UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

UNIDO

THE FINAL REPORT ON PROGRAMME FOR RATIONAL USE OF ENERGY RESOURCES
IN FOOD PROCESSING AND PLASTIC FORMING INDUSTRY IN INDIA AND PAKISTAN

ECCJ

UNITED NATIONS

INDUSTRIAL DEVELOPMENT ORGANIZATION

THE FINAL REPORT

ON

PROGRAMME FOR RATIONAL USE OF ENERGY RESOURCES

IN

FOOD PROCESSING AND PLASTIC FORMING INDUSTRY

IN

INDIA AND PAKISTAN

UNIDO Contract:95/056

Prpject No:US/RAS/94/044

The Energy Conservation Center, Japan

2

Contents

1. Preface

Excessive use of energy is one of the characteristics of many industrial plants in developing countries. This pattern of energy utilization is not sustainable. Therefore, it is imperative to introduce and disseminate information on modern energy conservation measures and technologies among the parties concerned in government and especially, at plant level. To fulfil these goals, UNIDO, with financial support from the Government of Japan, has been sponsoring a programme designed to increase awareness and knowledge of government officials and industrial users on rational use of energy saving technologies in developing countries.

In order to achieve the objectives of this programme, UNIDO has adopted the following strategy:

1. Conduct plant surveys to assess the existing technologies and operational practices, and to identify the necessary energy saving measures.

2. Prepare Handy Manuals on appropriate energy management and energy saving techniques and technologies.

3. Organize seminars to be attended by government officials, representatives of industries and plant managers, engineers and operators to:

   - present and discuss the content of the manuals, and
   - report on plant assessments and make recommendations for improvements.

4. Disseminate the manuals locally and to other developing countries.

The activities under this programme are carried out jointly by UNIDO and the Energy Conservation Center (ECC) of Japan, a subcontractor to UNIDO.

In 1995, the fourth project under this programme was implemented in India and Pakistan, targeting two energy intensive industrial sectors, food processing and plastic forming industries. This final report presents the output of the project.

2. Project Outline

The project goal was to increase awareness and knowledge among the concerned parties on rational use of energy saving technologies in food processing and plastic forming industries. The implementation strategy included the preparation of Handy Manuals on the targeted industries and the organization of seminars to facilitate information transfer. The project activities were conducted in the following chronological order:

<u>February 1995</u>

Assignment of two japanese experts in food processing and plastic forming industries

<u>March 1995</u>

Field survey on food processing and plastic forming industries in India and Pakistan by the experts

<u>May to October 1995</u>

Preparation of the draft Handy Manuals on food processing and plastic forming industries by the experts (Japan)

<u>October 1995</u>

Submission of three copies of the draft Handy Manuals to UNIDO for review and approval

<u>November 1995</u>

Holding of seminars in India and Pakistan to present and discuss contents of the manuals and the findings of the field surveys.

<u>September 1996</u>

Delivery of 600 copies of the finalized Handy Manuals to UNIDO

3. Evaluation of the seminars

In this section, an attempt is made to evaluate the seminars on the use of energy saving technologies in food processing and plastic forming industries in India and Pakistan, sponsored by the United Nations Industrial Development Organization (UNIDO) and the Ministry of International Trade and Industry (MITI), Japan, and organized by the Energy Conservation Center (ECC), Japan. The seminars were hosted by the Ministry of Petroleum and Natural Gas and the Ministry of Chemicals and Fertilizers of India and by the Pakistani Ministry of Water and Power. The first seminar was held on 6-7 May 1995, in Islamabad and the second on 14-15 May 1995, in New Delhi. About 60 participants from government agencies and private companies attended each seminar.

3.1 Energy situation in India

In India, coal accounts for 62% of energy supply, oil for 27% and natural gas for 7%. Coal production was 229 million tons in 1992, and is expected to reach 400 million tons by the year 2000. From 1970 to 1980, oil resources were developed rapidly and oil production was increased fourfold. Since 1985, oil production has remained steady. Natural gas is a by-product of oil production, and 30% of the produced natural gas is useless because of the lack of transport capacity and conversion equipment. 1992 consumption of commercial energy can be broken into industry 51%, residential/commercial 26% and transportation 22%. In recent years, electricity prices have been low due to over-production, and more than 20% of this electricity lost during transmission and distribution.

India's eighth five year plan predicts an energy saving of 5000 MWe which is equivalent to 6,000,000 tce per year and a new power plant capacity of 28,000 MWe, including 10,000 MWe from private power producers.

3.2 Energy situation in Pakistan

In Pakistan, the main energy resources are oil, natural gas and hydropower. Oil accounts for 42% of energy supply, natural gas for 36% and hydropower for 16%. Coal contribution is limited to 6%. The 1993 consumption of commercial energy can be broken down into industry 43%, residential/commercial 29% and transportation 29%.

Until 1940, coal accounted for 60% of energy supply but after the discovery of the Sui gas field in 1950, coal production was dramatically decreased. Current indigenous supply of oil and natural gas are sufficient to meet respectively 20% and 76% of current demand. Natural gas reserves are 661,500 million m^3 and the production was 17,800 million m^3 in 1994. Oil reserves are 197 millions of barrels and oil production was 20 million barrels in 1994. Oil consumption increases by 10% yearly. The Pakistani Government promotes the development of oil and natural gas resources by encouraging foreign investment.

In 1994, the Prime Minister task Force on energy recommended that energy efficiency should be one of the top priorities in mid- and long-term energy planning. The policy recommendations include rationalization of consumer-related policy and energy pricing, enactment of energy efficiency legislation, introduction of a policy which promotes use of energy-efficient modes of public transport (mass transit systems and railways), and introduction of five day week with no change in aggregate working hours.

In Pakistan, the promotion of energy conservation is the mandate of the National Energy Conservation Center (ENERCON) under the Ministry of Water and Power.

3.3 UNIDO Seminars

The UNIDO seminars were held with the aim of increasing awareness and knowledge of government officials and factory engineers in rational use of energy in food processing and plastic forming industries. Each seminar was attended by 60 participants.

The observation made by experts during the plant surveys were presented and the energy conservation measures documented in the Handy Manuals on energy conservation in food processing and plastic forming industries were discussed. The audience showed great deal of interest in the topics being presented, as reflected by their participation in the discussions.

3.4 Outputs and associated benefits

1) Participants mix:
The seminars were attended by a number of factory engineers who needed basic energy conservation know-how for factory operation. The seminars were also attended by plant managers and representatives from government and private sector. The extensive experience of ECC experts in various aspects of energy conservation was a relevant asset.

2) Government - Factories cooperation
The seminars facilitated a dialogue between government and private sector. This could be useful in future cooperation, as well as in establishing a better understanding among parties concerning the barriers and potential means to overcome them to achieve better energy management.

3) Transfer of information
The seminar provided potential opportunities for dissemination of information country-wide, as well as from India and Pakistan to other developing countries.

4) Contribution of the counterparts
Due to the efforts of the counterparts of both countries, a positive atmosphere was created to bring about awareness of the participants regarding energy conservation in the targeted industries.

5) Additional discussions
In addition to the core programme, discussions were held concerning the findings which arose from the field surveys and factory energy audit. This demonstration gave the participants a better understanding of different aspects of energy conservation.

3.5 *Participants input*

The participants were given the opportunity to evaluate the seminar through answering the following questionnaire:

1) Satisfaction concerning the subjects of the seminar
   - Very satisfied: 13%
   - Satisfied: 84%
   - Not satisfied: 3%

2) Availability to the job
   - Very available: 28%
   - Available: 66%
   - Not available: 6%

3) Difficulty of the contents of the seminar
   - Difficult: 0%
   - Medium: 81%
   - Easy: 19%

4) Useful topics in the seminar
   Energy management, outline of energy conservation, energy conservation technology in boilers and chillers, energy loss, waste heat recovery, demonstration of energy audit with measuring equipment, cleanliness in a food factory, recycling of plastic scrap, and relation between energy conservation and environment protection

5) Applicable technology at present
   - Combustion control by air ratio
   - Exhaust gas heat recovery in boilers
   - Energy conservation in chillers

3.6 *Potentials for propagation of energy conservation concept*

The energy conservation methods can be promoted though the following activities:

- Seminars on success stories in food processing and plastic forming industries

- Dissemination of information on energy conservation including energy audit through seminars and training programmes.

4. Schedule of the seminars

November	3	1995	Tokyo (12:00) to Islamabad (20.00) PK751
	4		Preparation of seminar
	5		Preparation of seminar
	6		Seminar, Food Processing Industry
	7		Seminar, Plastic Forming industry
	8		Factory observation
	9		Islamabad (10:15) to Lahore (11:20) PK381 Lahore (15:00) to delhi (16:40) PK270
	10		Preparation of seminar
	11		off day (Saturday)
	12		Off day (Sunday)
	13		Seminar, Food Processing Industry
	14		Seminar, Plastic Forming Industry
	16		Delhi (02:15) to Bangkok (07:35) TG915 Bangkok (11:10) to Tokyo (19:00) TG640

4.1 Seminar programme in Pakistan

6 November 1995, at Holiday Inn, Islamabad

Seminar on Energy Conservation Food Processing Industry

9:00-9:30	Registration
9:30-10:30	Opening Ceremony

Address by:

- Mr. A. Hassan Nazemi, Industrial Development Officer, Environment and Energy Branch, Industrial Sectors and Environment Division, United Nations Industrial Development Organization (UNIDO), Vienna, Austria.

- Mr. Shuhei Kojima, First Secretary, Embassy of Japan.

- Mr. Norio Fukushima, General Manager, International Cooperation Department, Energy Conservation Center (ECC), Japan.

- Mr. Arif Alauddin, Managing Director, National Energy Conservation Center (ENERCON), Ministry of Water and Power, Government of Pakistan

Main guest address by Mr. Arbab Ghulam Rahim, Parliamentary Secretary for Ministry of Water and Power, Government of Pakistan.

10:30-11:00	Refreshments
11:00-12:20	Energy Conservation in Food Processing industry (1)
12:30-14:00	Lunch
14:00-15-00	Energy Conservation in Food Processing Industry (2)
15:00-15-30	Coffee Break
15:30-16:30	Questions

7 November 1995, at Holiday Inn, Islamabad

Seminar on Energy Conservation in Plastic Forming Industry

9:00-9:30	Registration
9:30-10:00	Opening Ceremony Address by Mr. Arif Alauddin Address by Mr. Norio Fukushima Address by Mr. A. Hassan Nazemi
10:00-11:00	Energy Conservation in Plastic Forming industry (1)
11:00-11-30	Coffee Break
11:30-12:30	Energy Conservation in Plastic Forming Industry (2)
12:30-14:00	Lunch
14:00-15:00	Questions
15:00-15:40	Demonstration of Factory Energy Audit (1)
15:40-15:55	Prayer Time
15:55-17:00	Demonstration of Factory Energy Audit (2)
17:00	Closing
17:15	Refreshments

SEMINAR IN PAKISTAN

Picture on seminar (1)

Picture on seminar (2)

Seminar in Pakistan

4.2 Seminar programme in India

14 November 1995, at Holiday Inn, Crown Plaza, New Delhi

Seminar on Energy Conservation in Food Processing Industry

9:00-9:30	Registration
9:30-10:10	Opening Ceremony

Address by:

- Mr. J.K. Das, Executive Director, Petroleum Conservation Research Association (PCRA), India.

- Mr. Wilfred S. Nanayakkara, Country Director, United Nations Industrial Development Organization (UNIDO), India.

- Mr. Akira Tanji, First Secretary, Embassy of Japan.

- Mr. Norio Fukushima, General Manager, International Cooperation Department, Energy Conservation Center (ECC), Japan.

Main guest address by Dr. Vijay L. Kelkar, Secretary, Ministry of Petroleum and Natural Gas.

10:10-10:30	Coffee break
10:30-12:00	Energy Conservation in Food Processing industry (1)
12:00-13:30	Lunch
13:30-14:30	Energy Conservation in food Processing Industry (2)
14:30-15:00	Coffee Break
15:00-16:00	Questions
16:00	Closing

15 November 1995, at Holiday Inn, Crown Plaza, New Delhi

Seminar on Energy Conservation in Plastic Forming Industry

9:00-9:30	Registration
9:30-10:10	Opening

Address by:

- Mr. J.K. Das, Executive Director, Petroleum Conservation Research Association (PCRA), India.

- Mr. A. Hassan Nazemi, Industrial Development Officer, Environment and Energy Branch, Industrial Sectors and Environment Division, United Nations Industrial Development Organization (UNIDO), Vienna, Austria.

- Mr. Kanamaru, Representative, Japan External Trading Organization (JETRO), India.

- Mr. Norio Fukushima, General Manager, International Cooperation Department, Energy Conservation Center (ECC), Japan.

Main guest address by Shri N.R. Banerji, Secretary, Dept. of Chemicals and Petro-chemicals, Ministry of Chemicals and Fertilizers, Government of India.

10:00-12:00	Energy Conservation in Plastic Forming Industry
12:00-12:30	Questions
12:30-14:00	Lunch
14:00-16:00	Demonstration of Factory Energy Audit (1)
16:00-16:30	Coffee Break
16:30-17:30	Demonstration of Factory Energy Audit (2)
17:30	Closing

SEMINAR IN INDIA

Picture on seminar (1)

Picture on seminar (2)

Seminar in India

5. Schedule of the factory survey

No.	M	Day		Schedule
Mr. Fukushima, Mr. Honda and Mr. Asano				
1	May	14	Sun	12:20 lv. Narita (AI 301) 17:25 Ar. Delhi Meeting with counterpart PCRA
2		15	Mon	Visit to JETRO, Japan Embassy, PCRA and UNIDO
3		16	Tue	Survey at Mother Dairy (Milk), New Delhi Visit to Ministry of Petroleum and Natural Gas
4		17	Wed	Survey at Padmini Polymers (containers), New Delhi
5		18	Thu	Survey at Britania Industries (Bread, Cakes and Biscuits), New Delhi
6		19	Fri	Survey at Indo Lowenbrau Breweries Limited (Beer), New Delhi
7		20	Sat	Day off
8		21	Sun	Day off
9		22	Mon	Survey at Flex Industries (films), New Delhi
10		23	Tue	Visit to Ministry of Industry 18:00 Lv. Delhi (PK 271) 18:40 Ar. Lahore
11		24	Wed	07:00 Lv. Lahore (PK 612) 08:05 Ar. Islamabad Visit to ENERCON and Meeting with MD of ENERCON Meeting with Secretary of Ministry of Water and Power Meeting with ENERCON/UNIDO/UNDP Visit to Japan Embassay and JICA
12		25	Thu	survey at Tops Food and Beverages Ltd,. Hattar near Islamabad
13		26	Fri	Day off
14		27	Sat	Move from Islamabad to Lahore
15		28	Sun	Survey at Chaudry Dairies Ltd, near Lahore
16		29	Mon	Survey at Mitchells Fruit Farm Ltd., Ranala Khurd near Lahore
17		30	Tue	Survey at Thermosole Industries Ltd., Lahore Survey at Evergreen Plastic Industries (Pvt.) Ltd., Lahore
18		31	Wed	Meeting with ENERCON in Lahore
19	June	1	Thu	Meeting with ENERCON in Lahore 23:30 Lv. Lahore (TG 506)
20		2	Fri	06:10 Ar. Bangkok 11:00 Lv. Bangkok (TG 640) 19:00 Ar. Narita

6. Report of factory survey

Survey team: Mr. Fukushima, Mr. Honda, and Mr. Asano.
Survey period: 14 May to 2 june 1995

6.1 Food processing industries

Factory name	Mother Dairy	Britania Industry	Indo Lowenbrau Brewery
Place	Delhi	Delhi	Faridabad
Products	Liquid milk	Bread, cakes,biscuits	Beer
Annual sales	2,210 mil Rs	800 mil Rs	250 mil Rs
Fuel consumption	3,361 mil Rs	6,385 mil Rs	8.9 mil Rs
1) Furnace oil	610 kl/y	857 kl/y	1000 kl/y
2) Diesel oil		223 kl/y	440 kl/y
3) Coal	--------	-------	80 t/y
4) Natural gas	--------	-------	--------
Electric power	28,628 mil Rs	6,845 mil Rs	4,2 mil Rs
1) Electric consum.	9,513 MWh/y	2,852 MWh/y	1,8 MWh/y
2) Power factor	91.7 %	92 %	90 %
3) In-house generator	0	3 X 380 kVA	180+350+500 KW
Water consumption			
1) Underground water	586,049 t/y	24,000 t/y	210,000 t/y
2) City water	2,481 t/y	24,000 t/y	--------
Boiler			
1) Type	Fire tube	Fire tube	Fire tube
2) Number	1 set	2 sets	2 sets
3) Fuel	F.O.	F.O.	F.O./Coal
Energy use facility			
1) Chiller	12 sets		75 kW x4
2) Vacuum pan	-------	--------	--------
3) Heat exchanger	-------	--------	--------
Energy cost/sales	1.45 %	1.65 %	5.24 %
Energy intensity			

Energy conservation potential

Mother Dairy
1) Leakage of steam from connection valve of boiler
2) Insulation of valves
3) Low efficiency of chillers

Britania industries
1) Temperature control of baking furnace of bread: 20 deg. C. higher

Indo Lowenbrau Brewery
1) Insulation of valves
2) Heat recovery of molt pan
3) Low efficiency of chillers

Factory name	Tops Food & Beverages	Chaudry Dairies	Mitchell's Fruit Farm
Place	Hattar	Bhai Pheru	Renala Khurd
Products	Juice, jam, ketchup	Milk, dry milk	Ketchup, jam, squash, jelly
Annual sales	90 mil Rs	1,200 mil Rs	170 mil Rs
Fuel consumption	mil Rs	12,56 mil Rs	0,33 mil Rs
1) Furnace oil	---------	3,350 kl/y	60 kl/y
2) Diesel oil	--------	400 kl/y	20 kl/y
3) Coal	--------	-------	--------
4) Natural gas	Nm3	-------	--------
5) Fire wood	-------	-------	28,8 t/y
Electric power	0,559 mil Rs	13,38 mil Rs	0,9 mil Rs
1) Electric consum.	170 MWh/y	4,020 MWh/y	300 MWh/y
2) Power factor	90 %	95 %	90 %
3) In-house generator	0	2 x 380 kVA	350 kVA+250kVA
Water consumption			
1) Underground water	14,400 t/y	400,000 t/y	t/y
2) City water	-------	-------	--------
Boiler			
1) Type	Fire tube	Fire tube	Fire tube
2) Number	2 sets	4 sets	3 sets
3) Fuel	Natural gas	F.O.	F.O.
Energy use facility			
1) Chiller	-------		7.5 kW x 1
2) Vacuum pan	1 set		
3) Heat exchanger	1 set		
Energy cost/sales	%	2.16 %	0.72 %

Energy conservation potential

Tops Food & Beverages
1) Insualtion of tank
2) Recovery of drain
3) Waste heat recovery of boiler
4) Operation rate

Chaudry Dairy
1) Low efficiency of chiller
2) Insulation of valves
3) Insulation of boiler

Mitchell's Fruit Farm
1) Low speed of line
2) Insulation
3) No spare nozzle of boiler burner
4) Temperature of feed water of boiler
5) Modification of flash tank
6) Insulation of cocker

6.2 Plastic forming industries

Factory name	Padmini Polymers	Flex industries	Thermosole industries	Evergreen
Place	Sahdabad	Noida	Lahore	Lahore
Products	PET bottle, HDPE containers	Polyester films	Car parts, bottles	Household goods recycled plastic
Annual sales, mil Rs		1,080 mil Rs	12 mil Rs	20 mil Rs
Fuel consumption	0,63 mil Rs	12,56 mil Rs	0,33 mil Rs	
1) Furnace oil	---------	900 kl/y	--------	
2) Diesel oil	84 kl/y	2,250 kl/y	7 kl/y	
3) Coal	--------	-------	--------	
4) Natural gas	--------	-------	Nm3	
5) Fire wood	-------	-------	--------	
Electric power	5,94 mil Rs	13,38 mil Rs	0,55 mil Rs	1,8 mil Rs
1) Electric consum.	1,800 MWh/y	1,740 MWh/y	180 MWh/y	600 MWh/y
2) Power factor	90 %	90 %	90 %	80 % or less
3) In-house generator	3 X 250 KVA	2 X 3000 kW	100 kVA	--------
Water consumption				
1) Underground water	360 t/y	250,000 t/y	--------	t/y
2) City water	-------	-------	t/y	t/y
Fluid heater				
1) Type	-------	Fire tube	--------	--------
2) Number	-------	1 set	--------	--------
3) Fuel	-------	Diesel oil	--------	--------
Energy use facility				
1) HDPE process mach.	set	--------	3 sets	-------
2) PET process mach.	set	--------	-------	-------
3) Injection mach.	-------	--------	2 sets	8 sets
4) Film process	-------			
5) Crusher	-------	1 set	1 set	2 sets
6) Extruser	-------	-------	5 sets	
Energy cost/sales	%	2.4 %	7.3 %	9.0 %

Energy Conservation potential

1) Insulation of heater
2) Wire connection of heater
3) Power factor of transformer
4) Driving method of forming machine
5) Yield of products
6) Produciton control
7) Return of scrap
8) Increase of forming cycle: continuous operation
9) Finishing of mouse such s removal of fin
10) Maintenance of cooling tower
11) Water path of metal mold
12) Selection of forming machine suitable to products

7. Japanese experts list

7.1 Field survey

1) Mr. Norio Fukushima
Mechanical Engineer
General manager, International Cooperation Department,
Japan International Energy and Environment Cooperation Center,
The Energy Conservation center, Japan

2) Mr. Shiro Honda
Chemical Engineer, Consultant Engineer in Chemicla Engineering
Technical Adviser (Food processing expert),
The Energy Conservation Center, Japan

3) Mr. Kyoichi Asano
Chemical Engineer, Consultant Engineer in Chemical Engineering
Technical Adviser (Plastic molding expert),
The Energy Conservation Center, Japan

7.2 Seminar

1) Mr. Shiro Honda
Chemical Engineer, Consultant Engineer in Chemical Engineering
Technical Adviser (food processing expert),
The Energy Conservation Center, Japan

2) Mr. Kyoichi Asano
Chemical Engineer, Consultant Engineer in Chemical Engineering
Technical Adviser (Plastic molding expert),
The Energy Conservation Center, Japan

7.3 Home office

1) Mr. Norio Fukushima
Mechanical Engineer
General manager, International Cooperation Department,
Japan International Energy and Environment Cooperation Center,
The Energy Conservation center, Japan

2) Mr. Shiro Honda
Chemical Engineer, Consultant Engineer in Chemicla Engineering
Technical Adviser (Food processing expert),
The Energy Conservation Center, Japan

3) Mr. Kyoichi Asano
Chemical Engineer, Consultant Engineer in Chemical Engineering
Technical Adviser (Plastic molding expert),

8. Counterparts list

8.1 India

Mr. J.K. Das
Executive Director
Petroleum Conservation Research Association, India (PCRA)
(under Ministry of Petroleum and Natural Gas, Government of India)
1024, New Delhi House, 27, Barakhamba Road,
New Delhi, 110001
India
Phone: 91-11-3319066/3724498
Fax: 91-11-3715244

Mr. Niemal Shingh
Joint Secretary
Ministry of Petroleum and Natural GAs
Shastri Bhavan
Dr. Rajendra Prasad Road, New Delhi - 110001, India
Phone: 91-11-383-501
Fax: 91-11-384-787

8.2 Pakistan

Mr. Arif Alauddin
Managing Director,
National Energy Conservation Centre (ENERCON)
Ministry of Water and Power
ENERCON Buildint, SEctor G-5/2
Islamabad
Pakistan
Phone: 92-51-826001
Fax: 92-51-826003 92-51-214111

9. Conclusions and recommendations for follow-up actions

Energy conservation opportunities in food processing and plastic forming industries were identified In india and Pakistan through factories survey conducted in May in 1995 and seminars held in November 1995.

Our recommendations on the dissemination activities in energy conservation the following:

1) Dissemination activities in energy conservation technologies by Handy Manuals: the participants of the seminars may hold group meetings based on Handy Manuals in their companies.

2) Promotion of operation techniques improvement

   2.1 Food processing industry
      a) Temperature control of baking furnace
      b) Repair of steam leakage
      c) Combustion control of boilers

   2.2 Plastic forming industry
      a) Quality control of raw material
      b) Suitable molding methods
      c) Suitable heater connections
      d) Suitable cooling systems
      e) Reduction of idle time
      f) Improvement of yield

3) Promotion of equipment improvement

   3.1 Food processing industry
      a) Adoption of high efficiency chiller
      b) Waste heat recovery of baking furnaces and molt pans
      c) Insulation of tanks
      d) Recovery of condensate
      e) Increase of line speed

   3.2 Plastic forming industry
      a) Recycling of scrap
      b) Heat insulation of heating cylinder of molding machines
      c) Direct motor drive system of molding machines

Appendix 1. List of Surveyed Factories

Appendix 1. List of the Surveyed Factories

India

1) Food processing (three factories)

1. Mother Dairy
   Products: Milk
   Patpar Ganj, Delhi-110092
   Tel 2241991

2. Britania Industries Limited
   Products: Bread, Cake & Biscuit
   33, Lawrence Road, Delhi-110035
   Tel 7187184, 7189187
   Fax 11-7183499

3. United Brewried Limited
   (Unit: Indo Lowenbrau Breweries Limited)
   Products: Beer
   13/1, Mathura Road, Faridabad-121003
   Tel. 275300, 275364
   Fax. 276787

2) Plastic forming (two factories)

4. Padmini Polymers Ltd.
   Products: PET and HDPE Containers
   58/4, Site IV, Ind Area, Sahibabad
   Tel. 8771397, 8771411
   Fax. 8771410

5. Flex Industries Limited
   Products: Polyester film
   A-1, Sector-60, Noida-201301(U.P.)
   Tel. 011-89-35401
   Fax. 011-89-20099

Pakistan

1) Food processing (three factories)

1. Tops Food & Beverages
   (A Division of Murree Brewery Company Ltd.)
   Products: Juices, Squashes, Jams, and Tomato ketchup
   Plot No.14/1, Phase III, Industrial Estate, Hattar
   (Distt. Haripur) N.W.F.P
   Tel. 0595-617013, 617492

2. Chaudry Dairies Limited.
   products: Milk, Dry milk, Cream, and Butter
   62-K.M. Multan Road, Bhai Pheru (Kasur)
   Tel. 04943-3557,3558
   Fax. 04943-2857

3. Mitchell's Fruit Farms Ltd.
   Products: Ketchup, Squashes, Jams, Jellies, Toffees, Chilli garlic sauce, and Pickles
   Ranala Khurd, Distt. Olara
   Tel. 04443-3017 & 3018
   Fax. 92-4443-2416

2) Plastic forming (two factories)

4. Thermosole Industries (PVT) Ltd.
   Products: Plastic automobile & packing. Plastic bottles
   140-Main Industrial Area, Kot Lakhpat, Lahore
   Tel. 5117859/5115295
   Fax. 042-842189

5. Evergreen Plastic Industries (PVT) Ltd.
   Products: Household plastic goods and Recycled plastic
   16-K.M. Multan Road, Lahore
   Tel. 5839524

Appendix 2. Participants List of Seminar

Appendix 2. Participants List of the Seminar

New Delhi, India: 14 November 1995 (Food processing industry)

S.NO.	NAME	DESIGNATION	ORGANIZATION
1.	Ashok Chand	DGM	Dalmia Industries Ltd., New Delhi
2.	S.A. Rajamani	DGM	DFM Foods Ltd., Delhi
3.	B.L. Kapoor	Tech. Advisor	Pan Foods Ltd., New Delhi
4.	S.N. Mahindru	Sr. Consultant	Mahashian Di Hatti (P) Ltd., New Delhi
5.	Dr. E.K. Jayanarayanan	Head Brewer	Mohan Meakin Ltd., Ghaziabad
6.	N.K.Sawhney	DGM (OPS)	The Delhi Flour Mill Co. Ltd., Delhi
7.	G.S. Sandhu	MD	GMP Mech Engg (P) Ltd., Ludhiana
8.	A.S. Sekhon	Project Manager	Bindra Agro Inds. Corpn. Ltd., Chandigarh
9.	A.K. Gupta	Chief Engineer	Modi Vanaspati Mfg. Co., Modinagar
10.	P.L. Kaul	MD	Mariental India Pvt. Ltd., N. Delhi
11.	A.K.Khosla	Sr.MGR.(Process)	Mother Dairy, Delhi
12.	S.S.Bansal	Dy. Manager	Mother Dairy, Delhi
13.	T.V.Govindan	Sr.Plant Off.	Mother Dairy, Delhi
14.	S.K.Adlakha	Sr.Plant Off.	Mother Dairy, Delhi
15.	Dr .Anil Murgai	Consultant	Fluid Dynamics Research Group, N. Delhi
16.	Sisir Chowdhury	Works Engineer	Brittnnia Industries Ltd., Delhi
17.	Virendrra Pruthi	Maint. Engineer	Brittnnia Industries Ltd., Delhi
18.	R.C. Mahajan	Energy Economist	Energy Management Centre, New Delhi
19.	Satish Checker	Sr. Scientist (Food & Farm Prds)	Shriram Insstitute for Ind. Res., Delhi
20.	Satish Agarwal	MD	Induss Food Products & Equip. Ltd., Calcutta
21.	K.K. Vohra	Director	Phdcci, New Delhi
22.	D.R. Keswani	RM (M)	Crompton Greaves Ltd., New Delhi
23.	Pravin Khanna	Director	Super Snacks P Ltd., Gaziabad
24.	A.P. Khanna	General Manager	Swastik Biscuit Pvt. Ltd., Barabanki
25.	J.P. Jain	Executive	Swastik Biscuit Pvt. Ltd., Barabanki
26.	Shyan B Gupta	Partner	Delhi Oil Mills Co., New Delhi
27.	Rakesh Seth	Executive	Aumalut Biscuit Co. P Ltd., Kanpur
28.	Navin Khanna	MD	Aumalut Biscuit Co. P Ltd., Kanpur
29.	Vineet Virmani	MD	S P Vtrmani & Son (P) Ltd., New Delhi
30.	M. Sivaguru	Manager (Engg)	The TN Co. Milk Producers F Ltd., Madras
31.	M. Kasinathan	SG. DM (Engg)	The TN Co. Milk Producers F Ltd., Madras
32.	S.K. Surendiran	DM (Engg)	Ambattur Dairy, Madras
33.	R. Rathinam	DM (Engg)	Central Dairy, Madras
34.	P. Subbiah	Manager (P)	Salem Dairy, Salem
35.	Ramalingam	Manager (Engg)	Krishnagiri Dairy, Krishnagiri
36.	Muthiah	AM (Engg)	Madurai Dairy, Madurai
37.	Gnanasekaran	AM (Engg)	Erode Dairy, Erode
38.	Siddharth Singh	Secretary	Fed. of Biscuit Mfrs. of India, N. Delhi
39.	V.K. Sehgal	Director (HMD)	Bureau of Indian Standards, N. Delhi
40.	C.P. Puri	Jt. Dir. (HMD)	Bureau of Indian Standards, N. Delhi
41.	Pushpanathan	Factory Manager	Co-Co Products, Madras
42.	Badri Bishal Sarda	Director	Raichur Solvents Ltd., Raichur
43.	Dinesh C. Kanungo	GM (HO)	Modern Food Ind. (I) Ltd., New Delhi
44.	K.R. Nair	GM (DBU-II)	Modern Food Ind. (I) Ltd., New Delhi

45.	A.K. Rastogi	SEM (DBU-I)	Modern Food Ind. (I) Ltd., New Delhi
46.	D.D. Yadav	Mgr-Engg. (DBU-II)	Modern Food Ind. (I) Ltd., New Delhi
47.	Ravindran	Mgr-Engg. (FJBP)	Modern Food Ind. (I) Ltd., New Delhi
48.	B.P. Upadhyay	AM (HO)	Modern Food Ind. (I) Ltd., New Delhi
49.	A.K. Dass	AM (DBU-I)	Modern Food Ind. (I) Ltd., New Delhi
50.	Manoj K. Sunwal	Executive (DBU-I)	Modern Food Ind. (I) Ltd., New Delhi
51.	S.P. Sharma	Executive (DBU-II)	Modern Food Ind. (I) Ltd., New Delhi
52.	A.K. Pande	Executive (DBU-I)	Modern Food Ind. (I) Ltd., New Delhi
53.	Randhir Singh	Executive (Engg)	Modern Food Ind. (I) Ltd., New Delhi
54.	Lokesh Sharma	Plant Mgr	Pradeshik Co-Op Dairy Fed., Noida
55.	Manoj Limaye	Plant Mgr	Pradishik Co-Op Dairy Fed., Noida
56.	N.R. Singal	Manager (MSG)	National Dairy Dev. Board, New Delhi
57.	B.B. Raina	Executive (MSG)	National Dairy Dev. Board, New Delhi
58.	Hatim Bhai	Prop.	Top Products, Gujarat
59.	Subramanian	Chief Engr	Kavender Agro, WB
60.	P.L. Agarwal	Factory Mgr	Tim's Products, WB
61.		Addl DIR of Inds	Assam
62.	P.K. Kakoti	Dy. Director	NPC, Guwahati
63.	A.K. Sinha/ R. Deopon	Plant Mgr	Nalanda BiscuitS, WB
64.		Executive	Lucky Biscuits, WB
65.	Sahabbudin	Manager	Kar Agro Corn Prod Ltd, Karnataka
66.	Malikarjun	Executive	Kar Agro Corn Prod Ltd, Karnataka
67.	V.N. Awasthy	Shift Engr	Delhi Milk Scheme, Delhi
68.	P.K. MITTAL	Asst. Engr (C)	Delhi Milk Scheme, Delhi
69.		Executive	Godrej Foods Ltd.
70.		Executive	Vadilal Enterprises
71.	N.N. Mathur	Mgr-Services	Atash Industries, Noida
72.	J.K. Shah	Mgr-Process	Atash Industries, Noida
73.	V.G. Upadhyay	Prod. Mgr	Paam Eatables Ltd., Delhi
74.	Retd. Col. M Pratap	GM	Chand Fabricators, Badarpur
75.	MS. Meenakshi Panwar	Food Technologist	Chand Fabricators, Badarpur
76.	K.K. Mitra	Manager (M)	Lloyd Insulations (I) Ltd., New Delhi
77.	Kaushic Bose	Sr. Executive (M)	Lloyd Insulations (I) Ltd., New Delhi
78.	K.C. Gupta	Senior Official	Indo Lowenbrau Breweries Ltd., Fbd
79.	O.P. Babbar	Senior Official	Indo Lowenbrau Breweries Ltd., Fbd
80.	S.K. Jain	Area Leader	Indian Institute of Pet., Dehradun
81.	R.S. Dutt	CEO	Mount Shivalik Breweries, Chandigarh
82.	S.N. Chatterjee	Jt. Director	Cottage & Small Industries, WB
83.	D. Banerjee	Director	SIC, WB
84.	S.R. Asthata		Govt. of Bihar

New Delhi, India: 15 November 1995 (Plastic forming industry)

S.NO.	NAME	DESIGNATION	ORGANISATION
1.	Anil Agarwal	Owner	Plasticco, Delhi
2.	Ashok Sinha	Manager (Prod.)	Newpack Plastics Pvt. Ltd., Noida
3.	Rajesh Chawala	MD	Uphar Plastics Ltd., Delhi
4.	J.D. Bhatter	GM	Super Polyplast Pvt. Ltd., Kanpur
5.	Rajiv Khare	Officer	Flex Industries Ltd., Noida
6.	Pradeep Malik	Officer	Flex Industries Ltd., Noida
7.	S. Mandal	Officer	Flex Industries Ltd., Noida
8.	Manmeet Sing	Officer	Flex Industries Ltd., Noida
9.	Manoj Jhingan	Product Mgr. (PD)	Arctic India Sales, Delhi
10.	S.P. Jain	Director	Dipty Lal Judge Mal Pvt. Ltd., Delhi
11.	M.K. Gupta	Managing Director	Taj Plastic Udyog Pvt. Ltd., Delhi
12.	Parmod Goyal	Owner	Kamdhenu Plastics Industries, Delhi
13.	Sanjeev Kumar	Sr. Executive	Kamdhenu Plastics Industries, Delhi
14.	Ashok Kumar Chaudry	Chief Executive	Sam Components, Delhi
15.	S.K. Garg	Director	United services Pvt. Ltd., New Delhi
16.	Bharat Kukreja	Director	Consult Techniques (I) Pvt. Ltd., Faridabad
17.	Satish Checker	Sr. Scientist	Shriram Institute for Ind. Res., Delhi
18.	Shashank Jain	Engineer (EM)	Phdcci, New Delhi
19.	Sunit Gupta	Partner	Savera Enterprises, Delhi
20.	B.K. Shukla	Manager (Maint.)	Xpro India, Faridabad
21.	S.K. Hira	Engineer (Maint.)	Xpro India, Faridabad
22.	M.N. Pandita	Partner	Lords Polywears, Faridabad
23.	Y.R. Dhingra	Prop.	Duchem Engineers, Faridabad
24.	Arnold H. James	Manager (P&P Div.)	Kelvinator of India Ltd., Faridabad
25.	Chanderbhan	Jr. Manager	Kelvinator of India Ltd., Faridabad
26.	Anil Kamra	AM (M)	Crompton Greaves Ltd., New Delhi
27.	V.K Sehgal	Director (HMD)	Bureau of Indian Standards, N. Delhi
28.	C.P. Puri	Jt. Director (HMD)	Bureau of Indian Standards, N. Delhi
29.	Vikram Sahani	Prop.	Krishma Plastics, N. Delhi
30.	Virendra Singh	Dy. Secretary	Assocham, New Delhi
31.	Rajiv Sharma	MD	Gyan Packaging I P Ltd., Lucknow
32.	G.K. Srivastava	GM	Gyan Packaging I P Ltd., Lucknow
33.	P.K. Garg	Director	Garg Polymers, Kanpur
34.	I.P. Mishra	AM (E)	Kanpur Plastipack Ltd., Kanpur
35.	H.P. Sethi	Director	Jauss Polymers Ltd., New Delhi
36.	Pramod Pant	Vice-President (M)	Jauss Polymers Ltd., New Delhi
37.	S.S. Rana	GM (Opr.)	Jauss Polymers Ltd., New Delhi
38.	Vinit Khanna	Area Mgr (North)	Jauss Polymers Ltd., New Delhi
39.		Addl Dir of Inds	Assam
40.	P.K. Kakoti	Dy. Director	NPC, Guwahati
41.	Manish Bihany	Executive	Synthetic Moulder, WB
42.	S.K. Dutta	Executive	Synthetic Moulder, WB
43.	S.B. Lahoti	Partner	Lahoti Plastics, WB
44.	B.P. Khemka	Manager	Asiatic Plastics, WB
45.	B.S. Yadav	MD	Bryplast Pvt. Ltd., Ghazipur
46.	R.K. Dang	AGM	Jagatjit Ind. Ltd., Noida
47.	Raman Moglani	Director	Rasik Plast Ltd., Noida

48.		Executive	Rasik Plast Ltd., Noida
49.	Bir Singh Yadav	Mgr (Maint)	Supreme Industries Ltd., Noida
50.	Shalabh Sangal	AM (Prod.)	Supreme Industries Ltd., Noida
51.	Raviinder Jain	Partner	P.L. Industries, Delhi
52.	Sumati Jain	Partner	P.L. Industries, Delhi
53.	S.K. Jain	Area Leader	Indian Institute of Pet., Dehradun
54.	K.K. Seth	Partner	Bal Kishan & Co., Delhi
55.	M.M. Kohlt	Secretary	Association of Plastic Ind., Chandigarh
56	S.C. Sharma	President	Association of Plastic Ind., Chandigarh
57.	K.K. Mitra	Manager (M)	Lloyd Insulations (I) Ltd., New Delhi
58.	Kaushik Bose	Sr. Executive (M)	Lloyd Insulations (I) Ltd., New Delhi
59.	S.N. Chatterjee	Jt. Director	Cottage & Small Industries, WB
60.	D. Banerjee	Director	SIC, WB
61.	S.R. Asthata		Govt. of Bihar

Islamabad, Pakistan: 6 November 1995 (Food processing industry)

Islamabad, Pakistan: 7 November 1995 (Plastic forming industry)

S.No.	NAME	DESIGNATION
01.	Abdul Hameed	Sales Engineer
02.	Qari.M.Yousuf	
03.	Syed Mohsin Raza	Senior Engineer
04.	Mardan Ali	Principal Engineer
05.	Mujib Ullah Shah	Telecom Engineer
06.	Muhammad Hashim Khan	Researcher
07.	Khalid Mahmood	Telecom Engineer
08.	Iftikhar A. Raja	Consultant
09.	Dr. S. Hasan Ali Rizvi	Senior Engineer
10.	S. Salman Ahmed	
11.	Raja Mohammad Iqbal Satti	Chief Engineer
12.	Muhammad Akhtar Chaudry	General Manager (Tech)
13.	Muhammad Aslam Chaudry	Chief Executive
14.	Muhammad Hamed Khan	Tech. Services Manager
15.	Muhammad Alam	Executive
16.	Tariq Mahmood	Technician
17.	Izhar Hussain Athar	Senior Scientific Officer
18.	Khalid Mahmood	Consultant
19.	Dr. Basharat Hasan Bashir	Consultant
20.	Tasawar Hussan	SA-1 (DCC, PAEC)
21.	Mhammad Tahir	Assistant Engineer
22.	Tahir Muhammad	Research Officer (Mech. Engg)
23.	Salah-ud-Din	Engineer
24.	Muhammad Rafique	S.D.O. WAPDA
25.	Tariq Aziz	Senior Scientific Officer
26.	Zulfiqar A. Khan	Senior Engineer
27.	Zehra Abbas	Research Analyst
28.	Sajad Haider	Project Engineer
29.	Amir Qureshi	System Analyst
30.	Sadullah Hashmi	Factory Manager
31.	Dr. Ijaz Bashir	General Secretary
32.	Tokeer Ahmad Mughal	Director
33.	Najeeb Ahmed	Shift Engineer
34.	Kh. Munir Ahmad	Engineer Assistant
35.	Muhammad Javaid	Technician
36.	Tariq Mahmood	
37.	Muhammad Sudheer Tarique	Scientific Officer
38.	Syed Mohammad Owais Ahmed	Engineer
39.	Syed Ghazanfar Ali	Plant Protectionist
40.	Abdul Wahab Qureshi	Electrical Engineer
41.	Abdul Aziz	Cost Accounts Officer
42.	Tariq Mahmood	Dy. Engg. Advisor
43.	Sikandar Hayat	Field Assistant
44.	Muhammad Fahim Ashraf	Scientific Officer
45.	Muhammad Farooq	Site Engineer

46.	Nasir-ud-Din	Director Maintenance
47.	Tauqir Vaqar	Editor
48.	Shaukat Khan	Chief Executive
49.	A.H. Nazemi	Industrial Development Officer (UNIDO)
50.	Syed Baber Ali Shah	Engineer
51.	Bakht Muhammad	Student
52.	Raja Muhammad	A.S.M. (Bhoja Air)
53.	Jozer Lotia	Executive

Appendix 3. Opening Address of Chief Guest at the Seminar

INAUGURAL ADDRESS OF ARBAB GHULAM RAHIM, MNA
PARLIAMENTARY SECRETARY
MINISTRY OF WATER AND POWER
ISLAMABAD

EXCELLENCY FIRST SECRETARY
EMBASSY OF JAPAN
DISTINGUISHED GUEST
AND PARTICIPANTS !

I AM HONOURED TO BE HERE TODAY, IN THIS AUGUST GATHERING, TO INAUGURATE A WORKSHOP TO IDENTIFY THE ENERGY CONSERVATION OPPORTUNITIES IN THE FOOD PROCESSING AND PLASTIC FORMING INDUSTRIES. THIS WORKSHOP IS BEING HELD AT A MOST APPROPRIATE TIME, AS PAKISTAN TODAY FACES A MORE SERIOUS CHALLENGE IN THE AREA OF ENERGY THAN AT ANY OTHER TIME IN ITS HISTORY.

IN ORDER TO MEET THE RAPIDLY INCREASING DEMANDS FOR ENERGY, A LARGE PORTION OF FEDERAL DEVELOPMENT BUDGET IS NOW DIVERTED TO THE ENERGY SECTOR. AND IN SPITE OF THIS LEVEL OF COMMITMENT, FOUR OUT OF EVERY FIVE BARRELS OF OIL WE CONSUME ARE IMPORTED, WITH THE RESULT THAT IT TAKES ONE-FOURTH OF OUR EXPORT EARNINGS JUST TO PAY FOR OIL IMPORTS. THIS LEVEL OF FINANCIAL COMMITMENT, PLACES GREAT STRAINS ON SOCIAL PROGRAMS SUCH AS IMPROVED EDUCATION, HEALTH AND INFRASTRUCTURE DEVELOPMENT.

HOW HAVE OTHER DEVELOPING COUNTRIES MET THEIR ENERGY CHALLENGES. WE MUST LOOK AT SINGAPORE, WHICH IS 100% DEPENDENT UPON IMPORTED OIL FOR ITS ENERGY SUPPLY. AND KOREA, WHICH HAS FEWER ENERGY RESOURCES THAN PAKISTAN. HOW HAVE THESE AND SOME OTHER DEVELOPING NATIONS BEEN ABLE TO MAINTAIN THEIR ECONOMIC GROWTH IN SPITE OF HAVING FEW, IF ANY, LOCAL ENERGY RESOURCES.

THE ANSWER IS THAT THESE COUNTRIES RESPONDED QUICKLY AND DECISIVELY WITH AGGRESSIVE ENERGY CONSERVATION PROGRAMS. AS A RESULT, THESE COUNTRIES HAVE BEEN ABLE TO IMPROVE THEIR ECONOMIC PERFORMANCE BY IMPROVING THEIR ENERGY EFFICIENCY.

IT IS NOW TIME THAT PAKISTAN MAKES USE OF THE HUGE UNTAPPED CONSERVATION RESOURCE. ENERGY CONSERVATION MUST BE LOOKED AT AS ANOTHER "SUPPLY OPTION". INVESTMENT DECISIONS REGARDING CONSERVATION, BOTH, AT THE NATIONAL AND FIRM LEVEL, MUST BE MADE ON THE SAME ECONOMIC BASIS AS OTHER SUPPLY OPTIONS. IT IS ONLY IN THIS WAY THAT THE COUNTRY WILL ACHIEVE A "LEAST-COST" STRATEGY IN DEVELOPING ITS ENERGY RESOURCES.

I AM HAPPY TO SEE THAT PAKISTAN ENERGY CONSERVATION PROGRAM LED BY THE NATIONAL ENERGY CONSERVATION CENTRE (ENERCON) HAS BEEN WORKING WITH INCREASED INTENSITY AND HAS MADE FOR ITSELF A VERY SPECIAL PLACE IN THE NATIONAL ENERGY POLICY. I ALSO ACKNOWLEDGE THAT THIS YOUNG DYNAMIC ORGANIZATION NEEDS FURTHER

ENCOURAGEMENT BOTH FROM THE GOVERNMENT OF PAKISTAN AS WELL AS THE INTERNATIONAL COMMUNITY SO AS TO ALLOW IT TO MAKE THE CONTRIBUTIONS THAT IT HAS BECOME CAPABLE OF.

PAKISTAN'S LONG TERM ENERGY STRATEGY IS BASED ON ACHIEVING BALANCE AMONG OUR INCREASING NEEDS FOR ENERGY, OUR COMMITMENT TO A HEALTHIER AND CLEANER ENVIRONMENT, OUR DESIRE TO REDUCE DEPENDENCE ON IMPORTED SOURCES OF ENERGY, AND OUR DETERMINATION TO MAINTAIN THE MARKET ECONOMY SECOND TO NONE IN THE WORLD. PAKISTAN'S ENERGY POLICY WHICH HAS BEEN ACCEPTED AS A DYNAMIC POLICY IN THE WORLD CAN BE SUMMED UP IN THE THREE WORDS DEREGULATION, DECENTRALIZATION AND PRIVATIZATION. PAKISTAN'S ENERGY CONSERVATION POLICY IS BASED ON THE SAME PRINCIPLE.

WHEREAS, ENERCON'S PROGRAMMES IN THE INDUSTRY, TRANSPORT, BUILDINGS AND AGRICULTURAL SECTORS HAVE BEEN RECOGNIZED NATIONALLY, THIS WORKSHOP MARKS A BEGINNING TO A NEW ERA AS DEFINED BY THE MANAGING DIRECTOR, ENERCON. AN ERA OF INCREASED COOPERATION IN WORKING TOGETHER IN THE AREAS OF ENERGY CONSERVATION AND THE TECHNOLOGY TRANSFER FROM THE DEVELOPED TO THE DEVELOPING WORLD. THE NEED FOR ENERGY SAVING HAS BECOME A GLOBAL NEED. BOTH FROM THE ENERGY INDEPENDENCE AND ENVIRONMENT ASPECTS.

We hope to learn from the experience of MITI and ECC Japan, just as we learn from other energy conservation agencies to supplement our efforts in this noble cause.

I look forward to the results of this collaboration between the energy savings centres of two great countries, through the help of UNIDO.

In the end I would like to thank the management of ENERCON, Ministry of Industry and Trade International Japan, Energy Conservation Centre Japan and most importantly, the UNIDO for sponsoring, funding and organizing this workshop.

Thankyou.

SEMINAR ON ENERGY CONSERVATION IN FOOD PROCESSING INDUSTRY

VENUE : HOLIDAY INN
DATE : 14-11-1995

EXTRACT OF INAUGURAL ADDRESS BY
DR. VIJAY L.KELKAR, SECRETARY, MOP&NG

I am really happy that in an endeavour to improve the energy efficiency, UNIDO is kind enough to select India as one of the developing countries for such an important study through Energy Conservation Center, Japan with the co-operation of Petroleum Conservation Research Association.

Basically, the agro food industry hold the key to transformation of Indian agrarian economy. The new economic policy has give major thrust to this sector. However, to realise the full potential these industries are also to be competitive. Today with the opening up of our economy in consonance with the need of our times everyone of us has to endeavour to transform our country into an active player in the arena of global market. Within the openness of this globalised economy of today, it is imperative for all of us to give serious thoughts to improve the effectiveness with which we exploit our resources of energy.

The Indian food industry has been surviving on the same technology levels from the beginning. Hence, the products cannot compete because of poor product quality and production economies. Upgradation of technology, therefore, becomes essential.

It is an imperative that all out efforts are made to attach high importance to the selection of energy efficient and eco-friendly technologies which not only provide the quality upgradation to meet the international standards but also to meet and sustain the global competition. For this, the technology should be effective to reduce the input cost by way of minimising the wastage and improving the energy use efficiency. Hence, I will emphasise, while pursuing the hitech route for modernising our industry, adequate examination is necessary to make them energy efficient and sustainable under the Indian conditions and environment.

I am sure the seminar deliberation with the experts would definitely bring out meaningful conclusion, which will go a long way to improve the energy efficiency of the country.

Appendix 4. News Release on Seminar

WORKSHOP: The two-day workshop on Energy Conservation in Food Processing and Plastic Forming Industry will be inaugurated by Parliamentary Secretary for Water and Power, Arbab Ghulam Rahim at Holiday Inn, Islamabad, at 9.00 am.

The Nation

Monday,

November 6, 1995.

Workshop

ISLAMABAD: The two-day workshop on 'energy conservation in food processing and plastic forming industry' will be inaugurated by parliamentary secretary for water and power, Arbab Ghulam Rahim, at Holiday Inn, Islamabad, today at 9 a.m.

The workshop is being jointly organised by Enercon, ministry of water and power and energy conservation centre, Japan.

The United Nations Industrial Development Organisation (UNIDO) and ministry of international trade and industry, Japan are the sponsors of the workshop. — APP

The News

Monday

November 6, 1995.

Two-day workshop on Energy Conservation gets under way

ISLAMABAD, Nov. 6: The 2-day workshop on Energy Conservation, Food Processing and Plastic Forming Industries began here this morning. The workshop is being jointly organised by ENERCON, Ministry of Water and Power and Energy Conservation Centre, Japan.

Speaking at the inaugural ceremony, Parliamentary Secretary for Water and Power, Arbab Ghulam Rahim said that in order to meet the energy requirements of the country a full-fledged energy conservation programme must be formulated and followed. He expressed the hope that the steps being taken by ENERCON would achieve positive results with regard to energy conservation.

The Japanese First Secretary for Commerce and Development Mr. Shuhei Kojima in his brief address said that Japanese experts had prepared manuals about energy conservation, techniques in food processing and plastic forming industry which would be available for the participants of the workshop. He said that Japan also had to face energy crisis in the past and it was only through a proper energy conservation programme that it was able to overcome that crisis.

The Managing Director, ENERCON, Arif Alauddin, General Manager Energy Conservation Centre, Japan, Mr. Norio Fukushima and the Industrial Development Officer, UNIDO Mr. A. Hassan Nazemi also spoke on the occasion.

07 NOV 1995

Pakistan Times

ISLAMABAD.

07 NOV 1995 Pakistan Observer ISLAMABAD.

Parliamentary Secretary for Water and Power, Arbab Ghulam Rahim and MD Enercon, Arif Alauddin speaking at the inaugural ceremony of energy conservation workshop in Islamabad.

Workshop on conservation opens

Call for least-cost strategy in developing energy resources

ISLAMABAD (PPI)—Parliamentary Secretary for Water and Power, Arbab Ghulam Raheem has called for a least-cost strategy in developing energy resources.

Inaugurating the two-day workshop on "Energy conservation in food processing and plastic forming industry", he observed that this strategy can be designed only by taking investment decisions regarding energy conservation both at the local and the national level.

The workshop sponsored by United Nations Industrial Development Organisation (Unido), is jointly organised by National Energy Conservation Centre (Enercon) and Energy Conservation Centre (ECC) of Japan.

He said despite devoting a large portion of federal budget to the energy sector to meet rapidly increasing demands for energy, four out of five barrels of oil consumed is imported. As a result, one fourth of export earnings are paid for oil imports.

He regretted, "this level of financial arrangement places great strain on social programmes such as improved education, health and infrastructure development."

He said, "we must follow the example of countries who are 100 per cent dependent on imported oil for their energy supply but have been able to improve their economic performance by improving their energy conservation performance."

He maintained that Pakistan's long-term energy strategy is aimed at achieving balance between increasing needs for energy, commitment to a healthier and cleaner environment and desire to reduce dependence on imported sources of energy. Parliamentary Secretary for Water and Power said that Pakistan's energy policy which has been accepted as a dynamic policy in the world is based on the principles of deregulation, decentralisation and privatisation.

He said that the Enercon's programmes in the industry, transport, buildings and agriculture has been recognised nationally.

He observed that two-day workshop marks the beginning to a new era of increased cooperation in working together in the area of energy conservation and technology transfer from developed to developing world.

Norio Fukushima, General Manager ECC Japan said that the workshop is aimed at dissemination of energy conservation technologies for food processing and plastic forming industry.

Kojima, First Secretary for Commerce and Development in Embassy of Japan said that in April 1995, three-member team of ECC of Japan visited Pakistan under the auspices of the UNDP, jointly sponsored by the Unido and Japan's Ministry of International Trade and Industry (Miti) with an objective to promote private sector participation in delivering energy management services to local industries.

After concentration on two key industries including food processing and the plastic forming, the ECC of Japan team has once again come to Pakistan to convene a workshop and present manuals on energy conservation.

A Hassan Nazemi, representative of Unido said that one of the major jobs of the organisation is to provide guideline for taking energy conservation measures.

He stressed the need of awareness about energy saving technologies and practices among the government officials and industrial managers.

Arif Alauddin, Managing Director Enercon in his welcome address said that the improvement in energy performance in existing facility through cost-effective measures could reduce the need for the capital and for new facilities.

He said that the increasing demand of energy is disturbing implementation of projects regarding environmental protection.

پارلیمانی سیکرٹری برائے پانی و بجلی ارباب غلام رحیم اور انرکان کے ایم ڈی عارف علاؤالدین اسلام آباد میں توانائی کے بچاؤ کی ورکشاپ کی افتتاحی تقریب سے خطاب کر رہے ہیں

بجٹ کا بڑا حصہ توانائی کے شعبہ کو ترقی دینے کیلئے مختص ہے

انرکان جس پروگرام پر عمل کر رہا ہے اسکے حوصلہ افزا نتائج نکلیں گے

جاپان اپنے تجربات سے دیگر ممالک کی مدد کا خواہاں ہے، ورکشاپ سے ارباب غلام رحیم اور مقررین کا خطاب

اسلام آباد (وقائع نگار) وفاقی پارلیمانی سیکرٹری برائے پانی و بجلی ارباب غلام رحیم نے کہا ہے کہ ملک بھر میں توانائی کی بڑھتی ہوئی مانگ کو پورا کرنے کی غرض سے قومی بجٹ کا ایک بہت بڑا حصہ توانائی کے ادارے انرکان کو ترقی دینے کے لئے مختص کیا جاتا ہے وہ پیر کے روز وزارت پانی و بجلی اور کوجیپا کے زیر اہتمام فوڈ پراسیسنگ اور

باقی صفحہ 7 کالم 5 پر

بقیہ۔ مقررین خطاب

پلاسٹک سازی میں توانائی کی بچت کے موضوع پر دو روزہ ورکشاپ سے بطور مہمان خصوصی خطاب کر رہے تھے انہوں نے کہا کہ ملک میں تیل کی ضروریات پوری کرنے کیلئے ہمیں زیادہ تر درآمدات پر انحصار کرنا پڑتا ہے جو بیش قیمت زر مبادلہ کے کا موجب بن رہا ہے پاکستان میں مختلف سطح پر توانائی کی بچت اور بہتر استعمال کے لئے انرکان کا ادارہ جس پروگرام پر عمل کر رہا ہے وہ حوصلہ افزا نتائج کے حصول کا باعث ہو گا ورکشاپ سے خطاب کرتے ہوئے جاپانی سفارت خانے کے فرسٹ سیکرٹری برائے تجارت و ترقی شوہی نے کہا کہ پاکستان کی طرح جاپان کو بھی ماضی میں توانائی کے بحران کا سامنا کرنا پڑا اور اس مسئلے کا حل توانائی میں بچت کے منصوبے پر عمل در آمد سے ہی حاصل ہوا تھا انہوں نے کہا کہ جاپان میں بھی ادارہ بچت توانائی نے مختلف صنعتوں میں توانائی کی بچت کے منصوبہ پر کام کیا اور بہتر نتائج حاصل کئے انہوں نے کہا کہ جاپان اپنے تجربات سے دوسرے ممالک کی مدد کا بھی خواہاں ہے ورکشاپ سے ایم ڈی انرکان عارف علاؤالدین اور اقوام متحدہ کے ادارہ برائے صنعتی ترقی کے نمائندہ حسن کاظمی نے بھی خطاب کیا۔

PAKISTAN

NOVEMBER 7, 1995.

Workshop on energy conservation

ISLAMABAD: The 2-day workshop on energy conservation in food processing and plastic forming industries began here on Monday. The workshop is being jointly organised by ENERCON, Ministry of Water & Power and Energy Conservation Centre, Japan.

Speaking at the inaugural ceremony, Parliamentary Secretary for Water and Power, Arbab Ghulam Rahim, said that in order to meet the energy requirements of the country a full-fledged energy conservation programme must be formulated and followed. He expressed the hope that the steps being taken by ENERCON would achieve positive results with regard to energy conservation.

The Japanese first Secretary for Commerce & Development Shuhei Kojima in his brief address said that Japanese experts had prepared manuals about energy conservation techniques in food processing and plastic forming industry which would be available for the participants of the workshop. He said that Japan also had to face energy crisis in the past and it was only through a proper energy conservation programme that Japan was able to overcome that crisis.

The Managing Director, ENERCON, Arif Alauddin, General Manager Energy Conservation Center, Japan, Norio Fukushima and the Industrial Development Officer, UNIDO, A. Hassan Nazemi also spoke on the occasion.—APP

BUSINESS RECORDER

THE NATION
ISLAMABAD

Least-cost way for developing energy resources urged

ISLAMABAD (PPI) – Parliamentary Secretary for Water and Power, Arbab Ghulam Raheem has called for a least-cost strategy in developing energy resources.

Inaugurating the two-day workshop on "Energy Conservation in Food Processing and Plastic Forming Industry", he observed that this strategy can be designed only by taking investment decisions regarding energy conservation both at the local and the national level.

The workshop sponsored by the Untied Nations Industrial Development Organisation (UNIDO), is jointly organised by National Energy Conservation Centre (ENERCON) and Energy Conservation Centre (ECC) of Japan.

He said despite devoting a large portion of federal budget to the energy sector to meet rapidly increasing demands for energy, four out of five barrels of oil consumed is imported. As a result, one fourth of export earnings are paid for oil imports.

He regretted "This level of financial arrangement places great strain on social programmes such as improved education, health and infrastructure development".

He said "We must follow the example of countries who are 100 per cent dependent on imported oil for their energy supply but have been able to improve their economic performance by improving their energy conservation performance".

He maintained that Pakistan's long term energy strategy is aimed at achieving balance between increasing needs for energy, commitment to a healthier and cleaner environment and desire to reduce dependence on imported sources of energy.

The Parliamentary Secretary said that Pakistan's energy policy which has been accepted as a dynamic policy in the world is based on the principles of deregulation, decentralisation and privatisation.

He said that the ENERCON's programmes in the industry, transport, buildings and agriculture has been recognised nationally.

He observed that the two-day workshop marks the beginning to a new era of increased cooperation in working together in the area of energy conservation and technology transfer from developed to developing world.

Mr Norio Fukushima, General Manager of ECC, Japan said that the workshop is aimed at dissemination of energy conservation technologies for food processing and plastic forming industry.

Mr Kojima, First Secretary for Commerce and Development in Embassy of Japan said that in April 1995, three-member team of ECC of Japan visited Pakistan under the auspices of the UNDP, jointly sponsored by the UNIDO and Japan's Ministry of International Trade and Industry (MITI) with an objective to promote private sector participation in delivering energy management services to local industries.

After concentrating on two key industries including food processing and the plastic forming, the ECC of Japan team has once again come to Pakistan to convene a workshop and present manuals on energy conservation.

A. Hassan Nazemi, representative of UNIDO said that one of the major jobs of the organisation is to provide guideline for taking energy conservation measures.

He stressed the need of awareness about energy saving technologies and practices among the government officials and industrial managers.

Press Information Department

07 Nov

THE NEWS
RAWALPINDI.

Arbab for a cost-effective energy conservation plan

PPI

ISLAMABAD: We need to evolve a cost-effective strategy for developing the country's energy resources, said parliamentary secretary for water and power, Arbab Ghulam Raheem, while inaugurating a two-day workshop on 'Energy conservation in food processing and plastic forming industry,' here on Monday.

Sponsored by the United Nations Industrial Development Organisation (UNIDO), the workshop has been jointly organised by the National Energy Conservation Centre (Enercon) and the Energy Conservation Centre (ECC) of Japan.

Arbab Ghulam said, inspite of devoting a large portion of the federal budget to the energy sector to be able to meet the rapidly increasing demands for energy, four out of five barrels of oil consumed is imported. As a result, one-fourth of the export earnings are paid for oil imports.

"This financial arrangement places immense strain on other social programmes such as improved education, health and infrastructure development. We must follow the example of countries which are 100 per cent dependent on imported oil for their energy supply but have been able to improve their economic performance by improving their energy conservation performance."

Arbab Ghulam maintained that Pakistan's long-term energy strategy is aimed at striking a balance between increasing needs for energy, commitment to a healthier and cleaner environment, and the desire to reduce dependence on imported sources of energy.

Speaking on the occasion, Norio Fukushima, general manager ECC Japan, said the workshop aims to disseminate energy conservation technologies for food processing and plastic forming industry. Mr. Kojima, first secretary for commerce and development in the embassy of Japan, said that in April 1995, a three-member team of the ECC visited Pakistan under the auspices of the UNDP to promote private sector participation in delivering energy management services to local industries. After concentrating on two key industries including food processing and plastic forming, the ECC team has once again come to Pakistan to convene a workshop and present manuals on energy conservation.

A Hassan Nazemi, the representative of UNIDO, said one of the major jobs of the organisation is to provide guidelines for taking energy conservation measures. He stressed the need of awareness about energy saving technologies and practices among governmet officials and industrial managers.

In his welcome address, Arif Alauddin, managing director of Enercon said, improvement in energy performance in existing facility through cost-effective measures could reduce the need for capital and for new facilities. He said, the increasing demand for energy is disturbing implementation of projects pertaining to environmental protection.

Workshop on energy ends

ISLAMABAD, Nov 7 (APP): A two-day workshop on 'Energy Conservation in Food Processing and Plastic Forming Industry' concluded Tuesday.

Senator Waqar Ali Khan, who was the chief guest at the concluding ceremony, lauded the cooperation from the Japan government and United Nations Industrial Development Organisation (UNIDO) for the successful holding of the workshop.

THE MUSLIM

WEDNESDAY

NOVEMBER 8, 1995

Energy conservation workshop ends

ISLAMABAD (PPI) – Chairman Task Force on Energy and Environment Senator Waqar Ali Khan has said Pakistan highly values Japanese cooperation in energy conservation and related technologies.

He was addressing at the concluding ceremony of a two-day workshop on energy conservation in food processing and plastic forming industries" jointly organised by the National Energy Conservation Centre (ENERCON) and the Energy Conservation Centre (ECC) of Japan here on Tuesday night.

He said good products are manufactured under good environment therefore it is extremely important to maintain good environment at the factories. He asked the engineers, managers, technicians and specialists in the industries to implement their experience at their work place, he hoped that Japanese experience will be emulated here. Earlier A. H Nazemi, the representative of UNIDO commended the expertise of Japanese lecturers Mr Asano and Mr Honda for presenting well-formated years of experience in respective fields.

THE NATION

WEDNESDAY

NOVEMBER 8, 1995.

Kelkar calls for energy conservation

ENS ECONOMIC BUREAU

NEW DELHI, Nov 14: Dr Vijay L Kelkar, Secretary, Ministry of Petroleum and Natural Gas, has emphasised the imperative need for energy conservation in the context of the prevailing economic situation in the country.

He also stressed the need for the selection and adoption of eco-friendly energy efficient technologies which would be sustainable under the Indian conditions and environment.

INDIAN EXPRESS.

15/11/95.

Appendix 5. Seminar Pamphlet

Lecturer profile

Mr Norio Fukushima (Factory audit)
General Manager
International Cooperation Department
The Energy Conservation Center, Japan

Mr. Shiro Honda (Food processing expert)
Technical Advisor
The Energy Conservation Center, Japan

Mr Kyoichi Asano (Plastic forming expert)
Technical Advisor
The Energy Conservation Center, Japan

ENERCON offers a number of services to industry: industrial energy surveys, project feasibility studies, information on financing packages, demonstration projects and training courses such as this one.

For more information contact:

Deputy Chief (Training & Outreach)
ENERCON
ENERCON Building, Sector G-5/2
Islamabad (Pakistan)
Tel: 829022 / 826005
Fax: 51-826003

ENERCON

BOOK POST

ENERGY EFFICIENCY IS OUR BUSINESS

ENERCON

Workshop on Energy Conservation in Food Processing and Plastic Forming Industry

6-7 November 1995

Holiday Inn, Islamabad

Sponsored by
United Nations
Industrial Development Organization
(UNIDO)
&
Ministry of International Trade and Industry,
Japan (MITI)

Organized jointly by
The Energy Conservation Centre, Japan
&
National Energy Conservation Centre,
Ministry of Water and Power, Pakistan

INTRODUCTION

Energy Conservation aims at producing increased output with the same energy inputs and promoting economic efficiency by improving the productivity and competitiveness of energy - consuming enterprises.

In the developing countries, Energy Conservation can serve as an excellent vehicle for promoting industrial sector development by decreasing both the growing shortages of power supply and capital constraints of building new generating capacity.

In Pakistan the National Energy Conservation Centre (ENERCON) has been a forerunner in organizing and carrying out programs to promote energy efficiency in various sectors of national economy and in creating awareness on the subject.

This workshop on "Energy Conservation in Food Processing and Plastic Forming Industry" has been organized jointly by ENERCON and Energy Conservation Centre (ECC), Japan, with assistance from United Nations Industrial Development Organisation (UNIDO).

Workshop Objective

To promote energy conservation and accelerate technology transfer in food processing and plastic forming industry through lecture discussion supplemented with reference manuals.

PROGRAM

Energy Conservation in Food Processing Industry

Monday, 6 November 1995

9:00-9:30	Registration
9:30-10:30	Opening Ceremony
10:30-11:00	Refreshments
11:00-12:30	Workshop Session I
12:30-14:00	LUNCH
14:00-15:00	Workshop Session II (Continued)
15:00-15:30	COFFEE BREAK
15:30-16:30	Questions and Answer

Energy Conservation in Plastic Forming Industry

Tuesday, 7 November 1995

9:00-9:30	Registration
9:30-10:30	Workshop Session I
10:30-11:00	COFFEE BREAK
11:00-12:00	Workshop Session II (Continued)
12:00-13:30	LUNCH
13:30-14:30	Questions and Answer
14:30-17:00	ECCJ Energy Audit Workshop. Demonstration of factory audit by measuring devices
17:00	Closing ceremony
17:15	Refreshments

REGISTRATION CARD

Please return the card by 30th October, 1995

Please mark your attendance with O
1. First day (Food Processing)
2 Second day (Plastic Forming)

(Kindly print in block letters)

NAME :

JOB TITLE/POSITION :

COMPANY :

OFFICE ADDRESS :

OFFICE TELE/FAX NO :

Please return this card to:

Mr. Zakir Hussain Shah, Deputy Chief(T&O)
National Energy Conservation Centre
(ENERCON)
Ministry of Water and Power,
ENERCON Building, G-5/2,
Islamabad (Pakistan)

Tele: 829022
826005 Ext. 3120
Fax: 92-51-826003

PLEASE RETURN THIS CARD TO

Mr. S.K. Ghosh, Manager
Petroleum Conservation Research Association
1007, New Delhi House
27, Barakhamba Road
New Delhi - 110001

FACULTY PROFILE

Mr. Norio Fukushima (Factory Audit expert)
General Manager
International Cooperation Department
The Energy Conservation Center, Japan

Mr. Shiro Honda (Food Processing expert)
Technical Advisor
The Energy Conservation Center, Japan

Mr. Kyoichi Asano (Plastic Forming expert)
Technical Advisor
The Energy Conservation Center, Japan

OTHER DETAILS

- No registration fee for participation.
- Last date for receipt of registration forms - 30. 10. 1995.
- Participants are to arrange their own transport, accommodation etc. for attending the seminar.

Produced by Macro Graphics

Seminar
on
Energy Conservation
in
Food Processing
and
Plastic Forming Industries

Sponsored by

United Nations Industrial Development Organization (UNIDO) & *Ministry of International Trade and Industry, Japan (MITI)*

Organized by
The Energy Conservation Center, Japan

Cooperated by
Petroleum Conservation Research Association
(Under Ministry of Petroleum and Natural Gas, Government of India)

14-15 November, 1995
at
Hotel Holiday Inn, Crown Plaza, New Delhi

INTRODUCTION

Energy Conservation aims at producing increased output with the same energy inputs and promoting economic efficiency by improving the productivity and competitiveness of energy - consuming enterprises.

In the developing countries, Energy Conservation can serve as an excellent vehicle for promoting industrial sector development by decreasing both the growing shortages of power supply and capital constraints of building new generating capacity.

In Pakistan the National Energy Conservation Centre (ENERCON) has been a forerunner in organizing and carrying out programs to promote energy efficiency in various sectors of national economy and in creating awareness on the subject.

This workshop on "Energy Conservation in Food Processing and Plastic Forming Industry" has been organized jointly by ENERCON and Energy Conservation Centre (ECC), Japan, with assistance from United Nations Industrial Development Organisation (UNIDO).

Workshop Objective

To promote energy conservation and accelerate technology transfer in food processing and plastic forming industry through lecture discussion supplemented with reference manuals.

PROGRAM

Energy Conservation in Food Processing Industry

Monday, 6 November 1995

9:00-9:30	Registration
9:30-10:30	Opening Ceremony
10:30-11:00	Refreshments
11:00-12:30	Workshop Session I
12:30-14:00	LUNCH
14:00-15:00	Workshop Session II (Continued)
15:00-15:30	COFFEE BREAK
15:30-16:30	Questions and Answer

Energy Conservation in Plastic Forming Industry

Tuesday, 7 November 1995

9:00-9:30	Registration
9:30-10:30	Workshop Session I
10:30-11:00	COFFEE BREAK
11:00-12:00	Workshop Session II (Continued)
12:00-13:30	LUNCH
13:30-14:30	Questions and Answer
14:30-17:00	ECCJ Energy Audit Workshop. Demonstration of factory audit by measuring devices
17:00	Closing ceremony
17:15	Refreshments

REGISTRATION CARD

Please return the card by 30th October, 1995

Please mark your attendance with O
1 First day (Food Processing)
2 Second day (Plastic Forming)

(Kindly print in block letters)

NAME :

JOB TITLE/POSITION :

COMPANY :

OFFICE ADDRESS :

OFFICE TELE/FAX NO :

Please return this card to:

Mr. Zakir Hussain Shah, Deputy Chief(T&O)
National Energy Conservation Centre (ENERCON)
Ministry of Water and Power,
ENERCON Building, G-5/2,
Islamabad (Pakistan)

Tele: 829022
826005 Ext. 3120
Fax: 92-51-826003

Appendix 6. Terms of Reference for Subcontractor

2 September 1994

ENERGY CONSERVATION AND ENERGY SAVING TECHNOLOGIES IN THE PLASTIC FORMING AND FOOD PROCESSING INDUSTRIES OF (INDIA AND PAKISTAN)

TERMS OF REFERENCE FOR SUBCONTRACTOR

I. Project objective

To increase the awareness and knowledge of government officials and industrial users on appropriate energy-saving technologies in the plastics forming and food processing industries in India and Pakistan.

II. Background information

The current pattern of energy utilization in developing countries is not sustainable, since the excessive use of energy is one of the characteristics of many industrial plants in these countries. Therefore, it is necessary to introduce and disseminate information about modern appropriate energy conservation/saving technologies among the parties concerned in governments and especially, at plant-level in industries in developing countries.

In December 1983, UNIDO organized a Regional Meeting on Energy Consumption in Small and Medium Industries and an Expert Group Meeting on Exchange of Experience on Energy Conservation in Small and Medium Industries for Asian countries. During the meeting, it was revealed by some countries that for several energy-intensive industries (e.g iron and steel, pulp and paper, glass, cement and ceramic, and chemical industries), a saving of up to 10% on the energy consumption could be achieved through basis house-keeping improvements in terms of auditing and energy management. Larger savings could be achieved (up to 30% in a period of about 2-3 years) through the application of energy-saving technologies by retrofitting, installation of control mechanisms and simple process changes.

The Fourth General Conference of UNIDO, held in August 1984, advocated UNIDO's assistance to developing countries in their effort to achieve rational use of energy in industry and in obtaining energy from new and renewable sources. To achieve environmentally sound industrialization for developing countries, UNIDO is now being strongly called upon to systematically integrate energy-management and energy-saving components into technical cooperation projects.

In 1990, UNIDO started a new programme on the Rational Use of Energy-Saving Technologies and, in 1991, a first project -US/RAS/90/075 "Programme for Rational Use of Energy in Iron and Steel and Textile Industry" - was approved, financed by the Government of Japan. In-plant surveys, seminars and demonstration of factory audits and the application of appropriate technologies for the effective use of energy were conducted by Japanese and UNIDO specialists in Malaysia and Indonesia. As a result of this programme, a Handy Manual to provide guidelines on Energy-Saving Technologies for Iron and Steel and Textile Industries has been prepared. The manuals, currently available in English, are in process of translation into French and Spanish in order to be disseminated to other developing countries in Asia, Africa and Latin America.

The success of this promotional activity prompted UNIDO to request the support of the Government of Japan to carry out a similar project under this Programme. A second project was approved for the Rational Use of Energy-Saving Technologies in Pulp and Paper and Glass Industries in the Philippines and Thailand, where many of the above-mentioned industries were found, and human resources as well as technological levels were adequate for applying energy conservation technologies. In addition UNIDO was providing some assistance in the area of energy management. Also, strong counterpart institutions were available. Surveys were carried out and the seminars and demonstration through factory audits were carried out in February 1993. Also, handy manuals for energy-saving technologies in the pulp/paper and glass industries have been prepared and will be widely disseminated in three languages.

After two experiences and after an assessment by UNIDO and the Japanese counterpart on the results and multiplier effects of this programme in developing countries, it was agreed, in principle, to submit a new project for energy conservation and the rational use of Energy-Saving Technologies in Food Processing and Plastic Forming Industries in India and Pakistan. There exist number of industries in these industrial sectors in both countries, but still the aspect of conservation of energy is in some way neglected, much energy is wasted and it is necessary to assist them to utilize appropriate techniques to avoid this. This is the reason why UNIDO has selected these two industrial branches in the two countries for the next project. Also, a strong and adequate counterpart has been identified and human resources as well as technological levels are adequate for introducing energy conservation technologies.

Under this programme, India and Pakistan as well as other developing countries will benefit at the end of the project from UNIDO's experience in promoting and applying energy-saving technologies in the food processing and plastic forming industries, with a multiplier effect in the industrial and technology process development as well as in the environment conservation in these countries.

III. Scope of contracting service

A. As soon as possible following award of the contract, the Contractor's Team Leader will visit Vienna for a 2 day briefing by concerned technical staff in UNIDO's Industrial Sectors and Environment Division, and also by UNIDO's contracts section.

B. The Team Leader will then proceed to the field to join his/her colleagues (see paragraph G) where the team will undertake a survey of plastic forming and food processing industries to identify needs in respect of energy conservation and energy savings technologies. The survey will be based on plant visits and discussions with the national counterpart and specialised institutions list in Annex I attached herewith. Plants should be selected following consultation with these institutions. It is expected that the survey will require 3 weeks of field work.

The surveys should include detailed analyses of the energy consumption of installed plant and process. While executing the surveys the contractor's team will compile a list of technical issues concerning energy conservation and energy saving technologies in the industries of concern in India and Pakistan. These issues, (in the form of questions to which the national counterparts have requested answers), should be prioritized prior to the team's departure from each country.

C. On completion of field work the Team Leader should visit Vienna for detailed discussion of the team's findings and agreement with UNIDO technical staff on the content of the manual. The manual should present information (energy conservation techniques and energy efficient technologies) prepared in response to questions raised during the field surveys. Subjects to be covered and depth of coverage will be a matter for discussion during the discussion at UNIDO HQ.

D. In close co-operation with the national counterparts, two-days' seminars will be held in each country for top executives, middle level managers, government officials, engineers and technicians, and people responsible for the production process and policies regarding energy saving aspects in the concerned industries of the two countries as well as other Asian countries. The seminar lecturers will come from the subcontracted organization, from the counterparts in India and Pakistan as well as from UNIDO HQ.

E. UNIDO expects the subcontractor to prepare 600 copies each of the manuals in English on energy conservation/saving technologies in plastic forming and food processing industries, for the use of technical operators in improving energy efficiency practices at the plant level in developing countries. The two manuals will describe the selected energy conservation subjects according to the following frameworks:

Manual 1 - Plastic Forming Industry

Practically all plastics transformation technologies are based on the shaping of melted polymers in cold moulds.

There are several technical sub-sectors or areas in the plastics processing industry where energy consumption can be reduced:

- Proper design of moulds for extrusion, injection moulding, thermo-forming, blow moulding, transfer (press) moulding technologies in terms of organizing optimal cooling parameters of the moulds.
- Optimal selection of raw materials in terms of their melting point (which is directly dealing with the level of energy consumption) against required performance properties of the end products.
- Optimization of energy use by the main transformation equipment (e.g. extruders, injection moulding machines, etc.).
- Optimization of working energy parameters of supporting equipment (e.g. water chillers, motors, pumps, etc.).
- Introducing where possible, advanced closed heating-cooling systems (e.g heat pumps, heat pipes, etc.) design for use of secondary heat.
- Development and application of energy saving technologies for plastics wastes recycling.

There are thousands of plastics processing enterprises in Pakistan and India which belong to small-scale or medium-scale industries. Presently there is no proper established system in this sector in terms of required technical services, trouble shooting, quality control, energy auditing, etc.

Manual 2 - Food Processing

Two different approaches can be followed for the preparation of the manual on food processing. The final reflection should be a result of the discussion between counterpart, consultancy institution and UNIDO.

i) Either one given sub-sector (out of the 21 most relevant in the two countries) is selected and a specific document prepared; or

ii) a cross-sectional work identifying the major unit operations and related activities for the whole food industry (where an increase in the efficiency of energy utilization and energy savings exists would be carried out and the results expressed as a manual. In any of the cases, the basic framework should be followed:

- identification of the different unit operations where an energy conservation programme would have a positive impact (for instance: major savings can be obtained with the use of modern technology at the following operation : a) drying (including freeze-drying; b) liquid evaporation; c) refrigeration (including all phases of the refrigeration cycle); d) freezing (freezing cycle); e) baking; f) frying; g) extusion, etc.)

- without modifying the technology identification of the measures to be taken at the different unit operations level which would allow an adaptation of the present operation to an energy conservation oriented approach (for instance : a)proper insulation of liquid evaporators, dryers, refrigeration/heating tanks and extruders; b) reutilization of hot gases and liquids in evaporation systems (secondary heat); c) proper placement for adequate ventilation of refrigeration and freezing systems; d) pre-refrigeration/cooling or pre-heating of liquids in pausterization/sterilization system, etc.)

- identification of the other energy conservation measures within a given food processing plant which would improve the efficiency of energy utilization. The following could be mentioned as examples of the points to be focused on:

  a) utilization of efficient steam boilers and steam turbines;

  b) proper insulation of all industrial plant pipes where hot/cold liquids are transported;

  c) indication of the correct temperatures for receiving, processing and the storage of different raw materials and final products (particularly liquids as milk, juices, etc.);

  d) utilization of adequate ancillary equipment as pumps, valves, and control instruments;

  e) utilization of adequate transportation equipment as refrigerated or only insulated tanks and trucks;

  f) utilization of proper installations for storage and commercialization of relevant food products; etc.

- Detailed procedures to be followed at plant level in order to introduce to the manufacturing units the different energy conservation measures identified and recommended as a result of the technical assignment.

The manuals will demonstrate innovative energy conservation/saving technologies developed in Japan and adapted to the conditions and requirements of the plastic forming and food processing industries in developing countries. All analysis and recommendations given are based on existing and available technological solutions and resources. The suppliers of technology and sources of information must clearly be indicated. During the preparation of the manuals information available on UNIDO's expertise and experience in promoting energy conservation/saving technologies in developing countries as well as available in Japan will be reviewed by the subcontractor and incorporated into the proposed technical manuals.

The two technical manuals should be prepared in English. Three copies of the draft manuals will be submitted to UNIDO by the subcontractor for comments before final printing. 600 copies of each of the two technical manuals will be required to be forwarded to UNIDO HQ for distribution in developing countries. The two manuals will be prepared very clearly in order to have a practical application by the users.

F. A final report which summarizes all work done including the outputs of the seminars held in India and Pakistan as well as recommendations and conclusions for follow up actions in dissemination of energy conservation technologies among developing countries will be prepared by the subcontractor. 3 copies of the draft final report in English shall be submitted to UNIDO HQ for comments. The final version of this report should be prepared in 10 copies and forwarded to UNIDO HQ.

G. The subcontractor will provide the following personnel to carry out the scheduled project activities:

- 3 experts (a team leader, a plastic expert and a food processing expert) for 3 weeks, to implement plant observation in India and Pakistan including supervision of the local counterparts.

- At least two specialized technical experts for 2 weeks, to organize seminars and hold lectures as well as take care for the dissemination of the technical manuals in India and Pakistan and to carry out an ex-post survey to assess the implementation and results of energy conservation measures recommended by the subcontractor team.

During the preparation and implementation of all these activities, national experiences and expertise of the two countries on the application of energy conservation/saving technologies shall be involved and presented during the seminars.

H. The subcontracting organization will be fully responsible for the provision of all necessary facilities and services to conduct the scheduled seminars in India and Pakistan for 2 days each and for about 50 participants of each (plastic forming and food processing industries) seminar.

In particular the following facilities will be provided by the subcontractor:

- Seminar registration desks and receptions

- Simultaneous interpretation services (English, Japanese and national language)

- Microphones

- Audio-visual equipments, projector, movie screen, video-tape players, tape recorder, etc.

- Podium for lectures

- Miscellaneous services

The local counterparts in India and Pakistan shall assist the subcontractor in the provision of the above-mentioned facilities, but at no cost to them.

I. The subcontracting organization shall plan the activities falling under the scope of the subcontracting service in accordance with the Tentative Work Plan

IV. Evaluation

The project shall be subject to evaluation in accordance with the policies and procedures established for this purpose by UNIDO. Follow up activities will be undertaken by each country's government authorities and enterprises.

Annex I

Specialized institutions to be consulted in India and Pakistan for the proposed survey on Food Processing and Plastic Forming industries

Plastic Forming	Food Processing
Mr. A. Siddiqi General Manager Plastics Technology Centre ST-2/1 Sector-30, Korangi Industria Area P.O. box 8297 Karachi 74900, Pakistan Fax: 92-21-5060373 Telephone: 319401, 319402 Telex: 23541 FCCCL PK	Mr. Ihteshamuddin Head, Food Processing Division Pakistan Council of Scientific and Industrial Research (PCSIR) Lahore Pakistan Tel. 871262
The Director Central Institute of Plastics Engineering and Tools (CIPET) Industrial Estate Guindy, Madras - 600 032 India Tel. 432371-4 Telex: 041-8174 CIPT IN	Federation of Indian Chamber of Commerce and Industry Federations House Tansinmarg NEW DELHI 110001 Fax: 9411 3320714

Appendix 7. Handy Manual

“ FOOD PROCESSING INDUSTRY ”
“ PLASTIC FORMING INDUSTRY ”

HANDY MANUAL

FOOD PROCESSING INDUSTRY

UNIDO

Output of a Seminar on Energy Conservation in Food Processing Industry

Sponsored by

United Nations Industrial Development Organization (UNIDO)

and

Ministry of International Trade and Industry (MITI), Japan

Hosted by

Ministry of Petroleum and Natural Gas, India

Ministry of Water and Power, Pakistan

Organized by

The Energy Conservation Center (ECC), Japan

1995

India **Pakistan**

PREFACE

The conservation of energy is an essential step we can all take towards overcoming the mounting problems of the worldwide energy crisis and environmental degradation. In particular, developing countries are intereated in increaseing their awareness of inefficient poer generation and energiy usage in their countries. However, usually only a minimum of information on the rational use of energy available.

The know-how on modern energy saving and conservation technologies should, therefore, be disseminated to government and industrial managers, as well as to engineers and operators at the plant level in developing countries. It is particularly important that they acquire practical knowledge of the currently available energy conservation technologies and techniques.

In December 1983, UNIDO organised a regional meeting on energy consumption as well as an expert group meeting on energy conservation in small- and medium-scale industries for Asian countries. The outcome of these promotional activities prompted UNIDO to initiate a new regional programme designed to increase the awareness and knowledge of government officials and industrial users on appropriate energy saving processes and technologies. In 1991, the first project, Programme for Rational Use of Energy Saving Technologies in Iron and Steel and Textile Industries in Indonesia and Malaysia (US/RAS/90/075), was approved and financed by the Government of Japan.

The successful completion of this project prompted UNIDO to request the financial support of the Government of Japan to carry out similar projects under this programme in other developing countries. Since 1992, under continuous support of the Government of Japan, two other projects have successfully been completed: Rational Use of Energy Saving Technologies in Pulp and Paper and Glass Industries in the Philippines and Thailand (US/RAS/92/035); and Rational Use of Energy Saving Technologies in Ceramic and Cement Industries in Bangladesh and Sri Lanka (US/RAS/93/039).

This year the programme is being implemented in India and Pakistan, targeting two energy intensive industrial sub-sectors; namely, plastic forming and food processing industries.

In the food processing industry, a substantial amount of energy is consumed. Excessive use of energy is usually associated with many industrial plants worldwide, and food processing plants are no exception. Enormous potential exists for cost-effective improvement in existing energy-using equipment. Also, application of good housekeeping measures could result in appreciable savings in energy. Therefore, it is imperative to introduce and disseminate information about modern energy saving technologies among the parties concerned in government and especially, at plant level, in industries.

In order to achieve the objectives of this programme, the following strategy is being used:

1. Conduct surveys of energy usage and efficiency at plant level, to establish the required energy saving measures.
2. Prepare handy manuals on energy management and energy conservation techniques and technologies, based on the findings of the above surveys.
3. Present and discuss the content of the handy manuals at seminars held for government officials, representatives of industries, plant managers and engineers.
4. Disseminate the handy manuals to other developing countries for their proper utilization and application by the target industrial sector.

The present Handy Manual for the food processing industry was prepared by UNIDO, with the cooperation of experts from the Energy Conservation Center (ECC) of Japan, on energy saving technologies in the framework of the above-mentioned UNIDO programme. It is designed to provide an overview of the main processes involved in food processing, and present a concise guideline for the recommended energy saving measures.

Appreciation is expressed for the valuable contribution made by the following institutions to the successful preparation and publication of this manual:

- Ministry of Petroleum and Natural Gas, India;
- Ministry of Water and Power, Pakistan;
- Ministry of International Trade and Industry (MITI), Japan; and
- The Energy Conservation Center (ECC), Japan.

October 1995

Contents

1. Food Manufacturing Processes

1.1. The History of Food Processing

The origin of food processing goes all the way back to ancient Egypt, yet the period of those developments seems to symbolize the history of the culture of mankind. Nowadays, bread, which is characterized by its use of the fermentation action of yeast and which uses wheat flour as its raw material, is baked all over the world. The origins of beer also go back to Babylon and Egypt in the period from 3,000 to 5,000 BC. The foundation of the modern industry was built up with the introduction of machinery and technology of new methods from Germany. Nowadays, the processed foods that are thriving in grocery shops are modern processed foods and traditional foods, but their manufacturing technology, process control and manufacturing and packaging envirmonmental facilities have been advanced and rationalized to an incomparable extent in the last 30 years. As a result, products with high quality and uniformity are now being manufactured. This is based on the advancement of food science, and is, moreover, due to the general introduction of hygienics, applied microbiology, mechanical engineering, chemical engineering, electronic engineering and high-polymer technology. The most remarkable developments until now have been convenient pre-cooked frozen foods, retort pouch foods and dried foods. The mass production of excellent quality processed foods without using unnecessary food additives has been made possible in the last 30 years by grading and inspecting the process materials, carrying out proper inspections of processed foods, and advances in processing technology, installation and packaging technology and materials. The history of processed food is the history of the rationalization of advanced technology related to raw material treatment operations, processing operations, storage operations, other processing equipment, cleaning of facilities, sterilizing and conservation treatment operations and effluent and waste treatment operations. Worthy of note recently are developments in container and tank lorry transportation, concentration using membrane technology in processing operations, vacuum refrigeration, vacuum freezing and pressurized extrusion molding using two axle extruders. In storage operations, technologies such as vapor drying, heat exchange sterilization, deoxygenation agents, sterile filling packaging and PET bottle packaging have been developed. We have heard the plans of soft drinks manufacturers who want to switch from active sludge methods of wastewater treatment to methane fermentation methods.

1.2. Classification of Food Manufacturing Industry

The range of the food manufacturing industry is wide, and so classification varies from country to country. The Japanese food manufacturing industry is shown in Table 1.

This text takes up the manufacture of sugar, bread, soft drinks and beer, and in addition to this it takes up milk production within the dairy product manufacturing industry, a manufacturing industry that is common to all countries.

1.3. Production process of food

Steam, electric power and water are often used in the raw material processing stages of the production stage of the food products manufacturing industry, and milk, drinks and ketchup factories have refrigeration equipment in addition to boilers. Hygiene control, a common element in factories, is very important. Utilities include steam, cooling water, brine, compressed air, sterilized air and electricity. Along with the production process, wastewater treatment is also important. Most factories have storage, air conditioning and packaging equipment, and generators are fitted in case of power failure.

1.3.1. Liquid milk and dry milk processing

As an example of dairy product production, the manufacturing process of milk is shown in Fig. 1. Drinking milk is broadly divided into milk and processed milk. The only raw material of milk is fresh milk, but processed milk is made by ingredient regulation, using not only fresh milk as a raw material but also non-fat powdered milk or butter, etc. Depending on the sterilizing conditions, UHT milk (120 - 135°C 2 seconds holding pasteurization) is common, but in recent years there have been improvements in dairy farm milk production technology and fresh milk treatment technology, a decrease in the number of bacteria in fresh milk received in factories, and now high-quality fresh milk is being produced and supplied. At the same time, due to the tendency of consumer taste for natural foods, low temperature sterilization treatment milk (HTST 72°C held for 15 seconds, and LTLT 63°C held for 30 minutes) is now being produced.

Table 1 Classification of the Food Manufacturing Industry

1. Food manufacturing industry
   (1) Livestock food products manufacturing industries
      1) Meat products manufacturing industry
      2) Dairy products manufacturing industry
      3) Other livestock food products manufacturing industries
   (2) Marine food products manufacturing industries
      1) Marine foods canning and bottling manufacturing industry
      2) Seaweed processing industry
      3) Gelatin manufacturing industry
      4) Fish meat, ham and sausage manufacturing industry
      5) Fish paste products manufacturing industry
      6) Frozen marine products manufacturing industry
      7) Frozen marine food products manufacturing industry
      8) Other marine food products manufacturing industries
   (3) Canned vegetables, canned fruits and agricultural preserved food products manufacturing industries
      1) Canned vegetables, canned fruits and agricultural preserved food products manufacturing industries (except pickled vegetables)
      2) Pickled vegetables manufacturing industry (except cans, bottles and jars)
   (4) Seasonings manufacturing industry
      1) Miso manufacturing industry
      2) Soy sauce and edible amino acids manufacturing industries
      3) Chemical seasonings manufacturing industry
      4) Sauce manufacturing industry
      5) Cooking vinegar manufacturing industry
      6) Other seasonings manufacturing industries
   (5) Sugar manufacturing industry
      1) Sugar manufacturing industry (except refining industry) (using domestically produced sweet recource crops as raw material)
      2) Sugar refining industry (refined from purchased raw sugar)
      3) Grape sugar, starch syrup and isomeric sugar manufacturing industries
   (6) Cereal processing and flour milling industries
      1) Polished rice industry
      2) Scoured barley industry
      3) Wheat flour manufacturing industry
      4) Other cereal processing and flour milling industries
   (7) Bread and cake manufacturing industries
      1) Bread manufacturing industry
      2) Fresh cake manufacturing industry
      3) Biscuit and dried cake manufacturing industry
      4) Rice cracker manufacturing industry
      5) Other bread and cake manufacturing industries
   (8) Animal and vegetable fat manufacturing industries
      1) Vegetable fat manufacturing industry
      2) Animal fat manufacturing industry
      3) Edible fat processing industry
   (9) Other food products manufacturing industries
      1) Baking powder, yeast and other yeast agent manufacturing industries
      2) Starch manufacturing industry
      3) Noodle manufacturing industry
      4) Malted rice, seed malt, germ wheat and barley manufacturing industries
      5) Tofu and fried tofu manufacturing industries
      6) Bean jam manufacturing industry
      7) Frozen cooked foods manufacturing industry
      8) Household dishes manufacturing industry
      9) Other unclassified food products manufacturing industries
2. Drinks, feed and tabacco manufacturing industries
   (1) Soft drinks manufacturing industry
   (2) Alcohol manufacturing industry
      1) Wine manufacturing industry
      2) Beer manufacturing industry
      3) Sake manufacturing industry
      4) Distilled liquor and mixed alcohol manufacturing industries
   (3) Tea and coffee manufacturing industries
      1) Tea manufacturing industry
      2) Coffee manufacturing industry
   (4) Ice manufacturing industry

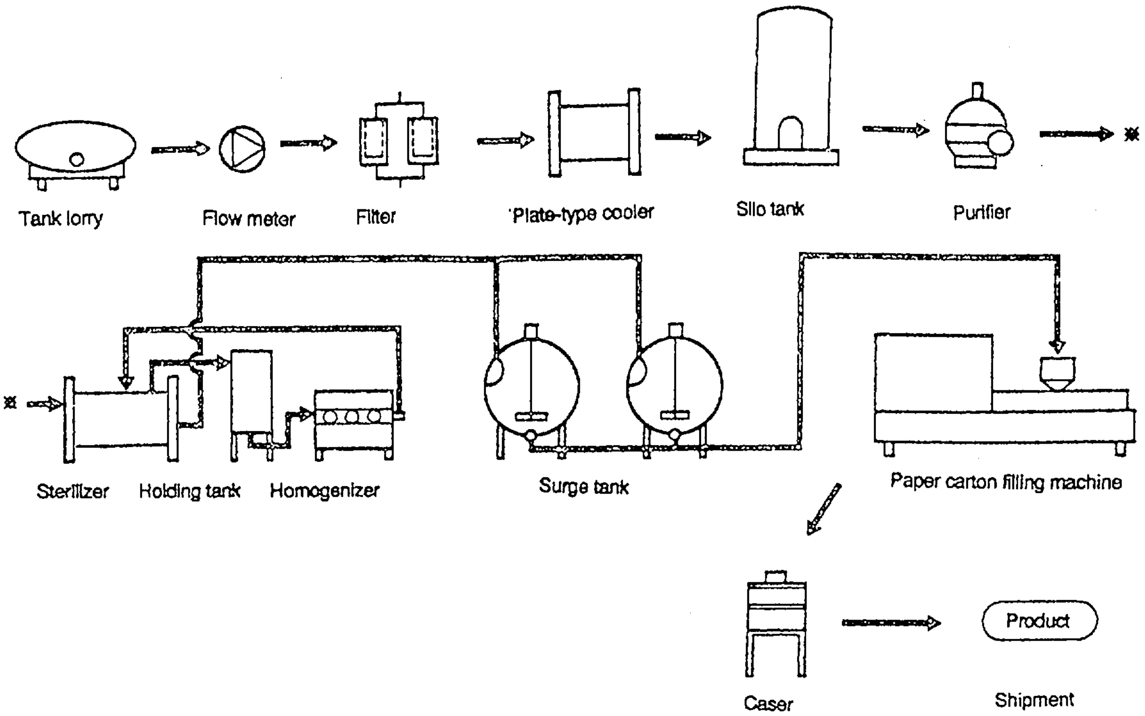


Figure 1 Milk production flow chart

A non-fat solid content of 80% or more, an acidity (lactic acid) of 0.18% or less, 50,000 bacteria (per 1 ml), and colon bacilli cluster (E. colli) negativity are stipulated internationally for processed milk. Among large scale factories in recent years, factories with a combined processed milk and drinking milk line and soft drinks line have appeared. The manufacturing flow chart of powdered milk is shown in Fig. 2.

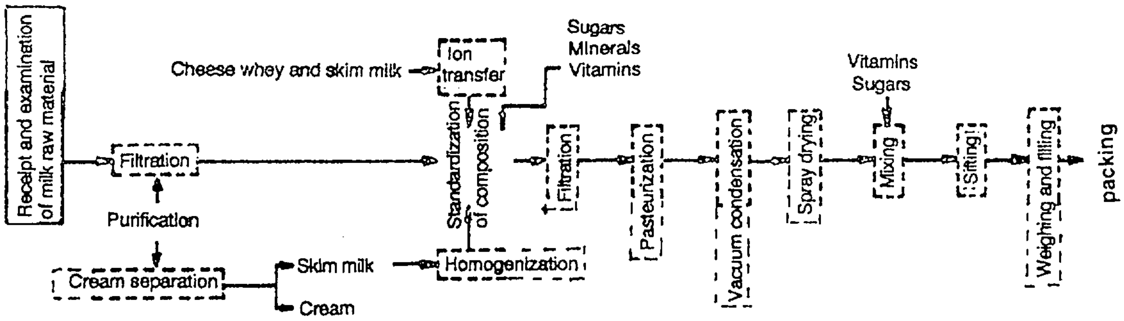


Figure 2 Powdered milk production flow chart

1.3.2. Beverages process

Among vegetable and fruit processed products, other than juice there are cans, bottles and plastic containers (1 portion) of jam and marmalade, and there are various production processes. As an example of this, the marmalade process is shown in Fig. 3. High pressure process jam has also begun to be produced. The fruit pectin, sugar and acid in marmalade are concentrated to achieve a suitable hardness, in the same way as jam, and marmalade is made from tangerines naval oranges, oranges and citrous fruits. There are 300 - 500 drinks per minute lines in operation on juice production lines.

1.3.3. Beer brewery process

Six million kiloliters of beer are produced in Japan each year. The various requirements for beer manufacturing are shown in Table 2, and the process is shown in Fig. 4.

Table 2 Various requirements for beer manufacturing (per 1000 liters of light beer)

Malt	110 kg
Additional raw materials	34 kg
Hops	1.4 kg
Rice	7.5 m^3
Power	105 kWh
Fuel	38 x 10^4 kcal
BOD	12 kg

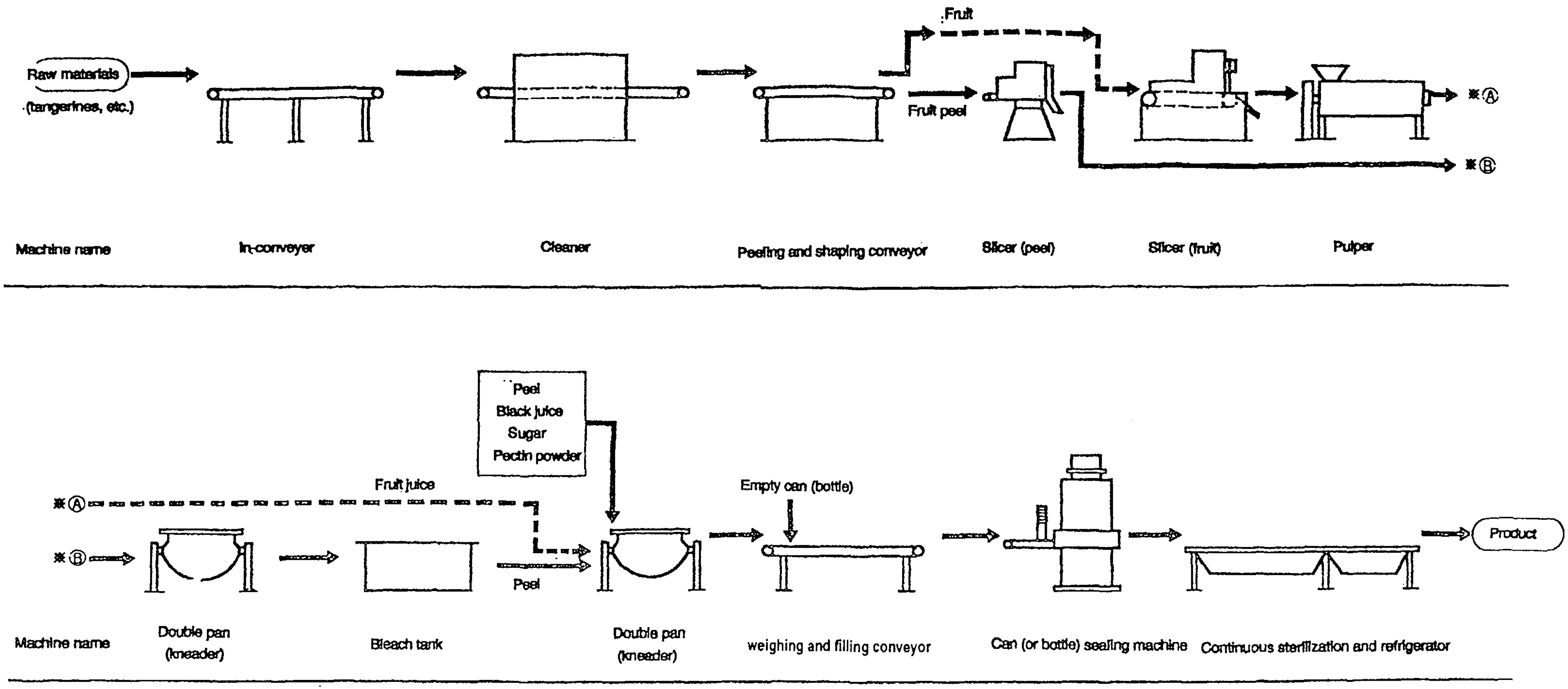


Figure 3 Marmalade flow chart

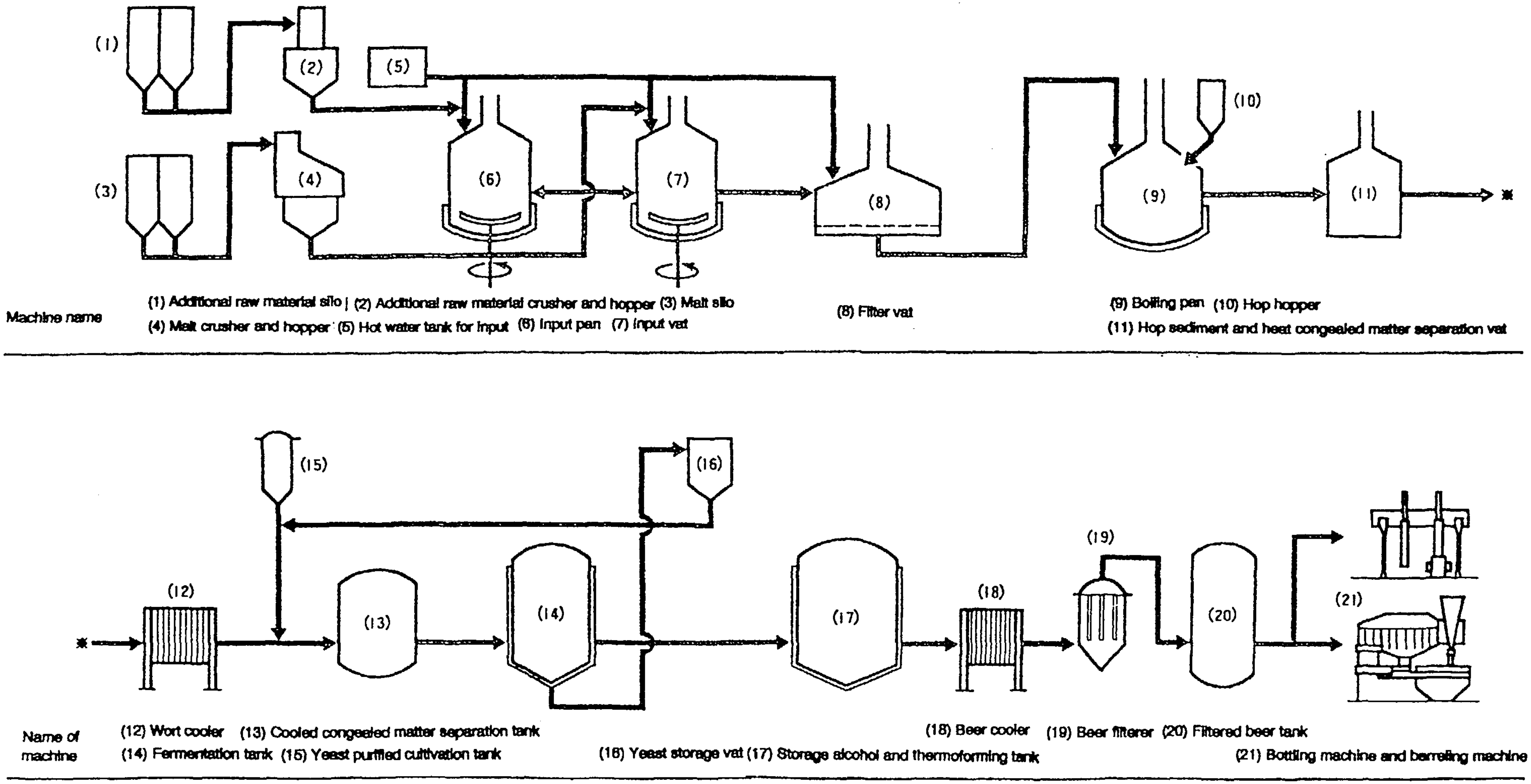


Figure 4 Beer flow chart

1.3.4. Bread and cake process

There is an extremely large variety of bread, and apart from large loaves baked in a square shape which are not very sweet, there are sweet breads and other kinds of breads. The characteristic of sweet breads is their particularly sweet taste, and they are largely classified as Western-style sweet bread, such as small breads and sweet rolls which are eaten as snacks between meals or as luxury foods. Molded large loaves of bread are made by the 2-stage fermentation method and are baked at 220 - 230°C. Table 3 shows a standard mixture example, and Fig. 5 shows a flow sheet.

Table 3 Standard mixture of white bread by the 2-stage fermentation method

	Ingredient name	Specification	Mixture (%)
1 stage Material	Wheat flour	Strong high grade	70
	Yeast	Compressed fresh yeast	2
	Yeast food		0.13
	Water		38
2 stage Material	Wheat flour	Semi-strong high grade	30
	Salt	Refined salt	2
	Sugar	White soft sugar	3
	Glucose		3
	Shortening		3
	Powdered milk		2
	Water		22

NB) The mixing rate is the percentage weight of the total amount of wheat.

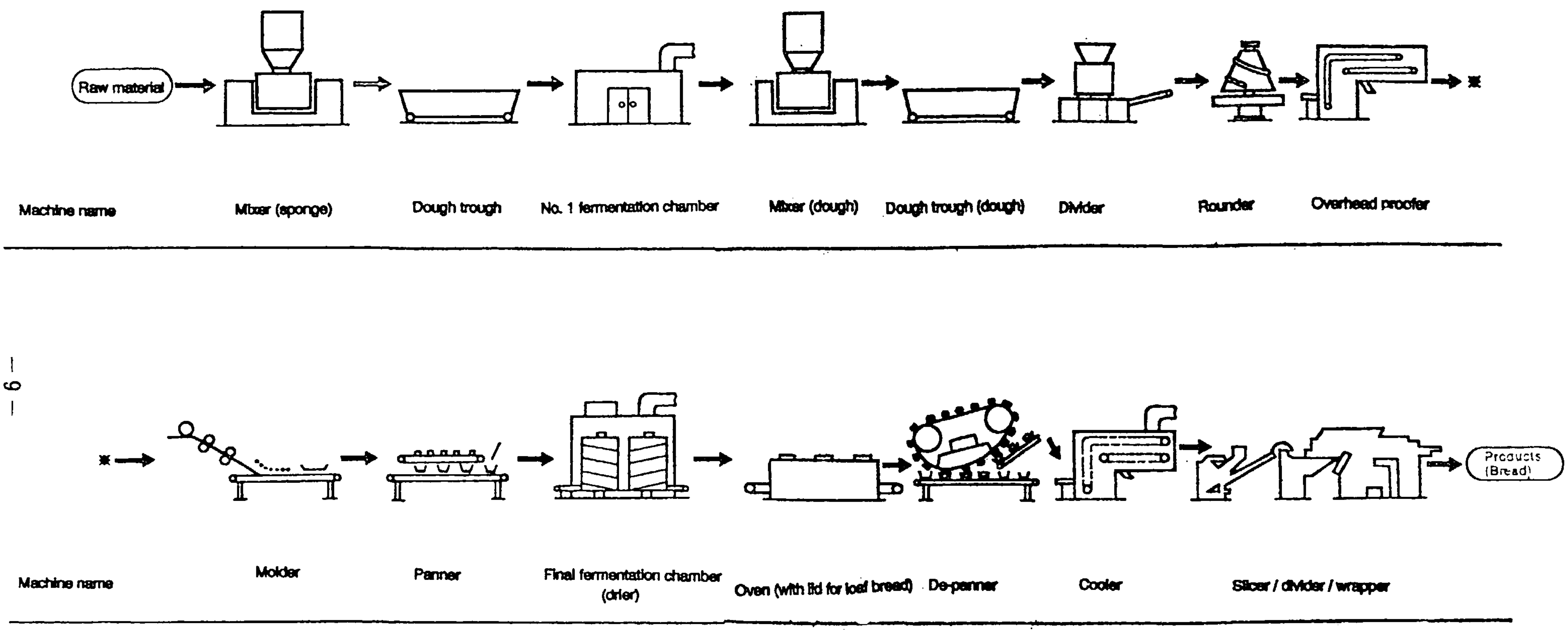


Figure 5 Bread flow chart

1.3.5. Sugar and canned products

Fig. 6 and Fig. 7 show the flow sheets for some other food products, refined sugar and canned foods.

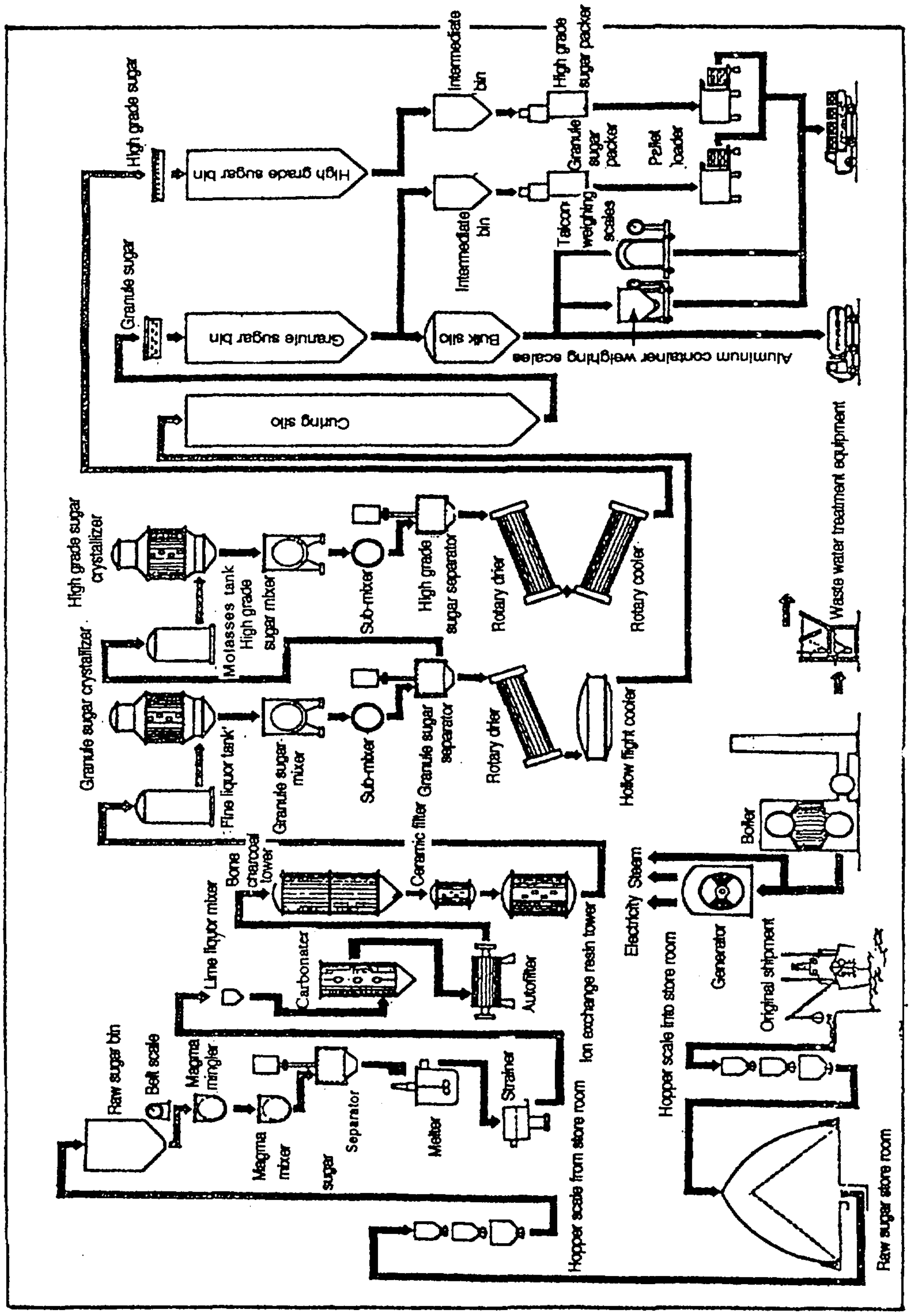


Figure 6 Flow chart of sugar

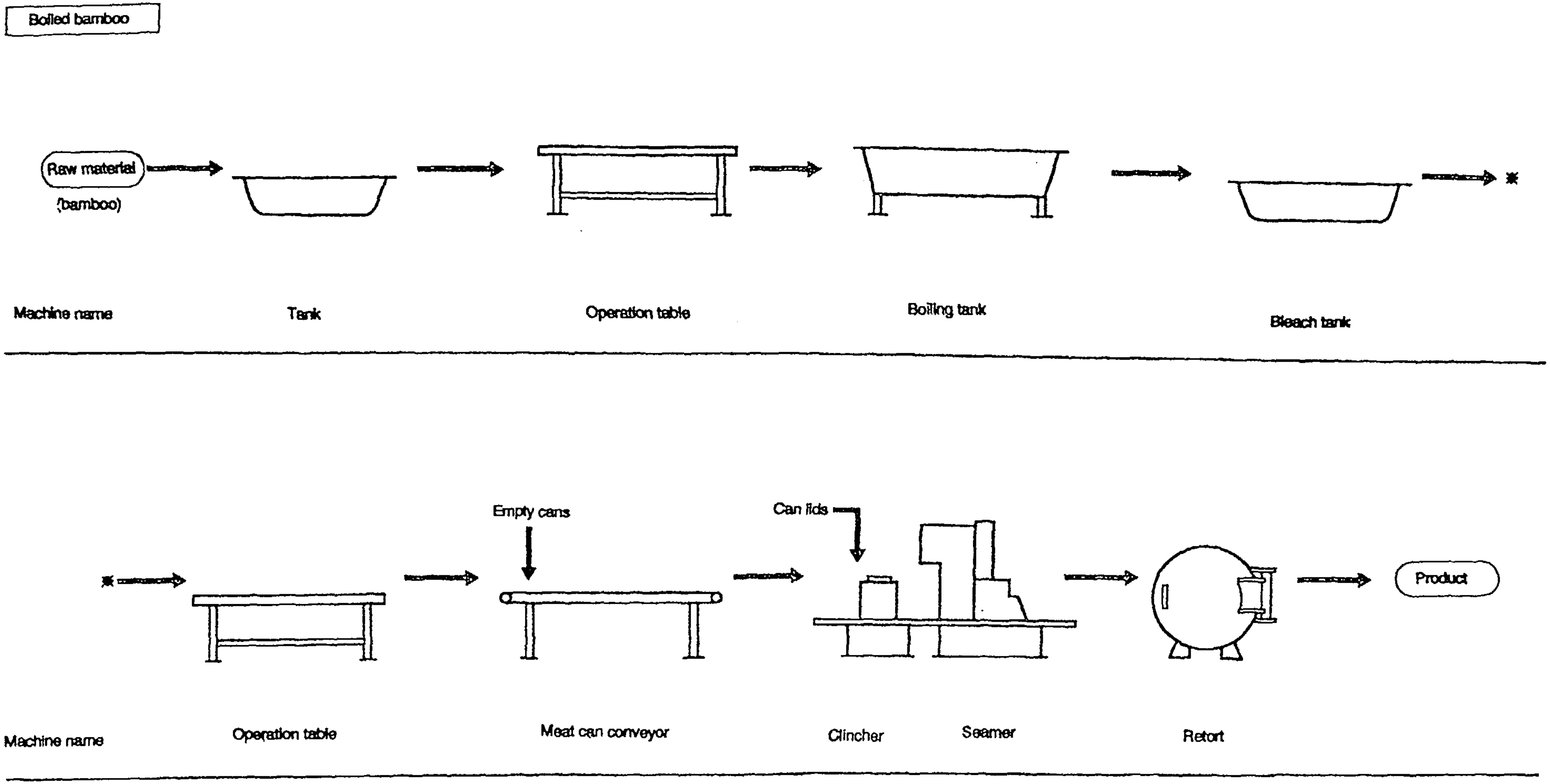


Figure 7 Flow chart of canned products

2. Characteristics of energy consumption in food processing

Looking at the scale of the Japanese food manufacturing industry in terms of the product shipment volume, it accounts for about 30 trillion yen, or 10% of the shipment volume of all manufacturing industries, in third position behind the electrical machinery and tool manufacturing industry and the transportation machinery and tool manufacturing industry.

2.1. Energy consumption of electricity and fuel

The gross energy consumption of the food products manufacturing industry is 2% of that of all manufacturing industries, occupying 6th position. As for the gross energy consumption of separate industries, it is comparatively high in the bread, cake, livestock food products and sugar manufacturing industries; as shown in Table 4, 77.5% of the total energy consumption is fuel, and the remaining 22.5% is purchased power (including hydraulic private power generation).

Table 4 Food products manufacturing industry energy consumption rate in small businesses

(Source: "Small Businesses Production Cost Index", 1990)

Industry	Energy consumption rate (%)			Water cost
	Electric power cost	Fuel cost	Total	
Canning	0.65	0.46	1.11	0.15
Frozen marine produce	1.03	0.30	1.33	0.42
Fish paste	1.37	0.99	2.36	0.17
Miso (Home manufactured product)	1.20	0.72	1.92	0.31
Soy sauce (Home manufactured product)	0.79	0.74	1.53	0.17
Bread	0.97	0.66	1.63	0.22
Cakes	0.93	0.59	1.52	0.11
Bean jam	1.28	1.22	2.50	0.36
Pickled vegetables	0.59	0.19	0.78	0.08
Noodles	1.21	0.63	1.84	0.12
Flour milling	0.87	0.08	0.95	0.02
Sauce	0.43	0.46	0.89	0.40
Other food products	1.06	0.76	1.82	0.15
Total manufacturing industry	1.24	0.46	1.70	0.09

(Note)

(1) Energy consumption rate = (Energy cost / sales) x 100 (%)

(2) Average values of operationally sound small businesses (capital ¥10,000,000 or less, or no more than 300 employees)

2.2. Liquid milk and dry milk process

The pasteurization of milk is almost completely carried out by the heat treatment sterilization method, and the ultra high temperature instantaneous sterilization method (UHT sterilization) has become widespread with the aim of ensuring long life, due to the number of bacteria in fresh milk being 1,000,000/ml as a result of progress in past dairy farming circumstances in Japan. In recent years, due to the tendency of consumer taste for natural food products, low temperature sterilization of milk (63 - 75°C sterilization) has also become widespread in the restricted market for products with a limited storage period. The UHT sterilization method can almost completely get rid of bacteria in milk and is a method developed along with the introduction of high heat exchange rate plate heat exchangers.

The UHT sterilization temperature conditions are 130°C held for 2 seconds, but long life milk is heated up to 150°C for thorough sterilization and packed with sterilized filling machines. Fig. 8 shows the flow sheet for UHT sterilization of milk. Fresh milk refrigerated at around 4°C is supplied by the milk pump to the plate-type heat exchanger's No. 1 heat exchanger and No. 1 heater, and its temperature raised to 85°C. Then by holding it for about 6 minutes in the holding tank, proteins that are easily denatured by heat are converted, which prevents scale coating on the high temperature part plate surface of the No. 2 heat exchanger and heater. After holding, fat globules are made very small with the previous homogenizer. Then the milk passes through the No. 2 heat exchanger and No. 2 heater and is heated to 130°C, and after holding for 2 seconds it is at once passed through the No. 2 heat exchanger, the No. 1 heat exchanger and the cooler and is cooled to 4°C or less. If the 6 minutes holding period is omitted, the milk is heated for about 30 seconds up to 130°C and then cooled to 4°C or less in a short time of around 30 seconds. An example of time progress is shown in Fig. 9. A UHT sterilizer, centered around a plate-type heat exchanger, can be arranged compactly.

For powdered milk, Fig. 10 shows an atomizer connected to a concentrator.

As reference examples, Table 5 shows examples of the sales of factories manufacturing milk, powdered milk and other dairy products against their comparative energy percentage (consumption rate).

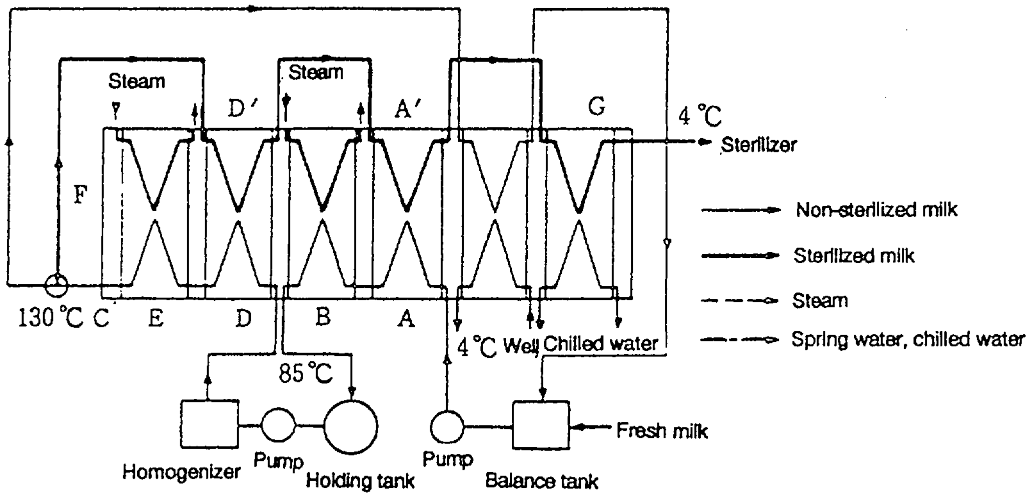
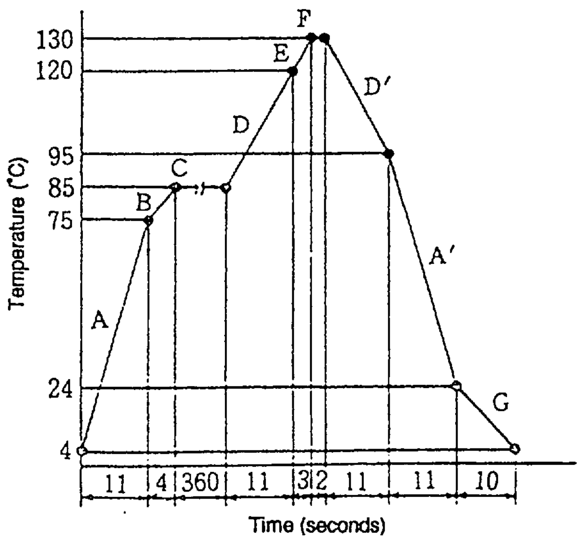


Figure 8 UHT milk flow sheet example



A, A′	No.1 heat exchange section	4→75°C 24←95°C
B	No.1 heater	75→85°C
C	6 minute holding section	85°C
D,D′	No.2 heat exchange section	85→120°C 95←130°C
E	No.2 heater	120→130°C
F	Sterilization temperature 2 second holding section	130°C
G	Cooling section	24→4°C

Figure 9 Example of temperature change with time of UHT milk

Table 5 Example of Consumption rate of milk processing

		Taiwan	Pakistan	Japan
Energy cost/sales	Fuel	0.81	1.05	0.50
	Electricity	1.77	1.11	1.00
	Total	2.58	2.16	1.50

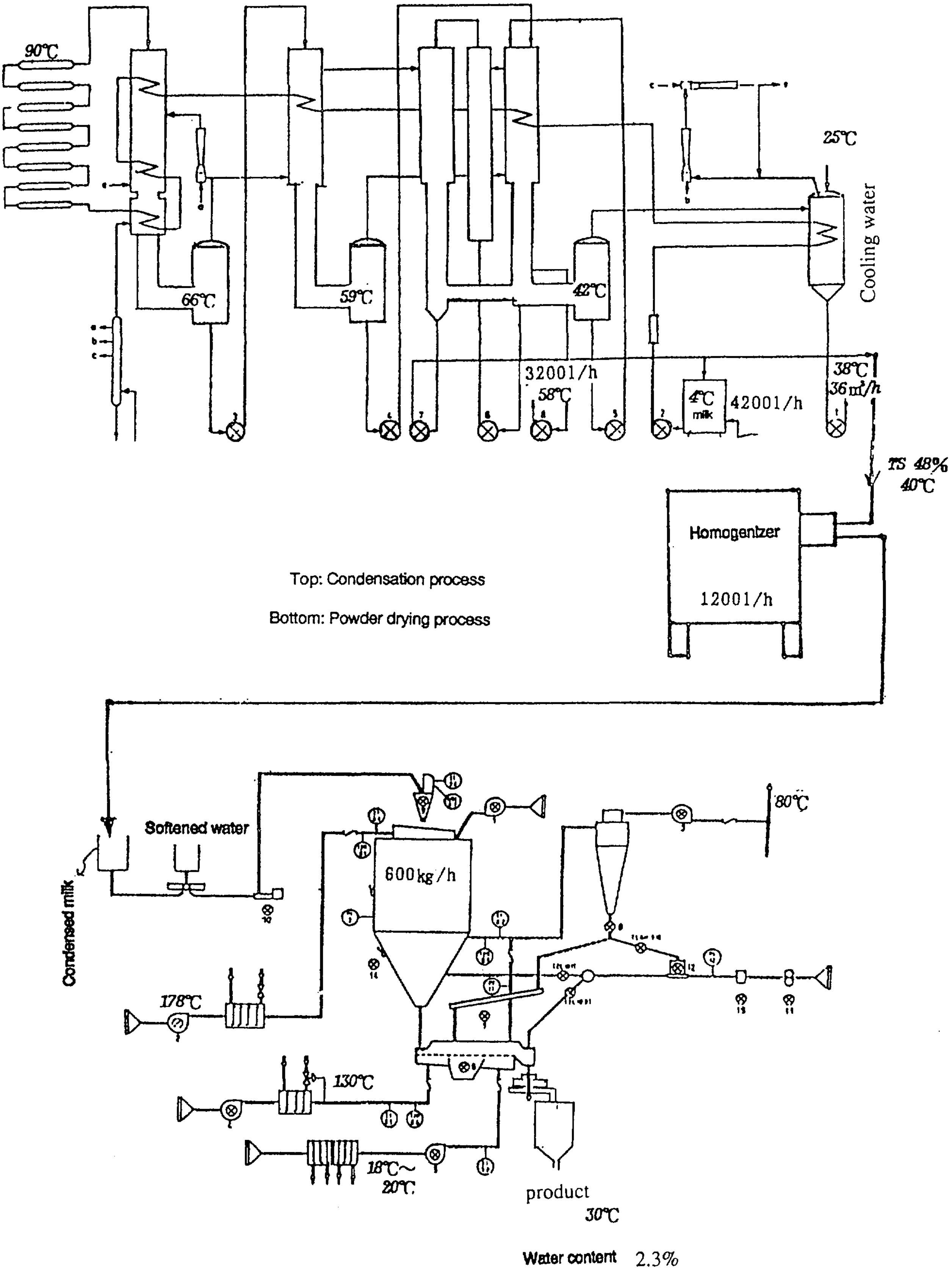


Figure 10 Powdered milk plant

2.3. Beverage process

As an example, the manufacturing process of tangerine orange juice is broadly divided into juice making, concentration, sterilization and filling. The general manufacturing process of juice is the same as that of tangerine oranges. There have been production developments and energy reductions in order to manufacture a higher quality product, and in particular the introduction of high technology has advanced in orange juice manufacturing. Pressed juice is passed through a vibrating strainer and is then concentrated after impurities have been removed. In general, heat concentration is used. This is a method of evaporating the water content by heating, but this can cause the juice to turn brown and lower its quality. Therefore it is necessary to reduce the pressure and concentrate it suddenly, so the vacuum concentration method is adopted. The types of vacuum method are a comparatively low temperature treatment and a high-temperature short time treatment but in either case there is quality deterioration because of a heating process. There is also the problem of scattering of odor components due to the vacuum. To solve this problem, there is the method of setting up fragrant ingredient recovery equipment to recover the fragrant ingredients and return them to the juice, there is the cut pack method of adding new juice to the concentrated juice, and there is a method of adding extremely small quantities of perfumed oil (manufactured essential oil) to the concentrated juice. However, there is always a big difference in comparison with fresh juice, and the adoption of freezing concentration methods to improve quality (fragrance and taste) is sought. The difficult point is the extremely high cost of the equipment of freezing concentration method. Without heating the squeezed juice at all, preliminary freezing is carried out, and only the juice's water content is crystallized and removed in a crystallizer. This can be adopted in the complete concentration of the fruit juice by a method of removing the remaining water content in a recrystallizer, and outstandingly good quality is achieved.

Machines used in the general juice process include a vacuum multi-effect evaporator, a vacuum evaporator, a crystallizer and a recrystallizer. Next the concentrated juice is clarified through the removal of various comturbidityponents(proteins,pectic substance,etc.) included in the fruit juice and reducing the turbidity, and here too a certain temperature and time are needed(40-45°C for 80-120 minutes)so the taste is always impaired. After sterilization with the plate heat exchanger, the filtered and clarified fruit juice is put into containers and the final product is refrigerated. There are some changes to the process if

100% fruit juice is made instead of concentrated juice, and the product is made without going through the concentration process. Jam and marmalade are also made in drinks factories, and many processes follow complicated paths.

2.4. Beer brewing process

An example was referred to Item 1.3.3 in which 105 kWh of electric energy were consumed and 38 x 10^4 kcal of fuel were used in a brewery per 1000 liters of beer produced. In Japan, 65% of the fuel are used in the molt pan and 35% of the electricity are used for the refrigerators.

Fig. 11 shows an outline of the refrigeration equipment. In the Japanese beer blewery the refrigeration process consumes 31% of the electricity and the annual electricity consumption by each process is shown in Fig. 12.

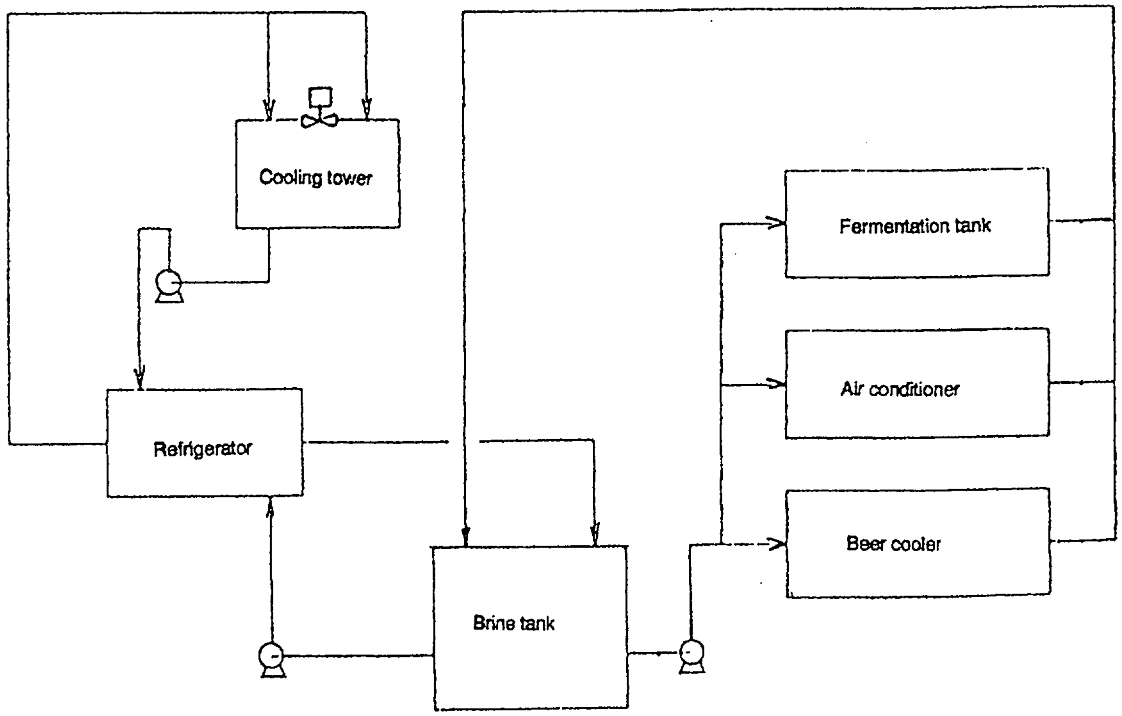


Figure 11 Outline of refrigeration equipment in bear blewing process

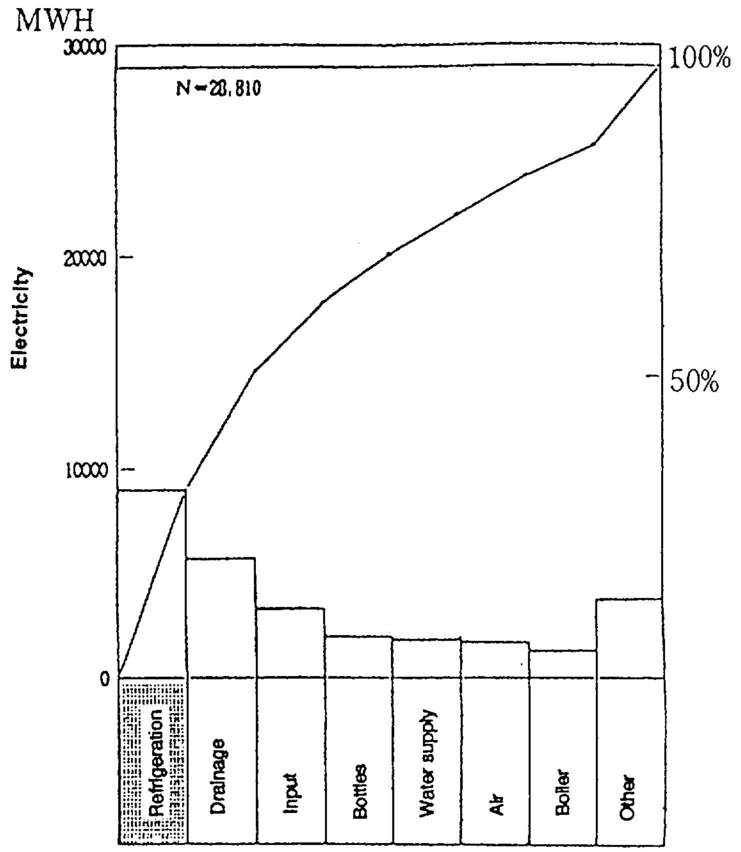


Figure 12 Annual consumption of electricity in bear blewing process

The flow sheet and material balance of a sugar refinery in Japan are shown in Fig.13 and Fig. 14. Energy consumption ratio in a sugar factory is shown in Fig.15.

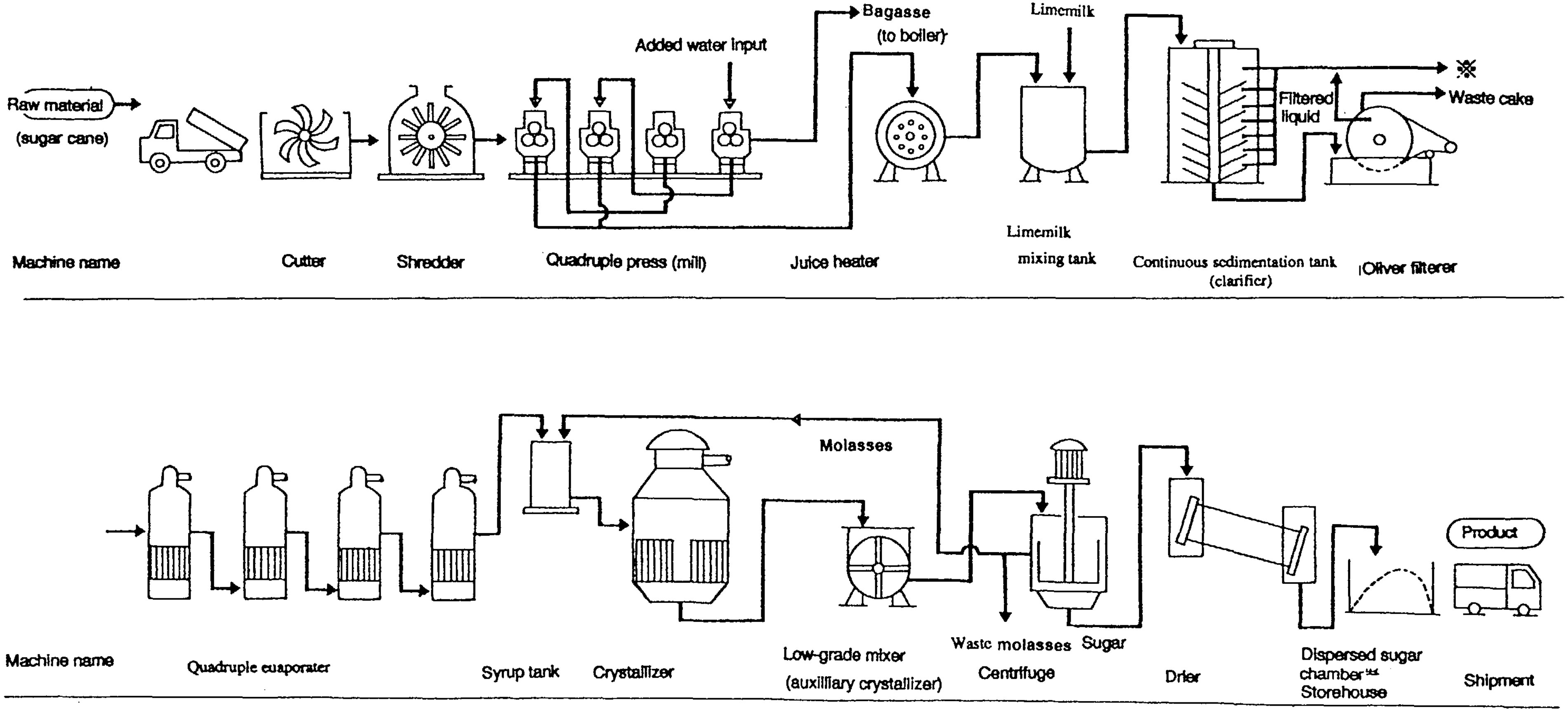


Figure 13 Sugar process flow chart

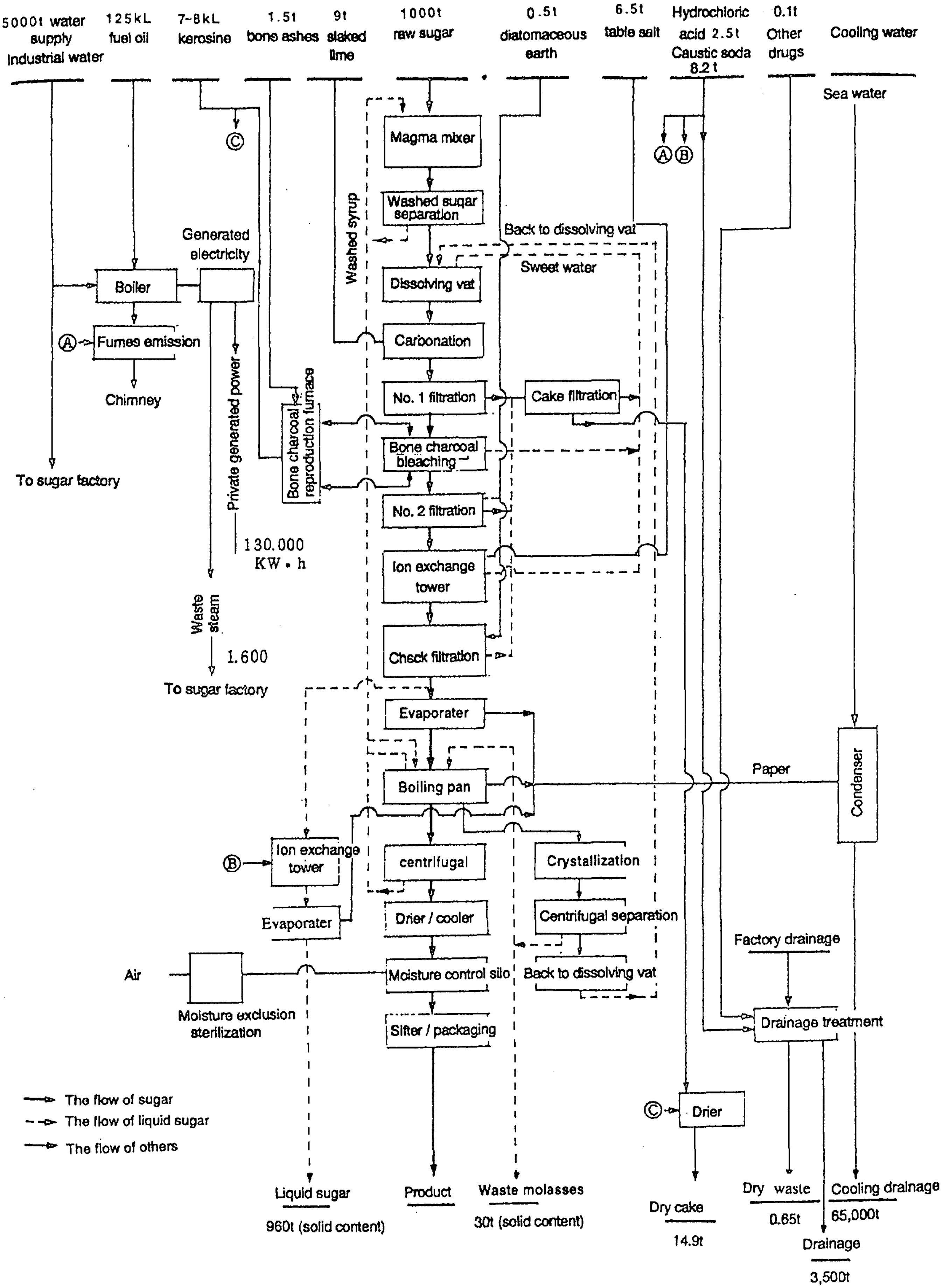


Figure 14 Example of sugar factory flow sheet and material balance

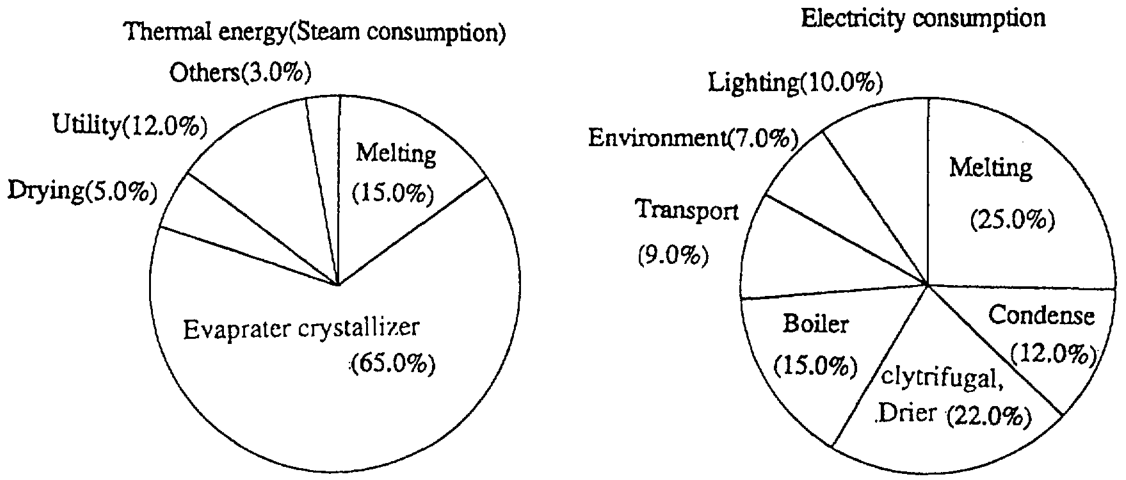


Figure 15 Energy consumption ratio in a sugar factory in Japan

3. Promotion of energy conservation technique

Energy conservation in industrial sectors starts from the software including operation control and process control, then extends into the hardware including equipment improvement and process improvement. Geverally, energy conservation efforts can be classified into the following three steps:

Step 1-Good housekeeping

Energy conservation efforts, made without much equipment investment, include elimination of the minor waste, review of the operation standards in the production line, more effective management, improvement of employees' cost consciousness, group activities, and improvement of operation technique.

For example, such efforts include management to prevent unnecessary lighting of the electric lamps and idle operation of the motors, repair of steam leakage, and reinforcement of heat insulations.

Step 2-Equipment improvement

This is the phase of improving the energy efficiency of the equipment by minor modification of the existing production line to provide waste heat recovery equipment and gas pressure recovery equipment or by introduction of efficient energy conservation equipment, including replacement by advanced equipment. For example, energy conservation efforts in this step include effective use of the waste heat recovery in combustion furnaces and introduction of the gas pressure recovery generator in the iron and steel works and a waste heat recovery generator in cement plants.

Step 3-Process improvement

This is intended to reduce energy consumption by substantial modification of the production process itself by technological development. Needless to say, this is accompanied by a large equipment investment. However, this is linked to modernization of the process aimed at energy conservation, high quality, higher added value, improved product yield and manpower saving.

3.1. Energy Management

The first step in energy conservation is to understand the quantity of energy used with regard to fuel, electricity and water. Next, we have to concretely understand the consumption and purposes for which each kind of energy is used in the factories and processes. To do this, data analysis and measuring are needed. Next, we make tables of energy consumption and cost and prepare the countermeasures (in every factory and every process). The following 5 points show the necessary energy for production.

(1) The energy required for a process and its service : Loss of Product energy loss
(2) The energy required for containers and equipment : Loss of Equipment energy
(3) Energy lost due to control : Loss of Control energy
(4) Energy lost due to energy conveyance and control : Loss of Supply energy
(5) Loss due to the purchase and generation of energy : Loss of Generation energy

The sum of these 5 losses is added up as the company's fuel expenses, electricity expenses and water expenses. This table is called the "Energy Consumption Chart", and by making it we can find energy conservation themes and make the study of effective measures easier.

The energy conservation techniques in the food processing industry are classified as follows:

Sector	Liquid milk and dry milk	Bread	Beer
1st step	Efficient use of heat exchanger	Temperature control of baking furnace	Recovery of waste heat of cooling water
2nd step	Replacement of low effciency chiller	Waste heat recovery of baking furnace	Insulation of valves Waste heat recovery of molt pan Replacement of low efficiency chiller
3rd step			
Sector	Sugar	Bevarage	Kechup and jam
Sector	Recovery of waste heat of a filter	Shorten of idle operation time	Recovery of waste heat of cooling water
2nd step	Set of boiling pan stir	Insulation of tank Recovery of drain	Insulation of cooker
3rd step		Increase of operation rate	Increase of line speed
Equipment	Boiler		
1st step	Repair of steam leakage Combustion control Maintenance of burner nozzle		
2nd step	Waste heat recovery Recovery of drainage Preheat of feed water Modification of flash tank Insulation of boiler and valves		

3.1.1. Operation rate

The energy requirements of a factory include the electric power for lighting and air conditioning, as well as refrigerators and freezing equipment. These have an effect on the energy intensity due to the factory's operation rate. In addition, energy loss occurs due to stopping equipment already heated to high temperatue resulting of an increase in the loss of equipment energy. Therefore increasing production (such as amount of load, operation rate, and load factor) is effective for energy conservation.

3.1.2. Speed of line

There are optimum conditions for production line speed control, although the optimization of the consumption of power and thermal energy is being strived for.

There is an unestablished mutual connection with the operational rate, and generally this should be reexamined during equipment renewal.

Even if the overall energy consumption increases when factory production lines are speeded up, energy conservation is brought about by more products increase.

3.1.3. Required food processing machinery

Food processing machinery requirements are as follows.

1) Product safety and security
2) Good cleanliness
3) Good dismantling efficiency
4) Good inspection capacity

3.2. Energy conservation techniques in boilers

- Waste heat recovery

Loss of thermal energy occurs in boilers. The waste gas heat in the chimneys is particularly large, and it is recovered by the installation of economizers in the chimneys to preheate the feed water.

- Combustion conditions

Fuel oil is sprayed into the furnace from the spray nozzle of the burner tip. Therefore control of the diameter of the nozzle tip is important, becouse if the diameter is increased by 20%, the spray particles can get bigger, and more excess air is necessary for complete combustion; so periodical inspection and replacement are adviseable.

For oxygen control of exhaust gas in a fire tube boiler with 2 - 6 ton/H evaporation, with 4% O_2, an air ratio = O_2 / 21 - O_2 = 1.24 is aimed for. In a 10 - 30 ton/H water-tube boiler, with 2% O_2, the target is an air ratio of 1.05. These are tentative standards for fuel oil combustion, but the above targets are easily attained in the case of kerosene or gas boilers.

- Steam leakage

Auxiliary boilers are installed in many places in food factories. Steam generated by a boiler is passed through a pipe common to the adjacent boiler before being sent to the factory, so even a boiler which is not running is heated if there is a gate valve water leak, which involves a loss. It is necessary to repair factory plumbing leaks quickly.

- Recovery of drainage

Looking at examples where drainage from a production line is recovered in a condensate tank, steam often gets out of the upper part of the condensate tank. In such a case, sometimes a flash tank is fitted and used to preheat the boiler's combustion air, as shown in Fig. 16.

In this example, the increase in the amount of steam used after introducing energy must be dealt with, and flange steam and drainage are being looked at in all factories in order to carry out heat recovery.

It is planned to take another look at the flash steam and drainage of all factories for heat recovery. There is no information about a thermal balance calculated value, but the following results have been reported.

1. Money invested: ¥20,000,000
2. Money saved : ¥28,060,000/year
   Amount of recovered steam: 13,464 tons/year
3. Payback period: 0.71 year
4. Installation date: June 1989

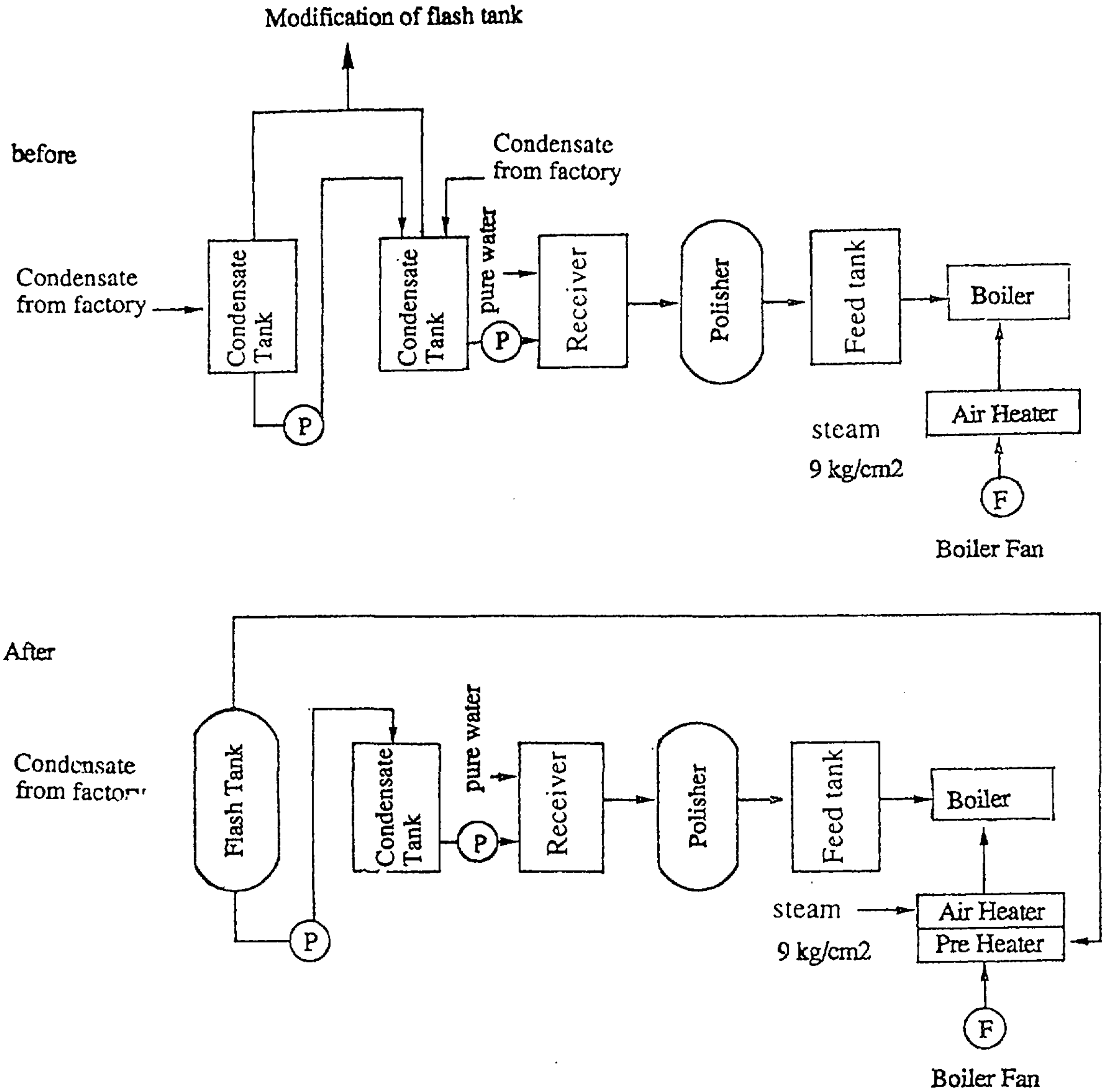


Figure 16 Modification of flash tank

- Heat exchange of feed water

Feed water should be almost pure water to prevent scaling occurring on the inside surface of the boiler, but 3 - 5% boiler water blowing is often carried out in an ordinary fire tube boiler. When heat recovery of thermal effluent within food factory processes is carried out, the effluent passes through a heat exchanger and supplies the boiler as good quality warm water.

3.3. Energy conservation techniques in bread factory baking furnaces

- Temperature control

In the bread molding process, bread is put into the furnace after putting it into the mold. Normal baking temperature is 220 - 230°C. If the factory control standard of 255°C is exceeded, the surface is clearly over-baked and sometimes it is burned. This means an increased control loss, and so a temperature which gives the proper color is needed. As shown in Fig. 17 we can see that an infrared range is desirable for heating foods, and has been rapidly developed recently. In practice, this is used for hollow baked cakes and rice crackers, and the baking time has been substantially shortened.

Energy conservation is strived for in bread baking factories by adopting a return method of recovering exhaust air and using it for the combustion air of a hot blast generating furnace.

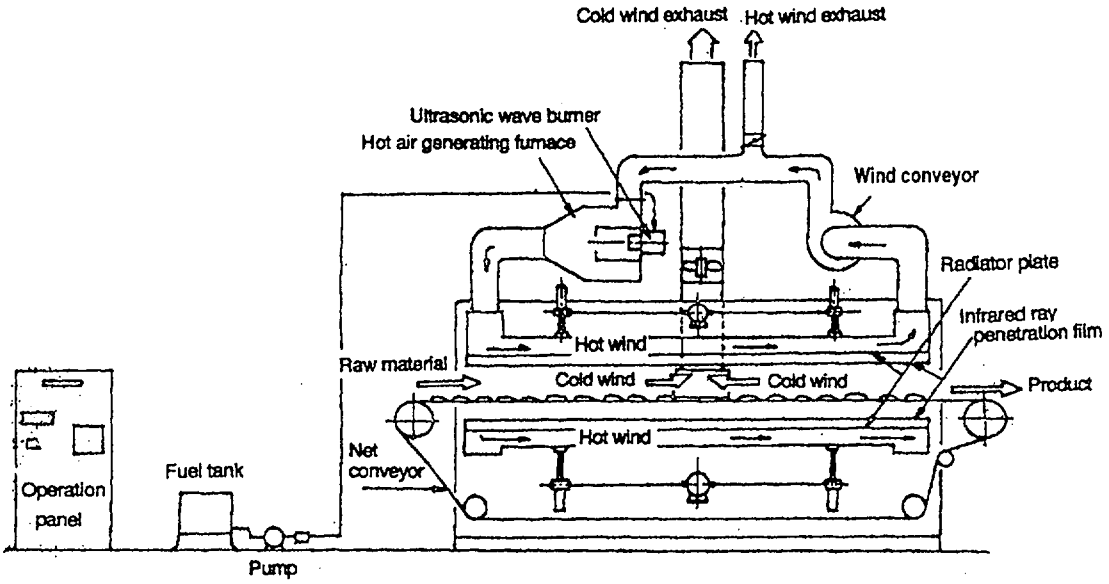


Figure 17 Extreme infrared continuous type baking furnace

3.4. Energy conservation techniques in molt pans in beer factories

Molt pans consume 65% of the thermal energy in beer factories. In Japan if a heat pump method is adopted to recover waste heat, first the heat exchangers are strengthened 2-fold for waste heat recovery, as shown in Fig. 18.

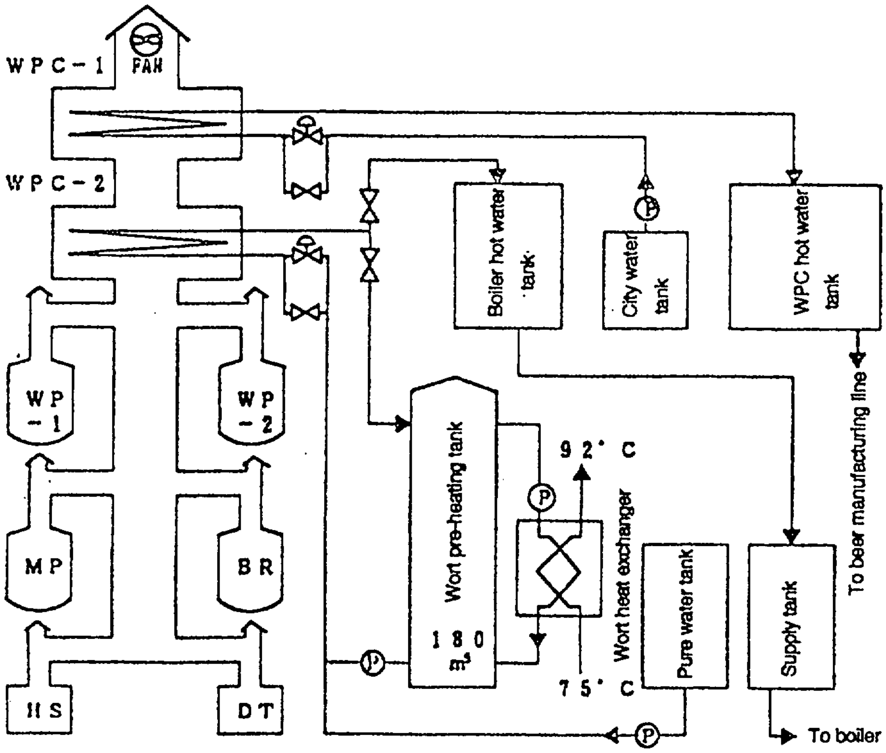


Figure 18 Input and WPC outline plan in beer blewery

A successful case of energy conservation.

Factory outline

1) Production items beer, soft drinks, liquified carbon dioxide
2) No. of employees 480
3) Amount of energy used per year

Amount of fuel used 8,264 kℓ

Amount of steam used 123,813 tons

Amount of power used 17,525,400 kWh

(In house generated power) 5,163,900 kWh

Outline of equipment

Wort Pan Containers WPCs (common name - Pancon)

In the insertion stage of the beer production process, finely crushed malt and hot water are put into a mash tub, rice and starch boiled in a rice cooker are added, the temperature is raised while moving from the mash tub to the mash pan, and extracted starch elements are changed to sugar by the action of enzymes to make wort. This is filtered, hops are added and the mixture boiled in a wort pan. A lot of condensate is generated by this temperature raising and boiling, which until 1981 was just released into the outside air; but in the same year, as an energy conservation measure, wort pan condensers (WPC 1) were installed to recover condensate as hot water. The WPC-2, shown in Fig. 18, was added in 1986 to recover the condensate that still remained.

Effects after measures

- Effect of shortening the time by adding wort pre-heated hot water

Number of times inserted per year - 2,493

Energy of 1 kg of steam - 660 kcal

Inlet average water temperature - 20°C

Amount of hot water added ($7.2m^3$ - $2.6m^3$) x 2,493 insertions/year = $10{,}969m^2$

Heat amount calculation (75°C - 20°C) x $10{,}969m^2$ = 603,295 x 103 kcal/kg

Steam conservation 603,925 x 10^3 kcal/kg ÷ 660 kcal/kg = 914 ton

Money saving 914 ton x ¥3,400/ton = ¥3,107,600

- Effect of reducing the amount of steam in the WPC hot water tank steam inline heater

12 and 14 times inserted per year – 1,029

Amount of reduced steam -0.62 ton/mixing

Amount of steam-1,029 times/year x 0.62 ton/mixing = 667 ton

Money saving- 677 ton x ¥3,400/ton = ¥2,301,800

- Effect of improving the sequence program

Time loss per mixing – 48 seconds

Time required per mixing - 1.5 hours

Amount of WPC hot water produced per insertion – $33m^3$

Steam heat amount -660 x 103 kcal/kg

48 seconds x 2,493 mixing/year = 119,664 seconds = 33 hours/year

33 hours ÷ 1.5 hours = 22 mixing

$33m^3$ x 22 mixing = $726m^3$

Amount of heat (90°C - 20°C) x $726m^3$ = 50,820 x 10^3 kcal/kg

Steam conservation 50,820 x 10^3 Kcal/Kg ÷ 660 kcal/kg = 77,000kg = 77 ton

Money saving 77 ton x ¥3,400 = ¥261,800

Total money of above 3 items

3,107,600 + 2,301,800 + 261,800 = ¥5,671,200

- Steam reduction rate 1.34% decrease from the amount of steam used last year

- Intangible effect

* The operation control became smoother because of control sequence improvements.
* The technique on operation of personal computer has been improved such as operation control method and sequencer operation.

3.5. Cooker

There has been an increase in the size of cookers along with the increase in size of food factories. Small cookers are often uninsulated. In particular, insulation work is not carried out because of the worry of leaking. The heat released from the surface of heating containers and furnaces is a result of natural convection and radiation. The radiation rate varies according to the quality of the surface material. The radiation rate can be increased by finishing the surface in jet black and color with aluminum paint, and so this is applied to small-size cookers which leak easily and are difficult to insulate. Normally it is possible to recover the cost of insulation in 2 - 3 years, when the surface temperature is 75°C or more. The actual size of the insulation can be as big as 25mm x 50mm.

The relationship between the furnace wall surface temperature and the amount of released heat can be calculated in the following way. The amount of heat released can be reduced much by the insulation.

Here is an example of an insulation calculation of a cooker. The cooker has a diameter of 1.5m and a length of 3.5m, as shown in Fig.19, and is a steam heater.

The released heat from the outside wall of the furnace which is installed inside the factory, in conditions of no wind, is calculated using the following equation.

$$Q = a \times (t-b)^{\frac{5}{4}} + 4.88\ \varepsilon\ \{((t+273)/100)^4 - ((b+273)/100^4\}$$

where

a: Natural convection coefficient, ceiling = 2.8, side wall = 2.2, furnace floor = 1.5,

Table 6 Radiation rates of various surfaces

Surface	Conditions	Temperature (°C)	Radiation rate ε
Aluminum	Highly polished surface	227-580	0.039~0.057
	Ordinary polished surface	23	0.040
	Rough surface	26	0.055
	Surface oxidized at 600°C	200-600	0.11~0.19
Iron and steel	Steel: polished surface	100	0.066
	Iron: polished surface	427~1.025	0.14~0.38
	Iron: coarse polished surface	100	0.17
Oxidized iron and steel	Iron: Dark surface	100	0.31
	Steel plate: Rolled steel	21	0.66
	Cast iron: Oxidized at 600°C	200-600	0.64~0.78
	Steel: Oxidized at 600°C	200-600	0.79
Aluminum paint	Aluminum content is reduced with time	100	0.27-0.67

Note 1) Japan Mechanics Society: Electrothermics data, p. 148

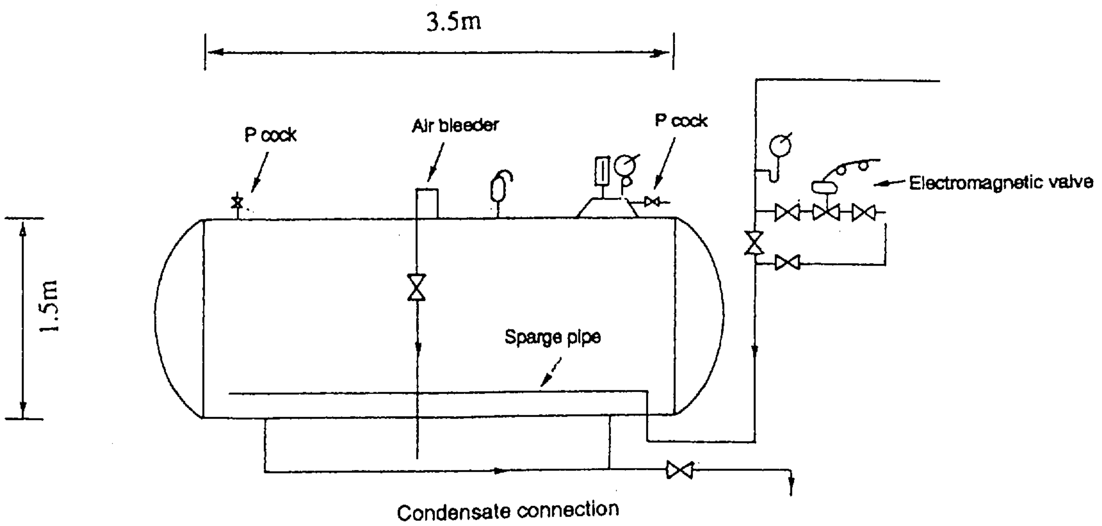


Figure 19 Retort cooker

horizontal cylinder furnace wall = 2.1

t: Outer furnace wall surface temperature (°C)

b: Air temperature surrounding the furnace (°C)

ε: Radiation rate of outer furnace wall

In the above equation, the first item on the right side represents the heat released by natural convection and the second item represents the heat released by radiation.

Radiation rates of various surfaces

The amount of released heat for an uninsulated cooker is as follows.

Cooker surface area: 15.7m^2

Surface temperature: 108°C

Air temperature: 34°C

Radiation rate of cooker's surface: 0.5 (dark brown)

$Q = 2.1 \times (108-34)^{\frac{5}{4}} + 4.88 \times 0.5\{((108+273)/100)^4-((34+273)/100)^4\}$

= 456 + 297 = 753 kcal/m2h

QA = (456 + 297) x 15.7 = 7159 + 4663 = 11822 kcal/h

The amount of heat released by natural convection is 7159 kcal/h, and the amount of heat released by radiation is 4663 kcal/h.

If insulated by 25mm of calcium silicate and an aluminum plate, as shown in Fig.20 the surface temperature is as follows.

$Q = (t_1-b)/(d/l + 1/a)$

where

t_1: Cooker inner surface temperature = 108°C

b: Air temperature = 34°C

d: Thickness of insulation material = 0.025m

l: Coefficient of thermal conductivity of insulation material = 0.042 kcal/mh°C

a: Natural convection coefficient, ceiling = 2.8, side wall = 2.2, furnace floor = 1.5, horizontal cylinder furnace wall = 2.1

Radiation rate of insulated cover surface = 0.04 (normally polished aluminum surface)

Q = (108-34)/(0.025/0.042 + 1/2.1) = 69 kcal/m^{2}h

Cooker insulated cover surface temperature (t_2) is as follows.

$t_2 = t_1 - Q \times d/l$

$= 108 - 69 \times 0.025/0.042 = 67°C$

The amount of heat released from the cooker surface with the insulation is reduced as follows.

$Q = 2.1 \times (67-34)^{\frac{5}{4}} + 4.88 \times 0.04\{((67+273)/100)^4-((34+273)/100)^4\}$

$= 166 + 109 = 275$ kcal/m^{2}h

$QA = (166 + 109) \times 15.7 = 2606 + 141 = 2747$ kcal/h

The amount of heat released by natural convection is 2606 kcal/h, and the amount of heat released by radiation is 141 kcal/h, and the reduction in heat released is 25% compared with before insulation.

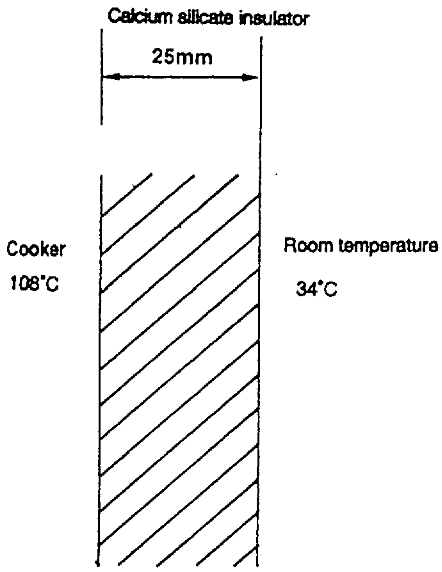


Figure 20 Insulation of cooker

3.6. Chillers

- Efficiency

Chillers are used in milk factories, beer factories, soft drinks and beverages factories etc. where low temperatures are required in the manufacturing In semitropical areas, the underground water temperature is high and it is difficult to increase the efficiency of chilling systems, so the chillers themselves are brought to the surface. In the case of Japan, the motors are small and compact compressors are used to increase the energy conservation of chillers. This might be a chance to take another look at chilling systems, by improving the cooling function of the condensation side of chillers. Cold water input and output control is needed in the case of air conditioning, combined use is needed when there are many machines, and the latest model chillers should be selected. A comparison of the kW output per 1RT (3,000 kcal/h) can also be referred to as a judgement standard. Apart from the most common examples of 1.5kW/RT, in parts of the Asian region there are also examples of 2kW/RT operations. The target is 1.0kW/RT, but factors such as the temperature in the region, must also be considered, and so a long-term study is necessary. Investment is needed, so energy conservation comes under Step 2. In table 7 there is an example of a canned vegetables factory where waste heat is later used.

Table 7 Use of chiller waste heat in a canned vegetables factory

Item		Pre-measure heat loss (%) (Note 1)		Post-measure heat loss (%) (Note 1) (Reduction rate %)	
Building	Process section	(Note 2) 22°C	12.3	22 °C	8.9 (28.0)
	Storage rooms	22°C		13 °C	
	Ceiling, side walls (Note 3)	Uninsulated		3 inch insulation	1.5 (87.9)
Equipment and pipe surfaces		Uninsulated	9.6	1 inch insulation	0.4 (96.1)
Hot drainage (Equipment drains, can cooling water, overflow water, etc.)		Unused	14.7	Drainage and can cooling water is used as boiler water.	7.6 (48.3)
				Drainage is used as boiler water and can cooling water is used for boiler supply water pre-heating.	8.2(44.3)
				Drainage and can cooling water is used for boiler supply water pre-heating.	9.2 (37.5)

(Note 1) Heat loss is proportional to the amount of input energy.

(Note 2) 22°C is the indoor temperature in winter (October - April).

(Note 3) Side walls are made of concrete blocks.

Remarks

1) This example is an actual factory in New York State, U.S.A., which has a range of 303 cans, 7,800,000 cases/year, 10,000 kcal/case of input energy, and a combination of retorts and continuous cookers.
2) Calculation assumed conditions
Boiler efficiency: 70%, heat exchanger efficiency :55%
Heat exchange rate : 85% (99°C drainage), 70% (30°C can cooling water)

- Refrigeration cycle

Refrigerant compressed by a compressor is sent to a condenser, then cooled by water and liquified, as shown in Fig. 21. The liquid refrigerant passes through an expansion valve and is vaporized in a vaporizer, at which time it takes the heat of vaporization from the surroundings thus carrying out the refrigeration operation. After this, the gaseous refrigerant returns to the compressor and the compression cycle is repeated.

The necessary energy to drive the compressor is in fact only a part of the energy taken from the surroundings in the vaporizer's refrigeration operation.

The type and output of the chiller is determined by the pressure loss, the required chilling capacity, the evaporation temperature and the pressure loss by pipe length.

The other specifications to be determined are as follows:

-Compression type:single stage/two stages

-Condenser type:water cooling/air cooling

-Compressor type:Reciprocating/screw

-Refrigerant:R22/ammonia

Production of R22 has been approved until the year 2010, but research into refrigerants for future models is underway, and there is a tendency to reconsider ammonia. Ammonia is harmful to the human body, and it is necessary to prevent leakage from a standpoint of safety and hygiene, but on the point of efficiency, it is thought to be compared with R22. (Substitute Freon). Normally the recipro method chiller is used in large factories. There has been a tendency recently to change compressor motors to small ones, to raise the efficiency of chillers. We can also see factories where worn-out chillers are being replaced with new models.

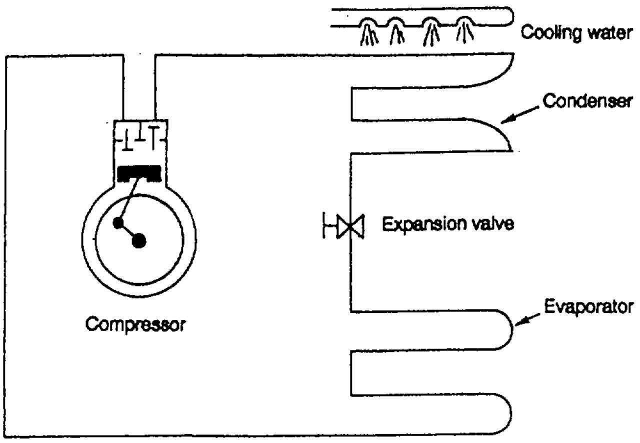


Figure 21 Refrigeration cycle

3.7. Steam piping inspection

A range of steam pipes should be allotted, and they should be thoroughly inspected. Steam leakage from valves, flanges and steam traps, etc. and places where insulation material is lost or is falling off can almost surely be found.

3.7.1. Steam leakage

Steam leakage is an important problem in energy management in a factory. Leaving the steam leakage alone means poor management of energy, and it also means many leakage of compressed air and water as well as steam.

The amount of steam lost due to steam leakage is actually extremely large, yet this is not widely recognized. Steam leakage of different diameters is shown in Fig.22. For example, if a 2mm hole is opened in a 5kg/cm^2 pressure steam pipe, 9kg per hour of leaked steam, or 6,480kg per month of leaked steam, will be diffused into the air and wasted. This is equivalent to about 500 liters of fuel oil.

If a 3mm hole is opened, there will be 14,400kg of leaked steam. If the amount of steam leakage from a hole (saturated steam) is called G(kg/h)

$G = 0.5626\ (D)^2\sqrt{P/V}$

D: hole diameter (cm)

P: steam pressure (kg/cm^2)

V: specific volume of saturated steam (m^3/kg)

3.7.2. Insulation

Thinking about insulation is also carefully avoided. There is a surprisingly large

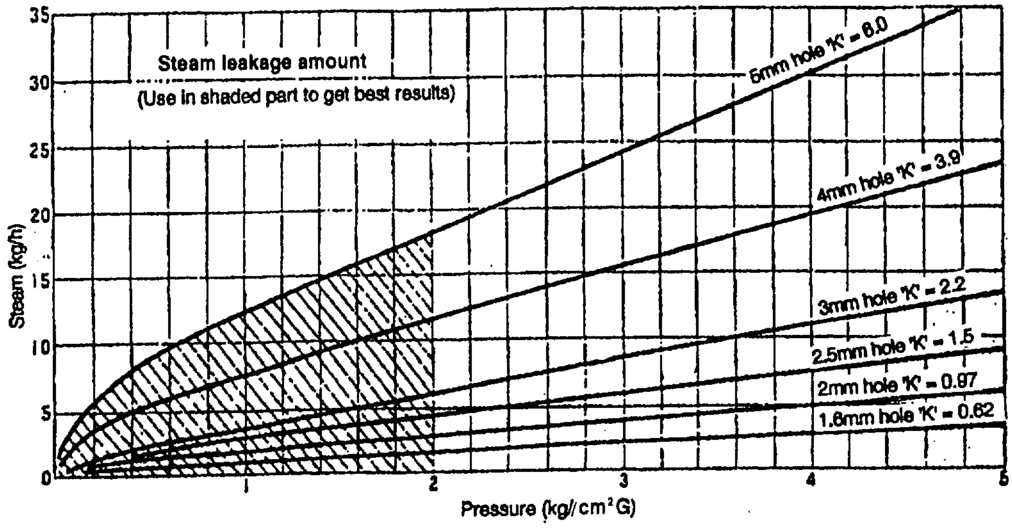


Figure 22 Steam emission of different diameters

number of factories with branch pipes which are uninsulated and left bare. There are also very few factories with insulated valve and flange parts.

Example of effectiveness of insulation of steam pipe per 1 meter length
(Steam pressure:5kg/ cm^2 ,Saturation temperature:158 ℃)

Pipe diameter	1"	1.5"	2"	2.5"	3"
Radiation haet of Bare pipe(kcal/mh)	225	320	400	505	590
Insulation thickness(mm)	50	65	65	65	65
Saved steam(kg/day)	9	14	17	22	27

In the case of a flange-type glove valve (10kg/cm^2), the insulated part surface suitable bare pipe length is 1.15m at 15A, 1.06m at 20A, 1.11m at 40A and 1.27m at 100A, about 1.1 - 1.3m of the same thickness piping is left uninsulated, and so if there are 100 valves in the factory then about 120m is uninsulated. Care is taken not to get the insulation wet.

Insulating all steam pipes inside an air-conditioned factory is effective.

3.7.3. Flash steam recovery

If a lot of steam drainage is recovered in factories that use a large amount of steam, such as sugar refineries or fruit juice concentrating factories, a flange tank is used.

Steam drainage which is generated from steam-using equipment is recovered in the flange tank shown in Fig. 23, and the flash steam which is revaporized in that tank is sent via a low pressure steam line and can be reused.

1) Flash steam calculation

The amount of flash steam generated is calculated with the following equation. Flash steam generation is shown in Table 8.

$W_F = ((h_1' - h_2') \div r) \times W_C$

W_F: Amount of flash steam (kg/h)

W_C: Amount of pre-flash drainage (kg/h)

h_1' : Specific enthalpy of saturated water under pre-flash steam pressure (kcal/kg)

h_2' : Specific enthalpy of saturated water under post-flash steam pressure (kcal/kg)

r: Latent heat of vaporization of saturated water under post-flash steam pressure (kcal/kg)

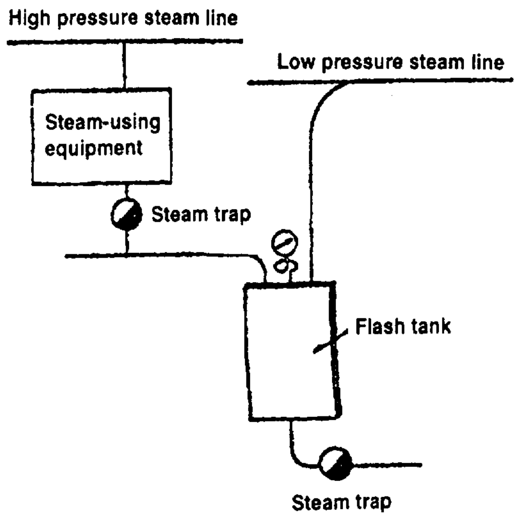


Figure 23 Steam drainage flash tank

3.8. Waste water treatment system

In Japanese large scale beer and soft drinks factories, there have been actual reductions in waste water treatment air blower electricity costs. Fig. 24 shows the waste water treatment equipment.

Factory outline

1) Production items : beer, orange, lemon, and carbon dioxide gas

Aeration blower system is shown in Fig.25.

Table 8 Flash steam generation (m^3/t)

High pressure lateral pressure kg/cm^2G	Flash tank intemal pressure kg/cm^2G																	
	0	0.3	1	1.5	2	3	4	5	7	10	12	14	15	16	20	30	40	50
1	66.3	33.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	109.4	67.4	23.1	10.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	142.2	93.3	40.7	23.4	12.2	-	-	-	-	-	-	-	-	-	-	-	-	-
4	169.1	114.6	55.1	34.2	22.2	7.7	-	-	-	-	-	-	-	-	-	-	-	-
5	192.2	132.8	67.5	43.5	30.8	14.4	5.4	-	-	-	-	-	-	-	-	-	-	-
7	230.5	163.1	88.0	58.9	45.2	25.4	14.5	7.7	-	-	-	-	-	-	-	-	-	-
10	276.3	199.2	112.5	77.2	66.2	38.6	25.3	16.9	7.1	-	-	-	-	-	-	-	-	-
12	301.8	219.3	126.2	87.5	71.7	46.0	31.4	22.0	11.1	3.0	-	-	-	-	-	-	-	-
14	324.5	237.2	138.4	08.6	80.2	52.6	36.7	26.6	14.6	5.6	2.3	-	-	-	-	-	-	-
15	335.1	245.7	144.1	100.8	84.2	55.6	39.3	28.7	16.3	6.9	3.4	0.9	-	-	-	-	-	-
16	315.2	253.6	149.5	104.9	87.9	58.5	41.6	30.8	17.9	8.1	4.4	1.8	0.8	-	-	-	-	-
20	381.7	282.4	169.1	119.5	101.6	69.1	50.3	38.1	23.6	12.4	8.1	5.1	3.9	2.9	-	-	-	-
30	456.4	340.6	208.6	149.1	129.0	90.3	67.7	53.0	35.1	21.1	15.6	11.7	10.2	6.9	4.9	-	-	-
40	544.2	387.1	240.1	172.7	151.0	107.3	81.7	64.8	44.3	28.0	21.6	17.0	15.2	13.6	8.9	4.1	-	-
50	564.2	426.6	266.9	192.8	169.7	121.8	93.5	74.9	52.2	33.9	26.7	21.6	19.5	17.7	12.3	5.2	1.8	-

The result of trying sensor control, so that the DO (Dissolved Oxygen) values of each block are made uniform, are shown in Fig. 26,

and the energy saving below is obtained.

27,000 (kWh)

Energy conservation rate

22.8%

(Revised electric power/previous year's electric power x 100 .... average value)

In this plant, blower operation stops automatically by the use of sensors. In recent years, many factories control blower operation by rotatation speed of motor.

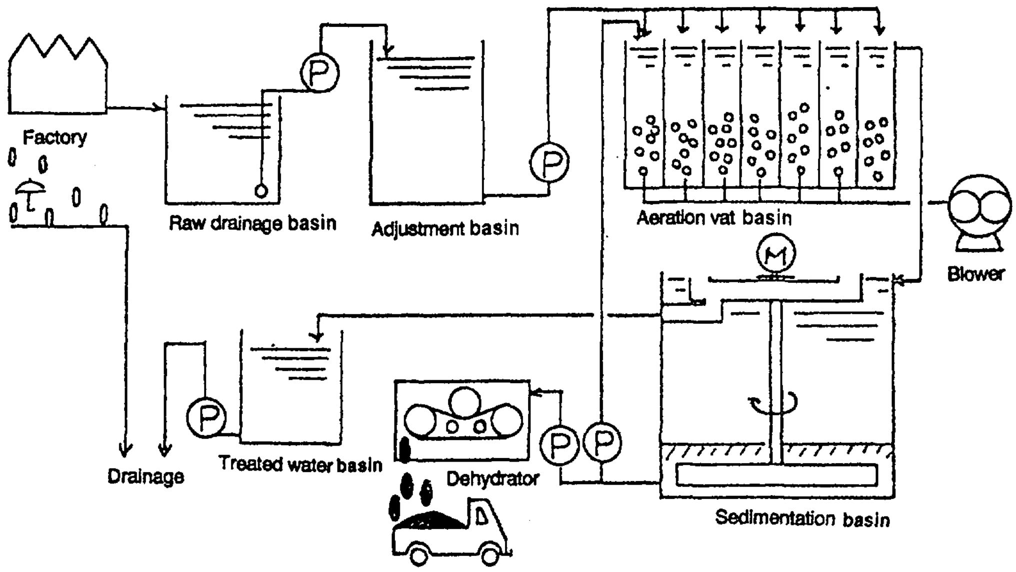


Figure 24 waste water treatment equipment

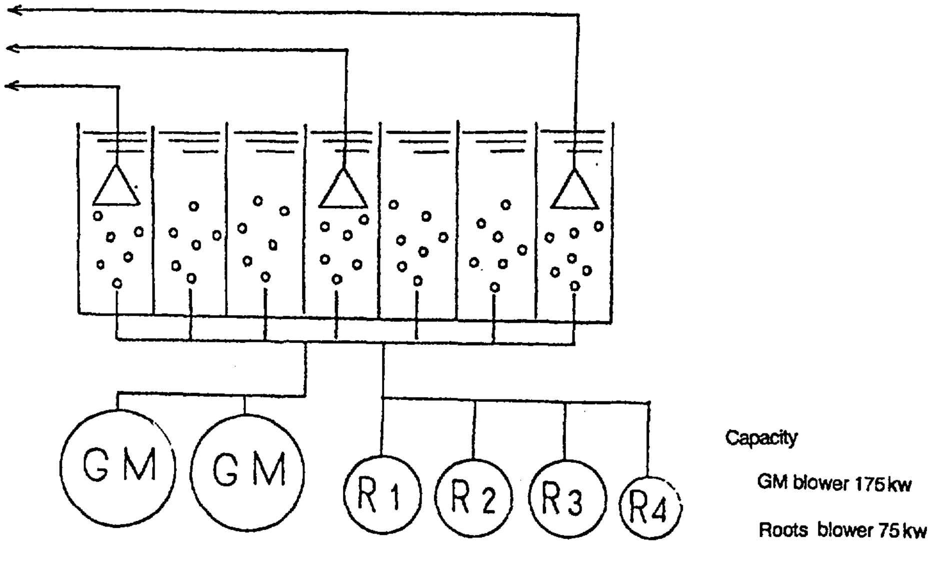


Figure 25 Aeration blower systematic diagram

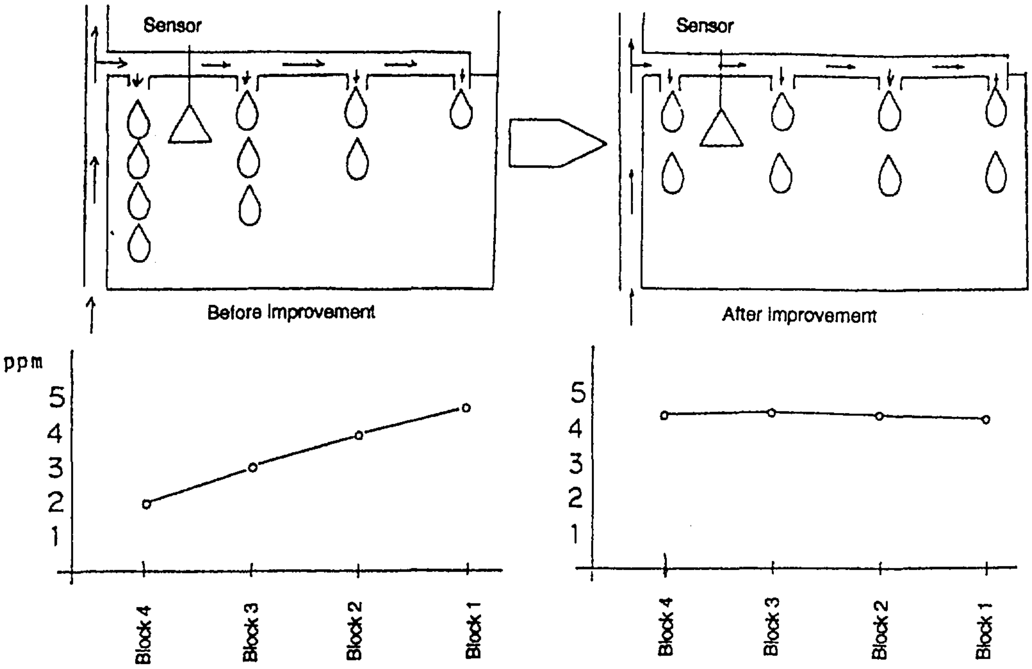


Figure 26 Raw wastewater inflow control and DO value adjustment

4. Conclusion

We have taken the typical types of industries in the food processing industry and mentioned their production processes and main equipment, and we have talked about the problems and energy conservation measures that are particularly important in the processes and equipment of each industry. There are 3 steps in energy conservation, and the activity of each step has been underway for the past 20 years.
In developing countries,first step activities such as combustion control and insulation are not yet implemented. We have also discussed how actual results in second step activities which require much investment, have been accumulating. Where there is investment, the pay-back period varies depending on the operating time of equipment, but if we assume a 2 shift or 3 shift operation, efficiency is good and there is a high possibility that investment will be considered. This is also an opportunity to replace those pieces of equipment which have become out of date, and it is hoped that models and equipment will be selected according to energy conservation methods. This probably applies to refrigeration equipment, etc., installed in food processing factories. The food processing industry is improving the quality of products based on hygiene, and high speed machinery packing operations and sterile packing technology are being developed along with the research and required increases in order to add value. These are factors which can improve energy intensity, and are therefore helpful towards the effective use of energy. We hope this manual will be supplied as a reference, to energy managers to achieve even more energy conservation.

HANDY MANUAL

PLASTIC FORMING INDUSTRY

Output of a Seminar on Energy Conservation in Plastic Forming Industry

Sponsored by

United Nations Industrial Development Organization (UNIDO)

and

Ministry of International Trade and Industry (MITI), Japan

Hosted by

Ministry of Petroleum and Natural Gas, India

Ministry of Water and Power, Pakistan

Organized by

The Energy Conservation Center (ECC), Japan

1995

India **Pakistan**

PREFACE

The conservation of energy is an essential step we can all take towards overcoming the mounting problems of the worldwide energy crisis and environmental degradation. In particular, developing countries are interested in increasing their awareness of inefficient power generation and energy usage in their countries. However, usually only a minimum of information on the rational use of energy is available.

The know-how on modern energy saving and conservation technologies should, therefore, be disseminated to government and industrial managers, as well as to engineers and operators at the plant level in developing countries. It is particularly important that they acquire practical knowledge of the currently available energy conservation technologies and techniques.

In December 1983, UNIDO organised a regional meeting on energy consumption as well as an expert group meeting on energy conservation in small- and medium-scale industries for Asian countries. The outcome of these promotional activities prompted UNIDO to initiate a new regional programme designed to increase the awareness and knowledge of government officials and industrial users on appropriate energy saving processes and technologies. In 1991, the first project, Programme for Rational Use of Energy Saving Technologies in Iron and Steel and Textile Industries in Indonesia and Malaysia (US/RAS/90/075), was approved and financed by the Government of Japan.

The successful completion of this project prompted UNIDO to request the financial support of the Government of Japan to carry out similar projects under this programme in other developing countries. Since 1992, under continuous support of the Government of Japan, two other projects have successfully been completed: Rational Use of Energy Saving Technologies in Pulp and Paper and Glass Industries in the Philippines and Thailand (US/RAS/92/035); and Rational Use of Energy Saving Technologies in Ceramic and Cement Industries in Bangladesh and Sri Lanka (US/RAS/93/039).

This year the programme is being implemented in India and Pakistan, targeting two energy intensive industrial sub-sectors; namely, plastic forming and food processing industries.

In the plastic forming industry, a substantial amount of energy is consumed. Excessive use of energy is usually associated with many industrial plants worldwide, and plastic forming plants are no exception. Enormous potential exists for cost-effective improvement in existing energy-using equipment. Also, application of good housekeeping measures could result in appreciable savings in energy. Therefore, it is imperative to introduce and disseminate information about modern energy saving technologies among the parties concerned in government and especially, at plant level, in industries.

In order to achieve the objectives of this programme, the following strategy is being used:

1. Conduct surveys of energy usage and efficiency at plant level, to establish the required energy saving measures.
2. Prepare handy manuals on energy management and energy conservation techniques and technologies, based on the findings of the above surveys.
3. Present and discuss the content of the handy manuals at seminars held for government officials, representatives of industries, plant managers and engineers.
4. Disseminate the handy manuals to other developing countries for their proper utilization and application by the target industrial sector.

The present Handy Manual for the plastic forming industry was prepared by UNIDO, with the cooperation of experts from the Energy Conservation Center (ECC) Japan, on energy saving technologies in the framework of the above-mentioned UNIDO programme. It is designed to provide an overview of the main processes involved in food processing, and present a concise guideline for the recommended energy saving measures.

Appreciation is expressed for the valuable contribution made by the following institutions to the successful preparation and publication of this manual:

- Ministry of Petroleum and Natural Gas, India;
- Ministry of Water and Power, Pakistan;
- Ministry of International Trade and Industry (MITI), Japan; and
- The Energy Conservation Center (ECC), Japan.

October 1995

Contents

1. Production process of plastic forming

1.1 History of plastic forming process

The word "plastic" means substances which have plasticity, and accordingly anything that is formed in a soft state and used in a solid state can be called a plastic. Therefore, the origin of plastic forming can be traced back to the processing methods of natural high polymers such as lacquer, shellac, amber, horns, tusks, tortoiseshell, as well as inorganic substances such as clay, glass, and metals. Because the natural high polymer materials are not uniform in quality and lack mass productivity in many cases, from early times it has been demanded in particular to process them easily and into better quality and to substitute artificial materials for natural high polymers. Celluloid, synthetic rubber, ebonite, and rayon are these artificial materials.

Presently, it is defined that the plastics are synthesized high polymers which have plasticity, and consequently substances made of these natural materials are precluded.

The history of plastic forming started together with the development of phenol resin in the beginning of the 20th century. Originally, plastics were not produced as plastic materials but derived from improvement of natural materials, and therefore, their processing methods also progressed on the extended line of conventional processing methods.

Several years after the industrial production of phenol resin, the production of vinyl chloride resin started, and then the production of styrene-based resins started. By the end of the firse half of the 20th century, almost all main materials of synthetic resins were developed.

As to the forming methods, it is said that the first injection molding machine was put to use in Germany in 1921; however, it can be said that this machine is an extension of the die-cast machine. All basic methods using pressing machines, rolling machines and extrusion machines had already existed since early days. The development and prevalence of plastic forming as shown today can be ascribed to the characteristics of materials, prices, and good processability arising from the uniformity of artificial materials and, in addition, their mass produceability and allowance for cost reduction.

An industry does not develop until there are demands and supply for the demands. The plastic industry is an exemplar model to meet these demands. This exemplar model, however, could cause unexpected harmful influences if the long-term perspective of plastics is not taken into consideration. One of them is the problem of treatment of wastes and another is the problem deriving from excessive consumption of energy.

1.2 Production process of plastic forming

There are two types of plastics. One is called thermosetting resin which does not soften again once it is formed and hardened, and the other is called thermoplastic resin which becomes soft or hard when its temperature rises or falls.

Although thermosetting resin has an older history, the majority of the presently used plastics are made of thermoplastic resins. The main plastic forming methods are shown in Table 1.

Table 1. Plastic molding process

No.	Molding process	Product
1.	Extraction molding	Pipe, etc.
2.	Injection molding	Bucket, housing of office automation equipment
3.	Blow molding	Container, bottle
4.	Vacuum forming	Packcase for egg (thin film product)
5.	Pressure forming	Suitcase (thick sheet product)
6.	Rotation (Roto) molding	Bottle, doll
7.	Inflation process	Film, sack
8.	Calender process	Film, sheet
9.	Fluidized bed process	Tub
10.	Compression molding	Electric parts: plug, switch box
11.	Transfer molding	Package molding for integrated circuit
12.	Pull trusion mold bar	

Among the methods mentioned above, 3 main methods are explained below.

1.2.1. Injection molding process

Fig. 1 shows the forming process. Figs. 2 and 3 show injection machines.

(1) In general, material arrangement and coloring are carried out in separate process.

(2) The drying process may be required for some plastics but not required by others.

(3) Materials are supplied to a molding machine from a hopper.

(4) Materials are heated to be plasticized with a heating cylinder. There are various methods for this process. The most popular method is as follows: The screw in-line feeds materials forwards while the screw itself goes rearwards, and when a specified volume of plastic material for plasticity is completed, the screw is moved forwards

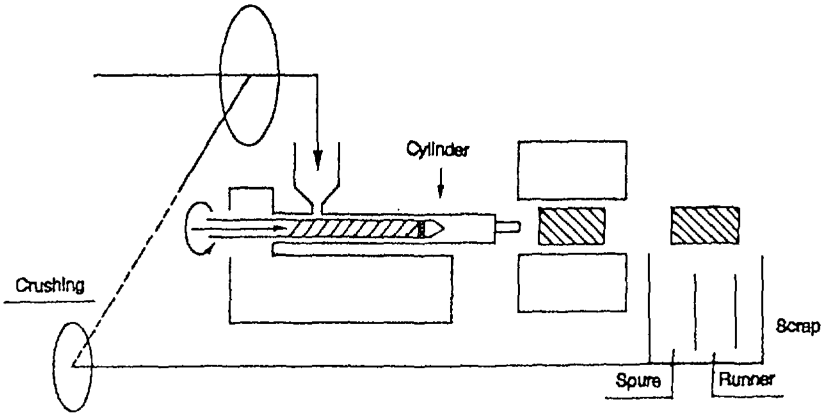


Figure 1 Injection molding process

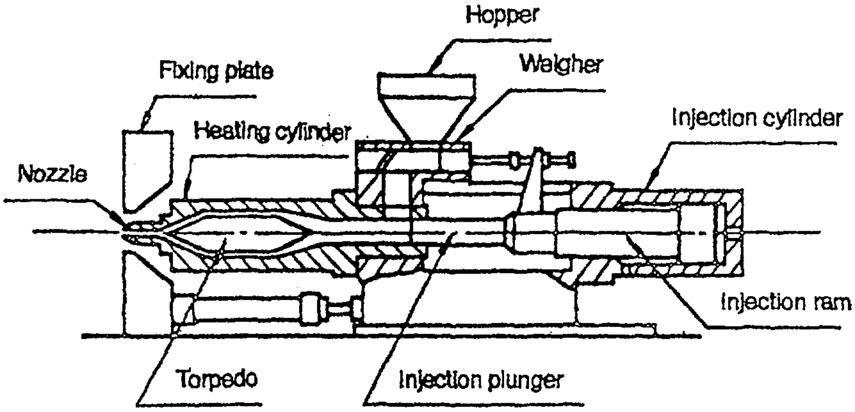


Figure 2 Plunger type injection equipment

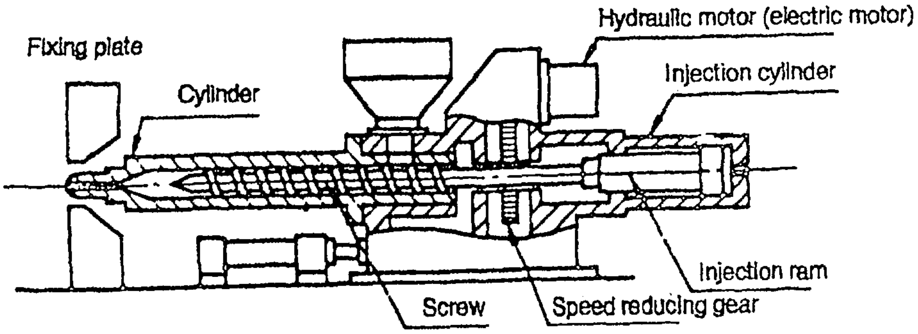


Figure 3 Screw type injection equipment (In-line screw system)

and a plastic resin is injected and charged into a closed die to mold a shape.

(5) The resin that has filled up the inside of the cavity of die is cooled in the die and becomes solid.

(6) The die is opened to take out molded products. Parts other than products (spure, runner, fin, defective products, etc.) which are produced by this process are regarded as non-conforming products and they can be used again as molding materials.

1.2.2 Extrusion molding process

Fig. 4 shows an extrusion molding process.

Fig. 5 shows an extrusion machine. Although there is no difference from the injection molding until a material is supplied, when the material is heated plastic in the heating cylinder, the position of screw is fixed, in general. Therefore, a resin which is made plastic is discharged continuously from the die. The discharged resin is molded into the basic shape and finally formed with the sizing die and cooled and solidified. The receiving equipment serves an auxiliary function to receive extruded products.
The products are cut or wound up according to their characteristics and purpose of use.

This molding method is most suitable for molding pipes, sheets, and films with uniform cross sections.

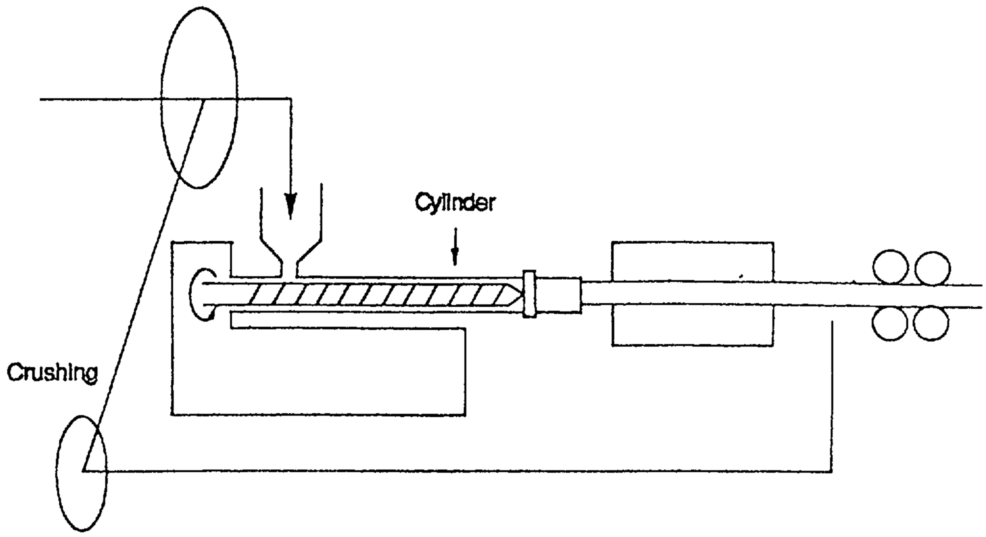


Figure 4 Extrusion molding process

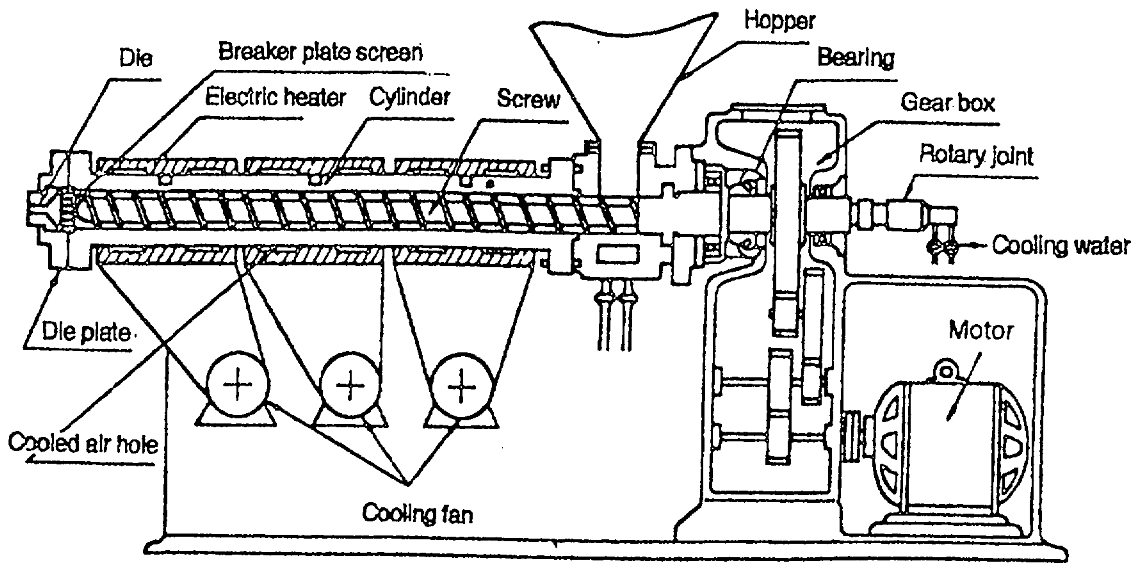


Figure 5 Mono-axis extruder

1.2.3. Blow molding process

There is no difference from the injection molding and extrusion molding until a material is carried into the hopper. The blow molding is a method which clamps a cylindrical material called "parison" with split molds and blows air inside to blow it up and press it onto the inner wall of the die. Fig. 6 shows the blow molding process.

The parison is a word which is used only for the blow molding and indicates a material in the form of a tube, pipe (bottomless or bottomed) or a pair of sheets before the material is blown up during the blow molding.

There are 2 molding methods for this parison; one is the direct blow method as shown in Fig. 7, in which the material is pushed out in the form of a pipe from the extrusion molding machine and the other is the injection blow method as shown in Fig. 8, in which an injection molding machine is used to form the material into a bottomed parison like a test tube.

In the case of the injection blow, the method called "extension blow", in which the material is blown up not only in lateral direction but also in longitudinal direction for improvement in physical properties, as shown in Fig. 9 is often used

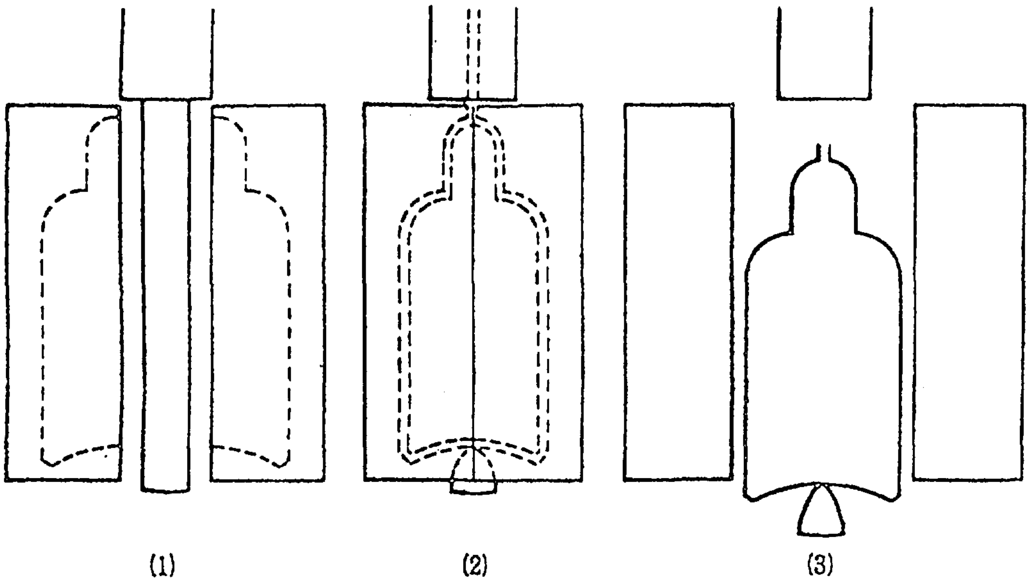


Figure 6 Blow molding conceptual drawing

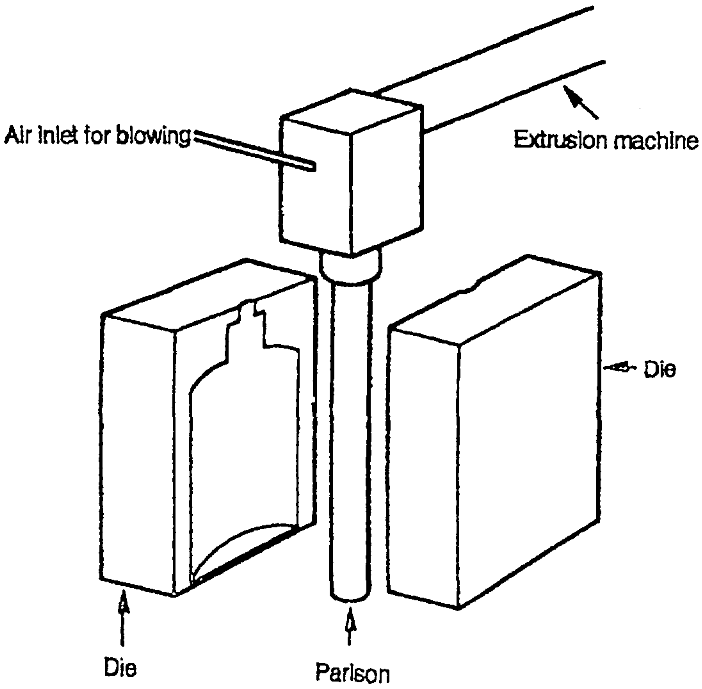


Figure 7 Direct blow conceptual drawing

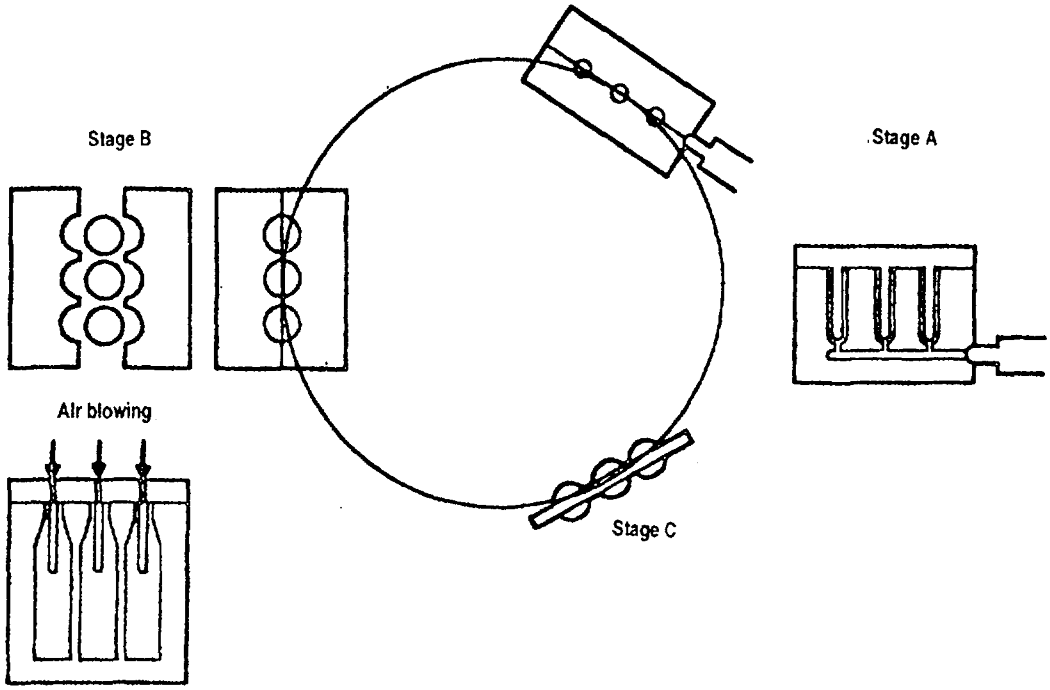


Figure 8 Conceptual drawing of injection blow molding machine

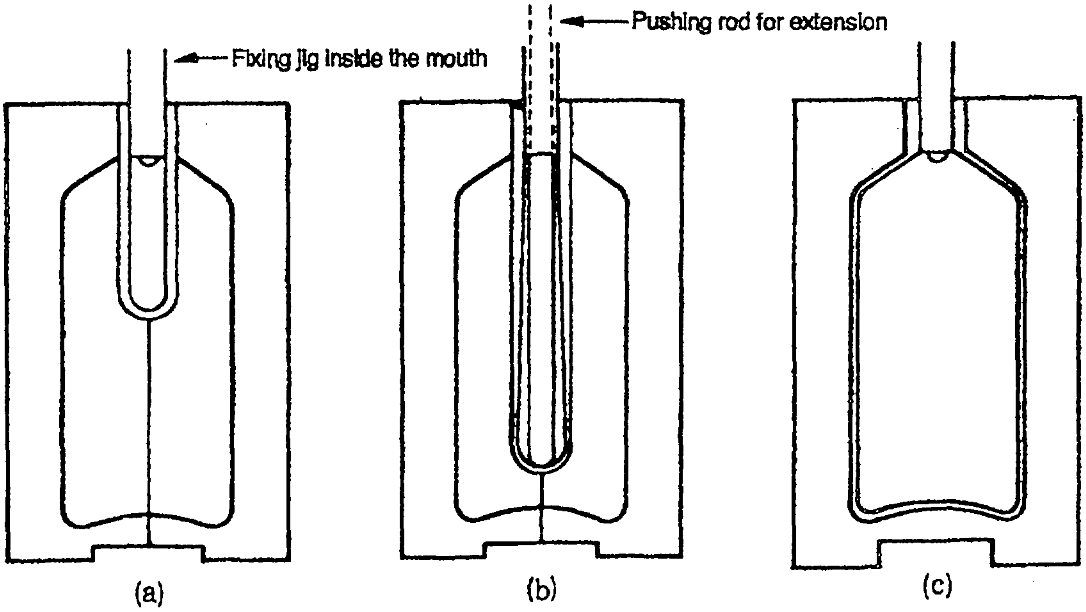


Figure 9 Conceptual drawing of extension blow molding process

1.2.4 Classification of plastic materials

Plastic materials consist of the thermosetting type and the thermoplastic type. Fig. 10 shows a classification of plastic materials and the production amount of plastic materials in Japan in 1994. The thermosetting materials account for less than 20% of all plastic materials, and the majority of them are used as coating agents and adhesives. Therefore, almost all plastic products are thermoplastic. Engineerring plastic does not yet account for 20% of all plastics.

Therefore, almost all of plastics forming products are thermoplastics resin. Engineering plastics which are PET(polyethylene telephthalare)bottles and polyesther film does not yet account for 20% of all plastics.

Accordingly,most of the materials for plastics forming products are vinyl cride, polystyrene and polyolefine.

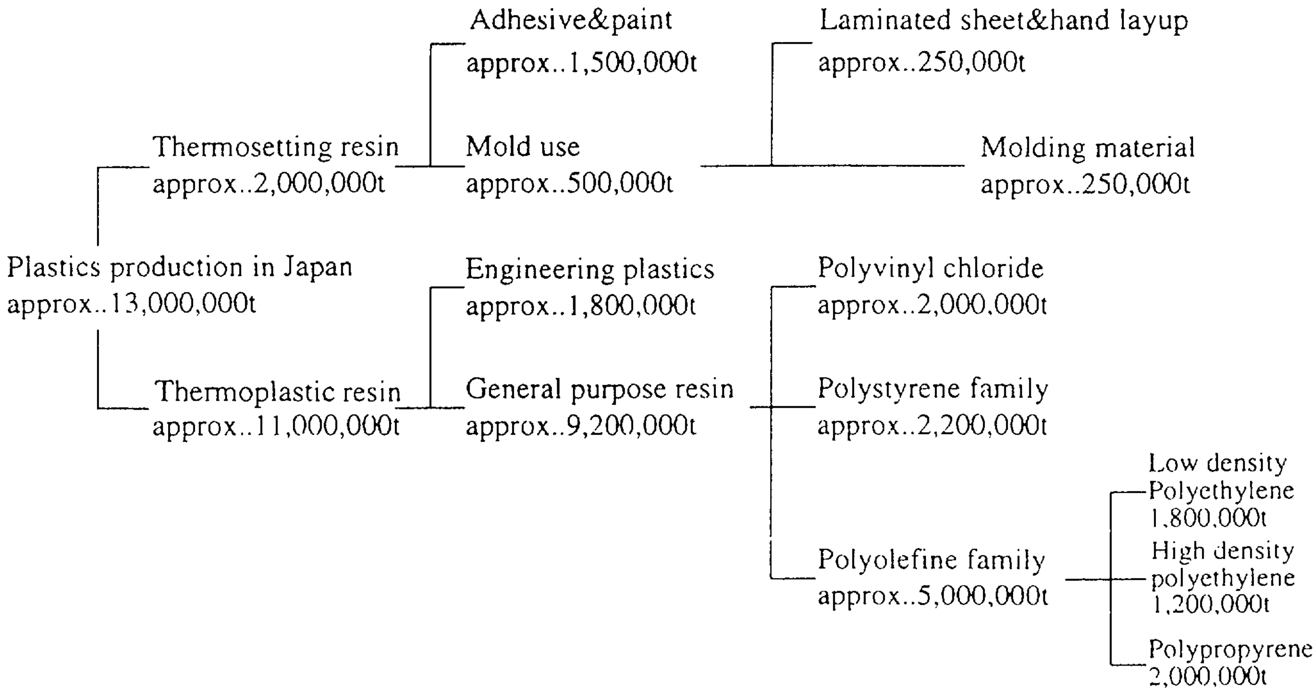


Figure 10 Amounts of plastics production in Japan (1994)

2. Characteristics of energy consumption in plastic forming

The production systems using plastic molding machines are shown in Fig. 11. The state of energy consumption in each system is as follows:

1) Molding machine: Consumes energy to melt and extrude material pellets.

2) Material supplying system: Consumes energy to operate the material supplying conveyors and to dry materials.There are 2 cases where scraps and runners of product are crushed and used again as materials and where they are crushed and melted again and regenerated as material pellet with an extruding machine, and energy is consumed for crushing, remelting and pelletization.
3) Die exchange system: Consumes energy necessary for preparation and machining of die, and also, consumes energy to regulate temperature of die (cooling).
4) Product taking out system: Consumes energy to cool products when they are taken out. After runners are taken out, they are crushed and used as material again. Crushing them also consumes energy.
5) Physical distribution system: Consumes energy for vehicles and cranes to transport and store products.
6) Information control system: Energy is consumed by monitors and computers for setting conditions and information control.

Among the above-mentioned systems, it is the forming machines that consume the most energy.

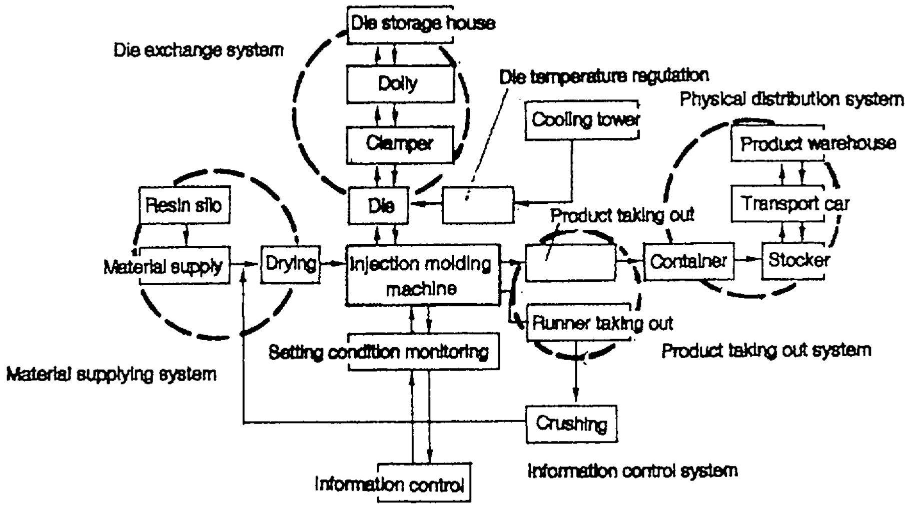


Figure 11 Plastic molding products manufacturing system

Presently almost all molded plastics are thermoplastic products. The basic method to form thermoplastic pellets is to "set a thermoplastic material in plastic state by heating" and form into "a desired shape" and then "cool and solidify it." The basic forming process is as follows: Heating for plasticity —-> forming —-> cooling and solidifying.

3. Promotion of energy conservation technique

Energy conservation in industrial sectors starts from the software including operation control and process control, then extends into the hardware including equipment improvement and process improvement. Generally, energy conservation efforts can be classified into the following three steps:

Step 1 - Good housekeeping

Energy conservation efforts, made without much equipment investment, include elimination of the minor waste, review of the operation standards in the production line, more effective management, improvement of employees' cost consciousness, group activities, and improvement of operation technique.

For example, such efforts include management to prevent unnecessary lighting of the electric lamps and idle operation of the motors, repair of steam leakage, and reinforcement of heat insulations.

Step 2 - Equipment improvement

This is the phase of improving the energy performance of the equipment by minor modification of the existing production line to provide waste heat and pressure recovery equipment or by introduction of efficient energy conservation equipment, including replacement by advanced equipment. For example, energy conservation efforts is this step include effective use of the waste heat recovery in combustion furnaces and introduction of the waste pressure recovery device and waste heat recovery generator in the steel and iron works and cement plant.

Step 3 - Process improvement

This is intended to reduce energy consumption by substantial modification of the production process itself by technological development. Needless to say, this is accompanied by a large equipment investment. However, this is linked to modernization of the process aimed at energy conservation, high quality, higher added value, improved product yield and manpower saving.

The following Table2 shows the classification of energy conservation techniques in the plastic forming industry:

Table 2 Three steps of energy conservation in the plastic forming

	Raw material process	Molding process	Plant
1st step	1)Quality control of raw material	1)Suitable plasticity method 2)Suitable heater connection 3)Increase in forming speed 4)Suitable forming method and equipment 5)Hydraulic operating fluid 6)Compressed air leakage 7)Suitable cooling system	1)Reduction inpreparation time at start 2)Reduction in time for change of products 3)Improvement of yield 4)Improvement of power factor of transformer 5)Emission of non-conforming products
2nd step		1)Heat insulation of heating cylinder	
3rd step	1)Scrap recycling	1)Change of driving system	

3.1 Raw material process

3.1.1 Quality control of materials

The forming materials have unexpectedly large non-uniformity of quality. Although the non-uniformity of quality of general purpose materials which are supplied continuously may not be very conspicuous, it should be assumed that this non-uniformity of engineering plastics is very large in batch production. Therefore, control of products and material lots should always be made.

Although the non-uniformity of quality may not be a serious problem for injection molding, it is an important factor for extrusion molding and blow molding.

The sizes of pellets also influence the forming property significantly. In particular, when pellets are used in the flake form, attention should be paid as much as possible to the uniformity of size and mixing ratio.

Coloring is generally conducted in a separate process. However, when the coloring quantity is large, coloring may be carried out by mixing coloring pigment with the screw (hopper blending).

Quantity of coloring with the master batch may not require much attention, but when a dry color or a liquid color is used, then it is necessary to take the color change procedure into account.

If pellets in the form of flake or pellet of extremely different sizes are transferred with the hopper loader or the dryer by combined use of the hopper loader, there is a possibility of causing separation of pellets resulting in defective molding.

3.1.2 Return control of scrap

There are many cases where scraps are put to a batch control. However, properties of scrap differ greatly in quality depending on their origin. For example, spure and runner as well as films under production which are just ejected remain utterly clean, therefore, it is required to return them on the spot. For example, polyester family resins (PET resin, etc.) which need sufficient drying are not humid immediately after forming. Hence, no re-drying is necessary if they are returned dry. Accordingly, it is utterly useless to stock them, allow them to absorb humidity, dry them for extrusion, or to soak them in water to let them absorb humidity.

In comparison, scraps which were generated after the finishing process as well as scraps which have fallen on the floor are extremely fouled. In general, the former can be flaked and returned again without any further treatment, while the latter should be melted and pelletized to remove rubbish and other contamination. For this purpose, automation of the finishing process should be progressed, equipment which can prevent scraps from falling on the floor should be prepared, and finish of the floor should be improved.
(At least, the floor should be finished to lustering polish cement which allows cleaning with a mop.)

Moreover, to regard various scraps which are so different in quality and to mix them together will reduce the quality of returned materials and push up the returning cost (energy cost in various meanings).

It is important to control the origin of occurrence of scraps. It is against the principle to remove contamination at the step of molding machine operation. The net of molding machine is provided in order to improve the mixing effect and to eliminate contamination, although their effects are not outstanding.

3.2 Molding process

3.2.1. The insulation of heat cylinders

As a rule, thermoplasticity is provided at the heating cylinder. A thermal medium such as oil may sometimes be used for heating. In general, however, this process is carried out only with an electric heater that uses resistance heat generation.
What is important in this context is the insulation of the heating cylinder.

The insulation of the heating cylinder does not simply mean to surround the heating cylinder with a heat insulating material so as to keep heat inside the heating cylinder. It is true that plasticity of resin is provided by heating the heating cylinder externally, the pieces of resin sufficiently rub against each other while they are transferred with the screw and they are heated by friction with the internal wall of the heating cylinder and by shearing force. And so, heating with the heater is the principle, but cooling is also required sometimes. In general, heating is carried out using an incomplete cover (without any cover in same cases) to provide air cooling on a constant basis.

Tig. 12 shows an example of a good cover in order to prevent heat radiation from heating cylinder (Fig.13). The cover is specified to have a dual wall, and a heat insulating material such as rock wool is inserted inside. A window is provided in a suitable portion, and it is opened and shut automatically in proportion to the rise of temperature. It is better if a blower is provided to it. The inside and outside of the cover and the heater holding bands need to be made of stainless steel or an equivalent which has a metallic luster and is free from rusting. If these improvements are not available, provide a cover which can fully enclose the heating cylinder, at least.

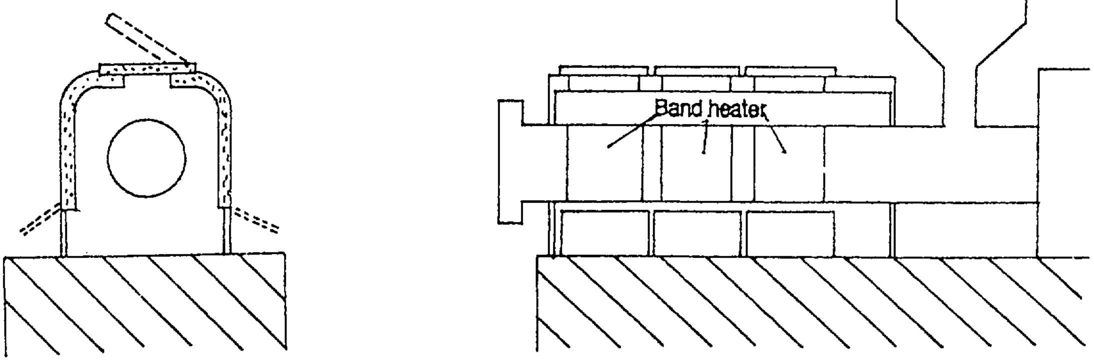


Figure 12 Heating cylinder cover

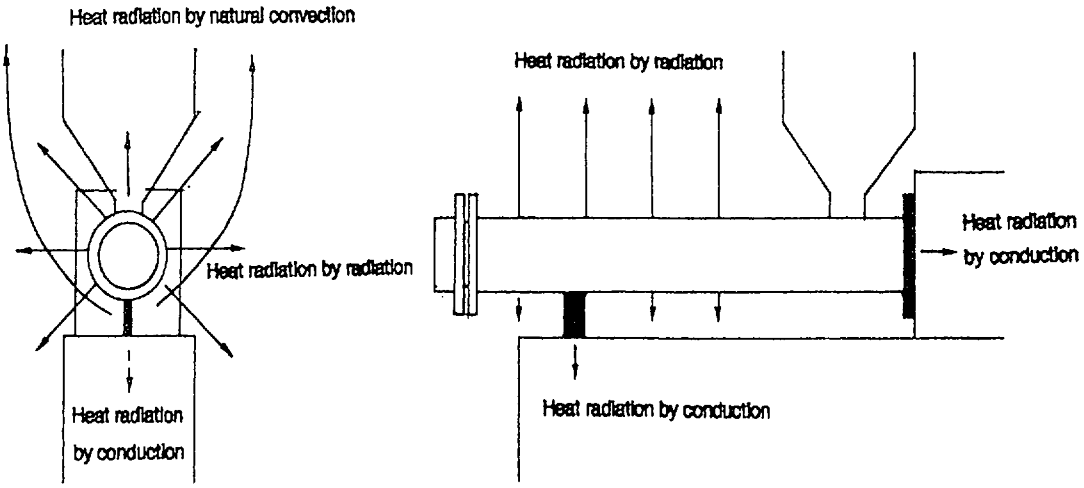


Figure 13 Heat radiation from heating cylinder

Heat loss from the heating cylinder is caused by conduction, convection and radiation from the contacting portions of the machine proper and others. Apart from conduction, we calculate heat radiation volume by convection and radiation. Assuming that:

Outer diameter of heating cylinder: 20 cm

Length of heating cylinder: 1.5 m; Surface area = $0.942 m^2 = 0.2 \times 3.14 \times 1.5$

Surface temperature of heating cylinder: 277°C (550°K)

Room temperature: 27°C

Wall surface temperature: 17°C (290°K)

Then, the heat conduction volume, q, (heat radiation volume) by natural convection per unit time and unit area is expressed by the following equation:

$$q = \alpha \Delta T$$

α is a conduction rate by natural convection, which is approximately $5 W/m^2.k$ and approximates $10 W/m^2.k$ when the temperature is near 300°C. Consequently, the heat radiation volume by natural convection, q_1 is calculated as follows:

$$q_1 = 10 \times (277 - 27) \times 0.942 \approx 24 kW$$

When no cover is provided thereto, the heat radiation volume q_2 (where only one machine is installed in a large room) is expressed as follows:

$$q_2 = \varepsilon \times 5.67 \times 10^{-8} \times (T_1^4 - T_2^4)$$

ε is a radiation rate which is 0.1 for metallic lustrous surface and 0.9 for a black surface. T_1 and T_2 are absolute temperatures of the heating cylinder and the circumferential wall, respectively. Therefore, the maximum radiation loss is calculated as follows:

$$0.9 \times 5.67 \times 10^{-8} \times \{(273 + 277)^4 - (273 + 17)^4\} \times 0.942 \approx 4 kW$$

In consequence, the heat radiation without a cover is the addition of 2.4 + 4 = 6.4 kW

The calculation expression (where there is not enough space from walls to install a cover) is expressed as follows:

$$q_2' = \frac{5.67 \times 10^{-8} \times (T_1^4 - T_2^4)}{(1/\varepsilon_1 + 1/\varepsilon_2 - 1)}$$

Assuming that ε_1 and ε_2 are 0.1 when heat insulating material is added, and that the temperature of the inner wall is 207°C and the temperature of the outer wall is 87°C where the natural convection heat conduction rate is $6 kW/m^2.k$, and in the case where no heat insulating material is added and the temperature of the inner wall is 207°C and the temperature of the outer wall is 197°C where the natural convection heat conduction rate is 8 $kW/m^2.k$, then the heat loss volume is calculated as follows:

Heat insulating material is installed:

Between heating cylinder and inner wall ≈ 0.11 kW

Between the outer wall of cover and room wall ≈ 0.03 kW

Heat radiation by natural convection ≈ 0.36 kW

The total loss of heat ≈ 0.5 kW

Where a cover is installed without any heat insulating material, the heat loss is calculated as follows:

Only a cover is installed:

Between heating cylinder and inner wall ≈ 0.11 kW

Between the outer wall of cover and room wall ≈ 0.13 kW

Heat radiation by natural convection ≈ 1.5 kW

The total loss of heat is 1.74 kW.

Comparing this value with the heat loss of 6.4 kW where no cover is provided, it can be said that there is a considerable energy saving volume.

(1) Be sure to install a cover on the heating cylinder in order to prevent natural convection.

(2) Replace the heating cylinder cover (in general, presser of the band heater) and the inside/outside of the cover with metallic and lustrous plates such as stainless steel plate (silver coating color, at least). Provide heat insulation so that the surface temperature of these covers can be restricted as low as possible.

(3) Repaint the walls and ceiling of workshop to a bright color (white color has the lowest radiation rate).

3.2.2 Heater temperature control

The basis of temperature control is feedback control. Detect the heater temperature of extruder with a thermocouple and convert it into an electric volume and compare this as a feedback volume with a set value. If there is a deviation, determine the operation volume of the deviation and operate the electromagnetic relay so that the heater temperature can be the same value as the set value.

Turning ON/OFF the electromagnetic relay turns heater electricity ON and OFF and permits regulating and maintenance of the heater temperature at a set temperature.

Figs. 14 and 15 show a drawing and a block diagram of the heater circuit of an extruder.

There are the following signal volumes for the temperature controlling system:

(1) Control volume (controlled variable): A target volume of control(e.g., heater temperature)

(2) Operation volume (manipulated variable): A volume added to the control target to perform control. Modifying this variable makes it possible to keep the controlled variable constant. (e.g., volume of electric current inputted to the heater)

(3) Deviation (error): A volume obtained by subtracting a detected value from a set value as target temperature. Normally, control is performed to eliminate this deviation volume.

(4) Measured value (process variable): Value which is converted from a detector (e.g., electromotive force of thermocouple)

When it is desired to operate a heating cylinder at 200°C, as shown in Fig. 16, the supplied power is controlled in proportion to the degree of temperature between a point of temperature below 200°C (assumed to be 190°C in this context) and a point over 200°C (assumed to be 210°C).

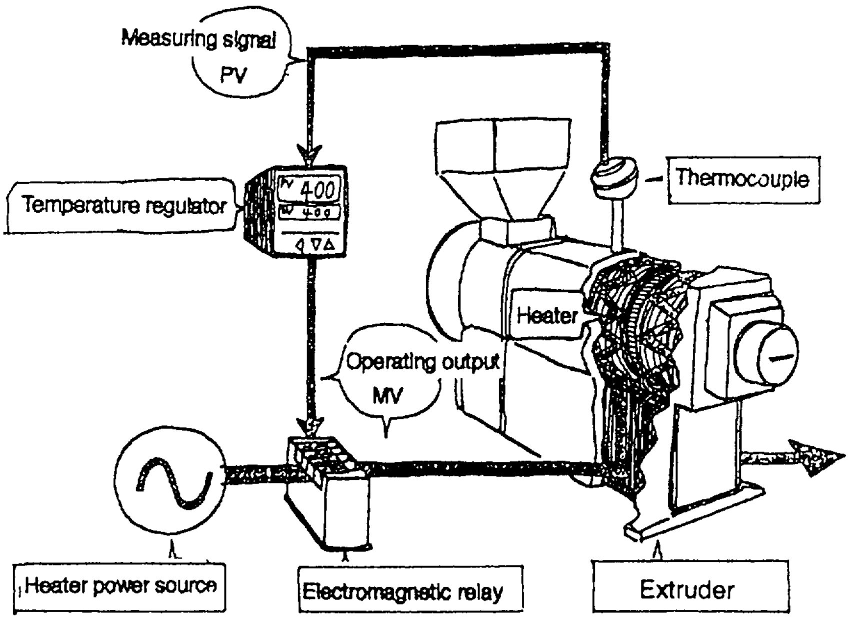


Figure 14 Heater circuit of extruder

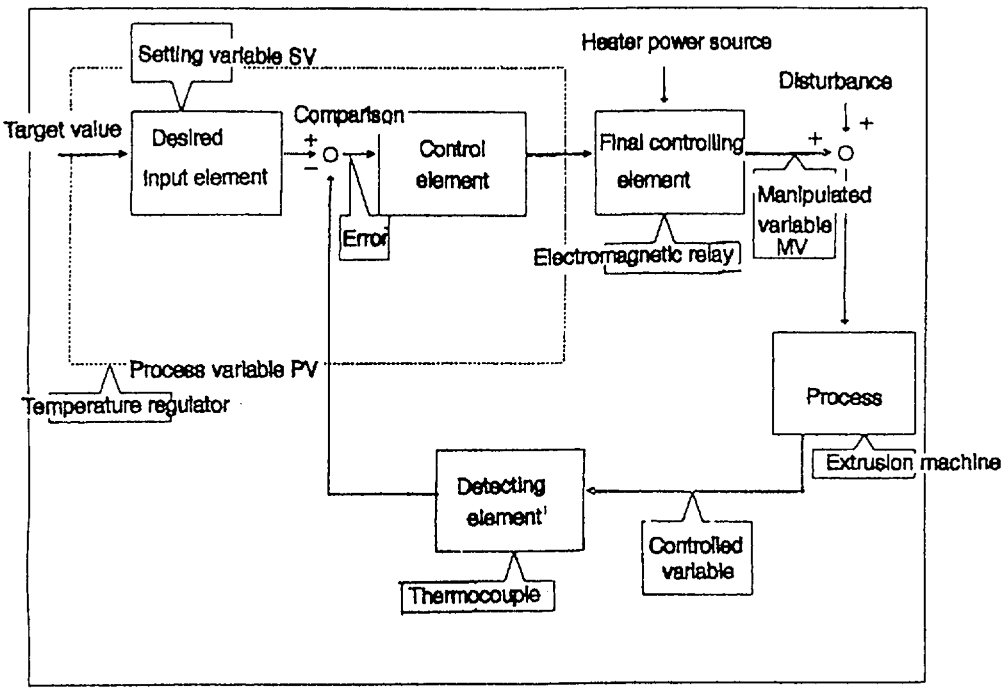


Figure 15 Block diagram of temperature control

This regulation is necessary, because overheating tends to occur if the supplied power is not decreased; moreover, calories are always consumed, and it is impossible to stop supplying electricity when a target value is obtained. Thus, this zone is called the proportional band to control the supplied power in proportion to the degree of temperature. When the temperature goes up further and exceeds the upper limit (210°C in this case), then it becomes necessary to cool down the heating cylinder. A blower is often used for this cooling; however, there are many cases where only radiation by natural convection is employed. As explained above, it is a total waste of energy to excessively use cooling equipment. The supplied power decreases when temperature falls to the proportional band. There are various methods to decrease the supplied power; one method is to regulate voltage and another method is to supply power on an intermittent basis, and there are some more methods. What is introduced next is a method to decrease the basic supplied power by changing over connection of electric wires.

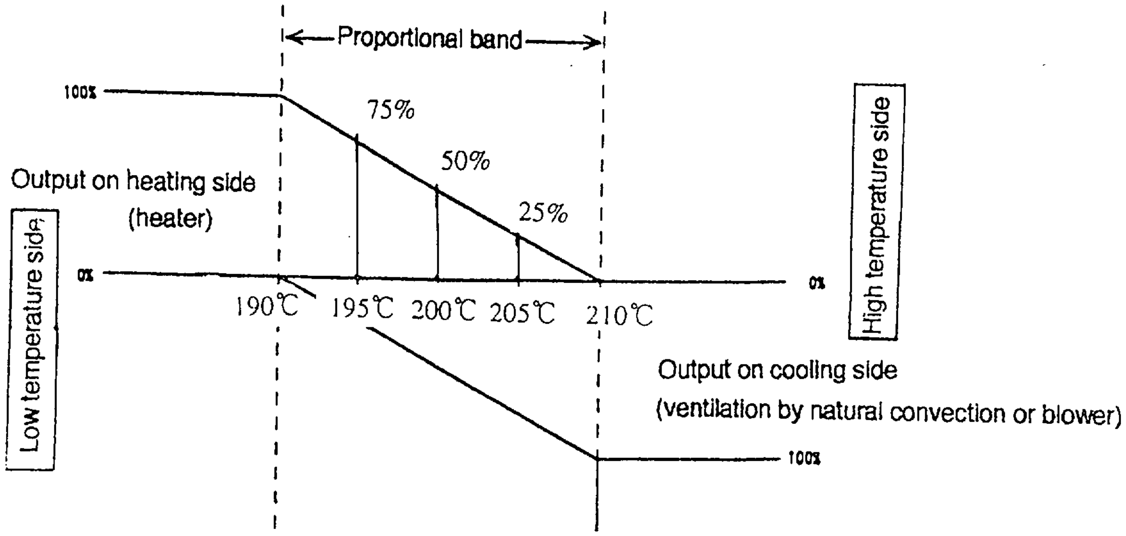


Figure 16 Proportional relation

In general, thermal plasticity is obtained by transmitting pellets with the screw in the heating cylinder. The heat that is involved in the plasticity can be classified into the following 3 categories:

(1) Heat that is generated by pellet friction

(2) Heat that is generated by shearing of melted resin

(3) Heat that is added externally.

Category (1) i.e., use of frictional heat, is reported to be effective for energy savings, however, reports on numeric values only are not made yet.

Category(2) (use of shearing heat) is utilized very effectively depending on products and kinds of material, however, a suitable design of the screw for this utilization is required, and there has been no report on energy only.

In contrast, there have been case studies on the category (3) (external addition of heat) indicating that a greater result was obtained by changing the electric wire connecting method. These case studies commonly relate to the extrusion molding machine, and basically the method can be applied to the injection molding machine as well.

Case Study: Improvement of extruder heater heating method

(1) Heat balance of extruder and thermal efficiency Product: Vinyl covered wire

Thermal efficiency = (Product output heat / input heat) x 100 (%)

extruder:

Heater capacity = 40 kW; driving electric motor capacity = 45 kW

Fig. 17 shows an extruder.

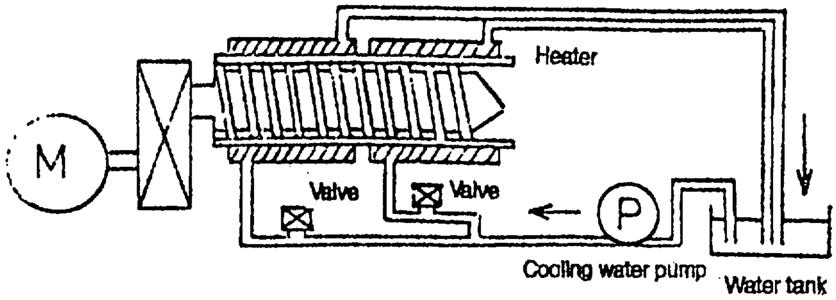


Figure 17 Extruder in water cooling system

Input heat:	Motor	17,500 kcal/h (56.3%)
	Heater	13,600 kcal/h (43.7%)
	Total	31,100 kcal/h (100%)
Output heat:	Product	11,300 kcal/h (36.3%)
	Cooling water	11,900 kcal/h (38.3%)
	Radiation	2,900 kcal/h (9.3%)
	Others	5,000 kcal/h (16.1%)
	Total	31,100 kcal/h (100%)

Thermal efficiency = (11,300/31,100) x 100 = 36.3%

Mean heater electricity consumption = 15 kWh/h

(2)Improving method

Thermal efficiency lowers due to repetition of heating and cooling. If the speed of temperature rise is lowered, useless heating can be prevented and less cooling is required. As the heater connection is the Δ connection, if the heater connection is changed for Y connection in order to decrease the heater capacity, then the capacity can be reduced to 1/3. This case study succeeded in decreasing the heater capacity by specifying the heater connection to be the Y - Δ connection and the Y connection is employed only during motor operation. Nevertheless, the PID (Proportional,Integrating and Differential) control is more suitable for temperature regulator of extruder in air-cooling system.

(3)Effects

Thermal efficiency before improvement: 30～40%

Mean heater power consumption: 15 kWh/h

Thermal efficiency after improvement: 40～50%

Mean heater power consumption 8.4 kWh/h

Comparison: approx. 130% and 56%

Figs. 18 and 19 show the Δ connection and Y connection. Figs. 20 and 21 show temperature changes before and after the improvement.

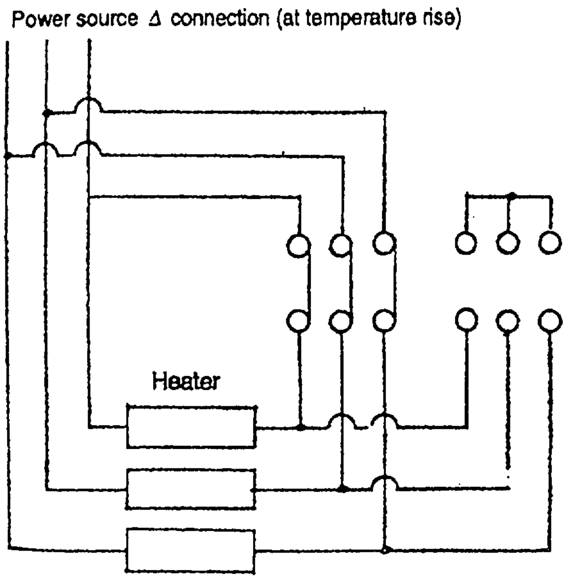


Figure 18 Δ connection

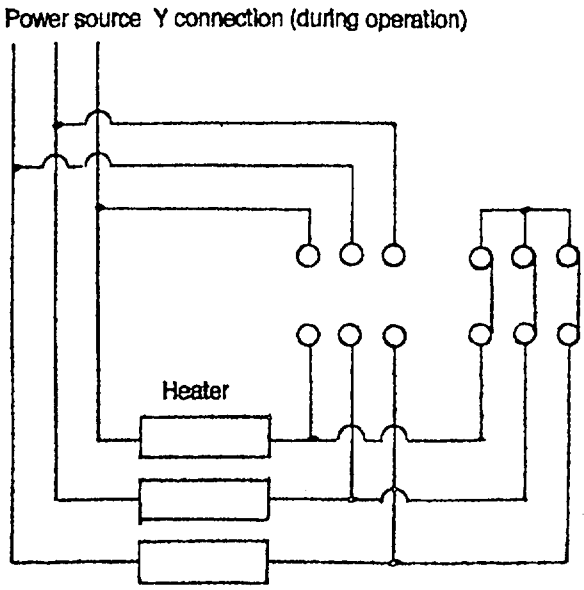


Figure 19 Y connection

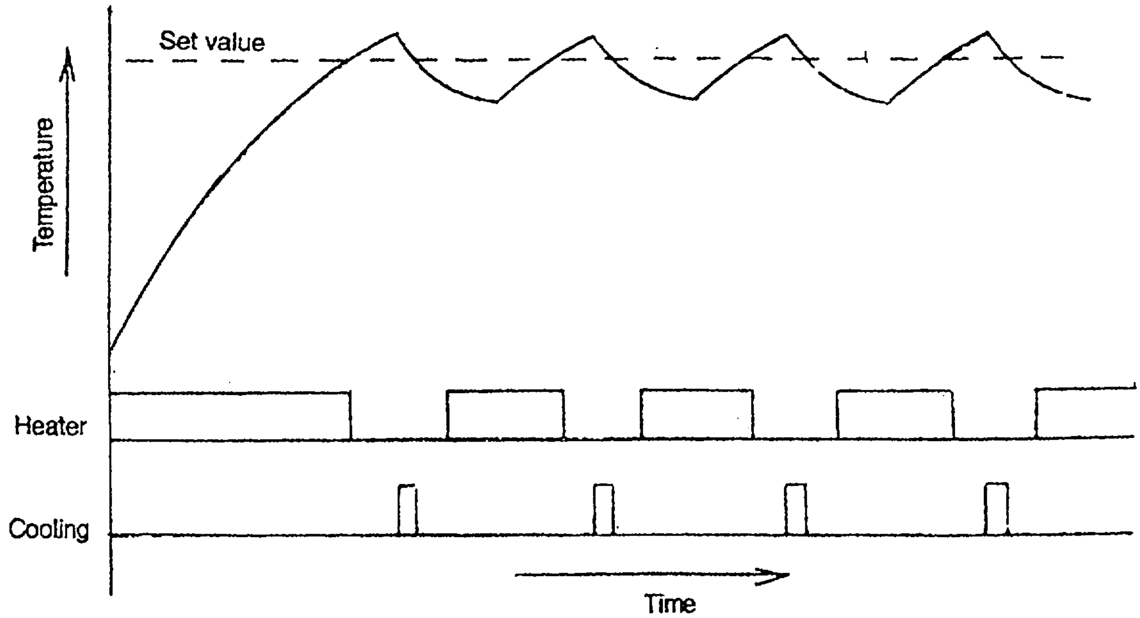


Figure 20 Transition of temperature before improvement

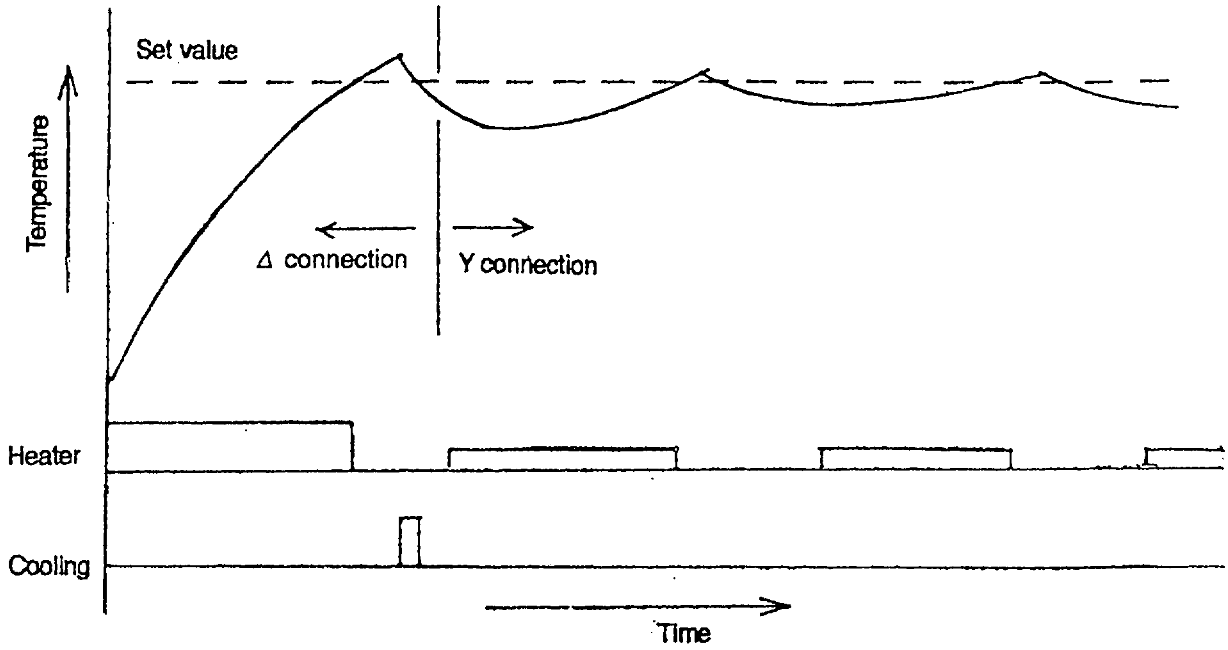


Figure 21 Transition of temperature after improvement

3.2.3 Driving the molding machine

The driving unit of the molding machine is mainly composed of the injection (extrusion) mechanism and the clamping (receiving) mechanism. The receiving mechanism of the extrusion molding machine used to apply electric power in early days, and in those days no hydraulic system was applied. As to other components, both systems were applied for various reasons. When judged from the viewpoint of energy saving, however, it is obvious that the direct motor driving system is superior to the hydraulic system in which hydraulic power is generated with a driving motor and so the direct motor driving system is applied in many molding machine recently. To take an example from the injection molding, the electric-powered servo machine is defined to be a machine whose injection system employs a servo motor and the clamping employs a toggle system. The toggle machine is defined to be an injection machine which applies a hydraulic system and the clamping employs a toggle system. The straight hydraulic machine is defined to be a machine in which both systems are operated by hydraulic power. Table 3 shows a comparison of power consumption volumes between an electric-powered servo machine and a straight hydraulic machine manufactured by the same maker, according to the same standard.

The straight hydraulic machine of this maker is equipped with a hydraulic mechanism for pressure holding independent of the main driving mechanism, and owing to these mechanisms, this energy saving type does not consume much electric

Table 3. Comparison of power consumption volumes between electric-powered servo machine and straight pressurizing machine

	Standard power consumption/h	Yearly power consumption	Ratio
Electric-powered servo machine	2.94 kW	21,168 kWh	
Straight hydraulic machine	4.30 kW	30,960 kWh	

Yearly operating hours 24 h/day x 25 days/month x 12 months = 7,200 h

power. Still the difference in power consumption is shown in table 3. Power consumption of the toggle machine falls between them.

With respect to minimization of power consumption, it is desired for hydraulic fluid of the hydraulic mechanism to have as low a viscosity in the lubrication of cylinder. However, an excessively low viscosity of the fluid will hinder machine operation. The viscosity of the hydraulic fluid is heavily affected by ambient temperature. It is, therefore, effective to change the types of hydraulic fluid according to temperatures in summer and winter. Accumulated leakage of air and water will result in a vast waste of electric power in the long run.

3.2.4 Increase in forming speed

The major themes of energy savings during the forming process consist in restricting electric power consumption while maintaining the production volume and in increasing the production volume without much increase in electric power consumption, because the latter will result in reduction of energy cost per product.

The basic process of forming thermoplastics is to form thermoplastic material and to take it out after cooling and solidifying it. The majority of energy is used for providing plasticity to the material, and this energy does not change very much by material volumes so long as the plasticity is provided continuously with the same machine. That is to say, even if the production volume per unit time is increased by 50% or 100%, the energy that is consumed for plasticity remains almost the same. For the purpose of energy savings, therefore, it is important to increase the forming speed by improving dies and ancillary equipment and thereby to decrease the energy cost per product.

(1) Extrusion molding by reducing useless friction

In the case where one kind of resin is extruded with one machine, the discharge volume of resin changes to a large extent depending on the pressure applied to the resin. Although the discharge volume changes greatly, the total electric power consumption changes little. In the case of extrusion molding, the resistance(pressure)of the die to the resin is effective for manufacturing products, however, most of the resistance (pressure) that is applies to the resin in the previous steps of the die is useless.Therefore, filtration of contamination at the breaker of the molding machine should be restricted as an ancillary preparation. Basically, the role of net of the breaker plate is to assure the mixing effect.

(2) Extrusion molding: Continuous exchange device of contamination filtrating net

There are devices, such as the extruder net of the pelletizer for recycling whose purpose is to eliminate contamination. The net used to be exchanged by shutting down the machine operation once, or 2 nets and 2 passages were provided to change over the 2 passages by checking for pressure, and the net of the changed over passage was exchanged or cleaned. Recently, however, nets in the form of a belt or a disk are shifted sequentially to carry out exchange of a net without greatly changing the discharge volume while continuing to operate extrusion process. Such equipment has been manufactured.

(3) Injection molding: Balancing or eliminating the internal stress

It is important to arrange the gate position and geometry so that deformation by internal distortion does not occur in the cooling step.

Speed up of solidification leads to reduction in die temperature more often than not, and this forms an orientation layer of resin on the surface of the product, leading to its internal distortion. Since the internal distortion causes deformation, it is necessary to install the gate in a position where the stress by this internal distortion does not generate (i.e., deformation). As shown in Fig. 22, for example, it is known that in the case where a product is a wide and thin bottle lid, deformation appears easily when a side gate is provided and the shot cycle is sped up, however this deformation does not appear easily where a three-plate mold (die) and a center gate are installed. Depending on product shapes, the shape of the gate also exerts influence.

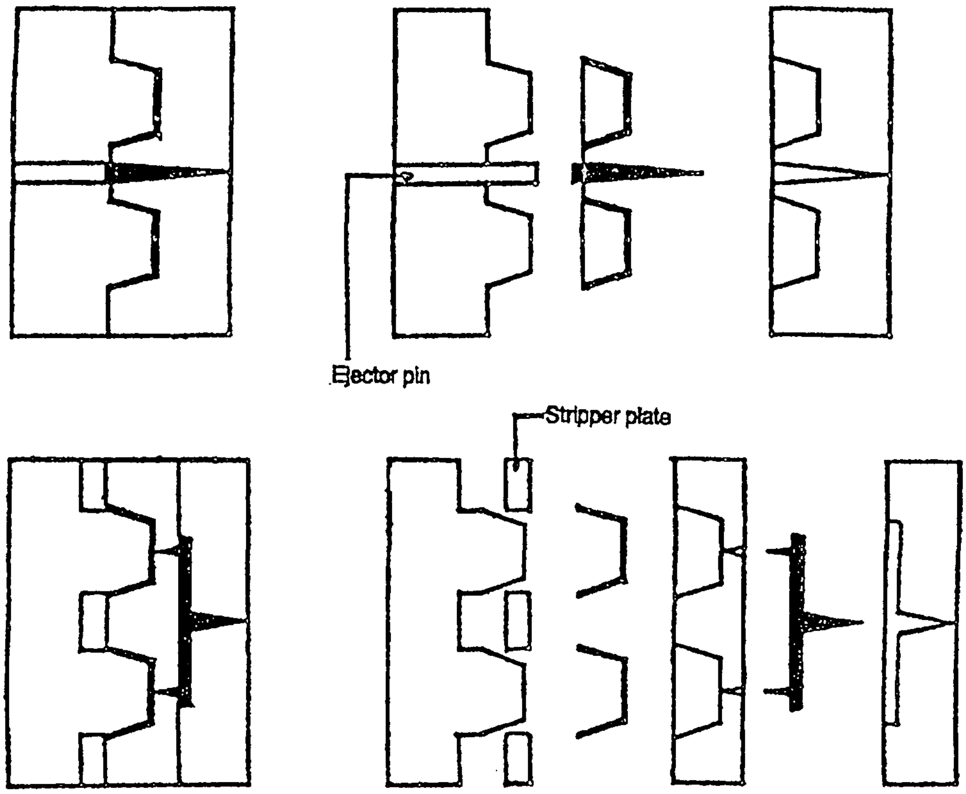


Figure 22 Side gate and center gate

In some cases, positive elimination of the orientation layer is also attempted. Plate-formed products tend to bend in one direction. The orientation layer mentioned before shrinks when it is cooled, but its shrinkage does not occur uniformly; as a result, the layer tends to bend in the direction where shrinkage is greater. The orientation layer characteristic by disappears when it receives a force applied at right angles to it. Therefore, as shown in Fig. 23, the bend will disappear by adopting a die structure which press-fits a compaction core in a manner to cut the orientation layer. The press-fitting of the core is possible by both hydraulic pressure and pneumatic pressure.

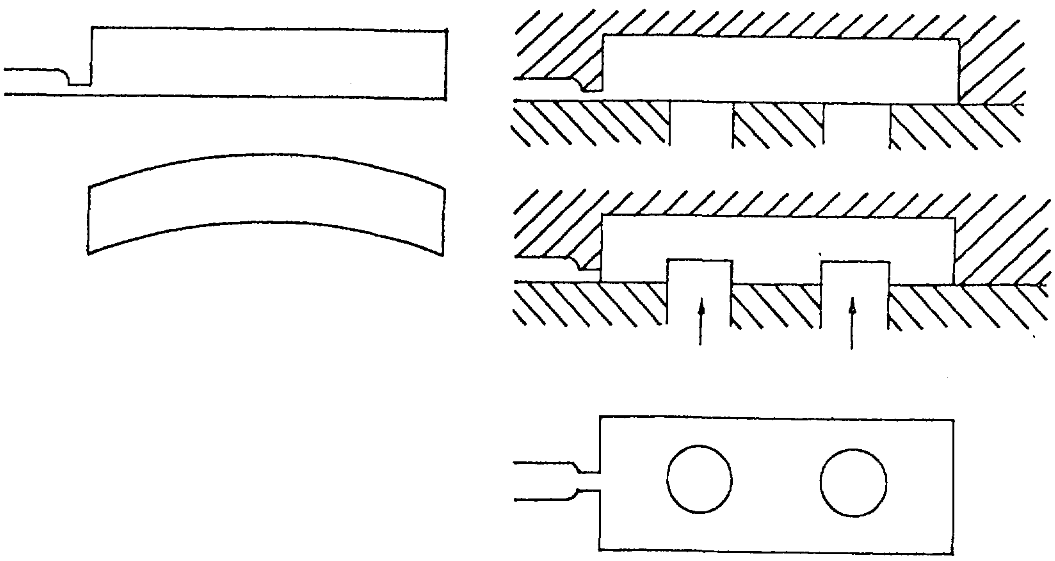


Figure 23 Example of bend elimination

(4) Blow molding: Accumulator head

In an operation of an extruding machine with a single die head,the driving motor steps every time of pavison pushing. Basically, however, such molding should be avoided.

If the accumulator type die head as shown in Fig. 24 is adopted, the molding can be continued without stopping the motor. This adoption makes it possible to achieve twice the yield with the same energy in the same time. Intermittent operation of the motor would incur various problems such as occurrence of peak current, wear of switch, and damage to the machine.There is also a method which installs a double head for changeover of valves, as shown in Fig. 25.

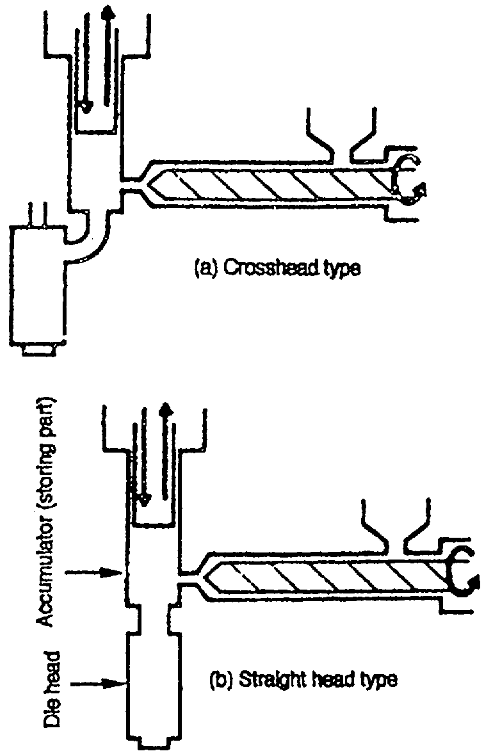


Figure 24 Accumulator system

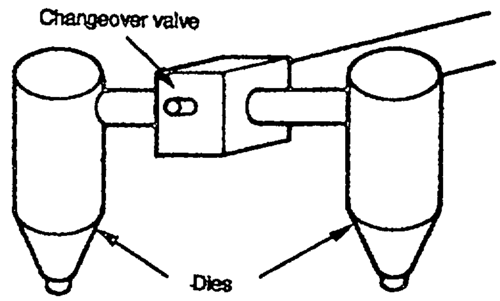


Figure 25 Conceptual drawing of double-head type

3.2.5 Standard for selection of molding machine

There are various and diversified forming methods for plastics, and there are suitable forming machines for each method. Even if some forming machines are classified into one group of forming method and called by the same name, there may be large differences in content. And so, an excellent forming machine cannot manufacture good products if it is not suitable for a specified product. Accordingly, it is important to select a forming machine which is suitable for the products to be manufactured. In a factory where forming machines are already installed, it is important to choose orders of products by checking whether or not the forming machines match the ordered products. Next, mismatch of products and forming machines as well as the standard for selection of injection molding machines and blow molding machines is as follows:

(1) Injection molding machine

There are various types of injection molding machines. It does not necessarily mean that it is better to use expensive machines for manufacture of better quality products. Ordinary injection molding products can be classified into the following 4 groups. It is recommended to use an exclusive-use machine for special molding such as 2-color molding. Inappropriate molding process will make product quality lower and will lead to occurrence of accident. Please select a suitable molding machine, making sure of the group to which the products to be manufactured belong. If molding machines are already installed, select products which match the existing machines. (Table 4)

Table 4. Grouping of injection molding products

Molding	Products
General Molding	Molding of general molded products including appearance products: Select molding machine according product capacity.
Low Deformation Molding	Molding thick-wall molded products such as lenses that prohibit internal deformation.
High Transcription	Molding of molded products which demand to accurately transcribe the surface of die to the surface of products such as compact disk and models of flowers and insects.
Precision Molding	Molding of molded products of which demand on dimensional precision for mechanism parts is strict.
Special Molding	Injection compression molding,2-color molding,sandwich molding, gas injection molding,etc.

(2) Blow molding

In the case of blow molding, it is obvious whether a blow molding machine matches or does not match products more so than it with injection molding machines. Fig. 26 systematically shows blow forming methods. This distinction applies to even the simplest containers which are manufactured by blow molding.

a) Some products are suitable for direct blow molding, and others need to be manufactured by injection blow molding.

b) The injection blow is classified into no-extension blow and extension molding.

c) Depending on quantity, appropriateness of the cold parison method or the hot parison method should be selected.

In the field of the function blow, specialization of machines has progressed for productivity of manufacture in the same manner as the special molding field.

Table 5 shows the relation between products and molding machines in the field of blow molding.

(The 2-axis extension blow can be applied to any method by adding its function.
The multilayer blow can be applied to any method by changing its die structure for multilayer use.Accordingly,these are purposely not entered in this system diagram.)

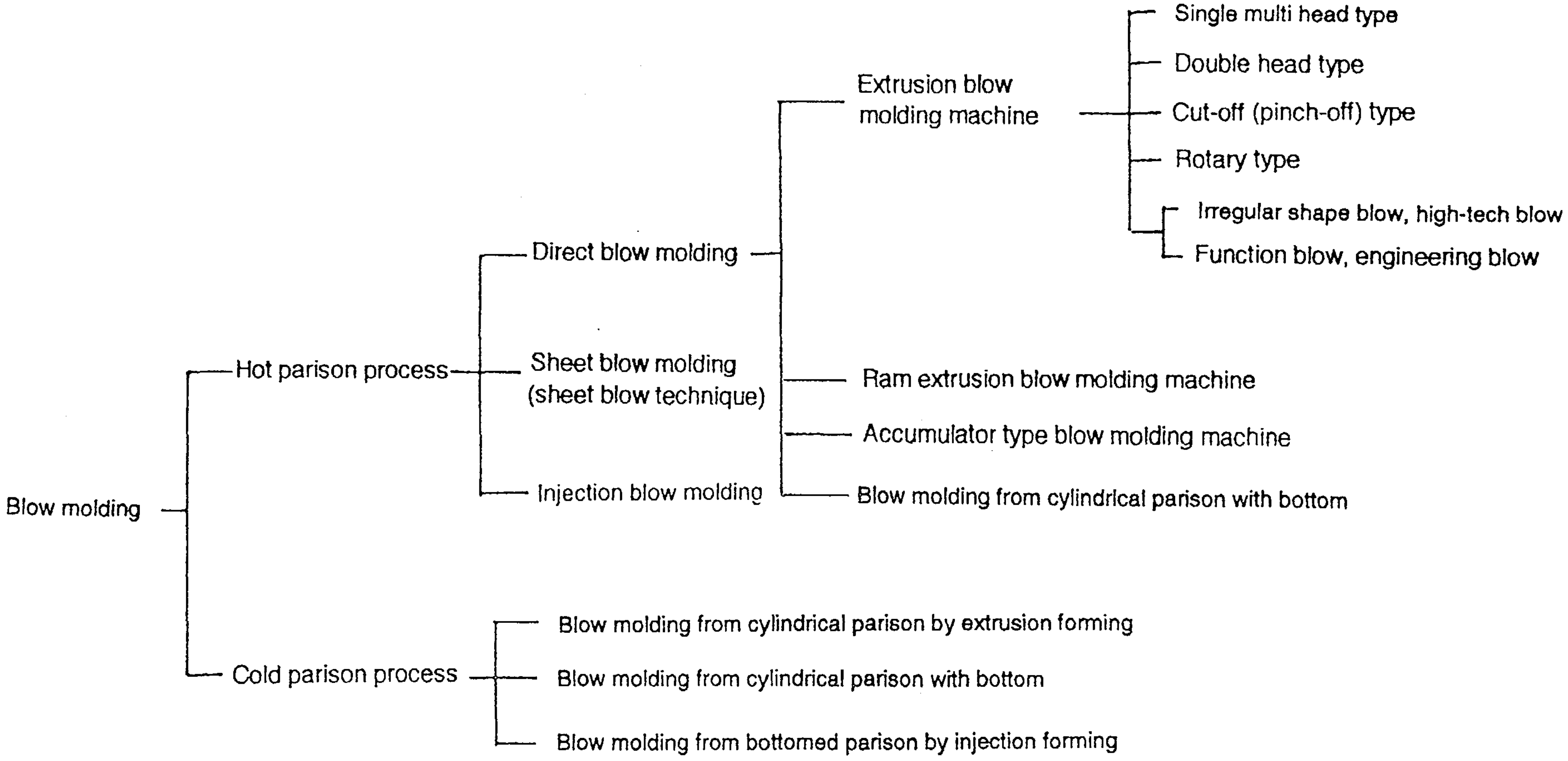


Figure 26 Systematic table of blow molding methods

Table 5. Blow molding:Relationship between products and molding machines

	Classification by quantity	Forming machine to be used
Large-sized container Large-size irregular shapedcontainer Irregular-shaped product	Larger than 10 liters Mainly for capacity up to 200 liters May mold greater than 200 liters	Single-head accumulator type Single layer,double layer,and 5 layers
Middle-sized container Middle,Middle size irregular shaped container (with a handle,etc.) Accumulator system only Possible to mold irregular-shaped products	Applicable from 1 to 10 liters Sometimes upto 20 liters	Single-head or multi-head (double head,tripie head)accumulator system Single layer,triple layer
		Single-head or malti-head (double head,triple head)extruder pushing and cutoff system Single layer,triple layer
		One-throw or two-throw extruder pushing and rotary system Single layer,triple layer
Small container	1 liter or less Sometimes up to 2 liters	Multi-head (mainly double head or triple head,sometimes 5-head)exruder pushing cutoff system Single layer,triple layer
		Injection blow Hot parison system,cold parison system Ordinary blow,extension blow Single layer,triple layer

3.3 Finishing process and others (Finishing and Printing)

After formed products are taken out of a forming machine, they necessarily enter some subsequent process.

What is important in the subsequent process is that manual modification or correction should be avoided as much as possible,because such manual modification or correction will increase non-uniformity of quality and lead to an increase of defective products.

In the field of injection molding, various kinds of in-mold automatic cutting equipment are contrived. Various contrivances are also made in the field of the direct blow molding where trimming is indispensable. And, in any forming method, taking out and arranging products need to be carried out, which should also be performed without using manual modification or correction as much as possible. Printing, adhesion, and jointing are important factors in the subsequent process.

3.3.1 Trimming (similar to overall pinch off) of large-sized product

Much difficulty follows trimming (similar to overall pinch off) of a large-sized product. If the cutting-off portion of the molding die is sharpened, the jointing portion will be torn and if the cutting-off portion of the molding die is made dull, the finishing process takes much labor. And if fins of the jointing portion are not removed, deformation necessarily occurs, resulting in molding defective products. In general, the wall of these products is thick, and the shot cycle cannot be shortened easily. In such a case, it is recommended to prepare a finishing die in addition to the molding die.

The difference between the forming die (mold) and the finishing die is that the cutting-off portion is made sharp although their shapes are exactly the same. Molding is performed with the forming die (mold), and when the shape of a product is almost completed in its mild state, the product is transferred to the finishing die. Then, air is blown again and pressure is applied to perform closing sufficiently. This method permits finishing of the product without incurring any cut at the jointing portions. Such use of 2 pieces of dies is also applicable to the shot cycle.

3.3.2 Trimming of the mouth of narrow bottles

In the case of the cut-off type molding machines, it is possible to automate the trimming process for the mouth of narrow bottles by intruducing a two-step closing system as shown in Fig. 27 and by slightly rotating the insertion inner diameter.

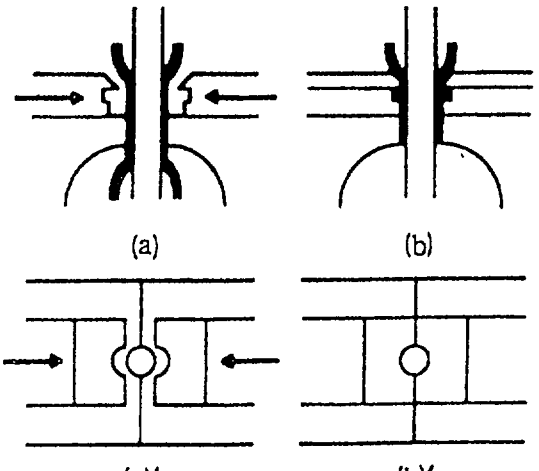


Figure 27 Conceptual drawing of automatic trimming of the mouth for cut-off Type bottles molding process

3.3.3 Joining in the secondary process

The insert molding, in which a single product member is inserted in a die, hinders not only the shot cycle but also tends to incur unexpected troubles such as dropping or biting of the member. In such a case, it is advantageous more often than not to perform jointing in a separate process although one process is added.

(1) Process a prepared hole in advance prior to the forming, and press-fit parts such as a nut to be inserted by using an ultrasonic vibrator in the secondary process. Then, the press-fit parts are heated and deposited by the effect of the ultrasonic vibrator. It is, however, required to provide a preventive measure such as cutting with a knurling tool to the outer periphery of the inserted parts.
Depending on shapes of parts, it is possible to employ a screw mechanism of self-tap type. When press-fitting metallic parts, there is a method to press-fit by heating the metallic parts with high-frequency waves without using the ultrasonic vibrator.

(2) If a member is in the shape of a pin, in most cases it is only required to process a prepared hole followed by simple press-fitting. In such cases, it is needed to provide a preventive measure by cutting the jointing part with a knurling tool or by crushing the joint.

3.3.4 Surface treatment

When performing printing or adhesion, it goes without saying that it is required to clean the surface to be processed. However, there are many kinds of materials such as polyolefine resin and others that require more measures for a satisfactory finish. In such cases, it is needed to provide a treatment which activates the surface. The representative cases are the corona discharge treatment used mainly for films, the flame treatment for formed products, and the corona discharge treatment for formed products. Since the primer treatment is easy, this treatment is applied for many purposes.

3.3.5 Printing

Printing to the product is indispensable for the subsequent process of molding in order to show value and use of product. Fig. 28 shows the kinds of printing systematically.

Among these kinds of printing, it is flexographic printing that is used for printing of sheet and film of plastic products, silk screen printing that is used mainly for bottles, pad printing that is mainly used for injection molding products, and the hot stamp for metallic luster.

Except in the hot stamp printing, ink drying becomes the biggest problem in the printing process. Natural drying used to be the main method. Presently, printed products are passed through a drying furnace, or an ultraviolet ray hardening ink is used for improvement in efficiency.

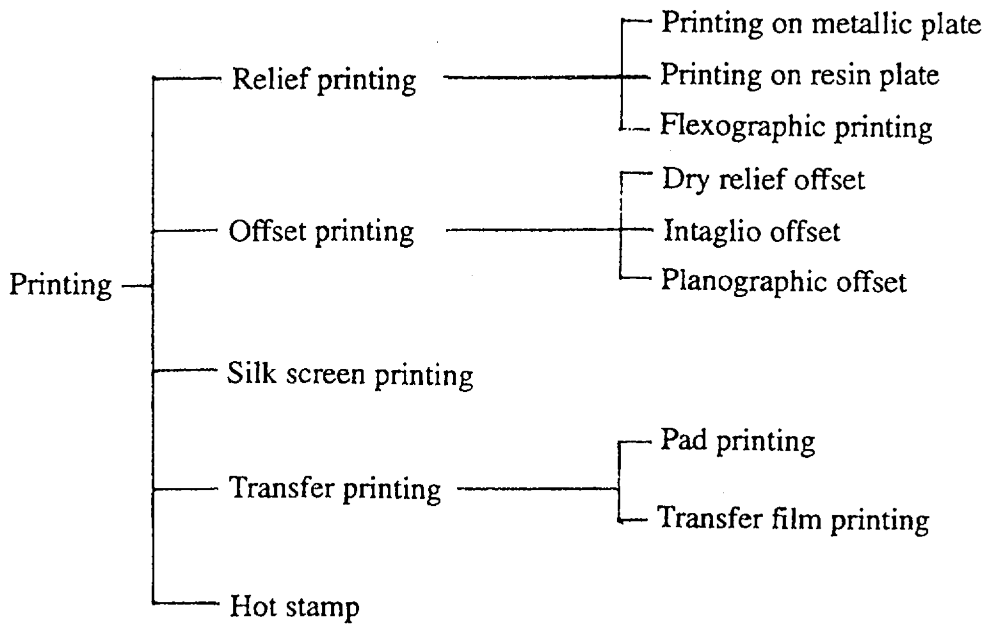


Figure 28 Types of printing

3.4 Mold design

3.4.1 Product shapes and die structures

What is important for the design of injection molding products is to make the wall thickness uniform and to allow sufficiently for the draft. The undercut should be strictly avoided.

Forced pulling must be avoided in any case. Be sure to provide a large roundness to each edge as much as possible. This also applies to blow molding and other methods. In addition, the basis of shaping by blow molding is the "slender shoulder and shrunk bottom." As to the arrangement of the cooling water pipe in the mold, the distance to the cavity surface needs to be slightly longer than the pich of the cooling water pipes If there is a portion which cannot be cooled easily, more cooling water pipes are required. In the case of the blow die, the cooling water pipes are arranged to have uniform space to one another. If it is difficult to install cooling water pipes or there is a fear of water leakage from the built-block type die, it is effective to use heat pipes. It is often employed to combine die materials such as combination of steel material and copper alloy or aluminum material of which heat conductivity and heat capacity are not the same.

If requirement for product quality is high, it is becomes important to improve technology of deairing and degassing. Natural exhaust of air or gas from die and die material is not sufficient, therefore, exhaust is forced using a vacuum. Although vacuum pumps were used before as the vacuum equipment, such pumps had problems of cost and handling. Recently, therefore, vacuum equipment which uses a compressor is used mainly. The exhaust hole used to be prepared by longitudinally arranging thin plates, but recently, the equipment called bent chip, as shown in Fig. 29, is available commercially. This bent chip has a high porosity with longitudinall arrangement of fine wire.

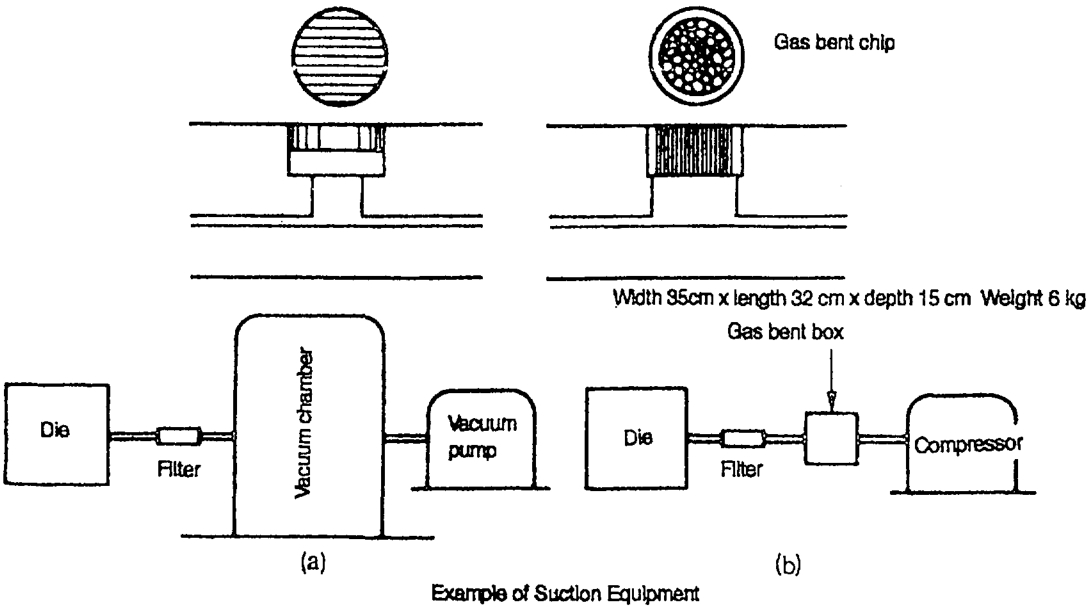


Figure 29 Gas bent chip and suction equipment

3.4.2 Examples of injection molding

The spureless die is often used. In the case of die structure of injection molding, the runner and the gate are indispensable elements for the structure, but the spure is not necessary. The spure has secondary drowbacks such as waste of material, difficulty in product taking out due to unsolid spure while product is solidified already.

It is possible to decrease the cross section of the runner by eliminating the spure. In general, it is possible to reduce the size of spure to approximately 1/5. Fig. 30 shows an example of improvement in yield by use of a spureless die. This example shows that a die using a 15-g spure and a 15-g runner to make a 70 g product is changed for a spureless die. Then, a simple calculation shows that a 70% yield can be improved to a 96% yield by reducing the spure to 0 g and the runner to 1/5 (3 g). Fig. 31 shows a conceptual drawing of an ordinary die and a spureless die. There are many methods to eliminate the spure. The most popular method is to employ an extension nozzle.

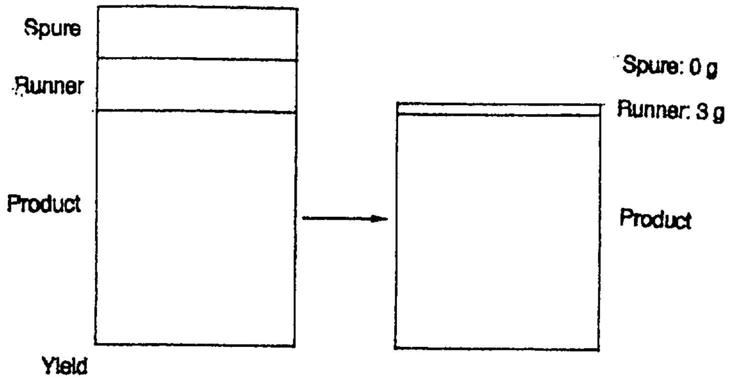


Figure 30 Example of improvement in yield with a spureless die

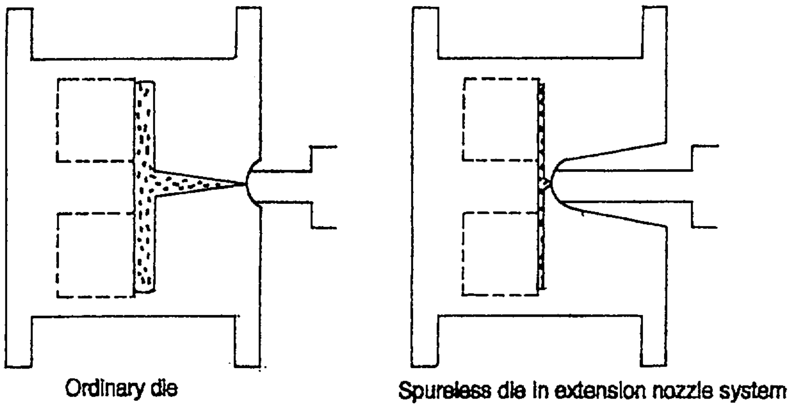


Figure 31 Conceptual drawing of dies

3.4.3 Example of inflation process

Sacks which are manufactured by the inflation process need to have enough strength. The strength of the bag is determined by the strength of the thinnest portion. Therefore, forming of uniform wall thickness is important. There are many methods to ensure uniformity of wall thickness. Fig. 32 shows one example thereof. That is to say, in this example, thickness is measured (circumference is always measured) immediately before winding and cold air is blown into the resin discharging port when a portion of thin thickness appears.

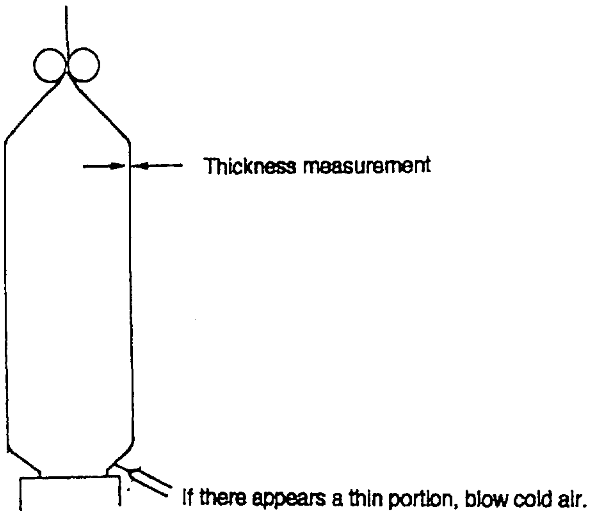


Figure 32 An Example of adjusting wall thickness by inflation process

3.4.4. Examples of blow molding

In the same manner as the inflation process, the main attention is given to preventing differences in thickness. The countermeasures are uses of the accumulator (see Fig. 33) to avoid draw down and the parison controller (see Fig. 34) for molding irregular shaped products.

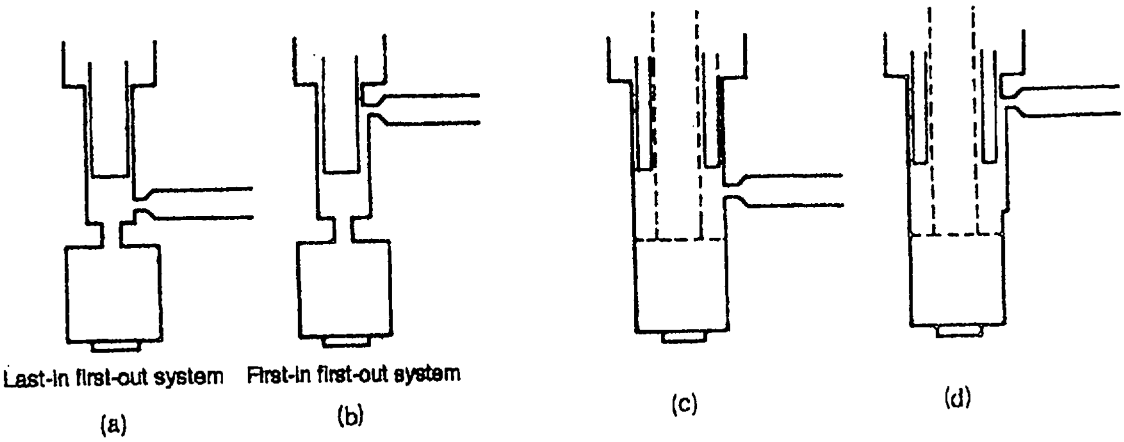


Figure 33 Accumulator

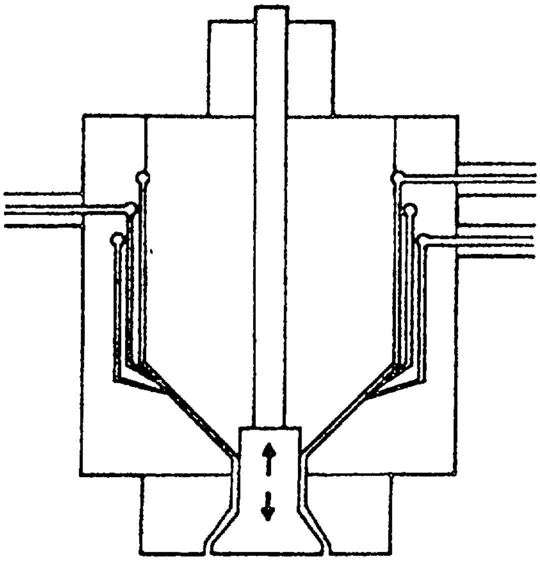


Figure 34 Die for multilayer blow and parison controller

3.5 Production control

3.5.1 Improvement in yield

Calculation expression of yield has quantity of product (weight) as the numerator and the total quantity of materials inputted into the hopper or the total quantity of materials discharged from nozzle as the denominator. That is to say, in connection to the expression of A (virgin materials) + B (in-house reproduction) ——> C (conforming products) + D (fins, scraps and non-conforming products), the yield is expressed as follows:

$$\text{Yield} = \frac{C}{(A+B)} \text{ or } \frac{C}{(C+D)} \quad \frac{\text{(Conforming products)}}{\text{(Total forming amount)}}$$

The materials consumed for die exchange, restart, color change and material change are to be evaluated individually and accunted as cost. In any case, energy for moving and crushing of return material is neccessary.

3.5.2 Production control and inventory control

After all specifications are satisfied and products are completed, the products should be sold as the final step.If the products do not sell, they are not different from defective products. particular, products sold in kits need to have counterpart components to be sold as a commodity. Lids without bottles cannot be a commodity.

3.6 Utilities

3.6.1 Improvement of power factor

The power factor of a transformer should be improved by performing measurements on a regular basis at a factory. The electric power that the factory receives is three phase, as a rule. This three phase electricity is often used as single-phase electricity for electric heat. Therefore, a balance between three-phase and single-phase is extremely important. The operating state of machines and change in their condition could also change the power factor.

The equipment, beginning with motors of which rush current is big, needs to restrict the peak current with capacitors; moreover, such equipment with big rush current should positively be replaced with equipment with small rush current. The rush current does not contribute towards production, but increases power consumption; moreover, it places a big burden on the power supplier -- more than superficial numerical values indicate.

3.6.2 Cooling

In forming thermoplastics, the plastic process by heating and the solid process by cooling are both important. In terms of quality and cost of products, it can be said that the solid process by cooling is more important than the former. Fig. 35 shows the cooling equipment of an injection molding machine. The process of cooling can be divided into the

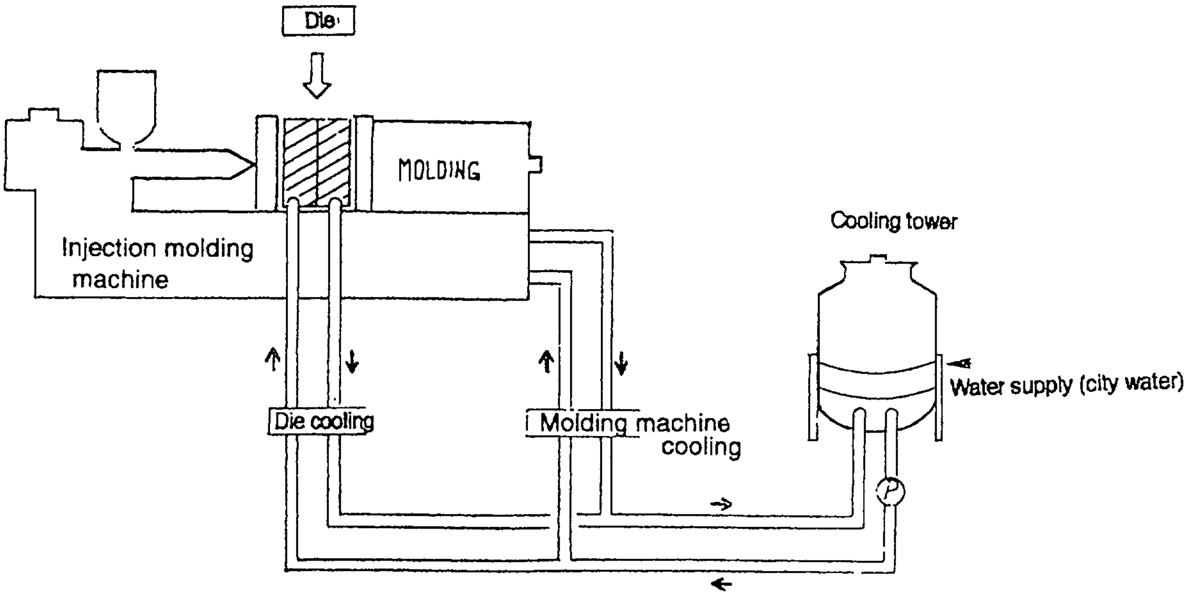


Figure 35 Cooling equipment of injection molding machine

components ancillary to the forming machine such as the die cooling component and the cooling water treating components such as the cooling tower and the temperature regulator.

(1) Maintenance of die cooling water channels

The cooling water channel of die should always be dried and provided with rust preventing treatment after the forming process is terminated. If rust is generated, the rust should be removed neatly. The channel needs to be cleaned from time to time because lime deposits and water scale tend to attach to it. Observation of these points will exert surprisingly outstanding effects.

Although cooling of the sizing die in the extrusion molding is the same basically, it is recommended to increase the cooling effect by reducing pressure to the cooling tank, if any, and to improve the showering effect by rotation in back and forth strokes.

(2) Maintenance of cooling tower

After passing through the cooling water channel, the cooling water is either cooled in the cooling tower, or its temperature is regulated with the temperature regulator. Maintenance of the temperature regulator conforms to the maintenance instruction manual without serious troubles, in general. The cooling tower tends to have algae and moss or mud, its discharge port tends to be clogged up with these substances, various kinds of rubbish might remain in the tower, and some part of it may remain broken. These points should be checked. A part of cooling water always evaporates in the cooling tower. Accordingly, supply of water alone rather increases solid contents on a gradual basis and therefore some cooling water always needs to be discharged (5 to 10% depending on water quality) constantly so as to maintain the good quality of water.

3.6.3 Cooling and Pressurization of the forming factory

Good products are manufactured in a good environment.

Therefore, it is extremely important to maintain a good environment in the forming factory. Fig. 36 shows an example at cooling of the forming factory. Cool air goes down and warm air goes up. Space without workers can be left hot. It is a waste of energy to cool the whole of a high-ceiling factory attached with fans on the ceiling for cooling.

A working place which manufactures precision products, products of neat appearance, and sanitary products should be enclosed tightly and the indoor pressure should be set higher than outdoor ambient pressure for the purpose of preventing dust and insects from entering. Consequently, on account of the higher indoor pressure, air flows constantly out of the factory. At such a working place, the entrance and exit have dual doors so that the air in the working place should not mingle directly with the outdoor air. And then, what is important next is that workers at such working places are required to wear suitable working uniforms.

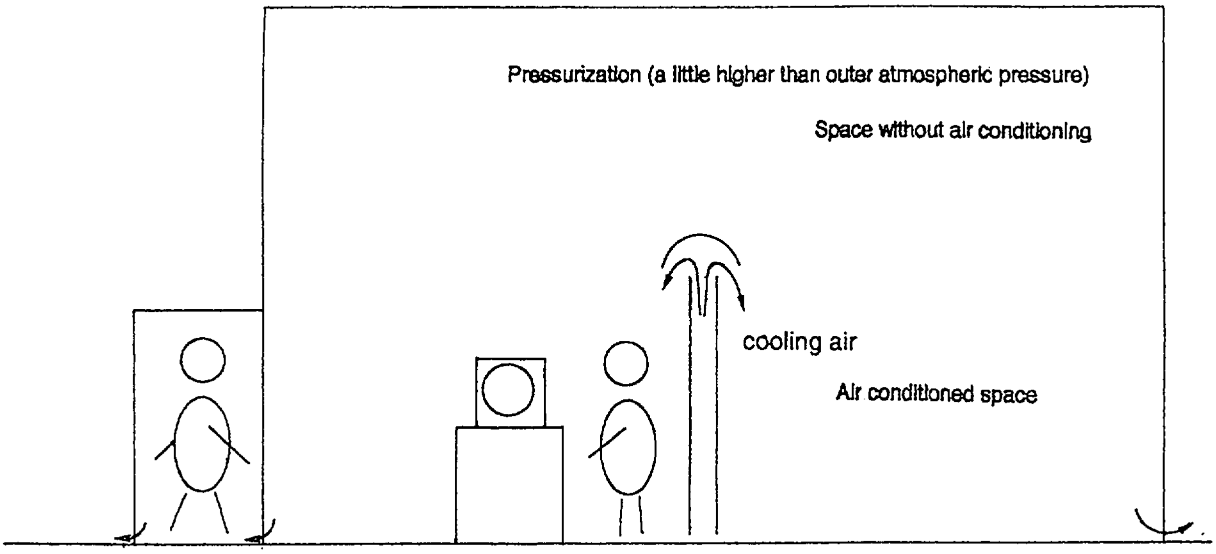


Figure 36 Example of cooling and pressurization at forming factory

3.7 Explanation of energy conservation equipment (Effective use of equipment and tools)

We have explained already that there is a vast difference in consumption of electric power between the hydraulic drive system and the electric drive system. The electric drive system gets power directly from motors (one-step drive), whereas the hydraulic drive system converts the power of a motor into hydraulic power(two-step power). This difference in effectiveness is obvious. For some decent reasons the explanation had to make a detour.

The servo motors that are presently put to use restrict the starting torque at a low value so as to avoid occurrence of unnecessary rush current, and inverters are used to perform electric current control according to required output. In addition, frequency control adjusted to motor speed is employed. Through these improvements, the required functions are exerted.

Next, as to the case study where energy savings are achieved by changing over the delta connection to the Y connection, changing the delta connection for the Y connection reduces the power supply volume to approximately 1/3 (precisely, $1 \times \frac{1}{\sqrt{3}} \times \frac{1}{\sqrt{3}}$). If the energy to be supplied is below this value, there is no problem, however, if the energy to be supplied needs to be greater than that, the burden on the driving motor will increase abnormally and there follows a fear of motor shut down. Accordingly, changeover of the delta connection to the Y connection requires sufficient attention to this point.

As to the heating control system, the phase control system and the zero cross control system are becoming the mainstream. The phase control system, as shown in Fig. 37, is a method which changes the phase angle of A.C. voltage applied to a load and thereby controls continuously the electric power supplied to the load. Basically, a thyristor element is employed to control the timing to apply trigger voltage.

Subsequently, as to the zero cross control system, as shown in Fig. 38, this is a method in which trigger voltage is applied to the thyristor element when A.C. voltage is 0 V so as to adjust electric power. The points at which the thyristor element is turned ON or OFF are located in the vicinity where voltage is 0 V and therefore there is no fear of noise occurrence. Because there is no mechanical changeover of contact points, there is no worry about the mechanical service life of the contact point. If the heating and cooling control system is employed jointly, it is reported that the electric power consumption (for heating only) can be reduced to 30% (energy saving by 70%) in comparison with the conventional ON-OFF system.

We have already mentioned the temperature control by the proportional band to some extent. At present the main control methods is PID (Proportional Integrating and Differential)control method.Using this method, the heating side is quickly reach and in stabilized at a target temperature, and at the same time, ventilation volume is adjusted to perform natural cooling or forced cooling by blower when temperature exceeds the target temperature.It is so designed that the equipment can be operated in an intermediate zone called dead band as much as possible. In the dead band, as shown in Fig. 39, the output is regulated to 0 both on the heating side and on the cooling side.

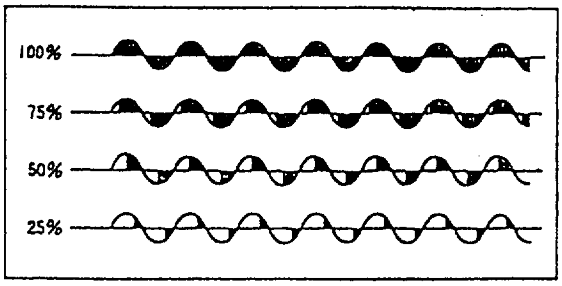


Figure 37 Phase control

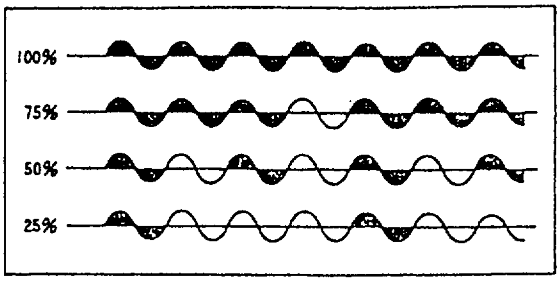


Figure 38 Zero cross control

If stabilization is achieved at Point B, by providing a dead band, the energy is reduced to 0.

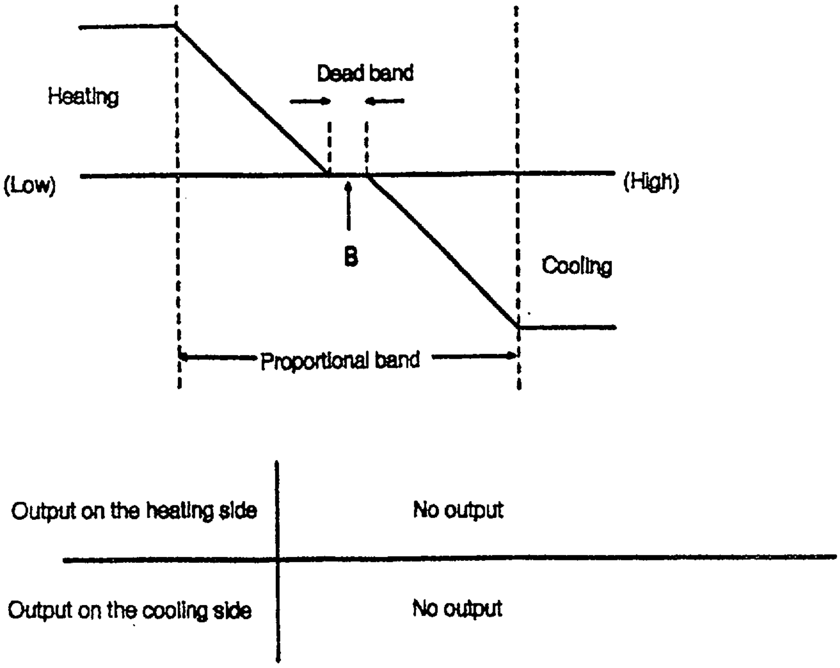


Figure 39 Temperature control by proportional band

4. Conclusion

As explained before, the energy saving technology in a plastic forming process can be divided into two aspects. The first is the technology for reducing the electric power used for heaters of the plastic heating process and the second is the technology to improve the quality and yield of products thereby increasing the production quantity of the first class goods. The technological improvement in the latter especially brings about a greater energy saving.

Considerations to be given in the actual forming site.

1) Maintenance / servicing of the production facilities and peripheral equipment.
2) Improvement activities for plastic forming methods and conditions.
3) Increase in plastic forming speed; pay attention to the cooling conditions of metal mold and the product unloading speed.
4) Yield improving activities.

How to effectively make use of limited resources and energy is directly related to how to make us happy.