in operating positions and times.

At present, no steam condensate is recovered. From the viewpoint of the effective use of heat, too, some measures should be taken to recover it.

(3. 2) Details

a. Recovery of steam condensate

A steam condensate recovery system should be installed.

The target recovery rate of steam would be 20% which is equivalent of 6 m^3/d of water saving.

(4.) Cost Estimation

Number	1
Method for Effective Use Method Item	 Recycle use Recovery of steam condensate
Water Saving Use Quantity (m^3/d)	 Boiler 6
Apparatus for Effective Use Apparatus Cost (10^3฿)	 Drain trap, strainer & piping 71
Unit Cost (฿/m^3) Fixed Operating Total	 5.0 - 5.0

5.3.3 Code No. of Factory: T-03

(1.) Outline of Factory

Capital (M¥): -

Annual Amount of Shipment: 2,200 - 2,400 t/Y

Total Area (m^2): 6,400

Total No. of Employees: 180

Main Products: Bleaching and Dyeing of Cloth

(2.) Present Situation of the Use of Industrial Water

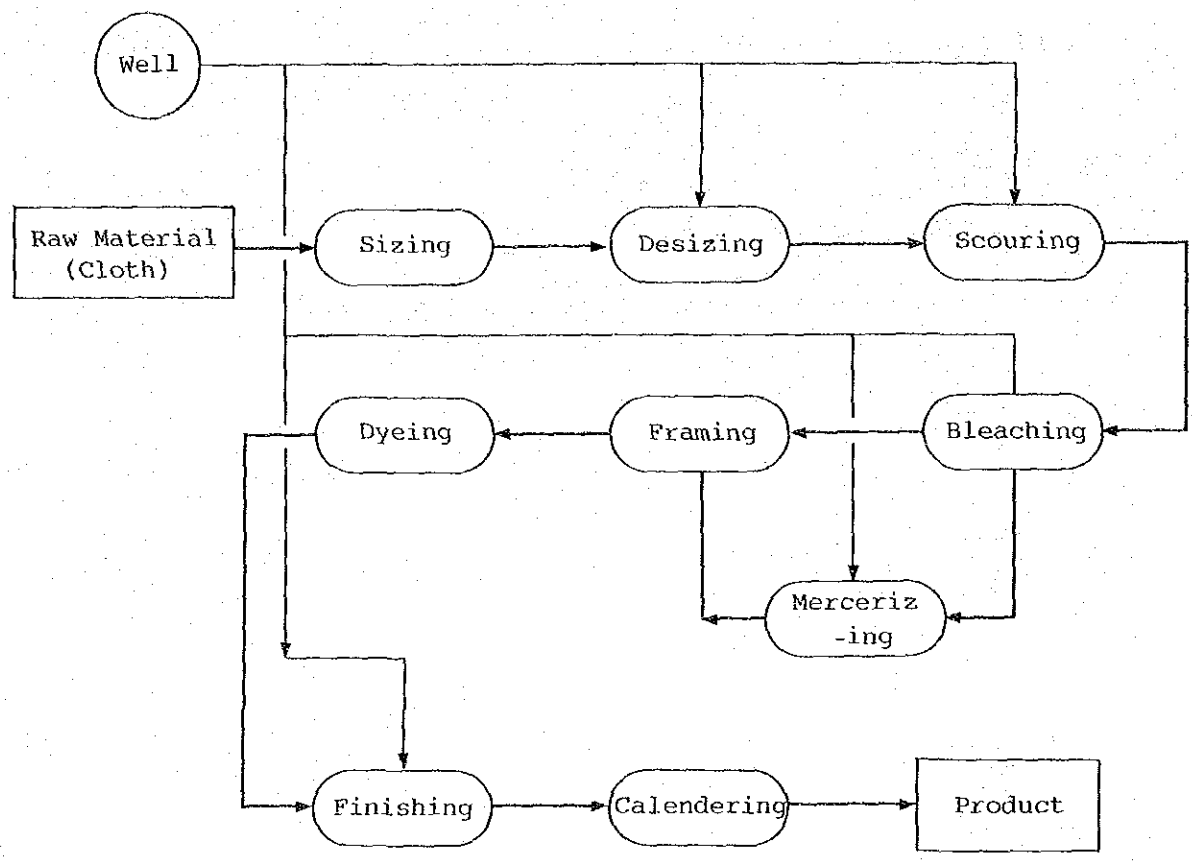
(2.1) Water Consumption

Unit: m^3/d

Use \ Source	Well Water	MWA	Others	Sub Total	Recover-ed Water	Total
Boiler	50			50	40	90
Material						
Processing & Washing	1,460			1,460		1,460
Cooling	150			150		150
Air Conditioning						
Others	205			205		205
Sub Total	1,865			1,865	40	1,905
Outside	20			20		20
Total	1,885			1,885	40	1,925

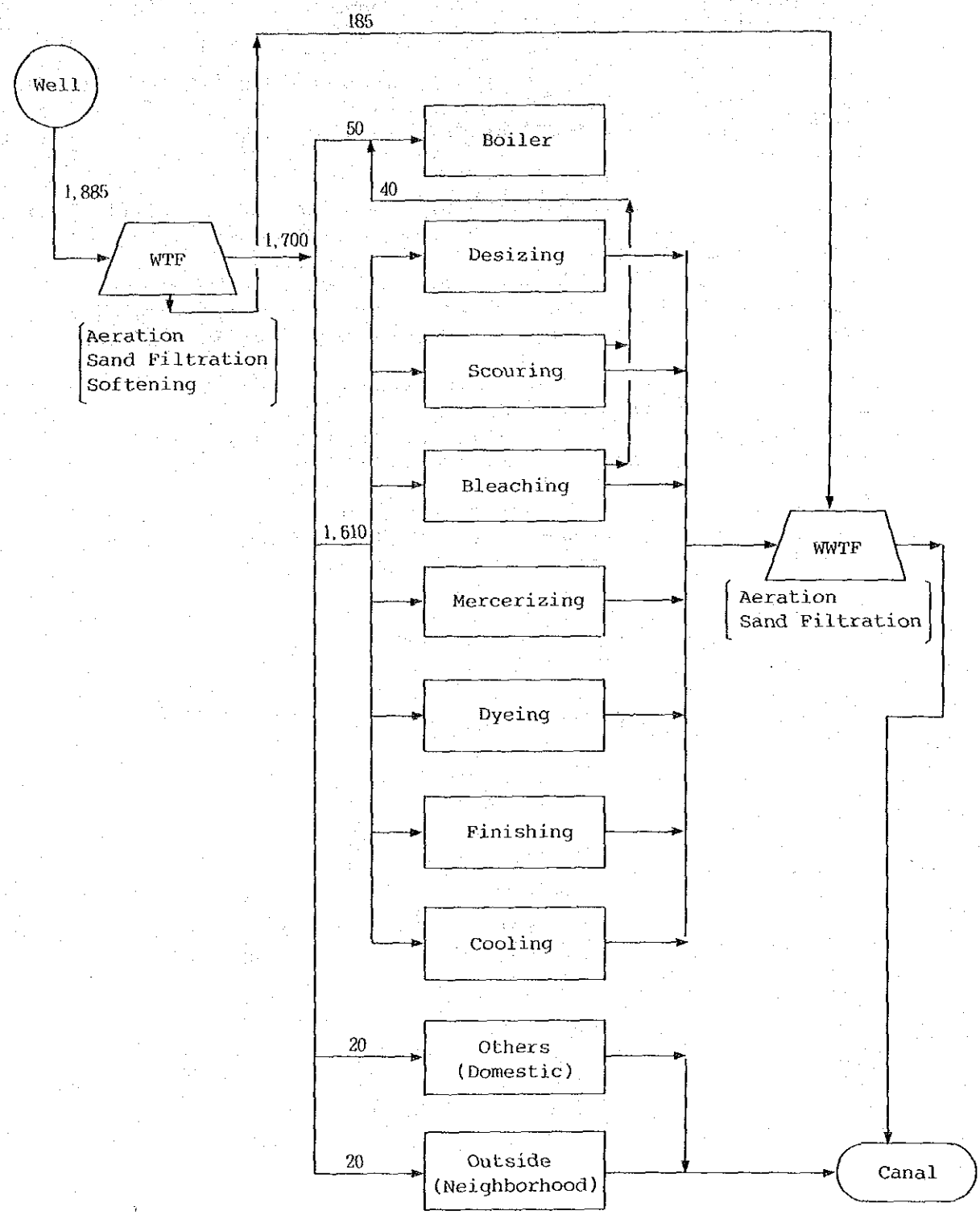
Recovery Rate (%): 2.1

(2.2) Process Diagram of Production Line



(2.3) Flow Diagram of Water Supply and Waste Water Discharge

(Unit: m³/d)



Legend: WTF = Water Treatment Facility
WWTF = Waste Water Treatment Facility

(2.4) Explanation of Present Situation

(2.4.1) Sources and Uses

Water used in this factory is all pumped up from four wells. Well water is softened before being used.

For the boiler, recovered water (steam condensate and cooling water used for the dyeing machine) is utilized. In case recovered water is not sufficient, softened make-up water is also supplied.

Owing to the extension work of the factory facilities, the pipings are now so complicated that it is impossible to know the water consumption for each production process.

Through water hoses provided at various places in the factory, softened water is used for the washing of floor and machine.

The water/production ratio of this factory is between 240 and 270 m^3/t. The quality of well water is 1,900 $\mu S/cm$ of electrical conductivity, 280 mg/lit of total hardness and 400 mg/lit of chloride ion, which indicates the water quality is not good.

The dyeing machines are made of stainless steel, and some of them are operated at the temperature of 130°C. Thus they are subject to stress corrosion cracking due to chloride ion.

The factory supplies some water (20 m^3/d) to neighboring houses.

(2.4.2) Water Treatment

The wells have no flow meters.

Well pumps are operated automatically by the signal from the level switch in the water storage tank.

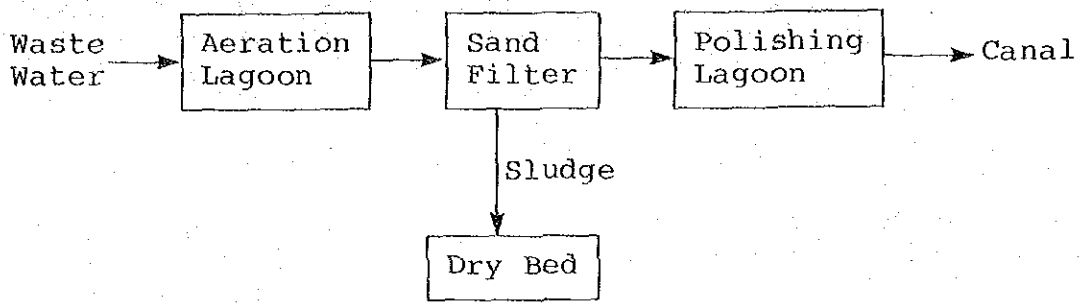
As stated above, the quality of water is poor. In addition, iron is contained in it.

At first, pumped up water is sent to the storage tank through a simple splash-bar-type aerator. Then the water goes through a pressure-type sand filter.

Finally the filtrated water is treated by softeners. This factory has four sets of softeners, three of which are usually in operation. The softened water is directly sent to the process.

(2.4.3) Waste Water Treatment

The waste water treatment facility of this factory is as follows.



All waste water goes through the above system. Waste water for regeneration from the sand filter or softeners should be sent to the polishing lagoon.

The high temperature waste water coming from the dyeing process raises the temperature of the aeration lagoon (38 °C), and hence reduces the effect of biological treatment. There seems to be necessary to install the primary cooling system for keeping the waste water treatment facility effective.

(3.) Plans of Effective Use of Industrial Water

(3.1) General

To establish effective measures for water saving, it is necessary to know the quantity of water used for each production process.

At present, softened water is used for washing the floor and machine. For washing, however, softened water may be substituted by sand filtrated water.

If the pipings are rearranged and the requirements of water quality are made clear, the consumption of softened water will be reduced by using sand filtrated water for production processes (e.g. desizing process), for which low quality water is usable. The saving of softened water will lead not only the cut down of treatment cost but also the saving of water for regeneration.

The factory is planning to improve the recovery system of cooling water and the re-use of cooling water for the boiler. The plan should be implemented promptly.

To minimize the loss of water (e.g. to prevent wasteful outflow of water from hoses), it is necessary to make every employee conscious of the importance of water saving.

(3.2) Details

a. Cascade use of cooling water for boiler

By installing a recovery tank, cooling water for high temperature jet dyeing machine could be re-used for the boiler through a cascade system. Quantity of water saving would be approximately 50 m^3/d.

b. Installation of hand control valve for washing water

No hand control valve is provided at present where water is used for washing of equipment and floor. Therefore, hand control valve should be installed. On an assumption that 150 m^3/d of water (10% of the total washing water) is used for washing of equipment and floor, 30 m^3/d of water (around 20%) would be saved.

c. Thorough control of water consumption

Flow meters should be installed in order to control the water consumption for each production process.

In order to save the consumption of softened water, pipings should be installed to supply sand filtrated water for certain uses (for example, the washing of machine and floor).

By taking above-mentioned measures, around 10% of the present quantity of washing water or 140 m^3/d would be saved.

(4.) Cost Estimation

#	Method for Effective Use		Water Saving Apparatus for Effective Use				Unit Cost (฿/m³)		
	Method	Item	Use*	Qt.** (m³/d)	Apparatus	Cost (10^3฿)	Fixed	Operating	Total
1	Application of cascade use	Cascade use of cooling water for boiler feed water	B	50	Hot water tank 30 m³ x 1 & piping	361	3.1	-	3.1
2	Application of water saving apparatus	Use of hand control valve for washing water	PW	30	Hand control valve 12 mm x 20 units	20	0.6	-	0.6
3	Control of water use	Thorough control of water use in each process	PW	140	Flow meter & piping	320	1.0	-	1.0
	Total			220		701			1.4

Note: Use* -- B = Boiler; PW = Processing & Washing
Qt.** = Quantity

5.3.4 Code No. of Factory: T-04

(1.) Outline of Factory

Capital (M$): 1

Annual Amount of Shipment (M$): 3

Total Area (m^2): 3,200

Total No. of Employees: 50

Main Products: Printing and Dyeing of Cloth

(2.) Present Situation of the Use of Industrial Water

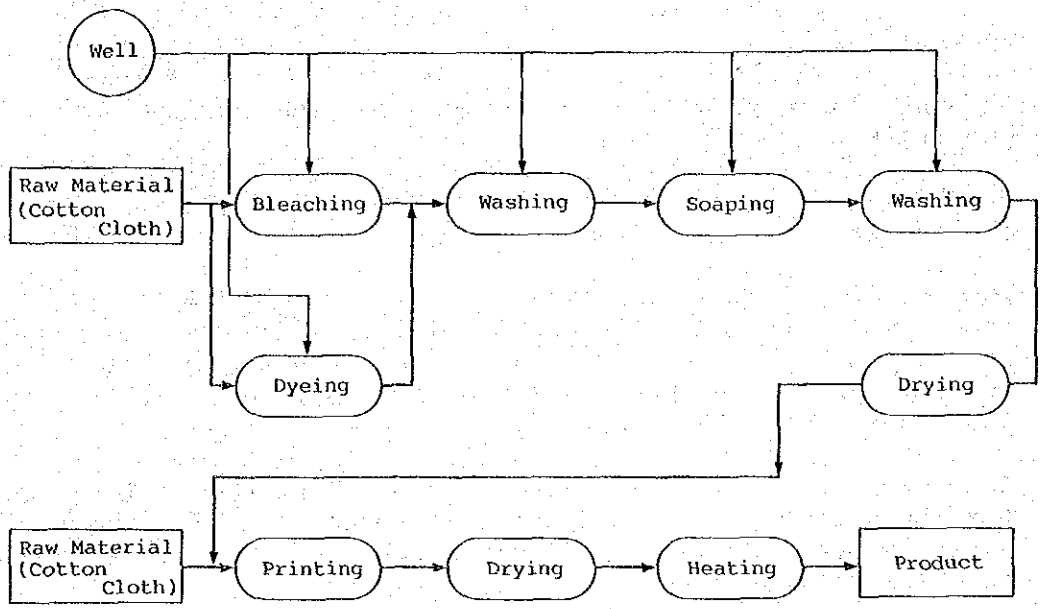
(2.1) Water Consumption

Unit: m^3/d

Use \ Source	Well Water	MWA	Others	Sub Total	Recover-ed Wate	Total
Boiler	5			5		5
Material						
Processing & Washing	15.5			15.5		15.5
Cooling						
Air Conditioning						
Others	4.5	1		5.5		5.5
Sub Total	25	1		26		26
Outside						
Total	25	1		26		26

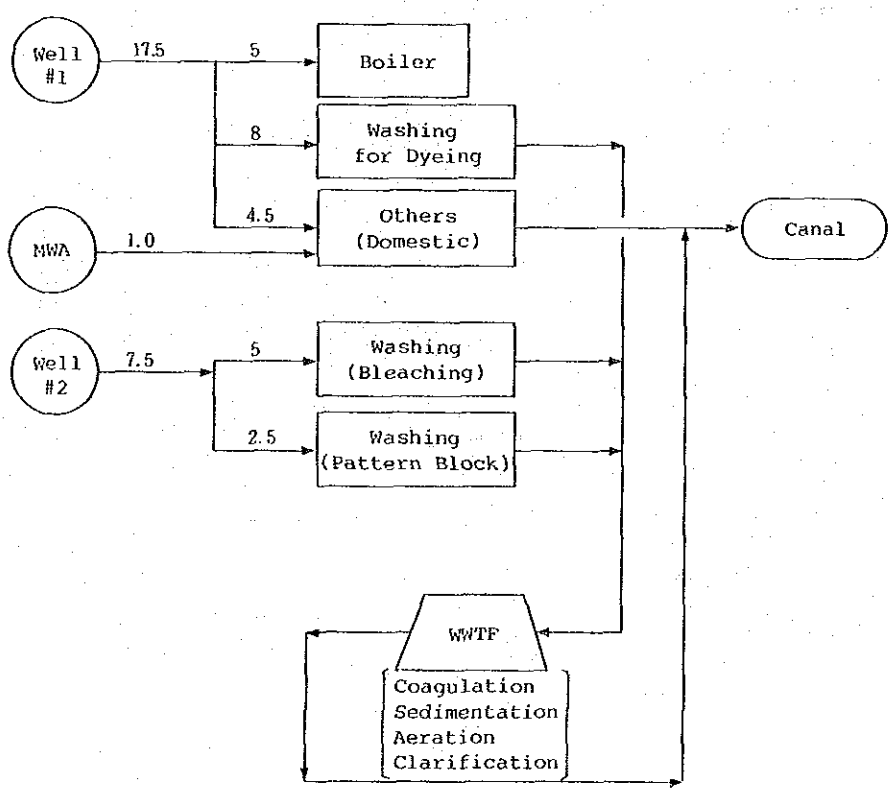
Recovery Rate (%): 0.0

(2. 2) Process Diagram of Production Line



(2. 3) Flow Diagram of Water Supply and Waste Water Discharge

(Unit: m^3/d)



Legend: WWTF = Waste Water Treatment Facility

(2.4) Explanation of Present Situation

(2.4.1) Sources and Uses

In this factory, well water is used for the production process. Currently two wells are in operation.

Drinking water of 20 m^3 per month is supplied from MWA by a mobile tank.

The quality of No.1 well water is 1,925 μS/cm of electrical conductivity and 2 mg/lit of turbidity, while the corresponding values for the No.2 well water are 3,650 μS/cm and 4 mg/lit respectively. Thus the quality of the No.1 well water is better than that of the No.2 well water.

Accordingly, the No.1 well water is used for the boiler, washing for the dyeing process and domestic purposes, while the No.2 well water is used for washing of pattern blocks as well as washing of the bleaching process.

Since no flow meter is installed, the water consumption data for each use is based on the factory's estimate.

In the Table (2.1) above, "others" includes the water used for the employees' dormitory (for 70 persons) in the factory. This water amounts to 64 lit/capita/d.

(2.4.2) Water Treatment

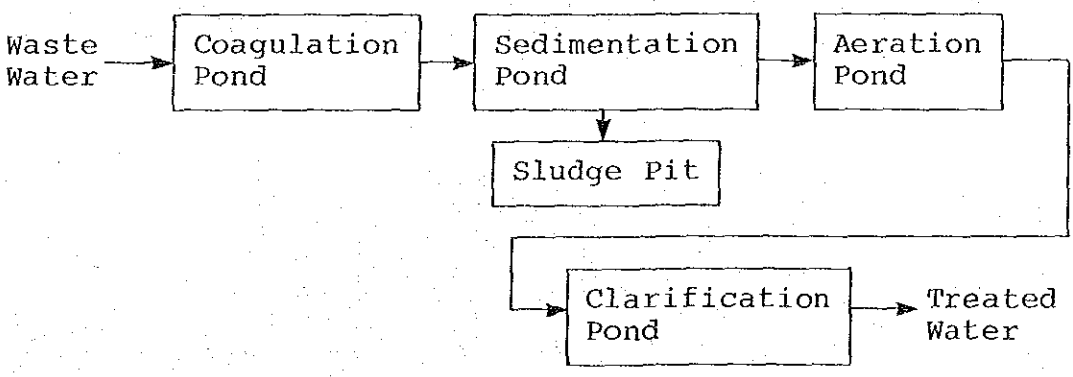
Well water is used without any treatment.

No water softener is provided for the boiler.

Washing water is pumped up from the concrete pit. The well water supply to the pit through the pipe is automatically controlled by a ball tap.

(2.4.3) Waste Water Treatment

The waste water treatment facility of this factory is as follows.



Because of the improper operation of coagulation and sedimentation, some flocks flow out into treated water.

Improvement for waste water treatment is necessary in respect of operating method, sorting out of inflow water and the like.

(3.) Plans of Effective Use of Industrial Water

(3.1) General

Since the total quantity of water consumption is very small, there is little room for further improvement of effective use.

5.3.5 Code No. of Factory: T-05

(1.) Outline of Factory

Capital (M$): -

Annual Amount of Shipment (M$): -

Total Area (m^2): 12,800

Total No. of Employees: 76

Main Products: Knitwear and Cloth

(2.) Present Situation of the Use of Industrial Water

(2.1) Water Consumption

Unit: m^3/d

Use \ Source	Well Water	MWA	Others	Sub Total	Recover-ed Water	Total
Boiler						
Material						
Processing & Washing	Assume 155					
Cooling						
Air Conditioning						
Others	Assume 25					
Sub Total	180					
Outside						
Total	Plan 180			180	Unknown	

Recovery Rate (%): -

(2.2) Process Diagram of Production Line

As this plant is under test operation, it is impossible to study this item, as well as (2.3), (2.4), (3.) and (4.).

5.3.6 Code No. of Factory: T-06

(1.) Outline of Factory

Capital (M₿): -

Annual Amount of Shipment (M₿): -

Total Area (m²): 6,400

Total No. of Employees: 76

Main Products: Bleaching and Dyeing of Cloth

(2.) Present Situation of the Use of Industrial Water

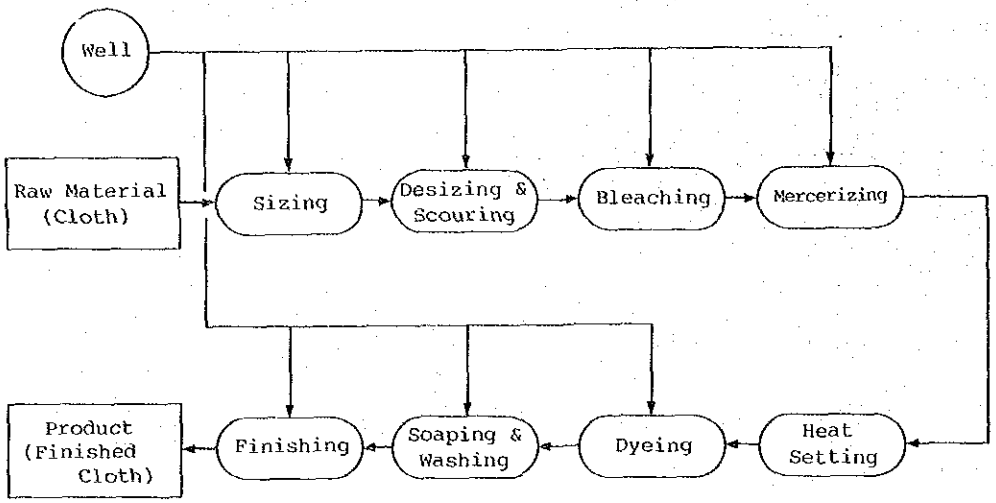
(2.1) Water Consumption

Unit: m³/d

Source / Use	Well Water	MWA	Others	Sub Total	Recover-ed Water	Total
Boiler	62			62		62
Material						
Processing & Washing	353			353		353
Cooling						
Air Conditioning						
Others	27			27		27
Sub Total	442			442		442
Outside						
Total	442			442		442

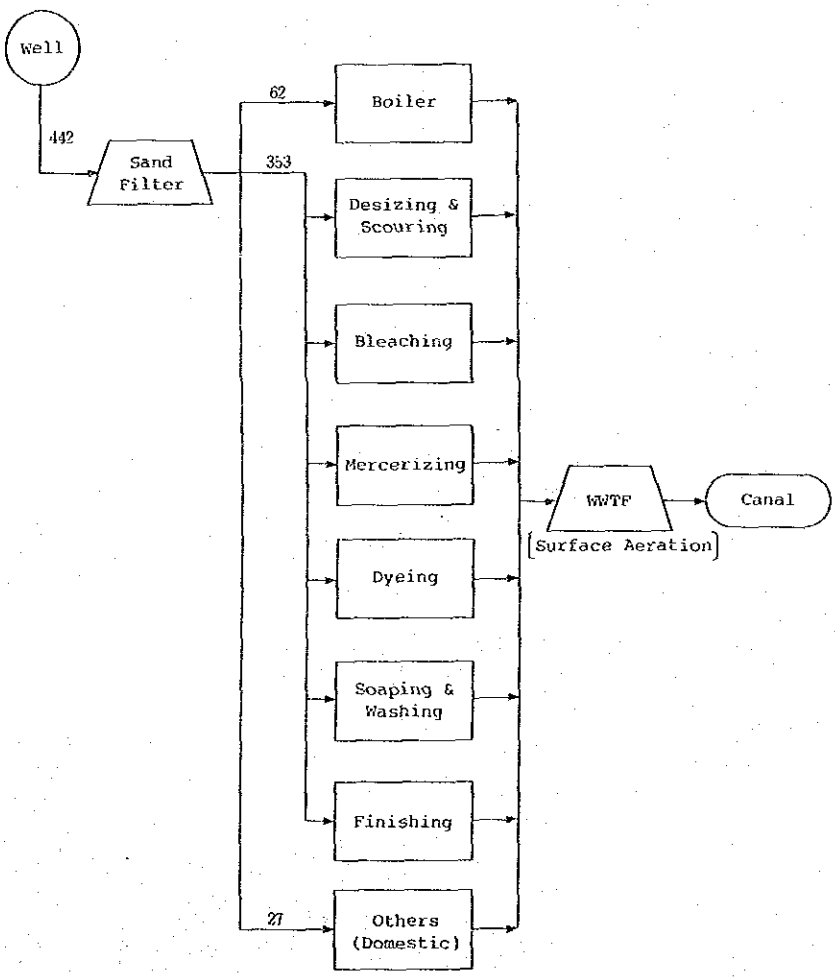
Recovery Rate (%): 0.0

(2.2) Process Diagram of Production Line



(2.3) Flow Diagram of Water Supply and Waste Water Discharge

(Unit: m^3/d)



Legend: WWTF = Waste Water Treatment Facility

(2.4) Explanation of Present Situation

(2.4.1) Sources and Uses

In this factory, two shallow wells (80 m deep) are the only source of water. Each well pump has the capacity of 15 m^3/min, its operation (on/off) being controlled in accordance with the water level of the buffer tank.

Well water is mainly used for the dyeing process (353 m^3/d). Beside that, 62 m^3/d and 27 m^3/d of water is used for the boiler and the domestic purposes respectively. The total water consumption amounts to 442 m^3/d.

At many places of the dyeing and bleaching processes, hand control valves are used. According to the explanation of factory's member, the water holdup in the processing apparatus is wholly replaced with new one in two hours.

(2.4.2) Water Treatment

The quality of well water is 1,824 μS/cm of electrical conductivity and 12 mg/lit of turbidity. Well water is treated by sand filter before being used.

(2.4.3) Waste Water Treatment

Waste water is treated by a surface aeration system before being discharged into a canal.

(3.) Plans of Effective Use of Industrial Water

(3.1) General

In this factory, little control is carried out in using water or disposing waste water.

Owing to the frequent extension work, the pipings are now so complicated that it is difficult to know the water consumption for each production process.

For the bleaching process, water is used effectively by adopting the continuous counter-current washing system.

This factory uses two different types (old and new) of dyeing machines. The consumption of water for each type of dyeing machine is shown on the next page.

Type	Number (installed)	Number (in operation)	Average consumption of water (m^3/unit/d)
Old	15	6	23.4
New	24	8	20.7

By further replacing old type machines with new ones, the consumption of water would be improved.

(3.2) Details

a. Thorough control of water consumption

By controlling the use of water more carefully, the present consumption of washing water (353 m^3/d) could be reduced by 10 to 20% or about 40 m^3/d of water could be saved.

Since these kind of water saving largely depends on the awareness of employees, it is difficult to estimate the cost for water saving.

b. Use of low-liquor-ratio-type dyeing machine

The old-type dyeing machine should be gradually replaced with water saving type machine (i.e. dyeing machine whose liquor ratio is low).

(4.) Cost Estimation

Number	1
Method for Effective Use Method Item	 Control of water use Thorough control of water use
Water Saving Use Quantity (m^3/d)	 Processing & Washing 40
Apparatus for Effective Use Apparatus Cost (10^3฿)	
Unit Cost (฿/m^3) Fixed Operating Total	

5.3.7 Code No. of Factory: T-07

(1.) Outline of Factory

Capital (M$): 20

Annual Amount of Shipment (M$): 120

Total Area (m²): 4,800

Total No. of Employees: 300

Main Products: Towel

(2.) Present Situation of the Use of Industrial Water

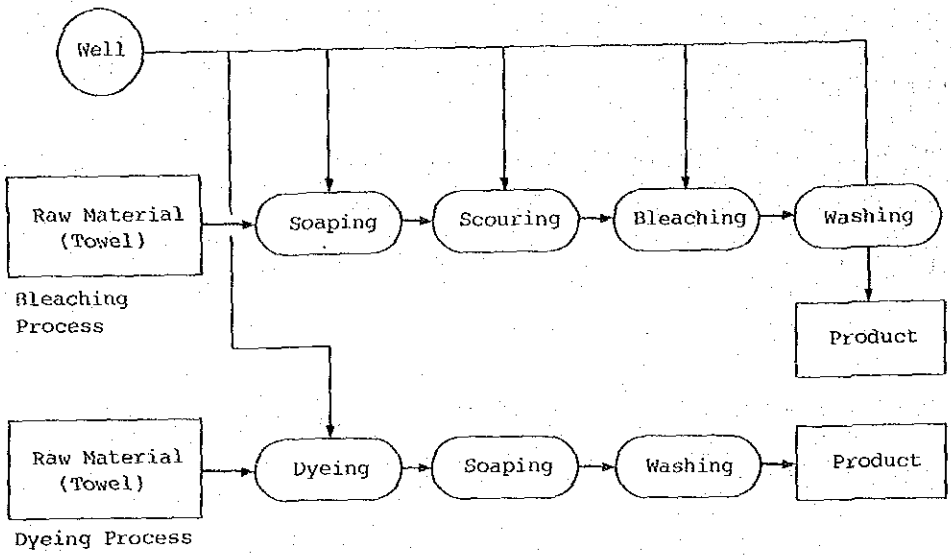
(2.1) Water Consumption

Unit: m³/d

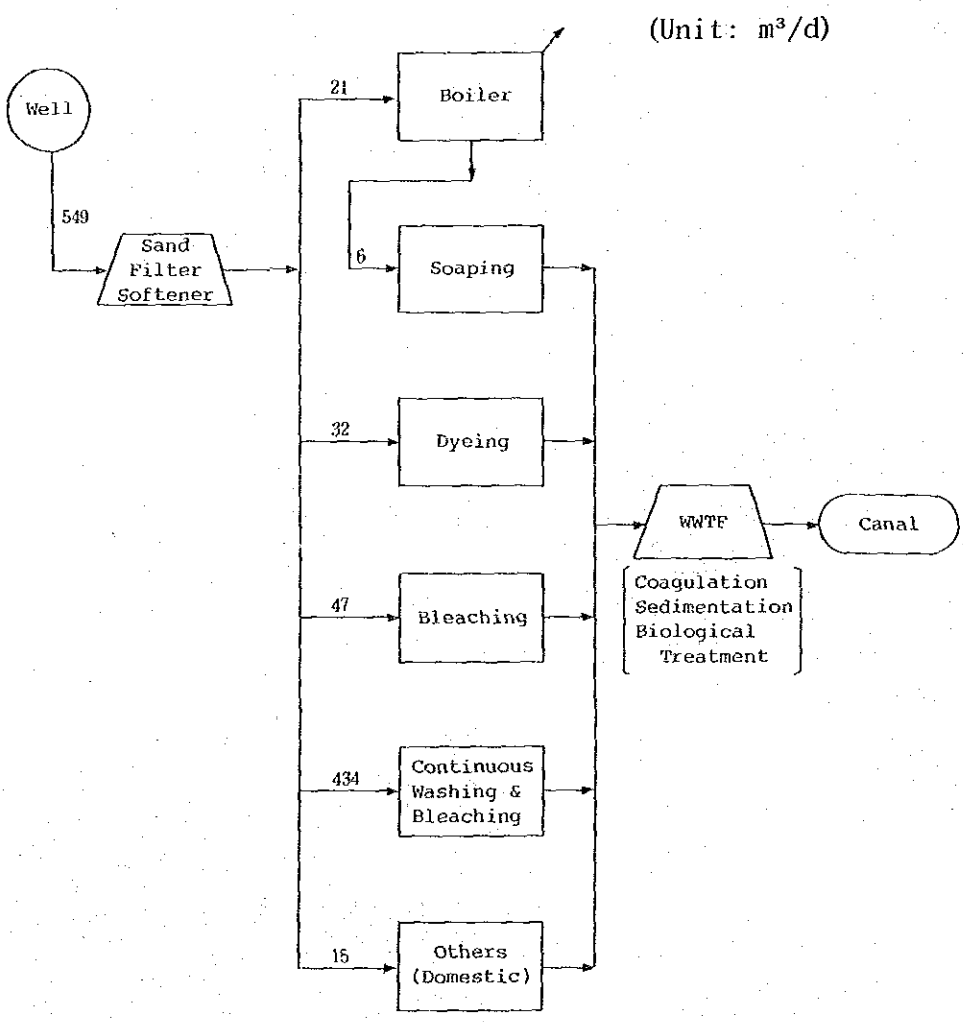
Source / Use	Well Water	MWA	Others	Sub Total	Recover-ed Water	Total
Boiler	21			21		21
Material						
Processing & Washing	513			513	6	519
Cooling						
Air Conditioning						
Others	15			15		15
Sub Total	549			549	6	555
Outside						
Total	549			549	6	555

Recovery Rate (%): 1.1

(2.2) Process Diagram of Production Line



(2.3) Flow Diagram of Water Supply and Waste Water Discharge



Legend: WWTF = Waste Water Treatment Facility

(2.4) Explanation of Present Situation

(2.4.1) Sources and Uses

This factory uses only well water. There are four shallow (60 m deep) wells at three different places of the factory. The fourth is a standby well and hence out of operation in normal times.

Since no flow meter is provided, the water consumption values in 2.1 are those estimated by the factory on the basis of the water levels of storage tanks.

Well water is mainly used for washing of towel bleaching and dyeing processes.

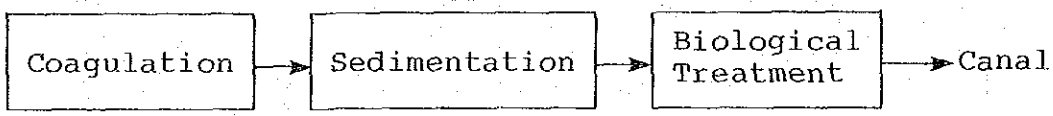
For domestic purposes, 15 m^3/d of water is used. Considering the number of employees (300), this figure is very low.

(2.4.2) Water Treatment

The quality of well water is 1,849 $\mu S/cm$ of electrical conductivity, 14 mg/lit of turbidity and 6.93 of pH. Well water is treated by sand filter and softener before being used.

(2.4.3) Waste Water Treatment

Waste water is treated and discharged into a canal as shown below.



(3.) Plans of Effective Use of Industrial Water

(3.1) General

The main use of water is the washing for bleaching and dyeing processes. The counter-current washing system is adopted for both processes, so that the use of water is already fairly effective.

Recovered steam condensate is used through a cascade system.

There is little room for the improvement in the effective use of water.

5.4 Metal Industry

5.4.1 Code No. of Factory: M-01

(1.) Outline of Factory

Capital (M$): 500

Annual Amount of Shipment (M$): 544.5

Total Area (m^2): 45,108

Total No. of Employees: 507

Main Products: Electric Fan, TV, Refrigerator and Motor

(2.) Present Situation of the Use of Industrial Water

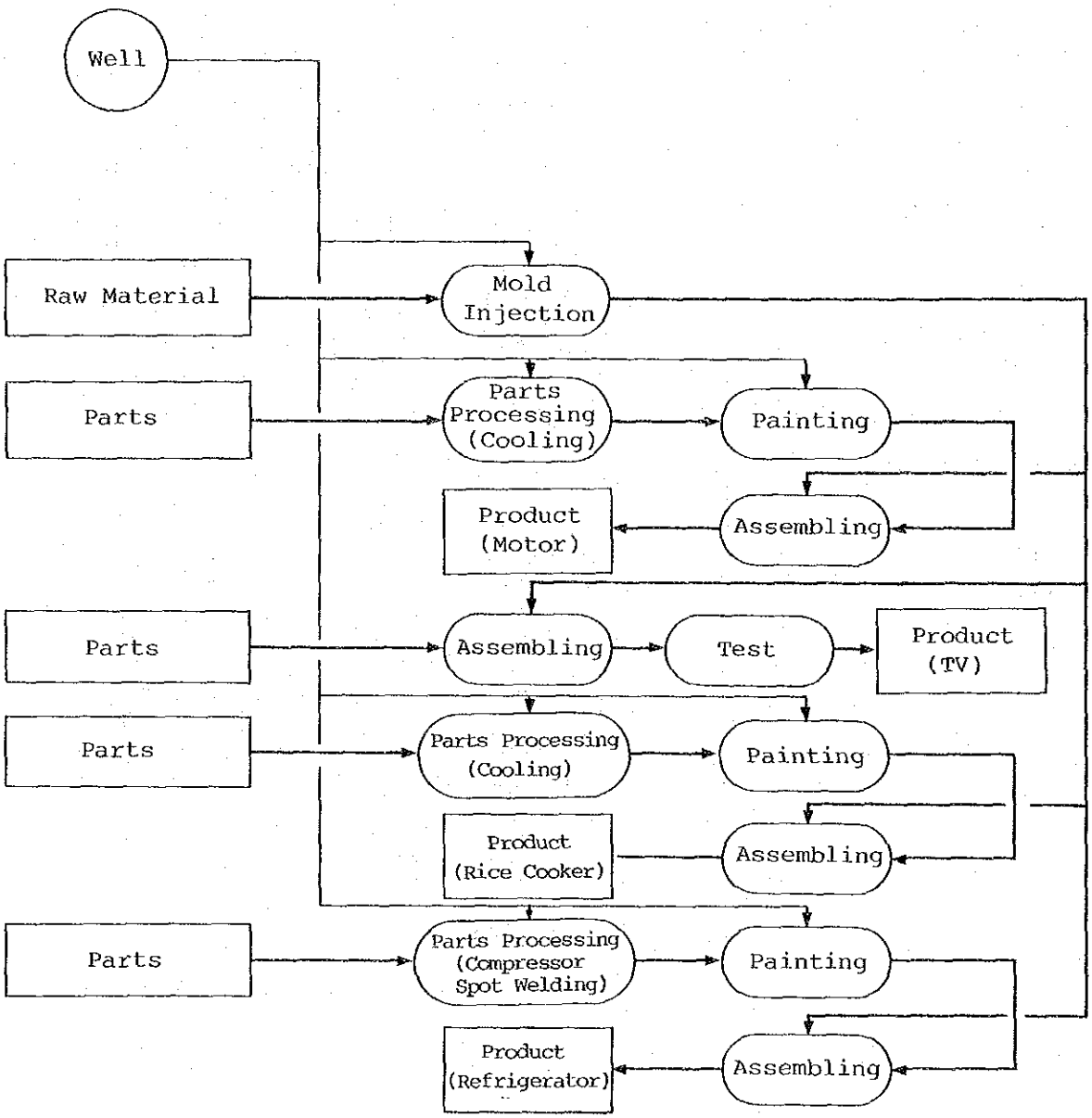
(2.1) Water Consumption

Unit: m^3/d

Use \ Source	Well Water	MWA	Others	Sub Total	Recover-ed Water	Total
Boiler						
Material						
Processing & Washing	245			245		245
Cooling	189			189	227	416
Air Conditioning						
Others	69			69		69
Sub Total	503			503	227	730
Outside						
Total	503			503	227	730

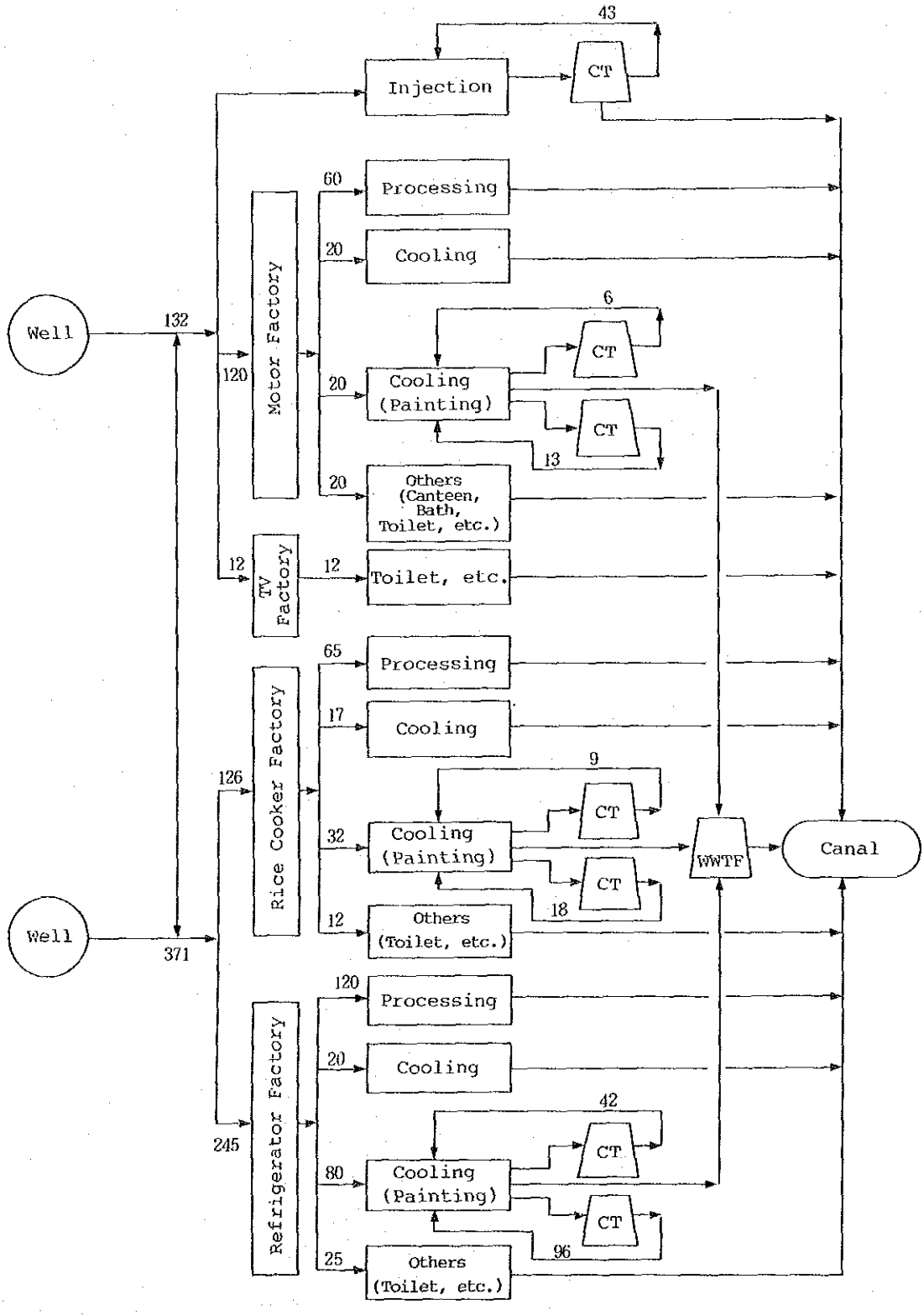
Recovery Rate (%): 31.1

(2. 2) Process Diagram of Production Line



(2.3) Flow Diagram of Water Supply and Waste Water Discharge

(Unit: m³/d)



(2.4) Explanation of Present Situation

(2.4.1) Sources and Uses

This factory is supplied by three wells in the premises. These wells supply water to three zones specifically allotted to each of them. They are interconnected with pipelines so that they could complement each other.

The depth of the wells range from 80 m to 100 m. Well water is pumped up and stored in the head tanks, and then supplied in the factory for various uses without any treatment. Each well is provided with a flow meter.

Well water is mostly used for washing, cooling and domestic purposes. The washing of metal is carried out through three stages (washing in two tanks equipped with heaters, chemical washing and finally water washing).

Product is washed with demineralized water in finishing stage. Discharged washing water is sent to a waste water treatment facility. All cooling water is recycled through a cooling tower.

Water for the painting process is supplied through a spray system.

The quantity of recycled water through the cooling tower is estimated on the basis of capacity of recycling pumps.

Per capita consumption of water for domestic use (drinking, hand washing and others) is calculated as 136 lit/capita/d, and this figure seems to be acceptable.

At the time of visiting survey, the refrigerator manufacturing plant of this factory was under extensional construction. Upon the completion of the extension work, the water consumption is likely to increase. However, it was not confirmed whether an additional well is to be dug. The quantity of water required for the construction itself seems to be small.

(2.4.2) Water Treatment

Well water is used without any treatment.

Demineralized water is used for washing at refrigerator plant and it is recycled.

(2.4.3) Waste Water Treatment

Waste water from the painting process is treated by various steps (sedimentation --> coagulation/-sedimentation --> gravity-type sand filtration) before being discharged into a nearby drainage canal.

(3.) Plans of Effective Use of Industrial Water

(3.1) General

Although cooling water is recycled through the cooling tower, the percentage (45%) of make-up water is too high. Make-up water would be fairly reduced if operation control of cooling tower is conducted properly.

By using simple treatment process such as sedimentation, coagulation and sand filtration, discharged washing water may be reclaimed for further use.

(3.2) Details

a. Raising of degree of concentration through improvement of operation control of cooling tower

If the ratio of make-up water to the total cooling water is decreased from the present 1:2.3 to 1:10, the quantity of make-up water would be 41 m^3/d. Thus, 139 m^3/d of water would be saved.

(4.) Cost Estimation

Number	1
Method for Effective Use Method Item	 Improvement of operation control Improvement of operation and maintenance of cooling tower to raise degree of concentration
Water Saving Use Quantity (m^3/d)	 Cooling 139
Apparatus for Effective Use Apparatus Cost (10^3฿)	
Unit Cost (฿/m^3) Fixed Operating Total	 0.5 0.5

5.4.2 Code No. of Factory: M-02

(1.) Outline of Factory

Capital (M₿): 30

Annual Amount of Shipment (M₿): 1,200

Total Area (m²): 9,600

Total No. of Employees: 684

Main Products: Steel Bar, Galvanized Sheet and Steel Fabricate

(2.) Present Situation of the Use of Industrial Water

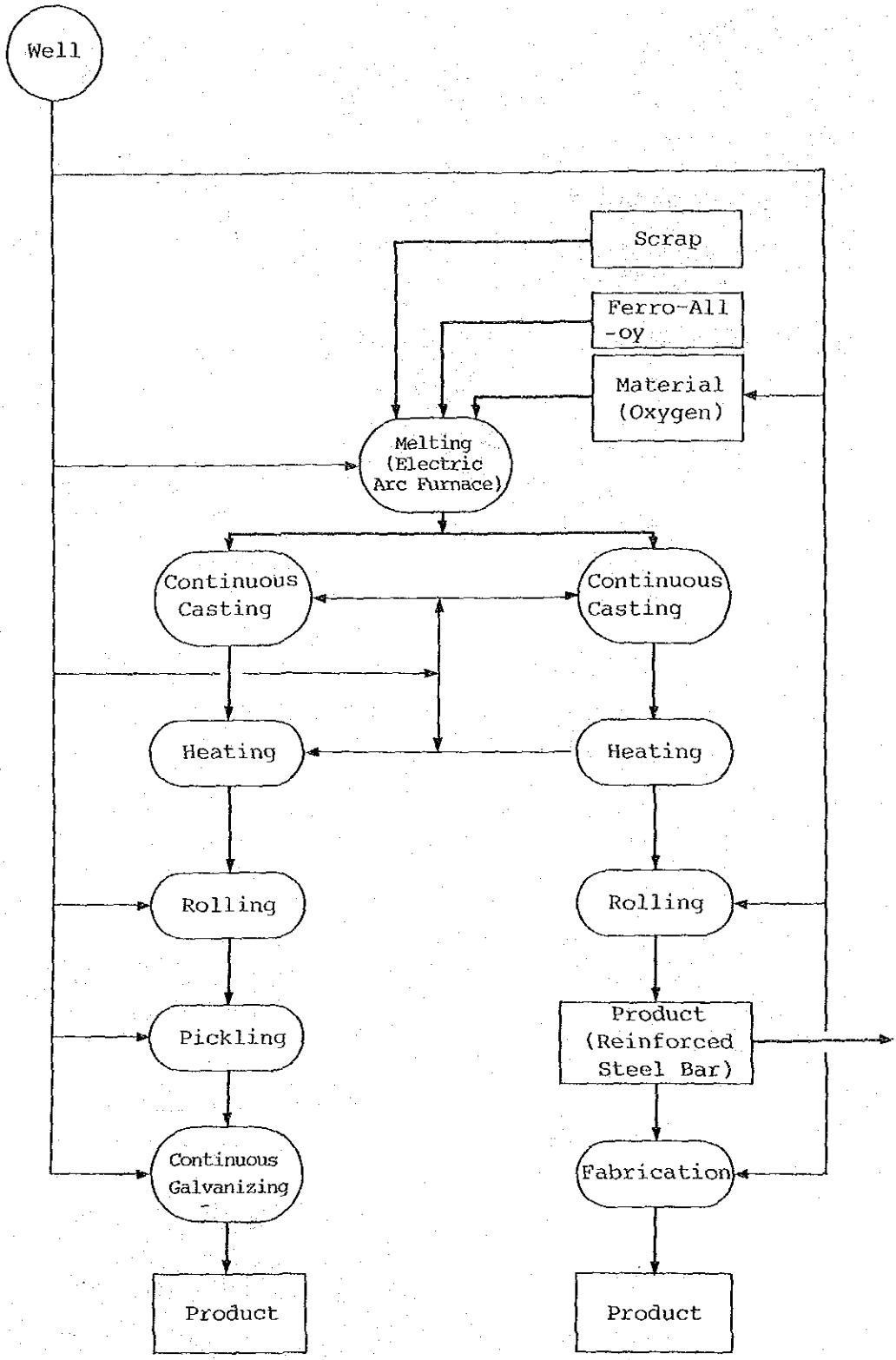
(2.1) Water Consumption

Unit: m³/d

Source / Use	Well Water	MWA	Others	Sub Total	Recover-ed Water	Total
Boiler	51			51	50	101
Material						
Processing & Washing	70			70		70
Cooling	290			290	320	610
Air Conditioning						
Others	30			30		30
Sub Total	441			441	370	811
Outside	750			750		750
Total	1,191			1,191	370	1,561

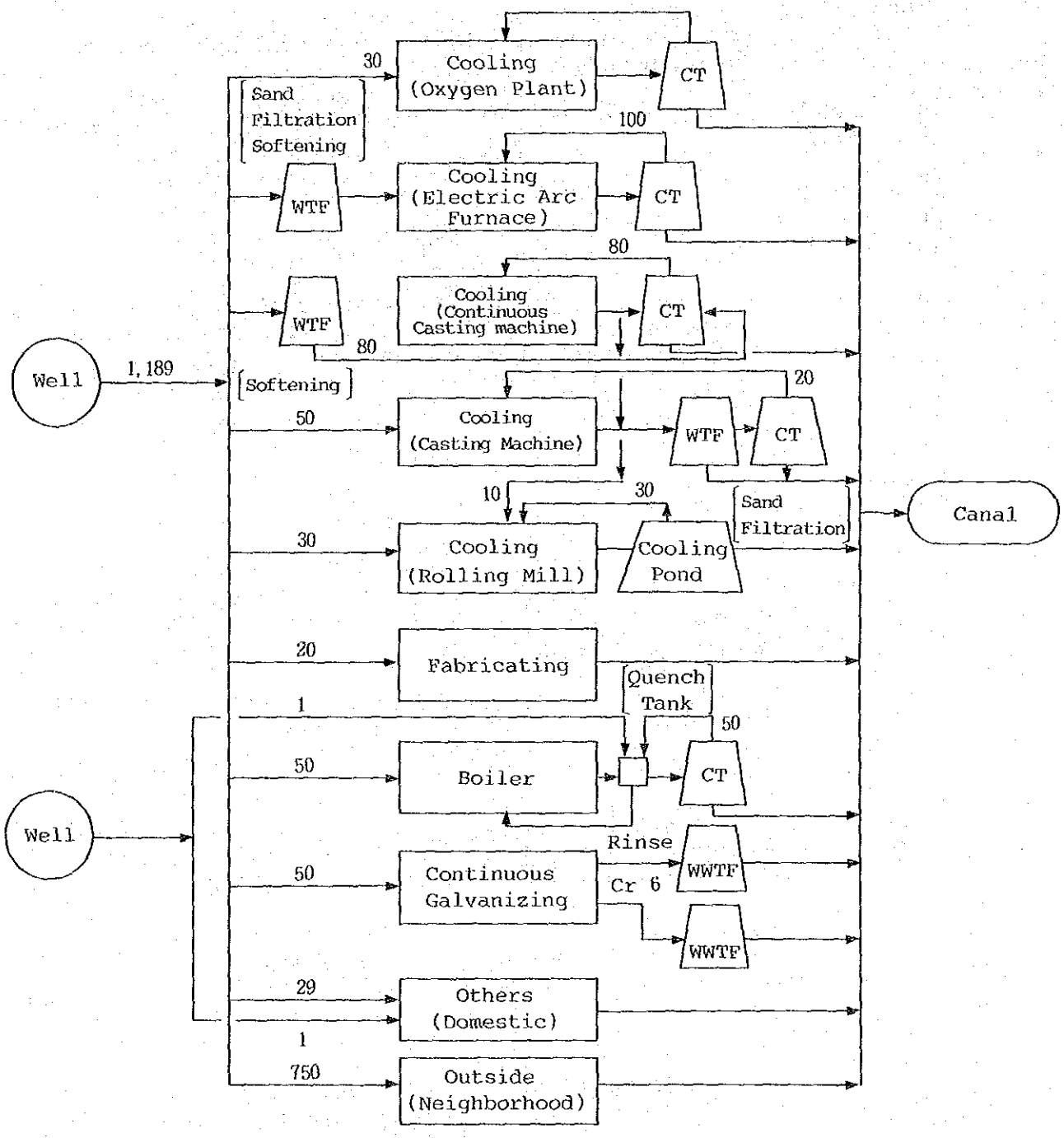
Recovery Rate (%): 45.6

(2.2) Process Diagram of Production Line



(2. 3) Flow Diagram of Water Supply and Waste Water Discharge

(Unit: m^3/d)



Legend: WTF = Water Treatment Facility
WWTF = Waste Water Treatment Facility
CT = Cooling Tower

(2.4) Explanation of Present Situation

(2.4.1) Sources and Uses

There are two wells (No. 1 of 120 m deep and No. 2 of 90 m deep). Since its water quality is poor, No. 1 well is dealt with as a reserved one now, and instead of this, newly developed No. 2 well solely meets the requirement.

As shown below, the water quality of the No.2 well is not very good, either.

Total hardness: 200 - 300 mg/lit
Chloride ion: 200 - 400 mg/lit
Electrical conductivity: 1,680 - 2,000 μS/cm.

Water for the electric furnace and the continuous casting machine is treated by softener. The quality of softened water is shown below. Compared with the average level of softened water quality in Japan, the value still remains on unsatisfactory level.

Total hardness: 150 - 250 mg/lit
Chloride ion: 200 mg/lit
Electrical conductivity: 1,300 - 1,500 μ/cm

Softened water is used as make-up water for the cooling tower. Yet, the quality of softened water is not good enough, and hence troubles (for instance, clogging of tower packing, corrosion of fans, etc.) may happen.

Also, the use of softened water for the continuous casting machine may lower the cooling efficiency through the formation of scales, and necessitate the frequent replacement of mold, thus reducing the overall production efficiency.

The above-mentioned problems in using softened water, though not directly connected with water saving, are so serious for the production efficiency that some measures should be taken.

In the Japanese steel industry, it is a common practice for a manufacturer to establish its own standards of the water quality. The Table M-02 below is an example of such standards.

This factory uses a large counter-flow-type cooling tower. Being installed inside the factory building, it operates very close to scrap braking and slag cooling. In consequence, hot steam, dust and vibration decrease the cooling capacity greatly.

Moreover, the louver of the cooling tower is destroyed and completely out of operation, which makes the cooling tower look like a dust collector. To operate the cooling tower properly in accordance with its design specifications, some measures should be taken.

Table M-02: Example of Water Quality Standard

Item \ Data	Direct Recycled Water		Indirect Recycled Water
	Hot Rolling	Continuous Casting Spray	
Temperature (°C)	<37 - 45	<45	<32 - 34
Turbidity	20		5
pH	6 - 9	8 - 9	7 - 9
M alkalinity (mg/lit)		100	80
Chloride ion (")	100	100	100
Total hardness (")			150
Ca hardness (")	100	150	100
Total iron (")			
Suspended sold (")	<30 - 50	<5	15
Evaporation residue (")			400
Electrical conductivity (μS/cm)			500
Sulfate ion (mg/lit)	100		100
Oil content (")		<5	
MDD* (mg/dm²/d)			10
Residual chlorine (mg/lit)			0.5 (4h/d)

* Index to show the corrosion rate

While recycled water of one continuous casting machine is treated by sand filter before being sent to the cooling tower, recycled water of another continuous casting machine is directly sent to the cooling tower.

Even from the viewpoint of water saving, it is recommendable to carry out the sand filtration for both kinds of recycled water. In addition, a sedimentation treatment before the sand filtration would reduce the frequency of backwashing, and hence lead to further water saving.

To cool the recycled water for rolling mills, a cooling pond is provided. However, that is not enough to cool down the recycled water (high-temperature recycled water could damage the bearings of the rolling mills). It may be necessary to install a cooling tower (on the cooling pond, for example).

The water recovery rate through the cooling tower is rather low (around 50%). The improvement in this respect would bring considerable water saving.

This factory supplies a fair quantity of water (750 m³/d) to the outside. The use of this water is unknown, but if the water supply to the outside is reduced or stopped (by using MWA water, for example), the use of well water is saved to that extent.

(2. 4. 2) Water Treatment

Except for the electric furnace and the No. 1 continuous casting machine, well water, although its quality is not good, is used without any treatment.

As stated above, the quality of softened water used for the electric furnace and the No. 1 continuous casting machine is not good enough, either.

Bottled water is used for the boiler as well as for drinking.

(2. 4. 3) Waste Water Treatment

The rolling mills (one for the steel bar production, the other for the galvanizing line) discharge waste water containing a considerable quantity of scales. Currently this waste water recycles through the cooling pond, but it seems necessary to install a sedimentation treatment system.

Waste water from the galvanizing line (especially, pickling waste water) requires careful treatment. At present, only neutrallization-tion treatment is applied. Since the neutralization produces a lot of sludge, its disposal may become a problem.

Waste water containing chrome is treated by reduction, sedimentation and sand filtration.

(3.) Plans of Effective Use of Industrial Water

(3. 1) General

All of cooling water recycles through the cooling tower. The present recovery rate of cooling water (make-up water/recycled water) is around 50%, which can be further improved by the proper operation control of the cooling tower.

(3. 2) Details

a. Raising of degree of concentration through improvement of operation control of cooling tower

If the ratio of make-up water to the total cooling water is lowered to 20% (or setting the degree of concentration of cooling water to about 1. 1), the quantity of make-up water for cooling would be 122 m^3/d. Thus, 168 m^3 of water would be saved.

b. Treatment of waste water discharged from rolling mills and continuous casting machines

Some measures should be taken to improve the treatment of waste water discharged from the rolling mills and the No. 2 continuous casting machine. It seems necessary to install a cooling tower for discharged water from the rolling mill and to provide a sedimentation system for discharged water from the continuous casting machine.

(4.) Cost Estimation

Number	1
Method for Effective Use Method Item	 Improvement of operation control Improvement of operation and maintenance of cooling tower to raise degree of concentration
Water Saving Use Quantity (m^3/d)	 Cooling 184
Apparatus for Effective Use Apparatus Cost (10^3円)	
Unit Cost (円/m^3) Fixed Operating Total	 - 0.5 0.5

5.4.3 Code No. of Factory: M-03

(1.) Outline of Factory

Capital (M¥): -

Annual Amount of Shipment (M¥): 15

Total Area (m^2): 24,000

Total No. of Employees: 250

Main Products: Automobile Parts (Wheel)

(2.) Present Situation of the Use of Industrial Water

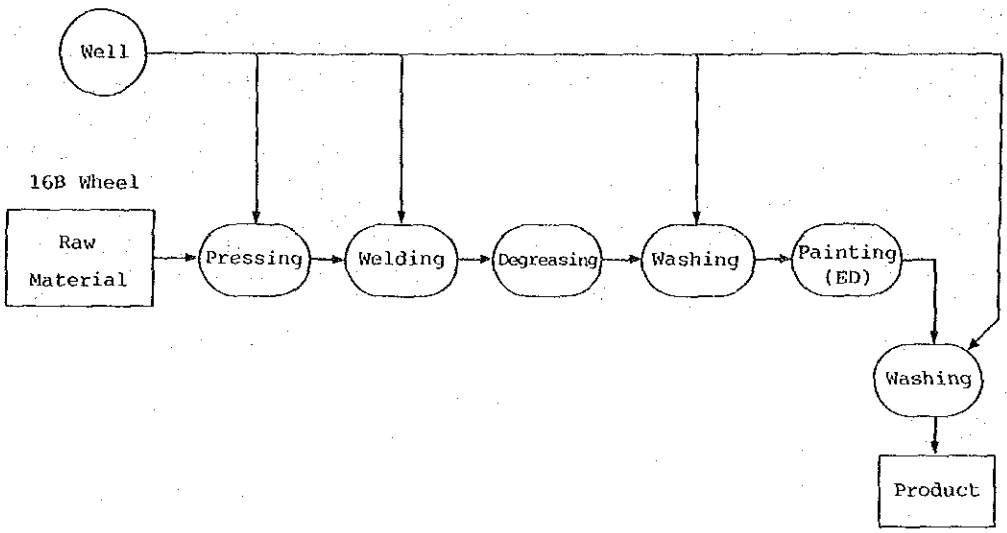
(2.1) Water Consumption

Unit: m^3/d

Use \ Source	Well Water	MWA	Others	Sub Total	Recover-ed Water	Total
Boiler	5			5		5
Material						
Processing & Washing	18			18	1,417	1,435
Cooling	46			46	1,025	1,071
Air Conditioning						
Others	93			93		93
Sub Total	162			162	2,442	2,604
Outside						
Total	162			162	2,442	2,604

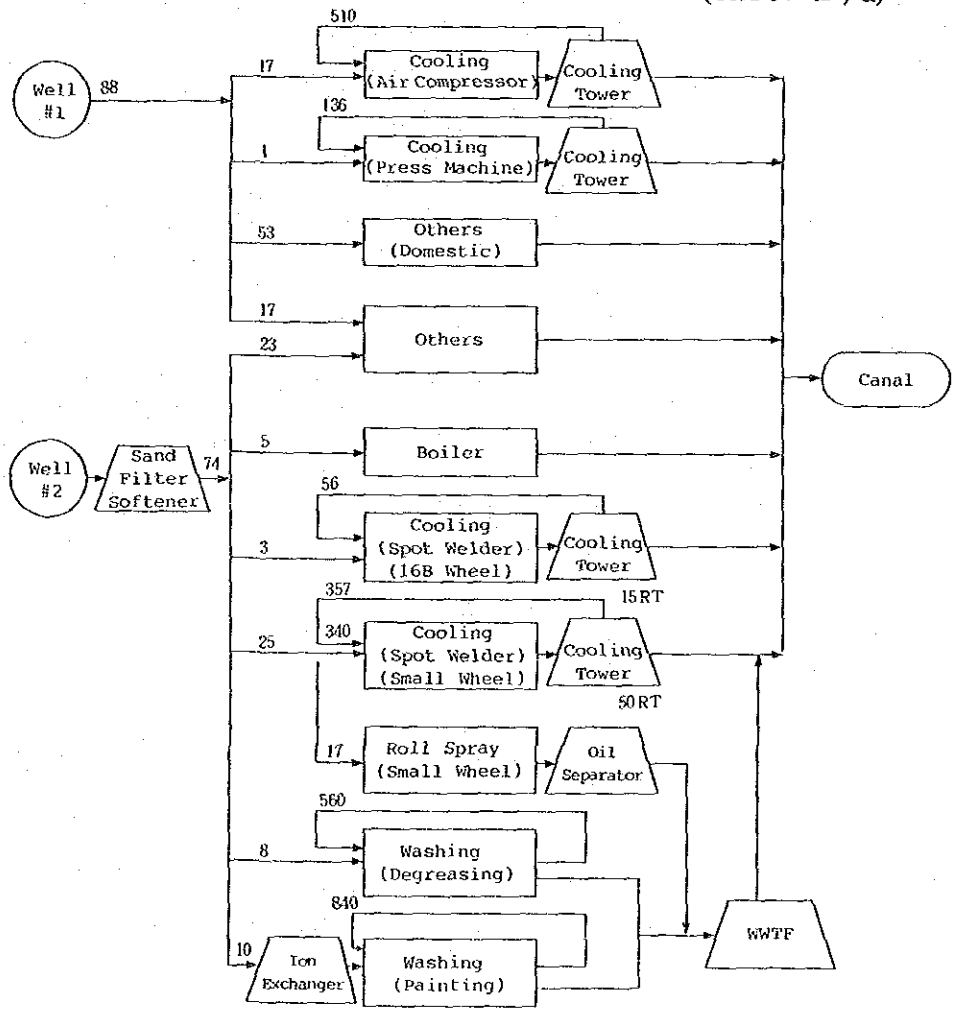
Recovery Rate (%): 93.8

(2.2) Process Diagram of Production Line



(2.3) Flow Diagram of Water Supply and Waste Water Discharge

(Unit: m³/d)



Legend; WWTF = Waste Water Treatment Facility

(2.4) Explanation of Present Situation Memorandum

(2.4.1) Sources and Uses

In this factory only well water is used. There are two wells (No.1 and No.2), each of which has a definite supply service zone. Both wells have the same depth (approx. 120 m) and the same pipe diameter (3 inches).

The No.1 well water is sent to a head tank and used without any treatment, while the No.2 well water is sent to a pressure tank after treated by sand filter and softener. Each well is provided with a flow meter.

Well water is mainly used for cooling, which recycles through cooling towers.

Only a small quantity of make-up water (35 m^3/d) is used for washing. This is because in October 1987 the factory introduced an electro deposition painting (EDP) system which reduced the consumption of washing water from 9 m^3/h to 2 m^3/h.

The largest usage of the water consumption is "others". Considering the number of employees (250), the quantity of domestic water (53 m^3/d) is reasonable. However, there is a significant quantity (40 m^3/d) of unaccounted-for water consumption (i.e. the difference between the total water consumption and the pumped up quantity). Since both wells are old (the No.1 well was installed 17 to 18 years ago, and the No.2 well 14 years ago) and their main pipings are buried, underground leakage may be conceivable.

Four cooling towers are installed in this factory. Whether make-up water for the cooling towers comes from the No.1 well or the No.2 well is not known, and hence the degree of concentration of cooling water cannot be exactly defined. The Table M-03, therefore, shows the estimated quantity of make-up water required for each cooling tower on the basis of some appropriate assumptions.

Table M-03: Estimated Quantity of Make-up Water

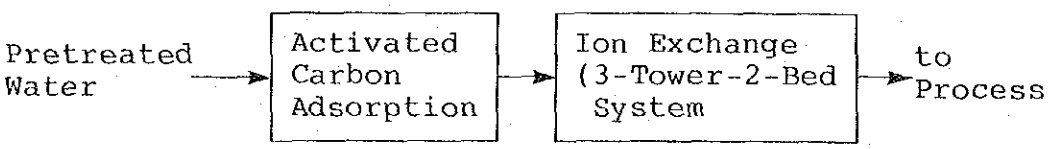
Cooling tower (No.)	1	2	3	4
Capacity (RT)	10	15	50	100
Recovered water (m^3/h), estimate (designed value)	8 (7.8)	7 (11.7)	20 (39)	30 (78)
Degree of concentration (N)	1.1	1.1	1.1	1.1
Temperature difference (°C)	3	3	3	3
Evaporation E (m^3/h)	0.04	0.04	0.11	0.16
Blow down water B (m^3/h)	0.4	0.4	1.1	1.6
Make-up water (m^3/h) M=E+B	0.44	0.44	1.21	1.76
Operating hour (h/d)	17	8	17	17
Make-up water (m^3/d)	7.5	3.5	20	30
Make-up water measured on the day of this survey (m^3/d)	1	3	8	17

(2.4.2) Water Treatment

With 820 μS/cm of electrical conductivity and zero mg/lit of turbidity, the No.1 well water is used without any treatment. The No.2 well water, on the other hand, has 1,350 μS/cm of electrical conductivity and zero mg/lit of turbidity, and is treated by sand filtration and softening processes as shown below.

The capacity of water treatment is estimated at 20 m^3/h. The electrical conductivity of the treated water is 1,280 μS/cm.

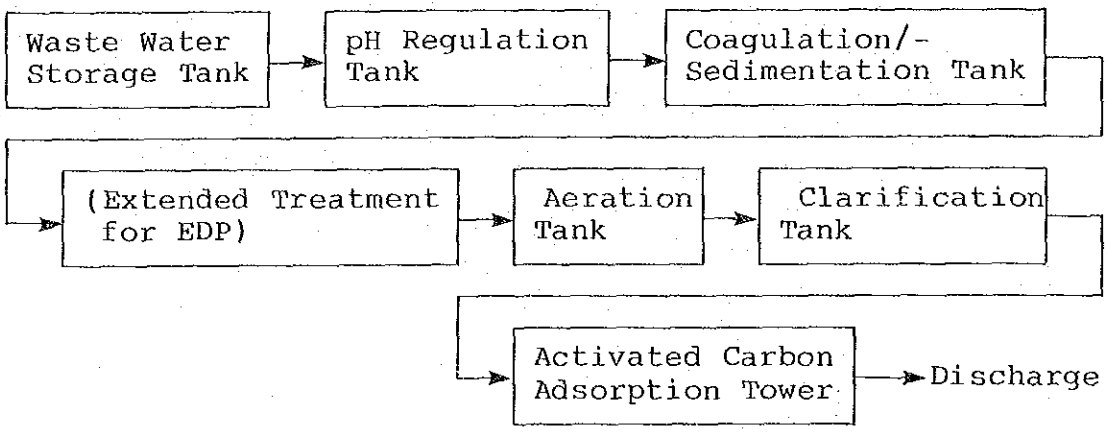
Water for the printing process is treated by the ion exchange. The flow of this treatment is shown below.



(Capacity: 8 m^3/cycle/bed Max. flow rate: 2 m^3/h)

(2.4.3) Waste Water Treatment

The waste water treatment system of this factory mainly treat waste water containing paint from the painting process. Process of that system is as shown below. (the treatment capacity: 6 m^3/h x 6 h/d = 36 m^3/d)



(The introduction of EDP has increased water turbidity and hence made it necessary to set up the treatments following the coagulation/sedimentation.)

(3.) Plans of Effective Use of Industrial Water

(3.1) General

Since the cooling water is already recycled through cooling towers, there seems no room for further improvement.

Also, the use of washing water is already highly effective and there seems virtually no room for further improvement.

(3.2) Details

a. Thorough control of water consumption and prevention of water leakage

Unaccounted-for water consumption amounts to about 40 m^3/d. Some measures should be taken to reduce this loss of water by identifying its causes (water leakage is likely to be one of the causes). The reduction of water loss much depends on the awareness of employees, and hence it is difficult to estimate the improvement cost.

(4.) Cost Estimation

Number	1
Method for Effective Use Method Item	 Control of water use Thorough control of water to decrease water leakage
Water Saving Use Quantity	 Miscellaneous (m^3/d) 40
Apparatus for Effective Use Apparatus Cost (10^3฿)	
Unit Cost (฿/m^3) Fixed Operating Total	 - - -

5.4.4 Code No. of Factory: M-04

(1.) Outline of Factory

Capital (M₿): 7

Annual Amount of Shipment (M₿): 8

Total Area (m²): 4,000

Total No. of Employees: 40

Main Products: Iron Rod (1,142 t/Y)

(2.) Present Situation of the Use of Industrial Water

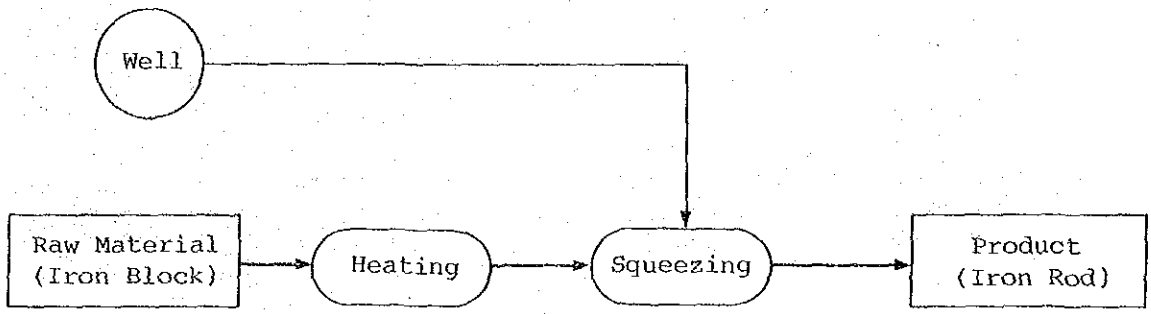
(2.1) Water Consumption

Unit: m³/d

Source / Use	Well Water	MWA	Others	Sub Total	Recover-ed Water	Total
Boiler						
Material						
Processing & Washing						
Cooling	1			1	960	961
Air Conditioning						
Others	5	2		7		7
Sub Total	6	2		8	960	968
Outside						
Total	6	2		8	960	968

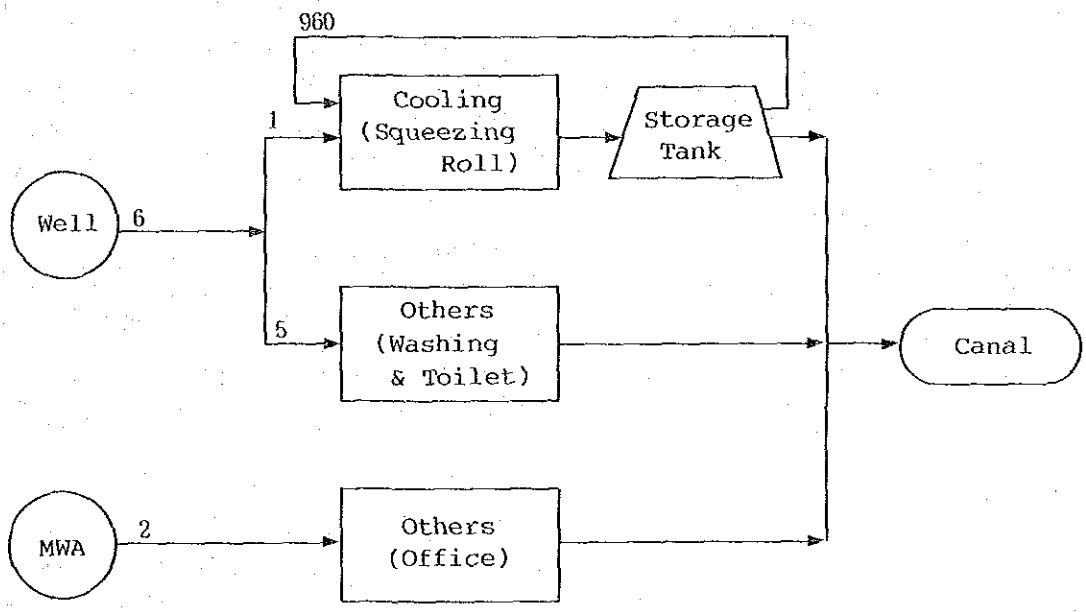
Recovery Rate (%): 99.2

(2.2) Process Diagram of Production Line



(2.3) Flow Diagram of Water Supply and Waste Water Discharge

(Unit: m^3/d)



(2.4) Explanation of Present Situation

(2.4.1) Sources and Uses

Well water and MWA water is used in this factory. There is only one well (83 m deep and 2 inch pipe diameter) in the factory premises.

No flow meter is provided in the well. When the well was once out of order, this factory used only MWA water and thus could get to know the exact quantity of total water consumption. In this study, the quantity of well water is estimated from this total quantity.

Well water is used for cooling of the squeezing roll and for domestic use (for toilets and baths), while MWA water is used in the office building.

Cooling water is recycled through a storage tank with a capacity of 15 m^3. Although there is no cooling tower, the water temperature is low enough.

Less stringent quality is required for cooling water in particular. However, due to unavoidable mingling of raw material scale into the water in the course of time, an entire renewal of cooling water, at least once in two weeks, is recommended.

The supply of cooling water to the storage tank is regulated in accordance with the water level.

The volume of water used for domestic purpose (both well water and MWA water) is 7 m^3/d, while the number of employees is 40. This makes the per capita consumption as 180 lit/d, which is not particularly high value.

(2.4.2) Water Treatment

Quality of well water is 4,700 $\mu S/cm$ of electrical conductivity, 6.52 of pH and 9 mg/lit of turbidity. It is sent to the storage tank and used without any treatment.

(2.4.3) Waste Water Treatment

Once every other week, water in the storage tank is wholly discharged into a canal without any treatment, although some oil appears on the surface of the water in the tank.

(3.) Plans of Effective Use of Industrial Water

(3.1) General

Since all cooling water is recycled and domestic water per capita is small, there is little room for further improvement.

5.4.5 Code No. of Factory: M-05

(1.) Outline of Factory

Capital (M¥): 100

Annual Amount of Shipment (M¥): 143.9
(Steel Bar 6,400 t/Y)
(Aluminum Bar 1,200 t/Y)
(Brass 285 t/Y)

Total Area (m²): 70,400

Total No. of Employees: 350

Main Products: Steel Bar, Aluminum Bar, Sash and Brass

(2.) Present Situation of the Use of Industrial Water

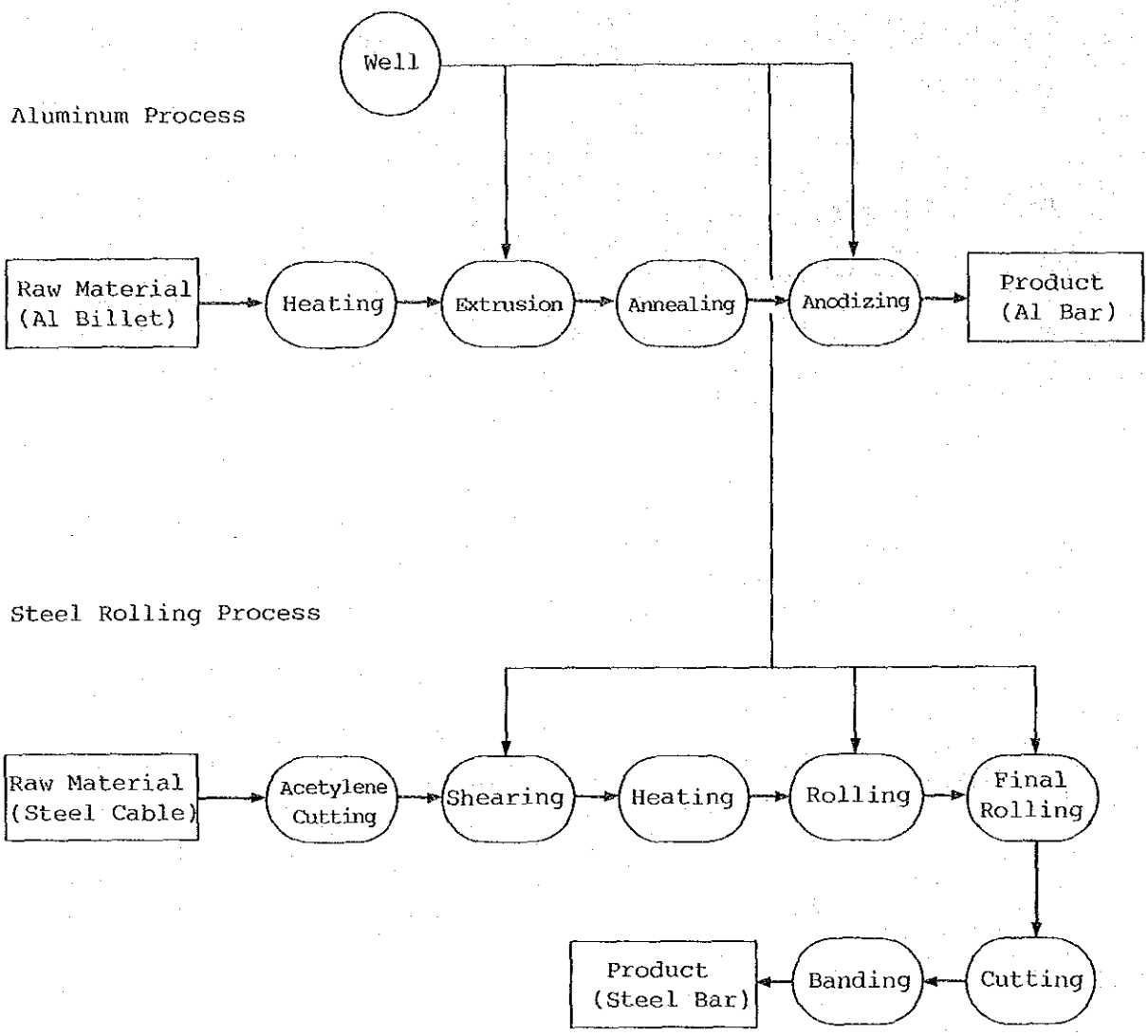
(2.1) Water Consumption

Unit: m³/d

Use \ Source	Well Water	MWA	Others	Sub Total	Recover-ed Water	Total
Boiler	38			38		38
Material						
Processing & Washing	314			314		314
Cooling	76			76	812	888
Air Conditioning						
Others	110			110		110
Sub Total	538			538	812	1,350
Outside	82			82		82
Total	620			620	812	1,432

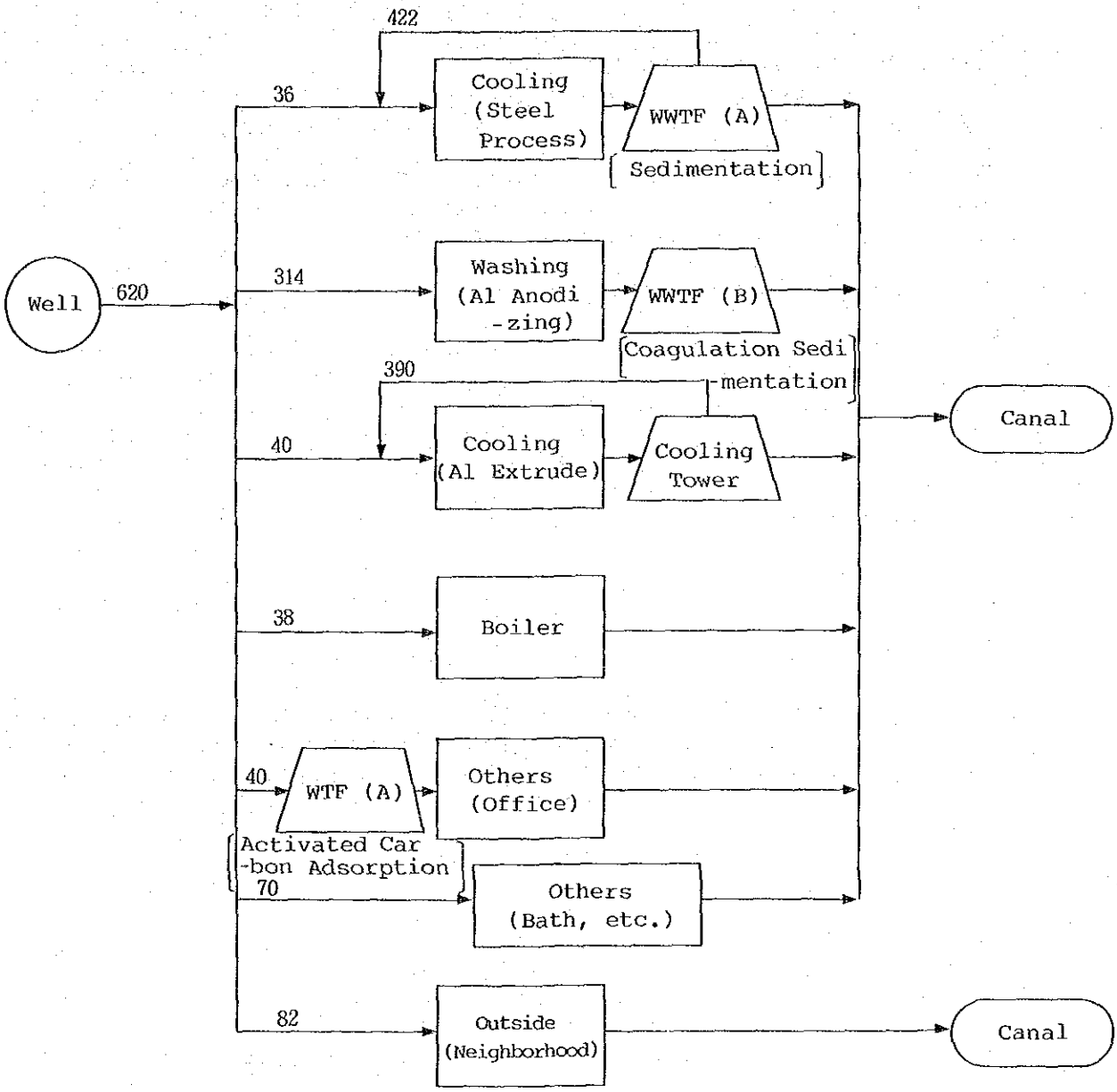
Recovery Rate (%): 56.7

(2.2) Process Diagram of Production Line



(2.3) Flow Diagram of Water Supply and Waste Water Discharge

(Unit: m^3/d)



Legend:

WTF (A) = Water Treatment Facility of Activated Carbon Adsorption Process

WWTF (A) = Waste Water Treatment Facility of Sedimentation Process

WWTF (B) = Waste Water Treatment Facility of Coagulation/Sedimentation Process

(2.4) Explanation of Present Situation

(2.4.1) Sources and Uses

In this factory, water is supplied by five wells (No.1 - No.5 wells), each of them is about 90 m deep. While No.1 well is independently used to supply water for the steel rolling process, other wells (No.2 to No.5) are connected to pipings and used to supply water for various uses except steel rolling.

The main uses of water are for washing in the aluminum adonizing process, cooling for the aluminum extruder, cooling for the rolls in the steel rolling process and the like.

The sequence of aluminum adonizing is shown in Fig. M-05.

This factory has two aluminum adonizing lines for which altogether 314 m^3/d of water is required. Cooling water for the extruder is recycled through a cooling tower. Cooling water for the steel rolling process, on the other hand, is recycled through a tank. (Make-up water is supplied to the tank if the water level is low. Owing to the gradual accumulation of scales generated from materials, the water in the tank is wholly replaced once a week.)

Because of the change of the boiler system (from the direct steam blowing system to the oil heater system), the make-up water required for the boiler has been greatly reduced.

For the domestic use, well water is treated by an activated carbon adsorption. Considering the number of employees (350), the quantity of domestic water (70 m^3/d) is not particularly large. In addition, this factory supplies 82 m^3 of water to neighboring houses.

(2.4.2) Water Treatment

Water of No.2, No.3 and No.4 wells, though its quality is not good (electrical conductivity: 1,700μS/cm, turbidity: 25 mg/lit) is used for processing without any treatment.

For drinking, however, it is treated by an activated carbon adsorption treatment.

(2.4.3) Waste Water Treatment

Waste water of the aluminum adonizing process is treated by a coagulation/sedimentation process using high molcular coagulant. The treated waste water has 7.7 of pH, 3,920 μS/cm of electrical conductivity and 7 mg/lit of turbidity.

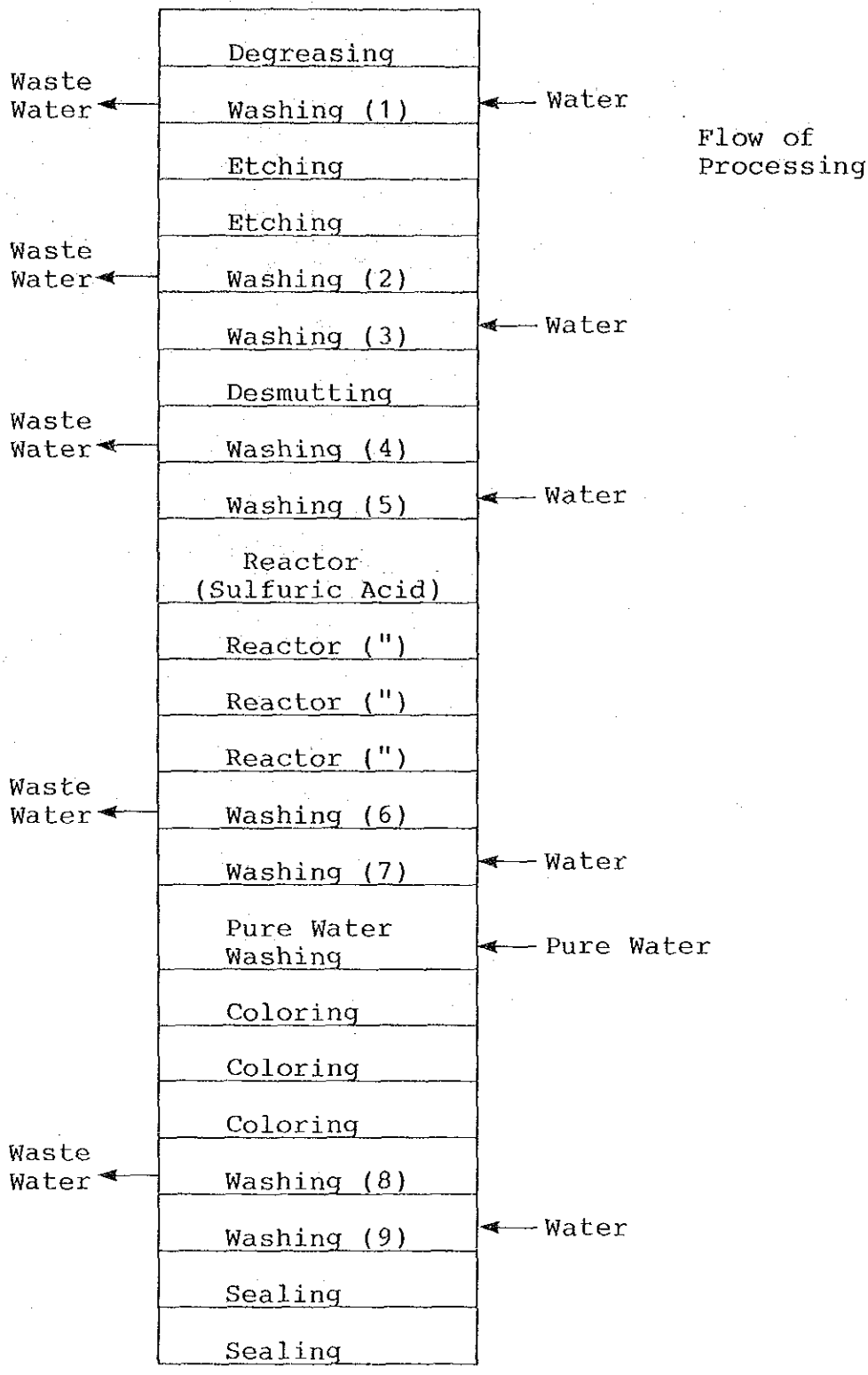


Fig. M-051: Sequence of Aluminum Adonizing

(3.) Plans of Effective Use of Industrial Water

(3.1) General

Since cooling water is already recycled, there is no room for further improvement.

Generally speaking, it is not easy to save washing water used in metal surface processing because the product quality is concerned. This factory, however, intends to re-use waste water for washing and hence some saving may be expected in the future.

Water for the domestic use is small in quantity and there is no room for further improvement.

(3.2) Details

a. Re-use of treated waste water for washing

Instead of well water, sand filtrated waste water might be used as washing water for degreasing and etching (1), (2) and (3) of the illustration in (2.4.1) in the adonizing process. That way, around 200 m^3/d of water would be saved. The table below shows the quality of well water and sand filtrated waste water.

Data / Item	pH	Electrical Conductivity (μS/cm)	Turbidity (mg/lit)
Well Water	7.10	1,670	25
Treated Waste Water	7.72	3,920	7

Judging from this comparison, it would be better to mix well water with sand filtrated waste water than use only the latter for the above-mentioned washing.

(4.) Cost Estimation

Number	1
Method for Effective Use Method Item	 Recycle use Re-use of treated waste water for washing process
Water Saving Use Quantity (m^3/d)	 Processing & Washing 200
Apparatus for Effective Use Apparatus Cost (10^3฿) Unit Cost (฿/m^3) Fixed Operating Total	 Sand filter, pump, electric instrument & piping 1,432 3.0 0.6 3.6

5.4.6 Code No. of Factory: M-06

(1.) Outline of Factory

Capital (M฿): 45

Annual Amount of Shipment (M฿): 50 (5,500 units/Y)

Total Area (m^2): 8,807

Total No. of Employees: 390 (Peak 400)

Main Products: Air Conditioner

(2.) Present Situation of the Use of Industrial Water

(2.1) Water Consumption

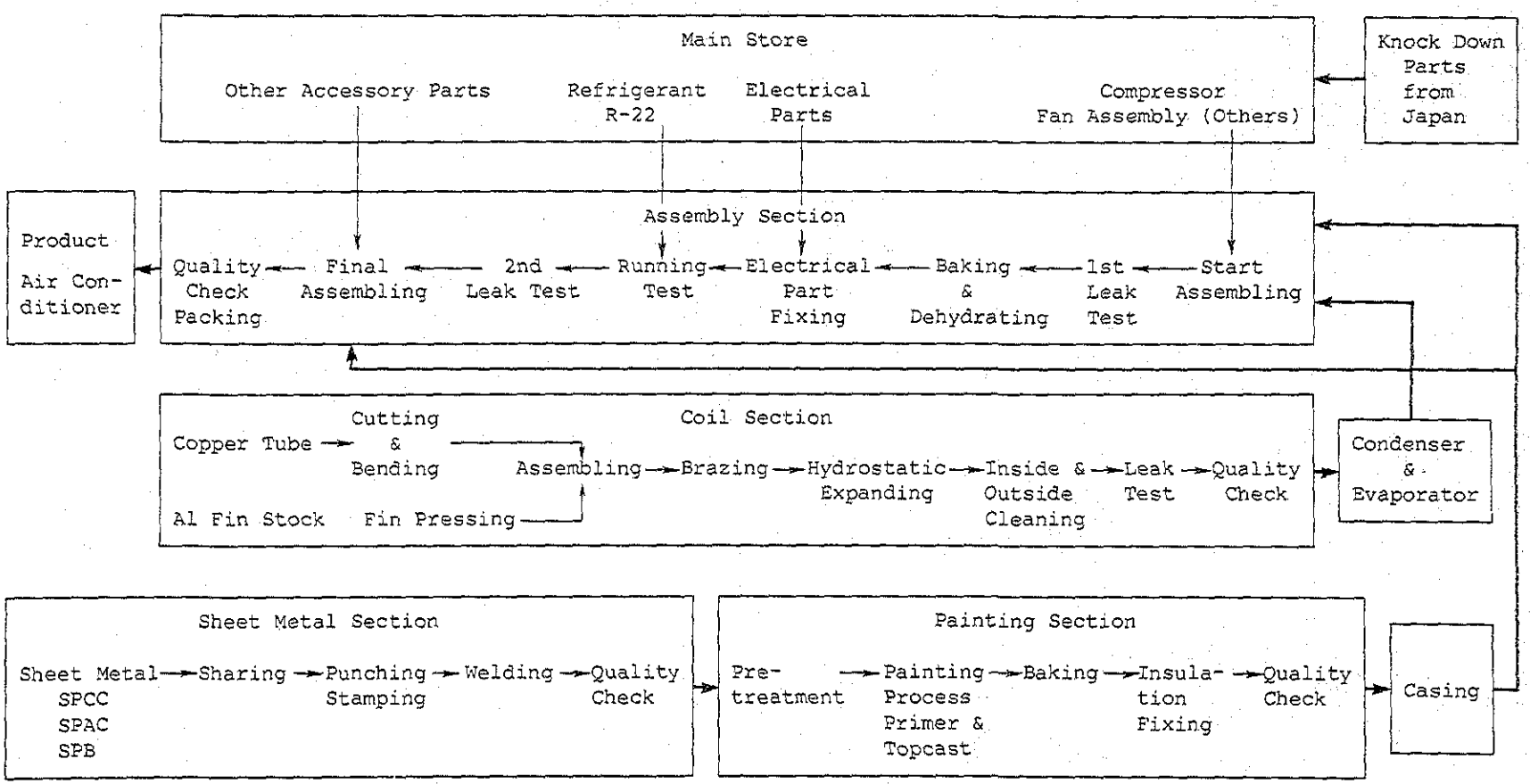
Unit: m^3/d

Source / Use	Well Water	MWA	Others	Sub Total	Recover-ed Water	Total
Boiler	5			5		5
Material						
Processing & Washing	25			25		25
Cooling						
Air Conditioning						
Others	20			20		20
Sub Total	50			50		50
Outside	20			20		20
Total	70			70		70

Recovery Rate (%): 0.0

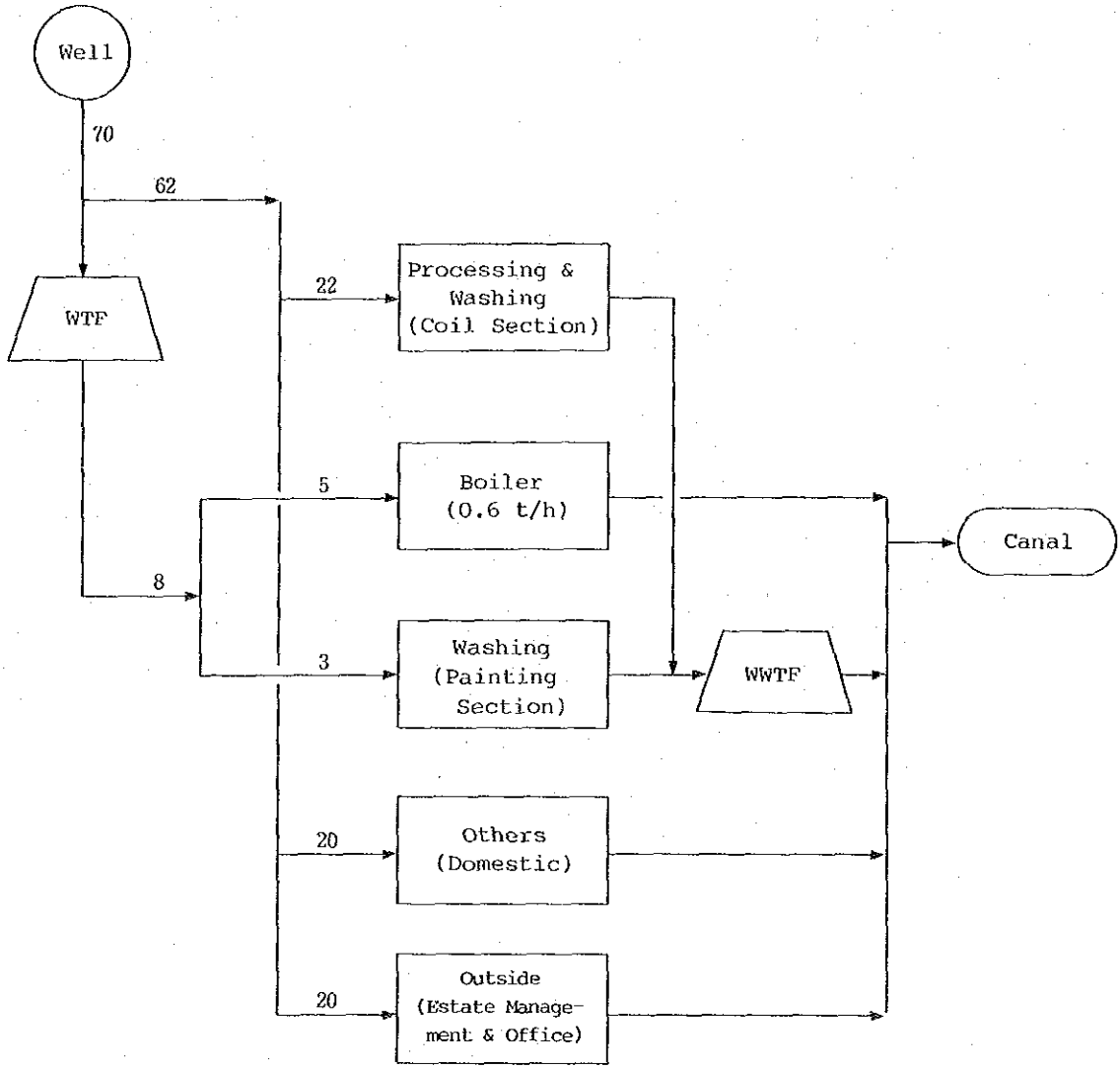
(2.2) Process Diagram of Production Line

M06



(2.3) Flow Diagram of Water Supply and Waste Water Discharge

(Unit: m^3/d)



Legend:
WTF = Water Treatment Facility of Sand Filtration, Ion Exchange and Activated Carbon Adsorption Processes
WWTF = Waste Water Treatment Facility of Coagulation, Sedimentation and Filtration Processes

(2.4) Explanation of Present Situation

(2.4.1) Sources and Uses

This factory is located in the Industrial Estate devel-oped by Siam Motors Co., Ltd.. The supply and consumption of water in this factory, therefore, is closely connected with the General Management Office of the Estate. For example, the item "outside" in (2.1) indicates the water supply to the Office.

There is a well of 80 m deep in the premises. Well water is pumped up to a head tank and supplied from there for various uses.

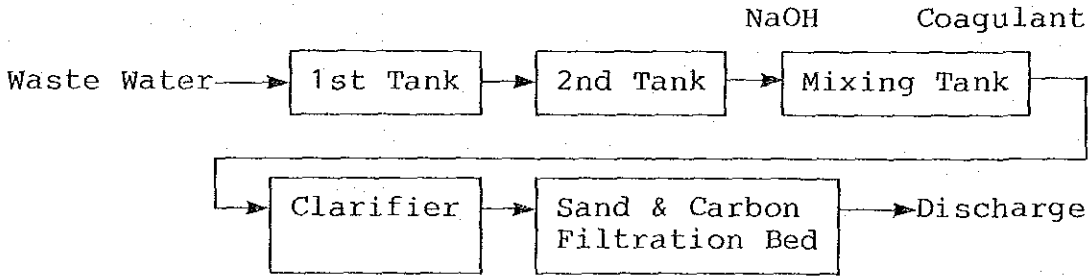
Well water is partly used without any treatment and partly treated by sand filtration, ion exchange and activated carbon adsorption. The treated water is used for the boiler and the painting process. The painting process requires water of high quality because it adopts the Bondelite surface treatment.

(2.4.2) Water Treatment

As stated above, water for the boiler and the painting process should be of high quality, and is treated by sand filter, ion exchanger and activated carbon adsorption tower.

(2.4.3) Waste Water Treatment

The waste water treatment facility in this factory is provided mainly to remove zinc contents in the waste water. Its schematic flow diagram is shown as below.



3.) Plans of Effective Use of Industrial Water

(3.1) General

Instead of well water, treated waste water may be used for washing in the Bondelite degreasing process.

By installing a storage tank to regulate the flow of water treated by sand filtration and activated carbon adsorption processes, some well water, though not large in quantity, could be saved.

Currently steam condensate is not recovered at all.

(3.2) Details

a. Recovery of steam condensate

By installing steam condensate recovery system, about 60% of generated steam might be recovered or 3 m^3/d of water might be saved.

b. Re-use of treated waste water for washing

Treated waste water might be used for washing in the Bondelite process. If 50% of the washing water is substituted that way, 10 m^3/d of water would be saved.

(4.) Cost Estimation

Number	1	2
Method for Effective Use Method Item	Recycle use Recovery of steam condensate	Recycle use Re-use of treated waste water for washing process
Water Saving Use Qt. (m^3/d)	Boiler 3	Processing & washing 10
Apparatus for Effective Use Apparatus Cost (10^3฿)	Drain trap, strainer & piping 31	Pump, electric instrument & piping 133
Unit Cost (฿/m^3) Fixed Operating Total	 4.2 - 4.2	 5.5 0.6 6.1

Total Water Saving (m^3/d) : 13

Total Initial Cost (10^3฿) : 164

Total Unit Cost (฿/m^3) : 5.7

Note: Qt. = Quantity

5.4.7 Code No. of Factory: M-07

(1.) Outline of Factory

Capital (M₿): 1

Annual Amount of Shipment (M₿): -

Total Area (m²): 2,400

Total No. of Employees: 87

Main Products: Parts of Motorcycle

(2.) Present Situation of the Use of Industrial Water

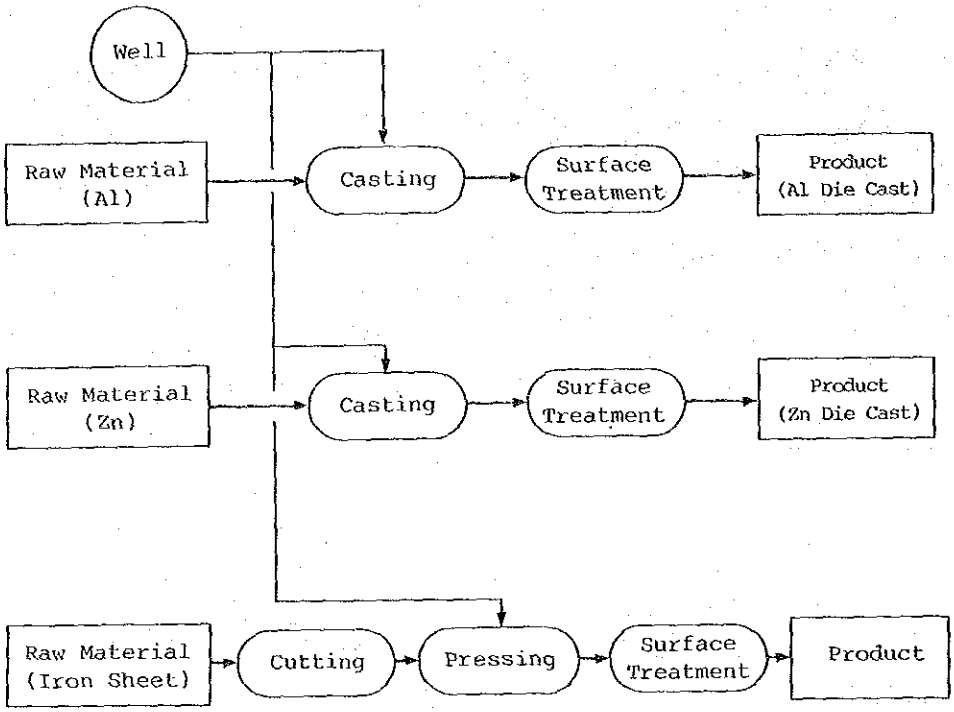
(2.1) Water Consumption

Unit: m³/d

Use \ Source	Well Water	MWA	Others	Sub Total	Recover-ed Water	Total
Boiler						
Material						
Processing & Washing						
Cooling	20			20	95	115
Air Conditioning						
Others	38			38		38
Sub Total	58			58	95	153
Outside						
Total	58			58	95	153

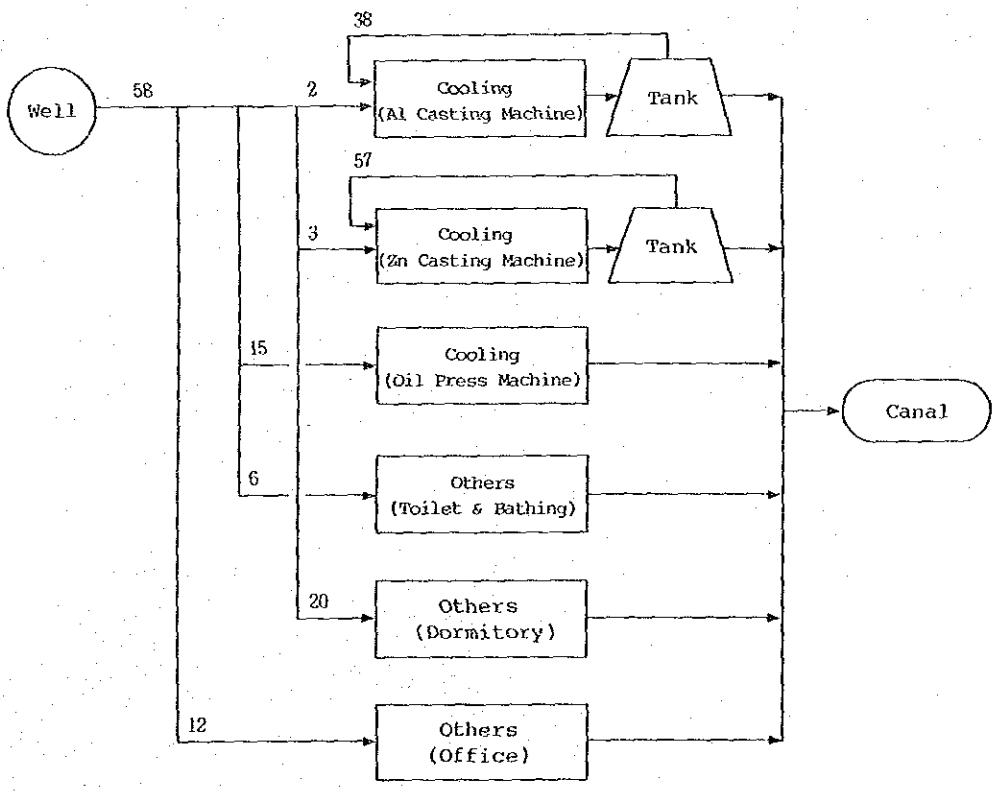
Recovery Rate (%): 62.1

(2.2) Process Diagram of Production Line



(2.3) Flow Diagram of Water Supply and Waste Water Discharge

(Unit: m^3/d)



(2.4) Explanation of Present Situation

(2.4.1) Sources and Uses

In this factory only well water is used. There is only one well (depth: 54 m, pipe diameter: 2 inches) in the premises.

Well water is sent to a head tank and supplied from there for various uses without any treatment. Since no flow meter is provided, the water consumption in the above table are based on either measured values on this survey or appropriate estimates.

Well water is mainly used for cooling of the die casting machine (for aluminum and zinc product) and also for cooling of the lubricating oil.

There are four die casting machines (two for aluminum and another two for zinc). Since cooling water for them is recycled, only a small quantity (5 m^3/d) of make-up water is required.

The indirect once-through cooling system is applied for the press machine. This requires around 15 m^3/d (1.8 m^3/h) of water.

Water for domestic use in this factory amounts to 38 m^3/d which breaks down to 20 m^3/d for the dormitory (40 employees), 12 m^3/d for the office building (together with executive's house) and 6 m^3/d for the comfort room.

(2.4.2) Water Treatment

Having fairly good quality (pH: 7.2, electrical conductivity: 970 $\mu S/cm$ and turbidity: 2 mg/lit), well water of this factory is used without any treatment.

(2.4.3) Waste Water Treatment

Since water is used only for cooling and domestic purposes, no treatment is applied to waste water.

(3.) Plans of Effective Use of Industrial Water

(3.1) General

At present, cooling water for press machine oil is used in once through system. It would be better to take some measures to re-use this cooling water.

The cascade use of the cooling water may not be very effective, because irregular, batch-based operation of the press machine would make it necessary to install a large storage water tank. A better way seems to install a cooling tank to recycle the cooling water.

(3.2) Details

a. Recycle of cooling water of once-through system through installation of receiving tank

Cooling water of once-through system for press machine oil might be recycled through installation of receiving tank. The quantity of water saving would be 14 m^3/d.

(4.) Cost Estimation

Number	1
Method for Effective Use Method Item	 Recycle use Recycle use of cooling water by installing receiving tank
Water Saving Use Quantity (m^3/d)	 Cooling 14
Apparatus for Effective Use Apparatus Cost (10^3₿)	 Tank 5 m^3 x 1, pump, electric instrument & piping 274
Unit Cost (₿/m^3) Fixed Operating Total	 8.5 0.5 9.0

5.4.8 Code No. of Factory: M-08

(1.) Outline of Factory

Capital (M₿): 15

Annual Amount of Shipment (M₿): 72

Total Area (m^2): 15,600

Total No. of Employees: 201

Main Products: Parts of Automobile (Muffler, Pedal, etc.)

(2.) Present Situation of the Use of Industrial Water

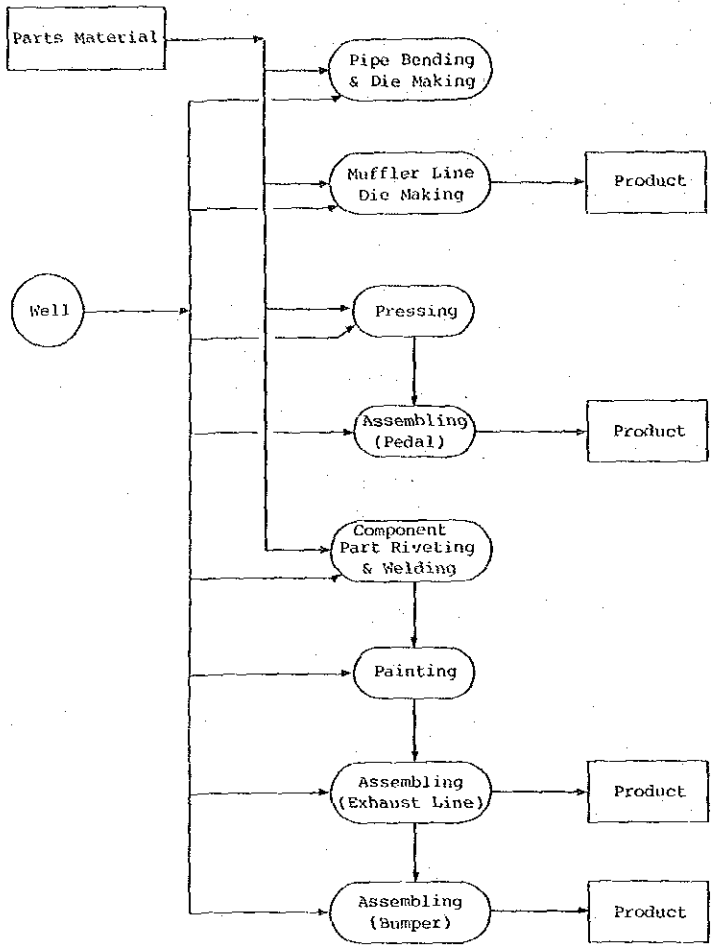
(2.1) Water Consumption

Unit: m^3/d

Source / Use	Well Water	MWA	Others	Sub Total	Recover-ed Water	Total
Boiler						
Material						
Processing & Washing	29			29		29
Cooling	5			5	10	15
Air Conditioning						
Others	6			6		6
Sub Total	40			40	10	50
Outside						
Total	40			40	10	50

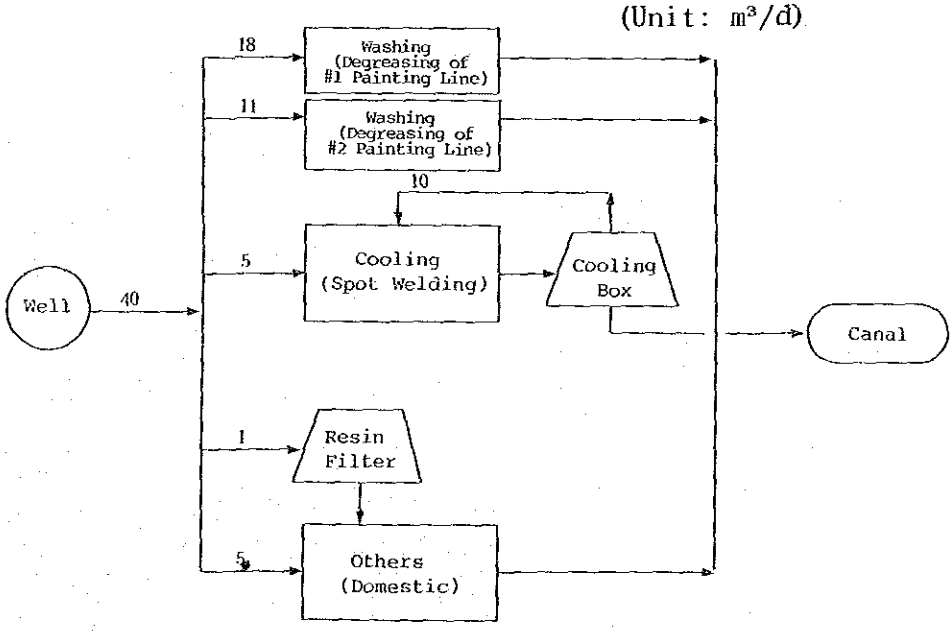
Recovery Rate (%): 20.0

(2.2) Process Diagram of Production Line



(2.3) Flow Diagram of Water Supply and Waste Water Discharge

(Unit: m^3/d)



(2.4) Explanation of Present Situation

(2.4.1) Sources and Uses

In this factory, the source of water is a well of 100 m deep. Using a pump of 3 horsepower, water is sent to a head tank and supplied for various uses without any treatment.

The quantity of pumped up water fluctuates greatly in accordance with the operating condition of the factory. The recent records fluctuate the range from 4 to 65 m^3/d.

Cooling water for the spot welding machine is cooled down from 50 °C to 35 °C through a cooling box (installed close to the machine). And, some part of water is recycled.

It seems unlikely that a natural cooling system (i.e. system without forced draft cooling) can bring down the water temperature to that extent. In fact, the ratio of make-up water to the total of recycled water is fairly high (nearly one-third).

Domestic water amounts to 6 m^3/d, which is very small for 201 employees.

(2.4.2) Water Treatment

As mentioned above, well water is used without any treatment. Only potable water (1 m^3/d) is supplied after being softened.

(2.4.3) Waste Water Treatment

Waste water is discharged without any treatment. The water consumption of this factory seems to be too small to set up waste water treatment facility.

(3.) Plans of Effective Use of Industrial Water

(3.1) General

As the overall updating of the production facility is likely to take place in the near future (most of the present production facility is rather outmoded), it would be recommendable to include the renovation of the water supply system in the updating plan.

Although the ratio of make-up water to cooling water is high, the overall quantity of cooling water is not so large as to require special water saving measures.

Because of the small quantity of water consumption, there is little room for further improvement.

5.4.9 Code No. of Factory: M-09

(1.) Outline of Factory

Capital (M₩): 150

Annual Amount of Shipment: Capacity 264,000 t/Y

Total Area (m²): 21,000

Total No. of Employees: 200

Main Products: Steel Angle, Channel, Flat Bar and Square Bar

(2.) Present Situation of the Use of Industrial Water

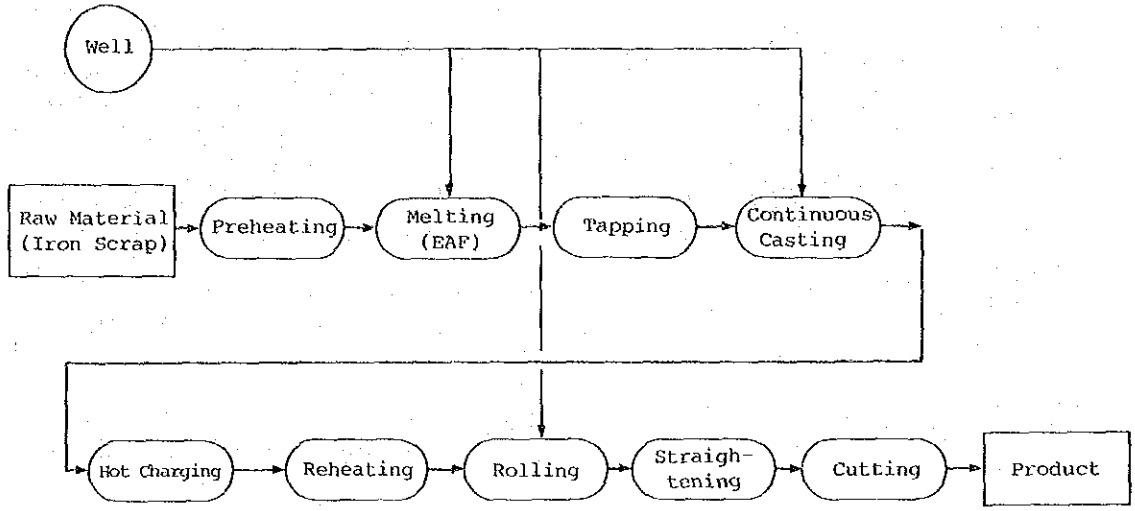
(2.1) Water Consumption

Unit: m³/d

Use \ Source	Well Water	MWA	Others	Sub Total	Recover-ed Water	Total
Boiler						
Material						
Processing & Washing	122			122	2,251	2,373
Cooling	329			329	6,119	6,448
Air Conditioning						
Others		45		45		45
Sub Total	451	45		496	8,370	8,866
Outside						
Total	451	45		496	8,370	8,866

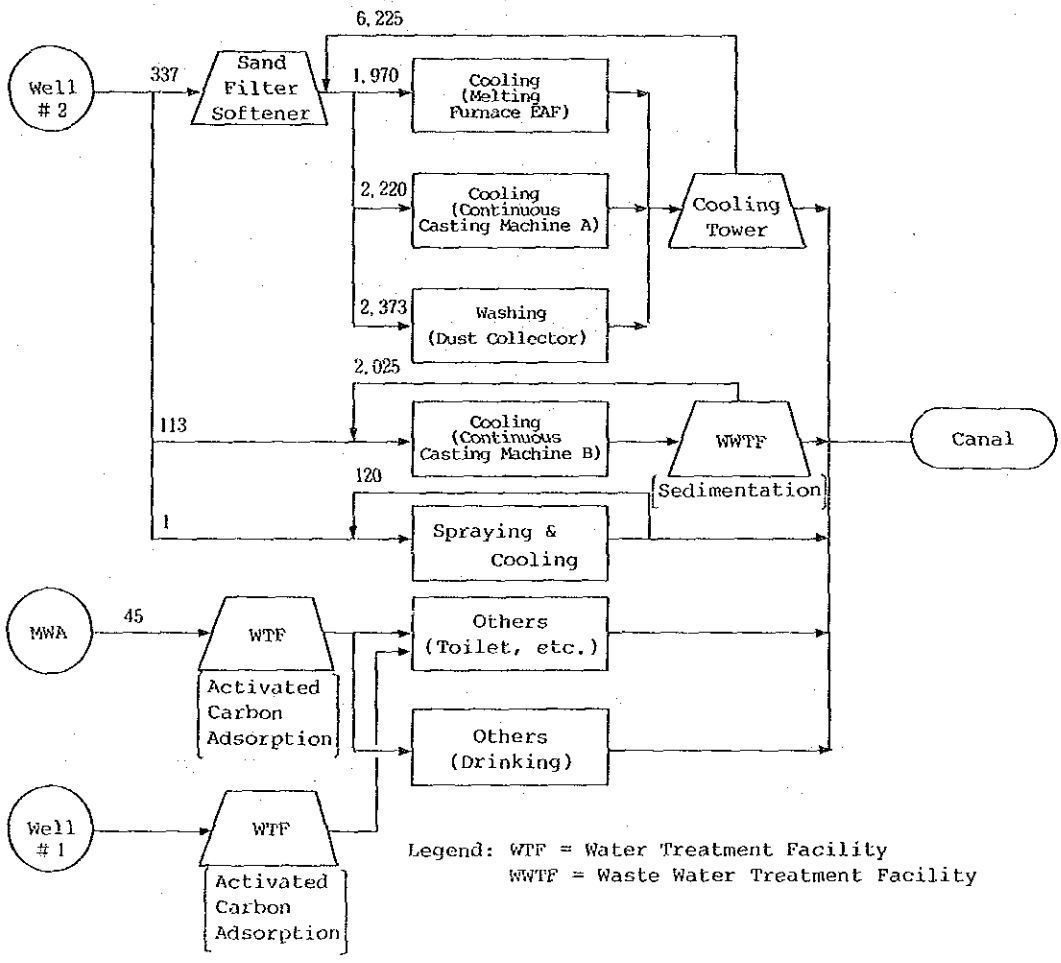
Recovery Rate (%): 94.4

(2.2) Process Diagram of Production Line



(2.3) Flow Diagram of Water Supply and Waste Water Discharge

(Unit: m^3/d)



(2.4) Explanation of Present Situation

(2.4.1) Sources and Uses

In this factory, the water is supplied from wells and MWA. There are two (No.1 and No.2) wells. The No.2 well (pipe diameter: 6 inches) is used to supply water to the production process, while the No.1 well (pipe diameter: 1 inch) is standby in case the supply of MWA water is stopped. Each well is provided with a flow meter.

Water is mainly used for cooling of the electric arc furnace and the continuous casting machine (A) as well as for washing of the dust collector.

Aside from increase of water temperature, used water in washing process for the dust collector is qualitatively clean enough just like the cooling water used for the arc furnace and the casting machine. Therefore, it is recycled through the same cooling tower together with cooling water.

The supply of make-up water to the cooling tower is regulated by means of level control. The quantity of make-up water is large (338 m^3/d) because of the evaporation loss. The degree of concentration of the cooling tower water is 1.7.

Cooling water for another continuous casting machine (B) is also recycled. Thus the use of water in this factory is highly effective.

(2.4.2) Water Treatment

As mentioned above, the No.1 well is standby in case of malfunction of MWA water supply. The quality being not good (660 $\mu S/cm$ of electrical conductivity and 10 mg/lit of turbidity), the No.1 well water is treated by an activated carbon adsorption before being used.

Also, MWA water has 1 mg/lit of turbidity and is treated by an activated carbon adsorption. It is used for drinking water. Quality of No.2 well water is 1,070 $\mu S/cm$ of electrical conductivity and 3 mg/lit of turbidity. It is treated by a sand filter and softener before being used.

(2.4.3) Waste Water Treatment

As most of processing water is for cooling, no treatment is applied to waste water. For the continuous casting machine (B), however, there is a simple clarification tank in which scales coming off from material surfaces are sedimented.

(3.) Plans of Effective Use of Industrial Water

(3.1) General

Most of water is used as cooling water that recycles through the cooling tower. And yet, the degree of concentration is still low (1.7) and could be raised.

From a recycling pit of cooling and spray water for the continuous casting machine (B), a considerable quantity of water overflows under certain operating conditions. By preventing this overflow, water would be further saved.

(3.2) Details

a. Raising of degree of concentration through improvement of operation control of cooling tower

As softened water is supplied to the cooling tower, the degree of concentration could easily raise to 2.5 to 3. By raising the degree to 2.5, the present 338 m^3/d of make-up water would be reduced to 233 m^3/d. Therefore, the quantity of water saving would be 105 m^3/d.

(4.) Cost Estimation

Number	1
Method for Effective Use Method Item	 Improvement of operation control Improvement of operation and maintenance of cooling tower to raise degree of concentration
Water Saving Use Quantity (m^3/d)	 Cooling 105
Apparatus for Effective Use Apparatus Cost (10^3฿)	
Unit Cost (฿/m^3) Fixed Operating Total	 - 0.5 0.5

5.4.10 Code No. of Factory: M-10

(1.) Outline of Factory

Capital (M₿): 20

Annual Amount of Shipment (M₿): 15

Total Area (m²): 6,400

Total No. of Employees: 60

Main Products: Drawing Dies and Carbide Tip

(2.) Present Situation of the Use of Industrial Water

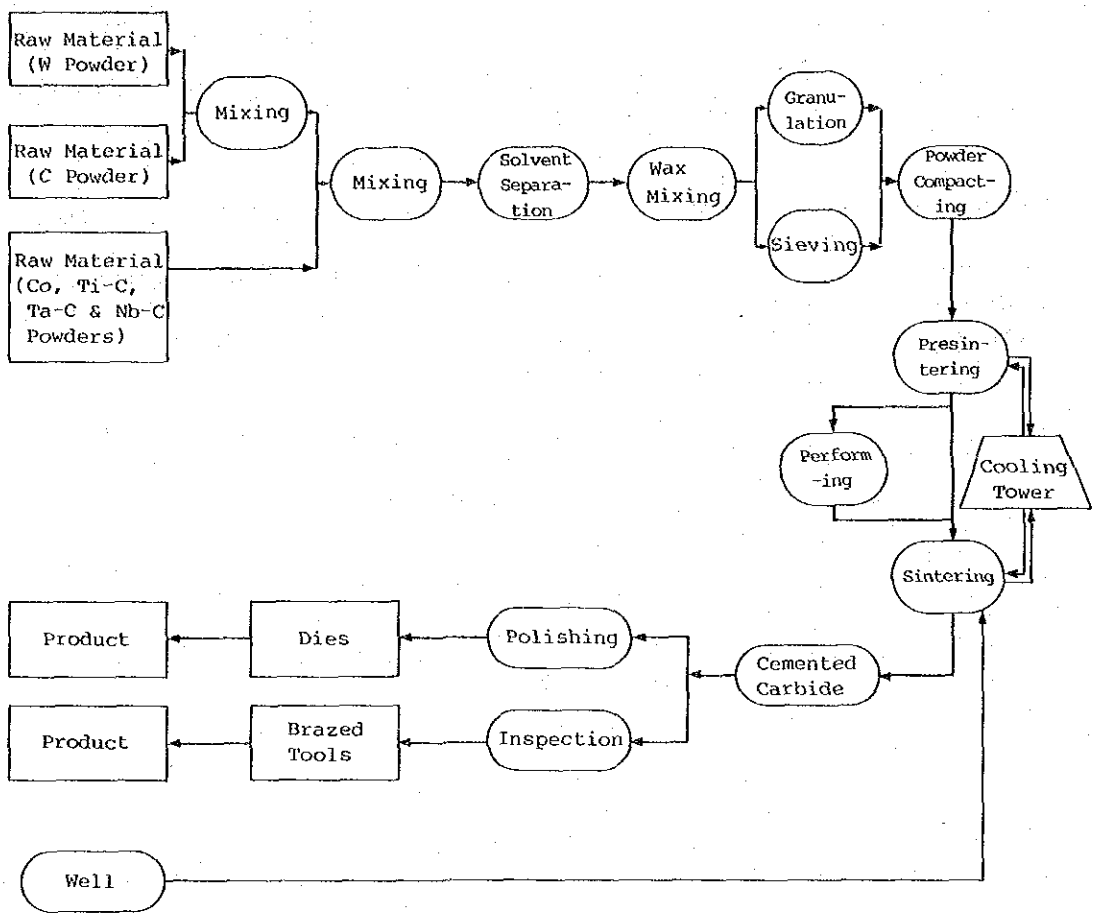
(2.1) Water Consumption

Unit: m³/d

Use \ Source	Well Water	MWA	Others	Sub Total	Recover-ed Water	Total
Boiler						
Material						
Processing & Washing						
Cooling	2			128	128	130
Air Conditioning						
Others	15			15		15
Sub Total	17			17	128	145
Outside						
Total	17			17	128	145

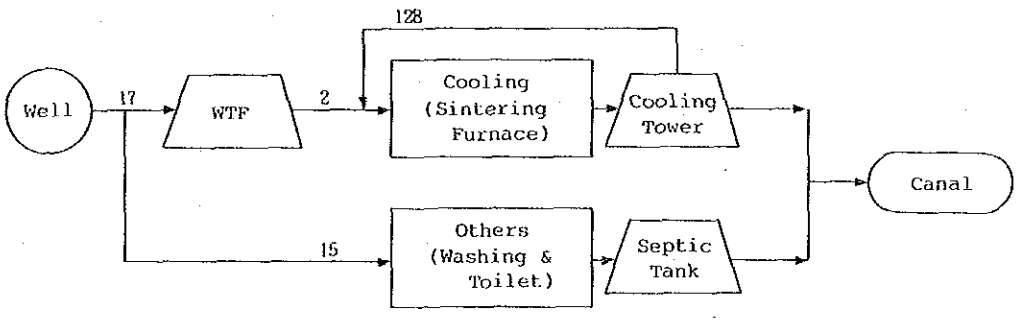
Recovery Rate (%): 88.3

(2.2) Process Diagram of Production Line



(2.3) Flow Diagram of Water Supply and Waste Water Discharge

(Unit: m^3/d)



Legend:
WTF = Water Treatment Facility of
Deionization and Softening Processes

(2.4) Explanation of Present Situation

(2.4.1) Sources and Uses

In this factory, water is supplied from a well (60 m of depth and 2 inches of pipe diameter).

Well water is mainly used for cooling of presintering and sintering processes and also for domestic purposes.

Cooling water for presintering and sintering processes is recycled through a cooling tower (20 RT). The designed recycle rate is 260 lit/min, but the actual rate is estimated at 160 lit/min.

A flow meter is installed between the well pump and the head tank. Therefore, the quantity of pumped up water, 17 m^3/d on average, is a highly reliable figure.

The supply of make-up water (2 m^3/d) for the cooling tower is regulated in accordance with the water level.

Water for domestic use amounts to 15 m^3/d, which is not particularly large for 60 employees.

(2.4.2) Water Treatment

Since the quality of well water is poor (2,700 μS/cm of electrical conductivity and 37 mg/lit of turbidity), cooling water for the sintering furnace is treated by deionizer and softener before being used. Quality of treated water has 2,800 μS/cm of electrical conductivity and zero mg/lit of turbidity.

Domestic water is supplied from the head tank without any treatment.

(2.4.3) Waste Water Treatment

This factory discharges only domestic waste water, so no treatment is applied.

(3.) Plans of Effective Use of Industrial Water

(3.1) General

As mentioned above, except domestic use, well water is used only as cooling water that is recycled. There seems to be little room for further improvement.

5.4.11 Code No. of Factory: M-11

(1.) Outline of Factory

Capital (M₱): 126

Annual Amount of Shipment (M₱): 530

Total Area (m²): 24,300

Total No. of Employees: 345

Main Products: Electric Parts of Motorcar (Alternator, Starter, Spark Plug and Car Air Conditioner)

(2.) Present Situation of the Use of Industrial Water

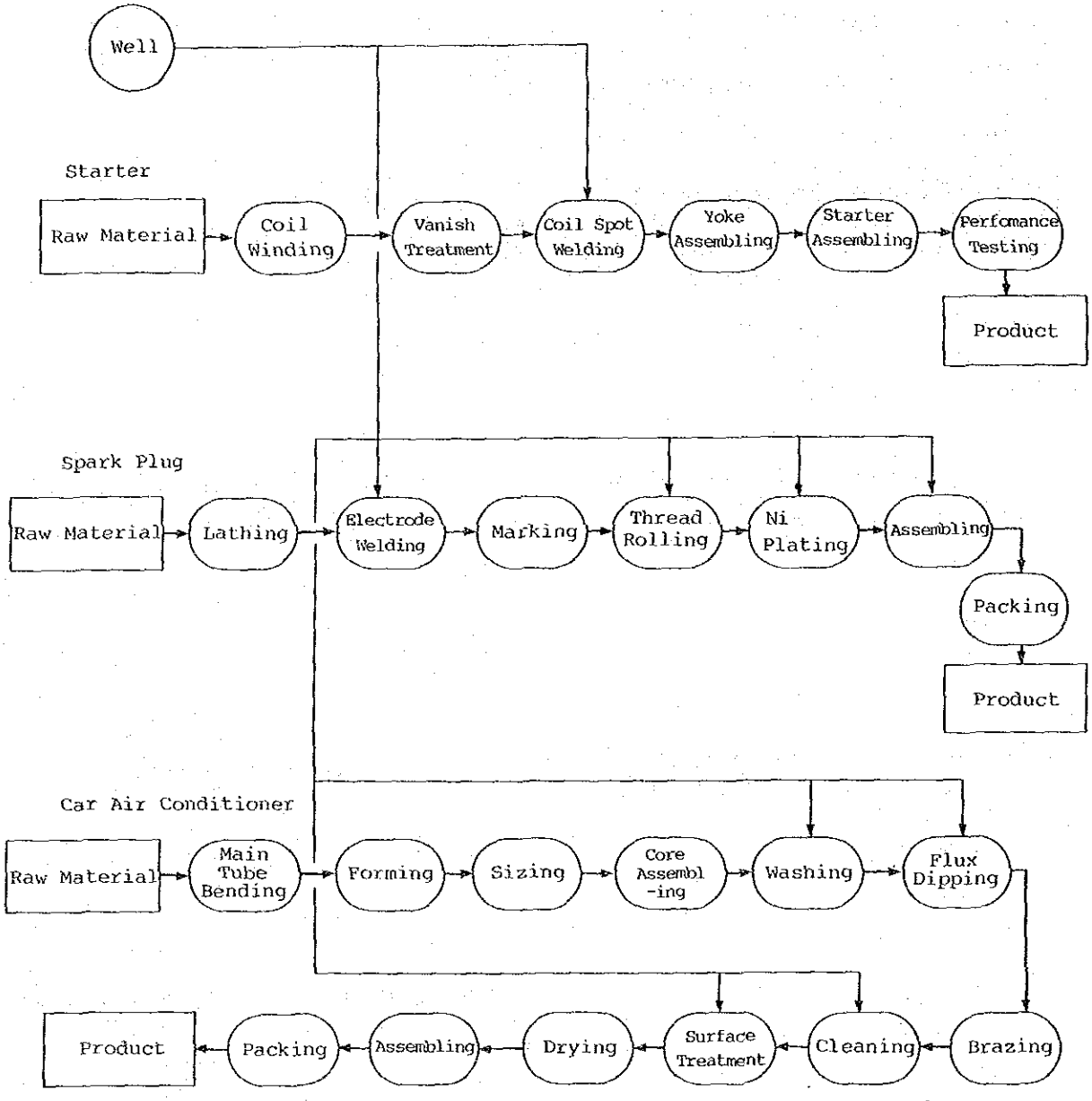
(2.1) Water Consumption

Unit: m³/d

Use \ Source	Well Water	MWA	Others	Sub Total	Recover-ed Water	Total
Boiler	5			5		5
Material						
Processing & Washing	130			130	10	140
Cooling	67			67	128	195
Air Conditioning						
Others	10			10		10
Sub Total	212			212	138	350
Outside						
Total	212			212	138	350

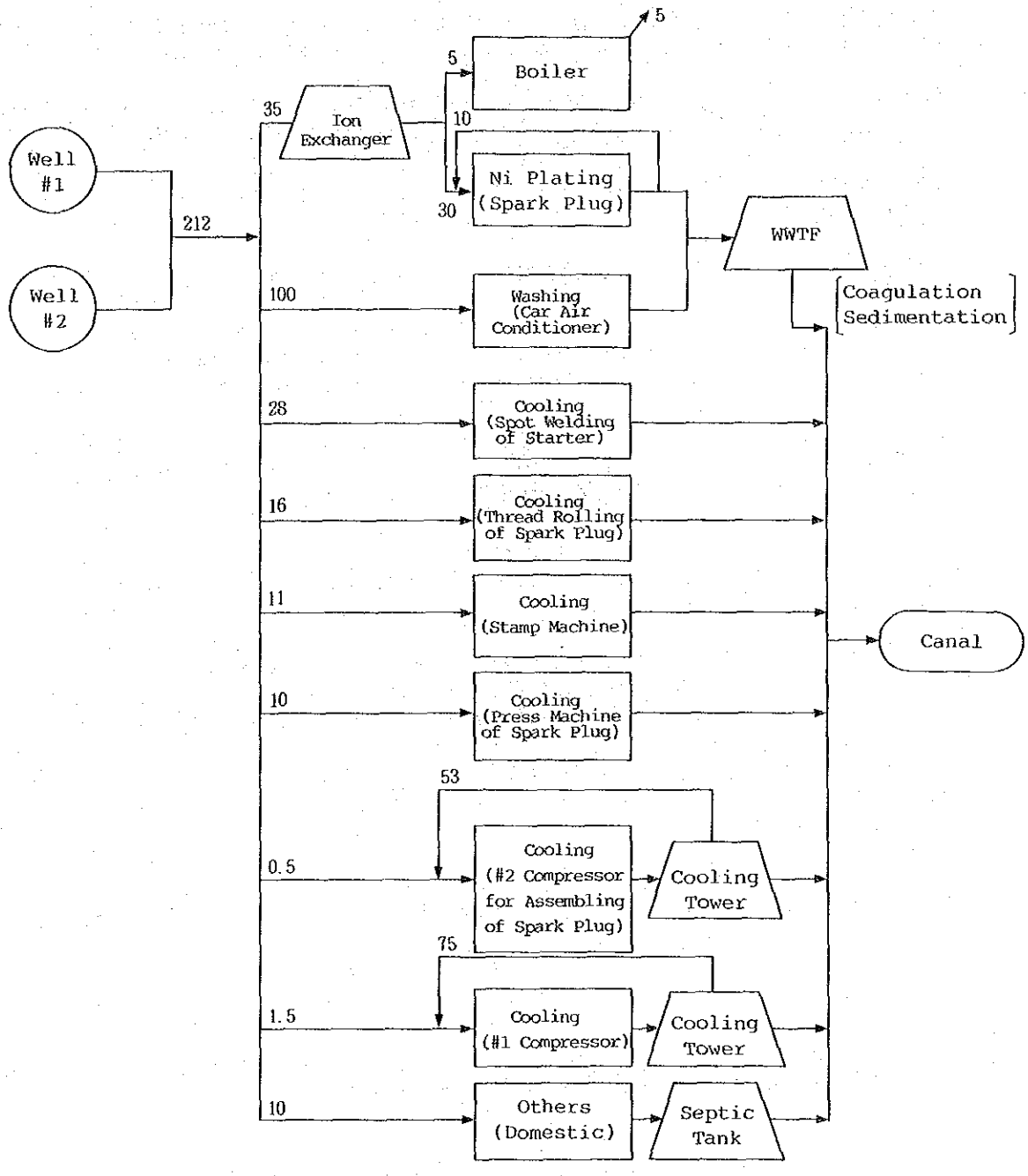
Recovery Rate (%): 39.4

(2.2) Process Diagram of Production Line



(2.3) Flow Diagram of Water Supply and Waste Water Discharge

(Unit: m^3/d)



Legend: WWTF = Waste Water Treatment Facility

(2.4) Explanation of Present Situation

(2.4.1) Sources and Uses

This factory uses only well water. There are two wells (one with 3 inches of pipe diameter and the other with 4 inches of pipe diameter) in the factory premises.

Well water is pumped up to a head tank and then supplied for various uses.

The pumps are operated with simultaneous put on cut off mode according to the water level in the head tank.

A flow meter is provided for No. 2 well, but none for No. 1 well.

Therefore, the administration estimates the pumped up quantity of No. 2 well on the basis of the ratio of the two wells, consequently the total consumption of water is also estimated.

Most water is used for washing of car air conditioners (100 m^3/d), washing in the Ni-plating process (30 m^3/d), cooling for various processes (67 m^3/d) and domestic purposes (10 m^3/d).

For washing in the Ni-plating process, the counter-flow method is adopted and washing water is re-used through a cascade system. The quantity of recovered water is estimated at about 10 m^3/d.

Cooling water for the No.1 and No.2 compressors and the spark plug assembling is recycled through two cooling towers, each of them has the capacity of 30 RT.

The designed recycle quantity of both towers is 21 m^3/h each, but the measured quantity was 10 m^3/h for the one (No.1 tower) and 7 m^3/h for the other (No.2 tower).

Cooling water for processes other than mentioned above is used in once-through system. There seems to be some room for further improvement in this respect.

(2.4.2) Water Treatment

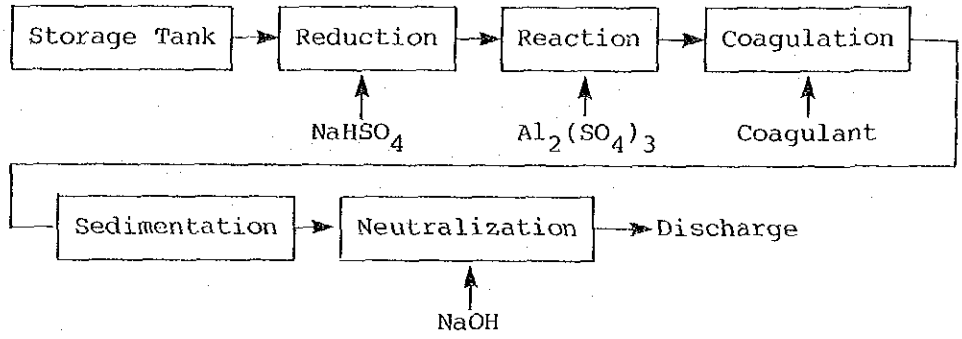
Water is pumped up from two wells and sent to the head tank. Then some water is used without any treatment, while the other water is treated by an ion exchanger before being used.

Water in the head tank has 900 $\mu S/cm$ of electrical conductivity and 1 mg/lit of turbidity.

Water treated by the ion exchanger is used for washing and plating bath in the Ni-plating process. Its also used for the boiler.

(2.4.3) Waste Water Treatment

Waste water from the Ni-plating process contains heavy metal such as Sn and Ni. Also, the car air conditioner assembling plant produces waste water containing heavy metal (Zn), acid (NHO3) and alkali (NaOH). This type of heavy waste water is gathered, treated and discharged in the following sequence.



(3.) Plans of Effective Use of Industrial Water

(3.1) General

Currently some cooling water is used in once-through system. It should be re-used by recycling.

As the cooling towers have still reserve capacity, the above-mentioned cooling water could be recycled through them.

The degree of concentration of cooling tower for compressors seems too high (3.3). It would be better to increase blow down water and lower the degree of concentration to around 2.

(3.2) Details

a. Recycle use of cooling water of once-through system through the existing cooling tower

Cooling water for spot welding and thread rolling might be recycled through the No.2 cooling tower. The quantity of water saving would be 43 m^3/d.

Cooling water for the stamp machine and the press machine might be recycled through the No.1 cooling tower. The quantity of water saving would be 20 m^3/d.

The capacities of the No.1 and No.2 cooling towers (before and after the implementation of improvement plan) are summarized below.

The quantity of water saving would reach 20 m^3/d.

The capacities of the No. 1 and No. 2 cooling towers (before and after the implementation of improvement plan) are summarized below.

Item \ Tower No.	1	2
Capacity (RT)	30	30
Before (Present) Recovered Quantity (m^3/h) Required Capacity (RT)	 10 14	 7 10
After Recovered Quantity (m^3/h) Required Capacity (RT)	 13 17	 12 17
Judgement of Plan	Feasible	Feasible

(4.) Cost Estimation

Number	1
Method for Effective Use Method Item	 Recycle use Recycle us of cooling water by existing cooling tower
Water Saving Use Quantity (m^3/d)	 Cooling 63
Apparatus for Effective Use Apparatus Cost (10^3฿)	 Pump, electric instrument & piping 318
Unit Cost (฿/m^3) Fixed Operating Total	 2.5 1.0 3.5

5.4.12 Code No. of Factory: M-12

(1.) Outline of Factory

Capital (M₿): -

Annual Amount of Shipment: 1,300 t/M

Total Area (m²): 7,200

Total No. of Employees: 31

Main Products: Steel Pipe of Furniture

(2.) Present Situation of the Use of Industrial Water

(2.1) Water Consumption

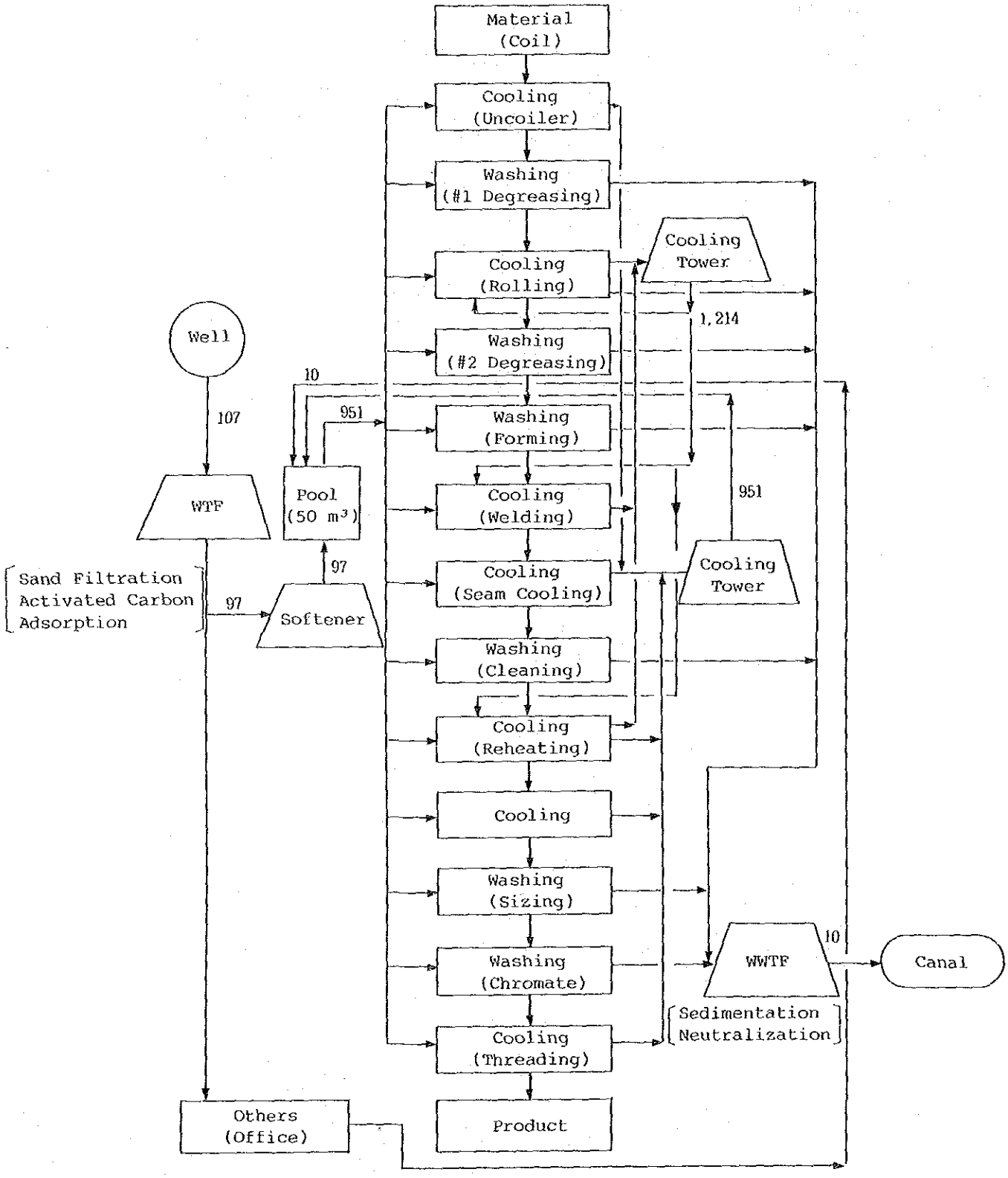
Unit: m³/d

Use \ Source	Well Water	MWA	Others	Sub Total	Recover-ed Water	Total
Boiler						
Material						
Processing & Washing	Assume 49			49	Assume 1,088	49
Cooling	Assume 48			48	2,175	2,223
Air Conditioning						
Others	10			10		10
Sub Total	107			107	2,175	2,282
Outside						
Total	107			107	2,175	2,282

Recovery Rate (%): 95.3

(2.2) Process Diagram of Production Line, and
Flow Diagram of Water Supply and Waste Water Discharge

(Unit: m^3/d)



Legend: WTF = Water Treatment Facility
WWTF = Waste Water Treatment Facility of

(2.4) Explanation of Present Situation

(2.4.1) Sources and Uses

At the time of the survey, this factory had not started its production on full scale. Therefore, some of the following explanation is hypothetical.

In this factory, water is supplied from a well (84 m deep). Well water is sent to a head tank (20 m^3) after treatment.

While domestic water is supplied directly from the head tank, processing water undergoes a softening treatment before being used.

To supply water to each production process, a pool with the capacity of 50 m^3 is installed. Well water (from the head tank) and recycled water (from the cooling towers) are gathered to this pool.

The quality of well water is shown below.

Item \ Data	Factory's Data	Survey's Value *
pH	6.3	7.85
Turbidity (mg/lit)	-	4
Electrical conductivity (μS/cm)	1,573	1,709
Total hardness (mg/lit)	385	
Chloride ion (mg/lit)	355	
Total ion (mg/lit)	0.5	

* Measured on October 30, 1988.

There are two cooling towers. The one (80 RT) operates at 90% of its capacity and the other (300 RT) at 20% of its capacity. The make-up water/recycled water ratio of the both towers are small (4.3% and 3.5% respectively), which indicates their operations are effectively controlled.

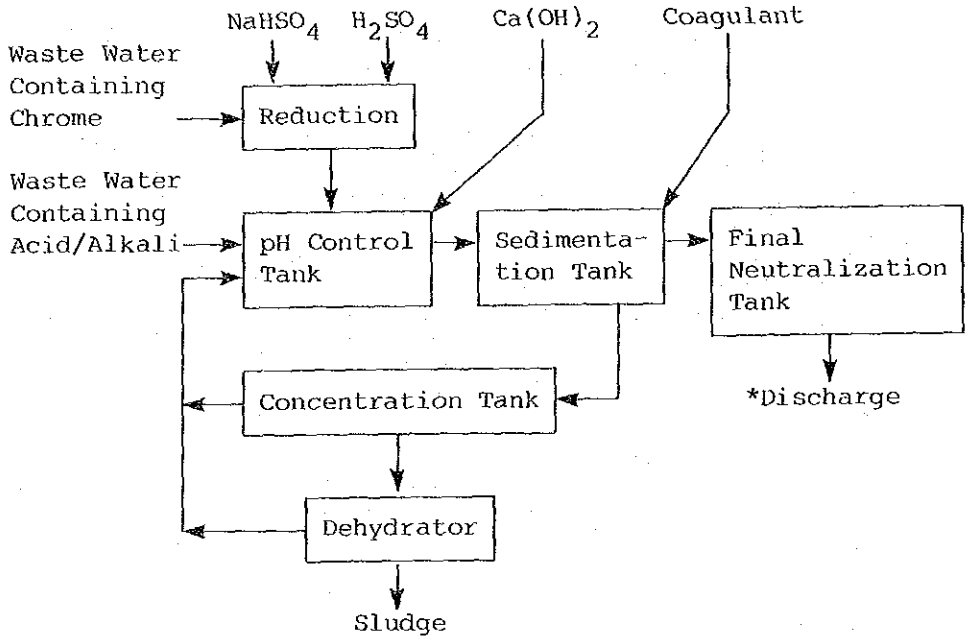
The electrical conductivities of recycled water are 1,830 μS/cm and 1,726 μS/cm respectively.

(2.4.2) Water Treatment

Water is treated as mentioned in (2.4.1) above.

(2.4.3) Waste Water Treatment

Waste water of the chrome plating process is treated as illustrated below. (In the illustration, treated waste water is "discharged". Yet, as stated in (2.2), the factory plans to recycle all treated water through the pool.)



(3.) Plans of Effective Use of Industrial Water

(3.1) General

As this factory adopts a complete water recycle system (a "closed system"), there is no room for further improvement. Rather, the water control system of this factory would provide a model for other factories.

5.4.13 Code No. of Factory: M-13

(1.) Outline of Factory

Capital (M₿): -

Annual Amount of Shipment: 100 t/d

Total Area (m²): 9,600

Total No. of Employees: 90

Main Products: Fine Steel Wire

(2.) Present Situation of the Use of Industrial Water

(2.1) Water Consumption

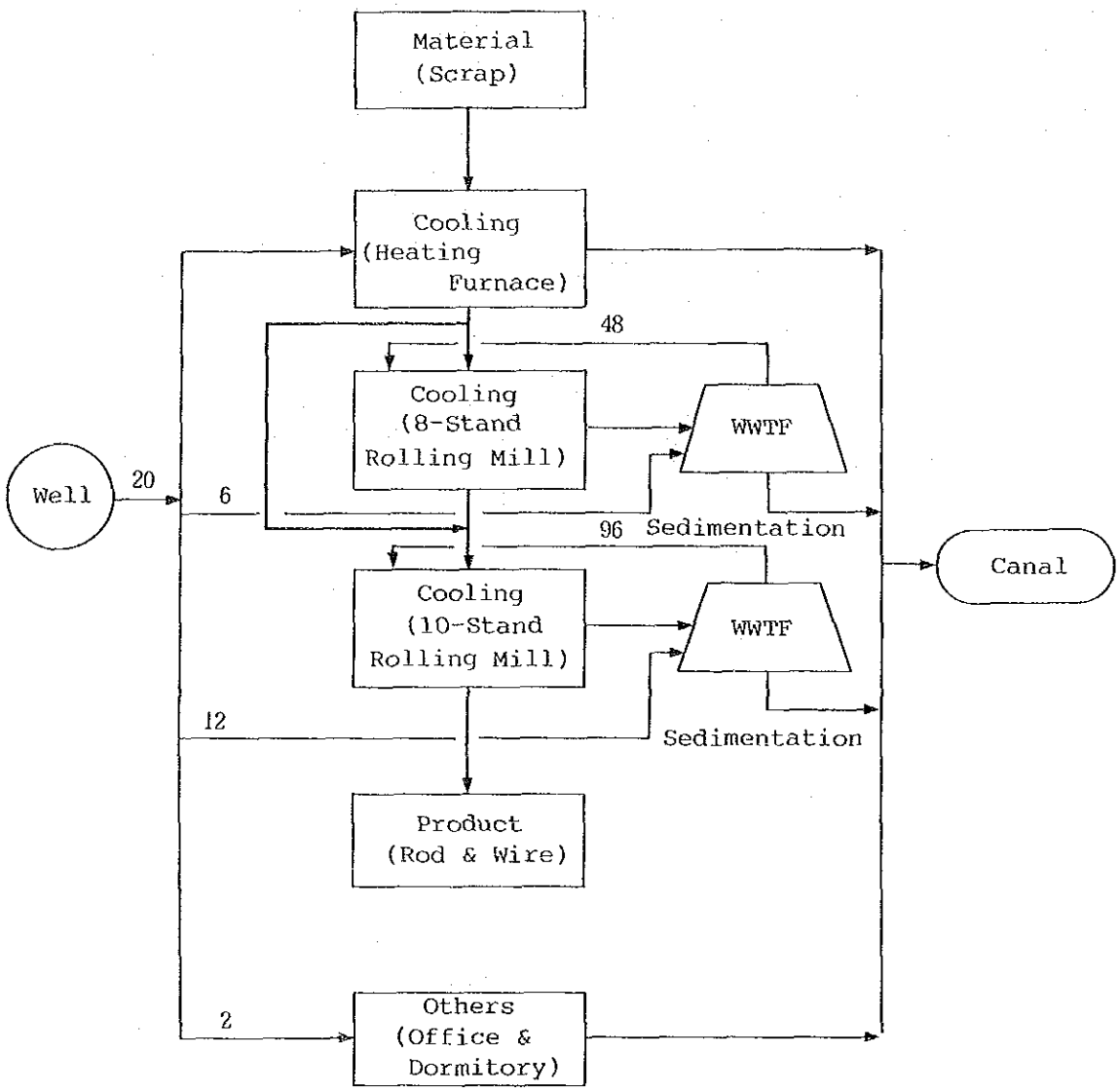
Unit: m³/d

Use \ Source	Well Water	MWA	Others	Sub Total	Recover-ed Water	Total
Boiler						
Material						
Processing & Washing						
Cooling	18			18	144	162
Air Conditioning						
Others	2			2		2
Sub Total	20			20	144	164
Outside						
Total	20			20	144	164

Recovery Rate (%): 87.8

(2.2) Process Diagram of Production Line, and
Flow Diagram of Water Supply and Waste Water Discharge

(Unit: m^3/d)



Legend:
WWTF = Waste Water Treatment Facility of
Sedimentation Process

(2.4) Explanation of Present Situation

(2.4.1) Sources and Uses

As virtually no data had been accumulated about the water consumption of this factory, the following explanation is based on the interviews and measurements carried out on the day of this survey.

The water source of this factory is a well inside the premises. The well has no flow meter. Well water is sent to a head tank (4 m^3) and supplied from there for various uses without any treatment.

The quality of well is not good. (pH 7.4, temperature 30 °C, electrical conductivity 1,989 μS/cm and turbidity 7 mg/lit)

Well water is mainly used as cooling water for rolling mills. There is no cooling tower, and cooling water is recycled through a small sedimentation tanks ("ponds").

Although water flowing from the rolling mills to the sedimentation tanks contains a lot of oil and grease, no oil/water separation is carried out. In consequence, water in the tanks looks very oily.

(2.4.2) Water Treatment

Well water is used for the production process without any treatment.

(2.4.3) Waste Water Treatment

The above-mentioned three sedimentation tanks also have function to treat waste water. The removal of scale is carried out from time to time by draining the water in the tanks.

(3.) Plans of Effective Use of Industrial Water

(3.1) General

The present water recovery rate is fairly high (87.8%). As the total quantity of water consumption is very small, there is little room for further improvement.

5.4.14 Code No. of Factory: M-14

(1.) Outline of Factory

Capital (M₿): 65

Annual Amount of Shipment (M₿): 73.2

Total Area (m^2): 83,315

Total No. of Employees: 310

Main Products: Trucks (Medium and Large Size) and Buses

(2.) Present Situation of the Use of Industrial Water

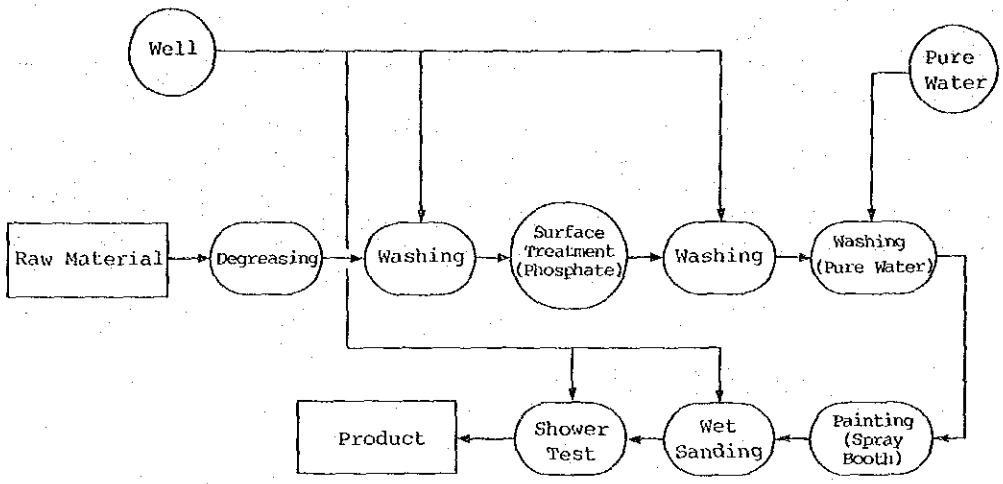
(2.1) Water Consumption

Unit: m^3/d

Use \ Source	Well Water	MWA	Others	Sub Total	Recover-ed Water	Total
Boiler						
Material						
Processing & Washing	205			205	350	555
Cooling	2			2	750	752
Air Conditioning						
Others	62			62		62
Sub Total	269			269	1,100	1,369
Outside						
Total	269			269	1,100	1,369

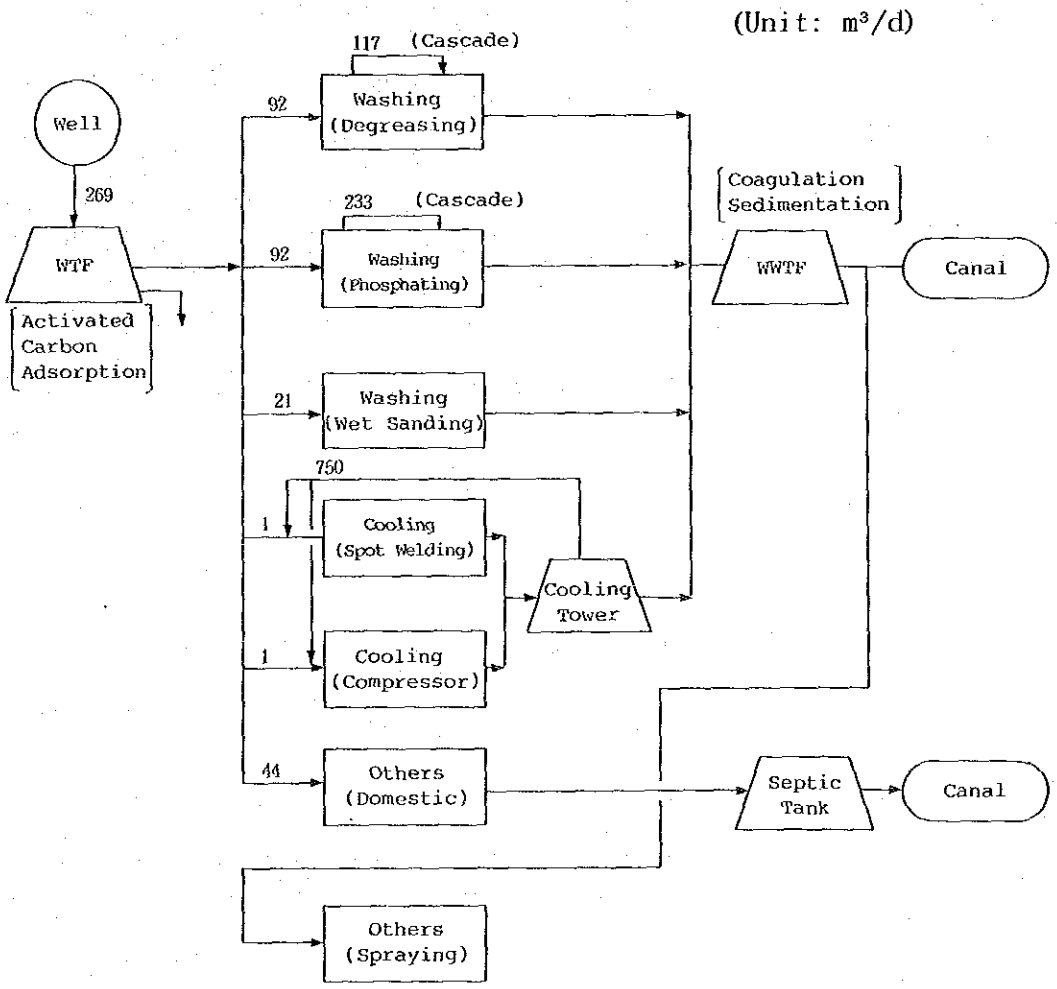
Recovery Rate (%): 80.3

(2.2) Process Diagram of Production Line



(2.3) Flow Diagram of Water Supply and Waste Water Discharge

(Unit: m^3/d)



Legend: WTF = Water Treatment Facility
WWTF = Waste Water Treatment Facility

(2.4) Explanation of Present Situation

(2.4.1) Sources and Uses

Although this factory purchases some pure water from the outside, most of water is supplied from two wells (the No.1 and No.2 wells). The No.2 well (150 m deep and 8 inches of pipe diameter) is the main one. The No.1 well (100 m deep and 8 inches of pipe diameter), its water quality being poor, is usually out of operation. As the No.2 well has no flow meter, the quantity of water consumption are estimated values.

Well water is mainly used for washing in the degreasing and the phosphating processes. Make-up water required for these two processes is estimated at about 92 m^3/d each. In these processes, cascade systems are adopted for the use of water.

Also, 21 m^3 of water is daily used for the wet sanding. As this process requires a constant supply of water, it is difficult to save water unless the wet sanding method itself is changed.

Purchased pure water (electrical conductivity: 1 μS/cm) is used for finish washing of the phosphating process. Around 2 m^3 of pure water (which costs 400 ₱/m^3) is used for this purpose.

Cooling water for the spot welding and the compressor is recycled through the cooling tower with the capacity of 150 RT (the recycle rate is 125 m^3/h). The supply of make-up water to the cooling tower is controlled by a ball tap. The degree of concentration of recycled water is very low.

Water used for the shower is also recycled.

Domestic water amounts to 44 m^3/d. The number of employees being 310, this is equivalent to 140 lit/capita/d, which is not particularly large.

(2.4.2) Water Treatment

Quality of No.2 well water is 1,100 μS/cm of electrical conductivity and zero mg/lit of turbidity, but is a brownish color owing to a high degree of iron contents (1.8 mg/lit). Therefore, to remove iron contents, it is treated by an activated carbon adsorption. Treated water is sent to a head tank before being supplied for various uses.

(2.4.3) Waste Water Treatment

The waste water treatment of this factory is mainly concerned with washing water for the degreasing, the phosphating and wet sanding processes. The coagulation/sedimentation system using aluminum sulphate is adopted. Around 100 m^3/d of waste water is treated.

(3.) Plans of Effective Use of Industrial Water

(3.1) General

The use of water in this factory is already highly effective by adopting the cascade use of washing water, the recycling of cooling water through the cooling tower, the re-use of treated waste water for sprinkling and the like. There is little room for further improvement.

5.4.15 Code No. of Factory: M-15

(1.) Outline of Factory

Capital (M$): 1,376

Annual Amount of Shipment (M$): 2,139 (127,000 t/Y)

Total Area (m^2): 41,600

Total No. of Employees: 469

Main Products: Tin Plate and Tin-Free Steel

(2.) Present Situation of the Use of Industrial Water

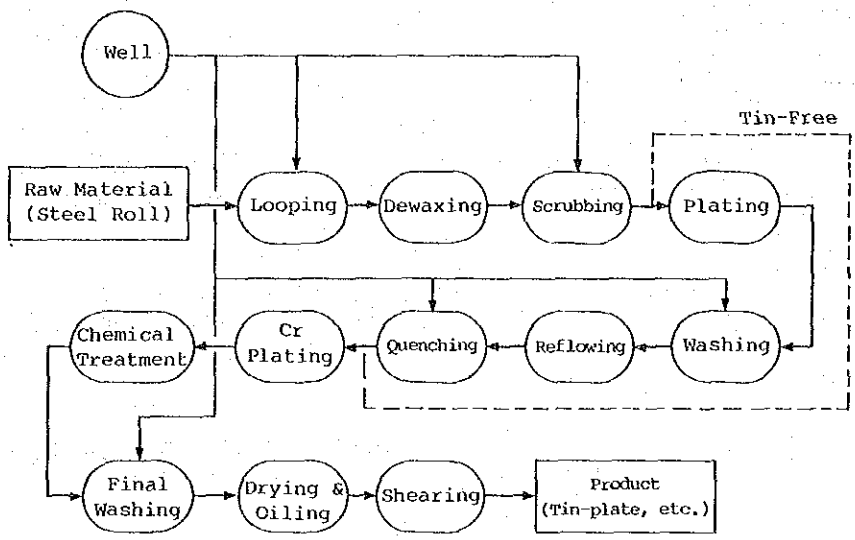
(2.1) Water Consumption

Unit: m^3/d

Use \ Source	Well Water	MWA	Others	Sub Total	Recover-ed Water	Total
Boiler	75			75		75
Material						
Processing & Washing	1,768			1,768		1,768
Cooling	844			844	4,800	5,644
Air Conditioning						
Others	475			475		475
Sub Total	3,162			3,162	4,800	79,62
Outside						
Total	3,162			3,162	4,800	7,962

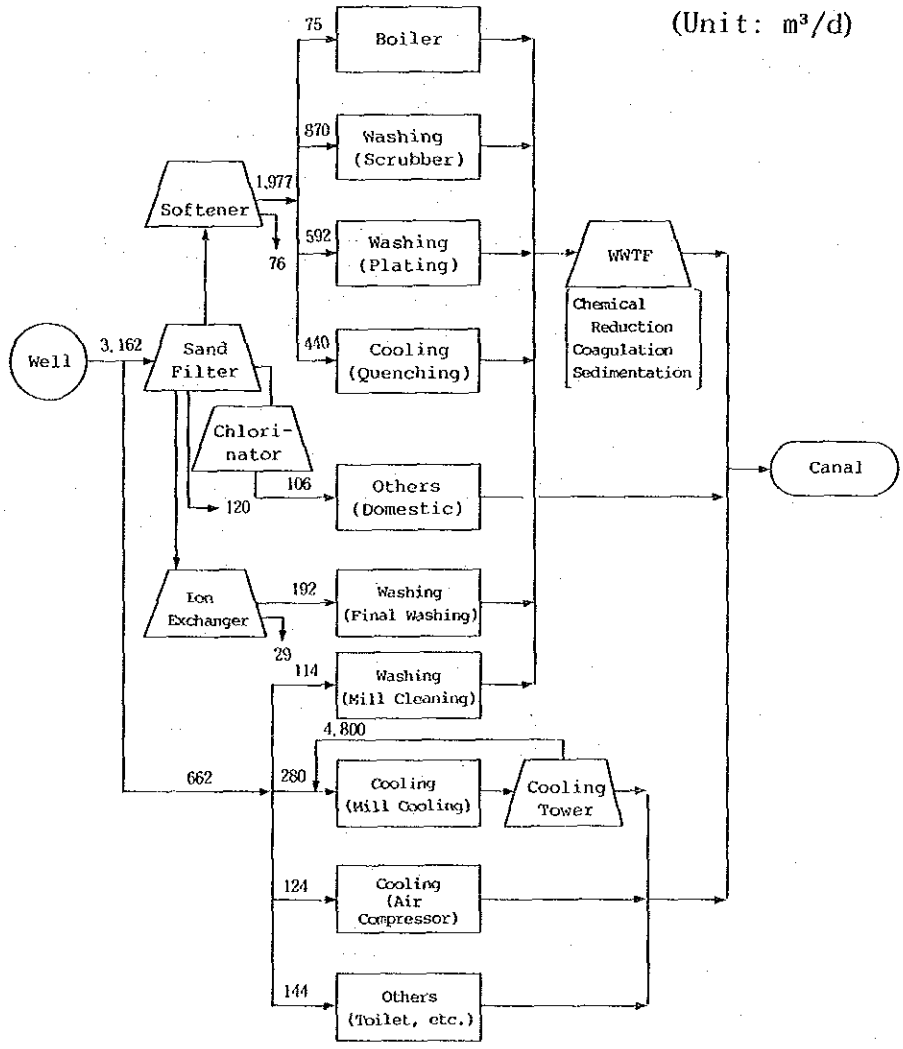
Recovery Rate (%): 60.3

(2.2) Process Diagram of Production Line



(2.3) Flow Diagram of Water Supply and Waste Water Discharge

(Unit: m³/d)



Legend: WWTF = Waste Water Treatment Facility

(2.4) Explanation of Present Situation

(2.4.1) Sources and Uses

The water sources of this factory are three wells (No.1 to No.3). The depths of the wells range from 100 m to 120 m. Three pumps, each with a capacity of 150-180 m^3/h, are used alternately. The quantity of well water is measured by flow meters.

The water is mostly used for washing (scrubbing, plating, quenching, chemical treatment, etc.) of the No.1 and No.2 electrolytic tinning lines and for cooling of the mill, air compressors, etc.

Cooling water for the mill is recycled through a cooling tower but cooling water for the air compressors is drained off after one pass.

Water consumption of domestic purposes is 250 m^3/d which is the fairly large quantity of 533 lit/capita/d for the 469 employees of this factory.

Water treatment is described later but the backwashing water is 120 m^3/d for sand filter, 76 m^3/d for softener and 29 m^3/d for ion exchanger, making a large total of 225 m^3/d.

(2.4.2) Water Treatment

Although water quality is very good, pH being 7.0, electrical conductivity 534 $\mu S/cm$ and turbidity zero mg/lit, it is treated by a sand filter, chlorinator, demineralizer, etc.

The flow is shown in Fig. M-15

(2.4.3) Waste Water Treatment

Waste water from the electrolytic tinning lines is treated by coagulation and sedimentation processes using iron sulphate.

(3.) Plans of Effective Use of Industrial Water

(3.1) General

The factory mentioned the following three points as their ideas for more effective use of water:

a. Recycle of compressor cooling water;

b. Cascade use of washing water for scrubber of No.1 electrolytic tinning line;

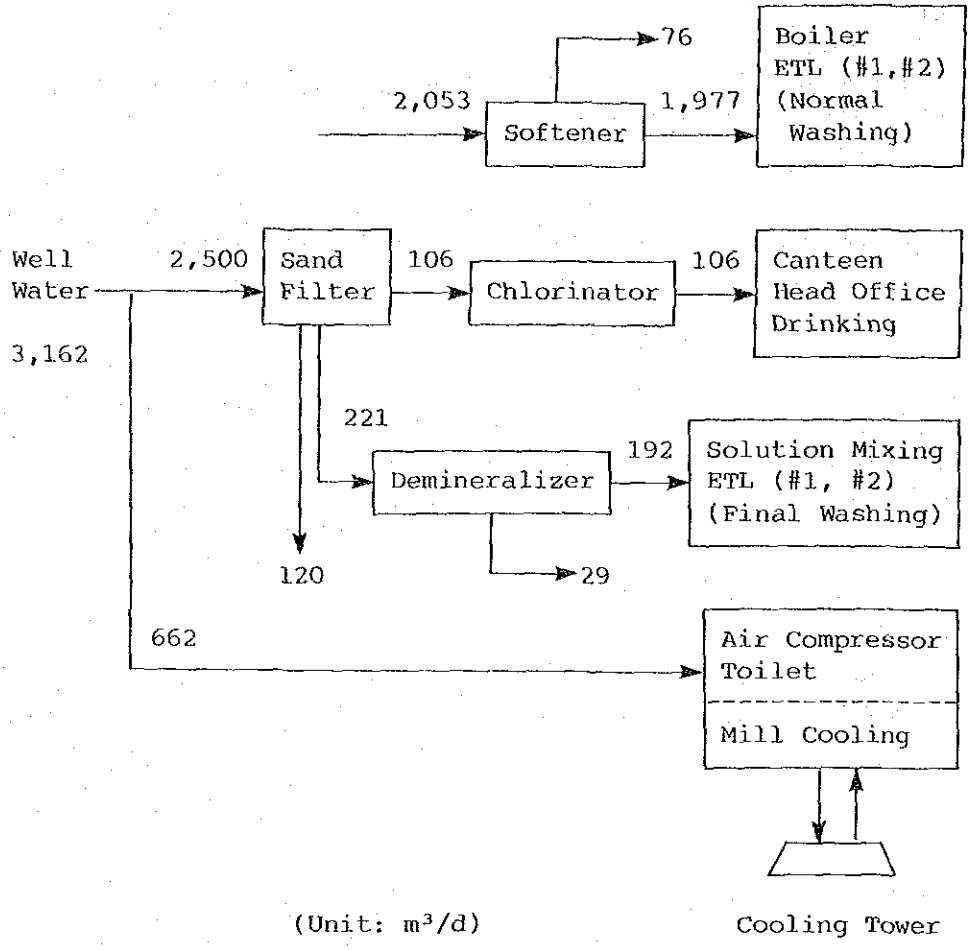


Fig. M-15: Flow of Factory M-15

c. Multistage use of final washing water of the above.

As cooling water other than for the compressors is recycled through a cooling tower, there is no room for further improvement.

As quality of washing water gives a direct influence to product quality, it is difficult to improve on its effective use. However, as the quantity of backwashing water for sand filter, etc. is large, plans to save of this should be considered.

As the quantity of domestic water is large, it should be investigated.

(3.2) Details

a. Recycle use of cooling water of once-through system through the existing cooling tower

As there is sufficient reserve capacity in the existing cooling tower, the cooling water for the compressor might be recycled through the cooling tower. The quantity of water saving would be 110 m^3/d.

b. Cascade use of washing water for scrubber

No. 1 electrolytic tinning line has two scrubbers, No. 1 and No. 2, and 6.9 m^3/h of water is supplied to each. By cascading from No. 2 to No. 1, possible quantity of water saving would be 166 m^3/d for 24 hours a day.

c. Multistage use of washing water for tinning process

In the final washing process of the No. 1 electrolytic tinning process, the washing water tank is divided in two sections, and demineralized water is supplied to each. This might be changed to multistage countercurrent flow. Possible quantity of water saving, based on the same premise as b., would be 146 m^3/d.

d. Reduction of backwashing water by improving operation control of water treatment system

The discharged backwashing water of the sand filters, softeners and ion exchangers amounts to 7% of the total make-up water. This could be lowered to 5%, and 63 m^3/d would be saved.

e. Check and control of domestic water consumption

If unit consumption of domestic water is reduced to 300 lit/capita/d, the total quantity would become about 141 m^3/d. Thus, about 110 m^3/d of water would be saved.

(4.) Cost Estimation

#	Method for Effective Use		Water Saving Apparatus for Effective Use				Unit Cost (฿/m³)		
	Method	Item	Use*	Qt.** (m³/d)	Apparatus	Cost (10³฿)	Fixed	Operating	Total
1	Recycle use	Recycle use of cooling water by existing cooling tower	C	10	Piping	23	0.1	0.5	0.6
2	Application of cascade use	Cascade use of scrubbing water	PW	166	Tank 4 m³ x 1, pump, electric instrument & piping	289	0.7	1.3	2.0
3	Multistage use	Multistage use of washing water in metal plating process	PW	146	Tank 2 m³ x 1, pump, electric instrument & piping	289	0.7	1.3	2.0
4	Improvement of operation control	Thorough control of operation and maintenance of water treatment system to decrease backwashing water	PW	63			-	-	-
5	Control of water use	Check and control of water requirement for domestic use	D	110			-	-	-
	Total			595		601			1.2

Note: Use* -- C = Cooling; PW = Processing & Washing; D = Domestic
Qt.** = Quantity

5.4.16 Code No. of Factory: M-16

(1.) Outline of Factory

Capital (M₩): -

Annual Amount of Shipment (M₩): 140 (6,620 t/Y)

Total Area (m²): 12,634

Total No. of Employees: 127

Main Products: Iron Wire, Steel Wire and Spring Wire

(2.) Present Situation of the Use of Industrial Water

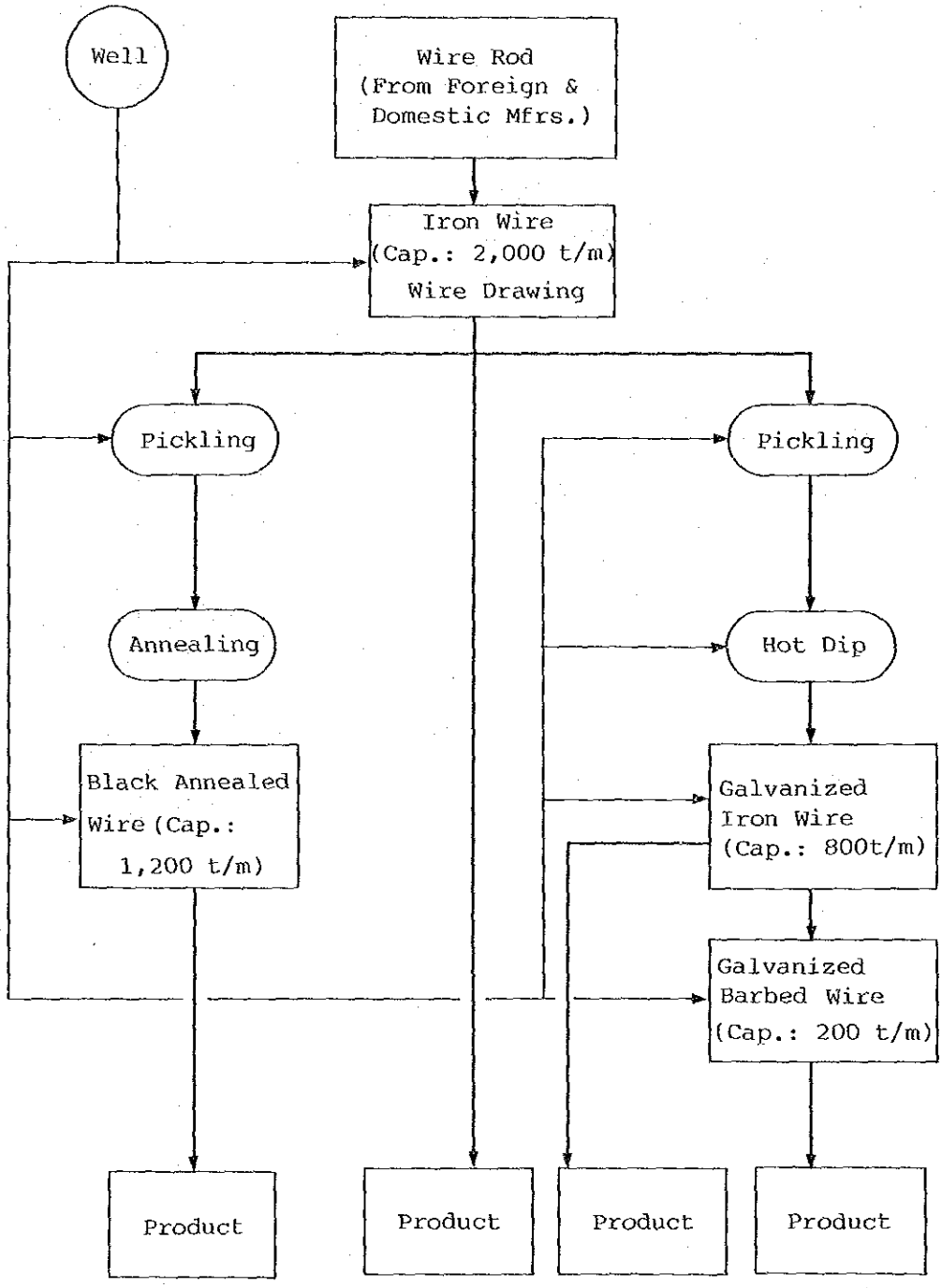
(2.1) Water Consumption

Unit: m³/d

Source / Use	Well Water	MWA	Others	Sub Total	Recover-ed Water	Total
Boiler						
Material						
Processing & Washing	440			440		440
Cooling	21			21	1,072	1,093
Air Conditioning						
Others	68			68		68
Sub Total	529			529	1,072	1,601
Outside						
Total	529			529	1,072	1,601

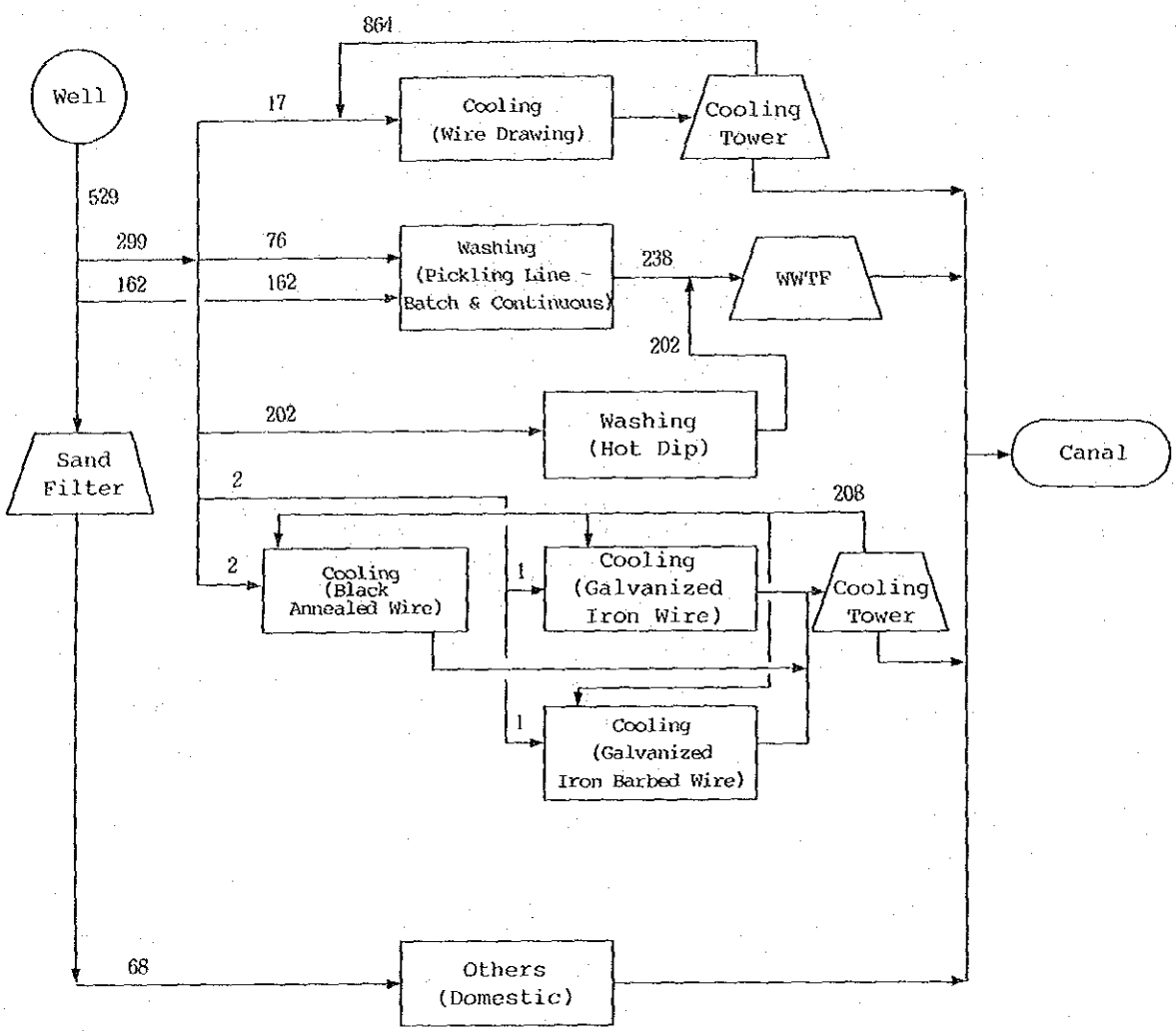
Recovery Rate (%): 67.0

(2.2) Process Diagram of Production Line



(2.3) Flow Diagram of Water Supply and Waste Water Discharge

(Unit: m^3/d)



Legend: WWTF = Waste Water Treatment Facility of
Neutralization and Sand Filtration Processes

(2.4) Explanation of Present Situation

(2.4.1) Sources and Uses

The water sources for this factory are two wells (No.1 and No.2). The average quantity of water pumped up from Well No.1 is 76 m^3/d and that from Well No. 2 is 459 m^3/d. The well water is first sent to a 40 m^3 storage tank and the water is supplied to the factory through two systems, one is directly and the other is via a pressure tank.

The water quality is good as follows:

pH:	7.10 - 7.28
Total iron:	0.13 - 0.16 mg/lit
Total hardness:	80 - 98 mg/lit
Manganese:	0.05 - 0.21 mg/lit
Chloride ion:	63 - 71 mg/lit
Electrical conductivity :	794 - 845 μS/cm

For domestic use, iron and manganese are removed.

The production record for 1986 of this factory is as follows:

Iron wire:	2,500 t
Galvanized iron wire:	900 t
Spring wire:	820 t
Galvanized steel wire:	2,400 t
Total:	6,620 t

From the foregoing, the water/production ratio would be 28.8 m^3/t of make-up water and 87.0 m^3/t of total water consumption.

Cooling water is used for the winder of the steel wire drawing machine and is recycled through a cooling tower (temperature 31 ℃ to 28 ℃).

Some 83% of the make-up water for product treatment and washing is used for acid cleaning and hot water washing.

68 m^3/d is used for domestic purposes which is rather large quantity of 535 lit/capita/d for the 127 employees.

(2.4.2) Water Treatment

Untreated well water is used for the production processes, but water for domestic use is treated by sand filter to remove iron and manganese, as mentioned previously.

(2.4.3) Waste Water Treatment

Waste water from acid cleaning and hot water washing is treated together by neutralization and sand filtration processes.

The quality of the treated waste water is as follows:

pH:	6.0 - 7.8
Suspended solids:	2.5 - 5.0 mg/lit
BOD:	1 - 16.4 mg/lit
Total iron:	0.05 - 2.85 mg/lit
Zinc:	0.02 mg/lit

(3.) Plans of Effective Use of Industrial Water

(3.1) General

While it is possible for the water for acid cleaning and hot water washing to be reclaimed and re-used, the costs for the necessary facilities and for operating the facilities make practical application difficult.

As mentioned previously, cooling water is recycled. The make-up water for the cooling tower amounts to only about 2% of the recycled quantity.

The quantity of water used for domestic purposes needs to be investigated as it is excessive.

(3.2) Details

a. Check and control of domestic water consumption

If unit consumption of domestic water is reduced to 300 lit/capita/d, the total quantity would become about 38 m^3/d. Thus, about $30^3/d$ of water would be saved.

(4.) Cost Estimation

Number	1
Method for Effective Use Method Item	 Control of water use Check and control of water requirement for domestic use
Water Saving Use Quantity (m^3/d)	 Domestic 30
Apparatus for Effective Use Apparatus Cost (10^3₿)	
Unit Cost (₿/m^3) Fixed Operating Total	 - - -

5.4.17 Code No. of Factory: M-17

(1.) Outline of Factory

Capital (M₿): 40

Annual Amount of Shipment: 53,200 t/Y

Total Area (m²): 24,212.5

Total No. of Employees: 413

Main Products: Parts of Automobile (Coil Spring, Leaf Spring, Seat and etc.)

(2.) Present Situation of the Use of Industrial Water

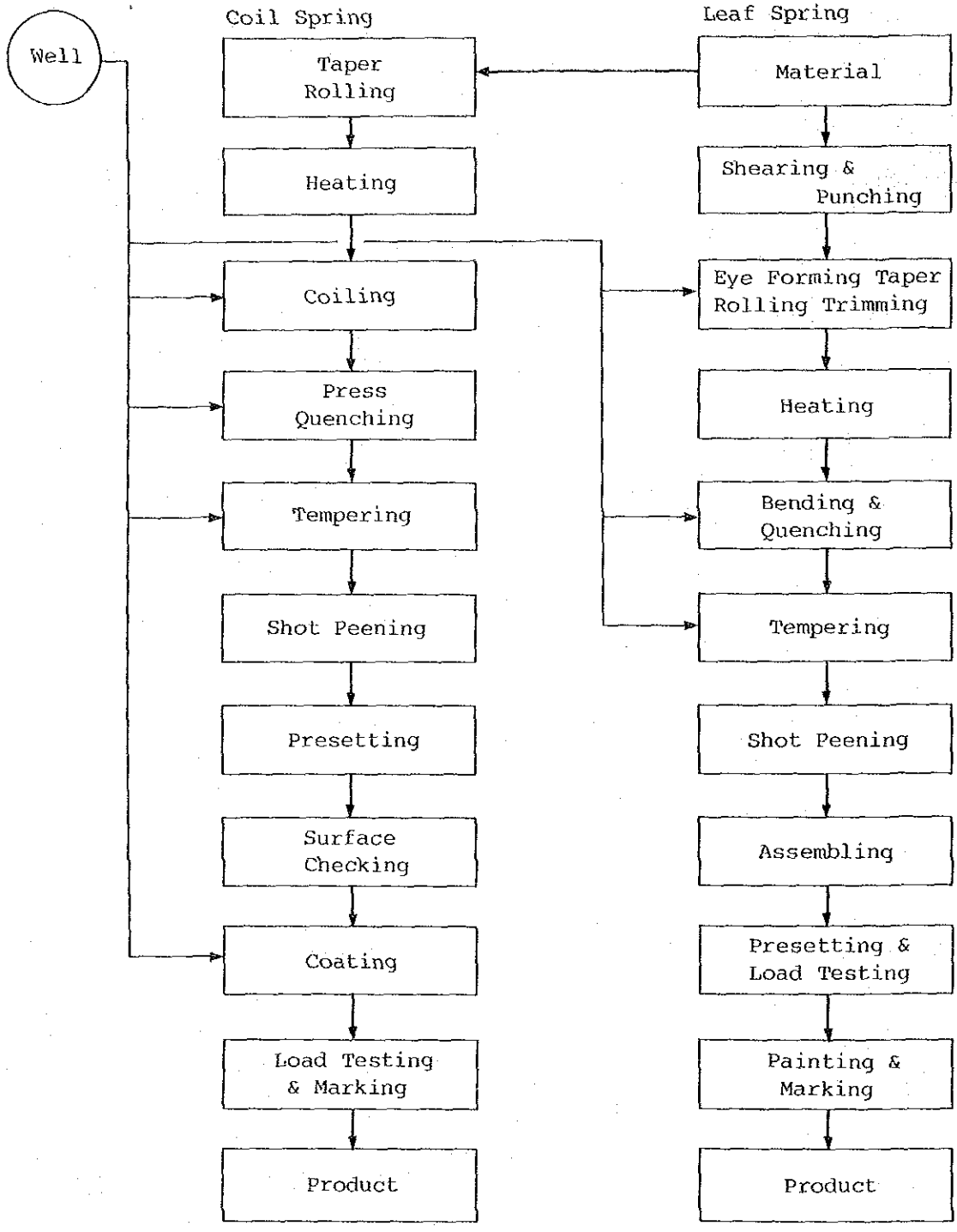
(2.1) Water Consumption

Unit: m³/d

Use \ Source	Well Water	MWA	Others	Sub Total	Recover-ed Water	Total
Boiler	4			4		4
Material						
Processing & Washing	37			37		37
Cooling	88			88	1,256	1,344
Air Conditioning						
Others	11			11		11
Sub Total	140			140	1,256	1,396
Outside						
Total	140			140	1,256	1,396

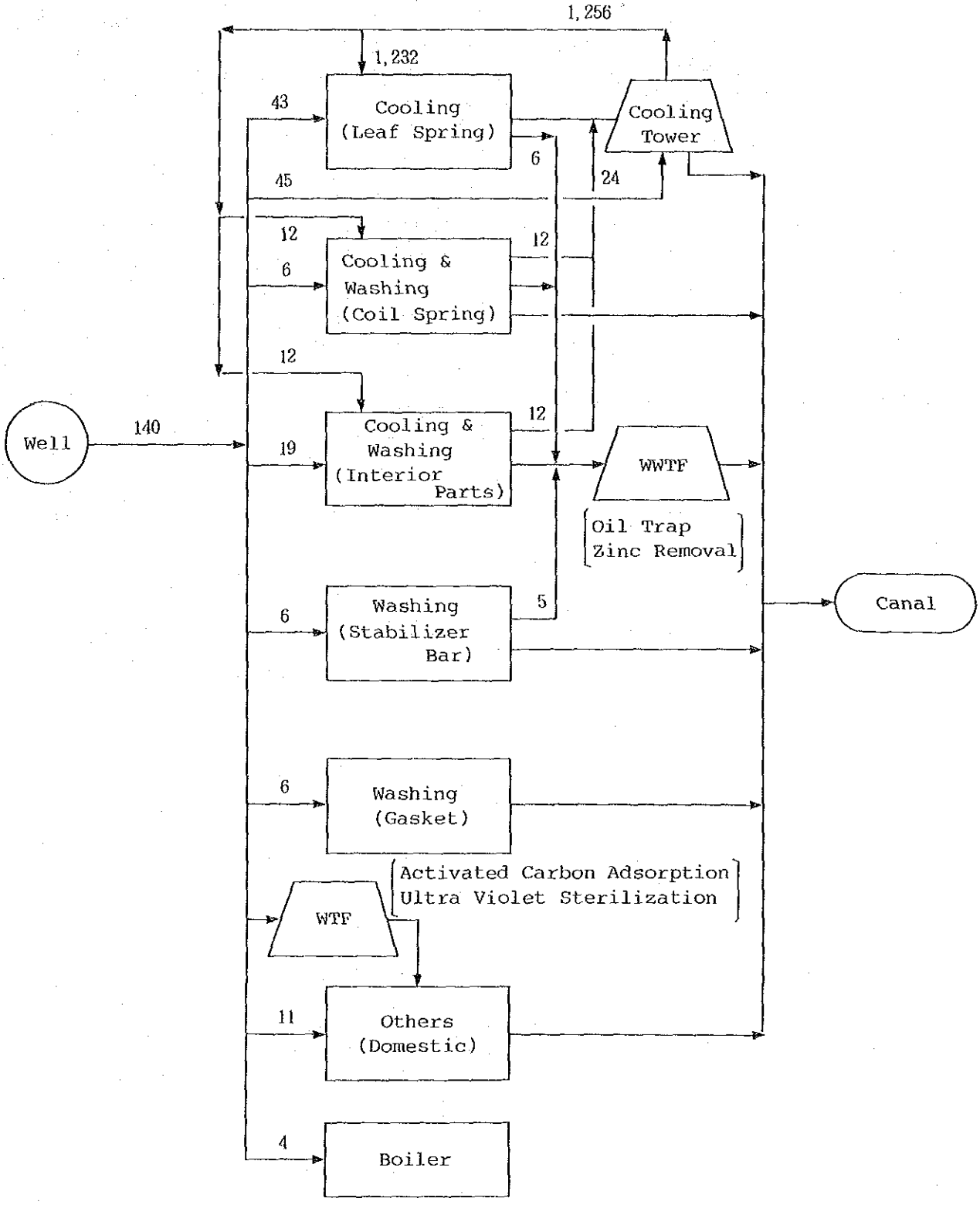
Recovery Rate (%): 90.0

(2.2) Process Diagram of Production Line



(2.3) Flow Diagram of Water Supply and Waste Water Discharge

(Unit: m³/d)



Legend: WTF = Water Treatment Facility
WWTF = Waste Water Treatment Facility

(2. 4) Explanation of Present Situation

(2. 4. 1) Sources and Uses

The water source of this factory is one well of 70 m deep. The well water is supplied for the production processes without any treatment, but it is carbon filtered and ultraviolet treated for office use.

Water quality is very good as follows:

Item \ Data	Factory data	Measured data
pH	7.9	7.05
Turbidity	4.4 NTU	4 mg/lit
Total hardness (mg/lit)	83	
Chloride ion (mg/lit)	90	
Total ion (mg/lit)	0.98	
Electrical conductivity (μS/cm)		863

Cooling water is recycled through a cooling tower, but according to calculations and measurements, the degree of concentration does not appear to be high.

(2. 4. 2) Water Treatment

The well water is used without any treatment. However, some is used in the office, as mentioned previously, after being carbon-filtered and ultraviolet treated.

(2. 4. 3) Waste Water Treatment

Waste water from the painting line is treated for removal of oil and grease with oil traps and that from the plating line is chemically treated for removal of zinc.

(3.) Plans of Effective Use of Industrial Water

(3. 1) General

As shown in the flow diagram, the recovery rate is as high as 90%. However, there is quite a bit of assumption in this figure. Water balance around the cooling tower is not fully clarified. If this were investigated further, it may be possible to save water by increasing the degree of concentration. However, currently there seems no apparent effective methods for further improvement.

5.4.18 Code No. of Factory: M-18

(1.) Outline of Factory

Capital (M₿): 130

Annual Amount of Shipment (M₿): 5,476 (18,800 units/Y)

Total Area (m^2): 124,800

Total No. of Employees: 585

Main Products: Passenger Car and Pickup Truck

(2.) Present Situation of the Use of Industrial Water

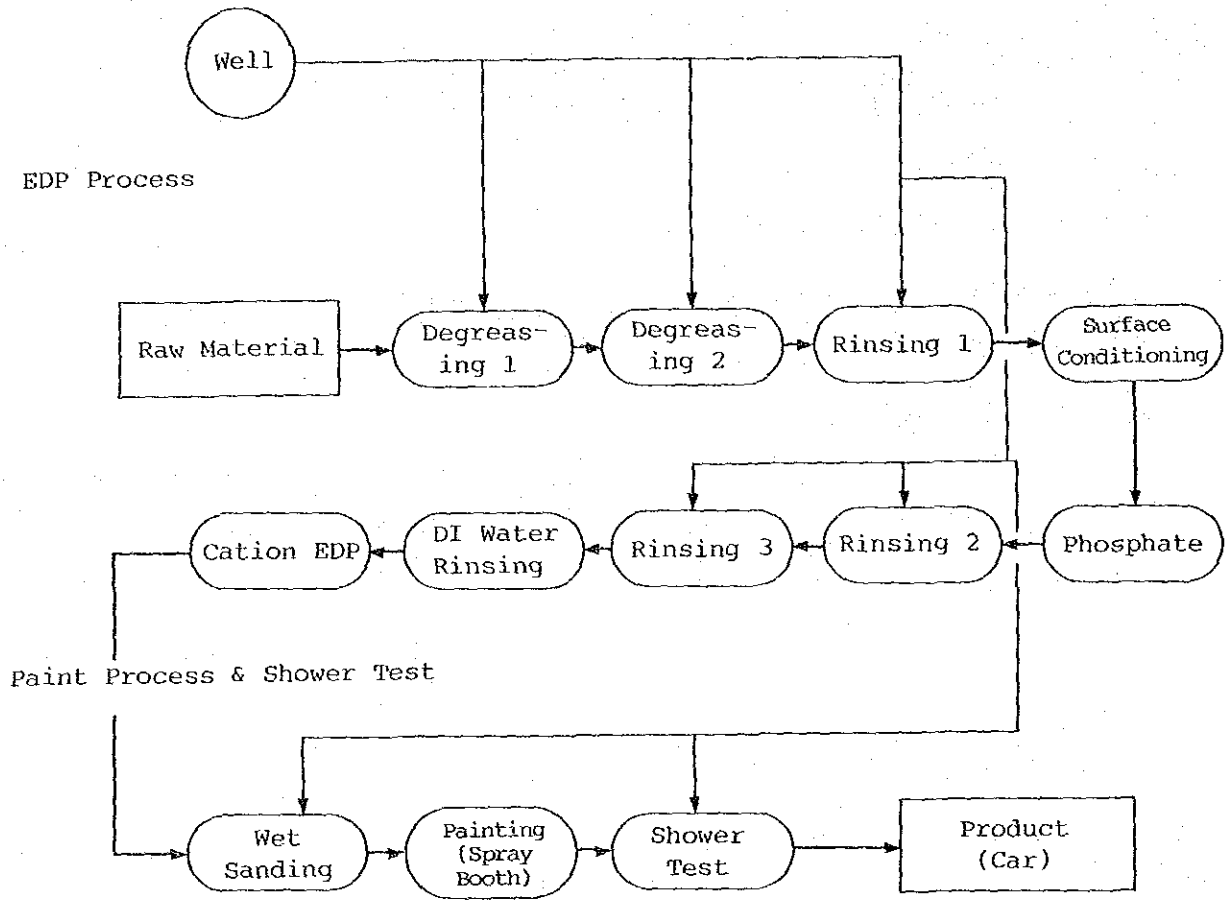
(2.1) Water Consumption

Unit: m^3/d

Source / Use	Well Water	MWA	Others	Sub Total	Recover-ed Water	Total
Boiler	1			1		1
Material						
Processing & Washing	301			301		301
Cooling	15			15	1,420	1,435
Air Conditioning	2			2	40	42
Others	298			298		298
Sub Total	617			617	1,460	2,077
Outside						
Total	617			617	1,460	2,077

Recovery Rate (%): 70.3

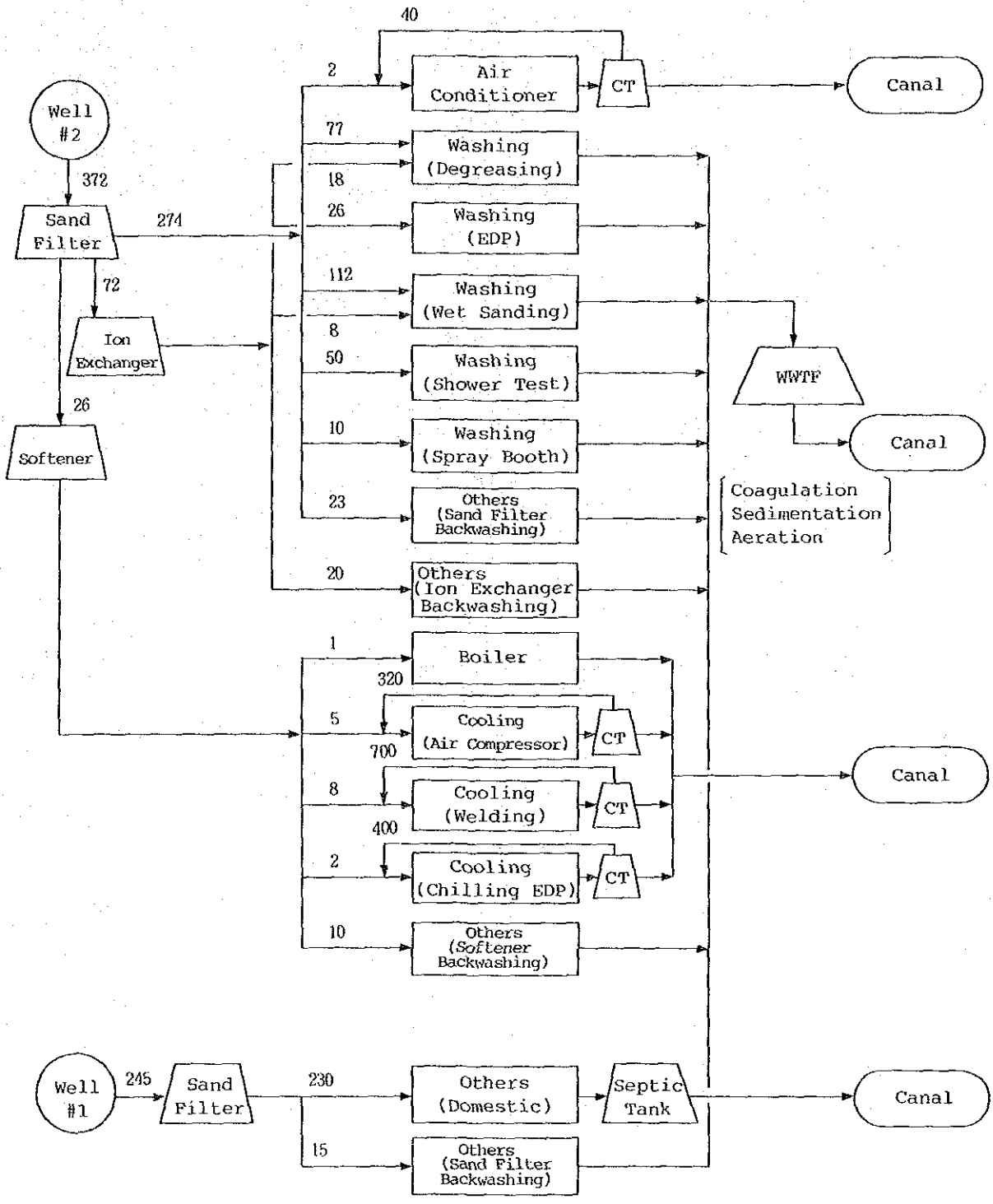
(2.2) Process Diagram of Production Line



Remarks: DI Water = Deionized Water
EDP = Electro Deposition Plating

(2.3) Flow Diagram of Water Supply and Waste Water Discharge

(Unit: m³/d)



Legend: CT = Cooling Tower
WWTF = Waste Water Treatment Facility

(2.4) Explanation of Present Situation

(2.4.1) Sources and Uses

The water source of this factory is Wells No.1 and No.2. Water from Well No.1 is used mainly for domestic use, while that from Well No.2 is used mainly for production line. Flow meter is installed in both wells.

The main use of the water is for pretreatment of painting; i.e. washing water for degreasing, etc. (95 m^3/d), for wet sanding (120 m^3/d) and for shower test (50 m^3/d).

In the pretreatment process of painting, the washing water is cascaded and the spray method is used for washing, so the water is being used effectively. While washing water used in wet sanding is wasted by overflow, etc. and in need of somewhat better control, in the actual sanding process, water must be supplied at all times so it is difficult to improve water use. The quantity of water for the shower test per unit production is rather high figure of 600 lit/unit.

The cooling water is almost completely recycled through cooling towers. Operating data of these towers are shown in Table M-18.

From these data, it may be seen that the equipment is being operated at fairly high degrees of concentration.

230 m^3/d is used for domestic purposes which is fairly high quantity of 390 lit/capita/d for the 585 employees.

(2.4.2) Water Treatment

Water quality of Well No.1 is 1,700 μS/cm of electrical conductivity and 9 mg/lit of turbidity and lt is used for domestic purposes after being treated by sand filter.

Water quality of Well No.2 is 850 μS/cm electrical conductivity and zero mg/lit of turbidity and it is treated by a sand filter for ordinary uses.

The sand filtrated water is further softened for the boiler and make-up water of the cooling towers.

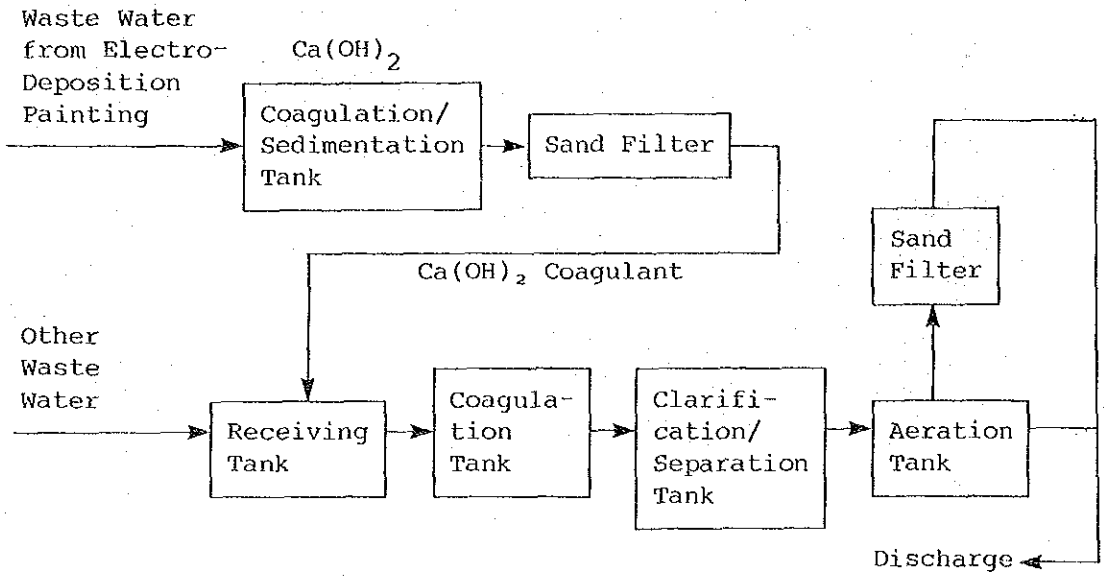
Also a part is used for the final washing, etc. of the electro deposition coating after being demineralized.

Table M-18: Operating Data of Cooling Towers

No.	1	2	3	4
Process (Cooling unit)	Air Compressor	EPD Chiller	Spot welding	Air conditioner
Recovered qt. (m^3/h)	50	50	100	5
Operating hours (h/d)	6.5	8.0	7.0	8.0
Recovered water (m^3/d)	325	400	700	40
Make-up water (m^3/d)	5	2	8	2
Make-up water Source	#2 Well Softened water	"		#2 Well Sand filtrated water
Conductivity ($\mu S/cm$)	1,120	"	"	"
Electrical conductivity of recycled water ($\mu S/cm$)	5,070	9,360	1,800	-
Degree of concentration	5	9	2	-

(2.4.3) Waste Water Treatment

The flow of waste water treatment is as follows:



(3.) Plans of Effective Use of Industrial Water

(3.1) General

Washing water for the precoating treatment of painting process is already being effectively utilized by adoption of the cascade system. Also, cooling water is being recycled through a cooling tower.

The quantity of water used for the shower test is large, so consideration should be given for water saving.

The quantity of water for domestic use is fairly large when compared to the number of employees (393 lit/capita/d).

(3.2) Details

a. Recycle of shower test water of once-through system

Shower test water of once-through system might be recycled. The supply of make-up water would be adjusted by ball-tap, a water level controller. Assuming 50% recovery, the possible quantity of water saving would be 25 m^3/d.

b. Check and control of domestic water consumption

If unit consumption of domestic water is reduced to 300 lit/capita/d, the total quantity would become about 176 m^3/d. Thus, about 54 m^3/d of water would be saved.

(4.) Cost Estimation

Number	1	2
Method for Effective Use Method Item	Recycle use Recycle use of shower shower water	Control of water use Check and control of water requirement for domestic use
Water Saving Use Qt. (m^3/d)	Processing & washing 25	Domestic 54
Apparatus for Effective Use Apparatus Cost (10^3฿)	Pump, electric instrument & piping 140	
Unit Cost (฿/m^3) Fixed Operating Total	 3.1 1.0 4.1	 - - -

Total Water Saving (m^3/d): 79

Total Initial Cost (10^3฿): 140

Total Unit Cost (฿/m^3): 1.3

Note: Qt. = Quantity

5.4.19 Code No. of Factory: M-19

(1.) Outline of Factory

Capital (M₱): 110

Annual Amount of Shipment (M₱): 2,710

Total Area (m²): 17,600

Total No. of Employees: 341

Main Products: Motorcycle and Engine for General Use
(Motorcycle 100,000 units/Y)
(Engine 20,000 units/Y)

(2.) Present Situation of the Use of Industrial Water

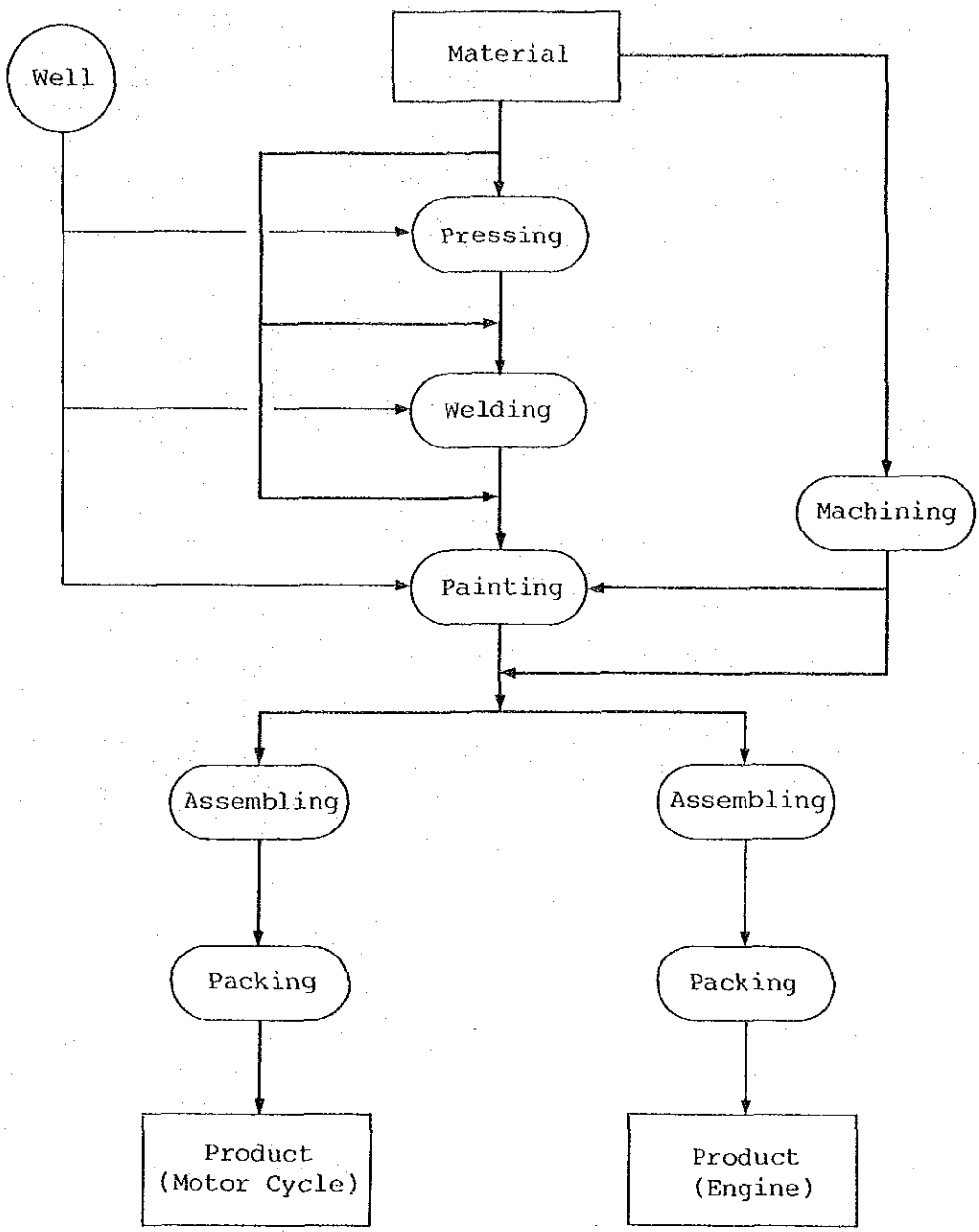
(2.1) Water Consumption

Unit: m³/d

Use \ Source	Well Water	MWA	Others	Sub Total	Recover-ed Water	Total
Boiler	8			8		8
Material						
Processing & Washing	40			40		40
Cooling	90			90	600	690
Air Conditioning						
Others	212			212		212
Sub Total	350			350	600	950
Outside						
Total	350			350	600	950

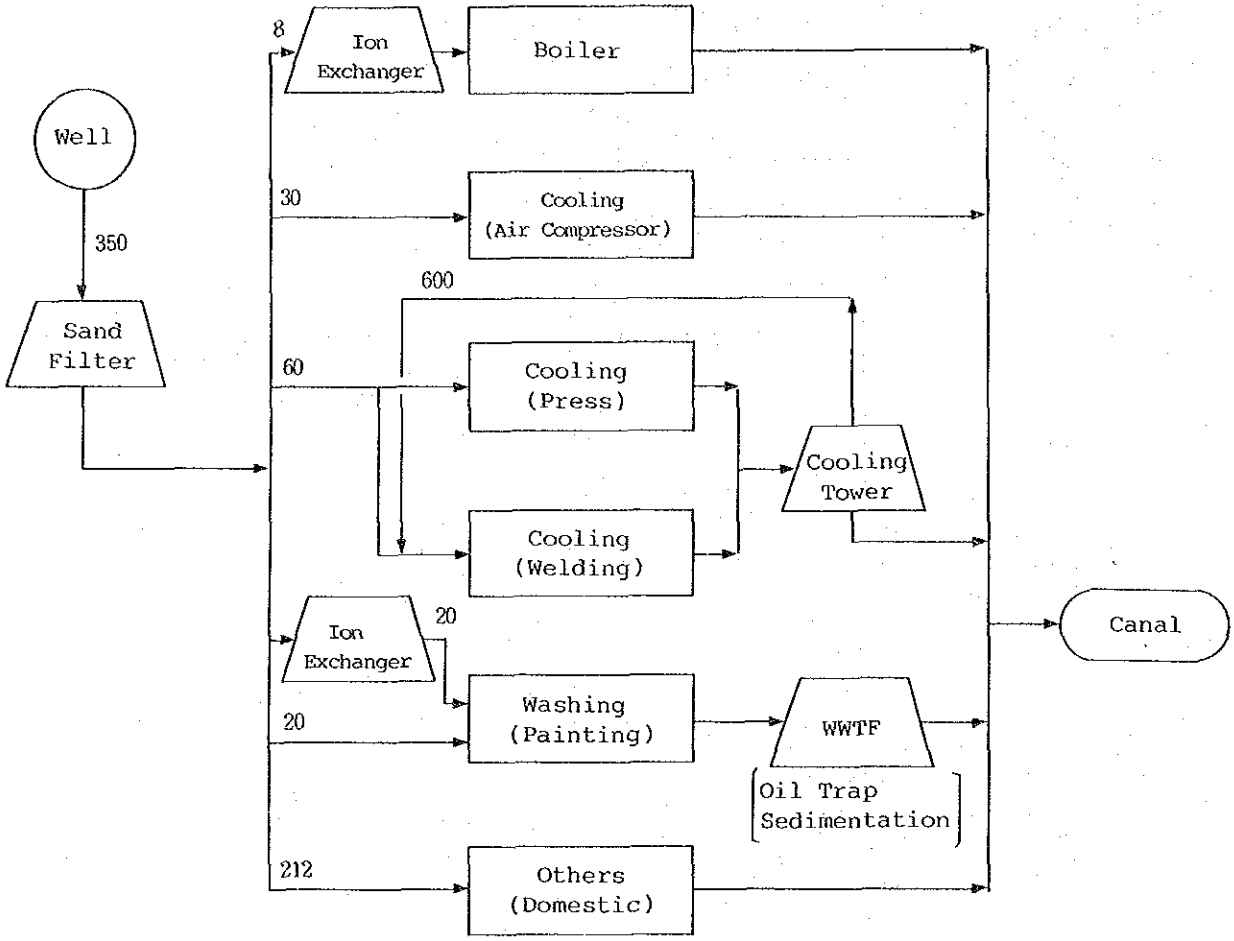
Recovery Rate (%): 63.2

(2.2) Process Diagram of Production Line



(2.3) Flow Diagram of Water Supply and Waste Water Discharge

(Unit: m³/d)



Legend: WWTF = Waste Water Treatment Facility

(2.4) Explanation of Present Situation

(2.4.1) Sources and Uses

Water source for this factory is one well (125 m deep) and the pumping capacity is 77 m^3/h.

The well water is treated by a sand filter, stored in a 20 m^3 tank and supplied to the factory via a pressure tank.

The main uses of the water are for cooling of the pressing process and welding process, and washing of the painting process. The assembling process does not use any water.

The painting process is divided into surface treatment and painting, with the former using water which is treated by sand filter and the latter, in the final washing process, using water which is treated by ion exchanger. The washing process adopts the multistage counter-current system, showing an effort made to utilize the water effectively.

Water used for cooling is recycled through cooling tower with a capacity of 250 RT. Based on the daily recycled quantity of 600 m^3/d, the tower is operating at about 43% capacity.

The degree of concentration of the cooling tower, when based on the ratio of the conductivity of the recycled water and the well water, is 1.18, so there is not much accumulation of it.

The quantity of water used for domestic purposes is 212 m^3/d which is 60% of the quantity of the well water used. This ls 606 lit/capita/d for the 350 employees, a very high level.

(2.4.2) Water Treatment

As mentioned before, all water used in the factory is treated by sand filter.

The water quality is rather poor so water for boiler and for final washing of the surface treatment process is treated by ion exchanger.

(2.4.3) Waste Water Treatment

Waste water from the surface treatment process is chemically treated, including precipitation, while that from the painting process is treated by oil traps, etc., and then discharged into the canal.

The waste water treatment facility was set up in April 1983. Its capacity is 40 m^3/d, but it is actually said that 35 to 40 m^3/d is being treated.

The quality of the waste water is as follows:

pH:	7
SS:	25 mg/lit or less
COD:	3 mg/lit or less
Oil and grease:	4 mg/lit or less
Total iron:	0.1 mg/lit or less
Zinc:	0.4 mg/lit or less
Nickel:	0.1 mg/lit or less

(3.) Plans of Effective Use of Industrial Water

(3.1) General

Cooling water for the compressor is used on a once-through system, so it could be recycled.

Steam condensate is not being recovered.

As mentioned previously, the quantity of domestic water is very large.

(3.2) Details

a. Recycle use of cooling water of once-through system through the existing cooling tower

Cooling water of once-through system for the compressor might be recycled through the existing cooling tower as it has enough reserve capacity. The quantity of water saving would be 27 m^3/d.

b. Recovery of steam condensate

By installing steam condensate recovery system, about 50% of generated steam might be recovered or 4 m^3/d of water might be saved.

c. Check and control of domestic water consumption

If unit consumption of domestic water is reduced to 300 lit/capita/d, the total quantity would become about 102 m^3/d. Thus, about 110 m^3/d of water would be saved.

(4.) Cost Estimation

#	Method for Effective Use		Water Saving		Apparatus for Effective Use		Unit Cost (¥/m³)		
	Method	Item	Use*	Qt.** (m³/d)	Apparatus	Cost (10³¥)	Fixed	Operating	Total
1	Recycle use	Recycle use of cooling water by existing cooling tower	C	27	Piping	21	0.4	0.5	0.9
2	Recycle use	Recovery of steam condensate	B	4	Drain trap, strainer & piping	28	3.5	-	3.5
3	Control of water use	Check and control of water requirement for domestic use	D	110			-	-	-
	Total			141		49			0.3

Note: Use* -- C = Cooling; B = Boiler; D = Domestic
Qt.** = Quantity

5.4.20 Code No. of Factory: M-20

(1.) Outline of Factory

Capital (M₿): 33

Annual Amount of Shipment (M₿): 70 (2,885,000 pcs./Y)

Total Area (m²): 19,200

Total No. of Employees: 105

Main Products: Piston Ring

(2.) Present Situation of the Use of Industrial Water

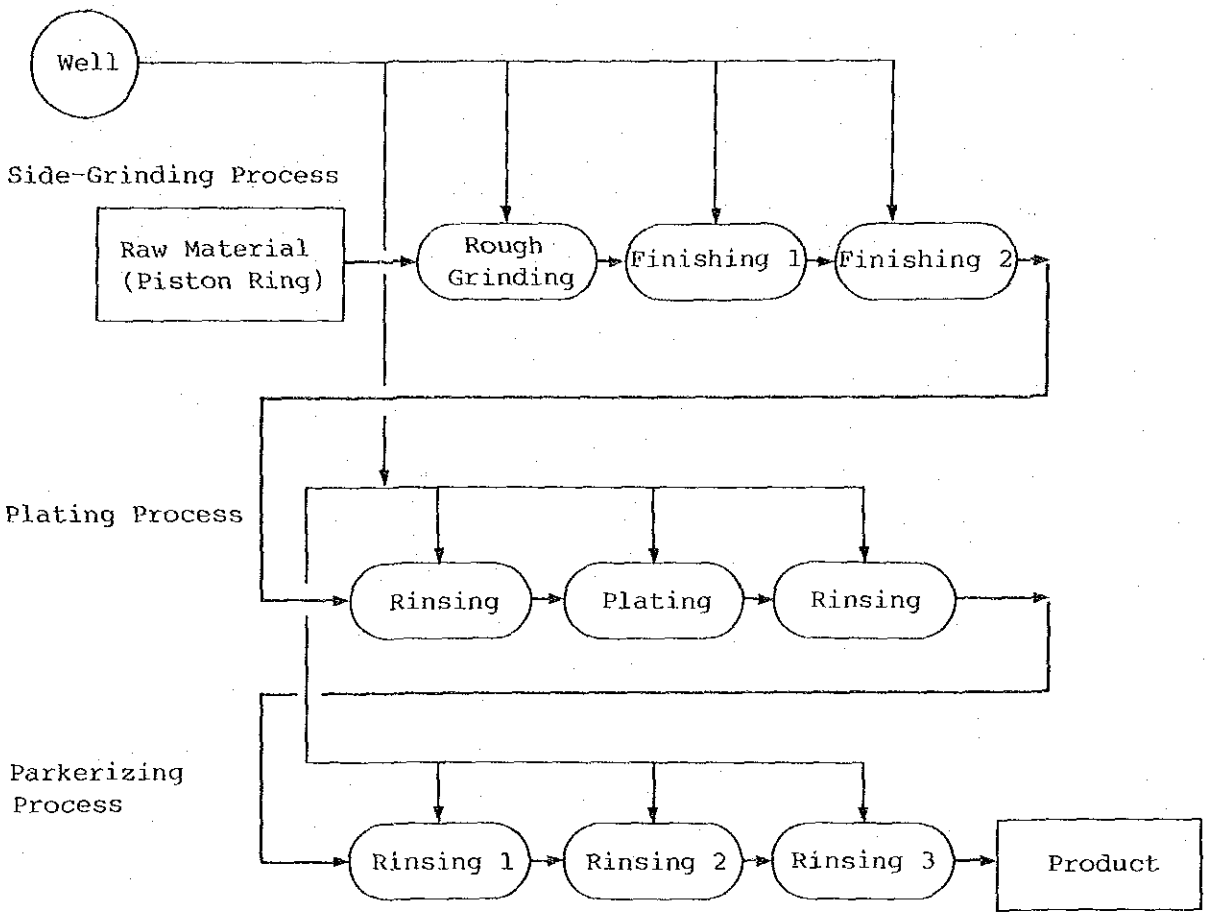
(2.1) Water Consumption

Unit: m³/d

Use \ Source	Well Water	MWA	Others	Sub Total	Recover-ed Water	Total
Boiler						
Material						
Processing & Washing	10			10		10
Cooling	5			5	404	409
Air Conditioning						
Others	8			8		8
Sub Total	23			23	404	427
Outside						
Total	23			23	404	427

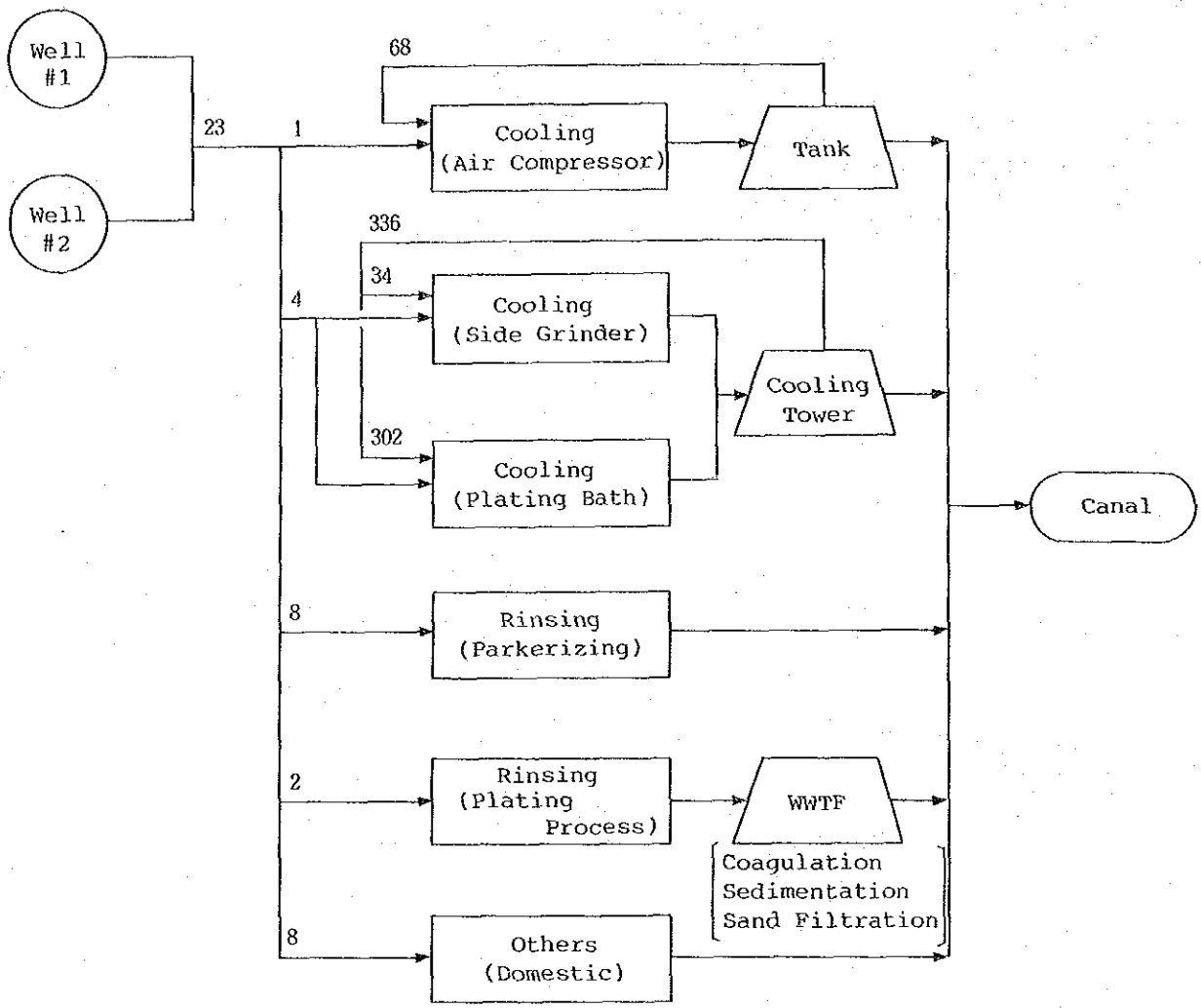
Recovery Rate (%): 94.6

(2.2) Process Diagram of Production Line



(2.3) Flow Diagram of Water Supply and Waste Water Discharge

(Unit: m^3/d)



Legend: WWTF = Waste Water Treatment Facility

(2.4) Explanation of Present Situation

(2.4.1) Sources and Uses

Only well water is used in this factory. There are two wells, No.1 and No.2 of which only No.1 is in use at all times. Both have pipings of 2 inches in diameter and provided with flow meter. The well water is used after being stored in a head tank. No water treatment is adopted.

The main use of the water is cooling water for the grinder and plating bath and for the air compressor. A cooling tower was installed in September 1987 for the former so, since then, the water is being recycled through the tower.

The capacity of the cooling tower is 300 lit/min (about 25 RT), but currently it is at the state of 245 lit/min (336 m^3/d). For the latter, although there is no special cooling facilities, the water is being stored in a tank and recycled. However, the feed quantity of make-up water is controlled manually by valve adjustment once a day.

Other processes using water are the plating, Parkerizing, etc., but water consumption is small.

After installation of the previously-mentioned cooling tower, well water consumption was reduced (about 80%) from 130 m^3/d to 23 m^3/d.

Water consumption of domestic use is 8 m^3/d. Considering the number of employees of 105, the level is not high.

(2.4.2) Water Treatment

Well water quality is 1.280 $\mu S/cm$ of electrical conductivity and zero mg/lit of turbidity. The figure of electrical conductivity is somewhat high, but since it poses no special problem, the water is used without any treatment.

According to water quality measurements, the electrical conductivity of the recycled water of the cooling tower is 2.400 $\mu S/cm$ (about double that of the well water) and that of the recycled compressor cooling water is 3.900 $\mu S/cm$ (about 3 times that of the well water) but these have not created any special problems.

(2.4.3) Waste Water Treatment

A chromate plating process is used, so Cr^{6+} is discharged from the waste washing water. Therefore only the waste water from this process is treated by deoxidizer, clarifier and sand filter before being discharged. Other waste waters are being directly discharged into the canal.

(3.) Plans of Effective Use of Industrial Water

(3.1) General

As the cooling water is already recycled and the consumption of washing water and water for other uses (domestic use) is small, there seems little room for improvement on the present situation.

5.5 Chemical Industry

5.5.1 Code No. of Factory: C-01

(1.) Outline of Factory

Capital (M$): 18

Annual Amount of Shipment (M$): 100

Total Area (m^2): 20,800

Total No. of Employees: 67

Main Products: Medicines (Tablet, Injection and Syrup)

(2.) Present Situation of the Use of Industrial Water

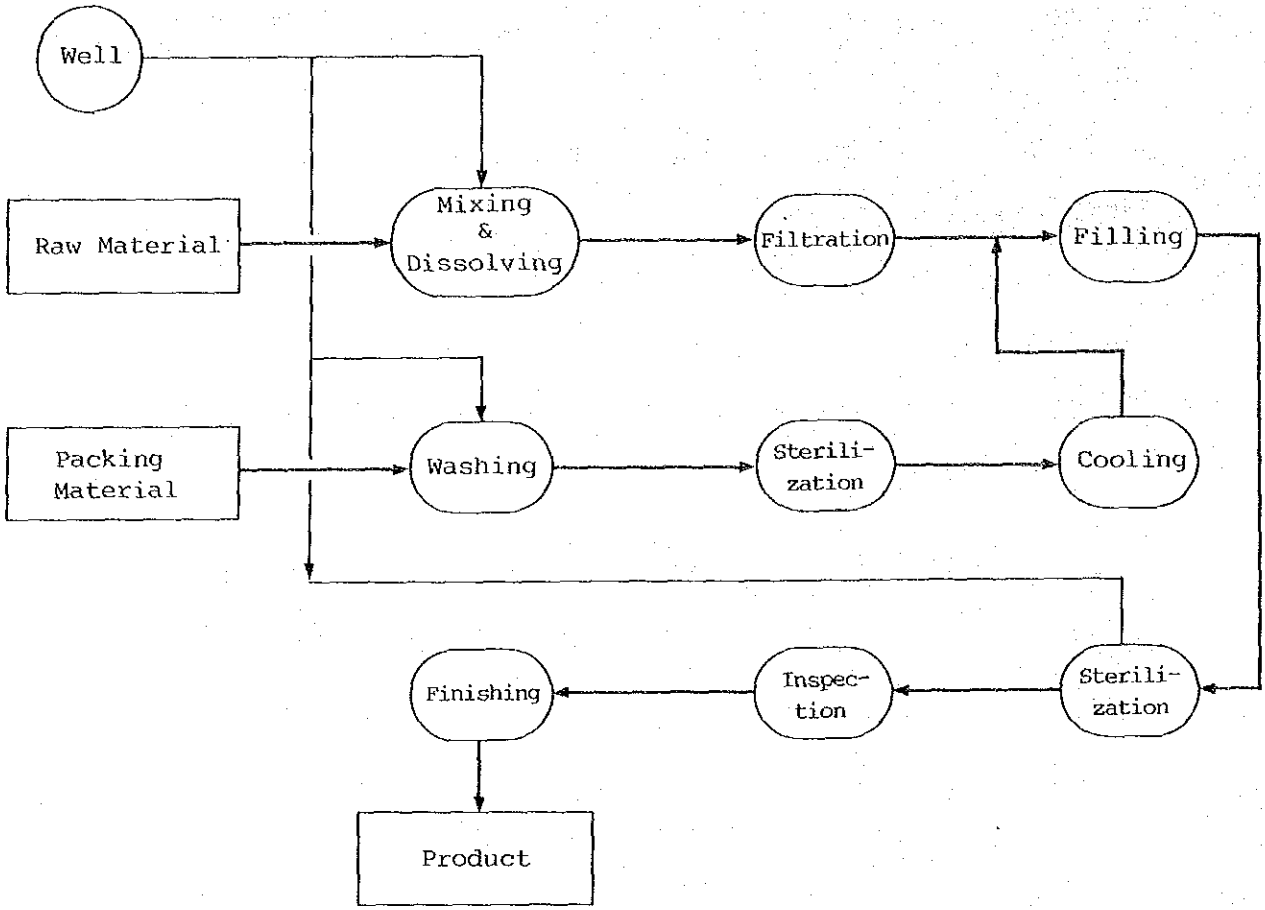
(2.1) Water Consumption

Unit: m^3/d

Use \ Source	Well Water	MWA	Others	Sub Total	Recover-ed Water	Total
Boiler	5			5		5
Material						
Processing & Washing	20			20		20
Cooling	1			1	280	281
Air Conditioning						
Others	49			49		49
Sub Total	75			75	280	355
Outside						
Total	75			75	280	355

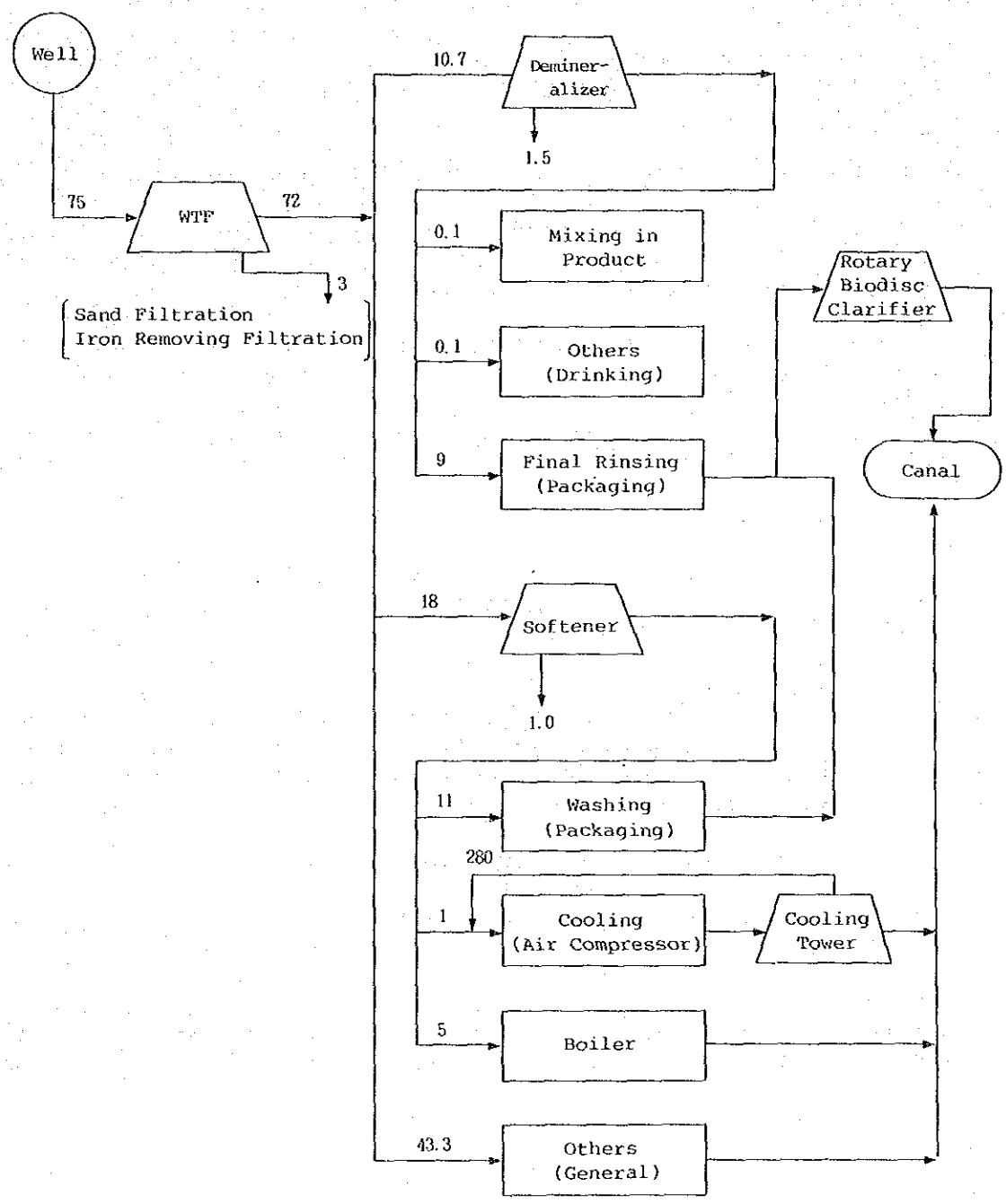
Recovery Rate (%): 78.9

(2.2) Process Diagram of Production Line



(2.3) Flow Diagram of Water Supply and Waste Water Discharge

(Unit: m^3/d)



Legend: WTF = Water Treatment Facility

(2. 4) Explanation of Present Situation

(2. 4. 1) Sources and Uses

In this factory, water is supplied from a single well.

The quantity of water is recorded and checked by flow meters installed on the outlet of the pump, the deminerazer and the softener.

Most of water is used for the washing of machines and equipment.

Cooling water for the chiller and the air compressor is recycled through the cooling towers. softened water is used as make-up water for cooling tower. The degree of concentration is 2. 3.

The well water is yellowish brown color, having a fairly high turbidity of 92 mg/lit and electrical conductivity of 1, 700 μS/cm.

For drinking, demineralized water is used.

(2. 4. 2) Water Treatment

Well water is initially treated by a sand filter and an iron removing filter, and then, while a part of it is sent to the softener and the demineralizer for further treatment, the most part is directly used for washing and other purposes.

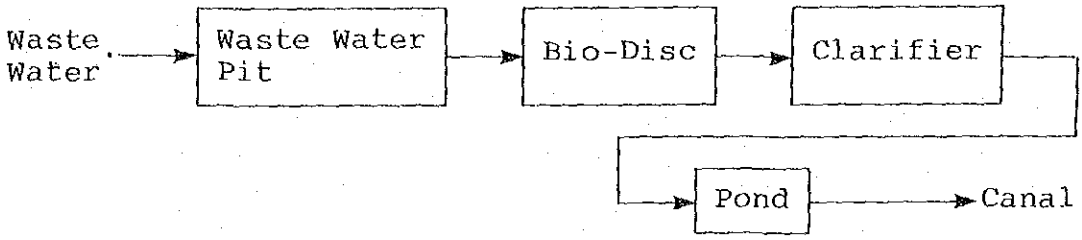
The softener unit is composed of a sand filter and two softeners. Softened water is mainly used for washing of packing component and equipment. It is also used as make-up water for the boiler and cooling tower.

The demineralizer system is composed of an activated carbon adsorption tower, a 2-bed-3-tower ion exchanger and a mixed-bed polisher. Demineralized water is used mainly for final washing of packing component.

The quantity of recycled water of the cooling towers is estimated at around 35 $m^3/h/2$ towers. When the chiller and air compressor stop, the cooling tower and circulation pumps automatically stop the operation.

(2.4.3) Waste Water Treatment

The waste water treatment facility of this factory is as shown below.



(3.) Plans of Effective Use of Industrial Water

(3.1) General

The confidential nature of the business prevented the study team from investigating the use of water for medicine production process. Therefore, the study had to be limited to the water treatment facility. As far as it is concerned, there is little room for further improvement.

5.5.2 Code No. of Factory: C-02

(1.) Outline of Factory

Capital (M$): 30

Annual Amount of Shipment (M$): 450

Total Area (m²): 81,600

Total No. of Employees: 102

Main Products: Resins

(2.) Present Situation of the Use of Industrial Water

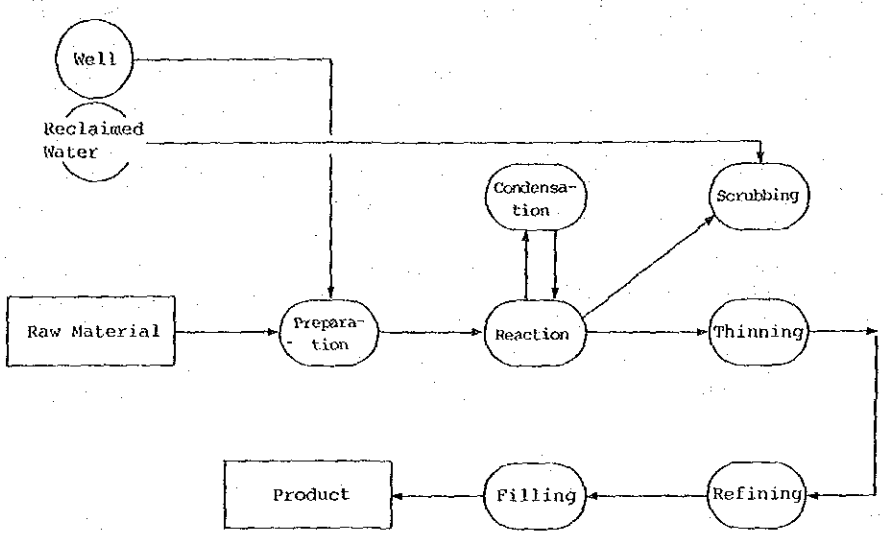
(2.1) Water Consumption

Unit: m³/d

Source / Use	Well Water	MWA	Others	Sub Total	Recover-ed Water	Total
Boiler	19			19		19
Material	10			10		10
Processing & Washing	80			80	500	580
Cooling	50			50	5,200	5,250
Air Conditioning						
Others	151			151		151
Sub Total	310			310	5,700	6,010
Outside	20			20		20
Total	330			330	5,700	6,030

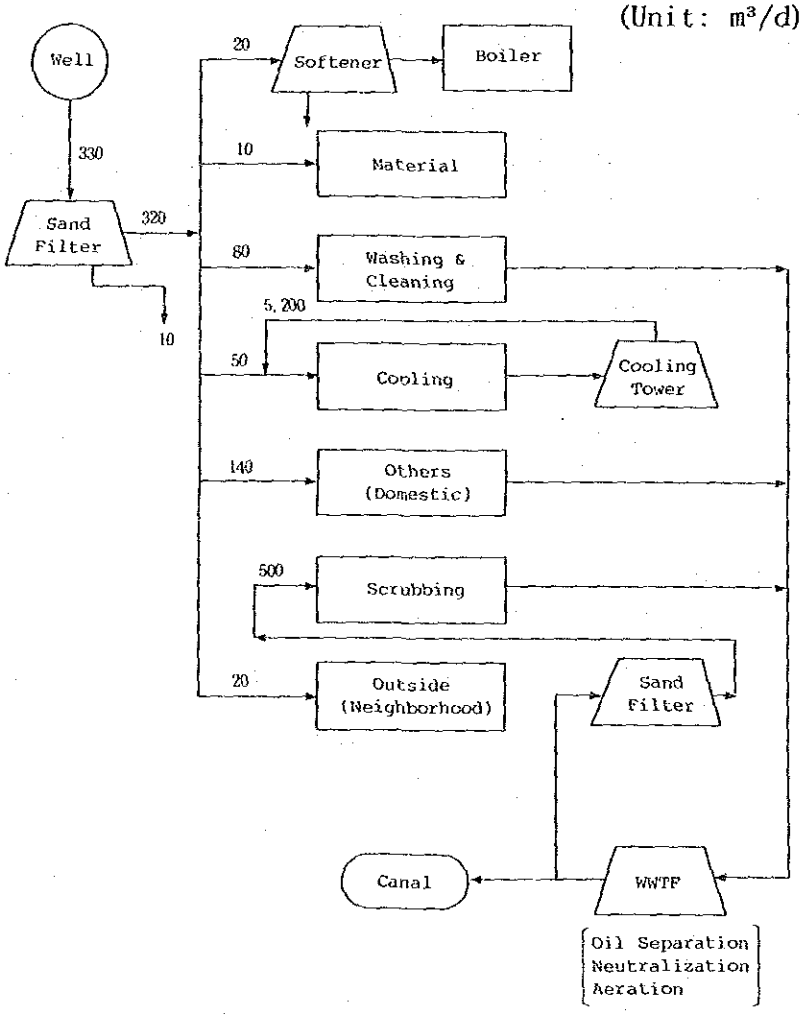
Recovery Rate (%): 94.8

(2. 2) Process Diagram of Production Line



(2. 3) Flow Diagram of Water Supply and Waste Water Discharge

(Unit: m³/d)



Legend: WWTF = Waste Water Treatment Facility

(2.4) Explanation of Present Situation

(2.4.1) Sources and Uses

In this factory, water is supplied from two wells. Normally one well is in operation and the other is standby.

A flow meter is installed at the outlet of the water feed tank, so that the total quantity of make-up water can be checked.

Flow meters are also installed at the pipe lines for office and domestic use as well as for domestic use outside the factory.

Make-up water is mainly used for domestic purposes inside the factory (the office, the dormitory for 80 persons, warehouse, etc.).

Cooling water is recycled through the cooling tower. Required make-up water is estimated at around 50 m^3/d. The degree of concentration of the recycling water is about 1.1, which is fairly low.

At scrubber, treated waste water of approximately 500 m^3/d is effectively re-used for the cooling of vapor from reaction column.

Since the production system is controlled by the batch-type operation, water consumption fluctuates from time to time.

(2.4.2) Water Treatment

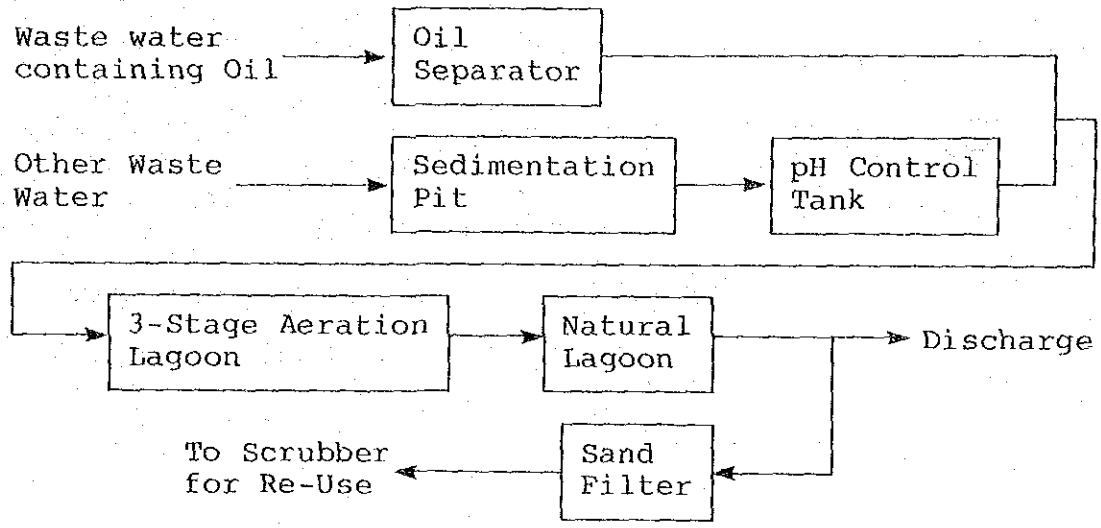
Although measured value of turbidity is zero mg/lit, well water is treated by sand filter before being used.

For the boiler make-up water, softened water is used.

No chemicals are injected into the recycled water of the cooling tower system.

(2.4.3) Waste Water Treatment

Flow of waste water treatment facility of this factory is shown below.



(3.1) General

As exemplified by the re-use of waste water discharged from various processes, water use of this factory is much advanced.

The degree of concentration of the cooling tower is low (approximately 1.1). Although it is difficult to control the cooling water consumption because of the batch-based plant operation, it seems feasible to raise the degree of concentration up to around 2.

Water consumption for the domestic use (including the use for the dormitory) is large. The domestic use of water amounts to around 770 l/capita/d.

(3.2) Details

a. Raising of degree of concentration through improvement of operation control of cooling tower

The present quantity of make-up water used for the cooling system is 50 m^3/d. On an assumption that the tower load during normal operation is same as at the time of the survey, the raise of the degree of concentration from 1.1 to 2 would reduce the make-up water to 10 m^3/d. Thus, 40 m^3/d of water would be saved..

b. Check and control of domestic water consumption

If unit consumption of domestic water is reduced to 300 lit/capita/d, the total quantity would become about 55 m^3/d. Thus, about 85 m^3/d of water would be saved.

(4.) Cost Estimation

Number	1	2
Method for Effective Use Method Item	Improvement of operation control Improvement of operation and maintenance of cooling tower	Control of water use Check and control of waterrequirement for domestic use
Water Saving Use Qt. (m^3/d)	Cooling 40	Domestic 85
Apparatus for Effective Use Apparatus Cost (10^3฿)		
Unit Cost (฿/m^3) Fixed Operating Total	- 0.5 0.5	- - -

Total Water Saving (m^3/d): 125

Total Initial Cost (10^3฿):

Total Unit Cost (฿/m^3): 0.2

Note: Qt. = Quantity

5.5.3 Code No. of Factory: C-03

(1.) Outline of Factory

Capital (M₱): 2.5

Annual Amount of Shipment (M₱): 15

Total Area (m^2): 275

Total No. of Employees: 120

Main Products: Electro-Plating and Aluminum Plating

(2.) Present Situation of the Use of Industrial Water

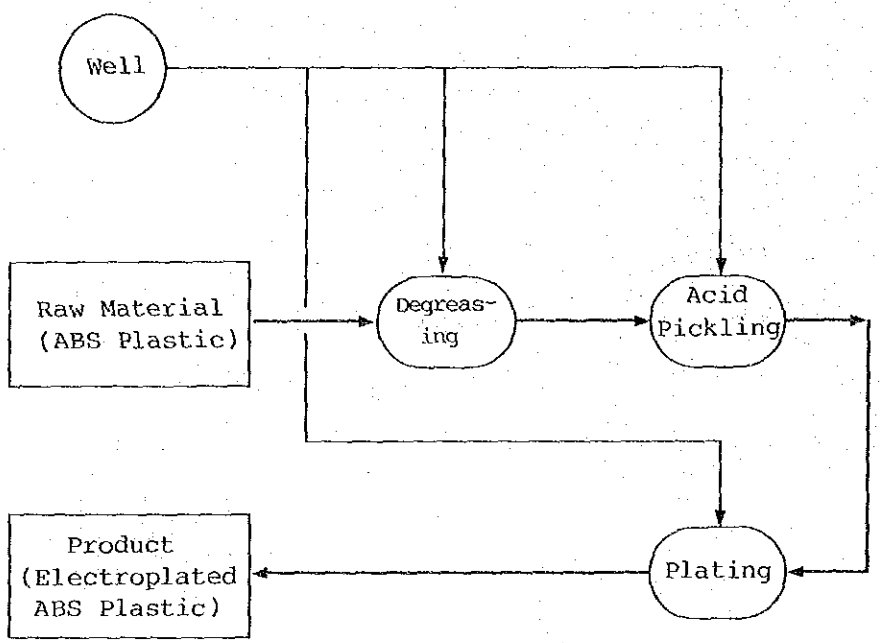
(2.1) Water Consumption

Unit: m^3/d

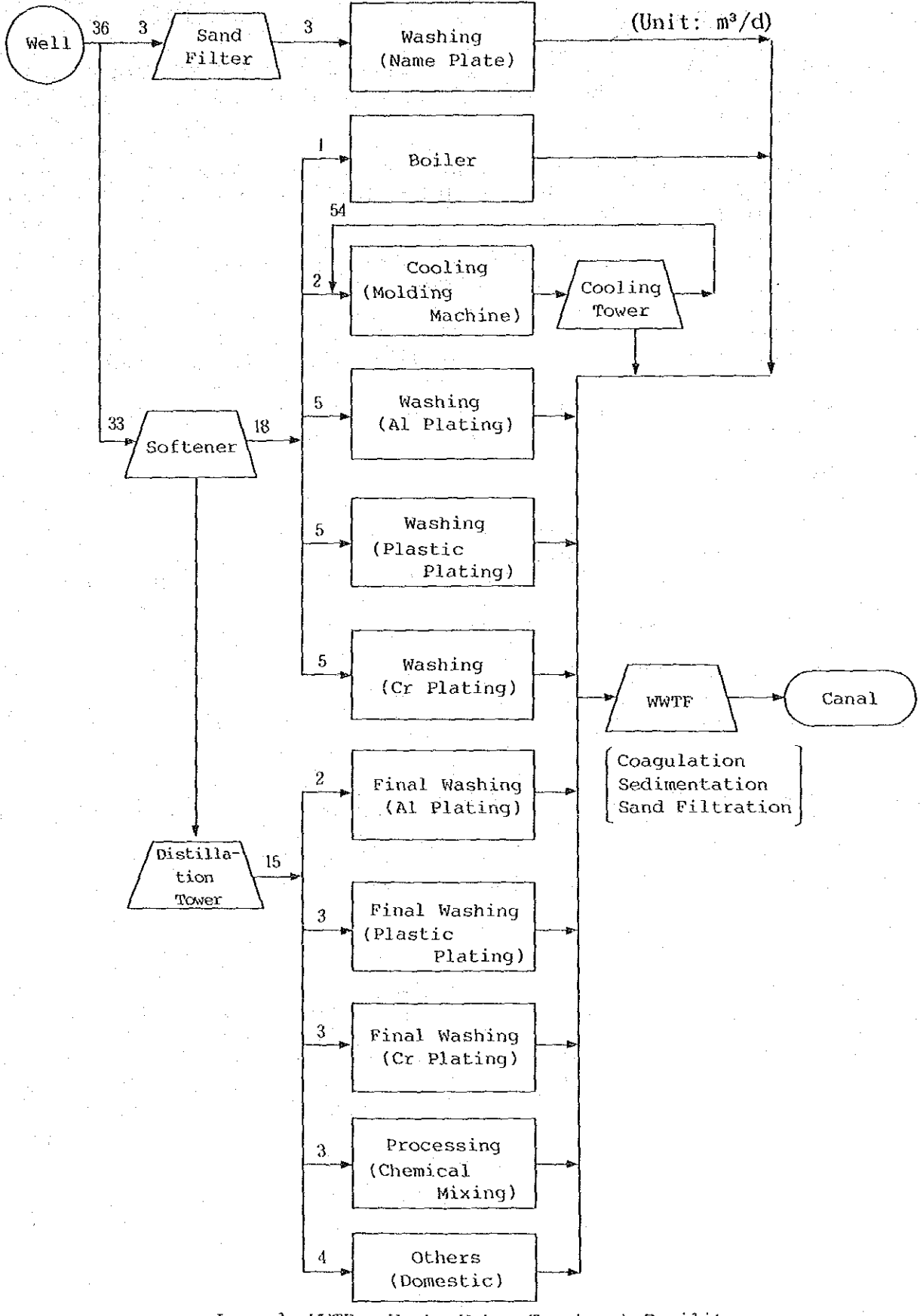
Use \ Source	Well Water	MWA	Others	Sub Total	Recover-ed Water	Total
Boiler	1			1		1
Material						
Processing & Washing	29			29		29
Cooling	2			2	54	56
Air Conditioning						
Others	4			4		4
Sub Total	36			36	54	90
Outside						
Total	36			36	54	90

Recovery Rate (%): 60.0

(2.2) Process Diagram of Production Line



(2.3) Flow Diagram of Water Supply and Waste Water Discharge



Legend: WWTF = Waste Water Treatment Facility

(2. 4) Explanation of Present Situation

(2. 4. 1) Sources and Uses

In this factory, water is supplied from two wells (both 75 m deep) located in the north western part of the factory. One well is standby.

Water is mainly used for washing in the electroplating process. For this process, washing is done first with softened water and then with distilled water.

Cooling water for the molding machine is recycled through the cooling tower. The design value of recycled water for the cooling tower (capacity: 10 RT) is 62 m^3/d, but the actual quantity is estimated at 54 m^3/d. This value is close to estimated quantity of 58 m^3/d based on the piping diameter.

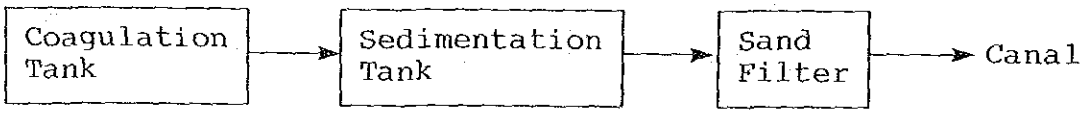
Domestic water is 4 m^3/d, that is, 33 lit/capita/d (120 employees). This figure is rather too low.

(2. 4. 2) Water Treatment

With the electrical conductivity of 770 $\mu S/cm$ and turbidity of 1 mg/lit, the quality of well water of this factory is fairly good. After being removed of iron by aeration and then softened, the well water is used for washing. In the final washing process of plating, softened water is used after being distilled.

(2. 4. 3) Waste Water Treatment

Waste water is treated and discharged as shown below.



(3.) Plans of Effective Use of Industrial Water

(3. 1) General

The main use of water is for washing. Washing is carried out by a continuous counter-current method. Washing water is wholly replaced with distilled water once a week for the final washing water tank, with softened water once a day for the first washing water tank and every other day for the intermediate washing water tank.

The fact that the water discharged into the canal after the above-mentioned treatment still has the color of chrome indicates that water replacement cycles cannot be made longer, and that the waste water cannot be re-used.

Although it is possible to raise the degree of concentration of the cooling water from the present level of 1.3 to 3, the water saving in this way would be only 1.3 m^3/d.

Judging from the above conditions, there is little room for further improvement.

5.5.4 Code No. of Factory: C-04

(1.) Outline of Factory

Capital (M$): 20

Annual Amount of Shipment (M$): -

Total Area (m²): 32,000

Total No. of Employees: 110

Main Products: Medicine

(2.) Present Situation of the Use of Industrial Water

(2.1) Water Consumption

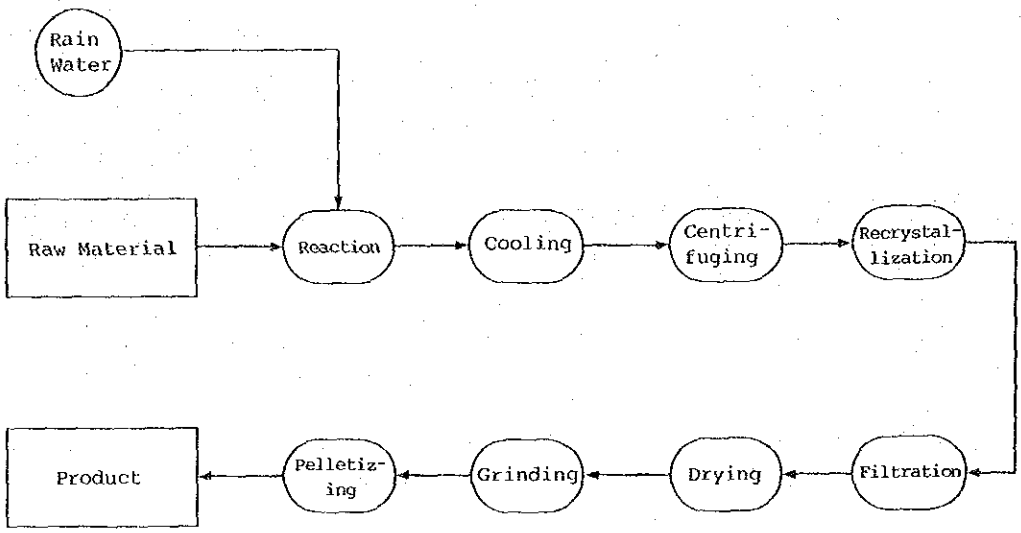
Unit: m³/d

Use \ Source	Well Water	MWA	Others *	Sub Total	Recover-ed Water	Total
Boiler			5	5		5
Material						
Processing & Washing		10	5	15		15
Cooling						
Air Conditioning						
Others		20		20		20
Sub Total		30	10	40		40
Outside						
Total		30	10	40		40

Recovery Rate (%): 0.0

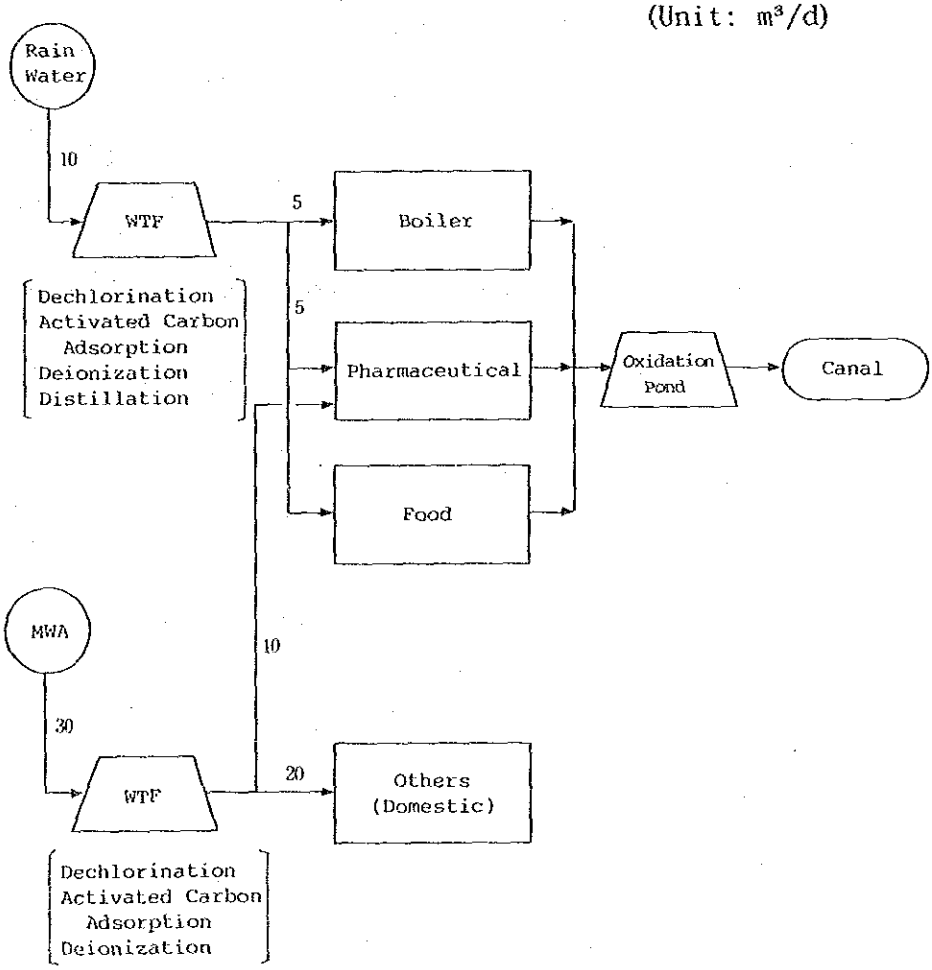
Note: * Rain Water

(2.2) Process Diagram of Production Line



(2.3) Flow Diagram of Water Supply and Waste Water Discharge

(Unit: m^3/d)



Legend: WTF = Water Treatment Facility

(2.4) Explanation of Present Situation

(2.4.1) Sources and Uses

In March 1987, this factory changed the water source from well to MWA. Currently this factory uses MWA water (30 m^3/d) and rain water (10 m^3/d).

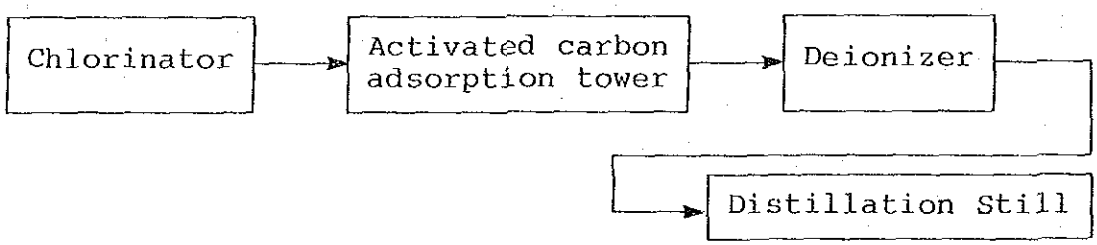
Water received from MWA is mainly used for domestic purposes, while rain water is used for the medicine and food production as well as for the boiler.

No cooling tower is installed. Air conditioning is based on an air cooling system.

Domestic water is estimated at 15 m^3/d. This value is not large, considering the number of employees (110).

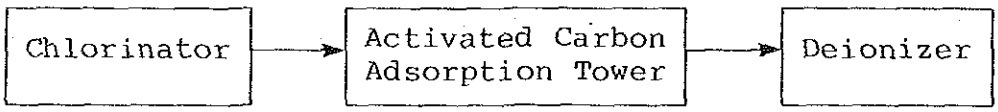
(2.4.2) Water Treatment

Rain water is treated as illustrated below.



Treated water has 8.8 $\mu S/cm$ of electrical conductivity and zero mg/lit of total hardness.

Water received from MWA is treated as illustrated below.



(2.4.3) Waste Water Treatment

Domestic waste water and toilet flushing water are treated through a septic tank before being discharged.

Waste washing water is treated in a lagoon and then discharged into a canal.

(3.) Plans of Effective Use of Industrial Water

(3.1) General

Judging from the application of the air cooling system for air conditioning and the low consumption of domestic water, there is no room for further improvement in the use of water.

A viewpoint of effective use of well water, saving of well water is performed completely by replacing well water with rain water and MWA water.

5.5.5 Code No. of Factory: C-05

(1.) Outline of Factory

Capital (M$):

Annual Amount of Shipment: 7,000 - 7,500 t/Y

Total Area (m^2): 64,000

Total No. of Employees: 325

Main Products: Caustic Soda, Hydrochloric Acid, etc.

(2.) Present Situation of the Use of Industrial Water

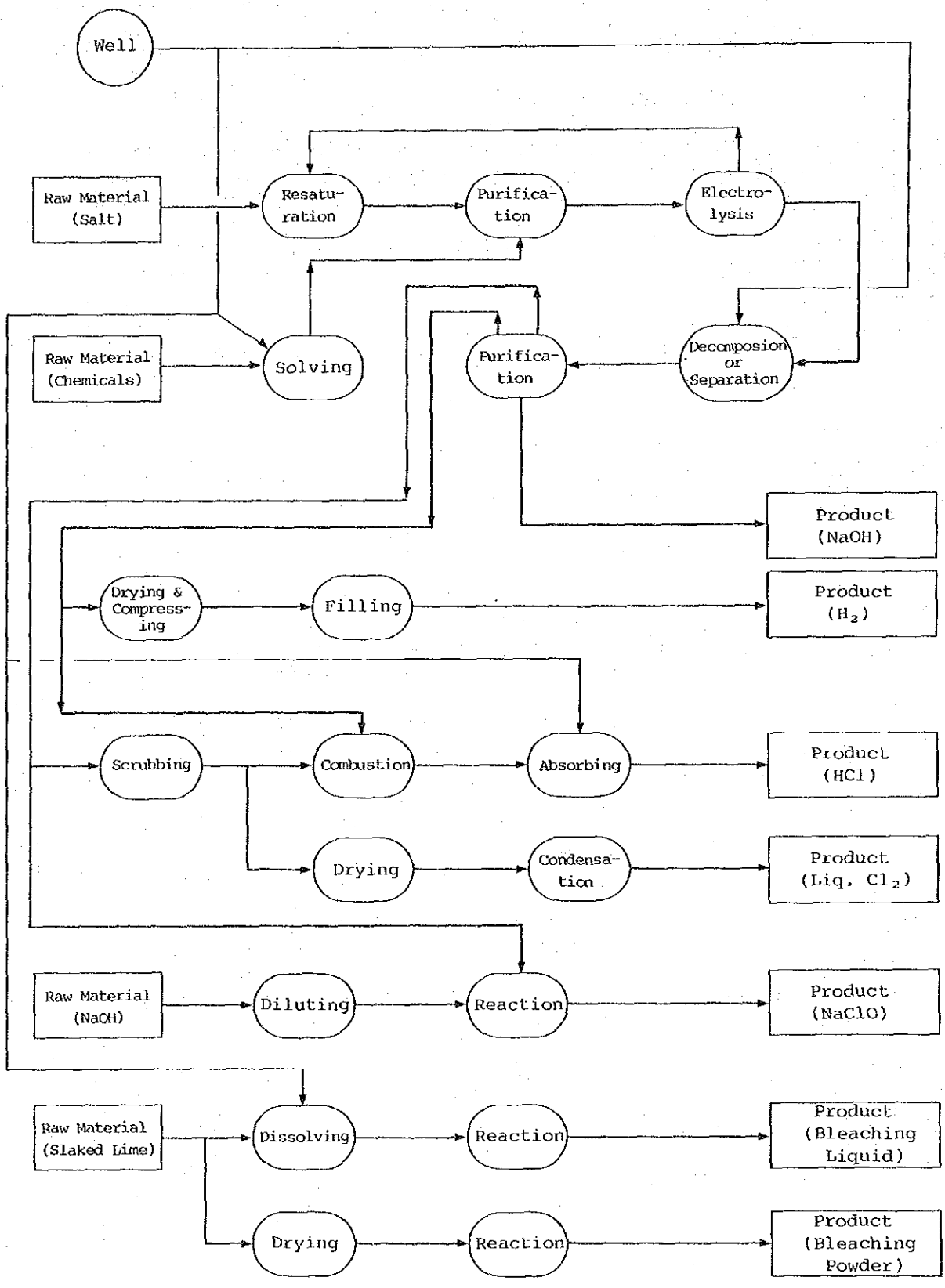
(2.1) Water Consumption

Unit: m^3/d

Use \ Source	Well Water	MWA	Others	Sub Total	Recover-ed Water	Total
Boiler	25			25		25
Material	400			400		400
Processing & Washing	285			285		285
Cooling	300			300	14,400	14,700
Air Conditioning						
Others	350			350		350
Sub Total	1,360			1,360	14,400	15,760
Outside	200			200		200
Total	1,560			1,560	14,400	15,960

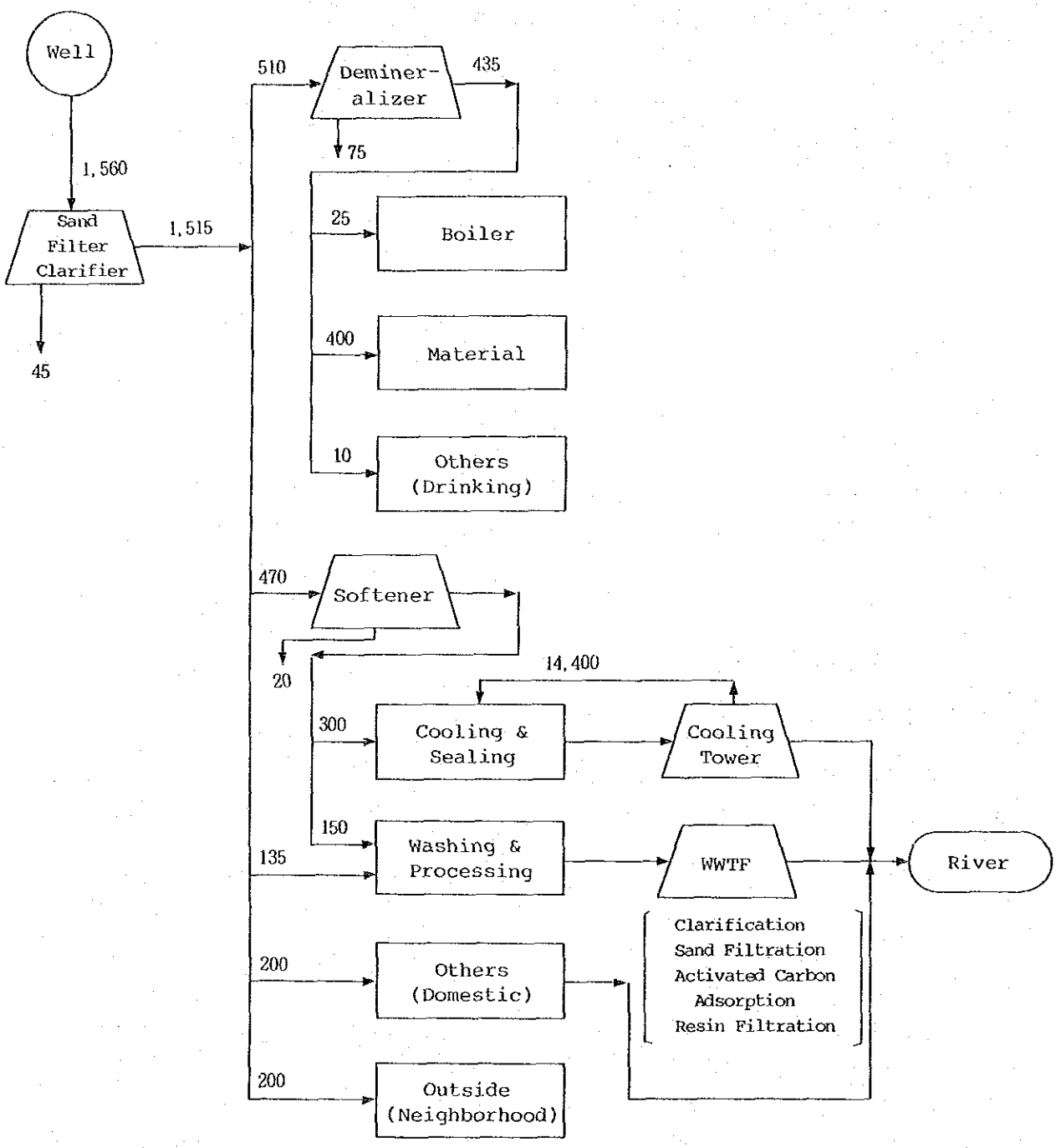
Recovery Rate (%): 90.2

(2.2) Process Diagram of Production Line



(2.3) Flow Diagram of Water Supply and Waste Water Discharge

(Unit: m^3/d)



Legend: WWTF = Waste Water Treatment Facility

(2.4) Explanation of Present Situation

(2.4.1) Sources and Uses

In this factory, water is supplied from four wells.

Well water of this factory contains a significant quantity of iron. Therefore, it is treated by iron-removal process (coagulation/sedimentation and sand filtration) before being used. Furthermore, some water is treated by demineralizer or softener.

Demineralized water is used for the boiler, raw material and drinking, while softened water is used for the cooling tower and washing.

Some washing water as well as miscellaneous water and water supplied to the outside of the factory are treated by iron removing process.

Cooling water is recycled through the cooling tower. The degree of concentration is 1.6 or 1.7. Softened water is used as make-up water of cooling tower. However, since the chloride ion concentration of the recycle water is high (1,300 mg/lit), the degree of concentration cannot be raised any more.

Caustic soda is produced by the electrolysis using the mercury process, so that the strict regulations of pollution control are applied to its waste water discharge. Consequently, the control of water use in this factory is also very rigorous.

(2.4.2) Water Treatment

The quality of the well water is quite poor as shown below.

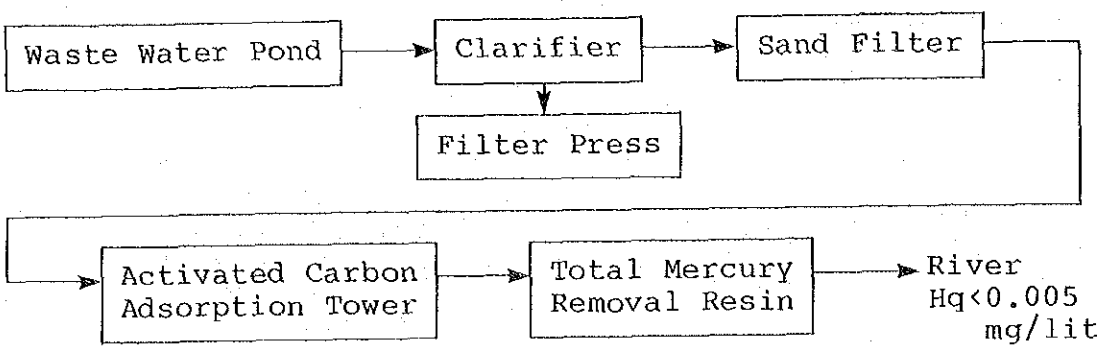
Electrical conductivity:	Approx. 2,500 μS/cm
Total hardness:	700 to 800 mg/lit
Chloride ion:	700 mg/lit

Since the well water has high iron content, iron-removing treatment is conducted as stated above.

The softener unit is composed of an activated carbon adsorption tank and two softeners. The softeners are operated alternately.

(2.4.3) Waste Water Treatment

The waste water of this factory is to be divided into two categories, namely, mercury-contained waste water and another waste water. Waste water containing mercury is treated as illustrated on the following page.



The capacity of the facility is 15 to 20 m^3/h, and mercury concentration in the effluent shows less than 0.005 mg/lit.

(3.) Plans of Effective Use of Industrial Water

(3.1) General

Generally speaking, in factories using the electrolytic production method, water balance is controlled very strictly, not excepting this factory.

At present, water consumption in the brine purification process is large because of the poor quality of raw salt. However, according to the factory, raw salt of higher quality would be used from next year on, so that the quantity of processing water would be greatly reduced.

As stated above, the degree of concentration of the cooling tower cannot be raised.

The consumption of domestic water is 210 m^3/d, which seems to be too large for 325 employees and 200 persons in the dormitory.

(3.2) Details

a. Check and control of domestic water consumption

If unit consumption of domestic water is reduced to 300 lit/capita/d, the total quantity would become about 163 m^3/d.

Thus, about 50 m^3/d of water would be saved.

b. Installation of pretreatment facility before demineralizing facility

Since the well water has a high concentration of chloride ion, the reverse osmosis equipment may be installed to pretreat the water before demineralizing. However, our study revealed that the installation cost would be too high compared with the possible benefit.

(4.) Cost Estimation

Number	1
Method for Effective Use Method Item	 Control of water use Check and control of water requirement for domestic use
Water Saving Use Auantity (m^3/d)	 Domestic 50
Apparatus for Effective Use Apparatus Cost (10^3฿)	
Unit Cost (฿/m^3) Fixed Operating Total	 - - -

5.5.6 Code No. of Factory: C-06

(1.) Outline of Factory

Capital (M₿): 10

Annual Amount of Shipment (M₿): 180

Total Area (m²): 32,000

Total No. of Employees: 67

Main Products: Pesticide

(2.) Present Situation of the Use of Industrial Water

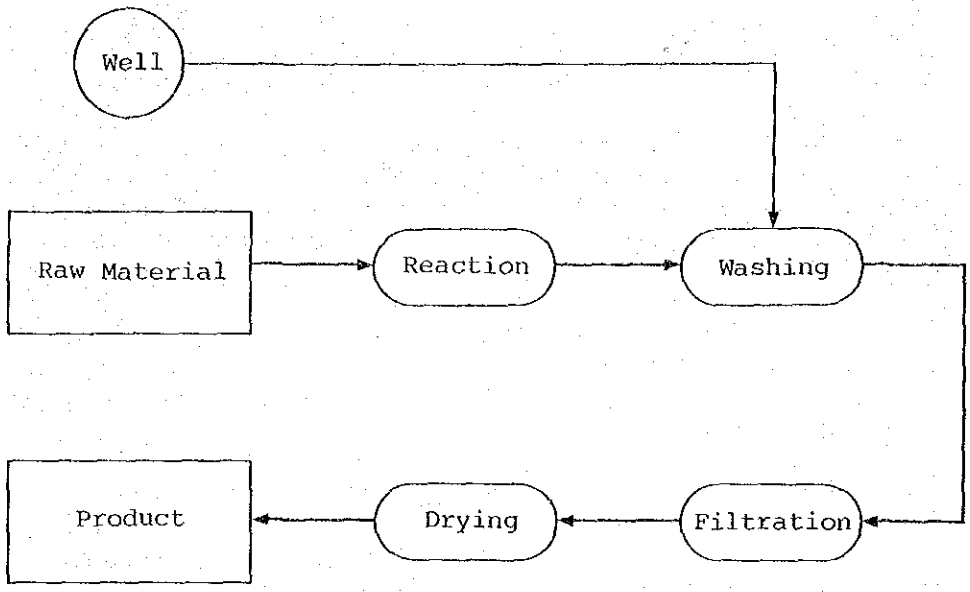
(2.1) Water Consumption

Unit: m³/d

Use \ Source	Well Water	MWA	Others	Sub Total	Recover-ed Water	Total
Boiler						
Material						
Processing & Washing	2			2		2
Cooling						
Air Conditioning						
Others	16			16		16
Sub Total	18			18		18
Outside	9			9		9
Total	27			27		27

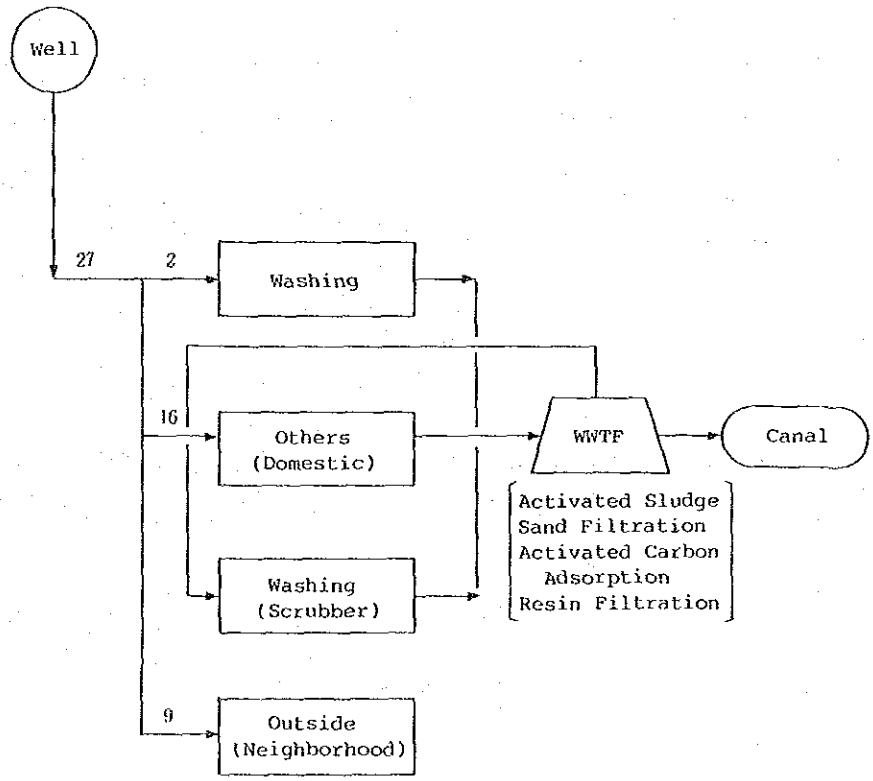
Recovery Rate (%): 0.0

(2. 2) Process Diagram of Production Line



(2. 3) Flow Diagram of Water Supply and Waste Water Discharge

(Unit: m^3/d)



Legend: WWTF = Waste Water Treatment Facility

(2.4) Explanation of Present Situation

(2.4.1) Sources and Uses

In this factory, only well water (27 m^3/d) is used.

The quantity of well water used for the production process (mainly for floor washing) is negligible (1 or 2 m^3/d). The water supplied to the outside of the factory is, judging from number of families (ten families) and the pipe diameter, is estimated at around 9 m^3/d.

Domestic water inside the factory (i.e. water for the bath, washing and sprinkling of the garden) is 16 m^3/d. Since there are 67 employees, this amounts to 240 lit/capita/d, which is a reasonable level.

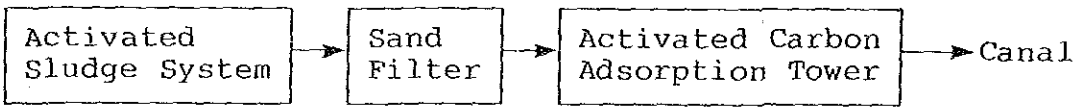
Treated waste water from the activated sludge process is re-used for washing of the venturi scrubber which is installed to prevent air pollution. The resulting dust-containing waste water is treated again by the activated sludge process.

(2.4.2) Water Treatment

Quality of well water is 720μS/cm of electrical conductivity and 7 mg/lit of turbidity. It is used without any treatment.

(2.4.3) Waste Water Treatment

Waste water comes from floor washing and domestic use is treated and discharged as shown below.



(3.) Plans of Effective Use of Industrial Water

(3.1) General

Judging from the present state of the water consumption, there is little room for the improvement in the use of processing and domestic water.

5.5.7 Code No. of Factory: C-07

(1.) Outline of Factory

Capital (M$): -

Annual Amount of Shipment (M$): 100 (4,475 t/Y)

Total Area (m²): 12,000

Total No. of Employees: 96

Main Products: Vegetable Oil, Soap and Margarine

(2.) Present Situation of the Use of Industrial Water

(2.1) Water Consumption

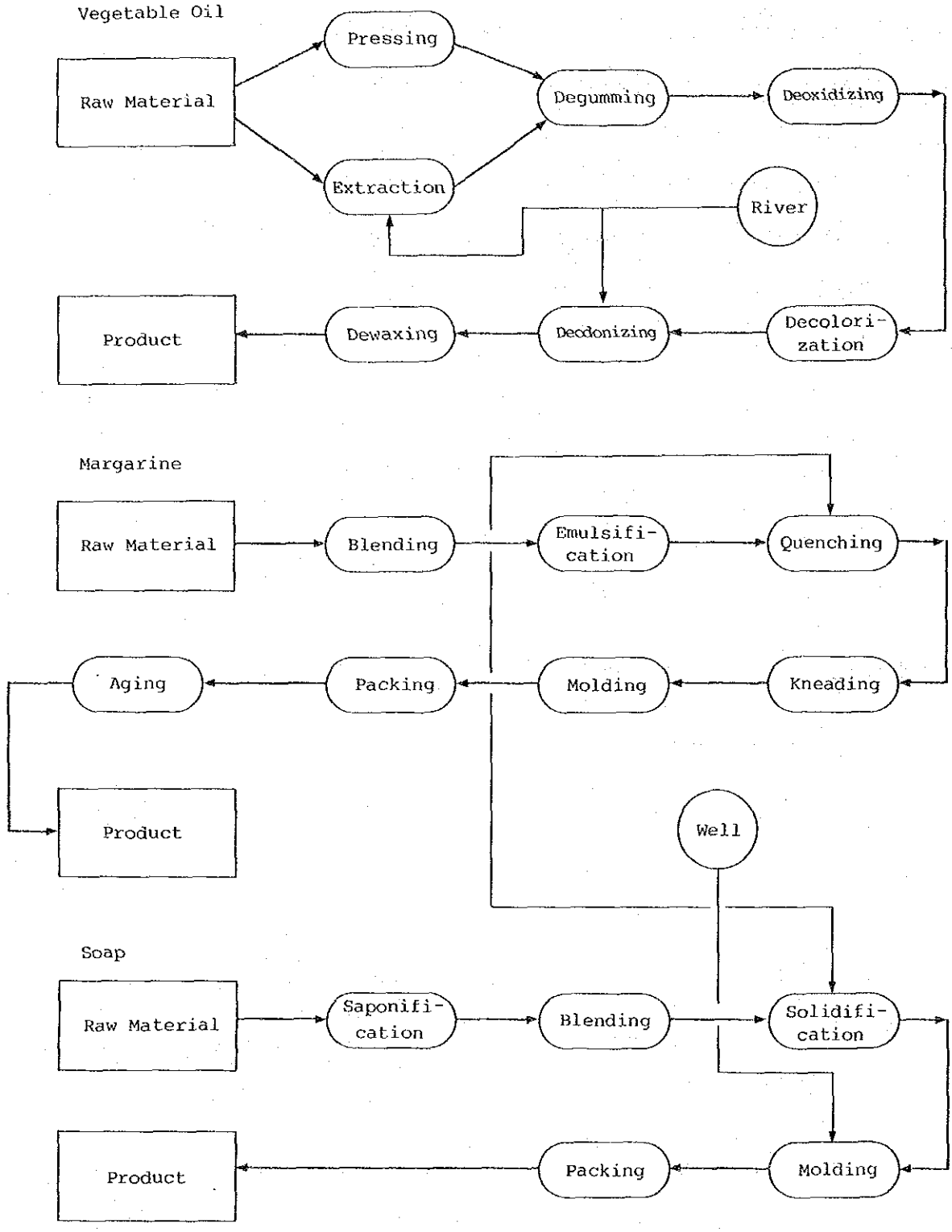
Unit: m³/d

Use \ Source	Well Water	MWA	* Others	Sub Total	Recover-ed Water	Total
Boiler	65			65	15	80
Material						
Processing & Washing	10			10		10
Cooling	3		55	58	25	83
Air Conditioning						
Others	5			5		5
Sub Total	83		55	138	40	178
Outside						
Total	83		55	138	40	178

Recovery Rate (%): 22.5

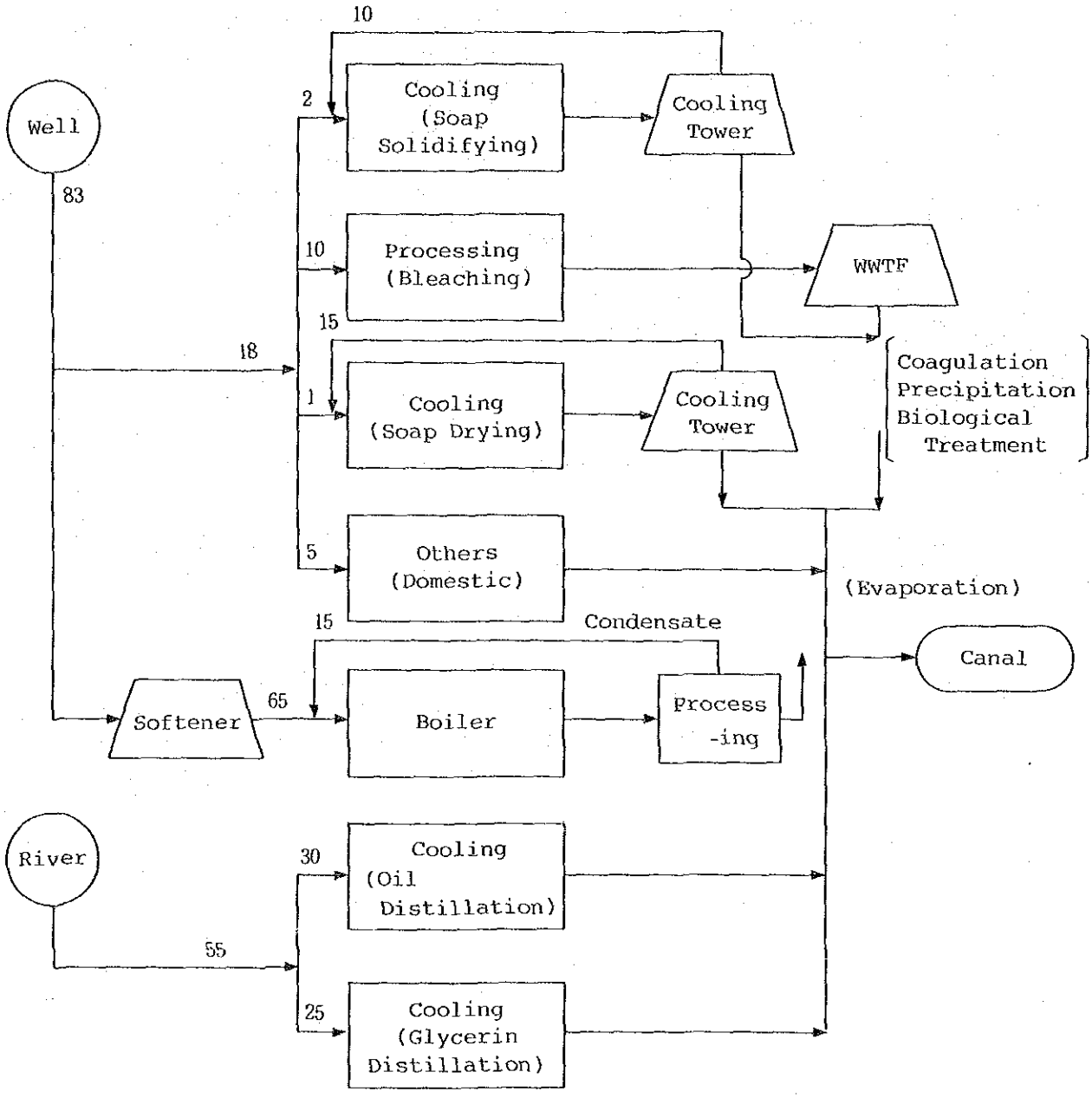
Note: * River Water

(2.2) Process Diagram of Production Line



(2.3) Flow Diagram of Water Supply and Waste Water Discharge

(Unit: m^3/d)



Legend: WWTF = Waste Water Treatment Facility

(2.4) Explanation of Present Situation

(2.4.1) Sources and Uses

This factory uses river water and well water. The main use of well water is for the boiler make-up water. Some well water, however, is used for processing and domestic purposes, too. River water, on the other hand, is used for the cooling water system.

It seems that river water is used in order to reduce operation costs, because it can be freely taken without any charge and bothering the water rights.

The river water is highly contaminated and contains a lot of dust. Therefore, without any treatment, it can be used only for the once-through cooling water system.

Two cooling towers are installed, one is a normal type and the other is a special type combining a cascade water tank and a forced-draft type cooling tower. The former is used for the soap drying process and the latter is used for the soap solidifying process.

Domestic water consumption is 5 m^3/d. Considering the number of employees (96), this figure is very low (52 lit/capita/d).

(2.4.2) Water Treatment

Well water has 280μS/cm of electrical conductivity and 33.3 mg/lit of total hardness. Make-up water for the boiler is treated by softener. Processing water and domestic water is used without any treatment. River water is also used for once-through cooling without any treatment.

(2.4.3) Waste Water Treatment

Cooling water is discharged into a canal without any treatment.

On the other hand, processing water and domestic water are discharged into a canal after being treated by coagulation/-sedimentation and biological oxidation.

(3.) Plans of Effective Use of Industrial Water

(3.1) General

The water recovery rate of this factory is 22.5%. This value is apparently low, but, owing to the use of river water, the consumption of well water is fairly saved in real terms.

Because of its high turbidity, the river water can be used only for once-through systems.

Most of well water is used for the boiler, and the well water for other purpose is recycled through the cooling tower.

Steam condensate is recovered for re-use in the boiler water system.

Judging from the above observations, there seems to be little room for the improvement in the use of water.

5.5.8 Code No. of Factory: C-08

(1.) Outline of Factory

Capital (M₿): 12

Annual Amount of Shipment (M₿): 533

Total Area (m²): 20,336

Total No. of Employees: 531

Main Products: Soap, Cosmetic and Confectionery

(2.) Present Situation of the Use of Industrial Water

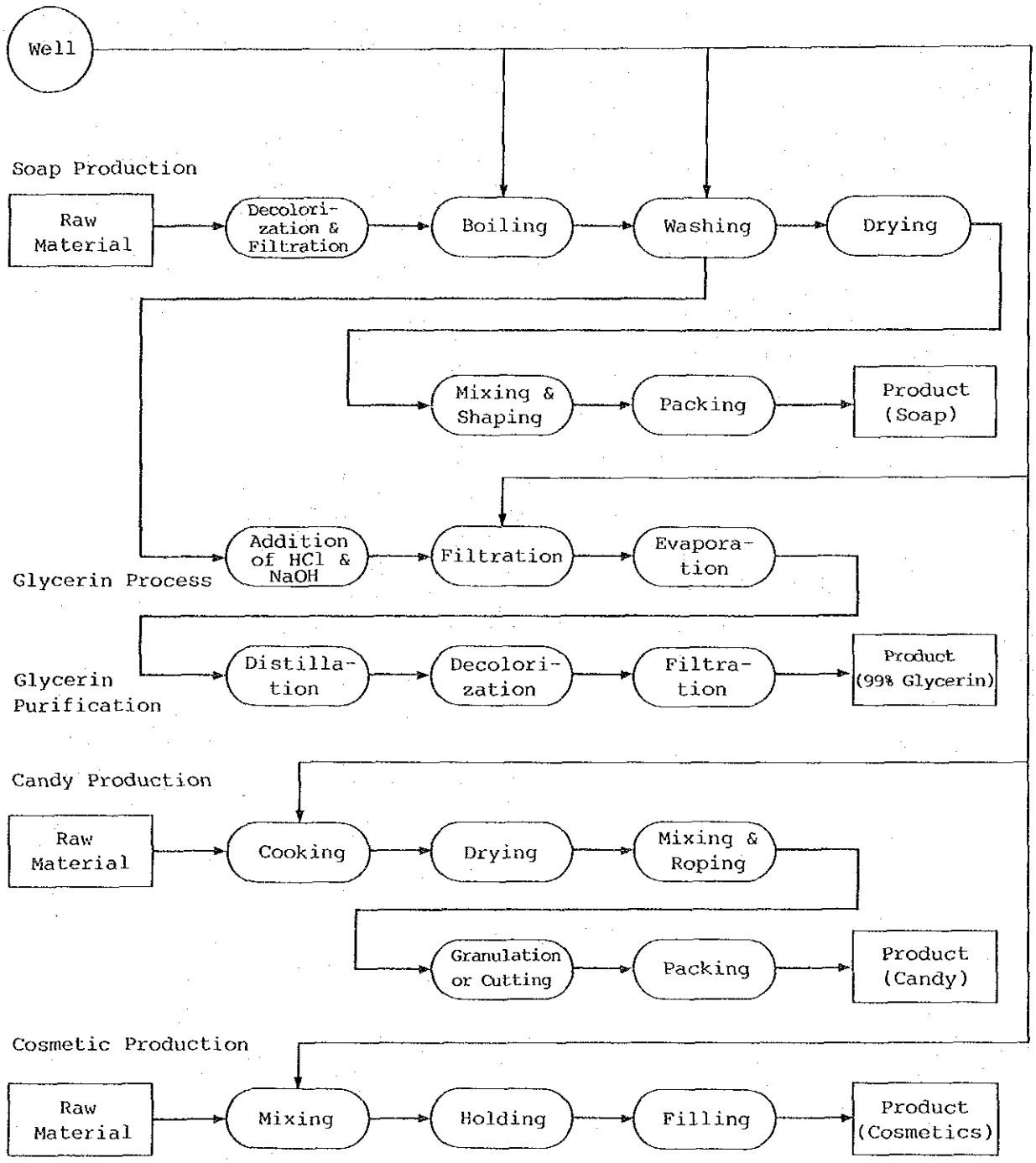
(2.1) Water Consumption

Unit: m³/d

Use \ Source	Well Water	MWA	Others	Sub Total	Recover-ed Water	Total
Boiler	102			102	20	122
Material	4			4		4
Processing & Washing	88			88		88
Cooling	200			200	3,750	3,950
Air Conditioning						
Others	328			328		328
Sub Total	722			722	3,770	4,492
Outside	30			30		30
Total	752			752	3,770	4,522

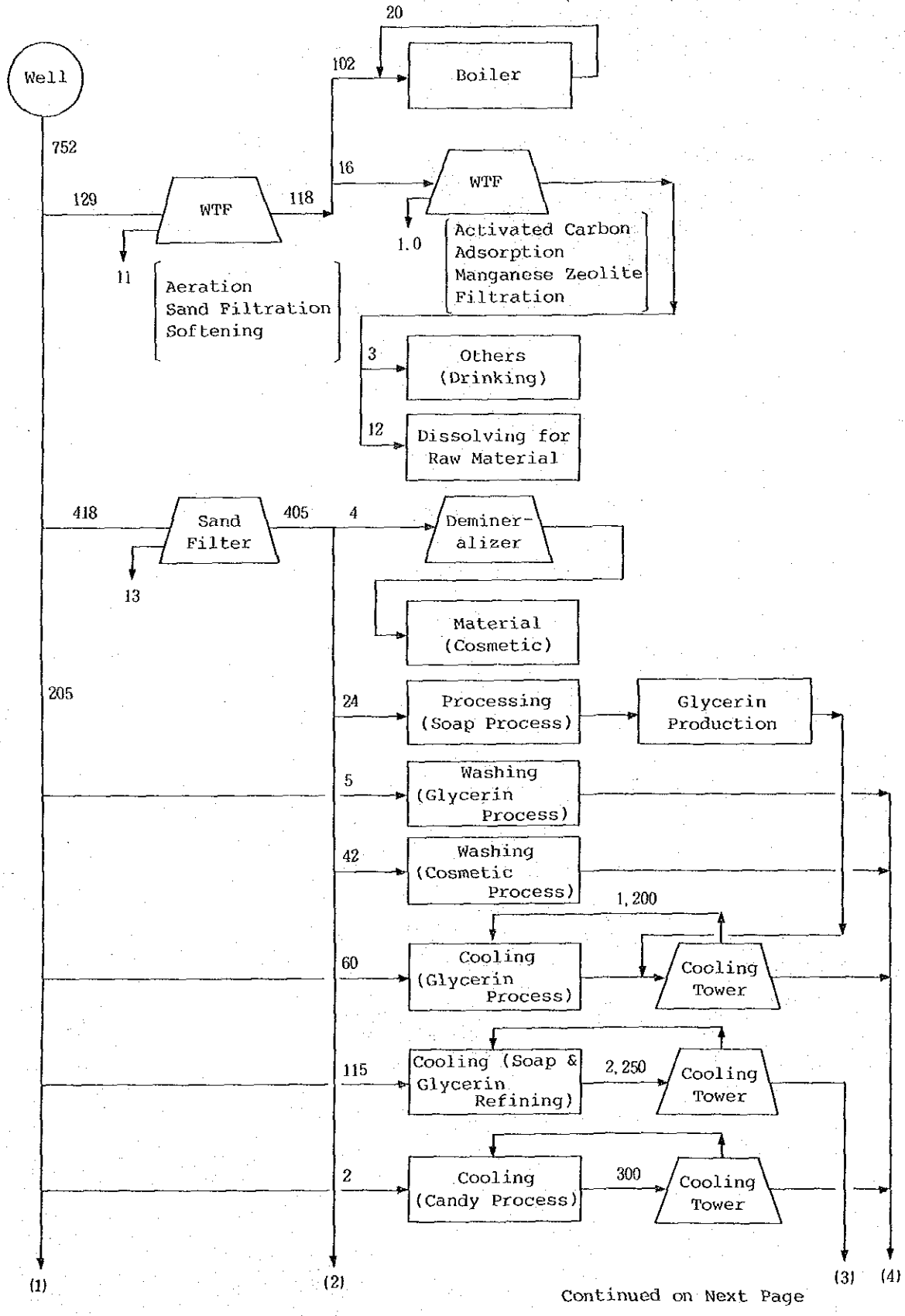
Recovery Rate (%): 83.9

(2.2) Process Diagram of Production Line



(2. 3) Flow Diagram of Water Supply and Waste Water Discharge

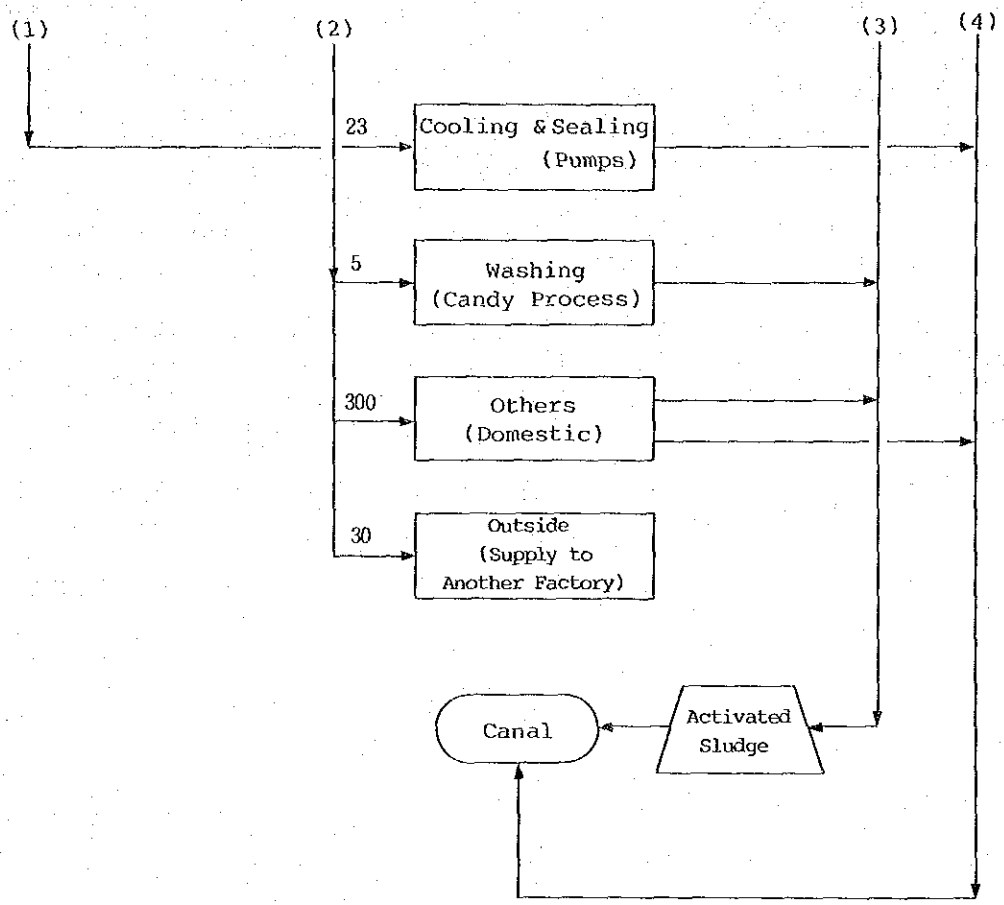
(Unit: m^3/d)



Continued on Next Page

(2.3) Continued

(Unit: m^3/d)



Legend: WTF = Water Treatment Facility

(2.4) Explanation of Present Situation

(2.4.1) Sources and Uses

In this factory, all water (including drinking water) is supplied from two wells. A flow meter is installed at the outlet of each well.

The main use of make-up water is for domestic purposes. The consumption level of 570 lit/capita/d is high.

Make-up water for the cooling tower accounts for around 24% of the total well water consumption.

Cooling water is recycled through three different systems. Among them, cooling water for refining purpose of soap and glycerin is applied to the direct barometric condenser and hence highly contaminated in spite of the low degree of concentration.

Because of the large steam consumption for the production process, the quantity of boiler make-up water is quite large.

For drinking use, well water is treated by softener and iron remover. For the production of cosmetics, demineralized water is used.

This factory supplies around 30 m^3/d of water to another factory.

(2.4.2) Water Treatment

The well water is brown color with high iron content, having turbidity of 8 mg/lit. For this reason, the boiler make-up water is supplied through an aeration, sand filtration and then softening treatment before being used.

For drinking and dissolving of raw material, the above softened water is further treated by carbon filter and a manganese-zeolite filter.

For make-up water for cooling tower, well water is used without any treatment.

Processing water and washing water are used after being treated by sand filter.

Pure water treated by a small scale demineralizer is used for the production of cosmetics.

(2.4.3) Waste Water Treatment

Waste water is treated by the activated sludge process.

The highly contaminated water from the barometric condenser of the No.1 cooling tower recycles through a concrete ditch. On way of recycling, however, some water leaks to the outside of the factory, thus causing the environmental pollution as well as the loss of well water.

(3.) Plans of Effective Use of Industrial Water

(3.1) General

The No.1 cooling tower requires proper operation control. By adopting such measures as the increase of degree of concentration, the prevention of water leakage and the like, the consumption of make-up water could be further reduced.

The consumption of domestic water reaches 570 lit/capita/d. Some measures should be taken to cut down this quantity.

(3.2) Details

a. Raising of degree of concentration through improvement of operation control of cooling tower

If the degree of concentration of the No.1 cooling tower is raised up to 1.5, the required quantity of make-up water would be reduced to 32 m^3/d. Thus, 80 m^3/d of water would be saved.

b. Check and control of domestic water consumption

If unit consumption of domestic water is reduced to 300 lit/capita/d, the total quantity would become about 160 m^3/d. Thus, about 140 m^3/d of water would be saved.

(4.) Cost Estimation

Number	1	2
Method for Effective Use Method Item	Improvement of operation control Improvement of operation and maintenance of cooling tower to raise degree of concentration	Control of water use Check and control of water requirement fo domestic use
Water Saving Use Qt. (m^3/d)	Cooling 80	Domestic 140
Apparatus for Effective Use Apparatus Cost (10^3฿)		
Unit Cost (฿/m^3) Fixed Operating Total	 - 0.5 0.5	 - - -

Total Water Saving (m^3/d): 220

Total Initial Cost (10^3฿):

Total Unit Cost (฿/m^3): 0.2

Note: Qt. = Quantity

5.5.9 Code No. of Factory: C-09

(1.) Outline of Factory

Capital (M₿): 360

Annual Amount of Shipment (M₿): 720

Total Area (m^2): 22,400

Total No. of Employees: 276

Main Products: Shampoo, Bleachers and Surface Active Agent

(2.) Present Situation of the Use of Industrial Water

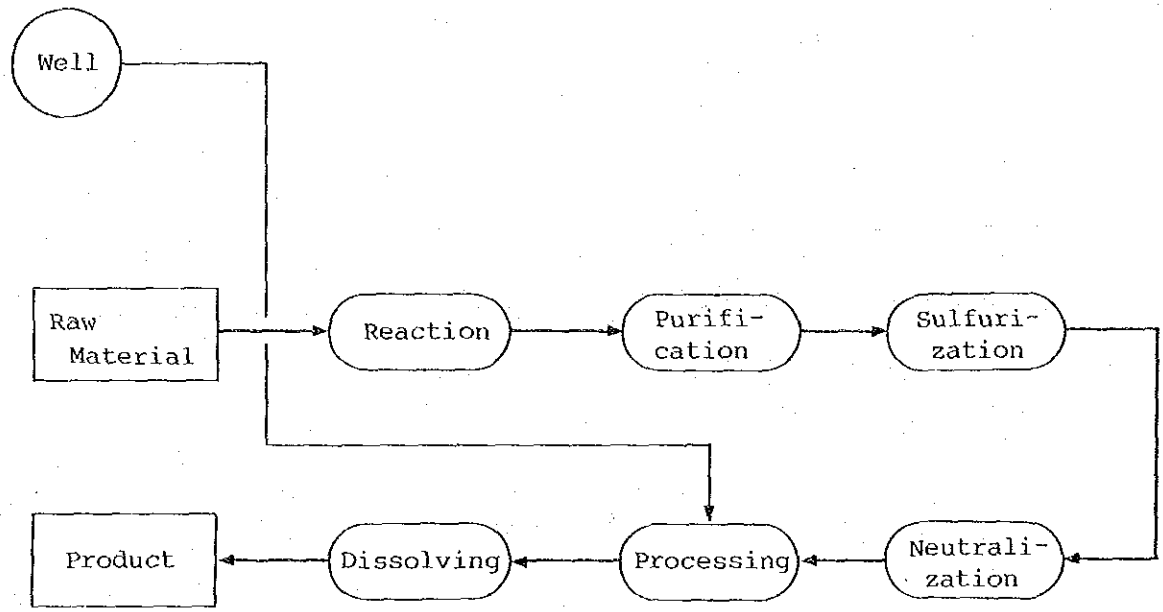
(2.1) Water Consumption

Unit: m^3/d

Use \ Source	Well Water	MWA	Others	Sub Total	Recover-ed Water	Total
Boiler						
Material						
Processing & Washing	184			184		184
Cooling	30			30	790	820
Air Conditioning						
Others	4			4		4
Sub Total	218			218	790	1,008
Outside	8			8		8
Total	226			226	790	1,016

Recovery Rate (%): 78.4

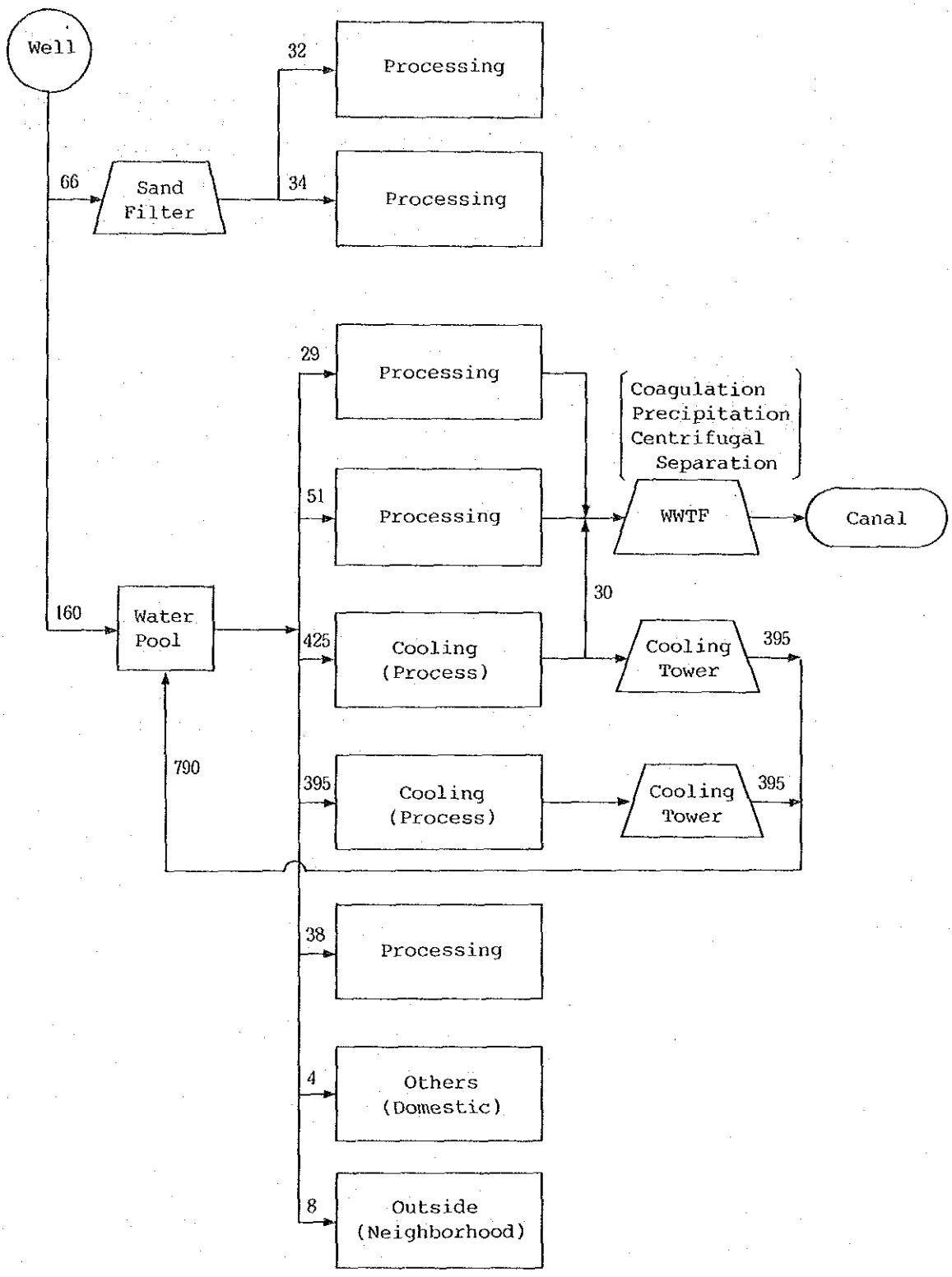
(2.2) Process Diagram of Production Line



Shampoo
Bleacher
Surface Active Agent

(2.3) Flow Diagram of Water Supply and Waste Water Discharge

(Unit: m^3/d)



Legend: WWTF = Waste Water Treatment Facility

(2.4) Explanation of Present Situation

(2.4.1) Sources and Uses

In this factory, water is supplied from a well of 141 m deep.

This factory is keen on saving water. Flow meters are installed at 25 different points of the production line. In this way 40 m^3/d of well water is saved through the prevention of water leakage.

The water consumption is measured 127 m^3/d on the day of the study. According to the factory's data (December 1986), it ranges from 58 m^3 to 350 m^3/d, and the annual average is 226 m^3/d.

Water including recycled water is mainly used for cooling (71%) and processing (29%). Since the details of the processes are unknown, "the cooling water pool" and "process water pool" shown on the Flow Diagram of Water Supply and Waste Water Discharge are regarded as cooling water and processing water respectively.

Domestic water amounts to 4 m^3/d, which is very small for 276 employees.

(2.4.2) Water Treatment

Water used for cooling, domestic and water supplied to the neighborhood is raw well water.

Process water is used after being treated by sand filter.

(2.4.3) Waste Water Treatment

Waste water from washing process is discharged into a canal after being treated by coagulation/sedimentation and centrifugal separation processes.

(3.) Plans of Effective Use of Industrial Water

(3.1) General

As regards to the use of cooling water, since the cooling tower and the cascade system are already utilized, there is little room for further improvement. Although it is possible to use treated waste water for garden sprinkling or car washing, the quantity of water saving would be negligible.

According to the member of factory, the recovery of water is not feasible because of high power charges for pump operation. Judging from the above observations, there seems little room for further improvement.