Section 7
Food Industry

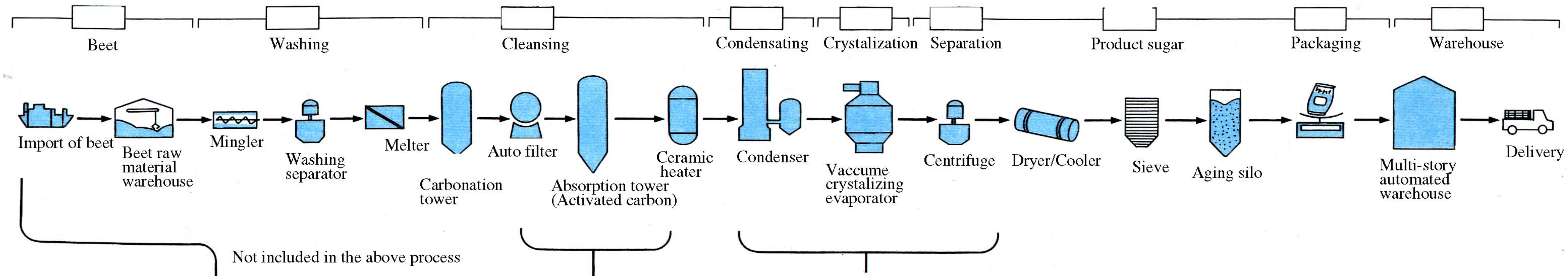
Process Flow

7-1 Sugar

7-2 Beer

7-3 Edible Oil

Food (Sugar) : Production Process and Energy Saving Technology



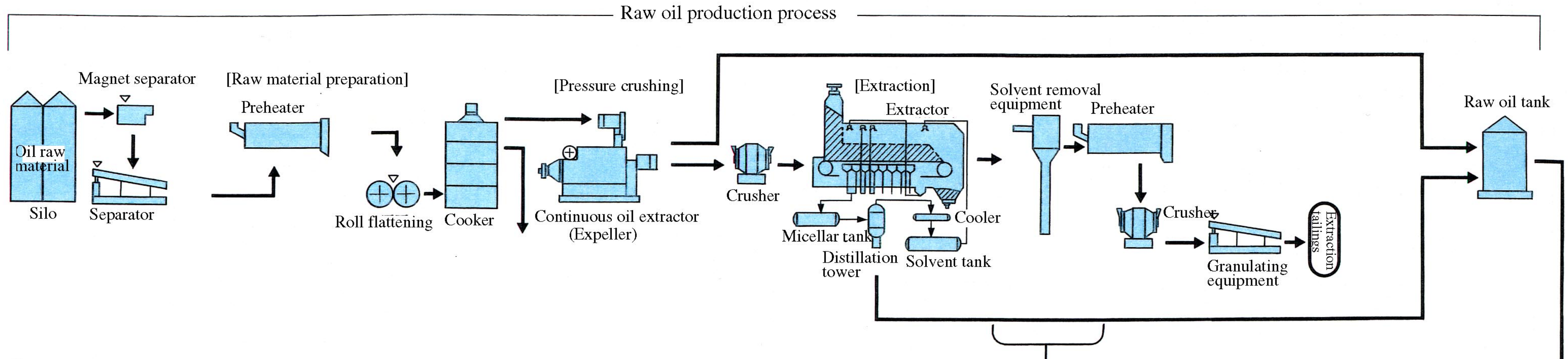
Item No.	Technology Item/Title
FS-PE-1	Drum-type beet slicer
FS-PE-2	Horizontal twin-screw pulp press

Item No.	Technology Item/Title
FS-PE-3	Clarifying sugar solution with magnesia

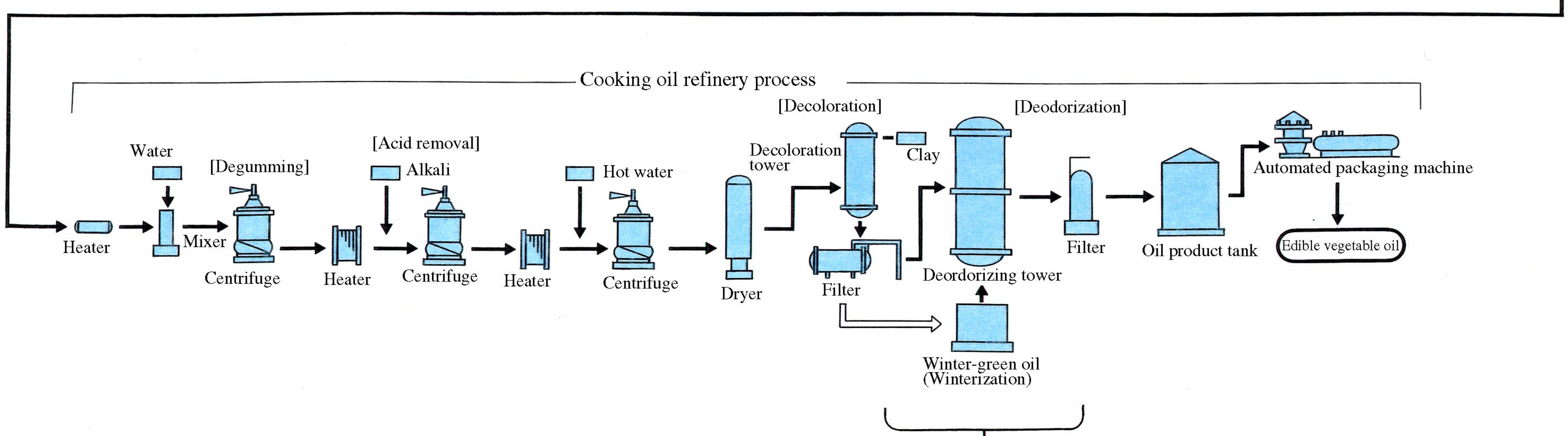
Item No.	Technology Item/Title
FS-PE-4	Forced circulation automatic crystallizing evaporator with mixer
FS-ME-1	Recovery of waste heat from the sugar solution concentration process and crystallizing evaporator

Item No.	Technology Item/Title
FS-OM-1	Steffen waste water concentration

Food (Edible oil) : Production Process and Energy Saving Technology

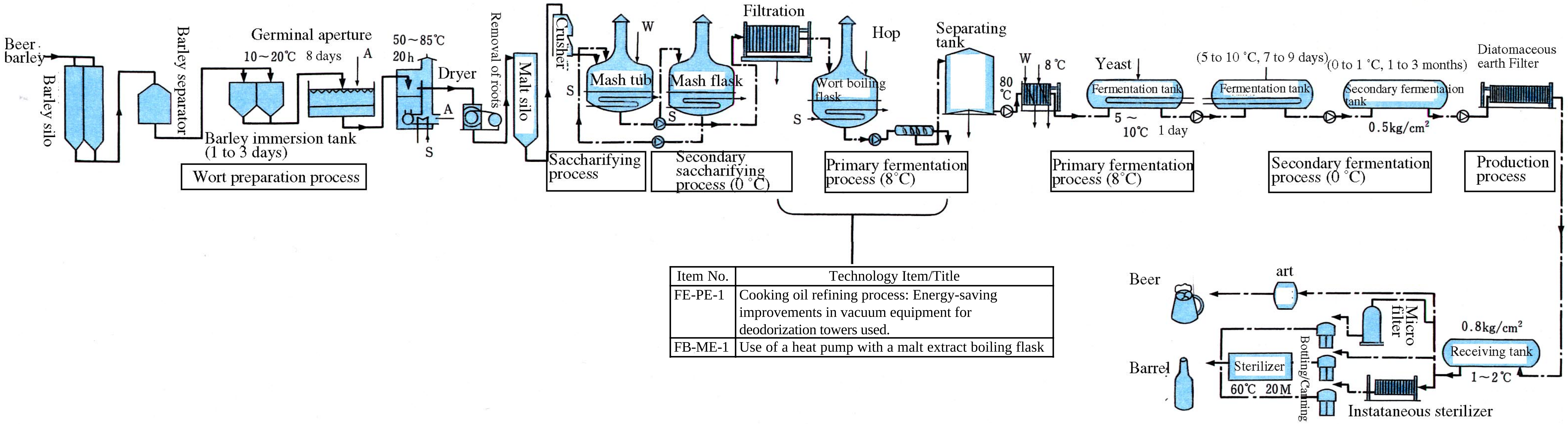


Item No.	Technology Item/Title
FE-PE-2	Edible oil refining process: Energy-saving improvements in solvent removal equipment



Item No.	Technology Item/Title
FE-PE-1	Edible oil refining process: Energy-saving improvements in vacuum equipment for deodorization towers

Food (Beer) : Production Process and Energy Saving Technology



Item No.	Technology Item/Title
FE-PE-1	Cooking oil refining process: Energy-saving improvements in vacuum equipment for deodorization towers used.
FB-ME-1	Use of a heat pump with a malt extract boiling flask

Data Sheets

7-1 Sugar

7-2 Beer

7-3 Edible Oil

7-4 General

FS-PE-1

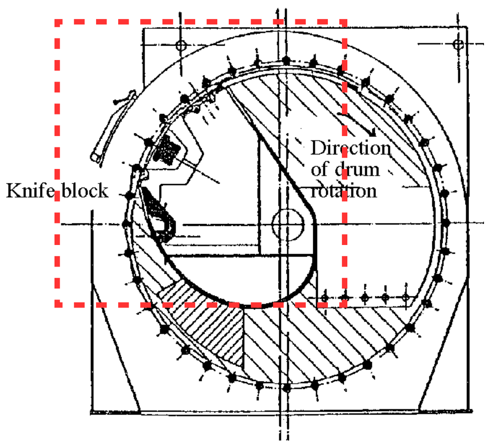
Energy Conservation Directory

[Industry Classification] Food:Suger	Drum-type beet slicer	[Energy Source] Fuel, Electricity
[Technology Classification] Production Equipment		[Practical Use] 1990s -

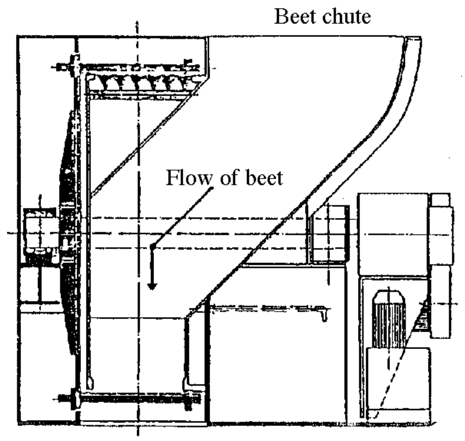
Outline	The sugar beet is cut into sticks (cosset) in the slicer, and fed to an extractor where the sugar is extracted using hot water.
Principle & Mechanism	The beet is fed into a horizontal drum, the inside of which is fitted with knives (knife block). The drum is rotated to cut the beet, which is then discharged.

[Description]

Structure explanation, Shape, and/or System diagram



Front view



Side view

Fig.1 Drum-type beet slicer

Improved section

Primary materials : Soft steel plate (casing)
Aluminum alloy (knife block)

Energy saving effects	Drive power required for slicing the beet is reduced by 30~40% in comparison with conventional disk slicers. As the equipment produces good quality cossett, the sugar extraction rate is improved, resulting a saving of approximately 6% in hot water required for extraction, and a consequent saving of approximately 7% in the steam required for heating in the concentration process. Energy savings : a crude oil equivalent of 1,200kl/year.
[Economics] Equipment cost	Investment amount (A) : 60 million yen Improvement effect (B) : 30 million yen/year Investment payback (A/B) : 2 years
Remarks	Equipment life : Approximately 15 years, however the knife block must be replaced every few years. Knife blocks are considered as consumables.

[Example sites]	[References]	[Inquiry]
Sugar refinery (extraction of sugar from beet).	Suckerindustrie, Vol. 111. July 1986 Makers'in-house technical documents	NEDO/ECCJ(JIEC)

FS-PE-2 Energy Conservation Directory

[Industry Classification] Food:Suger	Horizontal twin-screw pulp press	[Energy Source] Fuel
[Technology Classification] Production Equipment		[Practical Use] 1970s

Outline

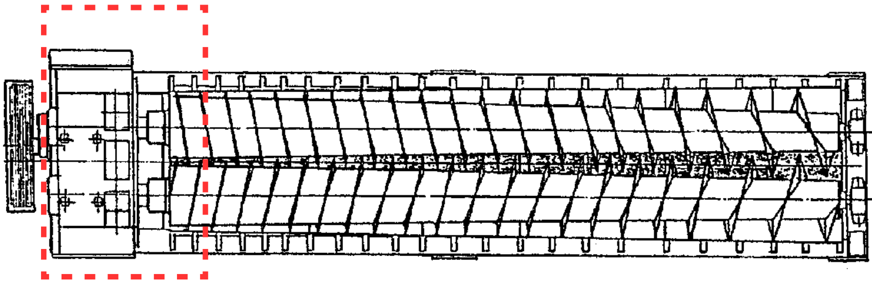
The beet is cut into sticks and the sugar content extracted in the extractor. The remaining beet pulp is compressed in this press to remove the water. After the water has been removed, the beet is fed to a dryer where it is formed into pellets for use as animal feed. The moisture removal rate at the pulp press directly affects the fuel consumption of the dryer in the subsequent stages.

Principle & Mechanism

A symmetrical pair of screws are arranged in parallel around tapered shafts. The screw pitch becomes finer, and the diameter of the tapered shafts increases, in the direction of feed of the pulp. The pair of screws rotate in opposite directions so that the beet pulp fed in at one end is compressed towards the other end while the water is removed in an efficient manner.

[Description]

Structure explanation, Shape, and/or System diagram



Improved section

Fig.1 Horizontal twin-screw pulp press (top view)

Primary materials : Stainless steel plate
The periphery of the screws is built up with overlaying weld for strength.

Energy saving effects

Moisture content of the pulp following compression is 7~9% less than that obtained with the conventional vertical single-screw press, thus allowing a reduction of approximately 40% in fuel consumption in the dryer. This results in a reduction in specific fuel consumption of approximately 7 liters of C-grade heavy oil per 60kg bale of pulp.

Table 1

	Before (with vertical single-screw press)	After (with horizontal twin-screw press)
Specific energy consumption (in liters of C-grade heavy oil / 60kg bale of pulp)	15 - 16	8 - 9
Crude oil equivalent (kl/year)	Base	Reduction of 1,200

[Economics] Equipment cost

Investment amount (A) : 40 million yen
Improvement effect (B) : 30 million yen/year
Investment payback (A/B) : 1.3 years

Remarks

Equipment life : Approximately 15 years, however the compression screws must be repaired every three years, and the external mesh replaced annually.

[Example sites]	[References]	[Inquiry]
Sugar refinery (extraction of sugar from beet).	Zuckerindustrie Vol. 115, No. 40 January 1990	NEDO / ECCJ(JIEC)

FS-PE-3 Energy Conservation Directory

[Industry Classification] Food:Suger [Technology Classification] Production Equipment	Clarifying sugar solution with magnesia	[Energy Source] Electricity, Fuel, etc. [Practical Use] 1980s

Outline	The use of a magnesia absorbent (MgO, $Mg(OH)_2$ or a mixture of the two) to clarify sugar solution, in place of the conventional carbonation , achieves a simplification of the clarification process.
Principle & Mechanism	Magnesia not only has strong absorption properties, but is able to absorb a wide range of both organic and inorganic substances. Absorption of colloids and organic high polymers is particularly good.

[Description]

Structure explanation, Shape, and/or System diagram

[Conventional process]

Carbonation → Bone charcoal method (activated carbon) → Ion replacement resin method

[Improved method]

Magnesia treatment method → Ion replacement resin method

1) Cost reductions through re-burning and repeated use of the magnesia.
2) Addition of a filter medium (which also improves re-burning) improves filtration.
3) Hot water is used to release the sugar from the magnesia cake.

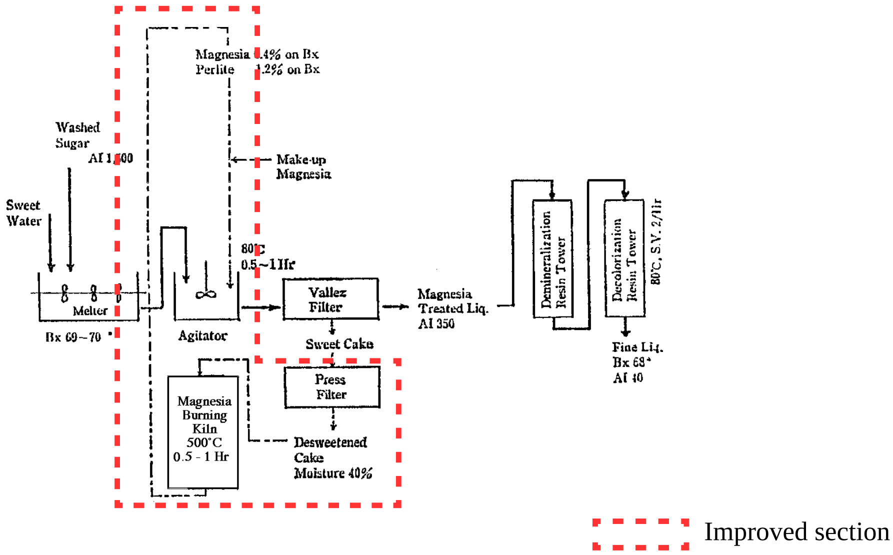


Fig.1 Flow of magnesia clarification process

Energy saving effects	1) Fine liquor concentration may be raised to Bx68˚, thus reducing the energy required for concentration, simplifying the process, and allowing major savings in energy. Reductions of approximately 70% in power requirements, and approximately 75% in fuel requirements are achieved. 2) Re-burning and repeated use of the magnesia reduces the proportion of cake discharged to approximately 10%, thus reducing the costs of treating waste and waste water. 3) Hydrated lime and bone charcoal (activated charcoal) are not required. 4) The excellent absorption qualities of magnesia allow simplification of the process, thus producing fine liquor of high purity.
[Economics] Equipment cost	Investment amount (A) : 600 to 1,000 million yen Improvement effect (B) : 150 to 300 million yen /year Investment payback (A/B) : 2 to 6 years
Remarks	

[Example sites]	[References]	[Inquiry]
Mitsui Sugar Co., Ltd	INS.SUGAR JNL.1989, VOL.91, NO. 1085 Journal of the Sugar Refining Technology Research Association(1989), Vol.32, P18~41 Journal of the Sugar Refining Technology Research Association (1989), Vol.37, P1~9	NEDO / ECCJ(JIEC)

FS-PE-4

Energy Conservation Directory

[Industry Classification] Food:Suger	Forced circulation automatic crystallizing evaporator with mixer	[Energy Source] Fuel, Washing water
[Technology Classification] Production Equipment		[Practical Use] 1970s

Outline

A forced circulation automatic crystallizing evaporator with a mixer is used in sugar solution concentration and crystallization. The mother liquor is subjected to forced circulation inside the evaporator in order to prevent settling of the crystals, and thus reduce the heat energy required as well as the amount of water necessary to prevent over-concentration.

Principle & Mechanism

Conventional evaporators require a considerable amount of water to prevent over-concentration. This evaporator contains a mixer for forced circulation of the mother liquor, thus reducing the amount of water, and the heating steam, required to prevent over-concentration. This design ensures uniform concentration of the mother liquor, crystal distribution, and temperature distribution, as well as improving the thermal conductivity within the evaporator.

[Description]

Structure explanation, Shape, and/or System diagram

The installation of the mixer in the evaporator is shown in the diagram below.
Liquid is added to the level set on the liquid level indicator, and heated with steam for concentration.
Seeding crystals are added to the sugar solution when the set viscosity is reached.
Almost no crystals settle out of the solution during the process of crystal growth, even without the addition of further water. Operation is automated with the use of a sequencer.

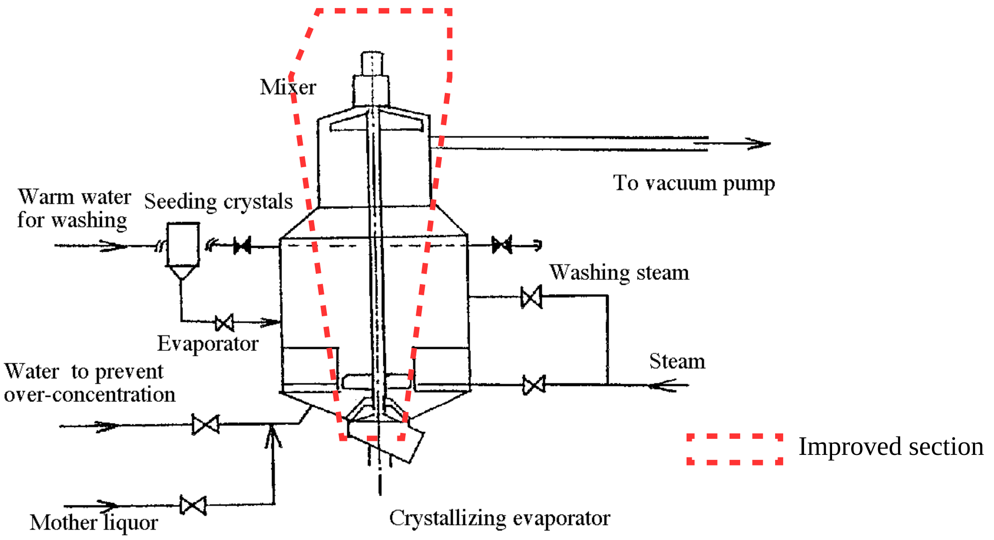


Fig.1 Installation of mixer in crystallizing evaporator

Energy saving effects

1) The conventional concentration and crystallizing processes used 65% of the total factory energy requirements. This was reduced by 30% (4,500kl/year crude oil equivalent) with the installation described.
2) The amount of warm water required to prevent over-concentration is reduced.
3) The circulation inside the evaporator is improved, thus improving the crystal quality (e.g. sugar curing).
4) The process may be automated.

[Economics] Equipment cost

Investment amount (A) : 100 million yen
Improvement effect (B) : 100 million yen /year
Investment payback (A/B) : 1 year

Remarks

Very few consumables required, with simple maintenance. Annual maintenance of the mixer bearings is required.

[Example sites]	[References]	[Inquiry]
Installed at a number of sites, primarily in the sugar refining industry.	Journal of the Sugar Refining Technology Research Association(1983), Vol.32, P49~59 Journal of the Sugar Refining Technology Research Association, Vol.39, P1~8 Design and construction of food plants, p190 - 193 Collection of Energy Conservation Cases (1985), P. 693 - 699	NEDO / ECCJ(JIEC)

FS-PE-5	Energy Conservation Directory	
[Industry Classification] Food:Suger [Technology Classification] Production Equipment	Uniform fan nozzle washer (Washing nozzle for centrifuge)	[Energy Source] Electricity, Washing water [Practical Use] 1990s

Outline

Improvements to the washing nozzle employed in centrifuges to provide uniform distribution of washing water ensure that all locations are evenly washed, and thus improve separation efficiency. This in turn results in savings in washing water (and pump power requirements), and improved sugar quality (e.g. color value).

Principle & Mechanism

Simply increasing the amount of washing water supplied to the nozzle results in dissolving more than the necessary amount of sugar crystals, a reduction in yield, and an increase in concentration with a consequent increase in the load on the evaporation process. This machine reduces the amount of warm water used in washing the sugar surface to a minimum while ensuring that washing is uniform.

[Description]

Structure explanation, Shape, and/or System diagram

Conventional nozzles		Improved Nozzle
Rotating Nozzle	Fixed Six-nozzle Wash	Uniform Fan Nozzle
The rotation of a circular plate results in the nozzle rotating on a circular track at a varying height above the washed surface. As it is difficult to ensure uniform washing, variations occur in the color value of the sugar.	Strips occur on the sugar surface in the area of the overlapping sprays, resulting in a tendency to produce variations in the color value.	A single nozzle allows washing of the sugar surface with a uniform spray. This reduces the amount of washing water required and resolves the problems inherent in the conventional methods.

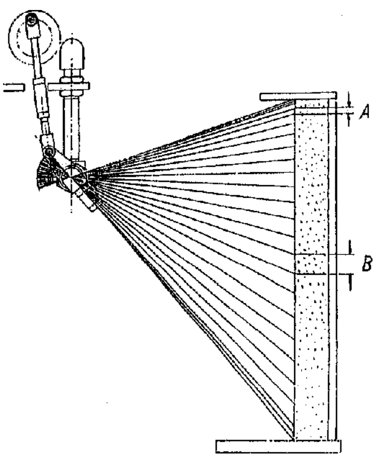


Fig.1 Rotating nozzle washing pattern

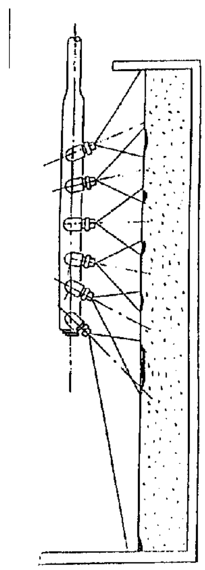
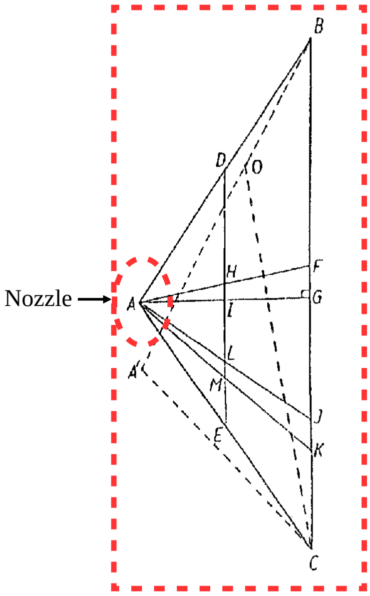


Fig.2 Fixed six-nozzle wash pattern



Improved section

Fig.3 Spray characteristics of uniform fan nozzle

Energy saving effects

Savings in wash water of approximately 15% in comparison with conventional wash nozzle designs. Only the minimum amount of sugar crystals is dissolved, improving the yield during separation, and reducing the load on the evaporation process by controlling increases in curing.

[Economics] Equipment cost

Investment amount (A) : 25 or 50 million yen
Improvement effect (B) : 25 or 50 million yen /year
Investment payback (A/B) : 1 year

Remarks

1) Efficiency is improved with increased nozzle spinning rate.
2) Intermittent washing is more effective than continuous washing.

[Example sites]	[References]	[Inquiry]
Nisshin Food Products Co., Ltd.	Journal of the Sugar Refining Technology Research Association(1995), Vol.43, P1~5	NEDO / ECCJ(JIEC)

FS-ME-1

Energy Conservation Directory

[Industry Classification]
Food:Suger

[Technology Classification]
Machinery & Equipment

Recovery of waste heat from the sugar solution concentration process and crystallizing evaporator

[Energy Source]
Fuel

[Practical Use]
1980s

Outline

1) MVR (Mechanical Vapor Recompression)
2) Recovery of waste heat from an evaporator

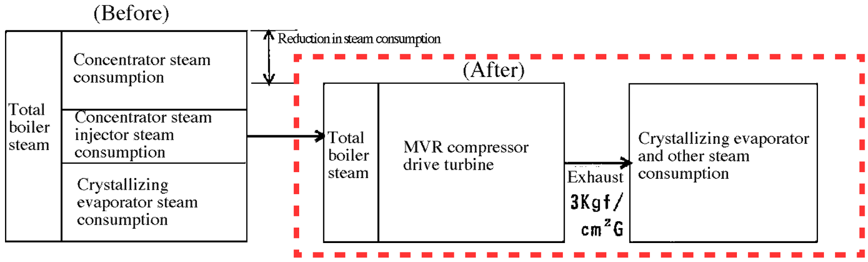
Principle & Mechanism

1) MVR for recovery of waste heat from the sugar solution concentration process
The use of MVR in the sugar solution concentration process to reduce the amount of steam required. In the conventional process approximately 25% of the steam generated during concentration of the solution is compressed with the use of a steam injector and reused in the concentration process, while the remaining steam which is not reused is discarded after being condensed in a barometric condenser.

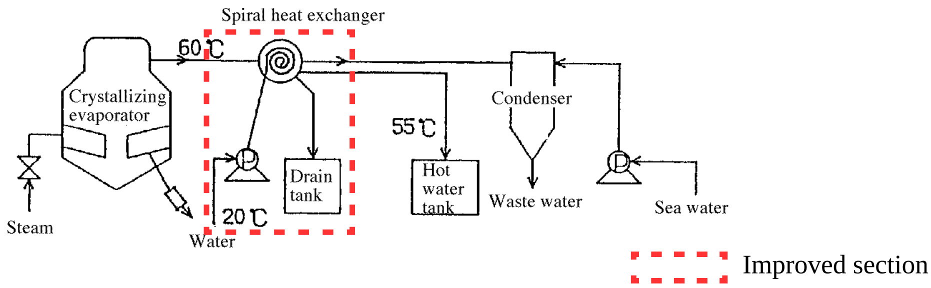
2) Recovery of waste heat from a crystallizing evaporator
The waste heat in the steam discharged from the crystallization process is recovered via a heat exchanger and used to produce hot water. The evaporator has a steam takeoff pipe fitted to the top of the sealed vessel, the pipe being connected to a vacuum pump. The temperature of the steam vented through this pipe is approximately 60˚C, this heat being recovered.

[Description] Structure explanation, Shape, and/or System diagram

1) MVR : All the steam generated in concentration of the sugar solution is compressed, and its temperature raised, with a compressor and the latent heat reused as a source of heat for concentration of the solution. This dramatically reduces steam consumption. The steam flow before and after the improvements is shown quantitatively below.



2) Recovery of waste heat from a crystallizing evaporator
While the waste steam is at a temperature of approximately 60˚C, the latent heat in a vacuum environment may be recovered via a heat exchanger as hot water and used in various processes. The discharged water after recovery of the heat is used for washing filters.



Energy saving effects

1) MVR
A reduction in the amount of steam required by 0.12 tons per ton of sugar in comparison with the steam injector method. The reduced size of the vacuum pump results in a reduction in power consumption of approximately 10% (crude oil equivalent of 1,200kl/year).

2) Recovery of waste heat from a crystallizing evaporator
A reduction in steam required in producing hot water of 0.03 tons per ton of sugar (crude oil equivalent of 300kl/year).

[Economics] Equipment cost

Investment amount (A) : 100 million yen
Improvement effect (B) : 40 million yen/year
Investment payback (A/B) : 2.5 years

Remarks

Investment recovered in 3~7 years with 2) alone.
As the temperature of the waste water from the condenser is reduced with 2), it has the benefit of preventing pollution.

[Example sites]
Installed at a number of sites, primarily in the sugar refining industry.

[References]
Journal of the Sugar Refining Technology Research Association(1988), Vol.36, P33~35
Collection of Energy Conservation Cases (1986), Vol.38, P. 12 - 18
Collection of Energy Conservation Cases (1985), P. 125 - 133

[Inquiry]
NEDO / ECCJ(JIEC)

FS-OM-1

Energy Conservation Directory

[Industry Classification]
Food:Suger

[Technology Classification]
Operation & Management

Steffen waste water concentration

[Energy Source]
Heavy oil, Coke, etc.

[Practical Use]
1970s

Outline

Steffen waste water is discharged from the process of recovering the sugar component from sugar solution (beet molasses) in which lime is reacted with the syrup. The concentration process is very expensive (due to fuel costs etc.).

Principle & Mechanism

1) The use of the RT Saccharate method reduces the amount of steffen waste water.
2) Fuel costs are reduced by using waste gas and steam from the sugar refining process, instead of boiler steam.
3) The amount of lime required is reduced through the use of the waste gas from the sugar refining process, and a resulting reduction in the amount of carbon dioxide used.

[Description] Structure explanation, Shape, and/or System diagram

1) Use of the RT Saccharate method
This method is characterized by circulation of approximately ten times the amount of water in the reactor vessel, and addition and dispersal of lime powder in a manner to attain equal concentration. This method allows concentration of the dilute sugar solution to approximately twice (12%) that obtainable with the conventional method. In addition, the amount of Steffen waste water is reduced, and solids concentration is increased.
2) Use of waste gas and steam from the sugar refining process
Waste gas from a utility boiler (in the sugar refining process) is used for in concentration of the Steffen waste water, and supplemented by steam from flash evoporation of drain , thus reducing the amount of steam taken from the boiler.
3) Use of waste gas from the sugar refining process
The carbon dioxide content of the Steffen waste water is supplemented by the waste gas from the carbon dioxide tank used in the sugar refining process.

Table Comparison of the Conventional and RT Processes

	Conventional method	RT method
Syrop processed (tons/day)	150	150
Concentration of dilute sugar solution (%)	5.5	12.0
Concentration of solids in waste water (%)	4.0	7.3
Amount of waste water (tons/day)	1260	620
Steam load (tons/day)	1200	560

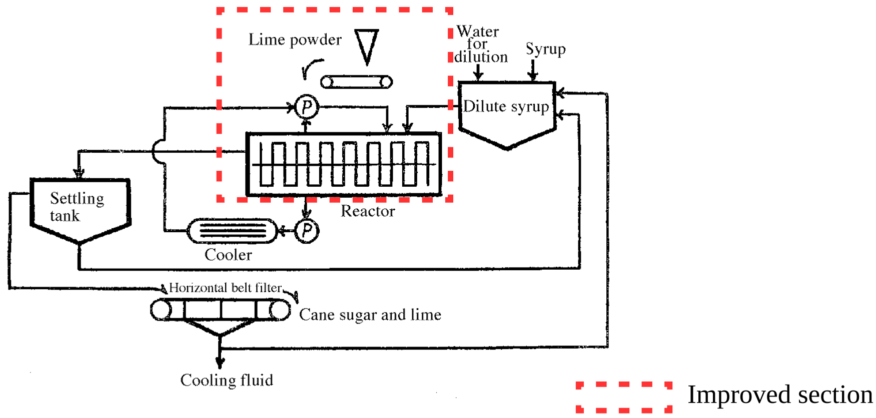


Fig.1 RT continuous saccharate process

Energy saving effects

1) Annual savings of 2,200kl of heavy oil (57.8 million yen) in comparison with the conventional method.
2) Annual savings of 80 tons of coke (2.6 million yen) in comparison with the conventional method in which coal is burned to obtain carbon dioxide, and annual savings in limestone of 1,000 tons (3.6 million yen).
3) Annual savings of 2 million yen in chemicals (HCl, NaOH) through the use of Steffen waste water for washing the concentrator.

[Economics] Equipment cost

Investment amount (A) : 130 million yen
Improvement effect (B) : 66 million yen/year
Investment payback (A/B) : 2 years

Remarks

Running costs (excluding plant depreciation) are reduced by approximately 3 yen per kg of concentrate.

[Example sites]
Sugar beet refining plants such as Hokkaido Toko

[References]
Collection of Energy Conservation Cases (1978), Vol.32, P1319~1327

[Inquiry]
NEDO/ECCJ(JIEC)

FB-PE-1

Energy Conservation Directory

[Industry Classification] Food:Beer	Malt extract boiling equipment using hot water	[Energy Source] Fuel, Electricity
[Technology Classification] Production Equipment		[Practical Use] 1980s

Outline

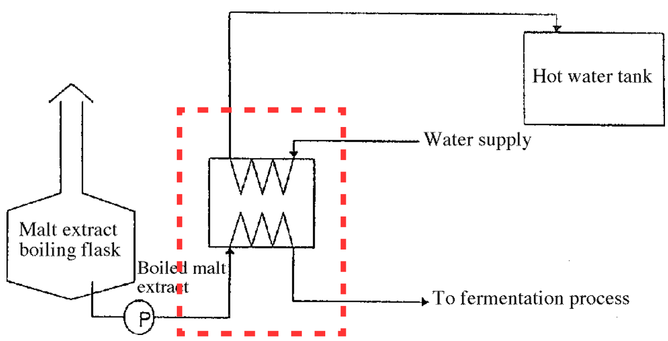
1) Malt extract cooling equipment
2) Waste steam condenser

Principle & Mechanism

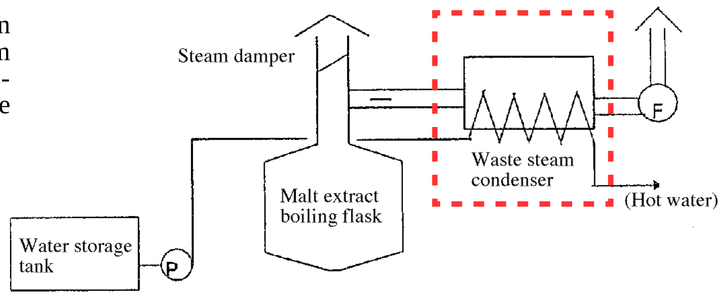
1) Malt extract cooling equipment
Fuel costs for water heating in the plant are reduced by recovering the water used in cooling the boiled malt extract as hot water which is then used as a heat source, or for cleaning and sterilizing bottles and boxes.
2) Waste steam condenser
Steam which was previously discharged is recovered in the form of hot water of 90 ˚C using a heat exchanger, this hot water being utilized as a heat source together with steam.

[Description] Structure explanation, Shape, and/or System diagram

1) Malt extract cooling equipment
A plate heat exchanger is normally used. The temperature of the recovered hot water is determined by the temperature required at the point of use, however it is normally above the temperature required for use as a heat source (78 ˚C). The heat released when cooling the boiled malt extract from 95 ˚C to approximately 30 ˚C is recovered.



2) Waste steam condenser
The exhaust pipe damper is closed when boiling the malt extract and the steam directed to the condenser. Water is supplied from the water storage tank at the same time.



Improved section

Energy saving effects

1) Malt extract cooling equipment
When the boiled malt extract is cooled from 95 ˚C to 30 ˚C, 75~100% of the energy required to heat the saccharificated and filtered malt extract from 78 ˚C to 100 ˚C, and to boil it (boiling ratio of 7~10%), is recovered as hot water.
2) Waste steam condenser
A reduction in the steam required in generating hot water (approximately 10% of the total steam requirements for the plant).
Total (1) + (2) = crude oil equivalent of 530kl/year.

[Economics] Equipment cost

Investment amount (A) : 30 million yen
Improvement effect : 13 million yen/year
Investment payback (A/B) : 2.3 years

Remarks

[Example sites]	[References]	[Inquiry]
Installed at a number of sites (beer companies).	Collection of Energy Conservation Cases (1992), P. 683 - 691	NEDO / ECCJ(JIEC)

FB-ME-1

Energy Conservation Directory

[Industry Classification]
Food:Beer

[Technology Classification]
Machinery & Equipment

Use of a heat pump with a malt extract boiling flask

[Energy Source]
Steam

[Practical Use]
1980s

Outline

Referred to as SSHP (Screw type Steam compression Heat Pump). A closed cycle heat pump able to operate at high temperatures of up to 150 ˚C and using steam as a medium, and which overcomes the disadvantages of mechanical vapor recompression (compression ratios of turbo and Roots compressors, mist, surging, and erosion etc.).

Principle & Mechanism

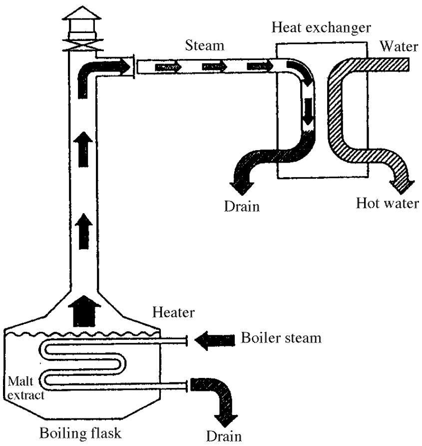
The steam discharged at 100 ˚C from the top of the flask is immediately compressed in the steam compressor where its temperature and pressure is raised to a level at which it may be used again for heating (130~140 ˚C). It is then passed through a heat exchanger (malt extract heater) within the flask for direct heating of the malt extract. Load may be continuously over a range of 25~100%.

[Description]

Structure explanation, Shape, and/or System diagram

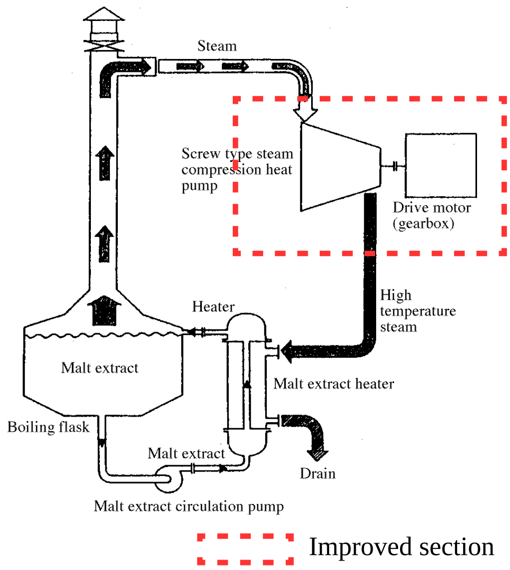
Conventional system

The flask contains a heating coil, and is covered with a jacket. The malt extract is boiled in batches by heating with boiler steam. Approximately 10% of each batch of malt extract is lost through evaporation.



This system

Pressure of steam used in heating malt extract
= 3.28Kg/cm^2 (absolute)
Temperature of steam used in heating malt extract
= 136 ˚C (saturated equivalent)
Malt extract steam pressureÅ@
= approximately atmospheric
Malt extract steam temperature = 100 ˚C
Volume of generated steam = 13 tons/hr (17 tons/B)



Energy saving effects

Table Utilities used (heavy oil equivalent)

	Conventional system	This system	Improvement effects	Crude oil equivalent
Boiler steam (l/B)	1,379	119	- 1,260	
Heavy oil (l/B)	-	273	+ 273	
Power (l/B)	-	40	+ 40	
Total (l/B)	1,379	432	- 947	- 1,400kl/year

[Economics] Equipment cost

Investment amount (A) : 120 million yen
Improvement effect :30 million yen/year
Investment payback (A/B) : 4 years

Remarks

The boiling process consumes approximately 35% of the total plant energy requirements. These improvements result in savings of approximately 60% of this figure, and annual financial savings of approximately 56,000 yen/B.

[Example sites]
Santory Ltd. and many others.

[References]
Collection of Energy Conservation Cases 1985 (Vol.37) No. 8, P. 22 - 28

[Inquiry]
N E D O /
ECCJ(JIEC)

FE-PE-1

Energy Conservation Directory

[Industry Classification]	Edible oil refining process	[Energy Source]
Food:Edible oil	Energy-saving improvements in vacuum equipment for deodorization towers	Steam
[Technology Classification]		[Practical Use]
Production Equipment		1992

Outline

The deodorization process employed in refining edible oil involves the maintenance of a high vacuum with the use of a 4-stage steam ejector. This improvement involves a reduction in steam consumption through control of ejector drive steam by measuring water temperature in a barometric condenser.

Principle & Mechanism

[Structure of Steam Ejectors]
In many cases, steam equipment in the chemical industry is used at reduced steam pressures. This pressure reduction entails the use of either an ejector or a vacuum pump. An ejector squirts high-pressure water and steam through a narrow nozzle to suck in steam from the steam generator and create a vacuum. Fig.1 shows the structure of a steam ejector.

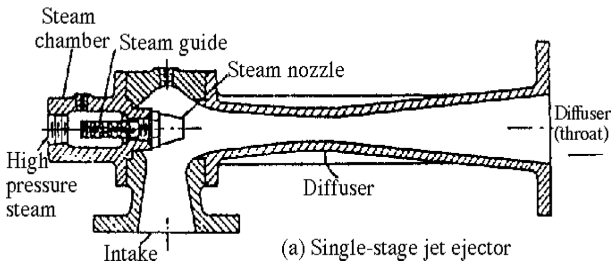


Fig.1 The steam ejector

[Description]

Structure explanation, Shape, and/or System diagram

Automatic Control of Ejector Drive Steam Pressure (see Fig.2)
(1) In a 4-stage steam ejector, the greatest consumption of steam occurs in the second booster, and this tendency is increased as the temperature of the water in the No. 1 barometric condenser increases.
(2) The water temperature at the inlet to the first barometric condenser is measured to facilitate automatic control of the drive steam pressure in the second booster.
(3) The relationship between the water temperature at the inlet to the first barometric condenser and the drive steam pressure in the second booster is computed for control of steam pressure.

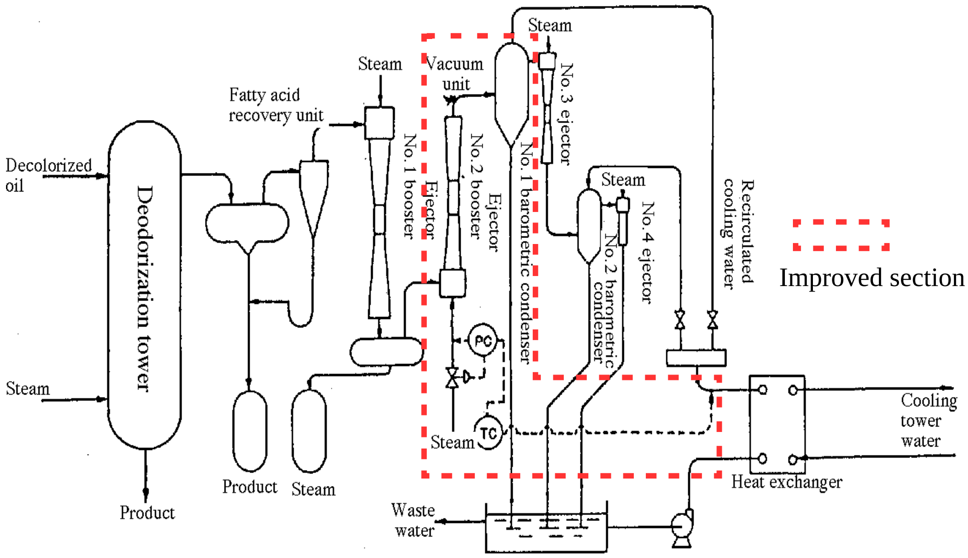


Fig.2 Flow of deodorization process flow employed in refining of cooking oil

Energy saving effects

Table 1 Energy-saving effects of ejector steam pressure control (operating 8,000h/y)

	Before	After	Benefits
Steam consumption	7,900kg/h	4,450kg/h (at water temperature of 20'C)	Reduction of 3,450kg/h
Crude oil equivalent			2,250kL/year

[Economics] Equipment cost

Investment amount (A) : million yen
Improvement effect (B) : million yen /year
Investment payback (A/B) : years

Remarks

This technology is widely used in vacuum operation of ejectors in general industrial distillation towers.

[Example sites]	[References]	[Inquiry]
Installed at a number of sites.	Collection of Energy Conservation Cases 1980 (Vol.32) No. 6, P. 85	N E D O / ECCJ(JIEC)

FE-PE-2

Energy Conservation Directory

[Industry Classification] Food : Edible oil	Edible oil refining process Energy-saving improvements in solvent removal equipment	[Energy Source] Steam
[Technology Classification] Production Equipment		[Practical Use] 1992

Outline

The solvent removal equipment employed in the process of extracting soybean oil in the edible oil refining process is designed to remove hexane solvents from the degreased soybean tailings, and to denature protein (transformation of water soluble protein to water insoluble protein by toasting). The improvements noted here prevent blocking of the scrubber at outlet of the solvent removal equipment with hexane solvent vapor containing degreased soybean dust, while at the same time improving the ability to remove the solvents, and thus improving the operating efficiency of the equipment, and reducing steam consumption.

[Description]

Structure explanation, Shape, and/or System diagram

Before	After
	The scrubber is no longer blocked, and the reduction in the amount of hexane washing fluid required reduces steam consumption.

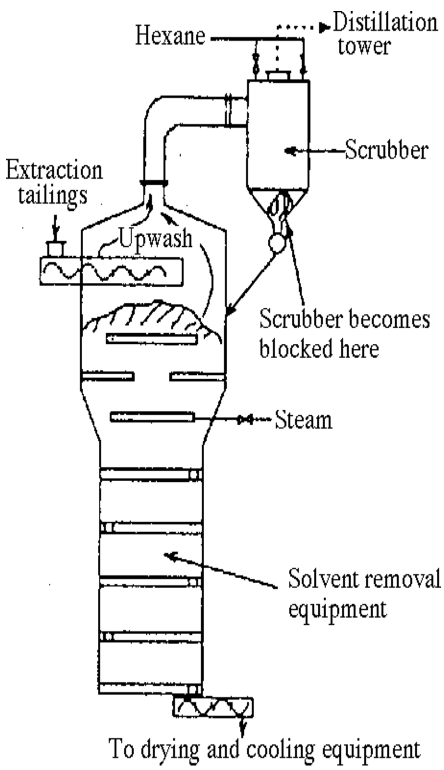


Fig.1 Solvent removal equipment prior to improvement

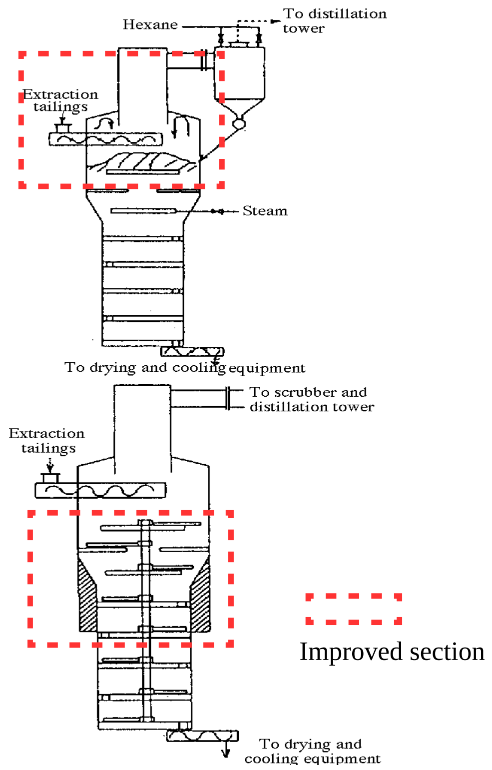


Fig.2 Improvements increase ability to remove solvents

Energy saving effects

Reduction in steam consumption : 9.6%
Education in solvent losses : 16.6%

[Economics] Equipment cost

Investment amount(A) : 15 million yen (construction costs)
Improvement effect (B) : 18.2 million/year (including reduction in solvent losses)
Investment payback(A/B) :0.8 year

Remarks

[Example sites]	[References]	[Inquiry]
Nikko Oils KK, Mizushima plant, and other installations.	Collection of Energy Conservation Cases (1995) P. 1529	NEDO / ECCJ(JIEC)

FG-PE-1	Energy Conservation Directory	
[Industry Classification] Food:General [Technology Classification] Production Equipment	High temperature, high humidity drying equipment	[Energy Source] Fuel [Practical Use] 1980s -

Outline

A drying method providing good heat efficiency through the use of a high humidity, high temperature (400-600˚C) air stream. A drying method which provides overwhelming improvements in energy conservation in comparison with conventional drying methods.

Principle & Mechanism

It has been found experimentally that the coefficient of heat transmission is higher with increased humidity at high temperatures (170 ˚C or more), and the rate of drying is increased. This dryer uses a high temperature, high humidity air, whose properties are closer to a superheated steam, and also uses special ///furaito/// appropriate to the degree of drying required, which allows highly efficient contact with the hot air stream, and a high thermal capacity coefficient.

[Description] Structure explanation, Shape, and/or System diagram

As this equipment employs diluted combustion gas as a heat source, the waste products of the drying process are limited to the air necessary for combustion and the steam from the products being dried, with the remainder being recycled, thus allowing a maximum heat efficiency of 90%.

[Features]

1) Rapid drying allows a reduction in size in comparison to conventional drying equipment.
2) High heat efficiency.
3) The size of the waste gas treatment equipment is reduced by at least half.
4) The high humidity of the waste gas gives it properties approaching that of steam, and it may therefore be employed as a heat source for waste heat recovery equipment.

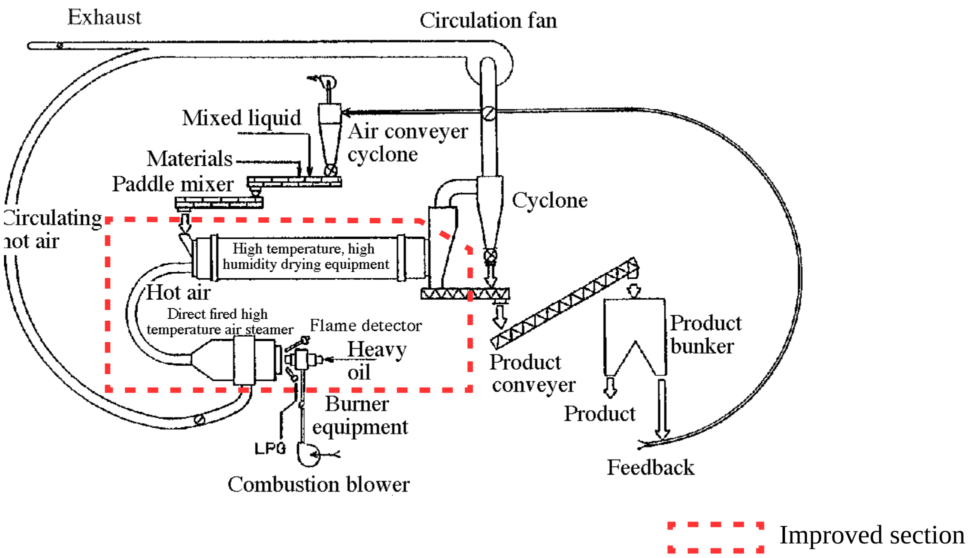


Fig.1 High temperature, high humidity drying system

Energy saving effects

Table 1 Energy-saving effects

	Conventional drying equipment	High temperature, high humidity drying equipment	Benefits
Heat efficiency (%)	55 - 70	75 - 90	
Fuel consumption efficiency (%)	100	70	30
Crude oil equipment (kl/year)	8,000	5,600	2,400

[Economics] Equipment cost

Investment amount (A) : 150 million yen
Improvement effect : 60 million yen/year
Investment payback (A/B) : 2.5 years

Remarks

The optimum system for drying in the food industry, and drying of raw materials in the mining industry.

[Example sites]	[References]	[Inquiry]
Installed at a number of sites (for drying corn, by-product food (e.g. sake lees), sludge etc.)	"Dryer", Noh Kubota, p.83 "Maker catalogue(Ohkawara Seisakusho)"	NEDO / ECCJ (JIEC)

FG-PE-2	Energy Conservation Directory	
[Industry Classification] Food:General [Technology Classification] Production Equipment	Fluidizing granulation spray dryer	[Energy Source] Fuel, Electricity, etc. [Practical Use] 1980s -

Outline

The conventional process involves the initial drying of liquid products such as milk, flavorings, and soup etc to a powder form, the addition of moisture for granulation, and subsequent re-drying to form the final granulated product. Equipment with multiple functions which provides for effective drying (and granulation) while conserving energy has appeared in recent years. This fluidizing granulation spray dryer incorporates the functions of spray drying and fluidized layered granulation, and is used in a variety of applications.

Principle & Mechanism

As shown in the diagram, the equipment incorporates several functions and eliminates the process in which moisture is added to the dried powder. The equipment has wide application for such products as soy sauce, polysaccharides, coffee, dextrine, amino acids (pharmaceuticals), and Chinese medicine.

[Description] Structure explanation, Shape, and/or System diagram

The equipment conserves energy through the following means.

1) As the material contains a small amount of moisture when discharged, a high spray dryer inlet temperature is possible.
2) The energy required in the conventional equipment to remove the moisture added in the granulation process is no longer necessary.
3) Exhaust temperature is reduced.
4) Transfer of the granulated product is not required.

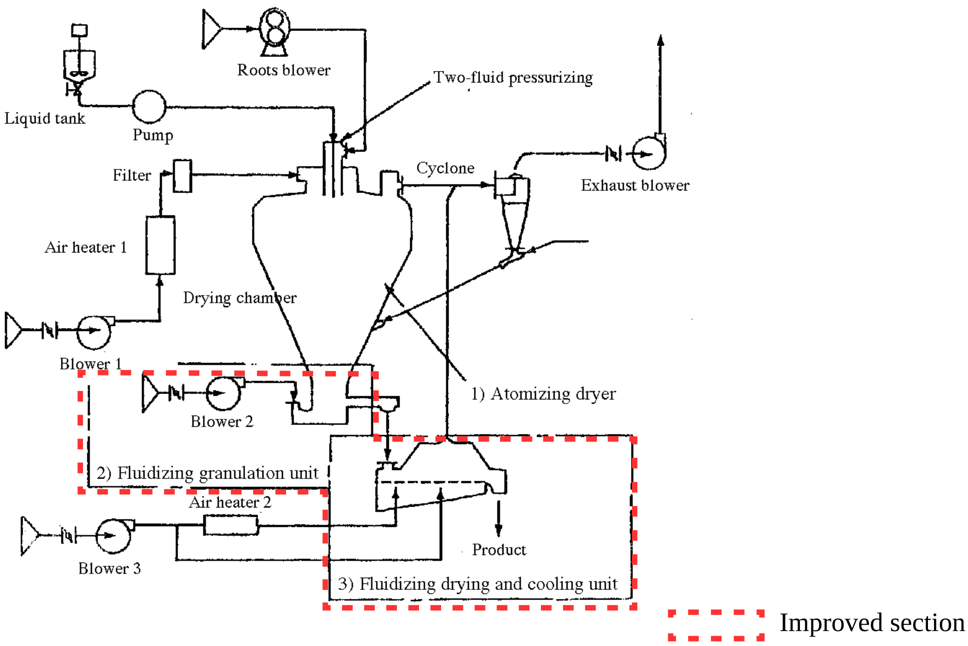


Fig.1 Fluidizing granulation spray dryer system

Energy saving effects

Example 1 : Energy savings of approximately 35% at a powdered milk plant.
Crude oil equivalent : 2,800kl/year
Example 2 : Energy savings of approximately 15% at a powdered food flavoring plant.
Crude oil equivalent : 1,200kl/year

[Economics] Equipment cost

Investment amount (A) : 140 million yen
Improvement effect : 70 million yen/year
Investment payback (A/B) : 2 years

Remarks

Existing examples of combination of classification, granule sorting, and final drying processes show that, in addition to the improvements in quality which this equipment provides, difficulties encountered in the manufacture of certain types of granular products with conventional equipment are resolved.

[Example sites]	[References]	[Inquiry]
Installed at a number of sites (see above).	"Dryer", Noh Kubota, p.152 - 155	NEDO / ECCJ(JIEC)

FG-PE-3

Energy Conservation Directory

[Industry Classification] Food:General	New ion exchange membrane method for salt production	[Energy Source] Electricity
[Technology Classification] Production Equipment		[Practical Use] 1980

Outline

An energy efficient ion exchange membrane method in which electrical energy is used to selectively concentrate the salt in sea water, the concentrate then being to evaporated and crystallized to obtain table salt.

Principle & Mechanism

As shown in Fig.1, this system consists primarily of a process in which salt in sea water is selectively concentrated (electrical dialysis via an ion exchange membrane), and a process by which crystals of table salt are extracted from the concentrate (evaporation and crystallization using a multi-effect evaporator).

[Description]

Structure explanation, Shape, and/or System diagram

A DC current is used to force permeation of salt in sea water through alternate anion and cation membranes and thus raise the salt concentration and produce a brine. This brine is evaporated and crystallized in an evaporator and crystals of table salt extracted. The specific consumption of power in the electrical dialysis process is greatly affected by the electrical resistance of the ion exchange membranes, current efficiency, and the ease with which the salt permeates through the membranes.

As shown in Fig.2, the concentration of brine and specific consumption of heavy oil are related.
(The following example assumes a salt production plant that uses in-house generating equipment, and an ion exchange membrane in a three-effect evaporator.)
The brine concentration is greatly affected by the ion exchange performance and the operating current density etc.

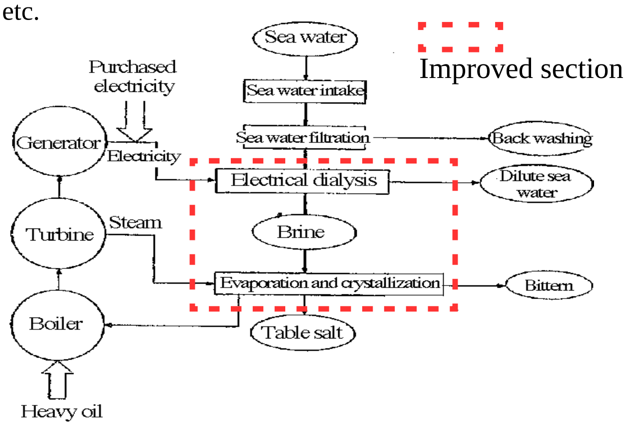


Fig.1 Block diagram of ion exchange membrane method for salt production

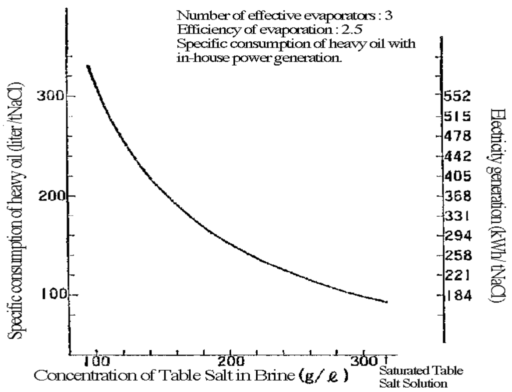


Fig.2 Relationship between salt concentration of brine and specific consumption of heavy oil

Energy saving effects

Table Comparison of power requirements of salt production plants

	Power requirements (kWh/ton of NaCl)			Power generation (kWh/ton of NaCl)	Power purchased (kWh/ton of NaCl)	Consumption of heavy oil (kWh/ton of NaCl)
	Electrical dialysis	Power	Total			
Conventional salt production	280	120	400	330	70	181
Energy-efficient salt production	190	120	310	280	30	152

* Energy consumption (crude oil equivalent) = 450kl/year

[Economics] Equipment cost

Investment amount (A) : 60 million yen
Improvement effect (B) : 27million yen/year
Investment payback (A/B) : 2.2 years (annual production of 10,000 tons of table salt)

Remarks

If heavy oil costs 57 yen/liter, and purchased electricity costs 18 yen/kWh, the energy costs of the conventional membrane salt production plant will be 11,577 yen/ton of NaCl. Therefore, using this new ion exchange membrane method, the cost of table salt will be reduced by 2,373 yen per ton.

[Example sites]	[References]	[Inquiry]
Introduced in 1961, and entered full use in 1972.	Collection of Energy Conservation Cases 1982(Vol. 34, No. 6)	N E D O / ECCJ(JIEC)

FG-ME-1

Energy Conservation Directory

[Industry Classification] Food :General	Use of waste products as an energy source	[Energy Source] Fuel
[Technology Classification] Machinery & Equipment		[Practical Use] 1970s -

Outline	The use of waste products of the food manufacturing process as boiler fuel, and recovery of heat in the form of steam or hot water, ensures effective use of waste products as an energy source, while reducing the cost of treatment of such waste products. This technology is applicable to a wide variety of industries such as sugar refining, flour milling, milk products, meat products, drinks, and flavorings.
Principle & Mechanism	In comparison to the combustion of combustible waste products such as wood shavings, paper off-cuts, waste oil etc, the waste products mentioned above require particular design and operating technology due to their corrosive and smelly nature, and their high water content. Many of these waste products also require high treatment costs. In addition, the heating value of these waste products is only 4,500~5,500kcal/kg (8,000~9,300kcal/kg for edible oils).

[Description] Structure explanation, Shape, and/or System diagram

1) Example of radiation-type Dutch oven + boiler
Waste products from the soy sauce and amino acid manufacturing processes, packaging materials waste, and waste oil etc are used. A total of 13,200kg/day (39,000,000kcal/day).
Boiler steam generation : 3.5ton/hr
Steam pressure : 10kg/cm^2
Maximum possible heat recovery: 39,000,000kcal/day x (boiler efficiency of 0.75) / 661kcal/kg = 44.251kg/day

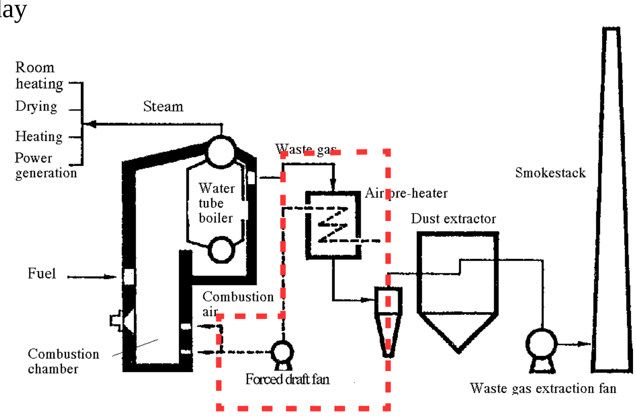


Fig.1 Boiler Using Food Processing Waste

2) Fluidized bed boiler
Fuel is fed into the furnace throughthe freeboard of the primary combustion chamber.
Silica sand used as fluidizing medium.
Auxiliary burners installed in air chamber, and hot air passed to combustion chamber.
Fuel consists of 80 tons/day of beer tailings and 50 tons/day of sludge, with total flow rate of 5,417kg/hr.
530kg/hr of A-grade heavy oil is used to support combustion.

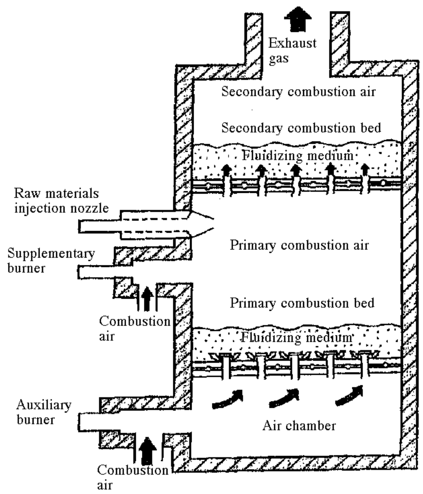
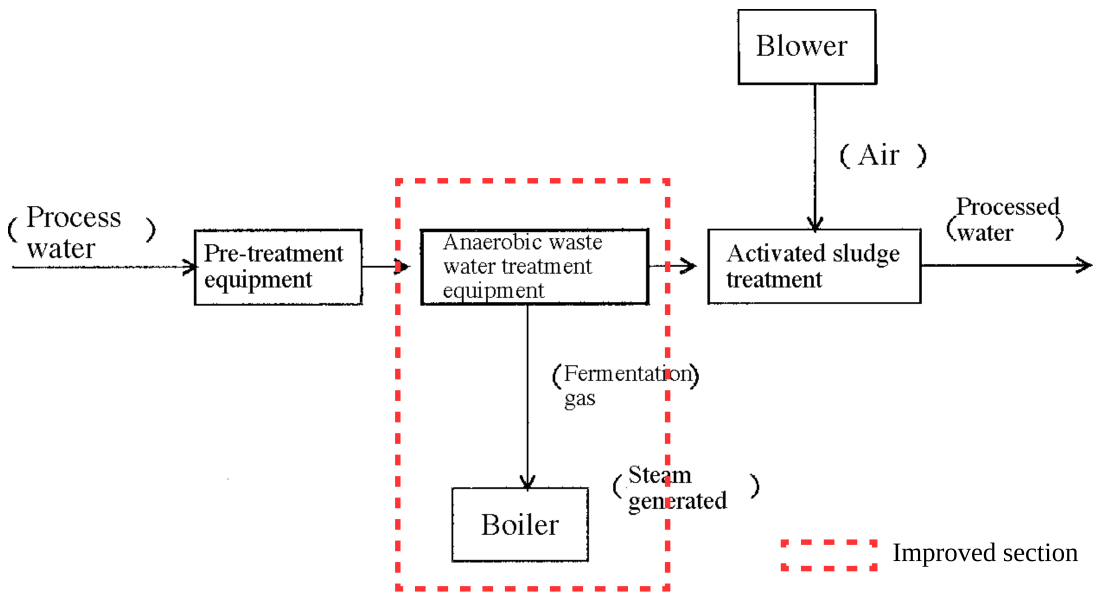


Fig.2 Fluidized bed boiler

Energy saving effects	Savings in heavy oil and steam recovery in example (1) above. 270,000 yen/day x 270 days/year = 72,000,000 yen/year (crude oil equivalent of 4,900kl/year) Savings in heavy oil, steam recovery, and reduction in treatment costs for beer tailings and sludge in example (2) above. 144,000,000 yen/year before installation - 62,000,000 yen/year = 82,000,000 yen/year
[Economics] Equipment cost	Investment amount (A) : Approximately 300 million yen Improvement effect : 150 million yen/year Investment payback (A/B) : 2 years
Remarks	See reference materials for examples of use (and benefits) of tailings from coffee extraction and soy sauce manufacturing processes.

[Example sites]	[References]	[Inquiry]
Installed at a number of sites (see Outline column).	Regarding 1) above: Collection of Energy Conservation Cases 1983(Vol. 35, No. 4); Collection of Energy Conservation Cases 1983(Vol. 35, No. 11) Regarding 2) above: Collection of Best Energy Conservation Cases 1991	NEDO/ ECCJ(JIEC)

FG-ME-2	Energy Conservation Directory	
[Industry Classification] Food:General [Technology Classification] Machinery & Equipment	Anaerobic waste water treatment equipment	[Energy Source] Fuel, Electricity [Practical Use] 1990s

Outline	Waste water containing organic waste products from the food manufacturing process is generally processed using the activated sludge method, however the method requires the high power costs and large equipment space, and also requires a solution to the problem of excess sludge. This equipment resolves these problems through a combination of anaerobic treatment of the waste water, and activated sludge treatment.
Principle & Mechanism	1) Organic waste products are broken down into fermentation gas (primarily methane gas) and water in an anaerobic reactor. 2) The fermentation gas is used as fuel for a boiler in which steam is generated. 3) The steam is used in the manufacturing process.
[Description] Structure explanation, Shape, and/or System diagram	The waste water treatment system is shown below. 
Energy saving effects	The following benefits are obtained in comparison with the conventional activated sludge treatment. 1) Reduction of 50% in power costs for waste water treatment. 2) Energy recovery (steam generation) of 7% through combustion of fermentation gas (reduction in fuel costs). 3) Reduction of 50% in costs of treating sludge. Energy costs of treating sludge 1) + 2) + 3) = Crude oil equivalent of 3,000kl/year
[Economics] Equipment cost	Investment amount (A) : Approximately 200 million yen Improvement effect (B) : 80 million yen/year Investment payback (A/B) : 2.5 years
Remarks	Anaerobic waste water treatment tanks are constructed of reinforced concrete, and have a life of approximately 15 years.

[Example sites]	[References]	[Inquiry]
Installed at a number of sites (e.g. sugar refining, beer brewing, fermentation, starch production, and and bean processing industries industries).	Fractionation of Concentrated Liquid Waste Using Anaerobic Processing. Collection of Energy Conservation Cases 1992, p497 - 503 Development of a High Level System for the Processing of Liquid Waste from the Sugar Refining Process. Journal of the Sugar Refining Technology Research Association, Vol.42, P33~39 (1994) Journal of the Sugar Refining Technology Research Association, Vol.42, P41~46 (1994)	NEDO/ECCJ(JIEC)

FG-ME-3	Energy Conservation Directory	
[Industry Classification] Food:General [Technology Classification] Machinery & Equipment	Gas turbine co-generation	[Energy Source] Electricity [Practical Use] 1990s

Outline

A considerable number of variable output 4MW class gas turbine co-generation units are currently installed in food manufacturing plants. In the milk products plant in the example below, power is both purchased from external sources, and generated within the plant, and a power-heat cogeneration system is operated at loads of 25~100% based on the power demand.

Principle & Mechanism

Gas turbine — — 4.1MW output at 14,950rpm, Compressor 11-stage axial, Turbine 3-stage axial
Generator — — 4,940KVA, 6,600V at 1,500rpm
Waste gas boiler — Twin unit water tube, natural circulation
Operating pressure 16.5kg/cm^{2}G, Rated steam output 9.9 tons/hr

[Description]

Structure explanation, Shape, and/or System diagram

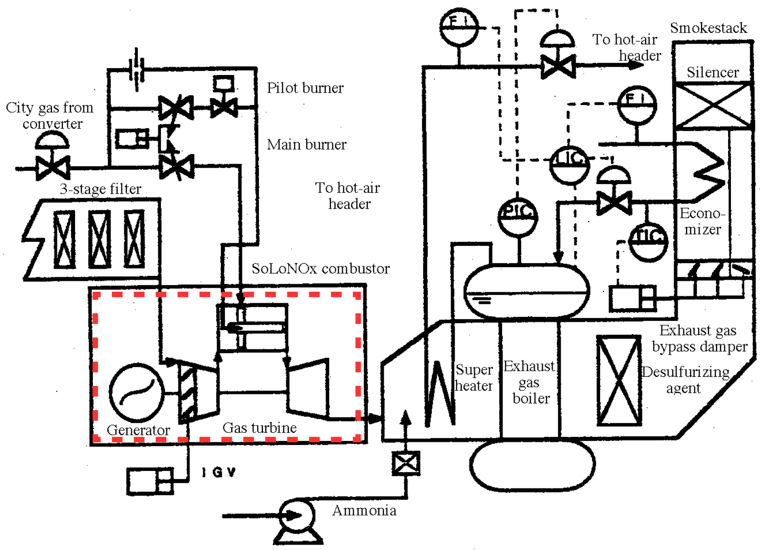
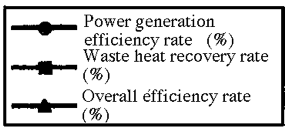


Fig.1 System flow

The use of SoLoNOx control (rarified and pre-mixed combustion) provides for excellent efficiency of power generation within the control range, and the excellent waste heat recovery efficiency at partial loads. The overall efficiency is flat in the vicinity of 80%.



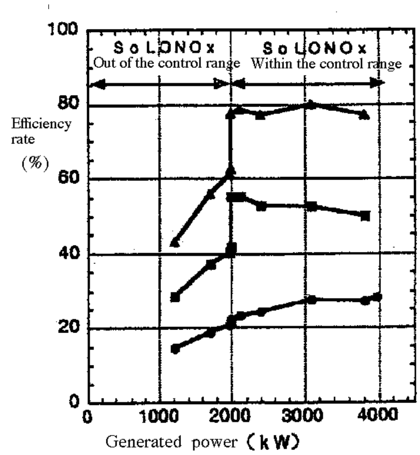


Fig.2 Efficiency characteristics

Energy saving effects

	Before installation (1995)	After installation (1996)	Annual benefits
Power output (MWH)	6,550	19,970	- 13,420
Power purchased (MWH)	24,040	11,700	- 12,340
Costs of purchased power (x 10,000 yen)	33,180	20,060	- 13,120
Costs of A-grade heavy oil (x 10,000 yen)	70	770	- 50

[Economics] Equipment cost

Investment amount (A) : 500 million yen
Improvement effect : 130 million yen/year
Investment payback (A/B) : 4 years

Remarks

63.6% of power requirements generated in-house.

[Example sites]	[References]	[Inquiry]
Installed at a number of sites.	Collection of Energy Conservation Cases 1998, p.129 - 135 Collection of Energy Conservation Cases 1990, p.647 - 654 New Energy Vanguard -21,1997, P.9	N E D O / ECCJ (JIEC)