Chapter 10 Technical Study for Dev Blok

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This chapter contains various kinds of information confidentially disclosed to EIE and JICA only and is not eligible to disclosure to the general public.

Chapter 11 Technical Study of Textile Factory

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11-1 Characteristics of the Textile Industry

This chapter concerns the energy audit of Izmir Basma Fabrikasi A.S. (IBF). The JICA study team intended to conduct a major audit of IBF and a minor one of its sister spinning and weaving company, Izmir Pamuk Mensucati T.A.S. (IPM), as has been agreed among EIE, the factory management and the study team. At the kick-off meeting for the energy audit with EIE, IBF and the study team, the IBF management said that they wished to concentrate on IBF and to cancel the audit of IPM, because IPM completed construction of a new spinning mill on a new site in a suburb of Izmir, and is now in the process of moving some machines from the present site; the conditions of the factory did not permit auditing. Accordingly, the audit of IPM was canceled.

IPM is a spinning and weaving mill, starting from cotton raw material and producing gray cloth, all of which goes to IBF. IBF is a printing, dyeing, and finishing factory, processing the gray cloth from IPM and other sources for commission printing. The amount of the commission printing accounts for two-thirds of the IPM products. The main products are fabrics for dress, nightwear, sheeting for bedsets, and curtains. Both companies are owned by the Giraud family; IPM was founded in 1912 and IBF in 1957. The factories emphasize good quality of their products as company's motto. Both factories are old and plan to move outside of Izmir in two to five years. From the energy audit point of view, spinning and weaving mills and dyeing, printing, and finishing factories are fairly different. In the absence of adequate data for the Turkish industry, Table 11-1 shows estimated unit energy consumption of major processes of a typical Japanese textile plant.

It may be noted from comparison between the spinning and weaving mills on one hand, and the dyeing, printing and finishing factories on the other, that:

1. The former is an industry of mass production and continuous operations are the rule. The latter produces many kinds of goods in small quantities in a number of steps, the combination of which varies depending upon the required quality of the products. Operations of processes are intermittent and batchwise.
2. The former consumes more electricity while the latter consumes more fuel. The total energy consumption is larger in the latter.

From these differences, the need for rationalizing energy use is more urgent in the latter than in the former.

Table 11-1 Estimated Unit Energy Consumption in the Japanese Textile Industry (Cotton, 1990)

Unit: 10^6 kcal/ton-product

Process	Case	Energy		
		Electricity	Fuel	Total
Spinning	20 Ne	2.1	0.4	2.5
	40 Ne	3.8	0.7	4.5
Weaving	Mean of Light and Heavy Weight	0.9	1.0	1.9
Dyeing--Finishing	Shirt (Fabric Weight 130 g/m^2)	1.3	11.7	13.0
	Casual Pants (250 g/m^2)	0.8	9.9	10.7
Printing--Finishing	Lady's Dress Fabric (130 g/m^2)	2.3	15.3	17.6
	Home Textiles (200 g/m^2)	1.6	16.1	17.7

11-2 Outlines of Factory, Facilities and Flowsheet of Major Products

11-2-1 Factory

(1) General

Outline of IBF is as follows:

1. Name of the factory: Izmir Basma Fabrikasi A.S.
2. Address: 1201 Sokak No: 3/E Halkapinar-Izmir
   Tel (232) 4339810
3. President: Mr. Frederick Giraud
4. Factory manager: Mr. Enver Oktay
5. Energy manager: Mr. Muzaffer Tomruk
6. Type of industry: Textile Fabric
7. Capital, billion TL: 119.5

The information given here is withheld from public disclosure because of its confidential nature.

(2) Outline of Major Products

Table 11-2 Production Amounts of IBF

The information given here is withheld from public disclosure because of its confidential nature.

11-2-2 Production Facilities and Flowsheet

Figure 11-3 shows the production flow diagram of IBF, and Table 11-3 shows their energy consumption.

(1) Singeing

The factory uses LPG. The cloth speed is 80 meters per minute; or the contact time is 1/20 second.

(2) Bleaching

The factory has two types of bleaching machines, rope bleaching and open width bleaching. They use hydrogen peroxide, sodium hypochlorite and sodium hydroxide as bleaching agents. This process is one of the most steam consuming processes. The washing temperature is from 30 to 95℃ and the bleaching temperature is from 30 to 100℃.

(3) Mercerizing

Cloth is treated in a caustic soda solution at room temperature for 30 to 50 seconds.

(4) Printing

Five rotary screen type printing machines are installed. These are the main facilities in the factory. The factory considers themselves skilled in printing roller preparation and pattern design. The factory simultaneously prints a maximum of 15 colors. Width of the machines is from 185 to 240 centimeters. Cotton fabrics are used mainly for printing.

(5) Dip dyeing

The factory has five jiggers. They are used for plain dyeing, bleaching, washing and other purposes. The plain dyeing temperature is from 60 to 90℃.

(6) Fixing

The fixing temperature is different according to the recipe.

(7) Finishing

The number of finishing machines is four. Their finishes are water repellent, soil repellent, flame retarding, crease free, soft feeling, etc. The temperature applied is from 100 to 180℃.

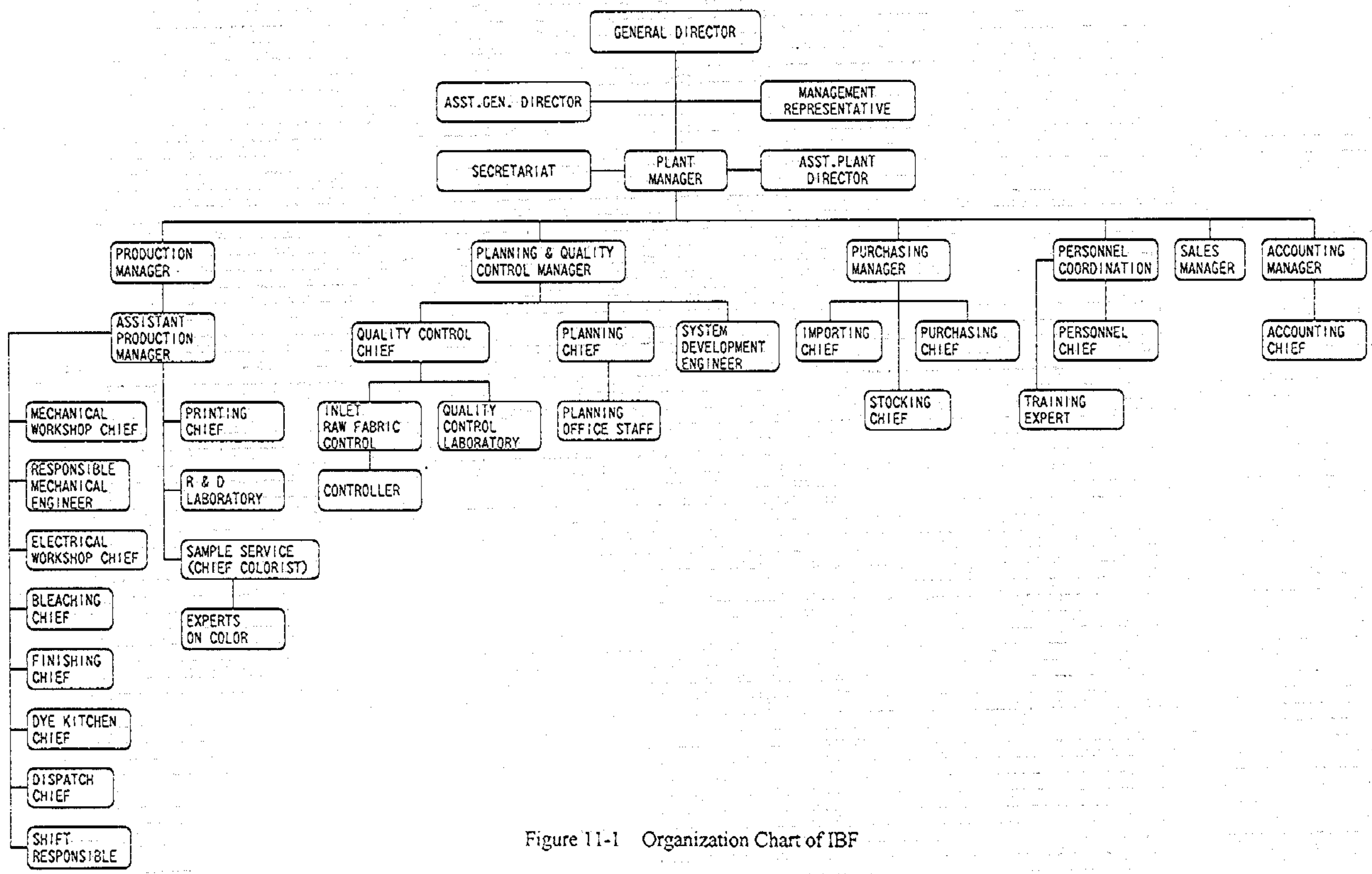


Figure 11-1 Organization Chart of IBF

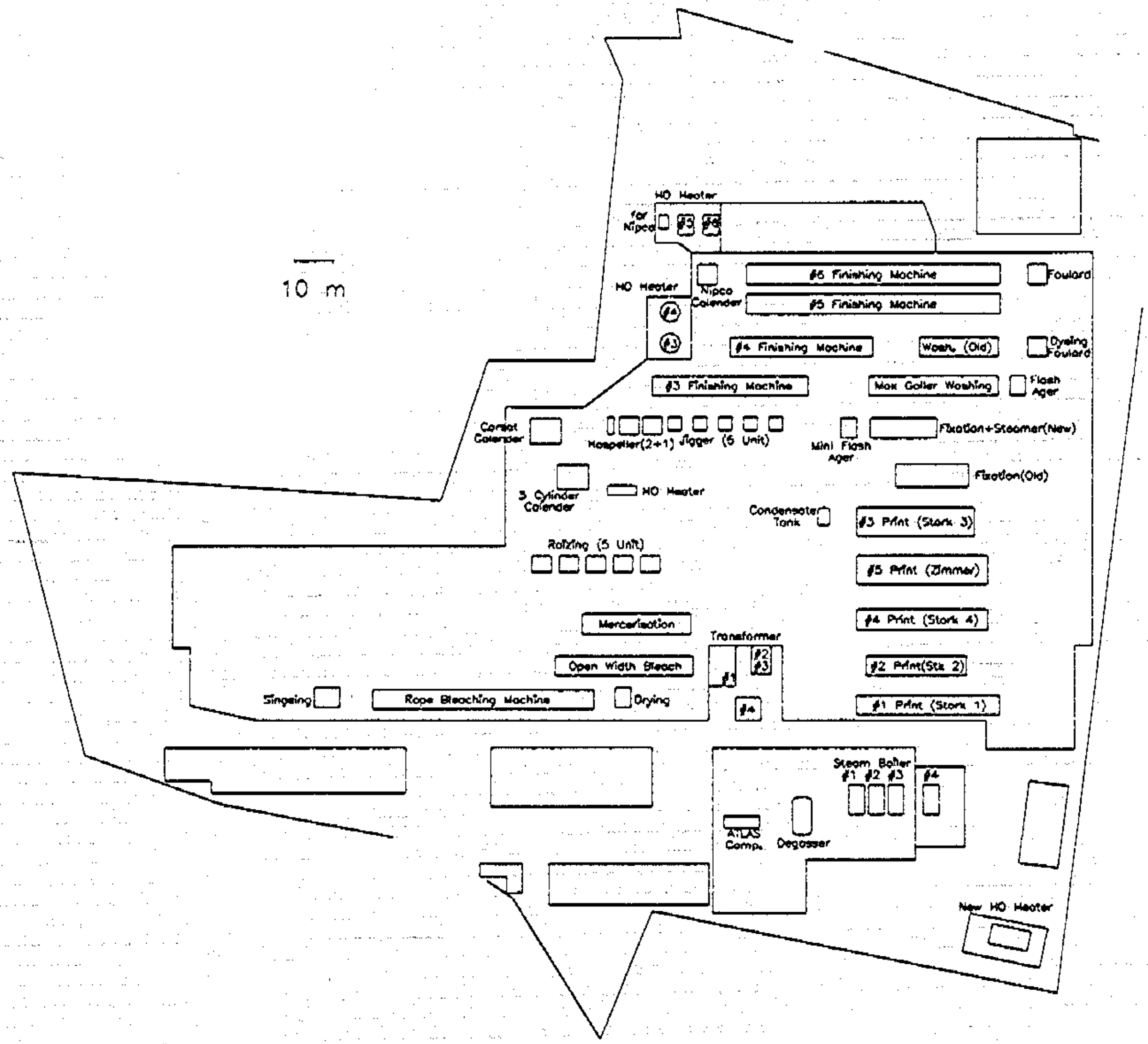


Figure 11-2 Process Layout of IBF

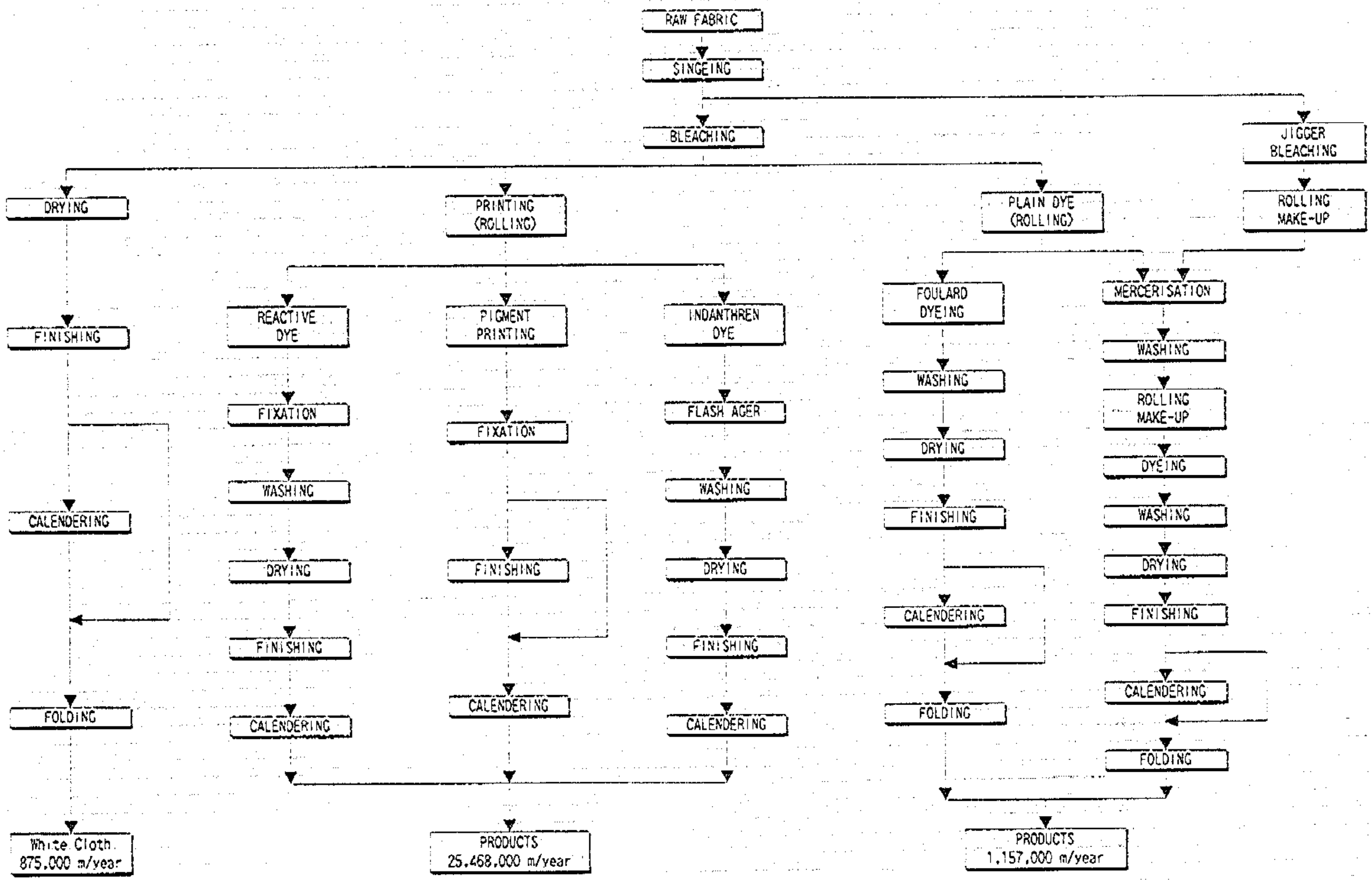


Figure 11-3 IBF Production Flow Diagram

Table 11-3 Major Utility Consuming Facilities

No.	Name of Facility	Utility Consumption				Connected Transformer
		Steam (kg/h)	Electricity (kW)	Hot Oil (kcal/h)		
				Normal	Start-up	
1	Rope Bleaching Range	1,250	108			No.1
2	Open Width Bleaching Range	1,750	157			No.4
3	Mercerization	600	34			No.2 & No.3
4	Small Bleaching Machines (Jigger)	600	10			No.2 & No.3
5	Washing Range (Kleine Wefers)	1,500	85			No.1
6	Washing Range (Max Goller)	1,600	170			No.2 & No.3
7	Cotton Flannel Machines (Raizing)	150	25			No.2 & No.3
8	Drying Machines (Flash Ager)	300	25			No.1
9	Drying Machines	900	23			No.1
10	Boiler House	900	90			No.2 & No.3
11	Water Treatment Unit		212			No.2 & No.3
12	Calendering Machine (Carsat)		22			No.2 & No.3
13	Calendering Machine (5 Cylinder)		52		125,000	No.2 & No.3
14	Calendering Machine (Nipco)		51		90,000	No.4
15	Printing Machines (Stork 1)		170	1,100,000	1,600,000	No.1
16	Printing Machines (Stork 2)		128	1,100,000	1,600,000	No.1
17	Printing Machines (Stork 3)		190	1,100,000	1,600,000	No.4
18	Printing Machines (Stork 4)		204	1,100,000	1,600,000	No.4
19	Printing Machines (Zimmer)		238	1,100,000	1,600,000	No.1
20	Finishing Machines (No.3)		140	1,300,000	1,600,000	No.1
21	Finishing Machines (No.4)		140	1,300,000	1,600,000	No.1
22	Finishing Machines (No.5)		257	1,400,000	2,000,000	No.4
23	Finishing Machines (No.6)		257	1,400,000	2,000,000	No.4
24	Compressor		75			No.4

11-2-3 Energy Supply Facilities

(1) Steam Boiler

IBF has four boilers horizontally-fired type, burning 35 tons a day of lignite from Soma. The specifications of the steam boilers are shown in Table 11-4. The steam is supplied to the processes of bleaching, mercerization, washing, drying, etc. Their nominal consumption is shown in Table 11-3.

Table 11-4 Specifications of Steam Boilers in IBF

No.	Built Year	Evaporation Capacity (ton/h)	Pressure Maximum (bar)	Pressure Normal (bar)	Temperature Normal (°C)	Fuel	Heating Area (m^2)	Economizer Area (m^2)	Stoker Area (m^2)	Maker
1	1954	5.0	10	8	169	Lignite	160	85	5.3	Walther Cie and Josef Martin
2	1954	5.0	10	8	169	Lignite	160	85	5.3	
3	1954	5.0	10	8	169	Lignite	160	85	5.3	
4	1976	6.0	10	8	169	Lignite	285	-	6.0	Sungurlar

The features of the boilers may be summarized as follows:

1. Horizontal smoked tube type
2. Economizer installed (Flue gas - Feed water heat exchange type in the convection section)
3. Coal-firing type
4. Small capacity at 5 tons/h
5. IDF and FDF installed
6. Screw feeder for coal
7. Air preheat (Ash - Supply air heat exchange)

(2) Hot Oil Heater

IBF has nine hot oil heaters for heating of the printing, finishing and calendering machines, because IBF's steam boilers cannot easily generate the high temperature necessary for the processes. The factory burns fuel oil and diesel oil. Normally the temperature of outgoing and returning oil at the heaters is 240°C and 220°C, respectively. The machines using heat and specifications of the hot oil heaters are shown in Tables 11-3 and 11-5, respectively. The factory constructed a new heater of a large capacity to replace the present Nos. 1 to 3 Heaters, which are connected to the printing machines.

Table 11-5 Specifications of Hot Oil Heaters in IBF and Heat User Machines

No.	Built Year	Heating Capacity (kcal/h)	User Machine (estimated from H.O. Heater List)	Pressure Maximum (bar)	Pressure Normal (bar)	Temperature Normal (℃)	Fuel	Maker
1	1986	1,720,000	Printing Machine (Stork 3)	10	6	240	Fuel Oil	Wiesloch
2	1989	2,000,000	Printing Machine (Stork 4)	10	6	240	Fuel Oil	Termostandard
3	1983	2,500,000	Printing Machine (Stork 1&2)	10	6	240	Fuel Oil	HTI
4	1973	1,600,000	Finishing Machine (No.3)	10	6	260	Fuel Oil	Wiesloch
5	1973	1,600,000	Finishing Machine (No.4)	10	6	240	Fuel Oil	Wiesloch
6	1987	2,300,000	Finishing Machine (No.5)	10	6	240	Fuel Oil	Termostandard
7	1987	2,300,000	Finishing Machine (No.6)	10	6	240	Fuel Oil	Thermtechnik
8	1988	125,000	Calender. Machine (5 cylinder)	10	6	240	Diesel Oil	AURA
9	1990	90,000	Calendering Machine (Nipco)	10	6	240	Diesel Oil	AURA
New	1996	7,500,000	Printing & Fixation Machines	10	6	240	Fuel Oil	Termostandard

The features of the hot oil heater systems are as follows:

1. The furnaces are all of radiation type; Nos. 5 and 6 heaters and the new heater have horizontal furnaces and Nos. 3 and 4 heaters have vertical furnaces.
2. There are two mini heaters for each calendering machine and two old heaters as standby for the new heater.
3. Each heater supplies heat by circulating hot oil to given grouped machines.
4. The heat in each hot oil system is consumed by machines freely according to their operation. These machines operate batchwise as dictated by the production plan. Naturally, the operation of the hot oil system fluctuates as demand for heat fluctuates.
5. Liquid fuel is used. No. 6 Fuel Oil is used for the new hot oil heater, the special fuel oil for Nos. 1 to 7 heaters and Diesel Gas Oil for the mini hot oil heaters.
6. Control system of the hot oil system is as follows:
   (1) Hot oil is fed to the heaters without flow control; flows are determined by the capacities of the pumps.
   (2) Each machine receives hot oil with a temperature-indicating controller, TIC, equipped with a three-way valve. The temperature of the hot oil returning to the heaters fluctuates widely depending upon the load of the users.
   (3) Fuel oil is fed to the heaters, in such a way that the outlet temperature of the hot oil remains constant, by manual operation.
   (4) The amount of combustion air to the new heater is controlled by the opening of the

dampers which is also manually controlled. The flue gas temperature is watched but the oxygen content of the flue gas is not. Other heaters do not have dampers.

7. A waste heat recovery system is installed in the new hot oil heater. Heat is recovered by heating the combustion air from the flue gas.
8. An automatic emergency shutdown system is installed.

(3) Electricity

Electric power is received from the City Electricity Network. IBF receives 3-phase 10.5 kV electricity. The price of electricity is divided into three classes according to duration of consumption. Three power meters count the sum of consumption in each class. IBF also has a special meter to measure excess and reactive power to be charged with a penalty rate. The four transformers reduce the received voltage to 400 Volts. The capacities of Nos. 1 to 4 transformers are 1,000 kVA, 500 kVA, 500 kVA and 1,600 kVA, respectively. Nos. 2 and 3 transformers are connected in parallel in the transformer facility, and electricity is distributed via three feed lines in the factory. Each feed branch has a condenser to improve power factor. The outline of the IBF electricity system is shown in Table 11-6 and Figure 11-4.

(4) Major Utility Consuming Facilities in IBF

Table 11-3 shows the major production facilities, their nominal utility consumption and the connected electric transformers.

Table 11-6 IBF Electric System

Electric Receiving Facilities

Receiving Voltage, Volt	10,500
Maximum Demand, kW	2,100
Power Factor	0.95
Number of Transformer	4 Stasions (Each receives city electricity directly.)

Transformer	No.1	No.2	No.3	No.4	Total
Capacity, kVA	1,000	500	500	1,600	3,600
Load, %	63	48		68	
kVA	630	480		1,088	2,198

Sections Connected to Transformer Stations

Sections are parallel connected to No.2 & No.5 transformer stations.

Transformer	No.1	No.2	No.3	No.4	Total
Dyeing Machines (Jigger)		5			5
Washing (Kleine, Max Goller, Flash Ager)	1	1			2
Rope Bleaching	1				1
Open Width Bleaching				1	1
Steamer (Drying)	1				1
Mercerization		1			1
Cotton Flannel Machines (Raizing)		5			5
Dye Preparation		1			1
Printing Pattern Material Preparation	1	1			2
Printing Machines (Stork)	2			2	4
(Zimmer)	1				1
Calendering Machines		2		1	3
Finishing Machines	2			2	4
Water Treatment Filter (Ion Exchange)		1			1
Waste Water Treatment				1	1
Steam Boilers	1	3			4
Hot Oil Heaters for Printing Machines (Old)	2			1	3
Hot Oil Heaters for Calendering Machines		1		1	2
Hot Oil Heaters for Finishing Machines				4	4
Centralized New Hot Oil Heater (in 1996)				1	1
Compressor Room				1	1
Office Building		X			X
Plant Lighting		X			X

Hot Oil Heater User Detail	No.1	No.2	No.3	No.4
for Printing Machine (Stork 1 & 2)	X			
for Printing Machine (Stork 3)	X			
for Printing Machine (Stork 4 & Zimmer)				X
for Printing Machines (Centralized HO Heater)				X
for Finishing Machine (No.3)				X
for Finishing Machine (No.4)				X
for Finishing Machine (No.5)				X
for Finishing Machine (No.6)				X
for Calendering Machine (Nipco)				X
for Calendering Machine (5 Cylinder)		X		

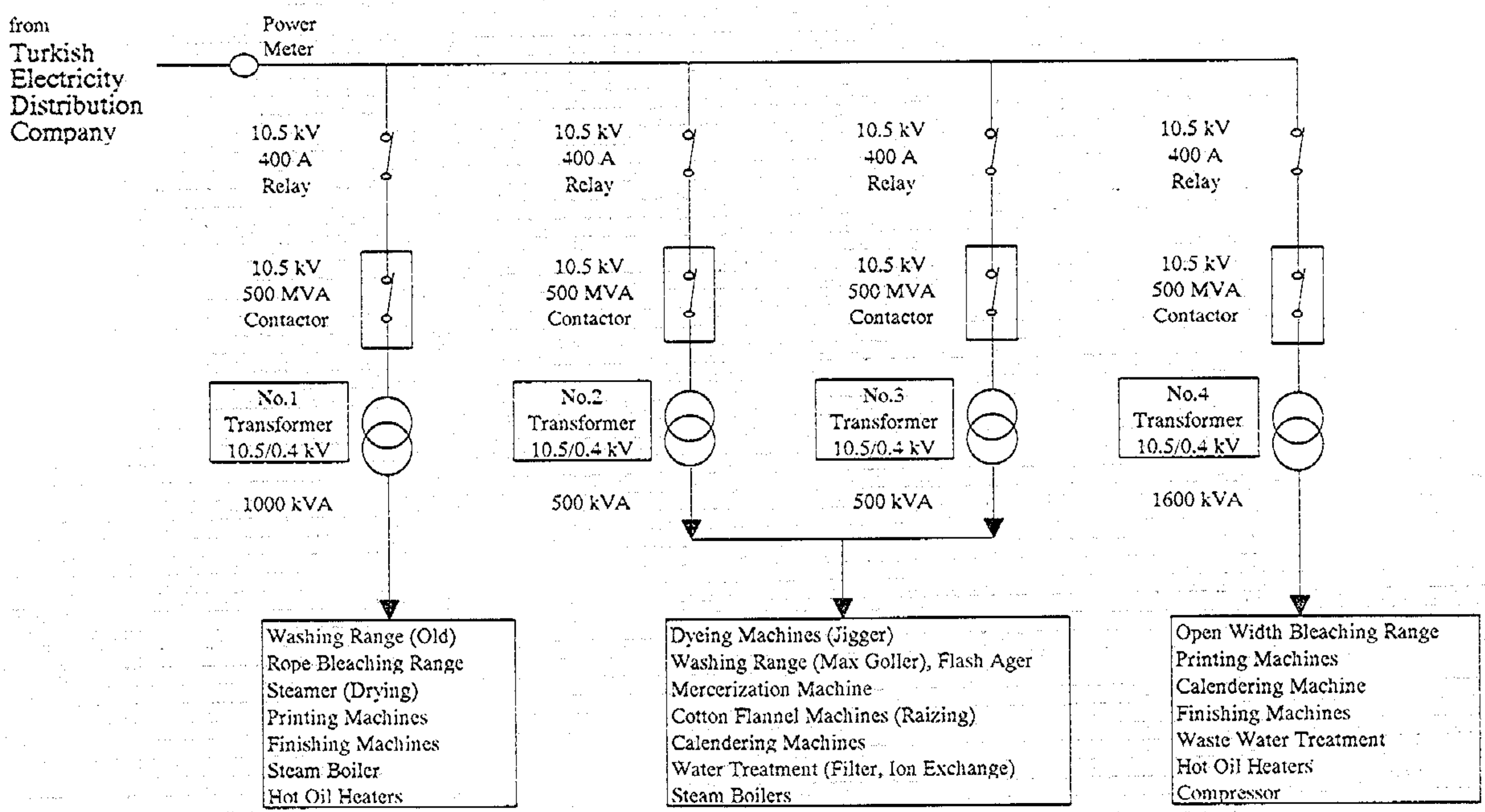


Figure 11-4 Single Connection Diagram of IBF Electric System

11-3 Outline of Operating Conditions

The operating condition of major production facilities and of energy supply facilities are described in Sections 11-2-2 and 11-2-3, together with their specifications. The operation mode is continuous, working 20 to 24 hours a day and 330 days a year. The factory has an annual maintenance schedule, and normally shuts down for maintenance for two weeks in August.

11-4 Trends of Consumption and Unit Consumption of Energy

11-4-1 Energy Consumption

Table 11-7 shows the energy consumption trend.

(1) Lignite

Lignite is the fuel for the steam boilers. It comes from Soma and normally has a heating value of 3,500 to 4,500 kcal/kg and 34 percent ash.

(2) Fuel Oil and Diesel Oil

The factory uses hot oil as a heating medium for printing, finishing and calendering machines. Fuel oil and Diesel oil are burned in hot oil heaters.

(3) LPG

LPG is burned in the singeing process.

(4) Electricity

Electricity is the power source for all motors and lighting.

Table 11-7 Trends of Energy Consumption in IBF

Name of Utility	1992	1993	1994	1995	1996 (Aug.)
Lignite, tons	7,299	15,918	16,306	13,428	8,063
Price, TL/t				1,238,000	2,501,000
Fuel Oil for Oil Heaters, tons	3,598	3,430	3,267	3,486	2,607
Price, TL/kg	1,528	2,243	5,520	10,633	14,702
Diesel Oil for Oil Heaters, tons			70	86	77
Price, TL/kg			11,900	19,950	39,830
LPG for Singeing, tons	59	95	100	105	71
Price, TL/kg				15,800	28,700
Electricity, MWh	11,752	12,219	12,433	11,403	7,553
Price, TL/kWh				3,254	

11-4-2 Unit Consumption of Energy

The unit consumption of energy is calculated as follows.

(1) Annual Production

IBF's record shows production of fabric in meters. The width and weight of fabrics varies from one lot to another, the following numbers are assumed.

Fabric weight, gram/m^2:	140
Width of fabric, cm:	160

(2) Annual Consumption of Energy

IBF consumes various kinds of energy as shown in Table 11-7. To facilitate comparison with other factories and with the data of Japanese counterparts, amounts of energy are converted into kilocalorie. The following conversion factors are used.

Lignite for steam boiler, kcal/kg	4,385
Fuel oil for hot oil heater, kcal/kg	10,000
Diesel oil for hot oil heater, kcal/kg	9,500
LPG for singeing, kcal/kg	11,000
Electricity, kcal/kWh	860

Table 11-8 Trends of Unit Consumption of Energy in IBF

	1992	1993	1994	1995	1996 (Aug.)
Production, 10^3 m	33,047	32,013	26,979	27,215	16,885
tons	7,402	7,171	6,043	6,096	3,782
Energy Consumption					
Lignite, tons	7,299	15,918	16,306	13,428	8,063
10^6 kcal	32,006	69,800	71,502	58,882	35,356
Fuel Oil, tons	3,598	3,430	3,267	3,486	2,607
10^6 kcal	35,980	34,300	32,670	34,860	26,070
Diesel Oil, tons			70	86	77
10^6 kcal			665	817	732
LPG, tons	59	95	100	105	71
10^6 kcal	649	1,045	1,100	1,155	781
Electricity, 10^3 kWh	11,752	12,219	12,433	11,403	7,553
10^6 kcal	10,107	10,508	10,692	9,807	6,496
Total					
10^6 kcal	78,742	115,653	116,629	105,521	69,435
Unit Consumption of Energy					
10^6 kcal/ton-Fabric	10.64	16.13	19.30	17.31	18.36

The unit consumption of energy in the years from 1994 to 1996 remained almost constant. The consumption increased from 1992 to 1993.

11-5 Current Condition and Problems with Energy Management and Conservation

The current practice of energy management may be expressed as follows against the generally accepted recommended practices.

1. Target for energy conservation: The factory does not have a target.
2. Systematic activities for energy management in the organization: Every Wednesday, an outside consultant comes. The factory has no such organization as an energy saving committee with participation by production managers.
3. Energy management utilization of data and records: The factory records the consumption of electricity and coal every month, but the records are used only for accounting.

4. Education, training of employees for energy management: Education on energy conservation has not been given to the workers.
5. Schedule of annual maintenance: The factory shuts down once a year and has an annual maintenance schedule.
6. Measures carried out for energy conservation and their effects: Energy conservation is achieved mostly by replacement of old machines by newer ones.

   Planning for energy conservation and expected effects: The factory is moving to a new site in 2 to 5 years. New investment in the present factory has been suspended. Natural gas is intended for the main fuel for the new factory, because the factory considers LNG more economical. The factory also considers reducing hot oil use and introducing a co-generation system.
7. Problems in promotion of energy conservation: Yes
8. Environmental pollution management:
   (1) Waste gas: Flue gas is used for water treatment. The flue gas from the stack is an environmental problem.
   (2) Waste water: Waste water is neutralized by the flue gas.
   (3) Waste disposal: Apparently no problem. There is a disposal site owned by the municipality. The factory is charged for the disposal by the city.

11-6 Current Condition and Problems with Facilities

11-6-1 Common Items

The following items commonly apply to major energy consuming and supply facilities.

(1) Lack of Measuring Meters of Energy Supply and Consumption

Flow meters of heating media such as steam and hot oil are not installed. Although a few water consumption, temperature, pressure meters are installed, meters are insufficient for energy management.

(2) Insufficient Thermal Insulation

Steam lines, hot oil lines and related equipment such as steam boilers, hot oil heaters and production machines are fully insulated; however, some parts of thermal insulation do not use good materials and/or do not have enough thickness. This causes undue heat loss.

(3) Excessive Electricity Consumption

Some motors are operated at higher rotations than required. The transformer capacity in the electric supply system is too large compared with the electric load of the group users. They are causing electricity loss.

11-6-2 Items for Production Facilities

(1) Intermittent Operation

Some facilities operate intermittently. This causes unnecessary energy loss. A production schedule should consider rational use of energy as a high priority target.

(2) Heat Loss from the Bleaching Range

Gray cloth is bleached and washed in the bleaching machines by water and steam to make white cloth, and they release heat to the atmosphere and drain hot water to the canal.

(3) Heat Loss in the Washing Range

White cloth is treated by printing, steaming, washing and finishing in the system to produce printed fabric. Some heat is lost to the atmosphere and to hot waste water, especially at the washing machine.

11-6-3 Items for Energy Supply Facilities

(1) Low Efficiency Operation of the Boiler and Hot Oil Heater

The existing steam boilers and hot oil heaters are small in capacity and operate independently of each other. Therefore, they are operated at low load levels compared with the design capacities. The operation of the entire energy supply system, including circulation of heating media, should be streamlined.

(2) Lower Steam Condensate Recovery

Only a small portion of the steam condensate is recovered. At present, the recovery rate is 30 percent. Recovery of steam condensate should have a high priority.

(3) Steam Loss from the Steam Lines

There is some steam loss through steam traps. Some leakage of steam to the atmosphere was observed.

(4) Steam Boiler

1) Measuring Equipment and Control

Few measuring instruments are installed on the boilers. The control is manually done by hand. The boilers originally had steam flow meters and flue gas composition indicators. They are not operational as a result of lack of maintenance and lack of chemicals required for measurements.

Operation procedure is as follows:

1. Steam pressure: Maintained at 7 Kg/cm^2.
2. Coal feed rate: The rotation of the coal feeder is controlled by hand.
3. Water level in boiler:
   (1) Nos. 1 and 3 Boilers: Manual control with the help of an alarm device
   (2) No. 2 Boiler: Controlled by a level controller
4. Air supply:
   (1) FDF: The dampers are fully open.
   (2) IDF: The opening of the dampers and rotation of the motor are controlled according to the combustion conditions inside the furnace and smoke in flue gas from the stack.. Sometimes, the content of O_2 in the flue gas is analyzed, but no action is taken to correct the observed results.

2) Operation

The data are recorded every hour. The recorded data do not vary with time. This could mean either that boiler operation is very stable or that measuring equipment does not work properly. Demand for steam fluctuates depending upon the consumption of the steam users. It follows then that the measuring equipment does not work properly. The factory records the following items:

1. Steam flow: There is no meter and therefore this is not recorded.
2. Water temperature at the inlet and outlet of the economizers
3. Exhaust gas temperature at the inlet and the outlet of the economizers
4. Pressure at the FDF outlets and the IDF inlets
5. Suction pressure: mm H_2O at some positions of the stokers
6. Damper position on ducts for controlling the air flow at each stoker
7. Position of gear change devices of the coal screw conveyers
8. Coal type and consumption quantity: One bucket carries approximately 420 kg.
9. Smoke pipe cleaning operation by steam

11-7 Method and Procedure of Energy Audit

Generally, an energy audit is carried out by the following procedure. For more details reference should be made to Section 11-14-2.

1. The information related to energy use of the factory including both management and facilities is collected.
2. The flowsheets and specifications of facilities are investigated from the technical point of view.
3. Operation variables are measured on energy related points.
4. Operating conditions and data are observed.
5. The results of measurements and observations are analyzed.
6. Heat balance calculation is done.
   (1) Heat inputs
   (2) Heat outputs
   (3) Heat losses
7. The resultant heat balance is analyzed and conclusions are drawn.

An energy audit has to examine the energy supplying side and the energy consuming side. In the case of IBF, the following items were selected as important and were audited. EIE, IBF, and the study team agreed on the selection of items to be measured and measurements were done accordingly.

(1) Energy Supplier Side

1) Steam Boiler

Three of the four boilers under operation were audited.

2) Hot Oil Heater

All hot oil heaters and circulation systems were audited.

3) Steam Distribution System and Condensate Recovery System

IBF made by-passes on the steam lines to temporarily install eddy current flow meters for flow measurement. One such by-pass was made on the main steam delivery pipe, and the other on the distribution pipe to the bleaching machine. Along with this, the condensate recovery system was audited.

4) Water Supply and Drainage System

The amounts of water supply to the production facilities and the drainage were measured.

5) Electricity System

The electricity consumption in the whole factory and those of the main facilities were investigated.

(2) Energy Consumer Side

1) Bleaching Machines

IBF has two bleaching machines, a rope bleaching machine built in 1974 and an open width bleaching machine built in 1987. The latter was audited, because this bleaching machine is operated continuously and is more important to the factory. IBF plans to bring this bleaching machine to the new site. The nominal consumption of steam is 1,750 kg/h and that of electricity is 157 kW.

2) Washing Machines

IBF also has two washing machines, new and old. The new one, built in 1996 by Max Goller, was selected for the same reasons as that for the open width bleaching machine. The nominal consumption of steam and electricity is 1,600 kg/h and 170 kW, respectively. The older washing machine was built in 1974.

Table 11-9 presents the detailed plan for energy audit of IBF. The analytic tests shown in Table 11-9 were done by the temporary laboratory of the study team, the Mining Research Institute in Ankara, Bati Cement Incorporated and Turkish Petroleum Refinery in Izmir. Additional analyses were done by Chugai Technos Laboratory and Nippon Oil Company in Japan. In Table 11-9 "Measure or Estimt", "C", and "ASTM Dist" stand respectively for "Measurement or Estimation", "C", and "ASTM Distillation."

Table 11-9 Detailed Plan for Energy Audit of IBF (1/4)

Major items of energy audit	Subject	Measurement Item	Measurement Range	Measurement Points	Equipment of Analysis and Measurement: Modification of Equipment	Measure. / Estima.	Equipment	Factory	EIE	Study Team	Addi-tional	Local Labo.	Carry back to Japan	Remarks
1. Steam Boiler 3 out of 4 Boilers were operated. They were studied.	Boiler body	Surface temp.	Max 150C	20	No	M	Surface temp. meter		X		X			"Additional" is contact type.
	Boiler feed water	Flow rate	Max 6 t/h	1	No	M	Flow meter	X			X			
		Temperature	Max 150C	1	No	M	Thermometer	X		X				
		Quality		1	No	M	from Factory data	X	X	X				
	Generated steam	Flow rate	Max 6 t/h	1	No	E								
		Temperature	Max 200C	1	No	M	Glass bar thermometer	X			X			
		Pressure	Max 8 bar	1	No	M	Pressure gauge	X		X				
	Blowing drain	Flow rate		1	No	M	from Factory data	X						
		Blowing time		1	No	M	ditto	X						
		Temperature	Max 200C	1	No	M	Thermometer	X		X				
		Quality		1	No	M	ditto	X	X	X				
	Fuel (Lignite)	Consumption rate	1.3 t/h	1	No	M	Crane bucket	X						
		Industrial analysis		1	No	M						X		
		Elemental analysis		1	No	M	Elemental analyzer			X				
		Calorific value	3500 - 4500 kcal/kg	1	No	M	Bomb calorimeter			X		X		HHV
	Ash of lignite	Temperature	Max 500C	1	No	M	Thermocouple			X				
		Residual carbon		1	No	M						X		
		Calorific value		1	No	M	Bomb calorimeter			X		X		HHV
	Combustion air	Flow rate		1	No	E								
		Temperature	Max 150C	1	No	M	Thermometer			X				
	Exhaust gas	Flow rate		1	No	E								
		Temperature	Max 300C	3	No	M	Stack gas analyzer		X	X	X			
		Component		3	No	M	ditto		X	X	X			

Table 11-9 Detailed Plan for Energy Audit of IBF (2/4)

Major items of energy audit	Subject	Measurement Item	Measurement Range	Measurement Points	Equipment of Analysis and Measurement: Modification of Equipment	Measure. / Estima.	Equipment	Factory	EIE	Study Team	Addi-tional	Local Labo.	Carry back to Japan	Remarks
2. Steam System Main 5 groups were Measured.	Steam lines	Flow rate		2	Yes	M	Eddy current flow meter				X			
		Temperature	Max 200C	2	Yes	M	ditto				X			
		Pressure	Max 8 bar	2	Yes	M	ditto			X	X			
		Surface temp.	Max 150C	20	No	M	Surface temp. meter		X		X			
	Condensate lines	Flow rate		3	No	M	Ultlasonic flow meter				X			
		Surface temp.	Max 100C	3	No	M	Surface temp. meter		X		X			
		Temperature	Max 100C	3	No	M	Water quality meter			X				
		Quality		3	No	M	ditto		X	X				
	Steam traps	Working condition		50	No	M	Computerized management system		X		X			
		Flow rate		50	No	M	ditto		X		X			
		Temperature	Max 100C	50	No	M	ditto		X		X			
3. Hot oil system 7 Heaters were operated. Main 5 Heaters were studied.	Heater body	Surface temp.	Max 150C	20	No	M	Surface temp. meter		X		X			
	Hot oil	Flow rate	Max 500 kL/h	1	Not possible	M	Pump capaciyy data	X			X			
		Temperature	Max 300C	3	Not possible	M	Thermometer	X			X			
		Pressure	Max 10 bar	2	Not possible	M	Pressure gauge	X		X				
		Specific heat		1	No	E	Estimated from SpGr and ASTM Dist.			X	X	X	X	
	Fuel oil	Flow rate	Max 0.5 kL/h	1	Not possible	M	Tank gauge	X						
		Temperature	Max 150C	1	Not possible	M	Thermometer	X						
		Elemental analysis		1	No	M	Elemental analyzer			X			X	
		Calorific value	Max 10000 kcal/kg	1	No	M	Bomb calorimeter			X		X		HHV
	Combustion air	Flow rate		1		E								
		Temperature	Max 150C	3	No	M	Thermometer			X				
	Exhaust gas	Flow rate		1	No	E								
		Temperature	Max 300C	2	No	M	Stack gas analyzer		X	X	X			
		Component		2	No	M	ditto		X	X	X			
	Hot oil lines	Flow rate	Max 100 kL/h	5	Not possible		Specifications of machine							
		Surface temp.	Max 200C	20	No	M	Surface temp. meter		X		X			
	User facilities	Surface temp.	Max 200C	20	No	M	Surface temp. meter		X		X			

Table 11-9 Detailed Plan for Energy Audit of IBF (3/4)

Major items of energy audit	Subject	Measurement Item	Measurement Range	Measurement Points	Modification of Equipment	Measure. / Estima.	Equipment	Factory	EIE	Study Team	Addi-tional	Local Labo.	Carry back to Japan	Remarks
					Equipment of Analysis and Measurement									
4. Water supply and drainage system	Fresh water to major processes	Flow rate		6	No	M	Ultrasonic flow meter	X			X			or flow meter of factory
		Temperature		1	No	M	Glass bar thermometer				X			
	Waste water from major processes	Flow rate		6	No	M	Specifications of machine				X			
		Temperature		6	No	M	Glass bar thermometer				X			
5. Electricity system	Receiving transformers	Electric current		3		M	Ammeter	X						
		Voltage		3		M	Voltmeter	X						
		Power factor		3		M	Power factor meter	X						
		Electric power		3		M	Electric power meter	X						
	Main users of electricity	Electric current		11		M	Ammeter, Clampmeter	X	X	X				
		Voltage		11		M	Energy analyzer	X	X					
		Power factor		11		M	ditto	X	X		X			
		Electric power		11		M	ditto	X	X		X			
6. Open Width Bleaching Range (Babcock 1974)	Machine Body	Surface temp.	Max 100C	20	No	M	Surface temp. meter		X					
	Cloth	Flow rate		1	No	M	Factory speed controller	X						
		Temperature		2	No	M	Surface temp. meter		X					
		Moisture		2	No	M	Balance			X				
	Steam	Flow rate	Max 2000kg/h	1	Yes	M	Eddy current flow meter				X			
		Temperature	Max 200C	1	Yes	M	ditto				X			
		Pressure	Max 8 bar	1	Yes	M	ditto			X	X			
	Steam condensate	Flow rate		1	No	M	Flow meter	X			X			
		Temperature	Max 100C	1	No	M	Water quality meter			X				
		Quality		1	No	M	ditto			X				
	Fresh water	Flow rate	Max 50 t/h	3	No	M	Flow meter	X				X		
		Temperature	Max 100C	6	No	M	Glass bar thermometer				X			
	Warm Water	Flow rate		3	No	M	Flow meter	X		X				
		Temperature	Max 150C	3	No	M	Glass bar thermometer			X				
	Electricity	Electric current		1		M	Ammeter, Clampmeter	X	X	X				
		Voltage		1		M	Energy analyzer	X	X					
		Power factor		1		M	ditto	X	X		X			
		Electric power		1		M	ditto	X	X		X			

Table 11-9 Detailed Plan for Energy Audit of IBF (4/4)

Major items of energy audit	Equipment of Analysis and Measurement: Subject	Measurement Item	Measurement Range	Measurement Points	Modification of Equipment	Measure. / Estima.	Equipment	Factory	EIE	Study Team	Addi-tional	Local Labo.	Carry back to Japan	Remarks
7. Washing Range (Max Goller 1995)	Machine Body	Surface temp.	Max 100C	20	No	M	Surface temp. meter		X					
	Cloth	Flow rate		1	No	M	Factory speed controller	X						
		Temperature		2	No	M	Surface temp. meter		X					
		Moisture		2	No	M	Balance			X				
	Steam	Flow rate	Max 2000kg/h	1	Yes	M	Eddy current flow meter				X			
		Temperature	Max 200C	1	Yes	M	ditto				X			
		Pressure	Max 8 bar	1	Yes	M	ditto			X	X			
	Steam condensate	Flow rate		1	No	M								
		Temperature	Max 100C	1	No	M	Flow meter	X			X			
		Quality		1	No	M	Water quality meter			X				
							ditto			X				
	Washing water	Flow rate	Max 50 t/h	3	No	M								
		Temperature	Max 100C	6	No	M	Flow meter	X				X		
							Glass bar thermometer				X			
	Waste water	Flow rate		3	No	M								
		Temperature	Max 150C	3	No	M	Flow meter	X		X				
							Glass bar thermometer			X				
	Electricity	Electric current		1		M								
		Voltage		1		M	Ammeter, Clampmeter	X	X	X				
		Power factor		1		M	Energy analyzer	X	X					
		Electric power		1		M	ditto	X	X		X			
							ditto	X	X		X			

11-8 Execution Procedure of Measurement

The equipment used for the energy audit is shown in Table 11-9, with the measuring ranges, approximate numbers of measuring points, proprietors, etc. Table 11-10 shows personnel assignments to the measurement, and the schedule outline.

Table 11-10 Detailed Plan and Schedule for Energy of IBF (1/2)

Analyzing and Measuring Item			Personnel Allocation JICA Number	EIE Number	Factory Number	Days	-	August 27 Tue	28 Wed	29 Thu	30 Fri	September 2 Mon	3 Tue	4 Wed	5 Thu	6 Fri	9 Mon	Remarks
1. Steam Boiler 3 out of 4 Boilers were operated. They were studied.	Boiler body	Surface Temperature	2	1	1	6		X	X	X								
	Boiler feed water	Flow rate, Temperature, Quality						X	X	X								
	Generated steam	Flow rate, Temperature, Pressure						X	X	X								
	Blowing drain	Flow rate, Blowing time, Quality						X	X	X								
		Temperature						X	X	X								
	Fuel (Lignite)	Consumption rate						X	X	X								
		Industrial analysis					X											Analyzed in advance
		Elemental analysis					X											Analyzed in advance
		Calorific value					X											Analyzed in advance
	Ash of lignite	Temperature						X	X	X								
		Residual carbon, Calorific value					X											Analyzed after
	Conbustion air	Flow rate					X											Calculation
		Temperature						X	X	X	X	X	X					
	Exhaust gas	Flow rate					X											Calculation
		Temperature, Component						X	X	X	X	X	X					
2. Steam System Main 5 groups were Measured.	Steam lines	Flow rate, Temperature, Pressure	2	1	1	9		X		X	X	X	X	X			X	
		Surface Temperature						X		X	X	X	X	X			X	
	Condensate lines	Flow rate, Temperature, Quality								X	X			X				
		Surface Temperature								X	X			X				
	Steam traps	Working condition										X	X	X	X	X	X	
		Flow rate, Temperature										X	X	X	X	X	X	
3. Hot oil system 7 Heaters were operated. Main 5 Heaters were studied.	Heater body	Surface Temperature	2	1	1	4						X	X	X				
	Hot oil	Flow rate, Temperature, Pressure										X	X	X				
		Specific heat					X											Carry back to Japan
	Fuel oil	Flow rate, Temperature										X	X	X				
		Elemental analysis, Calorific value					X											Carry back to Japan
	Combustion air	Flow rate					X											Calculation
		Temperature										X	X	X	X			
	Exhaust gas	Flow rate					X											Calculation
		Temperature, Component										X	X	X	X			
	Hot oil lines	Flow rate, Surface Temperature										X	X	X				
	User facilities	Surface Temperature										X	X	X				

Table 11-10 Detailed Plan and Schedule for Energy of IBF (2/2)

Analyzing and Measuring Item			Personnel Allocation JICA Number	EIE Number	Factory Number	Days	August 27 Tue	28 Wed	29 Thu	30 Fri	September 2 Mon	3 Tue	4 Wed	5 Thu	6 Fri	9 Mon	Remarks
4. Water supply and drainage system	Fresh water to major processes	Flow rate, Temperature	1	2	2	5	X	X	X	X	X						
	Waste water from major processes	Flow rate, Temperature					X	X	X	X	X						
5. Electricity system	Receiving transformers	Electric current, Voltage, Power	2	1	2	9	X	X	X	X	X	X	X	X	X		
	Main users of electricity	Electric current, Voltage, Power					X	X	X	X	X	X	X	X	X		
6. Open Width Bleaching Range (Babcock 1974)	Machine Body	Surface Temperature	1	2	2	5	X	X	X	X	X						
	Cloth	Flow rate, Temperature, Moisture					X	X	X	X	X						
	Steam	Flow rate, Temperature, Pressure					X	X	X	X	X						
	Steam condensate	Flow rate, Temperature, Quality					X	X	X	X	X						
	Fresh Wwater	Flow rate, Temperature															
	Warm water	Flow rate, Temperature					X	X	X	X	X						
	Electricity	Electric current, Voltage, Power					X	X	X	X	X						
7. Washing Range (Max Goller 1995)	Machine Body	Surface Temperature	1	2	2	5						X	X	X	X	X	
	Cloth	Flow rate, Temperature, Moisture										X	X	X	X	X	
	Steam	Flow rate, Temperature, Pressure										X	X	X	X	X	
	Steam condensate	Flow rate, Temperature, Quality										X	X	X	X	X	
	Washing water	Flow rate, Temperature										X	X	X	X	X	
	Waste Water	Flow rate, Temperature										X	X	X	X	X	
	Electricity	Electric current, Voltage, Power										X	X	X	X	X	

11-9 Results of Measurement and Analysis

11-9-1 Open Width Bleaching Range

The open width bleaching range may be divided into two parts as shown in Figure 11-5, namely:

1. Chemical treatment and washing baths and a steamer. The chemical treatment and washing baths are located on the first floor. The steamer is located on the second floor.
2. Heat recovery unit from hot waste water. This is located behind the chemical treatment baths.

The outline of the heat recovery unit is shown in Figure 11-6. Measurements were done on the two parts, and the following results were obtained.

(1) Fresh Water and Fabric Speed

The open width bleaching range has nine baths, or sections to be exact, which contain cold, warm and hot water. Each fabric has a code number that determines the processes to be applied: bleaching, mercerization, washing, printing, drying, for example.

Each bleaching bath has two water inlets, cold and warm, to the water basin, one water inlet (mainly cold) for spraying onto squeezing cylinders, and one steam inlet to warm water. Bleaching machine operators manually open or close the water and steam valves to attain the required temperature of the contents of the baths by watching the temperature indicator on each bath. When the operation stops for a moment the water and steam valves are left open, while when the operation stops for a long time the valves are closed. This causes unnecessary heat consumption.

Water consumption was measured from the 3rd to 5th of September by reading the water meter. The measurement results are shown in Table 11-11.

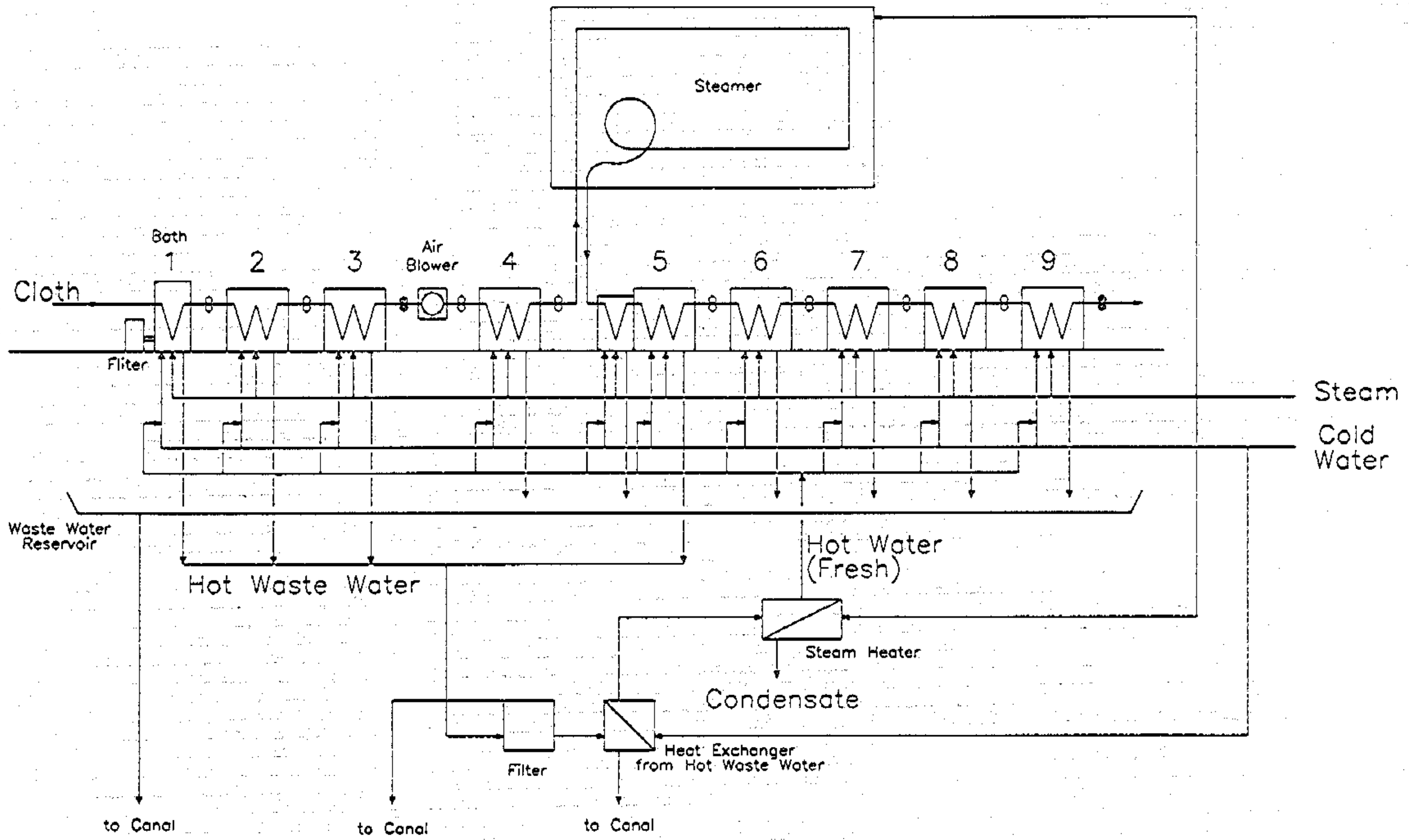


Figure 11-5 Schematic Flow Diagram of the Open Width Bleaching Range

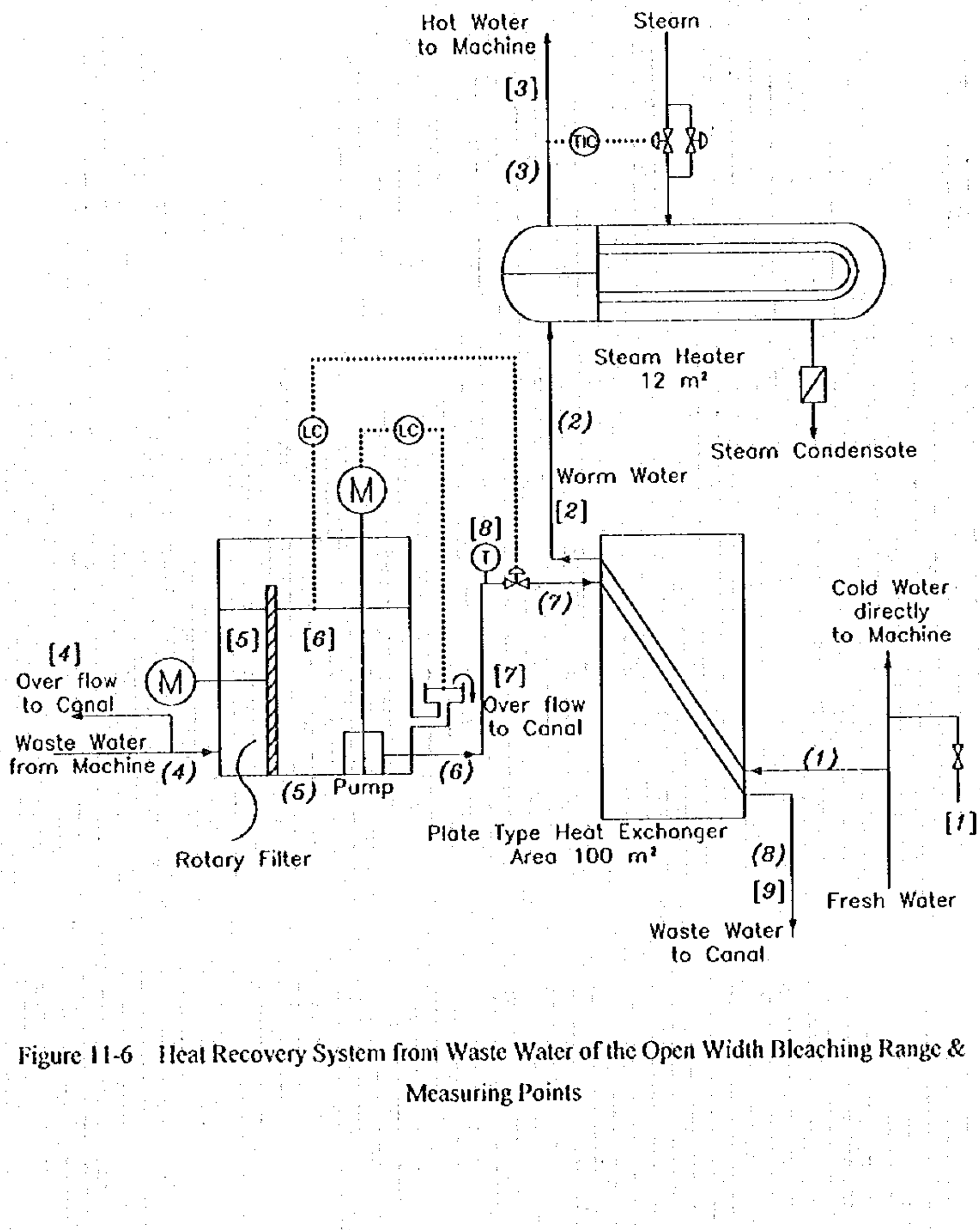


Figure 11-6 Heat Recovery System from Waste Water of the Open Width Bleaching Range & Measuring Points

Table 11-11 Water Consumption and Fabric Speed of Open Width Bleaching Range

	Sept. 3. 1996	Sept. 4. 1996	Sept. 5. 1996
Water Meter Reading, m^3	399,119	399,825	400,704
Water Consumption, m^3/day	--	706	879
Bleached Fabric, m/day	--	57,000	50,514
Machine Operating Time, hour and min.	--	20 h 45 min	21 h
Average Fabric Speed, m/min	--	45.8	40
Average Water Consumption, m^3/h	--	34	41.2

The average total water consumption rate of the range was 38 m^3/h and the inlet temperature was 27.5℃ (Refer to Tables 11-11 and 11-12). The fresh water flow is separated into two flows; one goes directly to the baths, the other to the heat recovery unit. The average fabric speed was 43 m/min.

(2) Waste Water

This range has a heat recovery unit that recovers heat from hot water discharges from Baths 1, 2, 3 and 5. The recovered heat is used for preheating water. The temperature and flow rates of waste water are shown in Table 11-12. The measured points are shown by numbers in Figure 11-6 and Table 11-12. The waste water in excess of the heat exchanger capacity overflows directly to the canal. Hot water temperatures of overflows were measured as 99.6℃ and water temperature from the machine may be considered the same. Because the system is closed, other water temperatures were not measured. Instead, pipe surface temperatures were measured. The overflows, at points [4] and [7], were measured. The measured values were: overflow 1 liter/second at point [4] and also overflow 1 liter/second at point [7], a total of 2 liters/second. The total overflow is: 2 liters/second = 7.2 m^3/hour. With zero degrees Centigrade being the base temperature of enthalpy, the following mass and heat flows are obtained.

Total overflow before the heat exchanger unit: 7.2 m^3/h (average)

Total heat loss as overflow: 7.2 x 1,000 x 99.6 = 717 x 10^3 kcal/h

The amount of waste water which exchanged heat was estimated by the design value of fresh water flow rate at 25 m^3/h and the measured temperatures of the fresh and waste water at the inlet and outlet of the heat exchanger. The estimated amount was about 5.2 m^3/h.

Waste water that exchanged heat: 5.2 m^3/h

Heat loss with the waste water that exchanged heat: 5.2 x 1,000 x 40

$= 208 \times 10^3$ kcal/h

Another portion of water is considered to be dumped directly from the machines as waste water without heat exchange or being evaporated to the atmosphere. From the measured values of the inside temperatures of Baths Nos. 4 and 6 to 9, an average temperature of 50°C is assumed.

Other wasted water: $38 - 7.2 - 5.2 = 25.6$ m³/h

Heat loss with waste water directly from the machine:

$25.6 \times 1,000 \times 50 = 1,280 \times 10^3$ kcal/h

Table 11-12 Measurement Results on Heat Recovery System from Waste Water at the Open Width Bleaching Range

No. on Figure 11-6	Subject	Temperature (°C)	Flow Rate (m³/hour)
[1]	Fresh Water	27.5	38
[2]	Fresh Water (after Heat Exchanger)	40	
[3]	Fresh Water, Hot (after Steam Heater)	90	
[4]	Waste Water (Over flow before Filtering Vessel)	99.6	3.6
[5]	Waste Water (Inside Vessel, before Rotary Filter)	99.6	
[6]	Waste Water (Inside Vessel, after Rotary Filter)	98.5	
[7]	Waste Water (Over flow after Filtering Vessel)	99.6	3.6
[8]	Waste Water (after Filtering Vessel)	92	
[9]	Waste Water (after Heat Exchanger)	40	
(1)	Fresh Water Inlet Pipe to Heat Exchanger	28 (Surface)	
(2)	Fresh Water Inlet Pipe to Steam Heater	34 (Surface)	
(3)	Fresh Water Outlet Pipe from Steam Heater	79 (Surface)	
(4)	Waste Water Inlet Pipe to Filtering Vessel	83 (Surface)	
(5)	Filtering Vessel	83 (Surface)	
(6)	Waste Water Outlet Pipe from Filtering Vessel	89 (Surface)	
(7)	Waste Water Pipe to Heat Exchanger	90 (Surface)	
(8)	Waste Water Pipe from Heat Exchanger	34 (Surface)	

(3) Steam

The total steam flow rate to the range is 2,200 kg/h. Steam is supplied directly to the baths, the steamer, and the steam heater after the heat recovery unit.

(4) Steam Condensate

Steam condensate is not recovered.

(5) Cloth (in and out)

The cloth flow rate is calculated by the following equation, and moisture content and temperature were measured.

Cloth flow rate = Fabric Speed x Fabric Width x Fabric Weight

In the case of the present range the fabric width, fabric weight, moisture content (dry base) and temperature are as follows.

The fabric width was 100 to 220 cm (average 160 cm)

The fabric weight was calculated by measurement by a balance and area measurement, g/m^2:

Sample 1	120
Sample 2	160
Average	140.

The moisture of the fabric obtained by weighing the dry and wet samples, in percentage, was:

Inlet: 79 to 80

Outlet: 80 to 81.

The temperature of the fabric in degree Centigrade was:

Inlet: 31

Outlet: 31.

(6) Temperature of Machine Surface and Heat Loss

The average measured surface temperatures and sizes of the baths and steamer are shown in Table 11-13. The heat loss from the machine surfaces was calculated by the following equations and the results are also shown in Table 11-13.

Radiation heat loss $= 0.86 \times (5.67 \times 10^{-8}) \times (\text{Emissivity}) \times (To^4 - Ta^4)$

Convection heat loss = (Heat transfer coefficient) x (To - Ta)

where

Conversion factor, Watts to kcal/h	0.860
Stefan-Boltzmann constant, $Watts/m^2K^4$	5.67×10^{-8}
Surface temperature, degree Kelvin	To
Ambient temperature, degree Kelvin	Ta

Table 11-13 Open Width Bleaching Range Size, Surface Temperature and Heat Loss from the Surface (1/4)

Ambient Temperature (°C)	31.0
Emissivity (-)	0.8
Heat Trans. Coefficient (k (kcal/m^2/h°C)	10

Unit No.	Unit Name	Dimension	Length (m)	Volume (m3)	Surface Area (m2)	Surface Temp. (°C)	Unit Heat Loss (kcal/m^2/h) Radiation	Convection	Rad.+ Conv.	Total Heat Loss (kcal/h)
1	1F No.1 Bath	Length	0.90							
		Width	3.00							
		Height	1.80							
		Volume		4.86						
		Fiber Inlet Side			5.40	81.0	279	500	779	4209
		Top Cover			2.70	80.0	273	490	763	2059
		Bottom Plate			2.70	83.0	293	520	813	2196
		Operation Side			1.62	82.0	286	510	796	1290
		Driving Side			1.62	83.0	293	520	813	1318
									Sub Total	11073
2	1F No.2 Bath	Length	1.70							
		Width	3.00							
		Height	1.60							
		Volume		8.16						
		Top Cover			5.10	95.0	382	640	1022	5214
		Bottom Plate			5.10	97.0	398	660	1058	5396
		Operation Side			2.72	97.0	398	660	1058	2878
		Driving Side			2.72	96.0	390	650	1040	2829
									Sub Total	16317
3	1F No.3 Bath	Length	1.70							
		Width	3.00							
		Height	1.60							
		Volume		8.16						
		Top Cover			5.10	36.0	22	50	72	370
		Bottom Plate			5.10	33.0	9	20	29	147
		Operation Side			2.72	34.0	13	30	43	118
		Driving Side			2.72	33.0	9	20	29	78
									Sub Total	713

Table 11-13 Open Width Bleaching Range Size, Surface Temperature and Heat Loss from the Surface (2/4)

Unit No.	Unit Name	Dimension	Length (m)	Volume (m3)	Surface Area (m2)	Surface Temp. (°C)	Unit Heat Loss (kcal/m²/h) Radiation	Convection	Rad.+ Conv.	Total Heat Loss (kcal/h)
4	1F No.4 Bath	Length	1.70							
		Width	3.00							
		Height	1.60							
		Volume		8.16						
		Top Cover			5.10	34.0	13	30	43	221
		Bottom Plate			5.10	32.0	4	10	14	73
		Operation Side			2.72	32.0	4	10	14	39
		Driving Side			2.72	32.0	4	10	14	39
									Sub Total	373
5	1F No.5 Bath (Forward)	Length	1.00							
		Width	3.00							
		Height	1.60							
		Volume		4.80						
		Top Cover			3.00	92.0	359	610	969	2908
		Bottom Plate			3.00	97.0	398	660	1058	3174
		Operation Side			1.60	97.0	398	660	1058	1693
		Driving Side			1.60	97.0	398	660	1058	1693
									Sub Total	9467
	1F No.5 Bath (Tail)	Length	1.70							
		Width	3.00							
		Height	1.60							
		Volume		8.16						
		Top Cover			5.10	93.0	367	620	987	5033
		Bottom Plate			5.10	95.0	382	640	1022	5214
		Operation Side			2.72	96.0	390	650	1040	2829
		Driving Side			2.72	95.0	382	640	1022	2781
									Sub Total	15857

Table 11-13 Open Width Bleaching Range Size, Surface Temperature and Heat Loss from the Surface (3/4)

Unit No.	Unit Name	Dimension	Length (m)	Volume (m3)	Surface Area (m2)	Surface Temp. (C)	Unit Heat Loss (kcal/m2/h) Radiation	Convection	Rad.+ Conv.	Total Heat Loss (kcal/h)
6	1F No.6 Bath	Length	1.70							
		Width	3.00							
		Height	1.60							
		Volume		8.16						
		Top Cover			5.10	95.0	382	640	1022	5214
		Bottom Plate			5.10	94.0	375	630	1005	5123
		Operation Side			2.72	96.0	390	650	1040	2829
		Driving Side			2.72	96.0	390	650	1040	2829
									Sub Total	15996
7	1F No.7 Bath	Length	1.70							
		Width	3.00							
		Height	1.60							
		Volume		8.16						
		Top Cover			5.10	63.0	164	320	484	2469
		Bottom Plate			5.10	65.0	176	340	516	2632
		Operation Side			2.72	65.0	176	340	516	1404
		Driving Side			2.72	65.0	176	340	516	1404
									Sub Total	7907
8	1F No.8 Bath	Length	1.70							
		Width	3.00							
		Height	1.60							
		Volume		8.16						
		Top Cover			5.10	42.0	51	110	161	821
		Bottom Plate			5.10	43.0	56	120	176	897
		Operation Side			2.72	42.0	51	110	161	438
		Driving Side			2.72	42.0	51	110	161	438
									Sub Total	2593

Table 11-13 Open Width Bleaching Range Size, Surface Temperature and Heat Loss from the Surface (4/4)

Unit No.	Unit Name	Dimension	Length (m)	Volume (m3)	Surface Area (m2)	Surface Temp. (C)	Unit Heat Loss (kcal/m2/h) Radiation	Convection	Rad.+ Conv.	Total Heat Loss (kcal/h)
9	1F No.9 Bath	Length	1.70							
		Width	3.00							
		Height	1.60							
		Volume		8.16						
		Top Cover			5.10	35.0	18	40	58	295
		Bottom Plate			5.10	31.0	0	0	0	0
		Operation Side			2.72	33.0	9	20	29	78
		Driving Side			2.72	32.0	4	10	14	39
									Sub Total	413
10	2F Steamer	Length	7.60							
		Width	3.00							
		Height	2.90							
		Volume		66.12						
		Top Cover			22.80	50.0	91	190	281	6417
		Bottom Plate			22.80	45.0	66	140	206	4691
		Front Side			8.70	44.0	61	130	191	1660
		Back Side			8.70	50.0	91	190	281	2449
	Operation Side	GlassWindow			3.82	93.0	367	620	987	3768
		Wall			18.22	49.0	86	180	266	4851
	Driving Side	GlassWindow			3.82	97.0	398	660	1058	4039
		Wall			18.22	47.0	76	160	236	4298
									Sub Total	32173
									Total	112881

Radiation Heat Loss = 0.86 x 0.0000000567 x (Emissivity) x (To^4 - Ta^4)
Convection Heat Loss = (Heat Trans Coefficient) x (to - ta)
Wh/kcal: 0.86
Stefan Bolzmann factor: 0.0000000567

(7) Temperature of Machine Inside

The average measured inside temperature of the baths and steamer is shown in Table 11-14.

Table 11-14 Inside Temperature in Baths and Steamer

(Unit: ℃)

No. of Bath	1	2	3	4	5	6	7	8	9
Temperature	95	100	35	33	98	98	67	43	35

Steamer	
Temperature	100

(8) Analysis

Using the results of measurement and calculation described above, the heat balance (0℃ basis) of the open width bleaching range was determined as follows. An energy flowcharts developed based on the heat balance are shown in Figure 11-17 in Section 11-10.

1) Heat Input

	Item	Value	Unit
(1)	Steam		
	Flow rate	2,200	kg/h
	Enthalpy	660	kcal/kg
	Heat input	1,452	10^3 kcal/h
(2)	Water		
	Flow rate	38,000	kg/h
	Temperature	27.5	℃
	Heat input	1,045	10^3 kcal/h
(3)	Cloth		
	Cloth speed	43	m/min
	Fabric width (average)	1.6	m
	Fabric weight (average)	140	g/m^2
	Moisture (dry base)	80	%
	Temperature	31	℃
	Specific heat (cotton)	0.319	cal/g℃
	Specific heat (moisture)	1	cal/g℃
	Heat input	20	10^3 kcal/h

(4)	Electricity		
	Consumption rate (measured)	68	10^3 kcal/h
(5)	Total heat input	2,585	10^3 kcal/h

2) Heat Output

	Item	Value	Unit
(1)	Steam condensate		
	Flow rate	2,200	kg/h
	Temperature	100	℃
	Heat output	220	10^3 kcal/h
(2)	Waste water		
1)	Over flow before the heat exchanger		
	Flow rate	7,200	kg/h
	Temperature	99.6	℃
	Heat output	717	10^3 kcal/h
2)	Waste water after the heat recovery unit		
	Flow rate	5,200	kg/h
	Temperature	40	℃
	Heat output	208	10^3 kcal/h
3)	Waste water directly from the machine		
	Flow rate	25,600	kg/h
	Temperature	50	℃
	Heat output	1,280	10^3 kcal/h
	Heat output (sub-total of waste water)	2,205	10^3 kcal/h
(3)	Cloth		
	Cloth speed	43	m/min
	Fabric width (average)	1.6	m
	Fabric weight (average)	140	g/m^2
	Moisture (dry base)	80	%
	Temperature	31	℃
	Specific heat (cotton)	0.319	cal/g℃
	Specific heat (moisture)	1	cal/g℃
	Heat input	20	10^3 kcal/h
(4)	Heat loss from surface of machine body		
	Heat outlet (as of Table 11-13)	113	10^3 kcal/h

	including Baths Nos. 1, 2, 5 & 6 (higher than 80℃)	69	
	Windows of steamer	8	
(5)	Others (unknown)	27	10^3 kcal/h
(6)	Total heat output	2,585	10^3 kcal/h

3) Heat Recycle

	Item	Value	Unit
(1)	Waste water		
	Flow rate	5,200	kg/h
	Temperature before heat exchanger unit	99.6	℃
	Temperature after heat exchanger unit	40	℃
	Heat recovered	313	10^3 kcal/h

11-9-2 Max Goller Washing Range

The Max Goller washing range was quite recently acquired by IBF, and operation started in December 1995. A schematic flow diagram is shown in Figure 11-7 with utility connections. The range comprises a foulard (padding)/flash ager and nine washing baths. All temperatures, water and steam flows are controlled by a computerized control system. Cold water enters the range and heated by steam to warm water. All parameters such as water temperatures of each unit, chemicals, amounts of steam and water are shown on the display control system. The results of the measurements are as follows.

(1) Steam

Steam flow rate to the flash ager was 370 kg/h, and that to the washing part was 1,580 kg/h on an average. The steam consumption of the range was measured by the total flow rate to the factory, while all other machines were stopped intentionally for this measurement. This is done because direct measurement of the steam flow to the Max Goller washing range requires modification of the facilities and this was found impossible. The measured results are probably larger than the actual consumption, because some leakage to other facilities through apparently closed valves might be included.

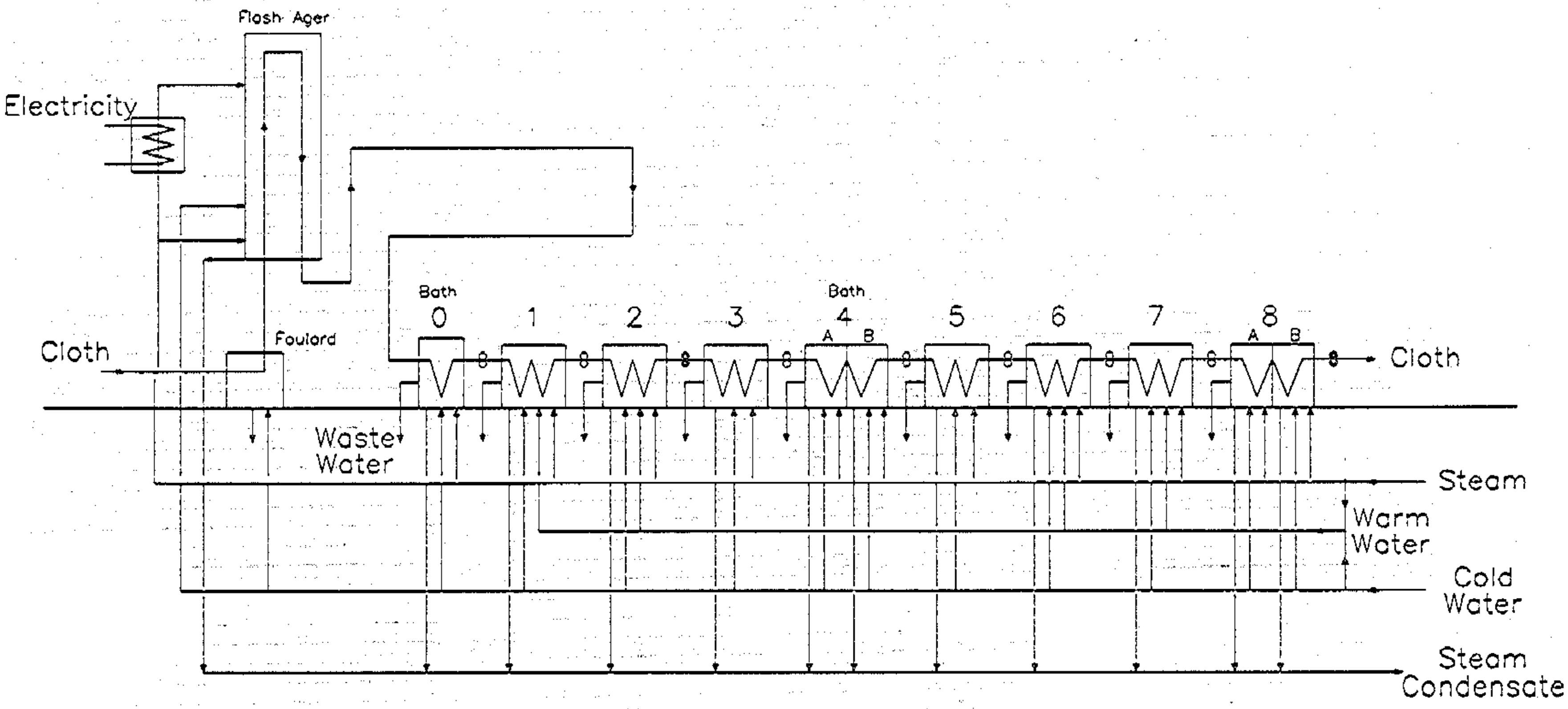


Figure 11-7 Schematic Flow Diagram of Mac Goller Washing Range

(2) **Fresh Water and Fabric Speed**

Water consumption is calculated by the water meter readings. The results are shown in Table 11-15.

Table 11-15 Water Consumption and Fabric Speed of Max Goller Washing Range

	Sept. 3. 1996	Sept. 4. 1996	Sept. 5. 1996
Water Meter Reading, m^3	19,086.2	19,479.8	19,674.0
Water Consumption, m^3/day	--	393.6	194.2
Washed Fabric, m/day	--	27,837	9,130
Machine Operating Hour, hour and min.	--	19 h 40 min	9 h 35 min
Average Fabric Speed, m/min	--	23.5	16.0
Average Water Consumption, m^3/h	--	20.0	20.3

The washing range is provided with automatic shutoff devices, which close the feed lines of water, chemicals and steam when the machine stops. Because of the devices, water consumption rates measured were almost the same for these three days. The average fresh water consumption was 20.2 m^3/h, and the average fabric speed was 19.8 m/min.

(3) **Cloth Flow Rate and Moisture Content (in and out)**

The fabric speed is shown in Table 11-15, and the fabric width and fabric weight are the same as for the open width bleaching range. The temperature and moisture content of the cloth were measured to be 31°C and 80 percent at the inlet and outlet of the range.

(4) **Electricity**

The flash ager has an electric superheater of steam to raise the inside temperature to 130°C. This is controlled automatically. The design capacity is:

9 kW x 4
6 kW x 4
Total 60 kW

(5) **Steam Condensate**

All steam condensate is recovered.

(6) Waste Water

This Max Goller washing range has no heat recovery system from the waste water. Only the first bath, No. 0 Bath, has a water cleaning and reusing system. Water coming from the first bath is cleaned in this system by a rotary disc filter and is sent back to the first bath and reused as prewashing water to be sprayed through nozzles on the fabric. Two types of washing are done in this machine, cold washing and hot washing. The temperature of the discharge water from the cold washing is about 30℃ and that from the hot washing is about 70℃. All discharges are sent directly to the canal, because no heat recovery system is provided.

(7) Temperature of Machine Surface and Heat Loss

The surface temperatures and dimensions measured of each unit of the range are shown in Table 11-16. The heat losses from the machine surfaces are calculated by the method applied to the open width bleaching range. The calculated surface heat losses are also shown in Table 11-16.

Table 11-16 Max Goller Washing Range Size, Surface Temperature and Heat Loss from the Surface (1/4)

Ambient Temperature (C °C)	31.0
Emissivity (-)	0.8
Heat Trans. Coefficient (k kcal/$m^2h°C$)	10

Unit No.	Unit Name	Dimension	Length (m)	Volume (m^3)	Surface Area (m^2)	Surface Temp. (C)	Unit Heat Loss (kcal/m^2/h) Radiation	Convection	Rad.+ Conv.	Total Heat Loss (kcal/h)
1	Flash Ager	Length	0.60							
		Width	2.70							
		Height	6.35-6.7							
		Volume		10.57						
		Top Cover			0.42	80.0	273	490	763	318
		Bottom Plate			1.62	50.0	91	190	281	456
		Front Side			18.09	50.0	91	190	281	5091
		Back Side			17.15	50.0	91	190	281	4825
		Right Side			3.92	50.0	91	190	281	1102
		Left Side			3.92	50.0	91	190	281	1102
	Bare Part	Frames arr. Lids			1.00	95.0	382	640	1022	1022
		Fan Body			0.50	92.0	359	610	969	485
		Inlet Pipe of Fan			1.00	95.0	382	640	1022	1022
		Outlet Pipe of Fan			2.00	51.0	97	200	297	593
									Sub Total	16017
2	No.0 Washing Bath	Length	0.50							
		Width	3.15							
		Height	1.50							
		Volume		2.36						
		Top Cover			1.58	31.0	0	0	0	0
		Bottom Plate			1.58	29.0	-9	-20	-29	-45
		Operation Side			0.75	31.0	0	0	0	0
		Driving Side			0.75	32.0	4	10	14	11
									Sub Total	-34

Table 11-16 Max Goller Washing Range Size, Surface Temperature and Heat Loss from the Surface (2/4)

Unit No.	Unit Name	Dimension	Length (m)	Volume (m3)	Surface Area (m2)	Surface Temp. (°C)	Unit Heat Loss (kcal/m²/h) Radiation	Convection	Rad.+ Conv.	Total Heat Loss (kcal/h)
3	No.1 Washing Bath	Length	2.15							
		Width	3.15							
		Height	1.50							
		Volume		10.16						
		Top Cover			6.77	31.0	0	0	0	0
		Bottom Plate			6.77	28.0	-13	-30	-43	-291
		Operation Side			3.23	31.0	0	0	0	0
		Driving Side			3.23	32.0	4	10	14	46
									Sub Total	-244
4	No.2 Washing Bath	Length	2.15							
		Width	3.15							
		Height	1.50							
		Volume		10.16						
		Top Cover			6.77	32.0	4	10	14	98
		Bottom Plate			6.77	29.0	-9	-20	-29	-194
		Operation Side			3.23	32.0	4	10	14	46
		Driving Side			3.23	32.0	4	10	14	46
									Sub Total	-4
5	No.3 Washing Bath	Length	2.15							
		Width	3.15							
		Height	1.50							
		Volume		10.16						
		Top Cover			6.77	40.0	41	90	131	889
		Bottom Plate			6.77	40.0	41	90	131	889
		Operation Side			3.23	39.0	36	80	116	376
		Driving Side			3.23	39.0	36	80	116	376
									Sub Total	2529

Table 11-16 Max Goller Washing Range Size, Surface Temperature and Heat Loss from the Surface (3/4)

Unit No.	Unit Name	Dimension	Length (m)	Volume (m^3)	Surface Area (m^2)	Surface Temp. (°C)	Unit Heat Loss ($kcal/m^2/h$) Radiation	Convection	Rad.+ Conv.	Total Heat Loss (kcal/h)
6	No.4 Washing Bath	Length	2.15							
		Width	3.15							
		Height	1.50							
		Volume		10.16						
		Top Cover			6.77	73.0	226	420	646	4375
		Bottom Plate			6.77	78.0	259	470	729	4937
		Operation Side			3.23	73.0	226	420	646	2083
		Driving Side			3.23	73.0	226	420	646	2083
									Sub Total	13478
7	No.5 Washing Bath	Length	2.15							
		Width	3.15							
		Height	1.50							
		Volume		10.16						
		Top Cover			6.77	81.0	279	500	779	5279
		Bottom Plate			6.77	82.0	286	510	796	5394
		Operation Side			3.23	78.0	259	470	729	2351
		Driving Side			3.23	77.0	252	460	712	2297
									Sub Total	15321
8	No.6 Washing Bath	Length	2.15							
		Width	3.15							
		Height	1.50							
		Volume		10.16						
		Top Cover			6.77	55.0	118	240	358	2427
		Bottom Plate			6.77	60.0	147	290	437	2956
		Operation Side			3.23	55.0	118	240	358	1156
		Driving Side			3.23	54.0	113	230	343	1106
									Sub Total	7645

Table 11-16 Max Goller Washing Range Size, Surface Temperature and Heat Loss from the Surface (4/4)

Unit No.	Unit Name	Dimension	Length (m)	Volume (m^3)	Surface Area (m^2)	Surface Temp. (°C)	Unit Heat Loss (kcal/m2/h) Radiation	Convection	Rad.+ Conv.	Total Heat Loss (kcal/h)
9	No.7 Washing Bath	Length	2.15							
		Width	3.15							
		Height	1.50							
		Volume		10.16						
		Top Cover			6.77	36.0	22	50	72	491
		Bottom Plate			6.77	31.0	0	0	0	0
		Operation Side			3.23	35.0	18	40	58	187
		Driving Side			3.23	36.0	22	50	72	234
									Sub Total	911
10	No.8 Washing Bath	Length	2.15							
		Width	3.15							
		Height	1.50							
		Volume		10.16						
		Top Cover			6.77	36.0	22	50	72	491
		Bottom Plate			6.77	30.0	-4	-10	-14	-97
		Operation Side			3.23	35.0	18	40	58	187
		Driving Side			3.23	35.0	18	40	58	187
									Sub Total	767
									Total	56386

Radiation Heat Loss = 0.86 x 0.0000000567 x (Emissivity) x (To^4 - Ta^4)
Convection Heat Loss = (Heat Trans Coefficient) x (to - ta)
Wh/kcal: 0.86
Stefan Bolzmann factor: 0.0000000567

(8) Temperature of Machine Inside

The temperatures of water in the baths were also measured and are shown in Table 11-17.

Table 11-17 Temperature of Water in Each Washing Bath

(Unit: ℃)

No. of Bath	0	1	2	3	4	5	6	7	8
Temperature	28	28	28	42	82	87	62	31	30

(9) Analysis

A heat balance of the Max Goller washing range including the flash ager was calculated as shown below by the same method used for the open width bleaching range. The energy flow chart is shown in Figure 11-18 in Section 11-10.

1) Heat Input

	Item	Value	Unit
(1)	Steam		
	Flow rate	1,950	kg/h
	Flash ager	370	
	Washing range	1,580	
	Enthalpy	660	kcal/kg
	Heat input	1,287	10^3 kcal/h
(2)	Water		
	Flow rate	20,200	kg/h
	Temperature	27.5	℃
	Heat input	556	10^3 kcal/h
(3)	Cloth		
	Cloth speed	19.8	m/min
	Fabric width (average)	1.6	m
	Fabric weight (average)	140	g/m^2
	Moisture (dry base)	80	%
	Temperature	31	℃
	Specific heat (cotton)	0.319	cal/g℃
	Specific heat (moisture)	1	cal/g℃
	Heat input	9	10^3 kcal/h
(4)	Electricity		

	Consumption rate (measured)	35	10^3 kcal/h
(5)	Total heat input	1,887	10^3 kcal/h

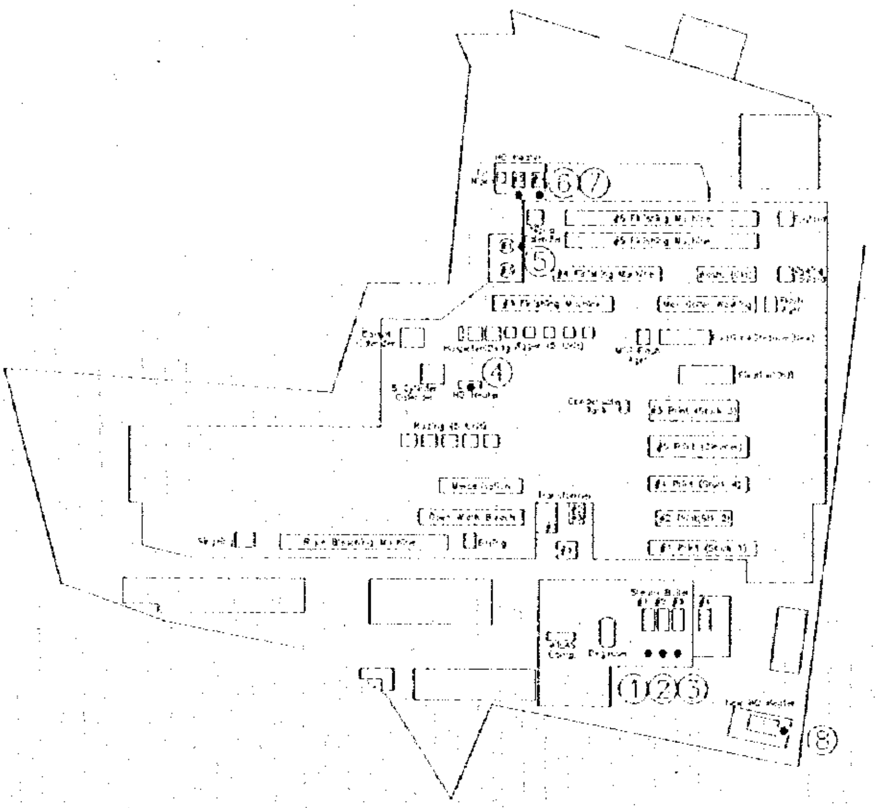
2) Heat Output

	Item	Value	Unit
(1)	Steam for aging		
	Flow rate Flash ager (assumed)	270	kg/h
	Enthalpy	660	kcal/kg
	Heat output	178	10^3 kcal/h
(2)	Steam condensate		
	Flow rate	1,680	kg/h
	Flash ager (assumed)	100	
	Washing range	1,580	
	Temperature	100	℃
	Heat output	168	10^3 kcal/h
(3)	Waste water		
	Flow rate	20,200	kg/h
	Temperature	70	℃
	Heat output	1,414	10^3 kcal/h
(4)	Cloth		
	Cloth speed	19.8	m/min
	Fabric width (average)	1.6	m
	Fabric weight (average)	140	g/m^2
	Moisture (dry base)	80	%
	Temperature	31	℃
	Specific heat (cotton)	0.319	cal/g℃
	Specific heat (moisture)	1	cal/g℃
	Heat output	9	10^3 kcal/h
(5)	Heat loss from surface of machine body		
	Heat outlet (as of Table 11-16)	56	10^3 kcal/h
	including Flash ager	16	
	Baths Nos. 5 & 6	28	
(6)	Others (unknown)	62	10^3 kcal/h
(7)	Total heat output	1,887	10^3 kcal/h

11-9-3 Energy Supply Side

The results of the measurements are as follows:

1. Hot oil heater flue gas measurement is shown in Figure 11-8 and Table 11-18.
2. Steam boiler flue gas measurement is shown in Figure 11-8 and Table 11-19.
3. Analysis of coal, ash, No. 6 fuel oil, DGO, special fuel oil and the hot oil is shown in Figure 11-9 and Table 11-20.
4. Flow rate of water from the well is shown in Table 11-21.
5. Flow rates of boiler feed water and coal consumption in boilers are shown in Table 11-21 and Figure 11-10.
6. Properties of boiler feed water and blowing drain are shown in Table 11-22.
7. Flow rates of water to each machine are shown in Figure 11-11.
8. Operating temperature of the hot oil heater is shown in Figure 11-12, and detail of the new hot oil heater system is shown in Figure 11-13.
9. Steam flow rates of each machine are shown in Table 11-23.
10. Surface temperatures of the steam line, hot oil line, boiler and hot oil heater are shown in Table 11-24.
11. Temperature and humidity in the factory are shown in Table 11-25.



	Sample		Sample
1	No.1 Steam Boiler	5	No.4 Hot Oil Heater
2	No.2 Steam Boiler	6	No.5 Hot Oil Heater
3	No.3 Steam Boiler	7	No.6 Hot Oil Heater
4	HO Heater for Calender Machine	8	the Newest Hot Oil Heater

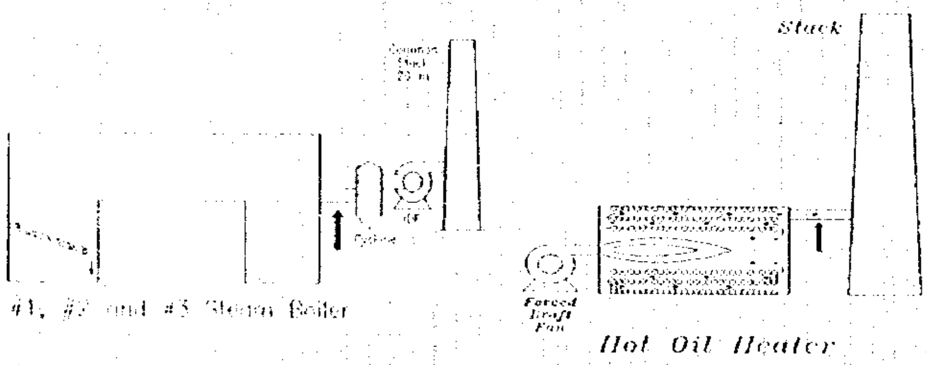


Figure II-8 Sampling Points of Flue Gas

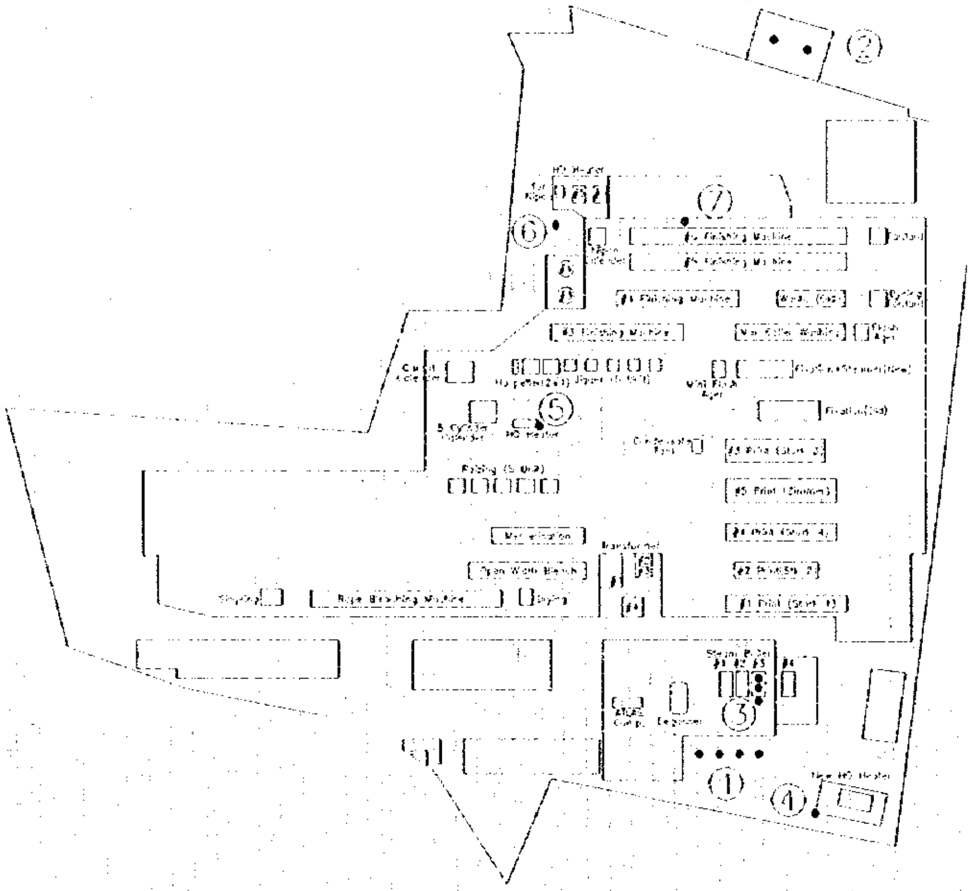
Table 11-18 Hot Oil Heater Flue Gas Measuring

Items	H_C	H_3	H_4	H_5	H_6	H_{New}
Gas Chromato.						(7/9)
O_2 %				20.12	5.44	12.15
N_2 %				81.20	82.55	80.96
CH_4 %				--	--	--
CO %				--	--	0.06
CO_2 %				0.87	12.19	6.83
O_2 Analyzer						
O_2 %				11.6	1.3	10.5
YOKOGAWA				260	241	(5/9)
Temp °C			(29/8)=>	328	301	270
Hodaka	(29/8)			(29/8)	(29/8)	(5/9)
Temp °C	148		257	339	319	279
O_2 %	11.4		5.7	6.6	3.8	11.6
CO ppm	16		25	40	34	179
CO_2 %	6.8		11.3	10.6	12.8	7.0
Eff. Gross	85.0		82.9	75 - 78	81.4	76.5
Eff. Net	90.0		88.0	80 - 81.2	86.4	80.9
λ %	122.3		37.5	46.2 - 50.4	21.5	124.7
Draft mbar	0.22		0.55	0.06 - 0.12	0.80	0.07 - 0.10
Remarks	On-Off Operation	Not Measured		Hodaka, Light Oil 30.1°C AT		Hodaka Heavy Oil

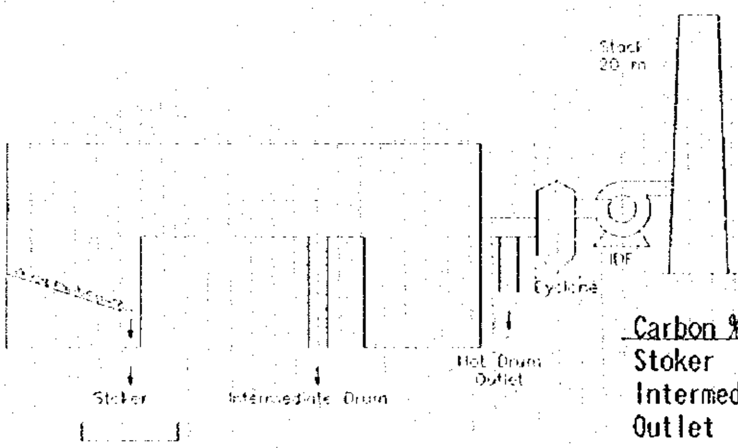
H_C --- Hot Oil Heater For 5 Cylinder Calendering Machine
On Time 1'18" - 1'25", Off Time 22" - 37"
H_3 --- Hot Oil Heater For #3 Finishing Machine
H_4 --- Hot Oil Heater For #4 Finishing Machine
H_5 --- Hot Oil Heater For #4 Finishing Machine
H_6 --- Hot Oil Heater For #5 Finishing Machine
H_{New} --- The Newest Hot Oil Heater For Printing and Fixation Machines

Table 11-19 Steam Boiler Flue Gas Measuring

Items	B_1	B_2	B_3	B_4	B_1
Gas Chromato.					
O_2 %	18.44	15.54	15.03		
N_2 %	82.46	82.40	80.96		
CH_4 %	0.006	--	--		
CO %	0.03	0.67	--		
CO_2 %	2.96	5.68	5.82		
O_2 Analyzer					
O_2 %	17.6 - 18.1	13.1 - 14.8	12.6 - 14.1		
YOKOGAWA	189	221	236		(3/9)
Temp °C	173	229	230	<=(29/8)	171
Hodaka	(29/8)	(29/8)	(29/8)		(3/9)
Temp °C	183	221	245		186
O_2 %	17.6	11.1	8.6		17.5
CO ppm	682	90	83		357
CO_2 %	2.4	7.0	8.7		3.1
Eff. Gross	61.6	80.9	81.7		63.7
Eff. Net	65.4	86.0	86.4		67.2
λ %	514.7	113 - 122	83.3		450
Draft mbar	9.5	9.4	8.2		9.4
Remarks				Not Operate	



Sample	Date	Sample Name
1	21/8	Coal for Boiler
2	21/8	Coal of Stock yard for Checking storage method
3	22/8	Ash of Steam Boiler, Details are shown below
4	21/8	No.6 Fuel Oil for the Newest Hot Oil Heater
5	21/8	Diesel Gas Oil for Inside Hot Oil Heater
6	21/8	Special Fuel Oil for Outside Hot Oil Heater 4 Unit
7	21/8	Hot Oil in Operation System (BP Type : Transain)



Carbon % Estimated by IBF

Stoker	5 - 8 %
Intermediate	3 %
Outlet	1 %

Figure 11-9 Sampling Points of Coal, Ash and Oil

Table 11-20 Analysis Details (1/2)

	MRI	BATI	TPR	JICA-EIE LAB	CHUGAI	NOC
Coal for Steam Boiler	Elementaly Industrial	Industrial	--	H.V.,Moist.	CHN	CHN
Ash 1 (from Stoker)	CR.HV	CR.HV	--	H.V.	CHN	CHN
Ash 2 (from Intermid. Drum)	〃	--	--	H.V.	--	--
Ash 3 (from Hot Drum Out.)	〃	--	--	H.V.	--	--
Hot Oil	--	--	Sp.Gr. Distillation Viscosity Flash Point	--	--	Sp.Gr. Distillation Viscosity Flash Point
No.6 Fuel Oil for HO Heater	--	--	Spec	H.V.	--	Spec
Sp.Fuel Oil for HO Heater	--	--	Data	H.V.		Data
Diesel Gas Oil for HO Heater	--	--		H.V.		

Analysis Result of Solid Fuel

BATI Labo.

Sample	Moisture (%)	Volatile Mat. (%-dry base)	Fixed Carbon (%-dry base)	Ash (%-dry base)	HHV (kcal/kg)
Coal for Steam Boiler	16.58	39.49	47.80	12.71	6,179
Ash 1 (from Stoker)	--	--	3.39	--	--

JICA - EIE Labo.

Sample	HHV (kcal/kg)	LHV (kcal/kg)	Moisture (--)
Coal for Steam Boiler	5,780	5,400	0.187
Ash 1 (from Stoker)	145	--	--
Ash 2 (from Intermid. Drum)	2,238	--	--
Ash 3 (from Hot Drum Out.)	1,410	--	--

CHUGAI

Sample	Moisture (%)	Carbon (%-dry base)	Hydrogen (%-dry base)	Nitrogen (%-dry base)	Specific Heat @ 80 C	Specific Heat @ 130 C
Coal for Steam Boiler	18.2	59.9	4.6	1.33	--	--
Ash 1 (from Stoker)	33.7	4.6	0.4	0.09	--	--
Ash from Another Factory	--	--	--	--	0.22	0.23

Table 11-20 Analysis Details (2/2)

Analysis Result of Liquid Fuel

JICA - EIE Labo. / NOC

Sample	HHV (kcal/kg)	LHV (kcal/kg)	Density 15 C (g/cm3)	Flash Point (PM, C)	Vis @ 40 C (mm2/s)	HHV (kcal/kg)	Carbon (%)	Hydrogen (%)	Nitrogen (%)	Sulfur (%)
No.6 Fuel Oil	10.110	9.500	0.9983	176	1.276	10.000	84.7	11.0	0.5	3.44
Sp.Fuel Oil	10.800		0.9489	84	219.4	10.460	85.4	11.7	0.5	2.26
DGO	11.080	10.300	0.8332	62	2.871	10.950	--	--	--	0.62

Analysis Result of Hot Oil

TPR Labo.

Sp.Gr. 60/60 F ASTM D-1298	0.8783
Flash Point,C ASTM D-93	202
Vis @ 100C,cSt ASTM D-445	5.79
@ 40C,cSt ASTM D-445	35.91
Distillation,C ASTM D-1160	
IBP	315
5	408
10	410
20	417
30	422
40	424
50	429
60	433
70	438
80	444
90	455
95	478
EP	487
Dist.Vol.	95.5

NOC

Density 15 C	0.8777
Flash Point (PM) (C)	200
Vis @ 100C (cSt)	5.739
@ 40C (cSt)	35.34
Distillation(Gaschromato.)(C)	
IBP	327
5	---
10	397
20	410
30	419
40	426
50	432
60	437
70	443
80	449
90	458
95	---
EP	579
Dist.Vol.	---

Specific Heat (kcal/kg C)	
@ 160 C	0.586
170 C	0.595
180 C	0.604
190 C	0.613
200 C	0.622
210 C	0.630
220 C	0.638
230 C	0.646
240 C	0.654
250 C	0.662
260 C	0.670
270 C	0.677
280 C	0.685
290 C	0.692
300 C	0.699

These Values are estimated by process simulation PROII, based on density and distillation data by NOC.

Table 11-21 Utility Water and Evaporated Steam Flow Rate

Date	Pump Up Water					Utility Water		Boiler Data		
	#1 Well (m3)	#2 Well (m3)	#4 Well (m3)	#7 Well (m3)	Total (m3)	Hard (m3)	Soft (m3)	Steam (ton)	Coal (kg)	Coal/Steam (kg/ton)
26/8/96	138	407	1,814	2,751	5,110	340	3,000	234	32,760	140.0
27/8/96	134	43	1,678	2,652	4,507	900	3,130	230	32,760	142.4
28/8/96	137	1,295	1,200	1,209	3,841	530	1,990	180	22,680	126.0
29/8/96	130	67	1,734	2,891	4,822	600	3,030	244	32,340	132.5
30/8/96	131	345	1,980	2,523	4,979	1,110	3,060	243	31,920	131.4
31/8/96	131	394	1,828	2,615	4,968	1,270	2,800	270	32,760	121.3
1/9/96						800	1,890			

#1 Well Depth : 53 m , Pump Elevation : 30 m
#2 Well Depth : 144 m , Pump Elevation : 35 m
#4 Well Depth : 199 m , Pump Elevation : 55 m
#7 Well Depth : 199 m , Pump Elevation : 55 m

Steam flow contains recovered condensate.

Utility Water Flow Counter Reading Value

Date	Pump Up Water				
	#1 Well (m3)	#2 Well (m3)	#4 Well (m3)	#7 Well (m3)	Total (m3)
26/8/96	40,200	389,463	761,750	408,797	
27/8/96	40,338	389,870	763,564	411,548	
28/8/96	40,472	389,913	765,242	414,200	
29/8/96	40,609	391,208	766,442	415,409	
30/8/96	40,739	391,275	768,176	418,300	
31/8/96	40,870	391,620	770,156	420,823	
1/9/96	41,001	392,014	771,984	423,438	

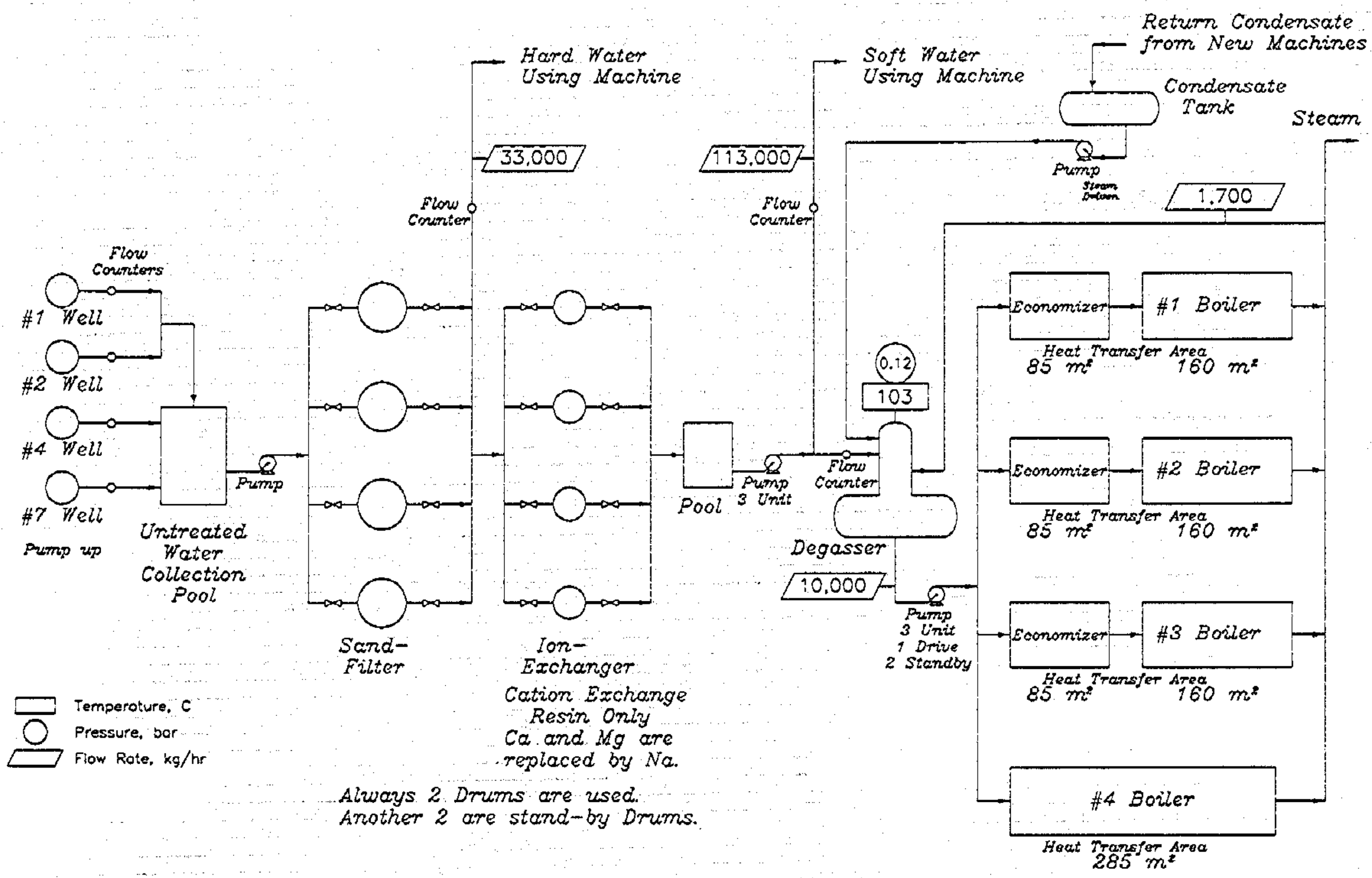


Figure 11-10 Detail of Boiler Feed Water and Utility System

Table 11-22 Properties of Feed Water, Blowing Drain

Date: Sep.10/1996

Boiler Water Analysis

	Raw Water	Soft Water		Make-up Water	Condens. Drum	Feed Water	Boiler				Hot Wat. Boiler	Condens. Recovery	Recommended Limit	
							No.	No.1	No.2	No.3			BFW	Blowing Drain
Total Hardness ppm CaCO			1.8			1.7		7.8	2.5	3.0			max. 2.0	--
Phenol Alkaline ppm CaCO			0			0		578	680	1,240			--	--
Total Alkaline ppm CaCO			306			290		940	1,100	1,673			--	max. 1,500
Hydroxide Alkaline ppm CaCO			0			0		216	260	807			--	--
Chloride ppm Cl^-			45.5			47.3		121	173	196			--	max. 1,000
Phosphate ppm PO_4^{3-}						0.89		8.10	11.95	12.0			--	5 - 10
DEHA ppm						0.39		0.165	0.135	0.08			--	0.2 - 0.4
Phosphonate ppm PO_4^{3-}						0.30		3.20	4.75	4.80			--	3 - 5
Total Iron ppm Fe						0.10		3.80	2.35	1.00			max. 0.1	max. 10.0
Sulphate ppm SO_4^{2-}													--	--
Silicate ppm SiO_2													--	--
Conductivity micro-S/cm			631			596		2,380	3,930	6,580			--	max. 7,000
PH			7.4			8.0		11.5	11.8	12.0			--	10.5 - 12

Boiler Operation Information

Feed Water Temperature	95 - 105 C
Condensate Recovery Rate, %	Maximum 10 %
Blowdown	According to Conductivity

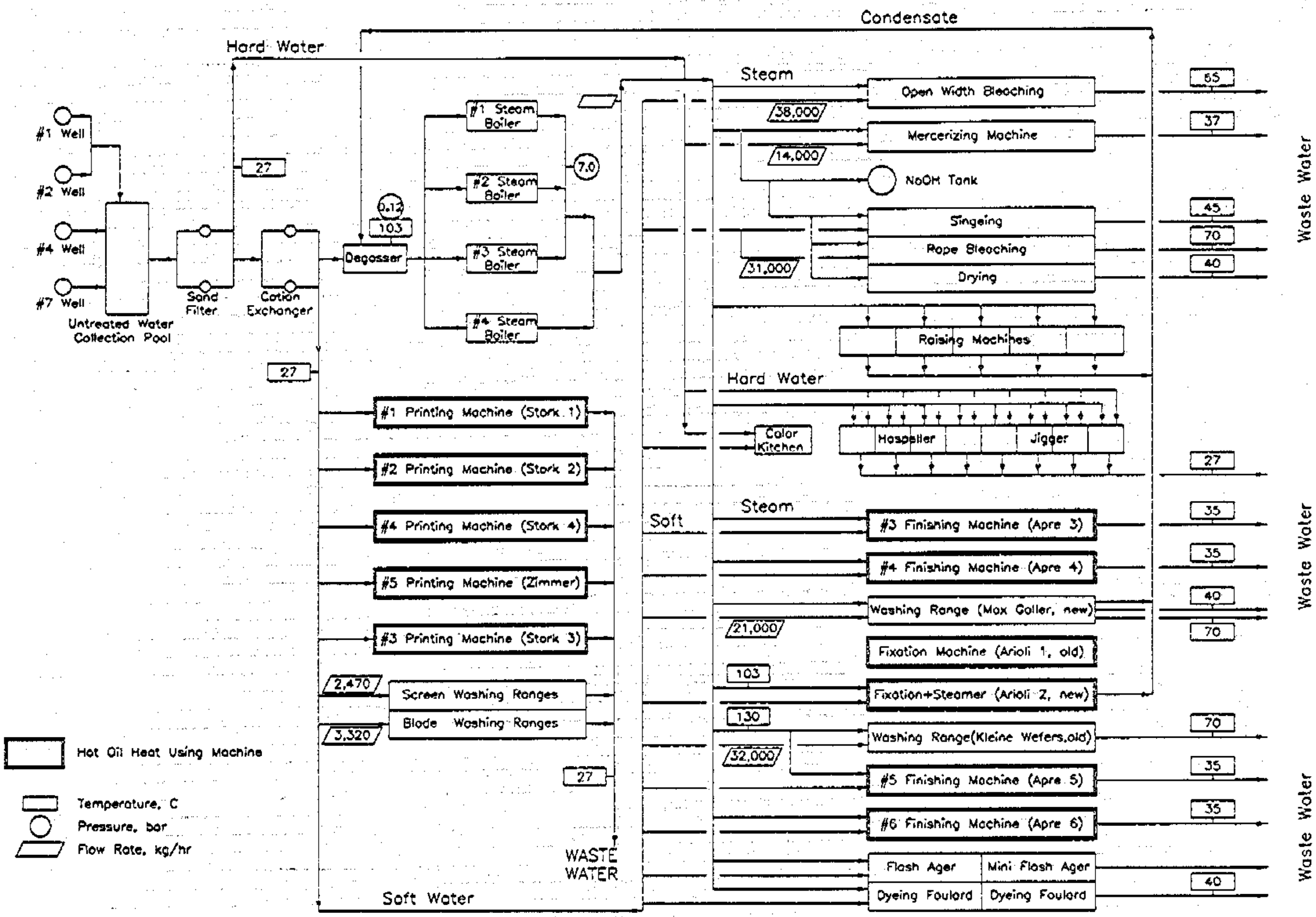


Figure 11-11 Water and Steam System

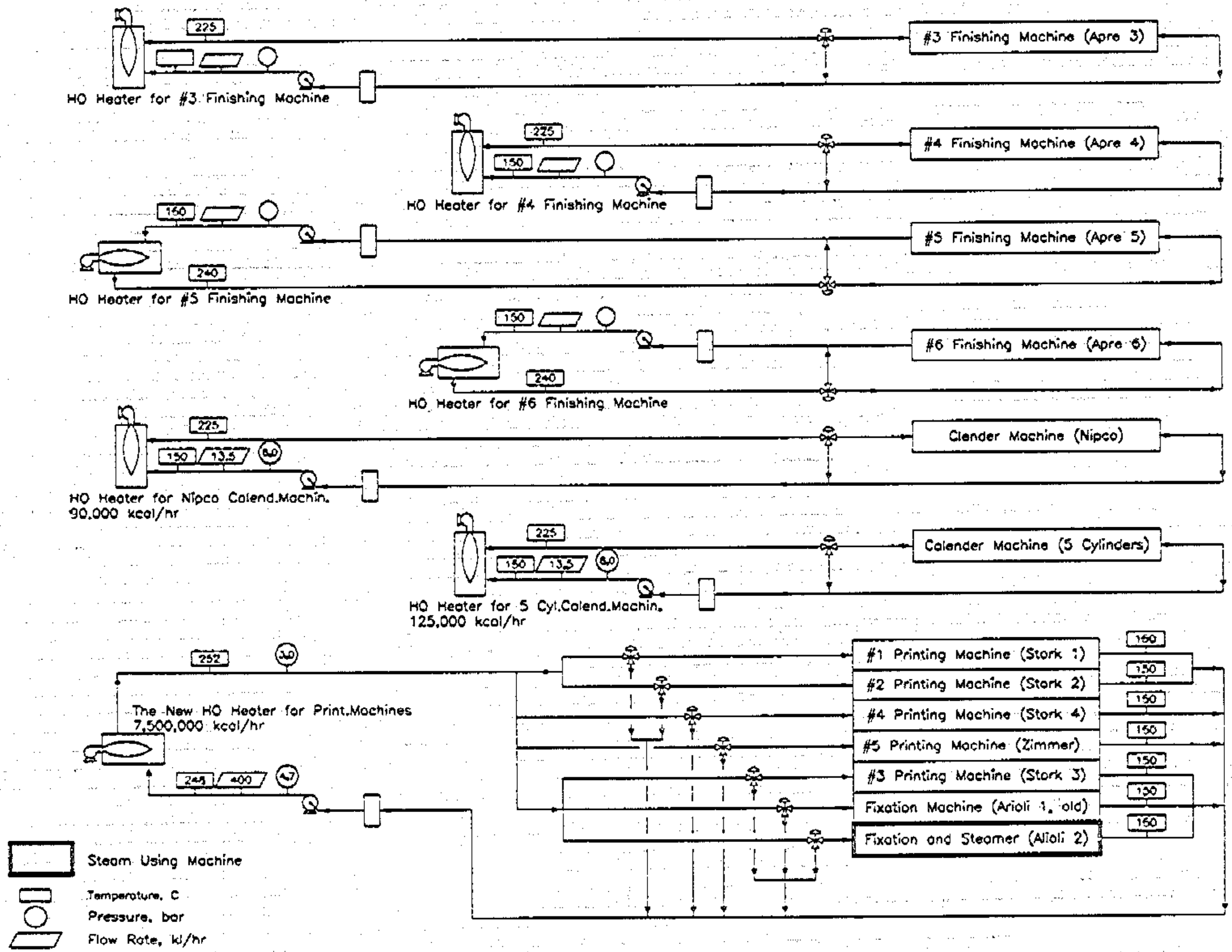


Figure 11-12 Operation Temperature of Hot Oil Heater

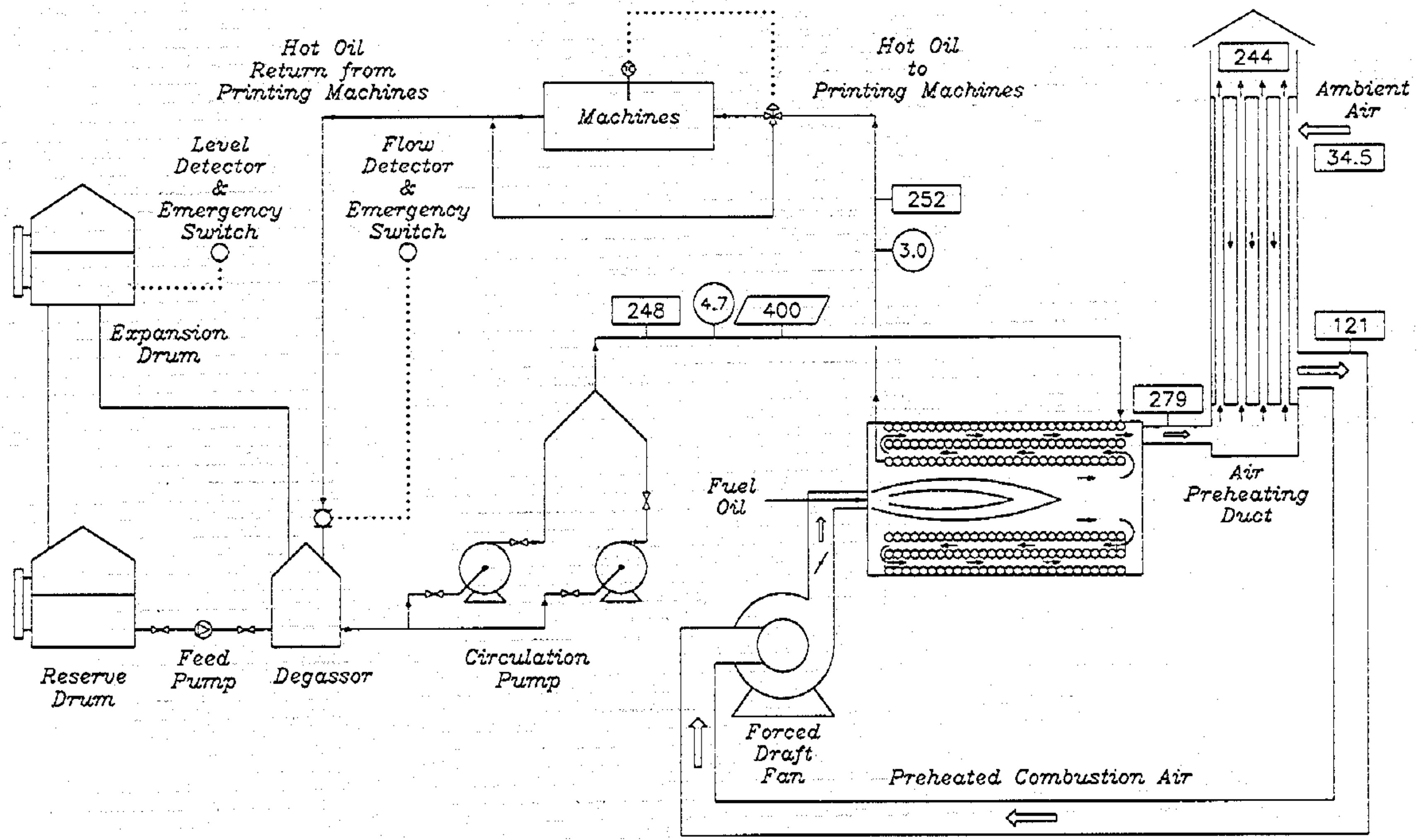


Figure 11-13 Detail of the New Hot Oil Heater System

Table 11-23 Steam Flow Rate

(Unit: kg/hr)

	Estimate	Design	Meas. 1	Meas. 2	Meas. 3	Meas. 4
Supply	(9,680)					
No.1, 2, 3 Boiler						
Main Line	(8,780)		3,400	3,800	2,210	
Open Width Bleaching	1,750		2,200	Ope.	Ope.(Ex.-Stop)	Stop
Rope Bleaching	1,250		Stop	Stop	Stop	Stop
Drying	900		Stop	Stop	Stop	Stop
Mercerization	600		Stop	Ope.	Ope.	Stop
Max Goller (New Washing)	1,500	1,500	Stop	Ope.	Stop	1,440 -- 1,710
Old Washing	1,600		Stop	Stop	Stop	Stop
Fixation Steamer			Stop	Stop	Stop	Stop
Mini Flash Ager			Stop	Stop	Stop	Stop
Flash Ager	300		Stop	Stop	Stop	370 (272)
No.1 Dyeing Foulard	150		Stop	Ope.	Ope.	Stop
No.2 Dyeing Foulard			Stop	Ope.	Ope.	Stop
No.3, 4, 5, 6 Fixation			Stop	Stop	Stop	Stop
Jigger	600		2/5 Ope.	Stop	Stop	Stop
Raising	130		Stop	Stop	Stop	Stop
Boiler	900		Ope.	Ope.	Ope.	Ope.

Table 11-24 Surface Temperature of Steam, Condensate and Hot Oil System

	Measuring Position		Temperature	Remarks
	Facility	Location	(°C)	
1	#1 Steam Boiler	Drum (2nd Floor)	50 - 65	Insulated
		Manhole (2F)	71	Brick part
		Door of Looking Window (2F)	148	Bare
		Steam Outlet Header (Top)	152	Bare
		Ash (1st Floor, Ground)	35	Ash Holder from Stoker
2	Steam Line	Main Header in Boiler Room	146 - 160	Bare, Mainly Valve
		(2nd Floor)	41	Insulated (Glasswool 80mm)
3		Outlet to Factory (1F)	39	Insulated
4		Inlet from Boiler	39	Insulated
5		Main Line, By-pass Point	155	Bare
			52	Insulated(Glasswool 110mm)
6	Condensate	Condensate Receiver	42	Insulated
7		Condensate Pump	90	Bare
8		Condensate Line	87	Bare
			44 - 50	Insulated (Glasswool 40mm)
9	#5, #6 HO Heater	Burner Side	160 - 190	Bare
		Back Side	150 - 180	Bare
		Cylinder Body	50 - 60	Insulated
10	New HO Heater	Burner Side	150 - 180	Bare
		Back Side	160 - 190	Bare
		Cylinder Body	50 - 60	Insulated
11	Hot Oil Line	Inlet to #5 Finish.Machine	46 - 48	Insulated (Glasswool 60mm)
		Outlet from #5 Finish Line	40	Insulated (Glasswool 60mm)
12		Inlet to #5 Finish.Machine	114	Bare
			47	Insulated
13		Inlet to #5 Finish.Machine	167	Bare
			53	Insulated
14		Outlet from #5 Finish Line	132	Bare
			46	Insulated

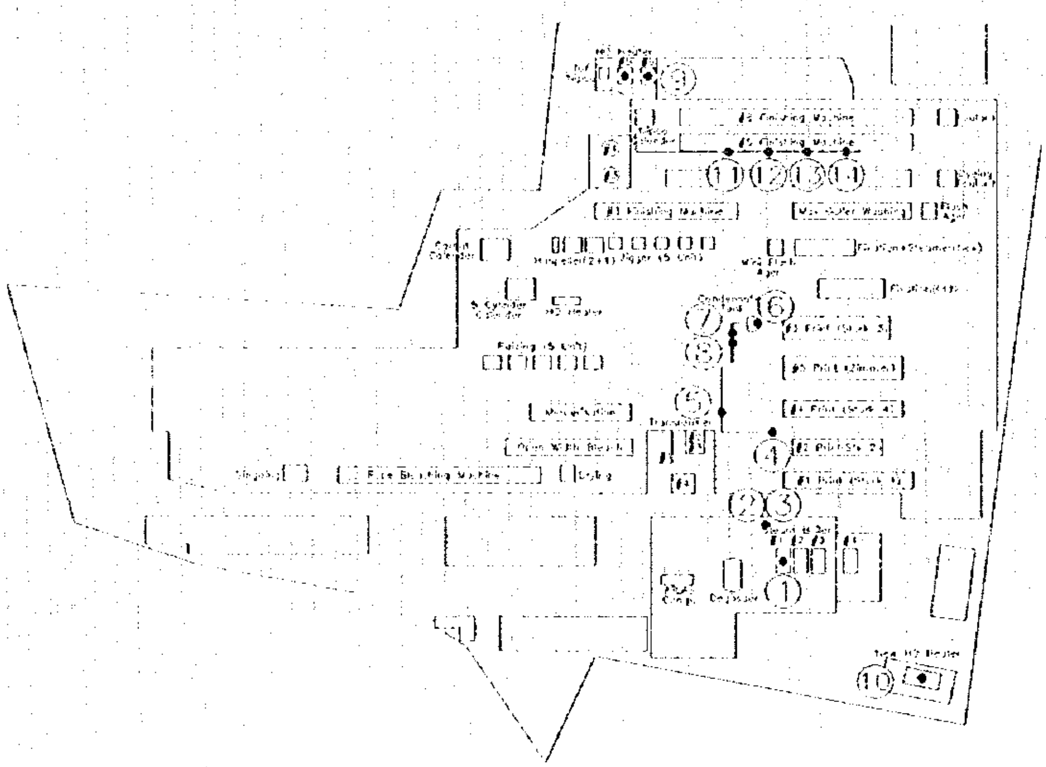
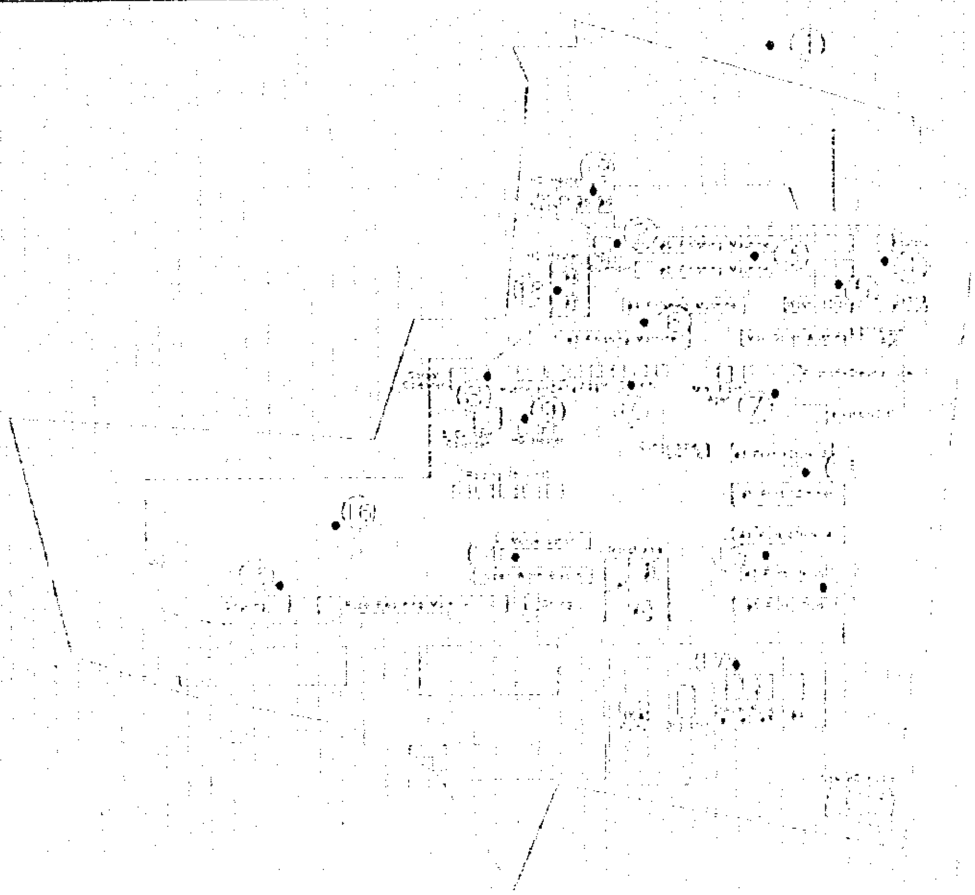


Table 11-25 Temperature and Humidity in the Factory

30. Aug 09:15 Fine Weather

No.	Measuring Position	Temperature °C	Humidity %
1	Outside of Factory	27.5	51.5
2	NIPCO Calendering machine	29.3	46.3
3	Between #5 & #6 Finishing Machines	37.3	36
4	Foulard	33.4	44.5
5	Between New & Old Washing Machines	32.5	44
6	Between #3 & #4 Finishing Machines	33.6	34
7	Between New & Old Fixation Machines	33.8	38.3
8	Carsat Calendering Machine	32.4	37.6
9	5 Cylinder Calendering Machine	32.4	40
10	Jigger Machines	32.1	41
11	Between #3 & Zimmer Printing Machines	33.7	45
12	Between #2 & #4 Printing Machines	32.3	47
13	Between #1 & #2 Printing Machines	32	38
14	Between Mercerise & Open Width Bleaching Mach.	30	52
15	Singeing Machine	28	52
16	Products Inspection Room	28.3	48
17	#1 Steam Boiler (2F)	32	40
18	#3, #4 Hot Oil Heater House	33.4	40
19	#5, #6 Hot Oil Heater House	31	42



11-9-4 Steam Boiler

(1) Measurement of Operating Condition

1. Flue gas temperature, °C: between 173 and 245, a large fluctuation
2. O_2 in flue gas, percent: 8.6 to 18.1, a large fluctuation

   The content of O_2 in the flue gas is very high. This means that the amount of air supply is too much and air may leak into the boiler combustion chambers.
3. Low heating value of coal and ash, kcal/kg:

   Coal 4,385

   Ash 488

   These values were obtained from the equations and the analytical values shown below.
4. Draft at IDF inlet, mbar: 9.5

Remark Low heating value estimation of coal and ash

(1)	Coal				
1.	JICA-EIE Laboratory's analysis data				
	High heating value, kcal/kg-dry base	5,780			
	Moisture, weight fraction	0.187			
2.	Chugai Laboratory's element analysis (left side)				
	Moisture, wt %	18.2	Left side data	Moisture, wt %	18.2
	Carbon, wt %-dry base	59.9	give	Carbon, wt %	49.0
	Hydrogen, wt %-dry base	4.6	break down	Hydrogen, wt %	3.8
	Nitrogen, wt %-dry base	1.33	(right side)	Nitrogen, wt %	1.1
	Others, wt %-dry base	(34.17)		Others, wt %	27.9
3.	LHV = HHV - 600 x (9 x h + W) = 5780 x (1 - 0.187) - 600 x (9 x 0.038 + 0.182) = 4699 - 314 = 4385 LHV: Low heating value, kcal/kg-wet base HHV: High heating value, kcal/kg-wet base h : Hydrogen weight fraction in coal W : Moisture weight fraction in coal				
(2)	Ash from stoker				
1.	Chugai Laboratory's element analysis				

	Moisture, wt %	33.7
	Carbon, wt %-dry base	4.6
	Hydrogen, wt %-dry base	0.4
	Nitrogen, wt %-dry base	0.09
2.	LHV = 8,100 x C + 29,000 x h = 8,100 x 0.046 + 29,000 x 0.004 = 488 LHV and h are same as above and C is carbon fraction in ash.	

(2) Approximate Heat Balance

1) Heat Input

	Item	Value	Unit
(1)	Coal		
	Amount of combustion	1,200	kg/h
	Heating value	4,385	kcal/kg
	Heat of combustion	5.26	10^6 kcal/h
(2)	Water		
	Flow rate	8.38	tons/h
	(Condensate return: assumed to be zero)		
	Temperature	103	℃
	Heat input	0.86	10^6 kcal/h
(3)	Air		
	Theoretical air rate*1	5.37	m^3/kg
	Air ratio (O_2% in flue gas 11.1% taken)	2.12	
	Amount of air	13,660	m^3/h
	Inlet temperature of air	30	℃
	Specific heat of air	0.32	kcal/m^3 ℃
	Heat input	0.13	10^6 kcal/h
(4)	Soot blow steam		
	Flow rate	0.075	tons/h
	Heat input	0.05	10^6 kcal/h
(5)	Total input heat	6.30	10^6 kcal/h

2) Heat Output

Item		Value	Unit
(1)	Steam		
	Flow rate	6.80	tons/h
	Pressure	7	Kg/cm^2
	Enthalpy	660	kcal/kg
	Heat output	4.49	10^6kcal/h
(2)	Flue gas		
	Theoretical flue gas rate*2	5.82	m^3/kg
	Amount of flue gas*3	14,200	m^3/h
	Temperature, (taken)	221	℃
	Specific heat of flue gas, (assumed)	0.33	kcal/m^3 ℃
	Heat output	1.04	10^6 kcal/h
(3)	Ash		
	Disposal rate*4	134	kg/h
	Temperature, (taken)	60	℃
	Specific heat, (assumed)	0.2	kcal/kg ℃
	Low heating value	488	kcal/kg
	Heat output	0.07	10^6kcal/h
(4)	Blow down water		
	Flow rate	1.58	tons/h
	Temperature	169	℃
	Heat output	0.27	10^6kcal/h
(5)	Heat loss from wall and others		
	Assumed	0.43	10^6kcal/h
(6)	Total heat output	6.30	10^6kcal/h

3) Boiler Efficiency

As a result, the boiler efficiency is calculated as shown below.

Steam output heat/total input heat	71.3	percent

Note*1 Theoretical air rate

A_0 = 100/21 x (c/12 x 22.4 + h/2 x 11.2 - o/32 x 22.4 + s/32 x 22.4)

= 100/21 x (0.49/12 x 22.4 + 0.038/2 x 11.2 + 0 + 0)

= 100/21 x (0.915 + 0.213)

$= 5.37$

values of c, h, n and w are from Chugai analysis data

Note*2 Theoretical flue gas rate

$G_0 = A_0 + h/2 \times 11.2 + w/18 \times 22.4 + o/32 \times 22.4 + n/28 \times 22.4$

$= 5.37 + 0.038/2 \times 11.2 + 0.182/18 \times 22.4 + 0 + 0.011/28 \times 22.4$

$= 5.82$

Note*3 Amount of flue gas

$G = G_0 + (m - 1) \times A_0$

$= 5.82 + (2.12 - 1) \times 5.37$

$= 11.83$

11.83 (Nm^3/kg-coal) x 1,200 (kg-coal/h) = 14,200

Note*4 Disposal rate

Ash $= 1{,}200 \times (100 - 16.58)/100 \times 12.71/100 \times 100/(100 - 4.6 - 0.4 - 0.09)$

$= 134$

16.58 is moisture wt % and 12.71 is ash wt % (dry base), together from Bati Cement Laboratory data

11-9-5 Steam Balance

(1) Outline

There is no steam flow meter on the supplier side (boiler outlet) and user side (each machine inlet) except for the flash ager in the factory. For this audit, two pieces of steam flow measuring equipment were installed, one on the main steam line and the other at the inlet to the open width bleaching machine, the largest steam consumer of the factory. Steam flows were measured for groups of subject machines as shown in Table 11-23.

(2) Steam Balance, tons/hour

The steam balance of boilers was calculated as below.

1.	Generation, tons/hour	
	Boiler feed water	8.38
	Blowdown	1.58
	Steam evaporated	6.80
2.	Consumption, tons/hour	
	Degasifier	1.70
	Soot blower	0.08
	Fuel oil heater	0.40
	Open width bleaching machine	2.20
	Flash ager	0.37
	Max Goller washing machine	1.58
	Other machines	0
	(Valves were closed at branch line from main line.)	
	Others (end users, heat losses, unaccounted-for losses)	0.47
	Total	6.80

11-9-6 Hot Oil Heater

(1) Main Operation Condition of the New Hot Oil Heater

The main operation condition of the new hot oil heater is given below.

	Item	Value	Unit
(1)	Flow rate of hot oil	300	kl/h
(2)	Temperature of hot oil		
	Inlet	240	℃
	Outlet	250	℃
	Temperature difference	10	℃
(3)	Properties of hot oil heater		
	Specific gravity	0.8783	
	Specific heat	0.45	kcal/kg ℃
(4)	No. 6 fuel oil combustion rate	4	tons/d
(5)	Properties of No. 6 fuel oil		
	Low heating value	9,600	kcal/kg
	Specific heat	0.48	kcal/kg ℃
(6)	Inlet temperature of No. 6 fuel oil at the burner	100	℃
(7)	Flue gas temperature		
	Outlet of combustion chamber	300	℃
	Outlet of flue gas-air exchanger	--	
(8)	Flue gas specific heat	0.34	kcal/Nm^3 ℃
(9)	O_2 % in flue gas	11	%
(10)	Temperature of air		
	Inlet of flue gas-air exchanger	35	℃
	Inlet of combustion chamber	90	℃
(11)	Specific heat of air	0.32	kcal/Nm^3 ℃

(2) Approximate Heat Balance Calculation of the New Hot Oil Heater

1) Heat Input

	Item	Value	Unit
(1)	Heat of combustion of No. 6 fuel oil	1.608	10^6 kcal/h
(2)	Input heat of No. 6 fuel oil	0.008	10^6 kcal/h

(3)	Input heat of Air		
	Air ratio	2.1	
	Theoretical air rate, Assumed	10.58	Nm^3/kg
	Amount of air	3,700	Nm^3/h
	Input heat	0.106	10^6 kcal/h
(4)	Input heat of hot oil	28.457	10^6 kcal/h
(5)	Total input heat	30.233	10^6 kcal/h

2) Heat Output

	Item	Value	Unit
(1)	Output heat of hot oil	29.643	10^6 kcal/h
(2)	Output heat of flue gas		
	Theoretical flue gas rate, Assumed	11.29	Nm^3/kg
	Amount of flue gas	3,821	Nm^3/h
	Output heat	0.390	10^6 kcal/h
(3)	Wall loss and others	0.146	10^6 kcal/h
(4)	Total output heat	30.233	10^6 kcal/h

3) Recovery Heat by the Flue Gas-Air Exchanger

Recovery heat by air side	0.065	10^6 kcal/h

4) Efficiency of the Hot Oil Heater

Item	10^6 kcal/h	Item	10^6 kcal/h	Percent
Input side		Output side		
Combustion heat	1.608	Net received heat of hot oil	1.186	68.9
Fuel oil input heat	0.008	Flue gas output	0.390	22.6
Air input heat	0.106	Net release heat	0.325	18.8
Fresh air input heat	0.041	Recovery heat	0.065	3.8
Recovery heat	0.065	Heat release from wall	0.146	8.5
Total input heat	1.722	Total output heat	1.722	100

The calculated efficiency is 68.9 percent.

11-9-7 Audit of Steam Line, Hot Oil Line and Condensate Recovery Line

The result of the audit on the above subjects may be summarized as follows:

1. The main lines of steam, hot oil and condensate are insulated. These are designed and fabricated adequately, and maintained in good conditions.
2. Small steam pipe lines to the end steam users are sporadically not insulated.
3. The insulation is of either glass wool or rock wool, from 50 to 90 millimeters thick covered by thin steel plate.
4. Measured surface temperatures of the steam lines, hot oil lines and condensate lines at typical points are as follows. (Unit: ℃)

Steam line:	Uninsulated pipe	155
	Insulated pipe	52
Hot oil line:	Uninsulated pipe	167
	Insulated pipe	53
Condensate line:	Uninsulated pipe	91
	Insulated pipe	50

5. Measures to prevent heat losses from lines are to determine the effect of insulation on the valves and flanges in the main steam lines and hot oil lines, to watch and prevent leaks of hot oil and steam using an appropriate device, and to conduct good maintenance and adequate repairing of the insulation on the small-sized steam lines, lines supplying steam for room heating, for example.

11-9-8 Steam Trap

(1) Drain Pit

Steam traps are immersed in hot water in pits. The pits should not hold hot water. Devices to remove hot water are needed. Such devices are preferably equipped with automatic on-off switches, effective in keeping the water levels low. The condensed water recovery line in this section is not insulated.

(2) Drying

The steam line in the drying machine leaks at flanges and bonnets. These leaks should be stopped.

(3) Rope Bleaching

1) Steam Trap System

Steam traps are needed at several points: points on the steam main line from where the line goes up, drain lines before temperature control valve passing through the wall to the sewer in the road, drain line before temperature control valve at the inlet of each machine and at the end of the steam main line.

2) Block Valve

Block valves are normally needed upstream of steam traps in the main steam line for maintenance of the steam traps. This practice may not be needed for this section, because the machine operates intermittently according to the operation plan. There is ample opportunity for maintenance. This is true with other machines in the factory.

(4) Mercerizing

It is needed to install a steam trap upstream of the depressurizing control valve.

(5) Check Valves before Rising Lines

It is necessary to install a check valve downstream of the steam trap in the case where the condensate recovery line goes to a higher position.

(6) Jigger

It is needed to install a steam trap at the end of the steam main line.

(7) Flash Ager and Max Goller Washing

There is some steam leakage from the flange of the piping at upper section of the Flash Ager. It is necessary to install a check valve downstream of the steam trap in the condensate recovery line.

(8) Outline of the Steam Trap Audit

Only a small number of steam traps operated under the design conditions when the measurement was done. Most steam traps operated under conditions which were deviated from the designs, notably to lower temperatures, because machines operated according to the production plan not to the design, many of them at lower temperatures attained by throttling the steam valves. The equipment for diagnosis of steam traps the study team brought along showed:

1. A few steam traps: Good operation
2. One steam trap: Blowing

3. Many steam traps: Low temperature
4. Many steam traps: Blocked out

The results of the steam trap audit are shown in Table 11-26, an output report of the equipment for diagnosis, and Table 11-27, the code list for the abbreviations used in Table 11-26. Figure 11-14 indicates locations of steam traps and their area numbers.

Table 11-26 Result of the Steam Trap Audit (1/2)

TLV PAGE: 1

STEAM TRAP MANAGEMENT LOG DETAILS

By Area Trap Number FILE : IBF

AREA NO.	TRAP NO.	APPL	I-O	MODEL	PRESS (kg)	TEST RSLT	SURF TEMP	STEAM LOSS	INSTAL DATE	OP. HOURS	RCMD MODEL
		PRTY	COND RCRY	SIZE	SAT. TEMP	LEAK LEV	SET TEMP	kg/hr $/year	INSPEC DATE	OP. DAYS	@STEAM $/ton
		EQUIPMENT		CONN	BACK (kg)	PREV. RSLT	INSP LOSS	COND. RATE	NEXT	REMARKS	
002	00010			S-THERMO	3.8	BLK	31	0.0		0	
				0	150	0	0	0	090696	0	0.00
				PT	0.0	NCH	0	0.0	0999		
002	00020			THERMO	3.8	L/C	53	0.0		0	
				0	150	0	0	0	090696	0	0.00
				PT	0.0	NCH	0	0.0	0999		
002	00030			THERMO	3.8	L/C	67	>0.0		0	
				0	150	0	0	>0	090696	0	0.00
				PT	0.0	NCH	0	0.0	0999		
002	00040			THERMO	3.8	L/C	78	0.0		0	
				0	150	0	0	0	090696	0	0.00
				PT	0.0	NCH	0	0.0	0999		
002	00050			THERMO	3.8	BLK	36	0.0		0	
				0	150	0	0	0	090696	0	0.00
				PT	0.0	NCH	0	0.0	0999		
002	00060			THERMO	3.8	BLK	39	0.0		0	
				0	150	0	0	0	090696	0	0.00
				PT	0.0	NCH	0	0.0	0999		
002	00070			THERMO	3.8	L/S	103	3.9		0	
				0	150	5	0	0	090696	0	0.00
				PT	0.0	NCH	0	0.0	0999		
002	00080			THERMO	2.5	BLK	32	0.0		0	
				0	139	0	0	0	090696	0	0.00
				PT	0.0	NCH	0	0.0	0999		
002	00090			THERMO	0.0	NCH	0	0.0		0	
				0	0	0	0	0		0	0.00
				PT	0.0	NCH	0	0.0	0999		
005	00010			THERMO	2.3	L/C	65	0.0		0	
				0	137	0	0	0	090696	0	0.00
				PT	0.0	NCH	0	0.0	0999		
006	00010			THERMO	2.3	GOOD	90	0.0		0	
				0	137	0	0	0	090696	0	0.00
				PT	0.0	NCH	0	0.0	0999		
006	00020			THERMO	2.3	L/C	51	0.0		0	
				0	137	0	0	0	090696	0	0.00
				PT	0.0	NCH	0	0.0	0999		
008	00010			THERMO	3.5	L/C	40	0.0		0	
				0	117	0	0	0	090696	0	0.00
				PT	0.0	NCH	0	0.0	0999		
008	00020			THERMO	3.5	BLK	39	0.0		0	
				0	117	0	0	0	090696	0	0.00
				PT	0.0	NCH	0	0.0	0999		

<CONTINUE>

Table 11-26 Result of the Steam Trap Audit (2/2)

TLV PAGE: 2

STEAM TRAP MANAGEMENT LOG DETAILS

By Area Trap Number FILE : IBF

AREA NO.	TRAP NO.	APPL	I-O	MODEL	PRESS (kg)	TEST RSLT	SURF TEMP	STEAM LOSS	INSTAL DATE	OP. HOURS	RCMD MODEL
		PRTY	COND RCRY	SIZE	SAT. TEMP	LEAK LEV	SET TEMP	kg/hr $/year	INSPEC DATE	OP. DAYS	@STEAM $/ton
		EQUIPMENT		CONN	BACK (kg)	PREV. RSLT	INSP LOSS	COND. RATE	NEXT		REMARKS
008	00030			THERMO	3.5	I/C	53	0.0		0	
				0	147	0	0	0	090696	0	0.00
				PT	0.0	NCH	0	0.0	0999		
008	00040			THERMO	3.5	I/C	65	0.0		0	
				0	147	0	0	0	090696	0	0.00
				PT	0.0	NCH	0	0.0	0999		
008	00050			THERMO	3.5	I/C	56	0.0		0	
				0	147	0	0	0	090696	0	0.00
				PT	0.0	NCH	0	0.0	0999		
008	00060			THERMO	3.5	I/C	59	0.0		0	
				0	147	0	0	0	090696	0	0.00
				PT	0.0	NCH	0	0.0	0999		
008	00070			THERMO	3.5	I/C	61	0.0		0	
				0	147	0	0	0	090696	0	0.00
				PT	0.0	NCH	0	0.0	0999		
008	00080			THERMO	3.5	I/C	45	0.0		0	
				0	147	0	0	0	090696	0	0.00
				PT	0.0	NCH	0	0.0	0999		
008	00090			THERMO	2.5	I/C	47	0.0		0	
				0	139	0	0	0	090696	0	0.00
				PT	0.0	NCH	0	0.0	0999		
008	00100			THERMO	3.5	I/C	13	0.0		0	
				0	147	0	0	0	090696	0	0.00
				PT	0.0	NCH	0	0.0	0999		
008	00110			THERMO	3.5	BLW	98	11.1		0	
				0	147	15	0	0		0	0.00
				PT	0.0	NCH	0	0.0	0999		
008	00120			THERMO	63.5	I/C	123	0.0		0	
				0	273	0	0	0	090696	0	0.00
				PT	0.0	NCH	0	0.0	0999		
008	00130			THERMO	3.5	I/C	61	0.0		0	
				0	147	0	0	0	090696	0	0.00
				PT	0.0	NCH	0	0.0	0999		
100	00010			THERMO	2.5	GOOD	81	0.0		0	
				0	139	0	0	0	090696	0	0.00
				PT	0.0	NCH	0	0.0	0999		

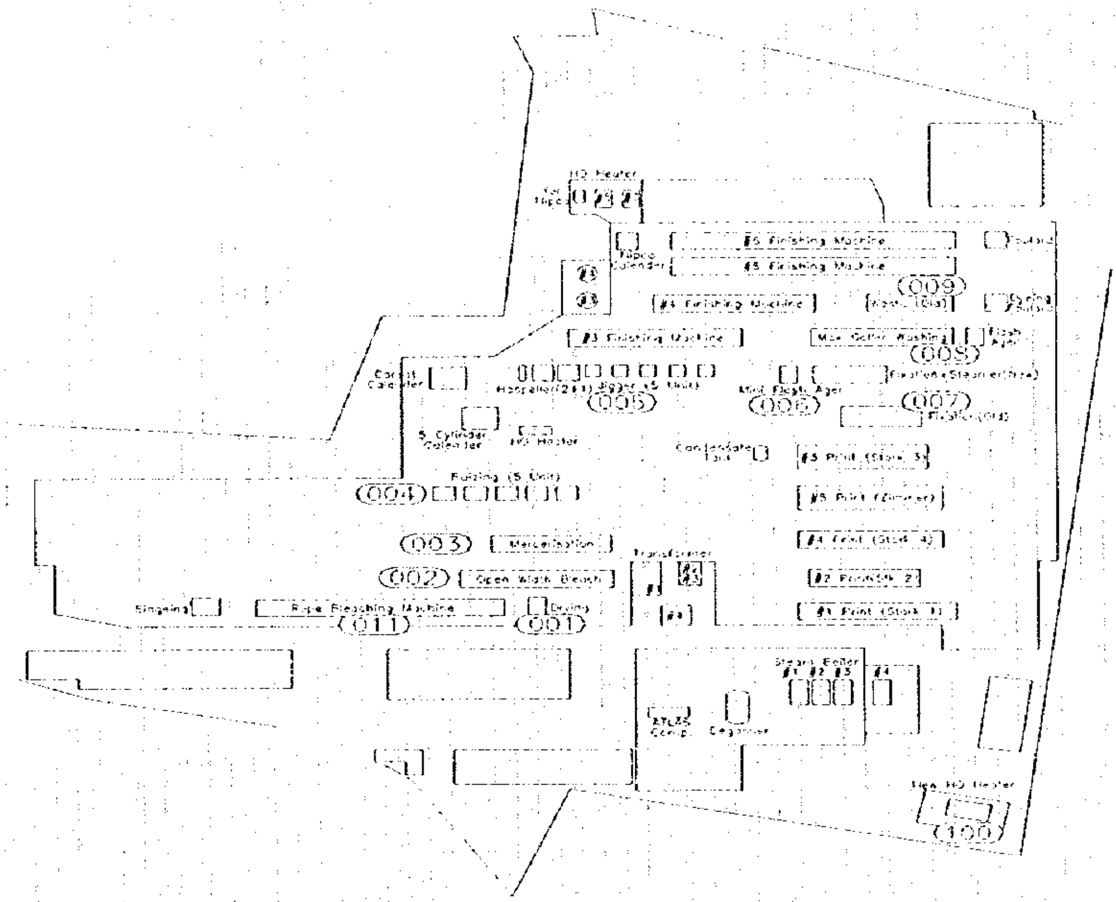
Remark Reference the Code List

Table 11-27 Code List of Steam Trap Audit

Item	Code	Abbreviation used	Meaning
Application	0	DRIP	Drip
	1	PROC	Process
	2	TRCR	Tracer
	3	HEAT	Heating
	4	C-DRYER	Cylinder Dryer
Priority	1	MOST	Most Important
	2	IMP	Important
	3	GENR	General
	4	AUX	Auxiliary
Location/ Elevation	0	O-LW	Outdoor Low
	1	I-LW	Indoor Low
	2	O-HG	Outdoor High
	3	I-HG	Indoor High
Condensate Recovered	0	NO	No (To drain)
	1	YES	Yes (Returned)
Mode of Operation	0	CONTINUOUS	Continuous
	1	BATCH	Batch
	2	PROC.C.	Proportional Control

Item								
Connection	00	PT	08	40kFF	16	63kRF	24	125lbRF
	01	SW	09	5kRF	17	125lbFF	25	150lbRF
	02	Other	10	10kRF	18	150lbFF	26	250lbRF
	03	5kFF	11	16kRF	19	250lbFF	27	300lbRF
	04	10kFF	12	20kRF	20	300lbFF	28	400lbRF
	05	16kFF	13	30kRF	21	400lbFF	29	600lbRF
	06	20kFF	14	40kRF	22	600lbFF	30	900lbRF
	07	30kFF	15	60kRF	23	900lbFF	31	1500lbRF

Item	Code	Abbreviation used	Meaning
Test Result	01	BLW	Blowing
	02	L/L	Leak / Large
	03	L/M	Leak / Medium
	04	BLK	Blocked
	05	NSV	Not in Service
	06	L/ C	Low Temp
	07	L/S	Leak / Small
	08	GOOD	Good
	09	ADJ	Adjustment Failed
	10	L/G	Leak / Gasket
	11	L/B	Leak / Body
	12	NCH	Not checked
	13		Not installed



Area Number	Area
011	Rope Bleaching Range
001	Drying Machine
002	Open Width Bleaching Range
003	Mercerization
004	Raizing Machines
005	Jiggers
006	Mini Flash Ager
007	Fixation
008	Max Goller Washing, Flash Ager
009	Old Washing Range
100	New Hot Oil Heater

Trap Number

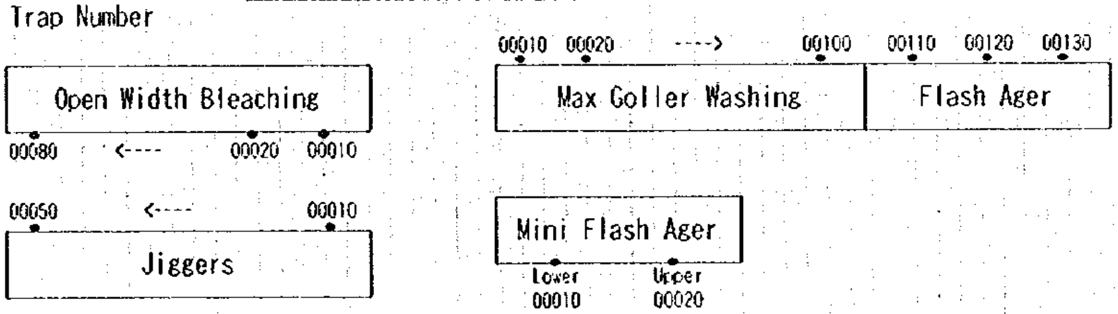


Figure 11-14 IBF Steam Trap Location Diagram

11-9-9 Electricity

Electricity measurements were done at each transformer and the points shown in Table 11-28. The power meter was read continuously at the factory entrance. Figure 11-15 gives the measured total electric load of the factory. During the last several years, distribution of electrical loads was changed and some saving of energy and money was realized. Peak power load was reduced. Consequently, the demand agreement with the City Electric Company was reduced from 2,500 kW to 2,100 kW. Figure 11-15 shows that the peak demand is below 1,900 kW.

The saving cost of electricity was as shown below.

Year	1991	1992	1993	1994	1995
Million TL/year	60	266	440	907	1,000

Table 11-29 shows the meter readings on each transformer read every morning during the audit period. Data on electricity of the main facilities such as open width bleaching, Max Goller washing range, hot oil heaters, and steam boilers, were measured by the energy analyzer connected to the line at the transformer or the local panel. In the case of steam boilers, the energy analyzer was connected after the connecting point of Nos. 2 and No. 3 transformers. Figure 11-16 shows the variation of electric load of the machines with time. Table 11-30 summarizes the results of measurements. Table 11-30 also shows estimated operating rates of the facilities.

Table 11-30 Electricity Consumption on Main Facilities

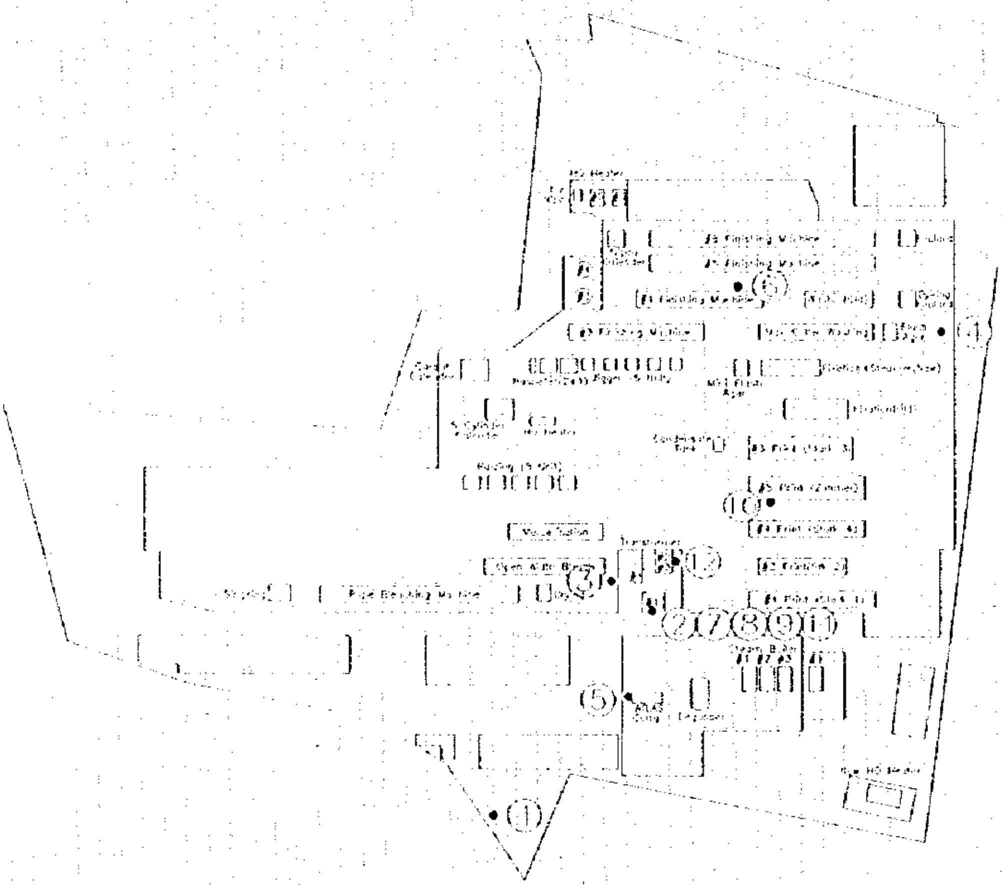
Facility	Current A	Power Factor	Power kW	Operating Rate, %
Open Width Bleaching	15 - 119	0.52 - 0.54	9 - 44	about 70
Rope Bleaching	4 - 61	0.29 - 0.83	1 - 37	about 50
Max Goller Washing	5 - 85	0.56 - 1.00	2 - 34	less than 30
ATLAS Compressor	56 - 135	0.54 - 0.89	22 - 77	about 50
#4 Finishing Machine	16 - 281	0.41 - 0.75	5 - 130	more than 80
#6 Finishing Machine	21 - 148	0.42 - 0 81	8 - 65	about 70
#3 Printing Machine (Stork 3)	6 - 244	0.61 - 0.95	4 - 127	-
#4 Printing Machine (Stork 4)	2 - 239	0.46 - 0.83	1 - 132	-

#5 Printing Machine (Zimmer)	9 - 278	0.45 - 1.00	6 - 125	-
New Hot Oil Heater	119 - 168	0.80 - 0.88	71 - 98	about 60
#1, #2, #3 Steam Boilers	82 - 159	0.62 - 0.76	38 - 67	almost Full

Table 11-28 IBF Electric Measuring

	Machine	Schematic Position	Measuring Location	Measuring Time Period	Interval
1	Receiving Electricity	Up of Trans	Receiving Meter Room	2/Sep.10:15 - 4/Sep. 14:15	1 hr
2	Open Width Bleaching	GT 3-3/A	Out of #4 Transformer	29/Aug.9:54 - 29/Aug.15:39	5 min
3	Rope Bleaching	GT 1-5/4	Local Panel	3/Sep. 9:53 - 4/Sep. 12:15	5 min
4	Max Goller Washing	GT 2-3/5	Local Panel	2/Sep.10:43 - 3/Sep. 14:37	5 min
5	ATLAS Compressor	GT 3-6/3	Local Panel	4/Sep.13:56 - 4/Sep. 17:06	1 min
6	#4 Finishing Machine	GT 1-2/2	Local Panel	4/Sep.16:35 - 5/Sep. 16:29	5 min
7	#6 Finishing Machine	GT 3-5	Out of #4 Transformer	3/Sep.14:53 - 4/Sep. 16:13	5 min
8	#3 Printing Machine (Stork3)	GT 3-7/1	Out of #4 Transformer	27/Aug.9:19 - 27/Aug.15:19	1 hr
9	#4 Printing Machine (Stork4)	GT 3-6/1	Out of #4 Transformer	4/Sep.11:23 - 4/Sep. 17:53	30 min
10	#5 Printing Machine (Zimmer)	GT 1-6	Local Panel	2/Sep.16:29 - 3/Sep. 2:28	30 min
11	New Hot Oil Heater	GT 3-8/1	Out of #4 Transformer	5/Sep.13:51 - 6/Sep.15:10	5 min
12	#1, #2, #3 Steam Boilers	GT 2-1	Out of #2 & #3 Transformer	5/Sep.17:05 - 6/Sep.16:35	5 min

Measuring Instrument
1 : Power Meter
2, 3, 4, 5, 6, 7, 12 : VIP MK3 ENERGY ANALYZER, Made by ELCONTROL in Italy (EIE's Analyzer)
8, 9, 10, 11 : MICROVIP 3 3-Phase energy analyzer, Made in Italy by ELCONTROL (IBF's Analyzer)



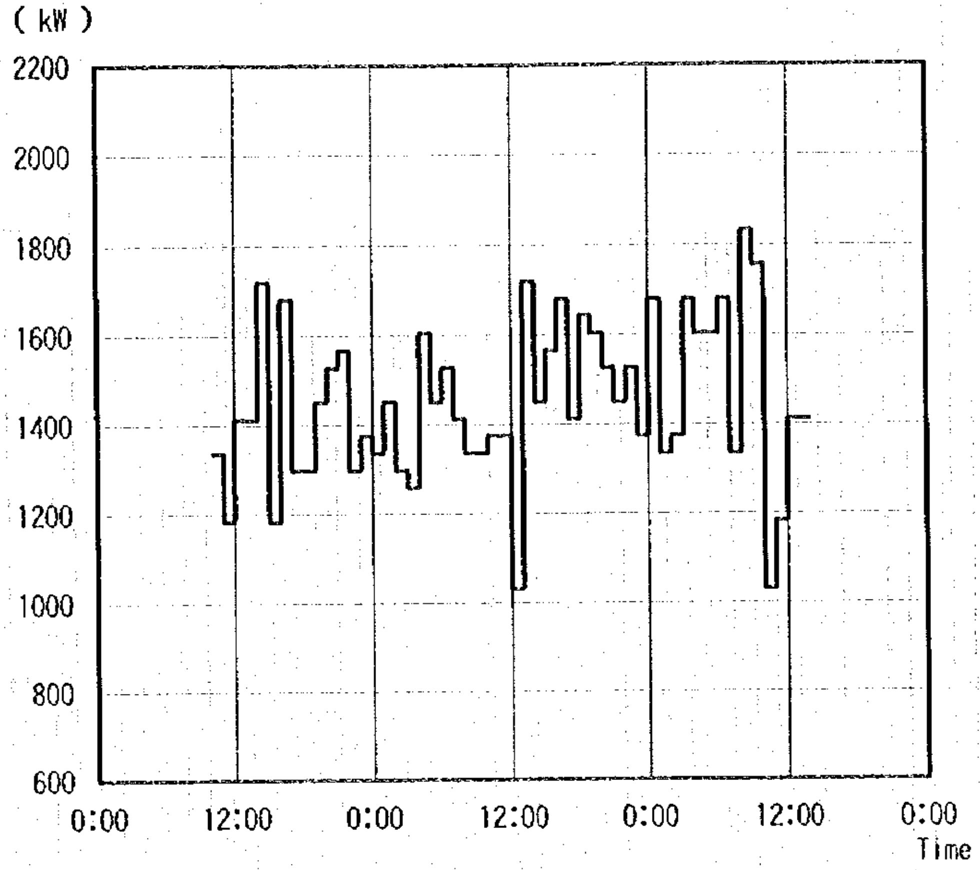


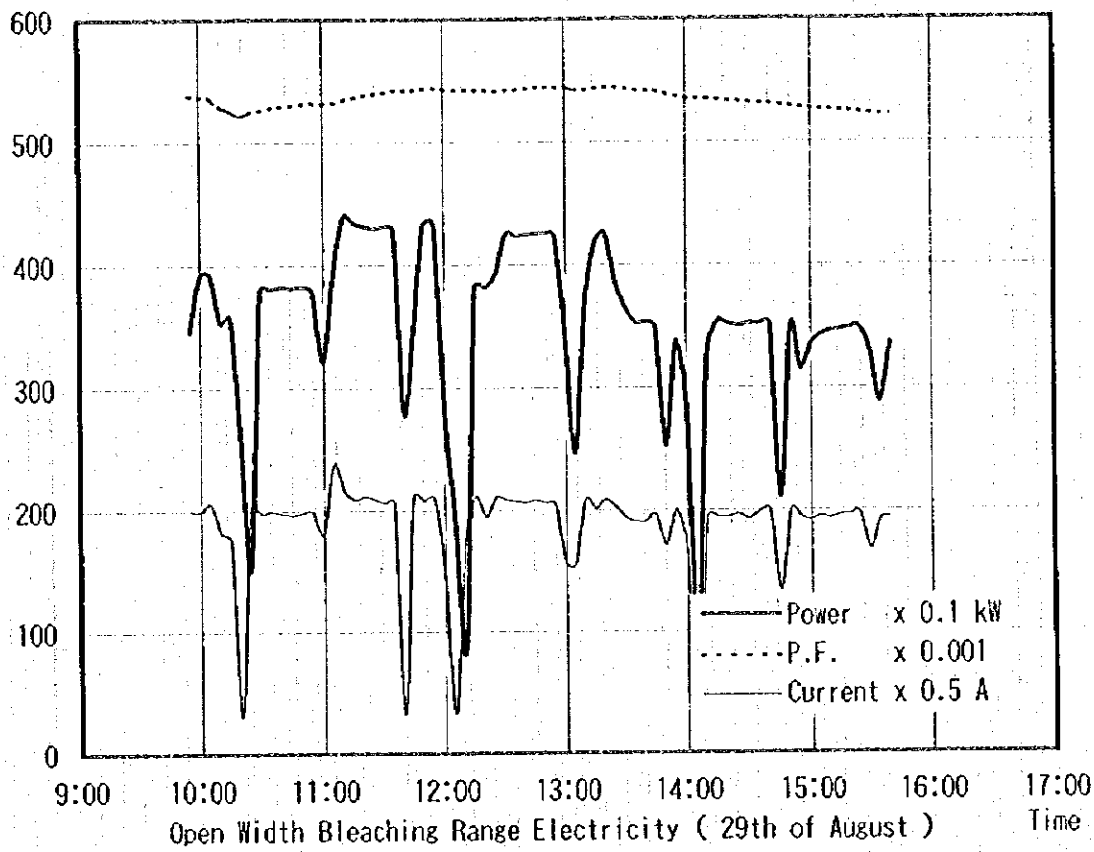
Figure 11-15 Total Electric Load of the Factory
(from 2nd to 4th of September)

Table II-29 Efficiency of Receiving Transformer

Measured at 9:00 every day

Day	AT1 #1 Transformer				AT2 #2 Transformer				AT2 #3 Transformer				AT3 #4 Transformer				Total Power (kW)
	Voltage (V)	Current (A)	P.Factor (-)	Power (kW)	Voltage (V)	Current (A)	P.Factor (-)	Power (kW)	Voltage (V)	Current (A)	P.Factor (-)	Power (kW)	Voltage (V)	Current (A)	P.Factor (-)	Power (kW)	
28 Aug.	Transformer Breakdown																
29 Aug.	385	200	0.91	121	385	300	0.98	196	385	300	0.97	194	385	1250	0.93	775	1287
30 Aug.	National Holiday																
31 Aug.	385	550	0.90	330	385	280	0.93	174	385	280	0.98	183	380	1300	0.91	779	1465
1 Sep.	400	400	0.93	258	400	180	0.92	115	400	180	0.55	69	380	1200	0.92	727	1168
2 Sep.	380	150	0.95	94	380	300	0.96	190	380	240	0.97	153	380	1000	0.99	652	1088
3 Sep.	375	400	0.94	244	375	280	0.95	173	375	240	0.98	153	375	925	0.99	595	1165
4 Sep.	380	550	0.91	329	380	270	0.98	174	380	260	0.98	168	400	1200	0.99	823	1494
5 Sep.	390	110	0.93	69	385	270	0.95	171	390	260	0.98	172	370	1100	0.95	670	1082
6 Sep.	380	550	0.91	329	385	270	0.93	167	385	280	0.98	183	370	1400	0.95	852	1532
7 Sep.	390	110	0.93	69	385	300	0.93	186	385	300	0.98	196	385	1400	0.99	924	1375
8 Sep.	400	100	0.91	63	400	200	0.93	129	400	200	0.99	137	400	1200	0.95	790	1119
9 Sep.	395	325	0.92	205	390	240	0.93	151	397	250	0.98	168	340	1050	0.95	587	1111

Power = Sqrt(3) x Voltage x Current x (Power Factor) / 1000



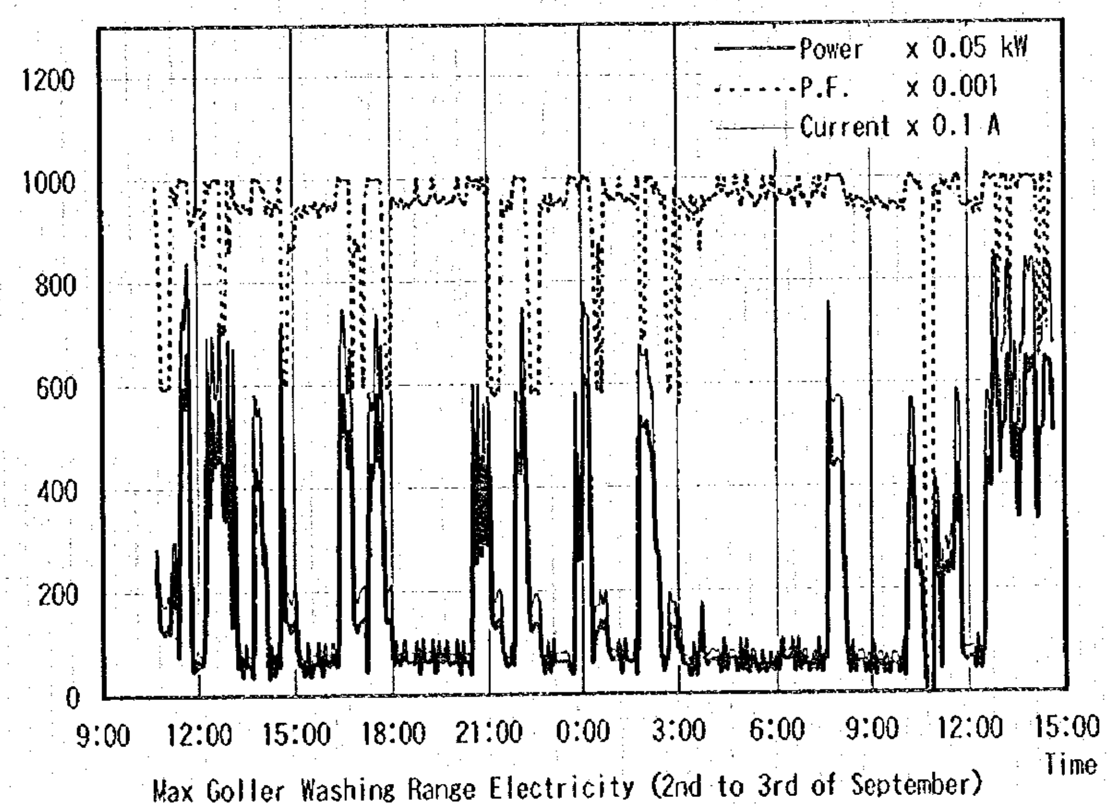
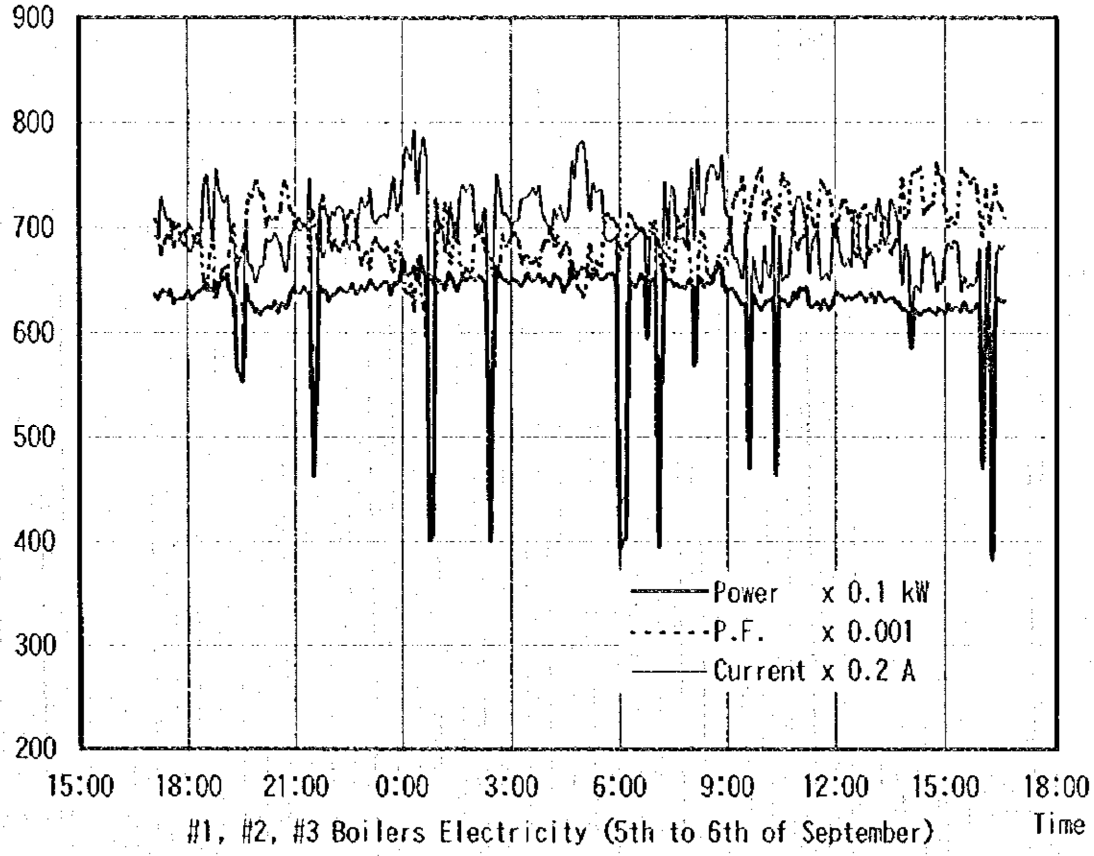


Figure 11-16 Electric Load of Main Facilities (1/3)



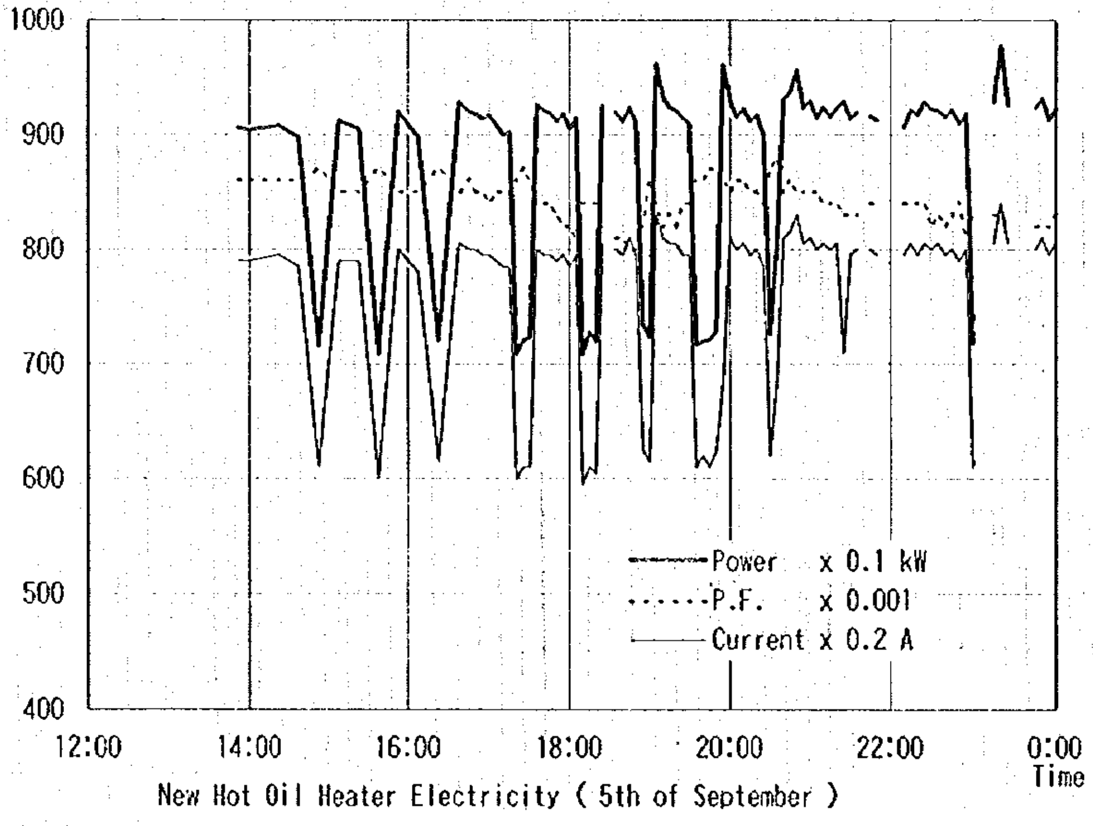
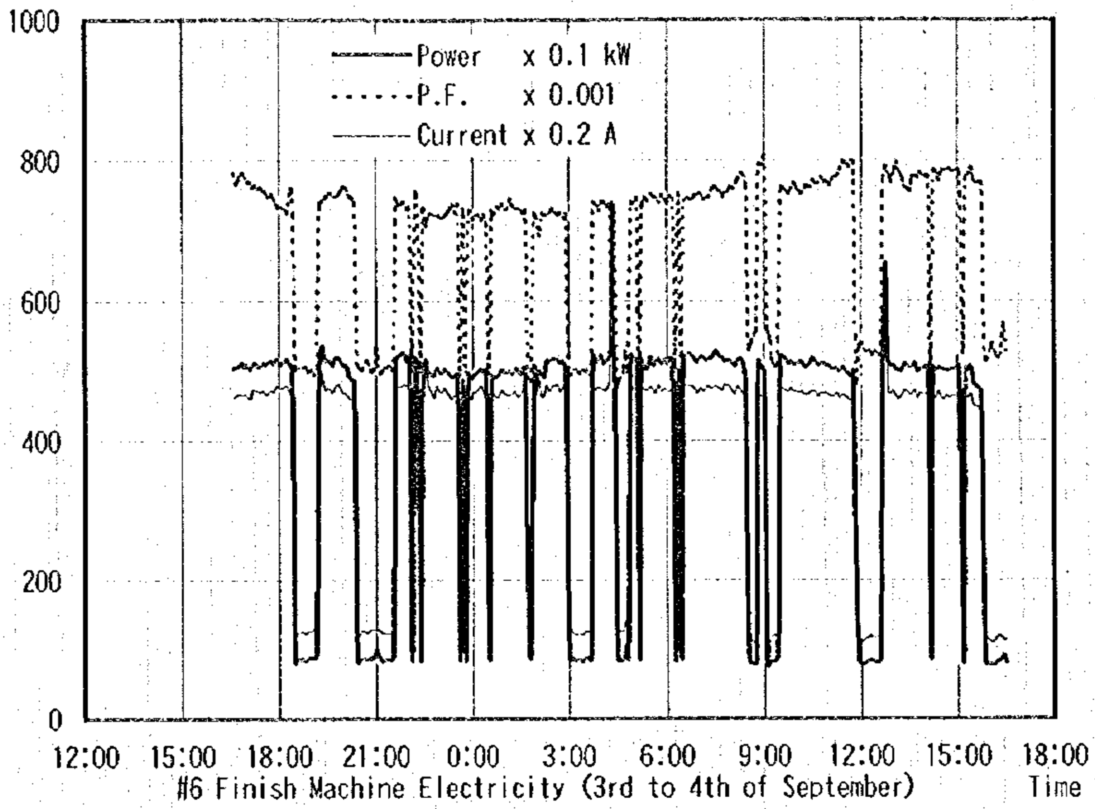


Figure 11-16 Electric Load of Main Facilities (2/3)



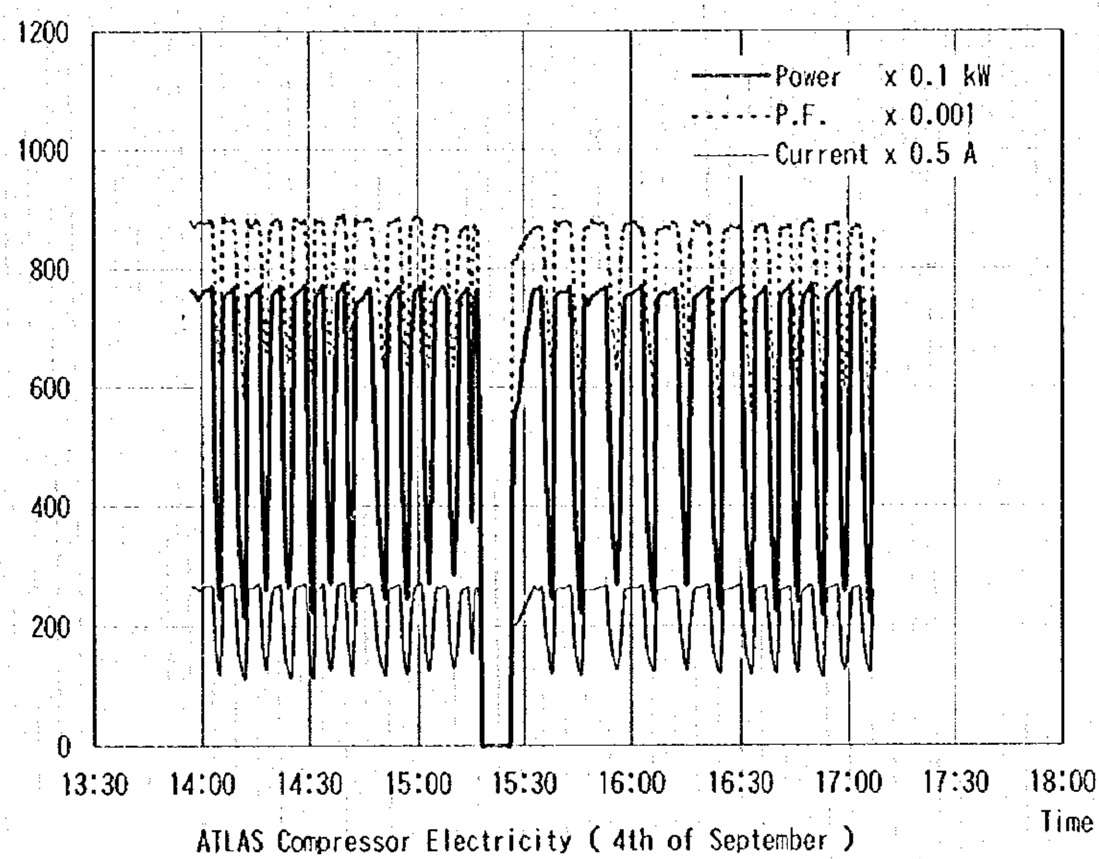


Figure 11-16 Electric Load of Main Facilities (3/3)

11-10 Energy Flowchart for Factory and Major Energy Consuming and Supply Facilities

11-10-1 Energy Flowchart for Factory

Total energy consisting of fuel, such as coal, No. 6 fuel oil, special fuel oil, diesel gas oil and LPG, and electricity was used in all facilities in the factory from January to August 1996 as shown in Table 11-31. Their percentages show the features of energy flow in the factory.

The heat consumption by IBF may be compared with that of a certain Japanese factory as follows. Keeping in mind the notes described in Section 11-14-4, the study team made a table of comparison, Table 11-32, using the available data of unit heat consumption of the Japanese factory (Refer to Tables 11-44, 11-45 and 11-47).

The results show that IBF's unit heat consumption is better than the similar Japanese factory in the two processes.

1. Total value of the scouring, bleaching, mercerization and drying processes
   The main reason would be that presently IBF is doing the so-called "wet on wet system," doing without unnecessary drying processes. If IBF emphasized heat recovery, the values of EN in Table 11-32 would show that there is an ample room to reduce heat consumption.

2. Printing and fixing process
   The data available in Japan are those for flat screen printing; IBF is operating rotary screen printers. This partly explains the difference.

Granting that the IBF and the Japanese factory would be different, the IBF's present unit heat consumption is fairly good, as shown in Table 11-32. Nevertheless, as shown by the results of the present energy audit and the values of EN in Table 11-32, IBF leaves ample room for reducing energy consumption.

Table 11-31 Energy Flowsheet of the Factory

(1996.Jan. -- Aug.)

Input	Fuel							Electricity	Energy Total
	Coal		No.6 Fuel Oil	Special Fuel Oil	Diesel Gas Oil	LPG	Sub Total		
ton or 10^3 kWh	8,063		586	2,021	77	70	----	7,533	
10^6 kcal	35,350		5,630	19,400	750	770	61,900	6,480	
Energy Conversion	4.49/5.26		1186/1608						
Efficiency (%)	85.4		73.8		(73.8)	100			
Energy Consuming Facility	Steam kg/h (%)	Steam 10^6 kcal	Hot Oil 10^6 kcal (%)			LPG 10^6 kcal	10^6 kcal (%)	10^6 kcal (%)	10^6 kcal (%)
Singeing	----	----	----	----	----	770	770 (1.5)	40 (0.6)	810 (1.4)
Open Width Bleaching Rope Bleaching Jigger, Mercerization	4,200 (43.5)	13,130	----	----	----	----	13,130 (26.3)	370 (5.7)	13,500 (23.9)
Drying	900 (9.3)	2,810	----	----	----	----	2,810 (5.6)	30 (0.5)	2,840 (5.0)
Printing Fixation	450 (4.6)	1,390	4,150 (21.8)	----	----	----	5,540 (11.1)	1,830 (28.2)	7,370 (13.1)
Max Goller Aging Washing	3,100 (32.0)	9,660	----	----	----	----	9,660 (19.3)	190 (2.9)	9,850 (17.5)
Finishing	----	----	----	14,320 (75.3)	----	----	14,320 (28.7)	1,250 (19.3)	15,570 (27.6)
Calendering Raising	130 (1.3)	390	----	----	550 (1.5)	----	940 (1.9)	320 (5.0)	1,260 (2.2)
Utilities Facilities Others	900 (9.3)	2,810	----	----	----	----	2,810 (5.6)	2,450 (37.8)	5,260 (9.3)
Total 10^6kcal		30,190 (60.4)		19,020 (38.1)		770 (1.5)	49,980 (%)	6,480	56,460
Energy Consumption Rate 10^6 kcal/ton-product (16,885 x 10^3m, 1.6 m-width, 140 g/m)							14.70	1.90	16.6

Table 11-32 Comparison of Unit Heat Consumption in IBF and a Japanese Printing Factory

Unit: 10^6 kcal/ton-product

Process	IBF	Japanese Factory	
		EP	EN
Singeing	0.23	0.26	0.26
Scouring Bleaching Mercerization	3.86	6.75	2.82
Drying	0.83		
Printing Fixing	1.63	7.36	7.42
Washing	2.84	2.98	0.92
Finishing	4.21	2.20	0.54
Sub-Total	13.60	19.55	11.96
Others	1.11	--	--
Total	14.70	--	--

Note: EP: Unit heat consumption estimated in 1983
EN: Unit heat consumption after possible heat recovery is performed
The value of EN of printing is calculated by assuming a smaller lot than that in 1983.

11-10-2 Energy Flow Chart of Major Energy Consumption and Supply Facilities

The energy flowcharts of the open width bleaching range, Max Goller washing range, steam boiler and hot oil heater are shown in Figures 11-17, 11-18, 11-19 and 11-20 respectively.

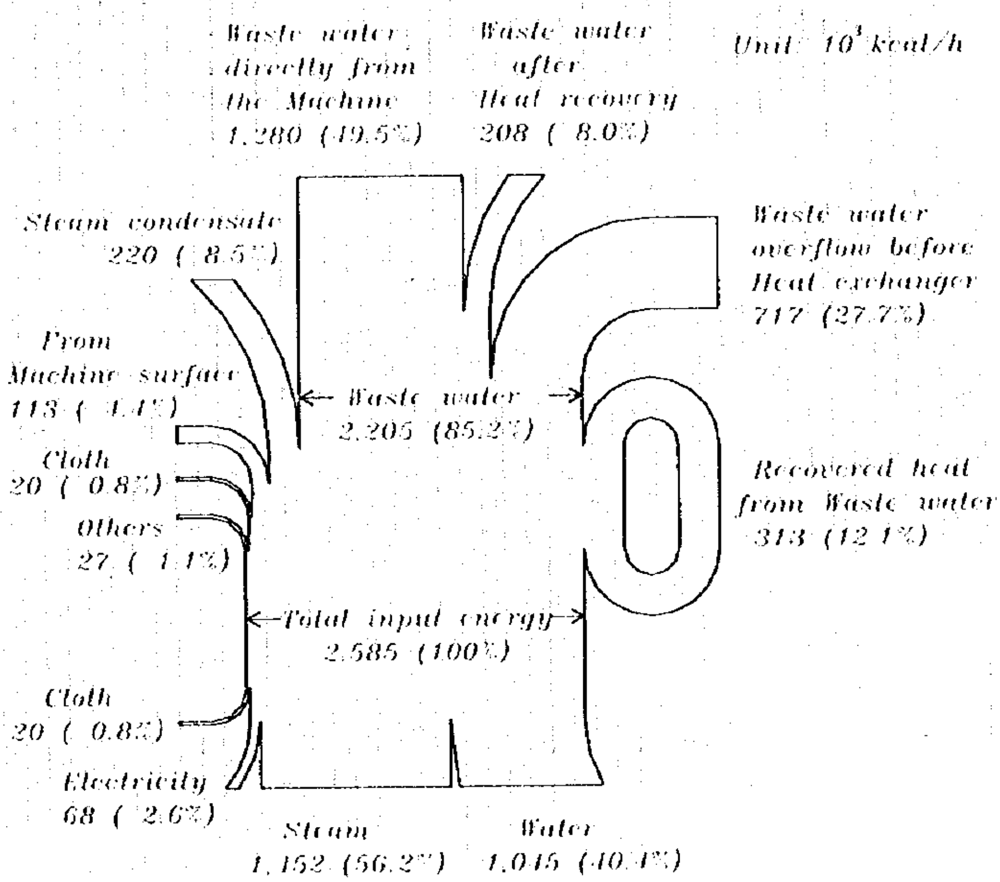


Figure 11-17 Energy Flowchart of the Open Width Bleaching Range

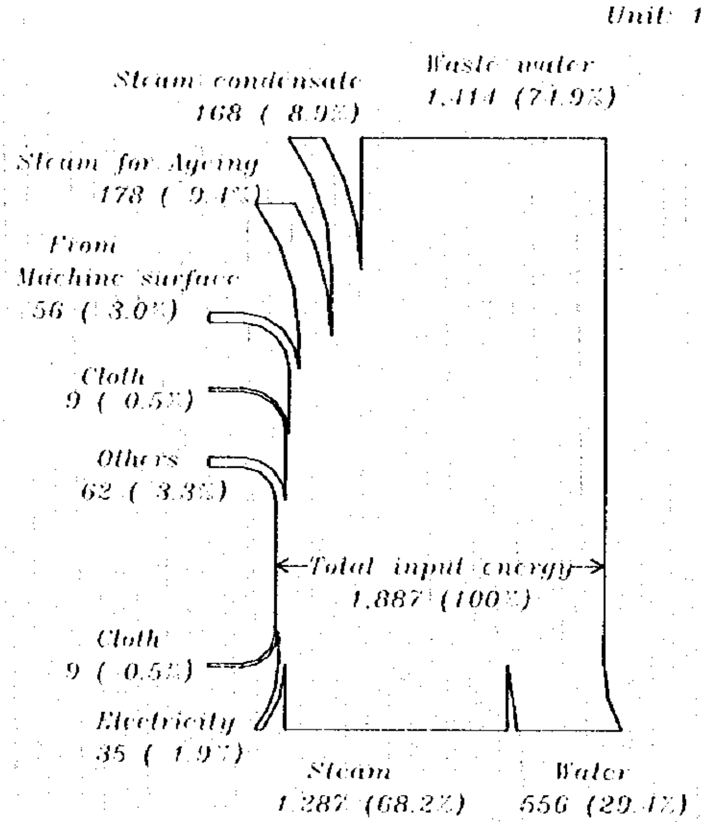


Figure 11-18 Energy Flowchart of Max Goller Washing Range

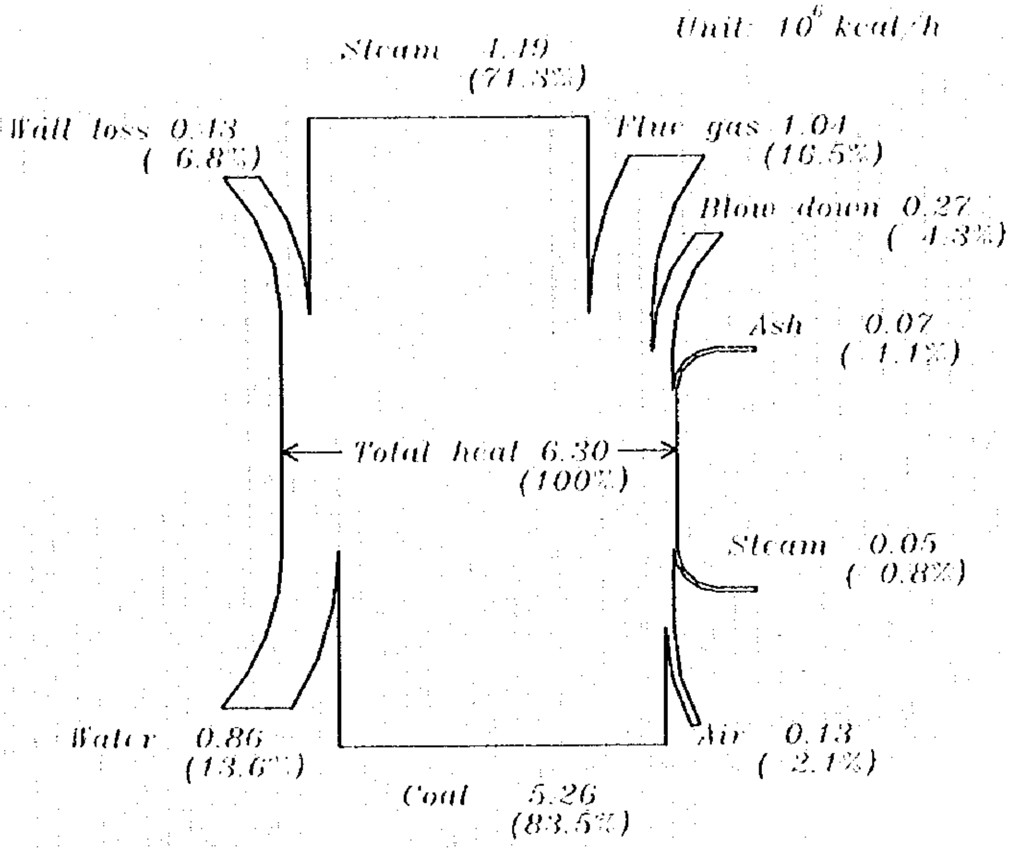


Figure 11-19 Energy Flowchart of Steam Boiler

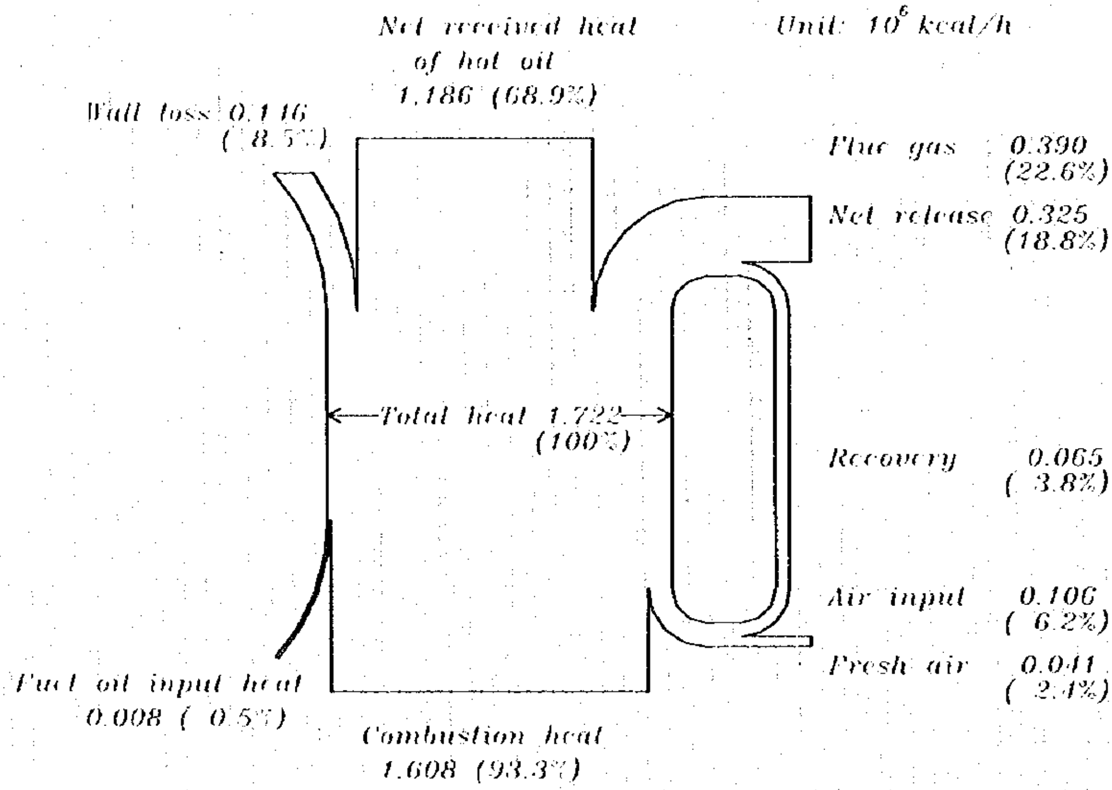


Figure 11-20 Energy Flowchart of Hot Oil Heater