Ministry of Industry and Trade
Socialist Republic of Viet Nam

No.

The Study on Master Plan for Energy Conservation and Effective Use in the Socialist Republic of Viet Nam

Final Report (Annex)

December 2009

JAPAN INTERNATIONAL COOPERATION AGENCY

ELECTRIC POWER DEVELOPMENT CO., LTD.

IDD
JR
09-075

Table of Contents

ANNEX 1

ENERGY USE SITUATION NOTIFICATION FORM IN JAPAN

Form 1 (Pertaining to Article 5)

* Date received	
* Date processed	

Energy use situation notification

Messer

Date:
Address:
Name: (Official stamp)

This report is presented in compliance with the provisions of Item 2 of Article 7 of the Law Concerning the Rational Use of Energy.

<table>
<tr><td>Name of factory</td><td colspan="7"></td></tr>
<tr><td>Address of factory</td><td colspan="7"></td></tr>
<tr><td>Business the factory is engaged in</td><td colspan="3"></td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="2">Consumption of energy</td><td rowspan="2">Fiscal year</td><td>Sum total</td><td colspan="2">Fuel and heat</td><td colspan="3">Electricity</td></tr>
<tr><td>kL-oe
(kilo litter oil equivalent)</td><td colspan="2">kL-oe
(kilo litter oil equivalent)</td><td colspan="3">MWh</td></tr>
<tr><td>Remarks</td><td colspan="7"></td></tr>
<tr><td>Designation number of Designated Energy Management Factory</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

[Remarks]

1. The size of the form shall be the Japanese Industrial Standard A4.
2. Report shall be handwritten clearly in ink in printed style, or typed.
3. There shall be no entry in the column marked with (*) in this form.
4. Enter the classified name and number in the column of “business the factory is engaged in” according to the detailed classification of Japan Standardized Industrial Classification on the business conducted in the factory.
   Enter the number given by Minister of Economy, Trade and Industry and Minister of Environment in the column of specific emission factory number in the beginning of report.
5. In the calculation of energy consumption, if a calculation method of heat value of fuel to generate heat is used instead of the conversion factor specified in Annex Table 2, provide with the data used as a basis for the calculation method.
6. If the energy consumption is not to correspond to Item 2 of Article 2 after the following fiscal year,

enter the corresponding matter and reason in the column of remarks.

7. In the case that the factory is already appointed as Type 2 Designated Energy Management Factory, enter the designation number of Designated Energy Management Factory of the factory in the column of "Designation number of Designated Energy Management Factory."

Contact to person in charge of notification

Address	
Name of factory	
Department and Section	
Name of person	
Phone	
Facsimile	

ANNEX 2

PERIODIC REPORT FORM IN JAPAN

Form 9 (Pertaining to Article 17)

* Date received	
* Date processed	

Periodic Report

To MESSRS.______________________________

Date

Address

Name (Official stamp)

This report is presented in compliance with the provisions of Item 1 of Article 15 (or Item 1 of Article 18 if applied) of the Law Concerning the Rational Use of Energy.

Designation Number of Designated Energy Management Factory		
Specific emission factory No.		
Name of factory		
Address	Tel (- -) Fax (- -)	
Business the factory is engaged in		Classified No.
Prepared by		
No. of Energy Manager License or No. of Lecture Certification of Responsible Person		

Table 1 Consumption of energy and byproduct energy sold

Type of energy, etc.			Unit	Fiscal year:					
				Consumption		Amount of byproduct energy etc. sold			
						Amount sold		Amount not contributed to the own production	
				Quantity	Heat value (GJ)	Quantity	Heat value (GJ)	Quantity	Heat value (GJ)
Fuel and heat	Crude oil (except for condensate)		kL						
	Condensate (NGL) of crude oil		kL						
	Gasoline		kL						
	Naphtha		kL						
	Kerosene		kL						
	Light oil (Diesel oil)		kL						
	Fuel oil A		kL						
	Fuel oil B/C		kL						
	Petroleum asphalt		t						
	Petroleum coke		t						
	Petroleum gas	Liquefied petroleum gas (LPG)	t						
		Petroleum-based hydrocarbon gas	1,000 m^3						
	Flammable natural gas	Liquefied natural gas (LNG)	t						
		Other flammable natural gases	1,000 m^3						
	Coal	Coking (stock) coal	t						
		Steaming (thermal) coal	t						
		Anthracite	t						
	Coal coke		t						
	Coal tar		t						

	Coke oven gas		1,000 m^3						
	Blast furnace gas		1,000 m^3						
	Basic oxygen furnace gas		1,000 m^3						
	Other fuels, etc.	City gas	1,000 m^3						
		(　　　　)							
	Steam for industry		GJ						
	Steam for other than industry		GJ						
	Hot water		GJ						
	Cold water		GJ						
	Sub-total of fuel and heat		GJ						
Electricity	General electricity enterprises	Purchased electricity in daytime	MWh						
		Purchased electricity in night time	MWh						
	Others	Purchased electricity other than above	MWh						
		In-house electricity generation	MWh						
	Sub-total of electricity		MWh/GJ						
GJ in total									
kL in crude oil terms					a		b		c
Change from the previous year (%)									

Table 2 Outline, operating conditions, new installations, modifications, or removal of equipment pertaining to rational use of energy and principal equipment that consumes energy

	Name of equipment	Outline of equipment	Operating conditions	New installation, modification or removal
Equipment pertaining to rational use of energy				
Principal equipment other than the above that consume energy				

Table 3 Production volume etc.

	Fiscal year:	Change from previous year (%)
Production volume, floor area or other value which has close relation with consumption of energy ( )	d	

Table 4 Energy intensity relating to the use of energy

	Fiscal year:	Change from previous year (%)
Energy intensity = Energy consumption (kL in crude oil terms) (a – (b + c)) / Production volume, floor area or other value which has close relation with consumption of energy d		

Table 5 Change of energy intensity relating to the use of energy for past 5 years

	FY:	FY:	FY:	FY:	FY:	Average change of energy intensity in 5 fiscal years
Energy intensity in use						
Change from previous year (%)		A	B	C	D	

Table 6 If a 1% or more improvement in annual average value of energy intensity has not been attained for past 5 years (A) or improvement of energy intensity has not been attained compared with the previous year (B), provide the reason.

Reason of (A)
Reason of (B)

Table 7 Status of compliance with judgment standards for the rational use of energy

Item (Equipment)	Setting of management standards	Compliance status regarding measurement and recording	Compliance status regarding maintenance and inspection	Measures for new installation
Rationalization of fuel combustion <Combustion equipment>	Setting management standards for air ratios, etc. ☐ Already set ☐ In progress (__%) ☐ Not set yet	Implementation of measurements and recording stipulated in management standards ☐ Periodically implemented ☐ Implemented as required ☐ Not implemented	Implementation of maintenance and inspection stipulated in management standards ☐ Periodically implemented ☐ Implemented as required ☐ Not implemented	Implementation of measures for new installation of combustion equipment ☐ Implemented ☐ Not implemented ☐ N.A.
Rationalization of heating, cooling and heat transfer <Heat utilization equipment>	Setting management standards for heating equipment, etc. ☐ Already set ☐ In progress (__%) ☐ Not set yet	Implementation of measurements and recording stipulated in management standards ☐ Periodically implemented ☐ Implemented as required ☐ Not implemented	Implementation of maintenance and inspection stipulated in management standards ☐ Periodically implemented ☐ Implemented as required ☐ Not implemented	Implementation of measures for new installation of heating equipment ☐ Implemented ☐ Not implemented ☐ N.A.
	Setting management standards for air-conditioning equipment, etc. ☐ Already set ☐ In progress (__%) ☐ Not set yet	Implementation of measurements and recording stipulated in management standards ☐ Periodically implemented ☐ Implemented as required ☐ Not implemented	Implementation of maintenance and inspection stipulated in management standards ☐ Periodically implemented ☐ Implemented as required ☐ Not implemented	Implementation of measures for new installation of air-conditioning equipment ☐ Implemented ☐ Not implemented ☐ N.A.
Use of recovered waste heat <Waste heat recovery equipment>	Setting management standards for waste heat recovery equipment, etc. ☐ Already set ☐ In progress (__%) ☐ Not set yet	Implementation of measurements and recording stipulated in management standards ☐ Periodically implemented ☐ Implemented as required ☐ Not implemented	Implementation of maintenance and inspection stipulated in management standards ☐ Periodically implemented ☐ Implemented as required ☐ Not implemented	Implementation of measures for new installation of Waste heat recovery equipment ☐ Implemented ☐ Not implemented ☐ N.A.

Item (Equipment)	**Setting of management standards**	**Compliance status regarding measurement and recording**	**Compliance status regarding maintenance and inspection**	**Measures for new installation**
Rationalization of conversion of heat into power <Dedicated power generation equipment and cogeneration system>	Setting management standards for gas turbines, etc. for dedicated power generation equipment ☐ Already set ☐ In progress (__%) ☐ Not set yet	Implementation of measurements and recording stipulated in management standards ☐ Periodically implemented ☐ Implemented as required ☐ Not implemented	Implementation of maintenance and inspection stipulated in management standards ☐ Periodically implemented ☐ Implemented as required ☐ Not implemented	Implementation of measures for new installation of Dedicated power generation equipment ☐ Implemented ☐ Not implemented ☐ N.A.
	Setting management standards for boilers, etc. for cogeneration equipment ☐ Already set ☐ In progress (__%) ☐ Not set yet	Implementation of measurements and recording stipulated in management standards ☐ Periodically implemented ☐ Implemented as required ☐ Not implemented	Implementation of maintenance and inspection stipulated in management standards ☐ Periodically implemented ☐ Implemented as required ☐ Not implemented	Implementation of measures for new installation of cogeneration equipment ☐ Implemented ☐ Not implemented ☐ N.A.
Prevention of energy loss due to radiation, heat transfer, resistance etc. <Heat utilization equipment and Power receiving and transforming equipment and distribution equipment >	Setting management standards for prevention of heat loss ☐ Already set ☐ In progress (__%) ☐ Not set yet	Implementation of measurements and recording stipulated in management standards ☐ Periodically implemented ☐ Implemented as required ☐ Not implemented	Implementation of maintenance and inspection stipulated in management standards ☐ Periodically implemented ☐ Implemented as required ☐ Not implemented	Implementation of measures for new installation of heat utilization equipment ☐ Implemented ☐ Not implemented ☐ N.A.
	Setting management standards for prevention of electricity loss ☐ Already set ☐ In progress (__%) ☐ Not set yet	Implementation of measurements and recording stipulated in management standards ☐ Periodically implemented ☐ Implemented as required ☐ Not implemented	Implementation of maintenance and inspection stipulated in management standards ☐ Periodically implemented ☐ Implemented as required ☐ Not implemented	Implementation of measures for new installation of power receiving and transforming equipment and distribution equipment ☐ Implemented ☐ Not implemented ☐ N.A.

Item (Equipment)	Setting of management standards	Compliance status regarding measurement and recording	Compliance status regarding maintenance and inspection	Measures for new installation
Rationalization of electricity conversion into power, heat, etc. <Electricity consuming equipment>	Setting management standards for electric power consuming equipment, such as electrical power application equipment, electric heating equipment and electrolytic equipment ☐ Already set ☐ In progress (__%) ☐ Not set yet	Implementation of measurements and recording stipulated in management standards ☐ Periodically implemented ☐ Implemented as required ☐ Not implemented	Implementation of maintenance and inspection stipulated in management standards ☐ Periodically implemented ☐ Implemented as required ☐ Not implemented	Implementation of measures for new installation of electrical power application equipment ☐ Implemented ☐ Not implemented ☐ N.A.
	Setting management standards for lighting equipment ☐ Already set ☐ In progress (__%) ☐ Not set yet	Implementation of measurements and recording stipulated in management standards ☐ Periodically implemented ☐ Implemented as required ☐ Not implemented	Implementation of maintenance and inspection stipulated in management standards ☐ Periodically implemented ☐ Implemented as required ☐ Not implemented	Implementation of measures for new installation of lighting equipment ☐ Implemented ☐ Not implemented ☐ N.A.

Table 8 Other measures taken for rational use of energy

Outline of measures	
Head (Responsible person) of the energy conservation promotion organization	(Position) (Name)

Table 9 Emission volume of carbon dioxide (CO2) generated by the use of energy

1. Emission volume of carbon dioxide (CO_2) generated by the use of energy

Emission volume of carbon dioxide (CO_2) generated by the use of energy	t-CO_2

2. Emission volume of carbon dioxide (CO2) generated by the use of fuel in a factory, which an electric power generation plant for electric power business or a heat supply plant for heat supply business is installed.

Emission volume of carbon dioxide (CO_2) generated by the use of energy	t-CO_2

3. Contents of calculation method or coefficient different to the calculation method or the coefficient specified by the Order based on the Act relating to the promotion of the measures for global warming

4. Providing of information or requests relating to protection of right and profits

Does the report of the above item 1 or 2 relate to request in Item 1 of Article 21-3 of Act relating to the promotion of the measures for global warming? (Indicate the appropriate answer by mark (○).)	1.Yes 2.No	Is the information provided according to Item 1 of Article 21-8 of Act relating to the promotion of the measures for global warming? (Indicate the appropriate answer by mark (○).)	1.Yes 2. No

[Remarks]

1. The size of the form shall be the Japanese Industrial Standard A4.
2. Report shall be handwritten clearly in ink in printed style, or typed.
3. There shall be no entry in the column marked with (*) at the beginning of Report.
4. Enter the number given by Minister of Economy, Trade and Industry and Minister of Environment in the column of specific emission factory number in the beginning of Report.
5. Enter the classified name and number in the column of business related to the factory according to the detailed classification of Japan Standardized Industrial Classification on the business conducted in the factory.
6. Enter the value in each unit and value in terms of heat amount in the "Consumption" columns of Table 1 by kinds of energy.
7. The columns for unused energy may be left blank in Table 1.
8. Enter the sold amount by kinds of energy and energy that do not contribute to their own production in the column of "Amount of byproduct energy etc. sold" of Table 1.
9. Enter the type of fuel, such as oil refinery gas, in the parentheses in the column below the "City gas" in section "Other fuels, etc." of Table 1, and the consumption. If two or more kinds of fuels have to be entered, provide new columns as required.
10. In the conversion to heat value form consumption of "Steam for industry", "Steam for other than industry", "Hot water" and "Cold water" column of Table 1, if a calculation method of heat value is used instead of the conversion factor specified in Annex Table 2 of the Energy Conservation Law, provide with the data used as a basis for the calculation method.
11. Enter the amount of electric power sold in the column of "Amount sold" of "In-house electricity generation".
12. Converted heat value to be entered in the column of the amount of byproduct energy etc. sold of "In-house electricity generation" in Table 1 is the converted value on a basis of 9,830 kilojoules for 1 kilowatt-hour or the converted heat value of fuel used for the electricity generation.
13. Enter the calculation value in column of the amount of unused for production oneself by the kind of electricity in Table 1, in the case that the amount of unused for production oneself is not arranged by the kind of electricity in Table 1.
14. Regarding fuels to be entered in GJ in Table 1, the symbol T (for Tera) or P (for Peta) may be suffixed to the figures.
15. In calculating the total of consumption of energy in Table 1, it is not necessary to add energy and their byproducts together. In this case, the kind and the quantity of such energy that was not added should be noted below Table 1.
16. Enter the fiscal year in question in the upper columns of Tables 1, 3 and 4. In the "Change from the previous year" column of each table, enter the value calculated by using the value stated in the periodical report submitted in the previous year (for Table 3 and Table 4, the value for the previous year shall be, in principle, the value calculated based on the formula used for the calculation of the value for the year in question). The calculation method shall be as follows.

$$\text{Rate of change over previous year (\%)} = \frac{\text{Value for the fiscal year in question}}{\text{Value for the previous year}} \times 100\ (\%)$$

17. In Table 2, enter the matters so that energy whose annual consumption for the equipment concerned covers 80% of total energy consumption in the factory.
18. Enter production volume or amount or value which has close relation with floor area or consumption of other energy, etc. in the “Production volume, floor area or other value which has close relation with consumption of energy” of Table 3, and enter the unit in the parentheses. Whichever may be selected, the same unit shall be used throughout the year. If a report was made in the preceding fiscal year or before, in principle, the same unit as used in that report shall be used. A total of equivalents for individual products based on the quantity of energy, etc. required to produce the main products in the factory may be entered in the column.
19. “Energy intensity” in Table 4 refers to the amount of energy consumed per unit of production.
20. Enter the 5 fiscal years including the latest fiscal years in the upper column of Table 5. Enter the calculated value by the calculation formula used for the year in the column of “Energy intensity in use” and “Change from previous year”.
21. Enter the value of 4^{th} root of multiplied value of “change from the previous year” for the past 5 years in the column of “Average change of energy intensity in 5 fiscal years” of Table 5. The calculation method shall be as follows.

    Average change of energy intensity in 5 fiscal years (%) = ($\boxed{A}$ * $\boxed{B}$* $\boxed{C}$ * $\boxed{D}$)^0.25 (%)

22. In Table 6, in the case that “Reason of (A)” is the same as “Reason of (B)”, “ Same as (A)” may be entered.
23. Indicate appropriate items by check mark (✓) and enter the value for a necessary item in Table 7. For equipment items that do not exist in the factory, their columns shall be indicated by shading with hatch lines.
24. For Table 9, enter the fiscal year in “Report year”.
25. CO_2 emission shall be calculated in accordance with the Act on Promotion of Global Warming Countermeasures
26. Enter the total amount of the followings (excluding the electricity and heat supply to others);
    (1) CO_2 emission by fuel combustion
    (2) CO_2 emission by electricity use
    (3) CO_2 emission by heat use
27. In the case of power plant and/or district heating and/ cooling plant, enter the CO_2 emission indicated the Remarks 26 (1) in table9.2.
28. In the case of applying an different calculation method from the calculation method or the coefficient instructed in the Order based on the Act on Promotion of Global Warming Countermeasures, explain the contents of the specified calculation method or coefficient (Table9)
29. In the case of “1. Yes” in Table 9.4, the document defined by the Act on Promotion of Global Warming Countermeasures shall be attached.

ANNEX 3

MIDDLE- AND LONG-TERM PLAN FORM IN JAPAN

Form 7 (Pertaining to Article 15)

* Date received	
* Date processed	

Middle- and Long-Term Plan

To Messers

Date

Address

Name

This report is presented in compliance with the provisions of Item 1 of Article 14 of the Law concerning the Rational Use of Energy.

Designated Number of Designated Energy Management Factory							
Name of factory							
Address	Tel (- -)						
Business the factory is engaged in							

I Plan Period

Fiscal year to Fiscal year

II The Contents of plan, and the expected effects of rationalization of energy use

Process	Contents of plan	Expected effects of rationalization of energy use

III Comparison with Previous Year Plan

Process	A plan to have been deleted	Reason
Process	A plan to have been added	Reason

IV The other matters relevant to Plan

[Remarks]

1. The size of the form shall be the Japanese Industrial Standard A4.
2. Plan shall be handwritten clearly in ink in printed style, or typed.
3. There shall be no entry in the column marked with (*) at the beginning of Plan.
4. Enter the classified name and number in the column of business related to the factory according to the detailed classification of Japan Standardized Industrial Classification on the business conducted in the factory.
5. Enter the name and quantity of equipment, system and technology etc. by the process unit in the column of "Contents of plan" of Item II. But if it is difficult to write the contents of plan by the process unit, enter the name of principal equipment in the column of "Process", and enter the plan by equipment.
6. Enter "kL" of crude oil equivalent of the expected effects of energy use rationalization expected by the implementation of the improvement plan in the column of "Expected effects of energy use rationalization" of Item II.
7. Enter the contents compared with the previous year of Item II in Item III. In addition, if the corresponding process is plurality, enter the contents in newly prepared column.
8. When the higher ranked plans (the project relevant to two or more factories, the whole plan Type-1 specified entrepreneur, etc.) relevant to the plan entered in the column of II, enter the positioning of the factory concerned in the contents of a plan and plan etc. in Item IV. Moreover, when entry is difficult only in this column, attach the related data.

ANNEX 4

COMPLETION EXAMINATION AND LECTURE SUBJECTS FOR ENERGY MANAGER TRAINING COURSE IN 2007 (JAPAN)

Completion Examination and Lecture Subjects for Energy Manager Training Course in 2007

A trainee is required to choose a training course of "Compulsory subject + Heat subject" or "Compulsory subject + Electricity subject" and receive the lecture for 52 units in total for 6 days. 1 unit of lecture hour is 40 minutes.
Completion examination is taken from 9:30 to 17:30 on 7th day.

Training Course	Completion examination subjects	Lecture subjects	Lecture hour (unit)
Compulsory subject	Compendium on energy management and laws	1. Compendium on energy management	7
		2. Laws & orders concerning rational use of energy	2
	Lecture hours of compulsory category in total		9

Training Course	Completion examination subjects	Lecture subjects	Lecture hour (unit)
Heat subject	Fundamentals of heat & fluid flows	1. Fundamentals of thermodynamics	8
		2. Fundamentals of fluidics	5
		3. Fundamentals of heat transfer engineering	5
	Fuel and combustion	1. Combustion and combustion control	4
		2. Combustion calculation	3
	Heat utilization facilities and their management	1. Measurement and control	5
		2. Boiler, steam transport and storage unit, steam motor, internal combustion engine, gas turbine	4
		3. Heat exchanger and heat recovery unit, freezing and air conditioning equipment	3
		4. Industrial furnace and thermal facilities materials	3
		5. Distillation･evaporation･condensation unit, drying unit, dry distillation and gasification unit	3
	Lecture hours of heat category in total		43

Training Course	Completion examination subjects		Lecture subjects	Lecture hour (unit)
Electricity subject	Fundamentals of electricity		1. Electric and electronic theories	3
			2. Automatic control and information processing	3
			3. Electrical measurement	2
	Electric facilities & equipment	Factory power distribution	1. Factory power distribution plan	2
			2. Operation of factory power distribution	2
			3. Energy conservation of factory power distribution	2
		Electric equipment	1. Electric equipment in general	2
			2. Rotating and stationary machines	2
			3. Energy conservation of electric equipment	2
	Electric power application	Electromotive power application	1. Electromotive power application in general	2
			2. Electromotive power application facilities	3
			3. Energy conservation of electromotive power application	2
		Electric heating	1. Theory and facilities of electric heating	2
			2. Energy conservation of electric heating	2
		Electric-chemistry	1. Theory and facilities of electrochemistry	2
			2. Energy conservation of electrochemistry	2
		Lighting	1. Theory and facilities of lighting	2
			2. Energy conservation of lighting	2
		Air conditioning	1. Theory and facilities of air conditioning	2
			2. Energy conservation of air conditioning	2
	Lecture hours of electricity category in total			43

Source: http://www.eccj.or.jp/mgr1/30ken_guide/index.html
Translation by JICA Study Team on 28 September 2007

ANNEX 5

CONTENTS OF TEXTBOOK OF TRAINING COURSE FOR ENERGY MANAGEMENT OFFICER IN JAPAN

Contents of Textbook of Training Course for Energy Management Officer in Japan

Source: "Textbook of training course for Energy Management Officer (not for sale)" published by Energy Conservation Center, Japan

Chapter 1 Basic knowledge and regulation on comprehensive energy management

Section 1 Meaning of Energy Conservation

1.1.1 Energy Conservation

1.1.2 The necessity for energy conservation
- (1) Fossil fuel resources
- (2) Energy conservation in a company

1.1.3 Energy Conservation and Environmental Issues
- (1) Global warming
- (2) Warming is advancing.
- (3) Future prediction
- (4) The outline of the Kyoto Protocol
- (5) The measure to global warming

1.1.4 Energy Cost

Section 2 Introduction to Energy

1.2.1 Kind of Energy

1.2.2 Energy resources
- (1) Fossil energy
- (2) Non-fossil energy

1.2.3 Flow of Energy

1.2.4 Energy Situation of Japan

1.2.5 Energy Consuming Structure of Factory and Building etc.
- (1) Energy consuming structure of a factory
- (2) Energy consuming structure of building etc.

1.2.6 Long-term Energy Supply-demand Outlook

Section 3 Energy Conservation Policy and Regulation

1.3.1 The premise of a policy

1.3.2 Energy master plan

1.3.3 The legal system of energy conservation

1.3.4 Main point of Law Concerning Rational Use of Energy (law and related regulation)

(1) General provision

(2) Basic Policy

(3) Standards of judgment etc.

(4) Type 1 designated energy management factories

(5) Type 2 designated energy management factories

(6) Transportation

(7) Building

(8) Machinery and equipment, and miscellaneous provisions

(9) Penal provisions

1.3.5 System and operation of examination and training course

(1) Person for energy management

(2) Energy management officer

1.3.6 Role of Energy Management Officer

(1) Factory and/or building, and basic policy

(2) Job of an energy management officer

(3) Duty of an energy management officer, an entrepreneur, and an employee

(4) An entrepreneur's duty and role of an energy management officer

Section 4 Basis of Energy Management

1.4.1 Total Management of Energy

(1) Change of a system

(2) Selection of energy source

1.4.2 How to Advance Energy Conservation Activities

(1) Energy conservation and how to advance energy conservation

(2) Maintenance of an energy management organization

(3) A setup of target of energy conservation

(4) Grasp of an energy use situation

(5) Judgment standard and energy intensity management

(6) Planning of an improvement proposal

(7) Concrete plan and implementation of improvement proposal of equipment

(8) Equipment maintenance and equipment improvement

(9) The example of the job of the energy management officer for energy conservation promotion

1.4.3 Support Measures for Energy Conservation

(1) Support system of energy conservation

(2) Energy audit

(3) ESCO business

1 4.4 Practical use of the information about energy conservation

Chapter 2 Technique of energy management

Section 1 Basic Knowledge of Energy Management

2.1.1 Energy and Work

(1) Action of using energy in a factory and building etc.

(2) State of energy

(3) Conversion of state of energy

(4) Supply of the energy in factories and buildings etc.

(5) Conservation of energy and evaluation of quality of energy

2.1.2 Energy Resources Used in Factory and Building Etc.

(1) Gaseous fuel

(2) Liquid fuel

(3) Solid fuel

(4) Natural energy

(5) Unused energy

2.1.3 Primary Energy Consumption

(1) Primary energy consumption

(2) Method of calculation of primary energy consumption

(3) Primary energy consumption intensity

2.1.4 Measurement and Control of Energy

(1) The object of measurement and measurement device

(2) Device for measurement of energy

(3) Automatic control

(4) Measurement and control of energy by BEMS (Building Energy Management System)

Section 2 Thermal Energy

2.2.1 Basic Knowledge of Heat

(1) Character of fuel

(2) Basis of combustion

(3) Basis of heat transfer
(4) Characteristics of steam
(5) Basis of heat exchange technology
(6) Basis and characteristics of electric heating

2.2.2 Combustion Equipment
(1) Combustion control
(2) Adjustment of inner pressure of furnace
(3) Heat dissipation prevention from furnace wall
(4) Examination of the operation method

2.2.3 Steam use equipment
(1) Management of a boiler
(2) Management of steam transportation piping
(3) Optimization of heat insulation
(4) Effective use of steam
(5) Management of a steam trap

2.2.4 Exhaust heat recovery
(1) Outline
(2) Heat recovery of combustion exhaust gas
(3) Exhaust heat recovery of process
(4) Heat recovery of an incinerator
(5) Heat recovery from hot waste water

Section 3 Electric Energy

2.3.1 Basic Knowledge of electricity
(1) Electric power and work
(2) Difference between direct current and alternative current
(3) Expression of alternative current
(4) Electric power and power factor of alternative current circuit
(5) 3-phase alternative current circuit
(6) Electric power of 3-phase alternative current circuit

2.3.2 Power Receiving and Distributing Equipment
(1) Power receiving and distributing equipment
(2) Transformer
(3) The capacitor for power factor improvement
(4) Management of load

2.3.3 Leveling of Load
(1) Demand control

(2) Thermal accumulating system

(3) Electric power storage system

2.3.4 Electric Motor

(1) Slip of induction machine

(2) Characteristic of induction machine

(3) Inverter

(4) Energy conservation technique

2.3.5 Fluid Apparatus

(1) A fan and a pump

2.3.6 Lighting

(1) Basis of lighting

(2) Requirements for energy conservation lighting

(3) Energy consuming structure and examination item for energy conservation of lighting equipment

(4) Energy conservation technique

Section 4 Basic Knowledge of Air-conditioning

2.4.1 Basic Knowledge of Air Conditioner

(1) Air conditioning system

(2) Design conditions of an air conditioner

(3) Kind and calculating method of heat load of air-conditioning system

(4) Basic composition of an air conditioner

(5) A classification and kind of air-conditioning system

(6) The flow of the thermal energy in an air conditioner

(7) Thermal storage type air-conditioning system

(8) The evaluation index of air conditioner

Chapter 3 Service of energy management in a factory

Section 1 Energy Consumption Equipment in Factory

3.1.1 Energy Supply System

(1) Outline

(2) Fuel equipment

(3) Power receiving and distributing system

(4) Cogeneration

3.1.2 Industrial Furnace

(1) Outline

(2) Regenerative burner (thermal storage type burner)
(3) Low air ratio combustion
(4) Burner control
(5) Management of an operation situation
(6) Heat pattern improvement
(7) Reduction of heat loss of furnace
(8) Exhaust heat recovery

3.1.3 Drying Equipment

(1) Outline
(2) Change of drying system
(3) Change of heat source
(4) Change of process, medium and material
(5) Operation management
(6) Reduction of heat loss of furnace
(7) Exhaust heat recovery

3.1.4 Boiler and Steam Use Equipment

3.1.5 Air Conditioner

(1) Object and the purpose of air-conditioning
(2) Characteristics of air-conditioning
(3) Energy conservation of air-conditioning

3.1.6 Fluid Apparatus and Equipment

(1) Air compressor (compressor)
(2) Fan (fan and blower)
(3) Oil hydraulic equipment
(4) Vacuum pump
(5) Pump
(6) Water system

3.1.7 Electric Power Application Equipment (Excluding fluid equipment and transportation equipment)

3.1.8 Electric Heating

(1) Characteristics of electric heating
(2) Kind of electric heating
(3) Technique of energy conservation

3.1.9 Lighting

3.1.10 Conveyance Equipment

(1) Crane

(2) Belt conveyor

(3) Elevator

3.1.11 Check list for energy management (factory)

Section 2 Management Standard and Report Document

3.2.1 Judgment Standard and Management Standard in Factory

(1) A standard portion and a target portion

(2) 6 fields and 4 management items of standard portion

(3) Standard values and target values of 6 management items

(4) Equipment and management standard

3.2.2 Preparation of Management Standard in Factory

(1) Outline and composition of energy management standard

(2) Item to be set as management standard

(3) Composition and contents to be specified for management standard

(4) Preparation of the energy flow diagram and management of energy consumption of the whole factory

(5) Identity of management standard and application of other standards

(6) The consideration matter in the case of setup and operation of management standard

(7) Important meaning and education of management standard

3 2.3 Notification and reporting of the factory by Law Concerning Rational Use of Energy

(1) Submission of “Notification of energy use situation notification”

(2) Submission of "Notification of assignment (death or dismiss) of Energy management officer”

(3) Periodical report

(4) medium- and long-term plan

Chapter 4 Service of the energy management in building etc.

Section 1 Energy Consumption Equipment in Building etc.

4.1.1 Energy Management of Building to be aimed at Energy Conservation

(1) Importance of energy management

(2) Effective use of energy and resources, and useless loss

(3) Actual condition of consumption of energy and resources

4.1.2 Energy Management of Air Conditioner

(1) Energy management of air-conditioning individual equipment

(2) Energy management as the whole air-conditioning system

(3) Energy conservation in design, operation and renewal of an air conditioner

(4) Check list for energy-conservation of air conditioner

(5) Energy conservation management and trial calculation example of effect

4.1.3 Energy management of electric equipment

(1) Energy management of main equipment

(2) Energy conservation management and trial calculation example of effect

4.1.4 Energy management of water supply quipment

(1) Energy management of main equipment

(2) Check list for energy-conservation of water supply equipment

(3) Energy conservation management and trial calculation example of effect

4.1.5 Energy Management of Conveyance Equipment

(1) Elevator

(2) Escalator

4.1.6 Analysis and evaluation technique of energy consumption

4.1.7 Check list of energy management building etc.

Section 2 Management Standard and Report Document

4.2.1 Judgment Standard and Management Standard in Building etc.

(1) Standard portion and target portion

(2) 6 fields and 4 management items of standard portion

(3) Standard values and target values of 6 management items

(4) Equipment and management standard

4.2.2 Preparation of Management Standard of Building etc.

(1) Outline of management standard

(2) Judgment standard and management standard

(3) Composition of management standard

(4) Contents of management standard

(5) Grasping of actual condition of energy consuming

(6) Analysis of record and data

4.2.3 Notification and reporting of Buildings by Law Concerning Rational Use of Energy

(1) Submission of “Notification of energy use situation notification”

(2) Submission of "Notification of assignment (death or dismiss) of Energy management officer”

(3) Periodical report

(4) medium- and long-term plan

ANNEX 6

PUNISHMENT IN ENERGY CONSERVATION LAW IN JAPAN

Punishment in Energy Conservation Law in Japan

Punishment on Factories, Buildings and Freight Carriers

Enacted on 1 April 2006

No.	Contents of violation	Specified Atricle (Applied Article)	Punishment of violation
1	Violation to regulation of appointment of Energy Manager (Type 1: Specified Business Operator), (Type 1: Designated Energy Management Factory)	Article 8, Paragraph 1	Fine of less than 1,000,000 yen
2	Violation to regulation of appointment of Energy Management Officer (Type 1 Specified Business Operator), (Type 1 Designated Energy Management Factory) (Type 2 Specified Business Operator), (Type 2 Designated Energy Management Factory)	Article 13, Paragraph 1 (Article 18, Paragraph 1)	
3	Violation of instruction and order on rational plan (Type 1 Specified Business Operator), (Type 1 Designated Energy Management Factory)	Article 16, Paragraph 5	
4	Violation of order by regulation of recommendation on rational use of energy in freight transportation (Specified Freight Carrier)	Article 57, Paragraph 3 (Article 69)	
5	Violation of order by regulation of recommendation on rational use of energy in freight transportation (Specified Carrier)	Article 64, Paragraph 3	
6	Violation of order by regulation of recommendation on improvement of performance for energy conservation of Specified Equipment (Manufacturer/importer of Specified Equipment)	Article 79, Paragraph 3	
7	Violation of order by regulation of recommendation on indication of energy consumption efficiency of Specified Equipment (Manufacturer/importer of Specified Equipment)	Article 81 ,Paragraph 3	
8	No notification or a false notification by regulation, nevertheless energy consumption in the previous business year is more than the amount to be applied to Type 1 Designated Energy Management Factory (Business operator that has a Factory)	Article 7, Paragraph 2	Fine of less than 500,000 yen
9	No notification or a false notification by regulation, nevertheless energy consumption in the previous business year is more than the amount to be applied to Type 2 Designated Energy Management Factory (Business operator that has a Factory)	Article 17, Paragraph 2	
10	No notification or a false notification by regulation for each freight transportation category, when the transportation capacity is beyond the specified level (Freight Carrier)	Article 54, Paragraph 2	
11	No notification or a false notification by regulation of volume of freight transportation, nevertheless volume of freight transportation that a Consigner make a Freight Carrier transport is beyond the level specified by Cabinet Order (Consigner)	Article 61, Paragraph 2	
12	No notification or a false notification by regulation for efficient use of energy in new construction, reconstruction, extension, repairing, remodeling, or retrofitting of Specified Building beyond the size specified by a Cabinet Order (Specified Construction Client), (Specified Building)	Article 75, Paragraph 1	
13	No notification by regulation of a medium- and long-term plan (Type 1 Specified Business Operator), (Type 1 Designated Energy Management Factory)	Article 14, Paragraph 1	
14	No notification by regulation of a medium- and long-term plan (Specified Freight Carrier)	Article 55	
15	No notification by regulation of a plan for archieving the target for rational use of enegy in freight transportation consigned to a Freight Carrier (Specified Consigner)	Article 62	
16	Violation to regulation of participation of a person who has a qualified Energy Manager's license in the preparing process of medium- and long-term plan (Type 1 Specified Business Operator), (Type 1 Designated Energy Management Factory)	Article 14, Paragraph 2	
17	No Reporting or a false reporting by regulation of periodical report (Type 1 Specified Business Operator), (Type 1 Designated Energy Management Factory) (Type 2 Specified Business Operator), (Type 2 Designated Energy Management Factory)	Article 15, Paragraph 1 (Article 18, Paragraph 1)	
18	No Reporting or a false reporting by regulation of status of energy use in freight transportation for each Freight Transportation Category (Specified Freight Carrier)	Article 56, Paragraph 1 (Article 69)	
19	No Reporting or a false reporting by regulation of status of energy use in freight transportation consigned to Freight Carrier (Specified Consigner)	Article 63, Paragraph 1	
20	No Reporting or a false reporting by regulation on the status of maintenance of Specified Building (Specified Construction Client)	Article 75, Paragraph 4	
21	No Reporting or a false reporting on the status of business in a Factory by regulation Refusal, obstruction or avoidance a inspection by regulation (Type 1 Specified Business Operator), (Type 1 Designated Energy Management Factory) (Type 2 Specified Business Operator), (Type 2 Designated Energy Management Factory)	Article 87, Paragraph 1 to Paragraph 3	

No.	Contents of violation	Specified Atricle (Applied Article)	Punishment of violation
22	No Reporting or a false reporting on the status of business in a enterprise by regulation Refusal, obstruction or avoidance a inspection by regulation (Freight Carrier), (Specified Freight Carrier), (Consigner), (Specified Consigner), (Specified Construction Client), (Manufacturer/importer of Specified Equipment) and others	(Article 98)	Fine of less than 500,000 yen
23	When a violence to above matters is commited, not only the offender is punished but also the juridical person or individual is punished by the fine prescribed in the respective Articles	(Article 98)	
24	No notification or a false notification by regulation on appointment or dismissal of Energy Manager (Type 1 Specified Business Operator), (Type 1 Designated Energy Management Factory)	Article 8, Paragraph 2	No-penal fine of less than 200,000 yen
25	No notification or a false notification by regulation on appointment or dismissal of Energy Management Officer (Type 1 Specified Business Operator), (Type 1 Designated Energy Management Factory) (Type 2 Specified Business Operator), (Type 2 Designated Energy Management Factory)	Article 13, Paragraph 3 (Article 18, Paragraph 1)	

Note: Penalty on passenger transportation and air transportation is not included in the above table.

Punishment on Designated Examination Body for Energy Manager and Registered Investigation Body

No.	Contents of violation	Specified Atricle (Applied Article)	Punishment of violation
26	Violation to regulation of obligation of confidentiality of officers or employees (Designated Examination Body for Energy Manager) (Registered Investigation Body)	Article 30, Paragraph 1 Article 51	Imprisonment with work for less than 1 year Fine of less than 1,000,000 yen
27	Violation to regulation of rescission of the registration or order of suspention of services (Registered Investigation Body)	Article 49	
28	Violation to regulation of order of suspention of services (Designated Examination Body for Energy Manager) (Designated Training Agency for Energy Management Officer)	Article 32, Paragraph 2 Article 36, Paragraph 2	
29	No notification or a false notification by regulation of susupention or abolishment of services (Registered Investigation Body) (Designated Training Agency for Energy Management Officer)	Article 46 Article 37	Fine of less than 500,000 yen
30	No Reporting or a false reporting on the status of business and accounting by regulation Refusal, obstruction or avoidance a inspection by regulation (Registered Investigation Body), (Designated Examination Body for Energy Manager) (Designated Training Agency for Energy Management Officer)	Article 87 Paragraph 4 to Paragraph 5	
31	No Reporting or a false reporting on keeping of books and stating of matters in the books Refusal, obstruction or avoidance a inspection by regulation (Registered Investigation Body), (Designated Examination Body for Energy Manager) (Designated Training Agency for Energy Management Officer)	Article 5 Article 33, Paragraph 1 to Paragraph 2	
32	Violation to regulation of abolishment of Examination Affairs without permission of Minister of Economy, Trade and Industry (Designated Examination Body for Energy Manager)	Article 25	
33	Violation to regulation of keeping of finacial statement, or stating of matters in finacial statement Refusal of request of inspection or copy of finacial statement (Registered Investigation Body)	Atricle 47, Paragraph 1 to Paragraph 2	No-penal fine of less than 200,000 yen

ANNEX 7

EE&C AWARD IN JAPAN

1. Energy Efficiency Commendation Program

The Energy Efficiency Commendation Program has an objective to raise awareness toward energy conservation and to promote energy efficient equipments and systems through giving award to individual, group, factory and firm who contributes to promotion of energy conservation. The program aims to contribute to development of energy efficiency industry and establishment of energy efficient society. The program used to give award only to the energy efficient equipment and system in the commercial and residential sector. From this year, "human resource" and "organization" are added as award to the program. This program is being implemented by The Energy Conservation Center, Japan (ECCJ) in commission from the Ministry of Economy, Trade and Industry, Japan (METI) (cited from home page of ECCJ: http://www.eccj.or.jp/bigaward/index.html).

Table 1 Category of Award

Human resource	inside firm
	support service
Organization	CGO (Chief Green Officer)/ inside firm
	Case: inside-firm (industrial)
	Case: inside-firm (commercial)
	Case: inside-firm(support service)
Equipment and system	Residential sector
	Commercial sector
	Vehicle

Source: Website of ECCJ: http://www.eccj.or.jp/bigaward/index.html

Figure 1 Energy Conservation Grand Prize

Source: Website of ECCJ: http://www.eccj.or.jp/bigaward/index.html

<Description of energy conservation activities for application>

Upon application, description of energy conservation activities is required, as shown in Table 2.

Table 2 Description of Energy Conservation Activities for Application

Human resource	- energy efficiency performance - innovativeness, originality - versatility, pervasive effect - continuity, sustainability - contributions to society
Organization	- energy management framework - outline of energy conservation activity - feature of energy conservation activity - background, how-and-why, and objective of activity - Improvements - energy efficiency performance - innovativeness, originality - versatility, pervasive effect - continuity, sustainability - degree of involvement of CGO
Equipment and system	- outline of equipment/system - technical features - background, how-and-why, and objective of development - specification of equipment/system - innovativeness, originality - energy efficiency performance - resource saving and recycling performance - marketability, merchantability, economic efficiency - environmental preservation, safeness - patent, award, presentation

2. Accreditation System of Energy Efficient Product Retailing Promotion Store

This system aims at accrediting retail stores that is actively providing energy efficiency information with customers or promoting energy efficient products (cited from home page of ECCJ: http://www.eccj.or.jp/bigaward/index.html). This program is being implemented by The Energy Conservation Center, Japan (ECCJ) in commission from the Ministry of Economy, Trade and Industry, Japan (METI).

Figure 2 Symbol of Energy Efficient Product Retailing Promotion Store

Source: home page of ECCJ: http://www.eccj.or.jp/bigaward/index.html

<Target>

- Large home appliance retailers having a total floor space of at least 500 m2, whose sales from home appliances account for 50% or more of total sales
- Small & Medium home appliance retailers having a total floor space of less than 500 m2 or equal, whose sales from home appliances account for 50% or more of total sales

<Evaluation point>

Evaluation point	Accreditation	Accreditation/award
1. Store manager's policy for sales of energy efficient product	○	○
2. Knowledge of energy efficiency of store staffs and maintenance of motivation	○	○
3. Easiness for buying energy efficient product	○	○
4. Sales performance of energy efficient product	—	○
5. Environmentally- friendly activities of store	○	○

3. Commendation Program for Superior Energy-Saving Machines

Every year the JMF presents awards to companies or groups of companies judged to have contributed to the promotion of efficient use of energy by developing and commercializing superior energy-saving machines. Eligible machinery should be developed and commercialized within the previous three years and should fall into one of the following categories: (1) general machinery as well as installations, facilities, and systems; (2) gauges and various measuring instruments; (3) machinery utilizing non-recycled resources such as industrial wastes, garbage, methane gas, and agricultural wastes (Automobiles and air conditioners are not eligible) (cited from home page of The Japan Machinery Federation: http://www.jmf.or.jp/japanese/commendations/energy/index.html).

Figure 3 Symbol for Superior Energy-Saving Machines

Source: home page of The Japan Machinery Federation: http://www.jmf.or.jp/japanese/commendations/energy/index.html

ANNEX 8

CONVERSION FACTOR
OF
ELECTRICITY TO PRIMARY ENERGY

Conversion Factor of Electricity to Primary Energy

1. Definition of Designated factories and buildings in Draft of Decree:

- Designated factories (buildings) mean the enterprises with total annual energy consumption, including fuels, electricity and thermal energy converted to equivalent tons of petroleum (TOE) more than 300 TOE ?-----.

2. Total annual energy consumption (TOE):

= Fuel consumption (ton) x Heat value (Mcal/ton) / 10,000(Mcal/TOE)
+ Electricity (MWh) x Conversion factor to primary energy (TOE/MWh)

3. Definition of TOE by International Energy Agency (IEA)

TOE (Ton of Oil Equivalent) = 10,000,000 kcal = 10,000 Mcal =10 Gcal= 41.87 GJ

4. Conversion Factor of Electricity to primary energy value in energy statistics

(1) IEA standard :

- Thermal power: Average thermal power generation efficiency eg.30-40 (%)
- Hydro power: Power generation efficiency = 100%
- Geothermal power: Power generation efficiency = 10%
- Nuclear power: power generation efficiency = 33%

Conversion Factor = 860 (kcal/kWh) / Power generation efficiency

The Study on Master Plan of Energy Conservation and Effective Use in The Socialist Republic of Vietnam

5. Conversion Factor of Electricity to primary energy for Designated factories and buildings in Japan

(1) Average thermal power generation efficiency at consuming end (%) is adopted to power generation efficiency.

(2) Conversion Factor to primary energy value:

Theoretical heat value: 1 kWh = 860 kcal

Conversion factor = 860kWh / power generation efficiency at consuming end
= 860kWh /0.366 = 2,349 kcal/kWh = 9,830 kJ/kWh

Average thermal power generation efficiency at consuming end in Japan = 36.6%

Example:

Annual electricity consumption = 12,000,000 kWh
Average thermal power generation efficiency at consuming end = 36.6%
Conversion factor = 2,349 kcal/kWh
Primary energy value = 12,000,000 x 2,349 = 28,188,000,000 kcal = 28,188Gcal
Primary energy value in TOE = 2,818.8 TOE/year

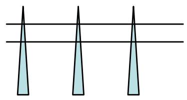
Thermal efficiency and loss in Japan in 2003

Net generating efficiency: 39.01%

Power plant

Gross generating efficiency: 40.85%

Power consumption in plant: 4.5%



Transmission and distribution loss: 5.3%

Substations loss: 0.13%

Consumer

Thermal efficiency at consuming end: 36.9%

6. Proposal of energy conversion factor of electricity to primary energy for Energy Conservation Law in Vietnam

(1) Energy statistics of Vietnam by Institute of Energy (IE) :

- **IEA standard is adopted already.**

(2) Designated factories and buildings:

- **Average thermal power generation efficiency at consuming end**
- **Revision of conversion factor: Every 5 year**

Example 1:

- **Average thermal power generation efficiency at consuming end in Vietnam is 31% in 2003.**
- **Conversion factor = 860 / 0.31 = 2,774 kcal/kWh = 11.6 GJ/MWh = 0.277TOE**

Example 2:

- **Fuel oil consumption = 200 ton/y, Power consumption = 1,000 MWh/y**
- **Energy consumption = 200 x 0.933 + 1,000 x 0.277 = 464 TOE/year**

Assumed that heat value of fuel oil is 9,330kcal/ton = 0.933TOE

ANNEX 9

ENERGY INTENSITY AND ELASTICITY

Energy Intensity and Elasticity

Presentation Outline

- **Energy Intensity**
- What is Energy Intensity?
- How is it related to the policy issue?
- How to measure Energy Intensity?
- Is Aggregate Energy Intensity a good indicator to measure energy efficiency?
- How about the Sectoral and Sub-Sectoral Energy Intensities?
- **Energy Elasticity**
- What is Energy Elasticity?
- How is it related to the policy issue?
- Why it tends to be different between developed and developing countries?
- **Indonesia's Energy Intensity and Energy Elasticity**
- Data availability for the calculation
- Tentative results of calculation

What is Energy Intensity?

The term "energy intensity", also called "energy ratio", indicates the ratio of energy use to GDP, meaning the total energy being used to support economic and social activity. It represents an aggregate of energy consumption resulting from a wide range of production and consumption activities. Therefore, it could be called "aggregate energy intensity" or "economy-wide energy intensity".(With reference to the definition given by *the UN Department of Economic and Social Affairs*)

How is it related to the policy issue?

•Purpose:

Trends in overall energy use relative to GDP indicate the general relationship of energy consumption to economic development and provide a rough basis for projecting energy consumption and its environmental impacts with economic growth. *For energy policy –making, however, sectoral or sub-sectoral energy intensities should be used*.

•International Conventions and Agreements :

UNFCCC (United Nation Framework for Climate Change Convention) and its Kyoto Protocol call for limitations on total greenhouse gas emissions, which are dominated by CO2 from fossil fuels.

How is it related to the policy issue?

•International Targets/Recommended Standards :

There are no specific targets for energy intensity. The Kyoto Protocol sets targets for total greenhouse gas emissions for developed countries only.

•Linkages to Other Indicators :

The ratio of energy use to GDP is an aggregate of sectoral energy intensity indicators and is thus linked to the energy intensities for the manufacturing, transportation, commercial/services and residential sectors. This indicator is also linked to *indicators for total energy consumption, greenhouse gas emissions and air pollution emissions*.

How to measure Energy Intensity?

•Measurement of Energy Use :

Total and sectoral energy consumption is obtained from national energy balances. Household and services/commercial consumption should be carefully separated, and manufacturing should be separated from other industries and agriculture.

Unit: Energy is measured in Joule

•Measurement of Output :

Components of GDP should be deflated to constant dollars by chaining each component, not simply by deflating each component by the overall GDP deflator.

Unit: GDP is measured in US dollars, converted from real local currency at purchasing power parity (PPP) for the base year to which local currency was deflated.

Is "Aggregate (nation wide)" Energy Intensity a good indicator to measure energy efficiency?

----No, because of the limitations below.

Energy/ Product amount (ton etc)

- Influenced by the Economic Structure and Sectoral Energy Intensities

•Variety of Products makes hard to calculate the Production amount

•Geographical Factors Influence the Comparison of Energy Intensity among Countries

•Difference of Energy Sources Confuse the Interpretation of Energy Intensity

How about the Sectoral and Sub-sectoral Energy Intensities?

----Opinions given by the UN Department of Economic and Social Affairs:

•The ratio of sectoral or sub-sectoral energy use to the output or activity of the sector or sub-sector provides a more useful indicator of energy intensity.

•Total energy use should be disaggregated into components, by sector (manufacturing, transportation, residential, commercial/services, industry, agriculture, construction, etc.) or sub-sector.

•For each sector or sub-sector, energy use can be related to a convenient measure of output to provide a sectoral or sub-sectoral energy intensity.

E.g. > energy use for steel-making relative to tonnes of steel produced

> energy consumption by passenger vehicles relative to passenger- or vehicle-kilometers

> energy consumption in buildings relative to their floor area.

Table: Summary of Major Sectoral Intensity Indicators

	Intensity of Energy Use In Manufacturing	Intensity of Energy Use In the Commercial/ Service Sectors	Intensity of Energy Use In the Residential Sectors
Brief Definition	Energy consumption per unit of manufacturing output	Energy consumption per unit of commercial/service sector output or per unit of commercial/service sector floor area.	Amount of energy used per capita or household in the residential sector
Unit of Measurement	Megajoules (MJ) per unit output of the manufacturing sector in constant US$	Megajoules per US$ (MJ/$) or megajoules per square meters (MJ/m^2).	Gigajoules (GJ) per capita or GJ per household
Relevance to Sustainable Development	Sustainable development requires increases in energy efficiency in order to reduce fossil fuel consumption, greenhouse gas emissions and related air pollution emissions.	The sector is less energy intensive than manufacturing and the growth of it relative to manufacturing contributes to the long-term reduction in the total energy intensity, though a large consumer of electricity.	As a major consumer of energy with a distinctive pattern of usage, many policies addressing energy efficiency and savings have been formulated for this sector, with the electric appliance as the focus.
International Arrangements	There are the UNFCCC and its Kyoto Protocol. Without specific international targets regarding energy use or energy efficiency, many industrialized countries have targets for reducing energy use and carbon emissions from manufacturing branches.	Without international agreements, international targets or standards, some countries are promulgating energy-efficiency standards for lighting, office equipment or other devices, while others are negotiating voluntary agreements to reduce energy consumption per square meter of floor space.	Without international agreements or targets, thermal standards for new homes are in effect in most of OECD and East European countries, China and some other countries in colder climates. Many have efficiency standards for boilers, some have efficiency standards on electric appliances.

What is Energy Elasticity?

•The term "energy elasticity", also known as "energy coefficient", refers to the sensitivity of energy consumption in response to the growth of GDP, or in other words, the percentage change in energy use associated with one percent change in economic activity. (*F. Gerard Adams and Peter Miovic*)

•While "energy intensity" is a concept with implication of "marginality", "energy elasticity" is a concept with implication of "average". *(Ozawa Masaharu)*

How is it related to the policy issue?

•The long term forecast of energy consumption is usually based on functional relationships between energy consumption and economic activity, regarding which past studies in Western Europe and the United States have frequently used the “energy elasticity”.

•The implicit “energy elasticity”, overall or sector-by-sector, remains an important consideration in judging the reasonableness or consistency of the forecast, though recent work has tended toward increased methodological sophistication.

(F. Gerard Adams and Peter Miovic)

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Why Energy Elasticity tends to be different between developed and developing countries?

•Since in advanced economies fuel use appears to grow more slowly than GNP; the elasticities generally have been found to be less than 1.0. Gross elasticities of energy consumption with respect to GNP have been estimated variously as between 0.7 and 0.9 and somewhat lower with respect to industrial production. In the developing countries, in contrast, the elasticity is frequently substantially above 1.0.

•By conversion to more efficient from less efficient fuels, the unadjusted elasticity was often less than 1.0 in developed countries. The adjusted elasticities on the other hand lay between 1.23 and 1.4 when related to GDP and between 1.04 and 1.15 when related to industrial production.

(F. Gerard Adams and Peter Miovic)

ANNEX 10

ON-SITE SURVEY REPORT
(INDUSTRY)

The Study on Master Plan
for
Energy Conservation and Efficient Use
in
the Socialist Republic of Viet Nam

On-site Survey Report
(Factories)

December 2009

1. Steel-making Factory A

1.1 Introduction

1) Factory name: Steel-making Factory A
2) Location: Hanoi City
3) Description of business
   (1) Sub-sector of industry: Steel rolling mill industry
   (2) Main products: Wire rod (6 to 8 mm in diameter), Deformed bar (10 to 40 mm in diameter)
   (3) Production capacity: 250,000 ton/y
   (4) Annual production: 180,000 ton/y
   (5) Number of employees: 245 persons
4) Person in charge of energy on-site survey: Production Manager and Electricity Manager
5) Outline of the factory

   The factory is a rolling mill, which began production of wire rod and deformed bar in 2001. Billets are supplied from group companies, because the factory does not have steel-making facilities.

1.2 Outline of energy on-site survey

1) Survey team member

   JICA Study Team: Mr. Norio Fukushima, Mr. Wataru Ishikawa, Mr. Hisashi Amano,
   Mr. Yoichi Isobe, Mr. Takeshi Onoguchi

   Institute of Energy: Mr. Hung, Mr. Song, Mr. Hoang Anh, Mr. Hau
2) Surveyed period: 1st to 3rd October, 2008 (3 days)
3) Surveyed equipment: Steel billet reheating furnace, cooling tower, receiving and transforming equipment and air compressor

1.3 Results of energy on-site survey

1) Improvement proposal items and the expected effects after improvement measure implementation are shown in Table 1.3-1 and expected effects by introduction of high efficient reheating furnace with regenerative burner are shown in Figure 1.4.2-1.

   The EE&C potential in the present equipment is 11.0%, and also the EE&C potential by introduction of high efficient reheating furnace is 15.1%.

Table 1.3-1 Improvement proposal items and the expected effect after improvement measure implementation

No.	Item No.	Improvement items	Expected effects		
			Kind of Energy	Amount of energy conservation (kL/y, kWh/y etc.)	Amount of energy saving (1,000 Dong/y)
1	1.4.2-2)	Billet reheating furnace: Improvement of air ratio; Change of air ratio of 0.96 to 1.1	Fuel oil	228 ton/y	2,736,000 × 1,000 VND/y
2	1.4.2-3)	Billet reheating furnace: Change of setting of inner pressure of furnace from 0.08kPa to 0.02kP	Fuel oil	114 ton/y	1,368,000 × 1,000 VND/y
3	1.4.2-4)	Billet reheating furnace: Improvement of heat holding action during operation stop	Fuel oil	155 ton/y	1,860,000 × 1,000 VND/y
4	1.4.2-5)	Billet reheating furnace: Reinforcement of heat insulation of furnace proper, with ceramic fiber	Fuel oil	129 ton/y	1,548,000 × 1,000 VND/y
6	1.4.3-1)	Cooling water pump: Water flow control with VSD (variable speed driving)	Power	312,000 kwh/y	249,600 × 1,000 VND/y
7	1.4.4-1)	Furnace fan: Applying VSD control on air flow fan	Power	619,000 kWh/y	495,200 × 1,000 VND/y
8	1.4.4-2)	Air compressor: Using multiple unit control and VSD type compressor	Power	397,000 kWh/y	317,600 × 1,000 VND/y
9	1.4.4-2)	Air compressor: Lowering discharge air pressure	Power	110,000 kWh/y	88,000 × 1,000 VND/y
10	1.4.5-1)	Power receiving system: Installing power monitoring system	Power	900,000 kWh/y	720,000 × 1,000 VND/y
Total of expected results			Fuel (total)	626 ton/y (626 toe/y)	19,450,000 × 1,000 VND/y
			Electric power (total)	2,338,000 kWh/y (647.6 toe/y)	1,620,800 × 1,000 VND/y
	Crude-oil equivalent of fuel and electric power (total) (Reduced volume of carbon dioxide (CO_2))			1,274 toe/y (ton-CO_2)	
	Annual energy consumption		Fuel (total)		5,700 ton/y
			Electric power (total)		18,000 MWh/y
			Total in factory		10,686 toe/y
	Energy conservation rate of the whole factory		Fuel (total)		11.0 %
			Electric power (total)		13.0 %
			Total in factory		11.9 %

Table 1.3-2 Improvement proposal items and the expected effect after improvement measure implementation by introduction of high efficiency reheating furnace

No.	Item No.	Improvement items	Expected effects		
			Kind of Energy	Amount of energy conservation (kL/y, kWh/y etc)	Amount of energy saving (1,000 Dong/y)
1	1.4.2-6)	Billet reheating furnace: Introduction of regenerative burner	Fuel oil	1,140 ton/y	13,680,000 × 1,000 VND/y
2	1.4.3-1)	Cooling water pump: Water flow control with VSD (variable speed driving)	Power	312,000 kwh/y	249,600 × 1,000 VND/y
3	1.4.4-2)	Air compressor: Using multiple unit control and VSD type compressor	Power	397,000 kWh/y	317,600 × 1,000 VND/y
4	1.4.4-2)	Air compressor: Lowering discharge air pressure	Power	110,000 kWh/y	88,000 × 1,000 VND/y
5	1.4.5-1)	Power receiving system: Installing power monitoring system	Power	900,000 kWh/y	720,000 × 1,000 VND/y
Total of expected results			Fuel (total)	1,140 ton/y (1,140 toe/y)	13,680,000 × 1,000 VND/y
			Electric power (total)	1,719,000 kWh/y (476 toe/y)	1,375,200 × 1,000 VND/y
Crude-oil equivalent of fuel and electric power (total) (Reduced volume of carbon dioxide (CO2))				1,616 toe/y ($ton-CO_2$)	
Annual energy consumption			Fuel (total)		5,700 ton/y
			Electric power (total)		18,000 MWh/y
			Total in factory		10,686 toe/y
Energy conservation rate of the whole factory			Fuel (total)		20.0 %
			Electric power (total)		9.6 %
			Total in factory		15.1 %

2) Annual energy consumption and energy intensity

(1) The Amount of annual energy consumption (C+D) B = 10,686 toe

(in which) The amount of crude-oil equivalent of electric power: C = 4,989 toe

(Purchased electric power E = 18,000 MWh) × 0.277

The conversion factor to primary energy of electric power is calculated according to 31% of thermal efficiency of thermal power generation station in Vietnam.

Conversion factor to primary energy = 860 / 0.31 = 2,770 Mcal/MWh = 0.277 toe/MWh

1 toe = 10,000 Mcal

Amount of crude-oil equivalent of all fuel consumption D = 5,700 toe

(sum total which carried out the crude-oil conversion of each amount of fuel)

Details (before conversion) Heavy oil ( ): 5,700 ton in 2006

Heat value = 10,000 kcal/kg

(2) Energy intensity (Energy consumption per annual shipment amount etc.)

Electric power intensity per production (E / production) = 100 kWh/ton in 2006

Fuel intensity per production (D / quantity of production) = 317,000 kcal/ton in 2006

Energy intensity is shown in Table 1.3-3.

Table 1.3-3 Production and Energy intensity

	2005	2006	2007
Production (ton/y)	150,000	180,000	240,000
Fuel oil consumption (ton/y)	4,800	5,700	
Fuel consumtion (Mcal/y)	48,000,000	57,000,000	
Fuel intensity (kcal/ton)	320,000	317,000	
Electricity consumption (MWh/y)	15,000	18,000	
Electricity intensity (kWh/ton)	100	100	

3) Remarks

(1) Energy price

Fuel oil: 12,000 VND/kg (2008),

Electricity: 04:00 - 18:00 896.5 VND/kWh

18:00 - 22:00 1,809.5 VND/kWh

22:00 - 04:00 489.5 VND/kWh

Average: 800 VND/kWh

4) Equipment

Specifications of production equipment in the factory are shown in Table 1.3-4

Table 1.3-4 Equipment specifications

No.	Equipment	Q'ty	Main specifications
1	Reheating furnace	1 set	Capacity: 56 t/h, Max. temperature: 1,200ºC, Walking beam type, Side charge and discharge, Recuperator for heat recovery, Preheated air temperature: 400ºC Side burner: 10-front, 6-side Fuel: Fuel oil Billet size: 130mm × 130mm × 12m length
2	Rolling mill	1 set	Full continuous type bar mill, Manufacturer: Danieli, Italy Capacity: 50t/h Deformed steel bar of D10 to D41 Wire rod of 6 to 8mm
3	Cooling tower	2 sets	1 set of direct cooling line: rolling mill 1 set of indirect cooling line: reheating furnace
4	Air compressor	6 set	Screw type, Motor: 75kW, Mitsu-Seiki and others, Delivery pressure: 0.7MPa, Discharge rate: 13m^3/min
5	In-house power generator	1 set	550 kVA, Diesel engine

5) Production process

Production process flow is shown in Figure 1.3-1.

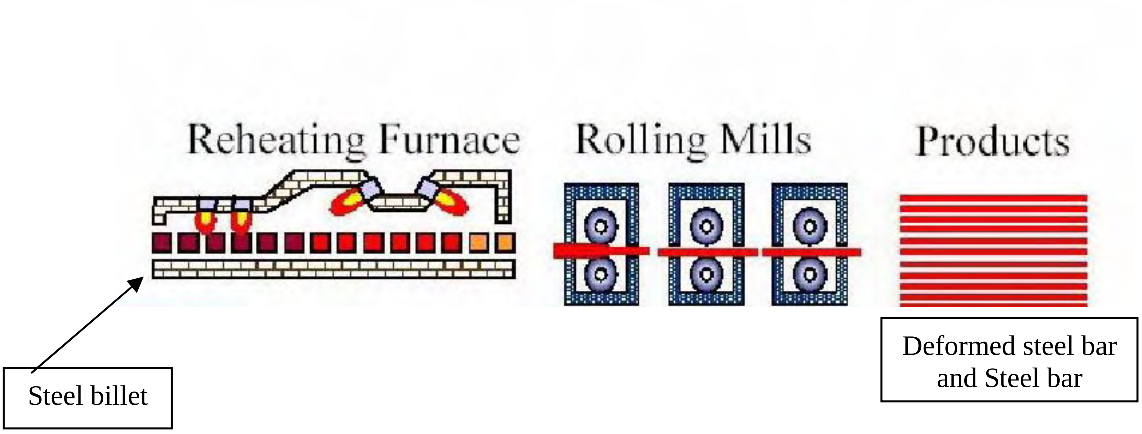


Figure 1.3-1 Production process flow in the steel-making factory

1.4 On-site survey results

1.4.1 General management matter

1) Energy management organization and target

(1) Present condition and problems

The target of activity of EE&C such as improvement of energy intensity is not set up.

Since managers have confidence in the performance of the equipment, they considers that there is no room of improvement. The standard values for operation are set according to manufacturer’s standard values and should be decided with the study of company it-self.

(2) Measures for improvement

Top management should set up the fiscal year target of EE&C activities.

Although troubles are few while equipment is new, maintenance plan should be made and performance of equipment should be kept.

Management standard of the company should be enacted for the promotion of quality control and energy management.

2) Implementation of measurement and record

(1) Present condition and problems

Combustion control is imperfect due to damage of temperature sensor of reheating furnace.

In order to no pressure gage at the inlet and outlet of filter of compressed air, blocking condition of filter is not monitored.

Although the operation control system of a rolling mill is good, monitoring and control system of electric power is not installed.

Nozzles for exhaust gas analysis of reheating furnace are not installed in the exhaust duct. The oxygen concentration in an exhaust gas should be measured and monitored.

(2) Measures for improvement

Inner temperature sensor of reheating furnace is very important for combustion control. The sensor and the meter should be managed according to priority.

For backup of combustion control of reheating furnace, the oxygen concentration analyzer in exhaust gas should be installed and monitored always.

3) Maintenance management of equipment

(1) Present condition and problems

Although equipment is new, maintenance of equipment is not good.

(2) Measures for improvement

Maintenance of equipment should be implemented according to management standard.

4) Energy consumption management

(1) Present condition and problems

Gathered data are not utilized enough, although many data are gathered in the rolling mill operation room.

(2) Measures for improvement

Change of consumption of fuel and electric power should be monitored with graph and unusual value should be detected early.

5) Energy intensity management of main products

(1) Present condition and problems

Production yield is good, which is 97.5% for wire rod and 95.5 to 97.0% for deformed bar.

Fuel intensity is 28.5-29.0 kg-oil/ton and electric power intensity is 122 kWh/ton for wire rod and 70 to 132 kWh/ton for deformed bar.

(2) Measures for improvement

Rolling mill equipment is operated for 7 years, and an equipment condition is good. It is necessary to establish the organization at the time of unusual value generating of energy intensity and production yield.

6) PDCA management cycle

(1) Present condition and problems

PDCA management cycle is not carried out.

(2) Measures for improvement

Improvement activities should be promoted.

7) Evaluation of an energy management situation

Evaluation of energy management situation is shown in Figure 1.4.1-1.

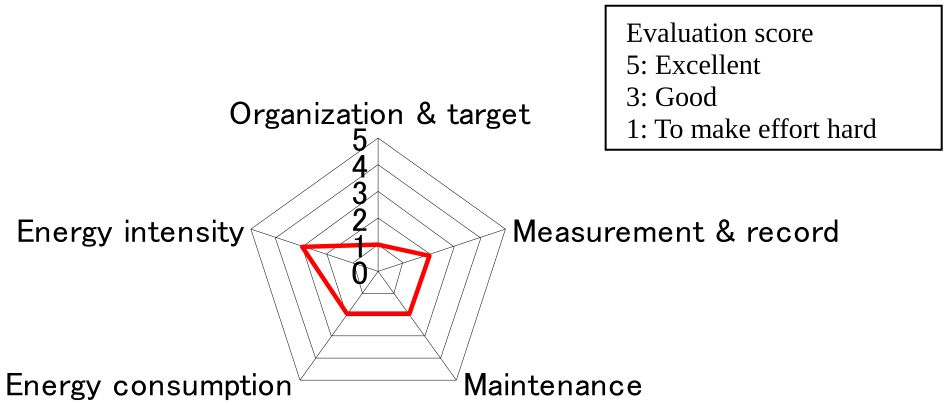


Figure 1.4.1.-1 Evaluation of energy management situation

1.4.2 Billet reheating furnace

A billet reheating furnace is a furnace which heats the billet of 130mm square × 12m length to 1,100ºC, and the fuel is fuel oil. The heated billet is sent to rolling mill and processed into the wire rod of 6mm to 8 mm in diameter, or deformed bar steel of 10mm to 41 mm in diameter. The furnace has a walking hearth type traveling unit and the charging and extraction of billets are side wall types to reduce dissipative heat at the time of charging and extraction. Air preheating for combustion air is carried out with waste heat recovery. The combustion situation and operation situation of the furnace can be monitored and operated in a rolling mill control room.

1) Heat Balance

Heat balance table was prepared with measurement for 2 hours in normal operation condition. The heat balance table is shown in Table 1.4.2-1. Measured value is shown in Table 1.4.2-2.

The effective heat value of a heating furnace is heat value which heats billets and so heat efficiency is 56%, which is same level of a Japanese heating furnace. Heat intensity is 1,060 MJ/t-billet (253 Mcal/t-billet), which is good.

A combustion air ratio is 0.96 according to calculation from fuel and combustion air volume, and so unburned loss of the fuel is generated by incomplete combustion and generating of CO can see near extraction port.

Other heat losses include the high temperature gas blow-off loss from openings of furnace and heat loss which cooling water carries out.

Although the oxygen concentration measurement in exhaust gas was scheduled, combustion air ratio has not been checked due to no sampling nozzle in exhaust gas line.

Table 1.4.2-1 Heat balance of billet reheating furnace

No.	Input heat	MJ/t	%	No.	Output heat	MJ/t	%
1	Fuel combustion heat	1,060.0	89.9	1	Heat content of discharged steel	661.5	56.1
2	Sensible heat of fuel	4.0	0.3	2	Sencible heat of exhaust gas	166.4	14.1
3	Sensible heat of air	114.0	9.7	3	Heat loss of incomplete burning	42.4	3.6
4	Heat content of billet	1.7	0.1	4	Dispartion heat loss of body	65.0	5.5
				5	Other heat loss	244.3	20.7
5	Recovered heat in REC	*117		6	Heat recovery in REC	*117	
6	Total	1,179.7	100	7	Total	1179.7	100

2) Improvement of Air Ratio

(1) Present condition and problems

Air ratio is 0.96 and unburned loss of fuel is presumed to 4% or more.

On the screen of the monitor of inside of furnace, the flame of burners is the form of a reduction flame.

Carbon monoxide (CO) is detected around the extraction port.

(2) Measures for improvement and expected effect

When combustion air ratio is set to 1.1, although exhaust gas loss will increase, fuel can be saved by 4% with temperature rising of combustion gas. And also CO is not generated.

Amount of fuel saving: 5,700 ton/y × 0.04 = 228 ton/y

Annual fuel cost reduction: 228 ton/y × 12,000,000 VND/ton = 2,736,000,000 VND/y

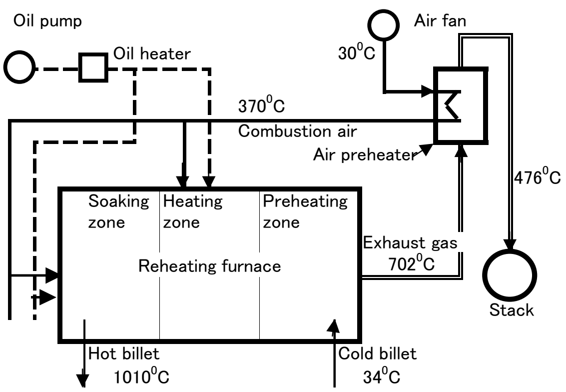
Table 1.4.2-2 Billet reheating furnace measurement sheet

Reheating furnace measurement sheet

Factory name: Steel-making A
Date of measurement: 2008/10/01
Inspecter JICA and IE

Each * mark indicates a measured value

	No.	Item	Unit	Data A	Data B	Data C	Average
	1	Measuring time		15:10	16:10		
*	1.1	Ambient temperature	degC	30	30		30.0
*	1.2	Temperature in the furnace	degC	1123	1123		1123.0
	2	Fuel oil		15:14	16:11	57min	
*	2.1	Fuel oil consumption in total (meter reading)	Liter	5,565,730	5,567,230	1,500	
	2.2	Fuel consumption in liter	L/h				1,579
	2.3	Specific gravity of fuel	kg/L				0.97
	2.4	Fuel consumption in kg	kg/h				1,532
*	2.5	Pressure	Mpa	1.0	1.0		1.0
*	2.6	Temperature	degC	115	113		114
	2.7	Lower calorific value of fuel	kJ/kg				41,870
	3	Combustion air					
*	3.1	Flow-rate (A)	m3N/h	15,430	15,355		15,393
*	3.2	Pressure at burner	Pa	655	657		656
*	3.3	Temperature at blower inlet	degC	34	34		34
	3.4	Temperature at outlet of preheater	degC	365	370		368
	3.5	Theoretical air volume	m3N/kg-oil				11
	3.6	Theoretical air flow-rate (A0)	m3N/h				16,082
	3.7	Air ratio (A/A0)					**0.96**
	4	Cooling water					
	5	Exhaust gas					
*	5.1	Furnace tail temperature	degC				
*	5.2	Temperature at inlet of preheater	degC	697	706		702
*	5.3	Temperature at outlet of preheater	degC	472	479		476
	6	Steel billet					
*	6.1	Size (Height * width * Length)	m3/piece	0.13	0.13	12	0.203
	6.2	Average weight (Size * 7.85)	kg/piece				1,592
*	6.3	Total charged numbers	Piece	249	287		38
	6.4	Total charged tonnage	ton				60.5
*	6.5	Charging temperature	degC	34	34		34
*	6.6	Discharging temperature	degC	1010	1010		1010
*	7	Furnace inner pressure at roof	**kPa**	0.08	0.08		0.08
	8	Surface temperature and area					
*	8.1	Furnace roof tempearture	degC	178			178
	8.2	Roof area	m2				
*	8.3	Furnace wall temperature	degC	Front/Back	Left	Right	
		Average	degC	119 / 103	77	186	
		Maximum	degC	256 / 189	90	201	
	8.4	Wall area	m2				
*	8.5	Recuperator wall temperature	degC	82	74		78
	8.6	Recuperator wall area	m2				



3) Setting change of inner pressure of furnace

(1) Present condition and problems

Inner pressure at ceiling part of reheating furnace is +0.08 kPa (8 mmAq), and the high temperature gas of furnace is emitted outside the furnace from the opening. Inner pressure of furnace is usually set at +1 to +2 mmAq. Loss by emission of high temperature gas is presumed to be 3%.

(2) Measures for improvement and expected effect

When inner pressure at ceiling part of reheating furnace is changed into + 0.02 kPa (+2 mmAq), fuel can be saved by 2%.

Amount of fuel saving: 5,700 ton/y × 0.02 = 114 ton/y

Annual fuel cost reduction: 114 ton/y × 12,000,000 VND/ton = 1,368,000,000 VND/y

4) Heat Holding method improvement at the stop of reheating furnace operation

(1) Present condition and problems

At present, annual operating days are 240 days, and period of operation stop is 1 day to 3 days. Burners of furnace are fired in order to keep the furnace temperature at 500ºC or more. The fuel cost for heat holding is very large.

(2) Measures for improvement and expected effect

When period of operation stop is 1 day or more, all billets are discharged, burners are extinguished, and openings of furnace are closed, and furnace heat is held. It is necessary to improve air tightness and sealing of the opening of reheating furnace.

In order to shorten the heating up time from the time of stop, it is effective to change the fire-resistant refractories of furnace to ceramic fiber from castable refractories.

Difference of fuel consumption are as follows, in the case of operation stop of 24 hours occurs at 2 times per month (24 times/year) .

Present condition: Fuel consumption for combustion at partial load of 30%:

1,532 kg/h × 0.3 × 24 × 24 / 1,000 = 265 ton/y

After improvement: Fuel consumption for combustion when heating-up time is 3 hours with ceramic fiber lining in the furnace instead of castable refractories:

1,532 kg/h × 3 × 24 / 1,000 = 110 ton/y

Amount of fuel saving: 265 – 110 = 155 ton/y

Annual fuel cost reduction: 155 ton/y × 12,000,000 VND/ton = 1,860,000,000 VND/y

5) Reinforcement of Heat Insulation of Furnace

(1) Present condition and problems

Radiation heat loss from wall and roof of furnace is 65 MJ/ton-steel (5.5%). Surface temperature of furnace wall is 100ºC or more at charging side, extraction side and a right-hand side wall. Average surface temperature of furnace roof is 178ºC. Judgment standard of Energy Conservation Law of Japan has prescribed 100ºC or less of furnace side walls, and 110ºC or less of roof parts. Fire-resistant refractories of furnace need to be improved.

(2) Measures for improvement and expected effect

A fire-resistant refractories design is performed so that surface temperature of furnace wall and roof may be 100ºC or less and 110ºC or less respectively. Considering that annual operating days are 240 days and operation stop period is 1 day to 3 days every week, fire-resistant refractories should be changed to ceramic fiber. Since thermal storage volume is small, ceramic fiber can shorten heating-up time sharply.

Dissipation heat loss can be reduced to 35 MJ/ton-steel when fire-resistant refractories of furnace is repaired so that surface temperature may be 100ºC or less for wall and 110ºC or less for roof.

Amount of fuel saving: (65 – 35) / 41,870 × 180,000 = 129 ton/y

Annual fuel cost reduction: 129 ton/y × 12,000,000 VND/ton = 1,548,000,000 VND/y

6) Adoption of regenerative type combustion burner (Regenerative burner)

(1) Present condition and problems

6 burners of heating zone and 10 burners of soaking zone are installed in furnace. Fuel intensity is 317,000 kcal/ton in 2006, which shows high-level operation in Vietnam.

Furthermore, in order to improve combustion efficiency to 300,000 kcal/ton or less, regenerative type combustion burner so-called regenerative burner is applicable. Stop and start operation of reheating furnace by operation stop in holidays and production plan make big heat loss.

(2) Measures for improvement and expected effect

Regenerative type combustion burner can be installed by converting burners and modifying furnace structure and fire-resistant refractories in heating zone and soaking zone. By installing regenetive burner, fuel consumption can be reduced by 20%. to 30%

Regenerative burner system is shown in figure 1.4.2-1. Combustion air is heated to 1,000ºC or over by heat exchange in regenerator of the burners and exhaust gas temperature is 200 to 250ºC, and so billet heating efficiency is improved to 65% to 75%.

Causions for introduction of regenerative burner are as follows:

a. To change fuel oil to fuel gas, because gas combustion is suitable to regenerative burner compared with oil combustion.
b. To prepare adjusting plan of products stock, because operation stops for 7 days to 20 days.
c. To use ceramic fiber in roof and side wall, because ceramic fiber has small heat accumulation loss.

Fuel intensity is improved by 20%.

Amount of fuel saving: 5,700 ton/y × 20% = 1,140 ton/y

Annual fuel cost reduction: 1,140 × 12,000,000 VND/ton = 13,680 VND/y

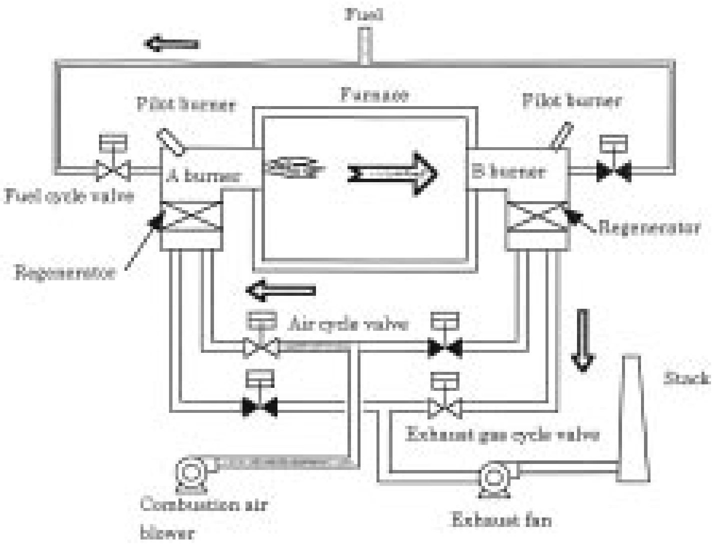


Figure 1.4.2-1 Regenerative burner system

1.4.3 Cooling facilities

1) Operation management of cooling tower equipment

(1) Present condition and problems

Cooling water supply system consists of 2 lines, direct cooling water line for jet-cooling to high temperature rolled steel shown in Figure 1.4.3-1 and indirect cooling water line for reheating furnace and lubricate oil cooling shown in Figure 1.4.3-2.

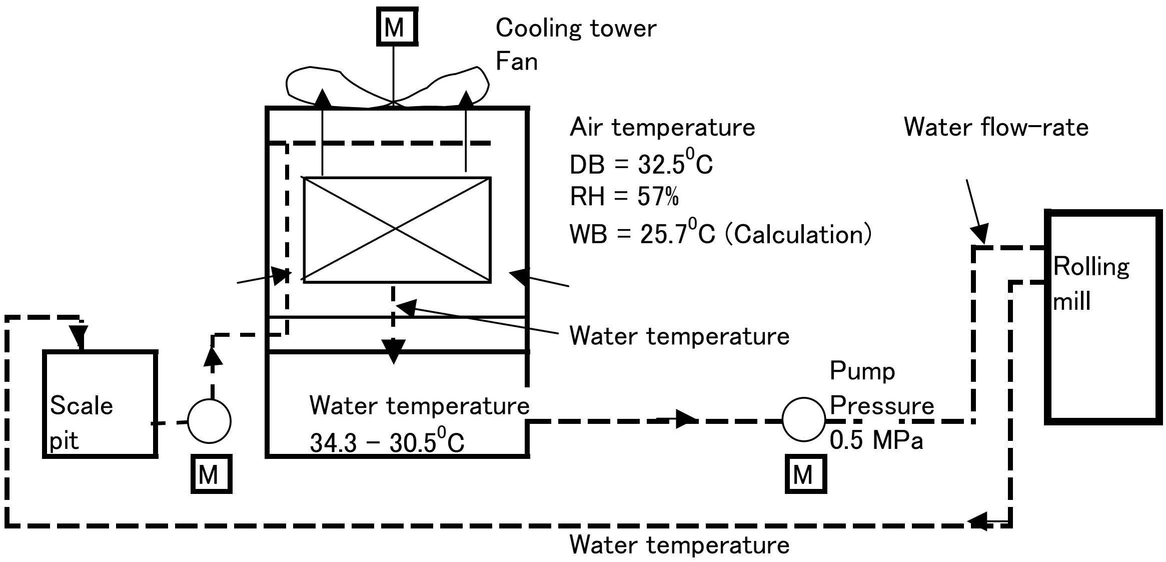


Figure 1.4.3-1 Cooling tower system for direct cooling water line

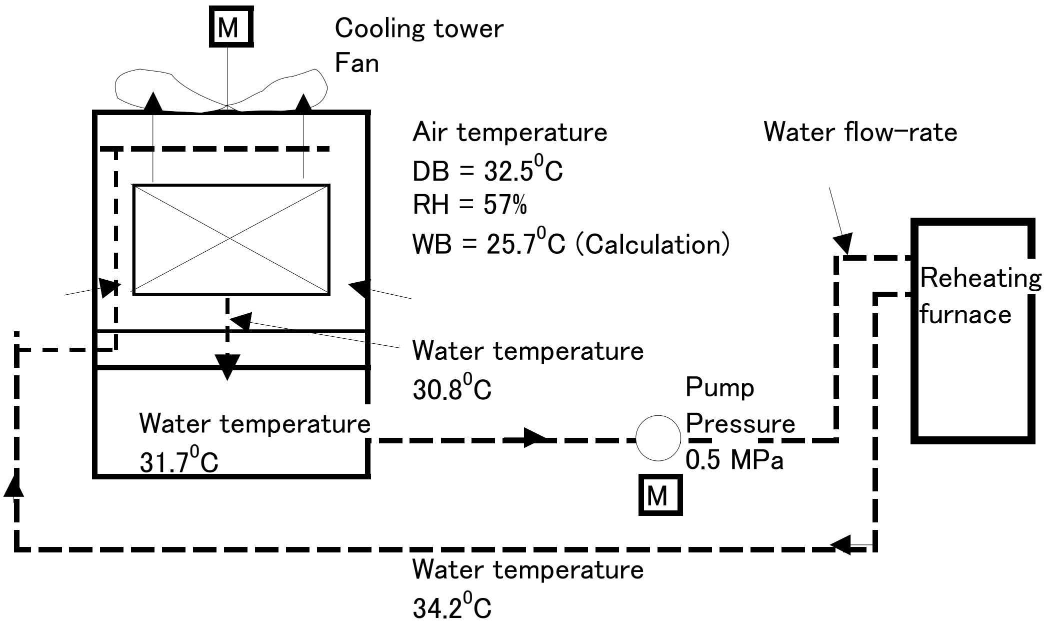


Figure 1.4.3-2 Cooling tower system for indirect cooling water line

Measured values at audit are shown in Figure 1.4.3-1 and 1.4.3-2.

Approach temperature, temperature difference between wet valve and cooling water, was measured at 5ºC. This value shows good thermal exchange condition between outer air and water in the tower. However, about transmission line, gap temperature difference between supply and return water was too small at 3.4 ºC, 34.2 to 30.8 ºC. This means poor efficiency on heat transportation. In cooling water transportation system, large temperature difference with small amount water flow is more efficient in view from the energy conservation but now the situation is vice versa.

(2) Measures for improvement and expected effect

We propose VSD control, which governs pump operation along to the information of cooling water temperature difference between supply and return and water flow volume. An example of cooling water pump with VSD control is shown in Figure 1.4.3-3.

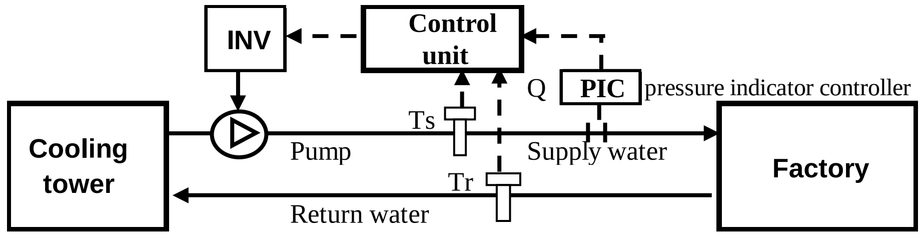


Figure 1.4.3-3 One example of cooling water pump system with VSD control

Water flow rate is regulated by VSD in accordance with temperature difference between supply water temprature (Ts) and return water temprature (Tr) to keep the temperature difference properly.

Shaft power of pump relates with water flow in cubic rule. I.e. shaft power is proportional to cubic of the pump-speed.

By increasing the temperature difference of 1.47 times of 3.4ºC to 5 ºC and decreasing the water volume to 1 / 1.47 = 68%, the pump shaft power decreases theoretically to cubic of 68%, that is 46%. However, on account of inverter efficiency of 95% and pump and motor efficiency of 94%, the shaft power reduces to 28.4%.

The rated power of pump will be calculated from the labeled data.

P = 0.163 × γ· × Q × H / η = 0.163 × 1 × 6.67 × 56 / 78% = 78kW

Where, γ: density of water 1.0 kg/m^3, Q: flow volume (m3/min), H: head (m), η: pump efficiency.

By assuming motor efficiency 90%, calculated rated motor power is 78kW / 90% = 86.7kW. Input power of motor is 83.8 kW, which is 96.6% of rated power.

Figure. 1.4.3-4 shows performance of proposed VSD control.

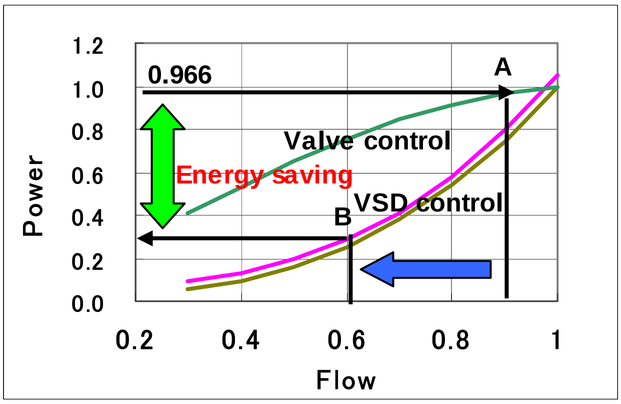


Figure 1.4.3-4 Performance of valve control and VSD control

“A” in Figure 1.4.3-4 shows operation point on the present system, and then “B” is operation point on VSD control system.

In the case of VSD control, amount of power saving is as follow.

Input power to the motor: 83.8kW × 28.4% = 23.8kW

Power saving: 83.8kW – 23.8kW = 60.0kW

Annual power saving is estimated as below.

Amount of power saving: 60.0kW × 20h/d × 240d/y = 312,000kWh/y

Annual power cost reduction: 288,000kWh/y × 800VND/kWh = 249,600 × 1,000 VND/y

1.4.4 Fan and compressor

1) Operation management of combustion air fan of reheating furnace

(1) Present condition and problems

Power consumption of combustion fan was measured in survey as shown in Figure. 1.4.4-1.

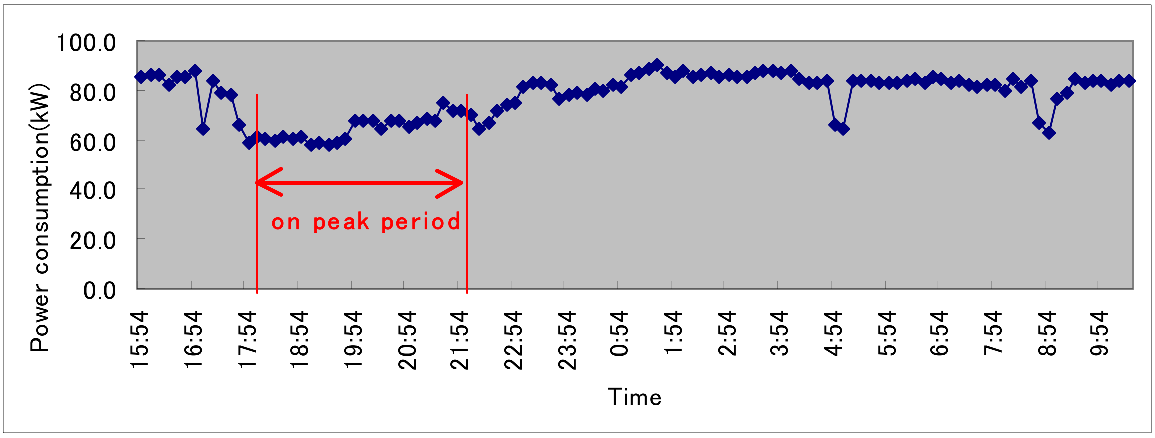


Figure 1.4.4-1 Power consumption of furnace fan

Suction damper is controlled along with furnace operation. Especially, the damper is closed during peak time frame from 18:00 to 22:00.

(2) Measures for improvement and expected effect

We propose Change of suction damper control to VSD control.

Performances of suction damper control and VSD control are shown in Figure. 1.4.4-2.

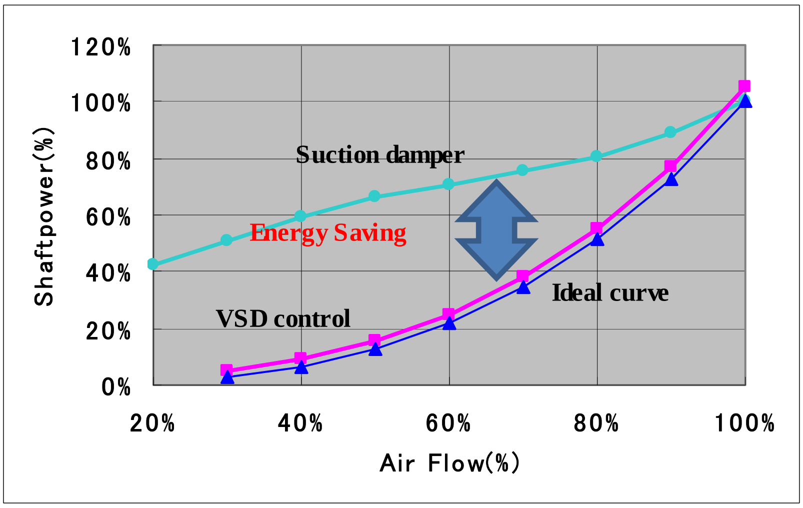


Figure 1.4.4-2 Performances of suction damper control and VSD control

Since shaft power reduces with cubic of air flow rate in VSD control, VSD control performs large energy saving.

As conditions for estimation, following items are assumed

a. Rated power of the fan: 89.9kW as maximum value during measured power consumption,.
b. Motor efficiency: 90%, inverter efficiency: 95%

Results of estimation are shown in Figure. 1.4.4-3.

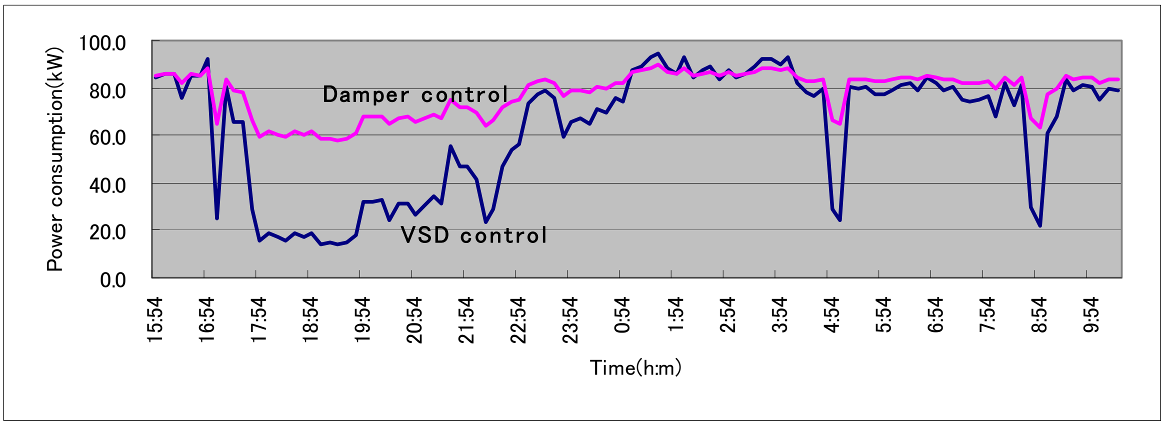


Figure 1.4.4-3 Power consumption under damper control and VSD control

As shown in Figure 1.4.4-3, VSD control makes big energy saving at low air flow rate. Average power consummations of on-peak time frame and the other time frame are calculated respectively and then daily power consumption and power saving are estimated. The results are shown in Table 1.4.4-1.

Table 1.4.4-1 Effects of VSD control

	Damper conrol		VSD control		Saving
	kWh/hour	kWh/day	kWh/hour	kWh/day	kWh/day
On-peak time frame	258	1,030	219	875	155
Other time frame	533	11,690	429	9,464	2,071

Amount of energy saving per year is calculated as follow.

Amount of power saving: (155 + 2,071)kWh/d × 260d/y = 619,000kWh/y

Annual power cost reduction: 619,000kWh/y × 800VND/kWh = 495,200 × 1,000VND/y

2) Operation management of air compressor

(1) Introduction of multiple units control and VSD type compressor

<u>Present condition and problems</u>

7 units of 75kW air compressor of gate-rotor and screw-type are installed and 4 units of them are working on the surveyed day. The variation of power consumption from light load to heavy load is shown in Figure. 1.4.4-4.

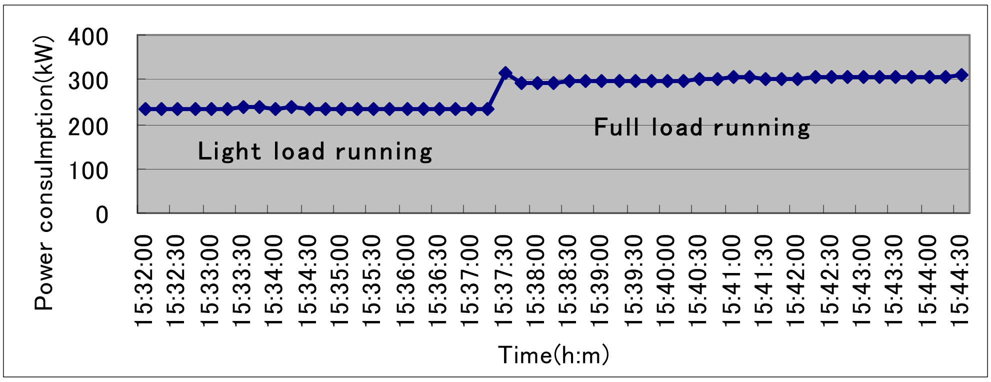


Figure 1.4.4-4 Variation of power consumed in compressor group

Power consumption stepped up from 234kW to 296kW, which corresponds to 74kW/unit. Judging from power consumption per unit, all the compressor seems to be operated in the 100% load.

Load factor in light load running before 15:37:30 in Figure 1.4.4-4 are calculated as the Table 1.4.4-2 with the function of Load/Unload and Purge mode.

Table 1.4.4-2 Load factors in light mode running

	Power con. kW	Load factor	Air flow rate
No.1 Compressor	56.2	76%	20%
No.2 Compressor	60.0	81%	37%
No.4 Compressor	67.8	92%	73%
No.7 Compressor	51.0	69%	10%
total	235.0		140%

Air flow rate means the ratio to the rated discharge air volume. Total of air flow rate of 140% shows the discharge volume that could be able to supply only 1.4 units if they were working in 100% load. Multiple units were running under partial load that is low efficiency.

Measures for improvement and expected effect

We propose to install a multiple unit controller to ensure efficient operation. By means of limiting only one compressor in partial load operation, the system could avoid degradation in the efficiency.

Performances of screw-type compressor under partial load are shown in Figure. 1.4.4-9.

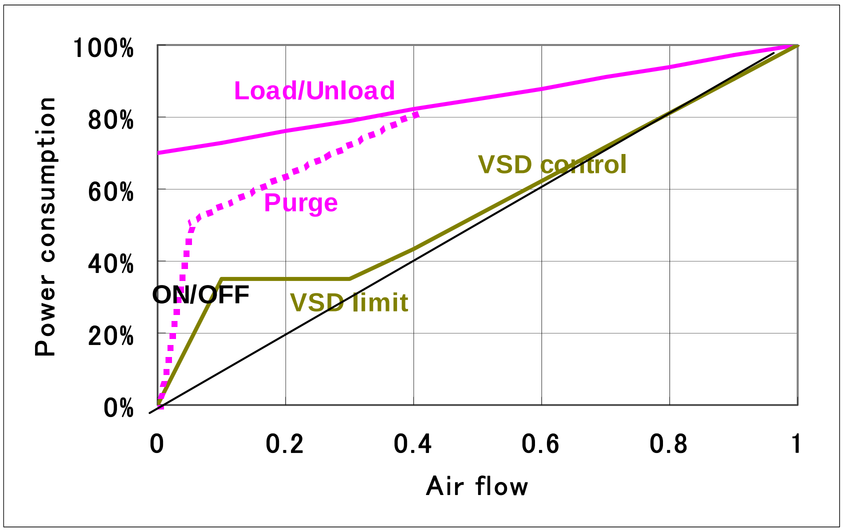


Figure 1.4.4-5 Chrematistics of screw type compressor

As shown in Figure 1.4.4-5, efficiency is low in partial load. A few compressors have load/Unload function and/or purging function in extremely low load operation, however avoiding to working in partial load is better choice. Multiple unit control system is effective to partial load operation. Figure. 1.4.4-6 shows performance of multiple unit control for 3 units.

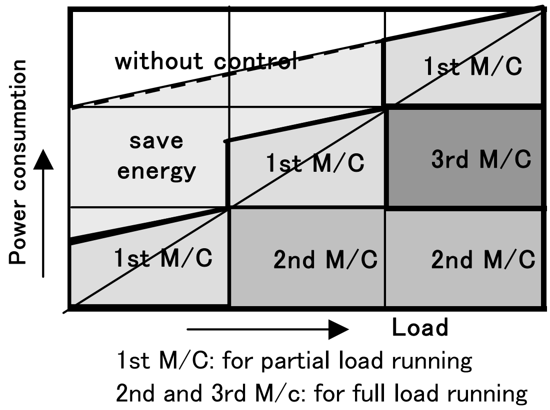


Figure 1.4.4-6 Performance of multiple unit control

With multiple unit control, number of running units varies in such way where only one unit runs in load/unload mode under low load condition and, if necessary, another compressor start running in full load operation, with rated power. Under any load conditions, partial loaded compressor is only one unit.

The area of 'Save energy' means amount of energy saving.

As shown in Figure 1.4.4-6, VSD Type compressor with inverter has a good performance in partial load.

The effects of introduction of a multiple unit controller and VSD type compressor are shown below.

From present arrangement, the system consists of 4 units of air compressor, one of which is VSD type compressor for partial load operation, is considered.

Since amount of partial load is equal to loads of 1.4 units in full load operation in Figure 1.4.4-6, the operation of one unit in full operation and another unit in 40% load is enough for the load.

Assuming efficiency of VSD type compressor in 40% load is 44%, power consumption of proposed system could be estimated as 74kW + 74kW × 44% = 106.6kW

Moreover, if ratio of lighter load operation hours were 50%, that is 12h/day, annual power consumption would be estimated as follow.

Amount of power saving: (233.9kW – 106.6kW) × 12h/d × 260d/y = 397,000kWh/y

Annual power cost reduction: 397,000kWh/y × 800VND/kWh = 317,600 × 1,000VND/y

(2) Lowering discharge pressure

<u>Present condition and problems</u>

Users of compressed air are as follows.

Air compressor ---- Furnace ------------ Cylinder for opening and closing the gates
--------------- Heavy oil atomizer for the burner
---------------- Press machine ---- De-scaling
-------------- Cylinder for coil rolling-up machine
-------------- To purge and clean the pipe for coil rolling-up machine

Discharge pressure is 0.55 to 0.6MPa. The pressure band between lower and upper limit is narrow. And numbers of running unit are decided according to manufacturing items

<u>Measures for improvement and expected effect</u>

Lowering discharge pressure of air compressor is one of the most effective measures in energy conservation.

Following items can be proposed

a. Air pressure along the pipeline should be investigated and pipeline should be changed with smaller pressure loss
b. Lower limit of air pressure for load equipment should be studied and pressure value should be newly set with suitable margin.

Pressure loss can be reduced in the piping by changing to loop type formation as shown in Figure 1.4.4-7.

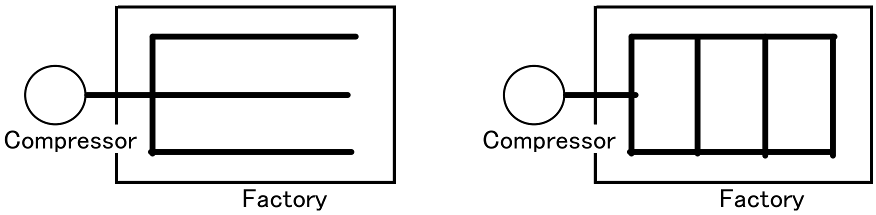


Figure 1.4.4-7 Tree branch type piping and loop shape piping

Also, air receiver tank should be installed near heavy air load equipment to decrease fluctuation of pressure and to reduce margin.

Figure 1.4.4-8 shows relation between discharge air pressure and input power of screw compressor.

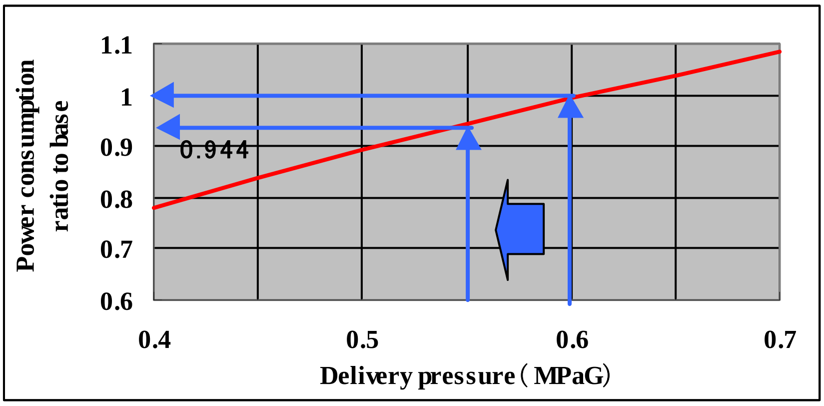


Figure 1.4.4-8 Discharge pressure and input power consumption

As shown in Figure 1.4.4-8, reduction of discharge air-pressure of compressor from 0.6MPa to 0.55MPa saves energy as much as 5.6% and more to 0.5MPa brings 11% saving. Effects of reduction of air pressure to 0.55 MPa from 0.6 MPa are shown below.

Measured power consumption of air compressor No.1: 234 kW

Measured power consumption of air compressor No.2: 396 kW

Average power consumption: (234 + 396) / 2 = 350 kW

Annual power consumption is as follow.

315kW × 24h/d × 260d/y = 1,965,600kWh/y

Effects of lowering the pressure to 0.55MPa is estimated as follow.

Amount of power saving: 1,965,600kWh/y × 5.6% = 110,000kWh/y

Annual power cost reduction: 110,000kWh/y × 800VND/kWh = 88,000 × 1,000VND/y

1.4.5 Power receiving and distributing equipment, Motor

1) Management of power receiving and distributing equipment

(1) Present condition and problems

Panels of transformers and motor control centers are laid out systematically in the room of electric power control center. It may be ranked up one of the top class in Vietnam.

Receiving power is measured and recorded in the form of per shift. The management that is advanced by one step forward than others is observed.

Figure. 1.4.5-1 shows a single lien diagram of power receiving system.

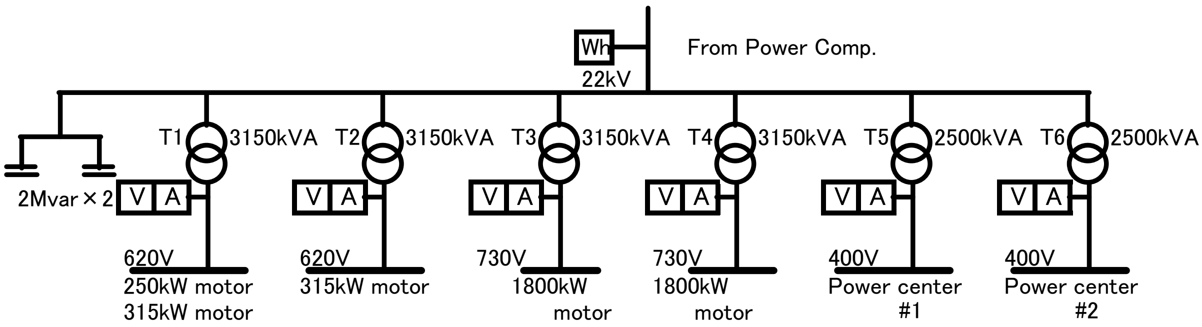


Figure 1.4.5-1 Single diagram of power receiving system

Voltage meter and current meter are placed on each panel. But power meter is not be installed there.

A multi meter for receiving power measurement is installed. However regrettably its signal does not seem to be used for any purposes.

The largest power consumer is direct current motor driving roller mill machine. DC motor is controlled by Thyristor Leonard system, magnetic field current and armature current are controlled with DC current rectified by Thyristor. Thyristor rectifier brings higher harmonics in power system. Static condenser of 2 Mvar × 2 units is installed for the filter of harmonics. This capacitor also improves power factor of the receiving power. Power factor of receiving power is 98% by the calculated from displayed value on the multi meter.

Daily power consumption is shown in Figure. 1.4.5-2.

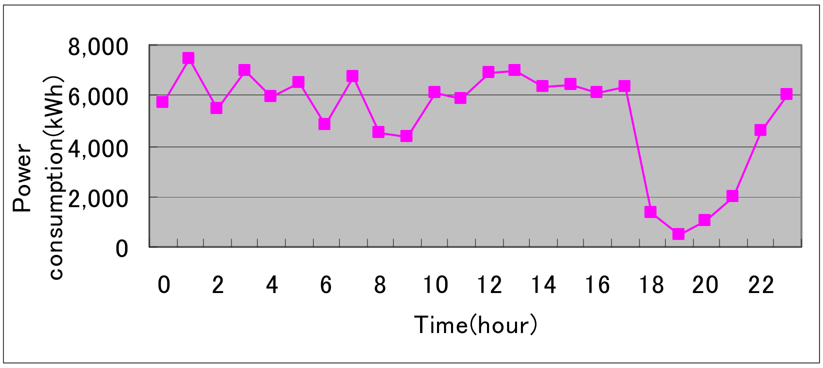


Figure 1.4.5-2 Daily power consumption

During on-peak time frame of 18:00 to 22:00 the factory stops operation and then power consumption reduced to small amount.

Subdivision of the power consumption estimated from the current of each transformer is shown in Figure. 1.4.5-3.

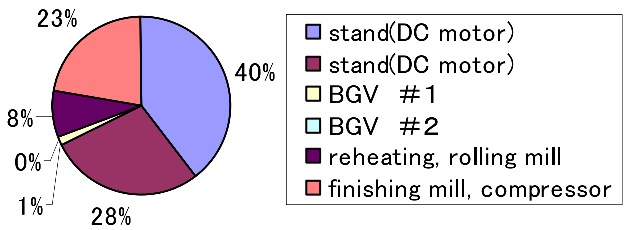


Figure 1.4.5-3 Main users and power consumption

Big motors, BGM: rated axial power 1,800kW, stopped at surveyed day and not consumed power.

The data acquisition system for has not yet established. In order to develop the effective energy conservation activities, more powerful data acquisition system is desired.

(2) Measures for improvement and expected effect

Installing data logging function into the power receiving system and then building a power management system can be proposed.

The energy conservation activity required at first grasping precisely the real states of energy consumption. For this purpose, a kind of automatic and mechanical system should be required. Whole power monitoring system, which includes measuring power of main branch feeders in the system, may be suitable. One of example is shown in Figure. 1.4.5-4.

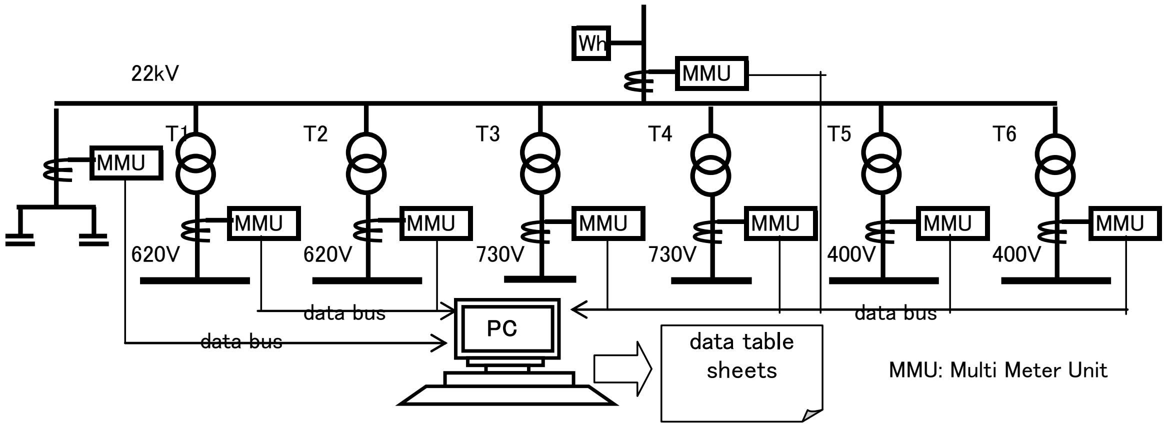


Figure 1.4.5-4 An image of power monitoring system

Digital multi-purpose meter for power measuring are used for picking up the electrical data from the power receiving system and the data are transmitted to a personal computer used for data out put device. The computer compiles tables of the monitoring data, which can be utilized for power management of the company.

With this system, hourly measuring of power consumption is available. This is the first step to fruitful and developing energy conservation activities. Ensuring actual state of the power consumption control and management during on-peak demand time is one of energy conservation activity from effective usage of the power monitoring system.

Expected effect is depending on the degree of utilization of the management system and improvement of energy conservation activity. But saving about 5 to 10% of the power consumption can be expectable.

Amount of power saving: 1,800,000kWh/y × 5% = 900,000kWh/y

Annual power cost reduction: 900,000kWh/y × 800VND/kWh = 720,000 × 1,000VND/y

2. Ceramics Factory B

2.1 Introduction

1) Name: Ceramics Factory B
2) Address: Hanoi City
3) Business
   (1) Type: Ceramics
   (2) Main product: Floor tile and Brick
   (3) Amount of product: 1,400,000 m^2 (2007)
   (4) Export: Taiwan, Korea, USA, UK, Japan
   (5) Employee: 253 persons
4) Person in charge of energy on-site survey: Vice President
5) Outline of the factory

   Production began in 2001 with equipment introduced from Italy. Almost all raw materials used are domestics and partly imported from Spain. Production of tile by this factory accounts for 5 % of the total production in Vietnam, and they are exported to Taiwan, South Korea, the U.S., the U.K. and Japan. It has a plan to a suburb of Hanoi City constructing a new factory, and begin production in 2010.

2.2 Outline of on-site survey

1) Survey team member

   JICA Study Team: Mr. Norio Fukushima, Mr, Wataru Ishikawa, Mr. Hisashi Amano
   Institute of Energy: Mr.Song ,Mr. Hoang Anh
   ECC-Hanoi: Mr. huynh, Mr. Hai, Ms. Linh
2) Surveyed period: 29th to 30th September, 2008 (2 days)
3) Request for energy conservation

   How to improve energy conservation
   How much is energy conservation effect

2.3 Results of energy on-site survey

1) Improvement items and effects of forecast after improvement

   Improvement items and effects of forecast after improvement by on-site survey is shown in Table 2.3-1. Energy conservation potential is 12.3%

Table 2.3-1 Improvement items and effects of forecast after improvement

	No.	Improvement item	Expected effect: Kind of energy	Expected effect: Amount of energy conservation (kℓ/y, kWh/y)	Expected effect: Amount of energy saving (×1,000 VND/y)
1	4.2.1	Fans and pumps; Applying variable speed driving (VSD) control to adjust the flow	Power	202,600kWh	176,282
2	4.2.2.1)	Air compressor: Installing multiple unit control and VSD type compressor.	Power	150,480kWh	130,918
3	4.2.2.2)	Air compressor: Lowering discharge air pressure.	Power	106,500kWh	92,655
4	4.3.2.1)	Roller hearth kiln number of operation burners	Fuel oil	135kℓ	985,500
5	4.3.2.2)	Roller hearth kiln blows waste heat (rejection heat) in to the pre-firing zone	Fuel oil	135kℓ	985,500
6	4.3.2.3)	Roller hearth kiln the sensible heat of the exhaust gas is recovered	Fuel oil	27kℓ	197,100
7	4.3.2.4)	Roller hearth kiln pressure in the kiln is to be negative	Fuel oil	27kℓ	197,100
8	4.4.1	Power receiving system: Installing power monitoring system	Power	382,400kWh	332,688
9	4.4.2	Power distribution: Enlarging cable size and installing static condenser to reduce loss through supply cable line.	Power	124,300kWh	108,141
Total of expected results			fuel	324 kℓ/y (297 toe/y)	2,365,200 × 1,000 VND/y
			power	966,280kWh/y (268 toe/y)	840,664,000 × 1,000 VND/y
Crude oil equivalent of fuel and electric power (total) (Reduced volume of carbon dioxide (CO2))				565 toe/y	
	Annual energy consumption		Fuel (total)	2,703kℓ/y	
			Electric power (total)	7,648,000kWh/y	
			Total in factory	4,594 toe/y	
	Energy conservation rate for the whole factory		Fuel (total)	12.0%	
			Electric power (total)	12.7%	
			Total in factory	12.3%	

2) Annual energy consumption and energy intensity

(1) The Amount of annual energy consumption (C+D) : B= 4,594 toe

(in which) The amount of crude-oil equivalent of electric power: C= 2,118 toe

(Purchased electric power E= 7,648 MWh) × 0.277

The conversion factor to primary energy of electric power is calculated according to 31% of thermal efficiency of thermal power generation station in Vietnam.

Conversion factor to primary energy = 860 / 0.31 = 2,770 Mcal/MWh = 0.277 toe/MWh

1 toe = 10,000 Mcal

Amount of crude-oil equivalent of all fuel consumption D = 2,475 toe

(Sum total which carried out the crude-oil conversion of each amount of fuel)

Details (before conversion) Fuel oil ( ): 2,703kl/y

D = 2,703kl/y × 0.99 × 0.925 = 2,475 toe/y

(0.99 = conversion coefficient for crude oil and 0.925 = specific weight of crude oil)

(2) Energy intensity (energy consumption per annual shipment amount, etc.)

Trend of energy intensity is shown in Table 2.3-2

Table 2.3-2 Production and energy intensity

	2006	2007
Production (m^2/y)	1,168,974	1,439,393
Fuel consumption (Fuel oil Kℓ)	950	2,703
Fuel intensity(ℓ/m^2)	0.81	1.88
Unit price for fuel (VND/kg-LPG)		7,300
Electricity consumption (MWh/y)	6,262	7,648
Electricity intensity (KWh/m^2)	5.52	5.3
Unit price for electricity (VND/kWh)		870

3) Remarks

(1) Energy price

Fuel oil: 7,300 VND/liter

Electricity: 870 VND/kWh

(2) Operation hours

Annual operation day: 330 days

Operation hours a day: 24 hours

4) Equipment

Specifications of tile production equipment are shown in Table 2.3-3.

Table 2.3-3 Specifications of tile production equipment

No.	Equipment	Q'ty	Main specifications
1	Roller hearth kiln	3	Size: 50m,102m,107m length Manufacturer: Italy NASETTI Fuel: Fuel oil Max. temperature 1200℃ Firing hour (in to out) 55～80 min
2	Spray dryer	2	Fuel : Fuel oil
3	Forming machine	3	Hydraulic press
4	Dryer	2	Waste heat of roller hearth kiln as heat source.
5	Air compressor	1	110kW screw type

5) Production process

Flow-sheet of tile production process is shown in Figure 2.3-1.

Raw material

Main raw material is domestic, and someone is imported from Spain.

Ball mill for body slip: 5 sets

Ball mill for glaze: 2 sets

Granule

Spray dryer: 2 sets (Fuel oil)

Forming

Hydraulic press: 3 sets

Firing

Roller hearth kiln: 3 sets (50m, 102m, and 107m length)

Fuel was changed from gas to fuel oil last year.

Max temperature: 1,200ºC

Firing hour (in to out): 55 min (300 mm-square tile) - 80 min (600 mm-square tile)

Production: 144m^2/hr (400 mm-square tile)

Polishing, inspection, packing and delivery

Chamfer, Polishing (the Nano grinding technology is introduced from Germany)

Row material → Fine grinding → Spray dryer → Forming → Drying

→ Glazing → Firing → Polishing → Inspection → Delivery

Figure 2.3-1 Flow-sheet of tile production process

2.4 On-site survey report

2.4.1 General management matter

1) Energy management organization and target

(1) Present condition and problems

Energy management organization is not established, and also the target of energy intensity and energy conservation activity. The equipment is the modern machine and problems are not in hardware, but the problems are how to introduce the firing technology and the management technique such as soft ware.

(2) Measures for Improvement

Energy conservation activity including cost reduction should be enforced and top management of the company should overcome these problems and introducing a soft ware.

2) Implementation of measurement and record

(1) Present condition and problems

The equipment is not different from that of Japan, but a part of the instrumentation and the record meter are out of order. therefore energy use condition is not grasped.

(2) Measures for Improvement

It is important for managers and engineers to recognize the energy conservation.

3) Maintenance of facility

(1) Present condition and problems

Some oil leakage is found in the piping of the oil pump. Maintenance is not done with the measurement devices broke down. It is necessary to set up management standard including the item and inspection frequency and to implement maintenance.

(2) Measures for Improvement

Periodic inspection should be implemented.

4) Management of fuel consumption

(1) Present condition and problems

The shortage and defective operation of instrumentation are seen partially, and also the energy consumption management is not implemented by using the measured and recorded data.

(2) Measures for Improvement

The maintenance of instrumentation is a starting point of energy conservation activity.

5) Energy intensity management of main products

(1) Present condition and problems

Since management of the energy consumption is not carried out, energy intensity has not been managed.

(2) Measures for Improvement

It is important for managers to recognize the energy conservation.

6) PDCA management cycle

(1) Present condition and problems

Maintenance of measuring instrument is the essential requirements for PDCA management cycles.

7) Evaluation of energy management situation

Evaluation of energy management situation is shown in Figure 2.4.1-1.

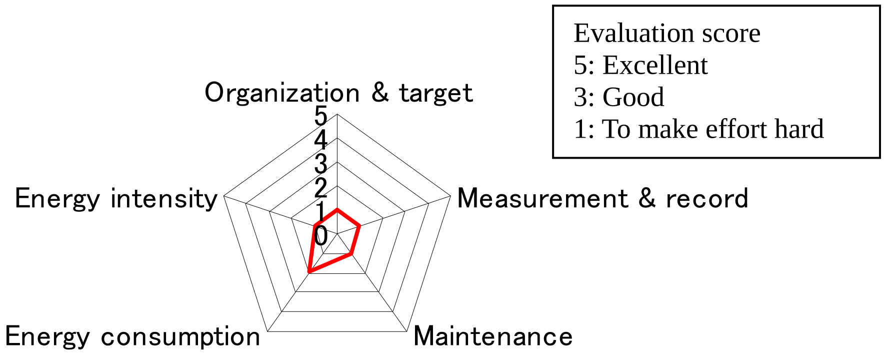


Figure 2.4.1.-1 Evaluation of energy management situation

2.4.2 Pump, fan, compressor, etc.

1) Operation management of pump and fan

(1) Present condition and problems

Valve control or damper control is generally used for flow control in fluid machinery like a pump and/or a fan. However, introduction of VSD (variable speed driving) control with inverter system to them makes a great improvement in the energy conservation.

Table 2.4.2-1 shows measured power consumption data and calculated load factors.

Table 2.4.2-1 Power consumption and load factor of related motors

Motor for	Rated power (kW)	Power consumption (kW)	Load factor
Pump 1	22	18.55	76%
Pump 2	11	12.3	101%
Dryer fan	45	33.0	66%
Furnace exhaust fan	22	19.4	79%

Note: Assumed motor efficiency is 90%.

A pump and fans except for pump 2, which consumes nearly the same amount to rated power, have possibility of energy saving with VSD control system.

(2) Measures for Improvement and expected effects

Adoption of VSD control to the fans and the pump can be recommended.

Power consumption of fan or pump is reduced in proportion to cubic of flow rate under VSD control. Then, even though inverter loss and degradation of efficiency of pump or/and fan are generated by low speed operation, VSD control makes big energy conservation.

Effects of VSD control are shown in Figure 2.4.2-1 about dryer fan and pump No. 1.

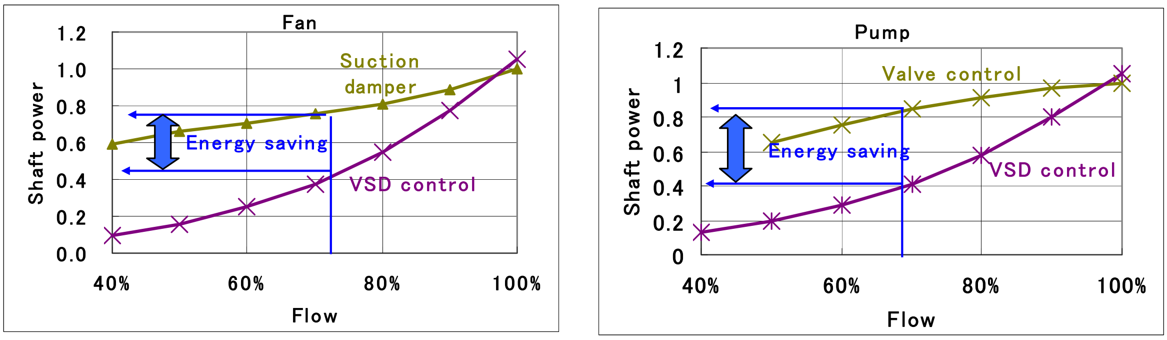


Figure 2.4.2-1 Performance of damper or valve control and VSD control

Amounts of saving energy by VSD control on the concerned equipment are calculated and shown in Table 2.4.2-2. On process of the estimation, following items are assumed:

Present flow control is as follow:

Pump: outlet valve control, actual height is 10% of pump's rated value

Fan: inlet damper control

Motor capacity margin to pump and fan: to pump 10%, to fan 15%

Table 2.4.2-2 Amount of power saving by VSD control

Equipment	Water or air flow-rate	Power consumption (kW)		Energy saving	
		Present	Proposed	kW	KWh/year
Pump 1	69%	18.5	8.8	9.6	76,290
Dryer fan	73%	33.0	18.5	14.5	114,915
Exhaust fan	93%	19.4	17.9	1.4	11,426

(Note) Assumption: Motor efficiency: 90%, Inverter efficiency: 95%

From Table 2.4.2-2,

Amount of power saving: (9.6 + 14.5 + 1.4)kW × 24h/d × 330d/y = 202,600kWh/y

Annual power cost reduction: 202,600kWh/y × 870VND/kWh = 176,262 × 1,000VND/y

2) Operation management of air compressor:

(1) Installation of multiple unit controller and VSD type compressor

Present condition and problems

The arrangement of compressors is shown in Figure 2.4.2-2, which consists of screw type air compressor of 50kW × 3 units and 37kW × 1 unit. Each compressor works by own pressure control protocol independently.

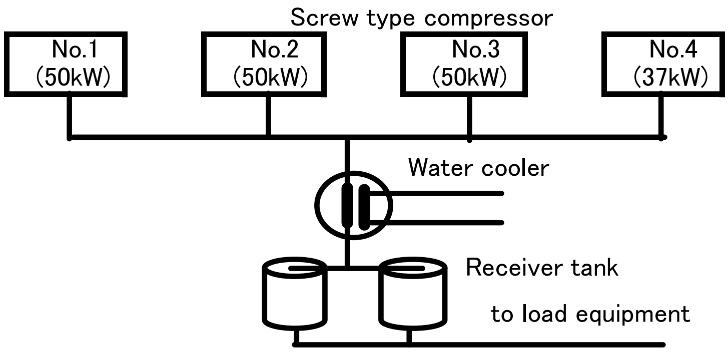
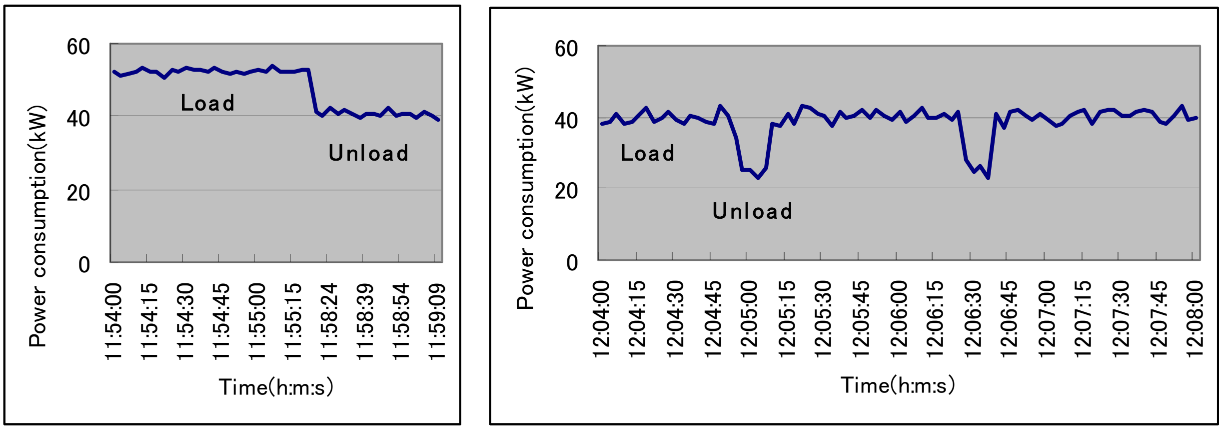


Figure 2.4.2-2 Arrangement of compressors

On the surveyed day, air compressors No.1 and No.2 were running as shown in Figure 2.4.2-3.



a) No1 compressor (50kW) b) No2 compressor (37kW)

Figure 2.4.2-3 Working-state of compressors

Two compressors are working properly, one runs on Load/Unload state and the other on constant rated load state. But, multiple-unit controller is not installed. Poorer efficient running may be occurred in the case of 3 and 4 units running or working at low load time frame like during nighttime.

Measures for improvement and expected effects

Multiple-unit controller is recommendable for ensuring efficient multi units operation.

Efficiency on the system can be improved by means of limiting only one compressor on partial load operation. The way of running-number-unit control is shown in Figure 2.4.2-4.

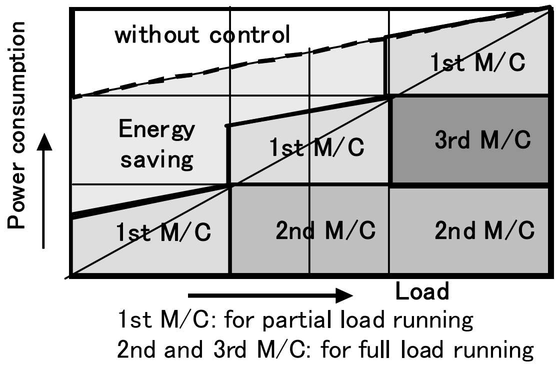


Figure 2.4.2-4 Multiple-unit control and its effect on energy saving

There is possibility that 3 sets of air compressor may run under partial load condition simultaneously without multiple-unit control. Screw type compressor which is operated under partial load consumes too much power and not efficient. For example, Un-loaded air compressors would consume 70% of the rated power.

With multiple-unit control, number of running units varies in such way where only one unit runs in load/unload mode under low load condition and, if necessary, another compressor start running in full load operation with rated power. Under any load conditions, partial loaded compressor is only one unit.

The area of “energy saving” shows amount of energy saving in figure 2.4.2-5.

If VSD type compressor is operated in partial load condition, more energy conservation can be achieved. VSD type compressor driven by inverter is very useful for partial load operation. However, lower limit of rotation speed should be considered.

Running mode and its effect of 2 units of VSD type compressors with multiple unit control of 50kW are shown in Figure 2.4.2-5.

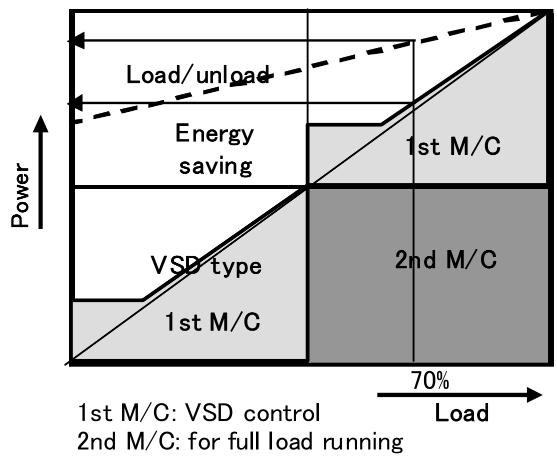


Figure 2.4.2-5 Effect of VSD type compressor under multiple-unit control

In consideration of the present operation on the surveyed day, load factor of 70% and power consumption of 91 kW are assumed for the estimation. Assumed conditions are load factor of 40% of VSD type unit shown as 1st M/C in Figure 2.4.2-5 and the efficiency of 44%. Total consumption is 50kW + 50kW × 44% = 72kW, including power consumption of rated operation unit of 2nd M/C in Figure 2.4.2-5.

Then, effect of adopting VSD type compressor is calculated as follow:

Amount of power saving: (91kW – 72kW) × 24h/d × 330d/y = 150,480kWh/y

Annual power cost reduction: 150,480kWh/y × 870VND/kWh = 130,918 × 1,000VND/y

3) Lowering the discharged air pressure

(1) Present condition and problems

Discharged air pressure of 0.6 to 0.7Mpa is rather high.

And the air piping is laid out in form of tree branches. This formation decreases air pressure at load end point, and so the discharge pressure is set higher.

(2) Measures for improvement and expected effects

Following items can be proposed

- Air pressure along the pipeline should be investigated and the pipeline should be modified to the one with smaller pressure loss.
- The lower limit of air pressure for load equipment should be studied and the new limit should be set with suitable margin.

Compressed air piping layout and air pressure at load end point are investigated on the audit and shown in figure 2.4.2-6. Piping formation like tree-branch can be seen on the figure.

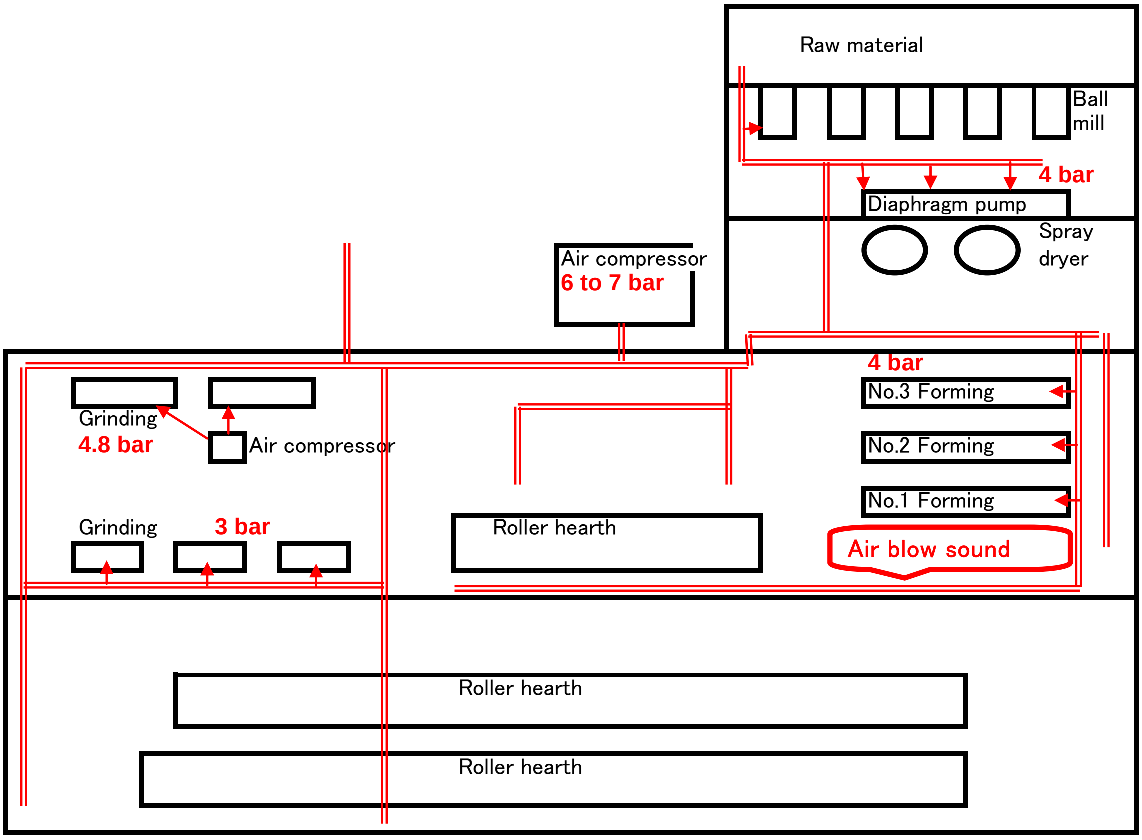


Figure 2.4.2-6　Compressed air piping layout and related loads in the factory

Pressure loss through the piping with piping formation to loop type formation can be reduced as shown in Figure 2.4.2-7.

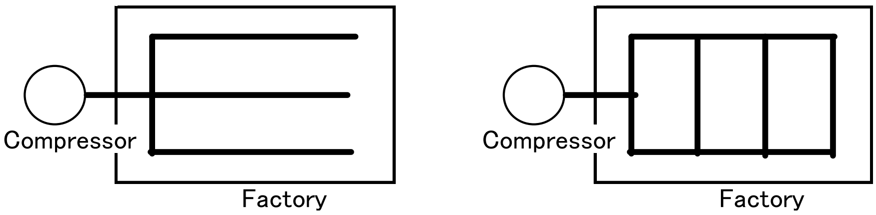


Figure 2.4.2-7　Tree branch type piping and loop shape piping

Since pressure control valves at site are set at 0.4MPa, discharge air pressure may be allowed to lower to 0.5MPa. If higher pressure is required for some equipment at site, pressure booster or a special piping for them may be installed. Figure 2.4.2-8 shows relation between air pressure and input power of screw compressor.

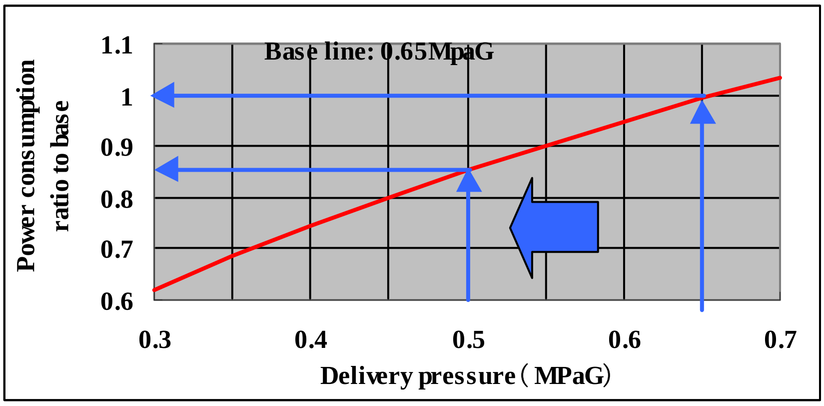


Figure 2.4.2-8   Relation between discharge air pressure and input power

As shown in Figure 2.4.2-8, lowering the discharge pressure of air compressor from 0.65MPa to 0.5MPa saves the energy by 15%.

If the power consumption is 90kW is average in a year, then annual power consumption is calculated as follows:

Annual power consumption: 90kW × 24h/d × 330d/y = 709,990kWh/y

Energy conservation is estimated as follow:

Amount of power saving: 709,990kWh/y × 15% = 106,500kWh/y

Annual power cost reduction: 106,500kWh/y × 870VND/kWh = 92,655 × 1,000VND/y

2.4.3 Roller hearth kiln

1) Heat balance

Results of calculation are shown below, through the measurement.

Heat efficiency: 27.4%

Energy intensity (calorie necessary for firing products in kg): 568kcal/kg

These figures are average value as the roller hearth kiln of floor tile.

The heat balance is shown in Table 2.4.3-1.

Table 2.4.3-1 Heat balance of roller hearth kiln

		Heat input		Heat output	
		× 10^3kcal	%	× 10^3kcal	%
	Heat input				
	heat from combustion of fuel	2,091.0	99.9	―	―
	heat carried in from pre-firing goods	0.2	0.1	―	―
Heat output	heat carried by firing goods	―	―	6.7	0.3
	heat carried by exhaust gas	―	―	663.5	31.7
	heat carried by steam evaporating from water in the pre-firing goods	―	―	45.4	2.2
	heat loss due to waste heat, radiation, conduction and so forth	―	―	1,375.6	65.8
total		2,091.2	100	2,091.2	100
Effective heat	effective heat par ton of firing goods				
	heat required for evaporating the water adhered	5.5 × 10^3kcal			
	heat required for evaporating the crystallized	53.5			
	heat required for decomposing the clay	139.9			
	heat required for firing of pre-firing goods	373.1			
	total	572.0 × 10^3kcal/t			
	thermal efficiency of firing goods	27.4%			
	energy intensity	568 kcal/kg			

2) Proposal for energy conservation in roller hearth kiln

(1) Reduction of number of operation burners

Present condition and problems

A lot of numbers of burners are in operation for production

Measures for improvement and expected effects

Several burners near the entrance can be extinguished to reduce fuel consumption as shown in Figure 2.4.3-1.

Expected effects: if 4 sets of burners near the entrance are extinguished, fuel consumption can be reduced by 5%.

Amount of fuel saving: 2,703 kl/y × 0.05 = 135 kl/y

Annual fuel cost reduction: 135 kl/y × 7,300 VND/liter = 985,500 × 1,000 VND/y

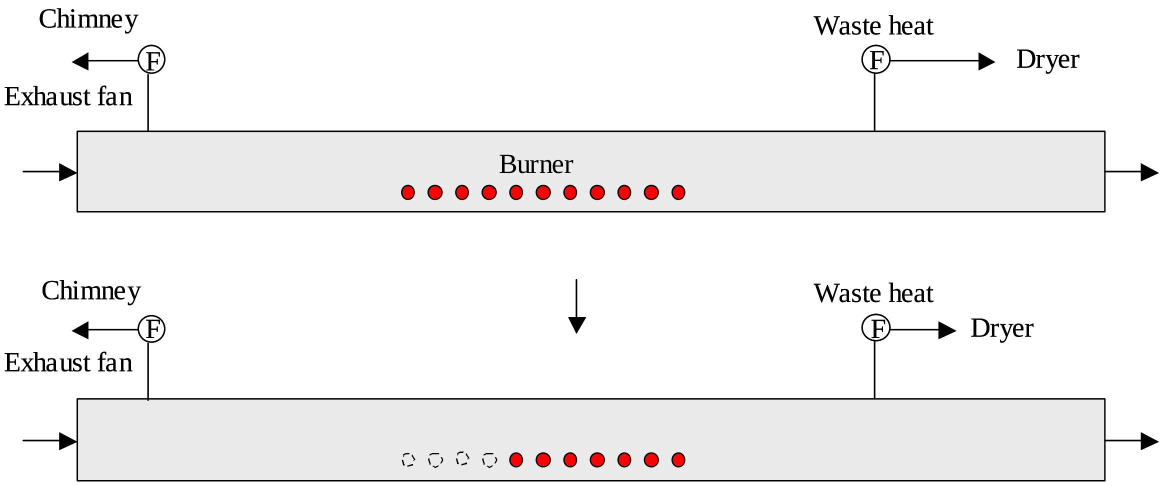


Figure 2.4.3-1 Reduction of numbers of operating burners

(2) Blowing waste gas into the pre-firing zone

Present condition and problems

All waste heat is used for a dryer.

Measures for improvement and expected effects

The amount of use of waste gas for a dryer is reduced, and the waste gas is blown in pre-firing zone to stir air in pre-firing zone and to reduce fuel consumption as shown in Figure 2.4.3-2.

Expected effects: If 80% of waste gas volume is blown into the pre-firing zone, fuel consumption can be reduced by at least 5%.

Amount of fuel saving: 2,703 kl/y × 0.05 = 135 kl/y

Annual fuel cost reduction: 135 kl/y × 7,300 VND/liter = 985,500 × 1,000 VND/y

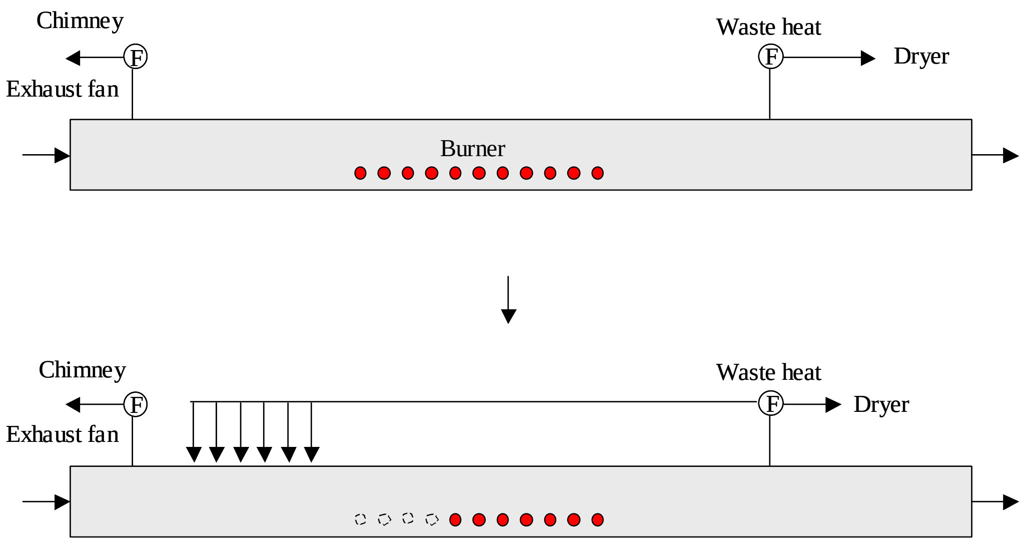


Figure 2.4.3-2 Blowing waste gas into pre-firing zone

(3) Recovery of sensible heat of exhaust gas

Present condition and problems

Temperature of exhaust gas is 191ºC, which is higher than standard temperature of 150ºC or less in Japan.

Measures for improvement and expected effects

If sensible heat of exhaust gas is recovered with the heat exchanger and used for pre-heating of combustion air, fuel consumption can be reduced by 1% as shown in Figure 2.4.3-3.

Amount of fuel saving: 2,703 kl/y × 0.01 = 27 kl/y

Annual fuel cost reduction: 27 kl/y 7,300 VND/liter = 197,100 × 1,000VND/y

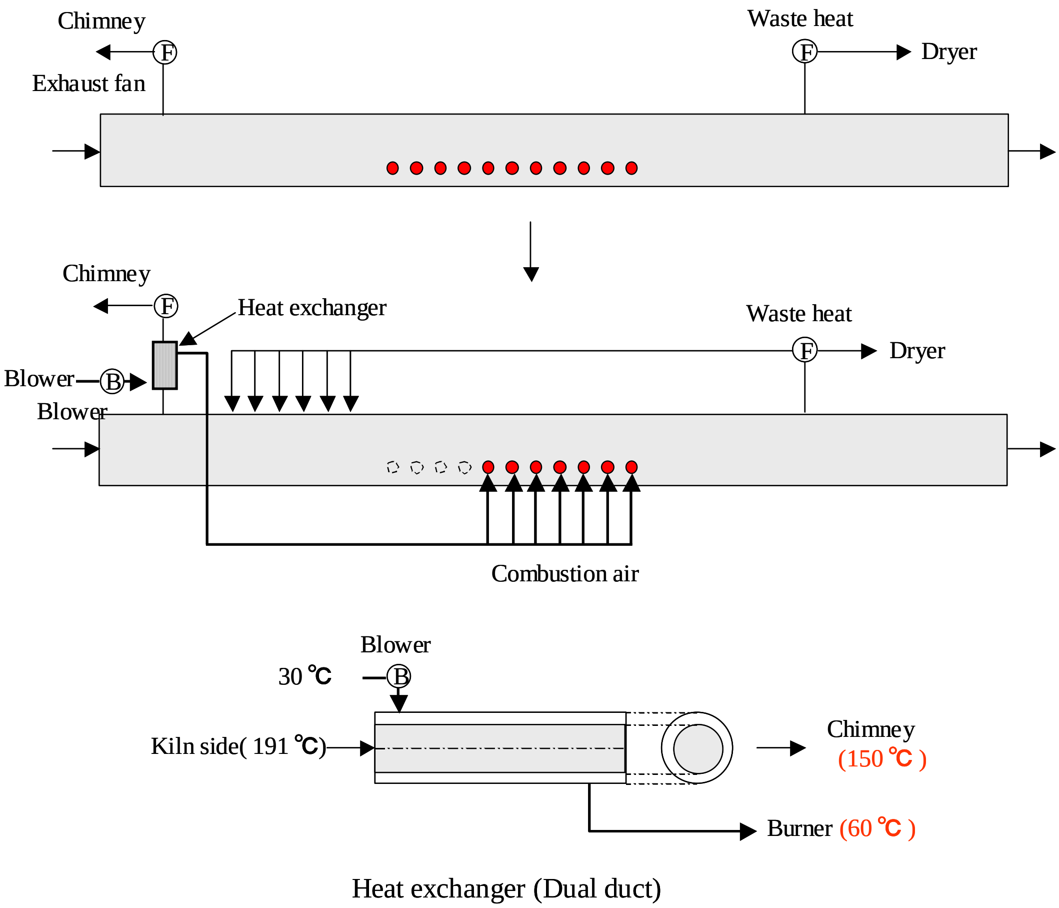


Figure 2.4.3-3 Recovery of sensible heat of exhaust gas

(4) Pressure control in the kiln

Present condition and problems

Since pressures in the kiln are positive, dissipative heat loss is generated much.

Measures for improvement and expected effects

If pressure in the kiln is controlled at ±0mmH_2O at the first burner port, fuel consumption can be reduced by 1% as shown in Figure 2.4.3-4

Amount of fuel saving: 2,703 kl/y × 0.01 = 27 kl/y

Annual fuel cost reduction: 27 kl/y × 7,300 VND/liter = 197,100 × 1,000VND/y

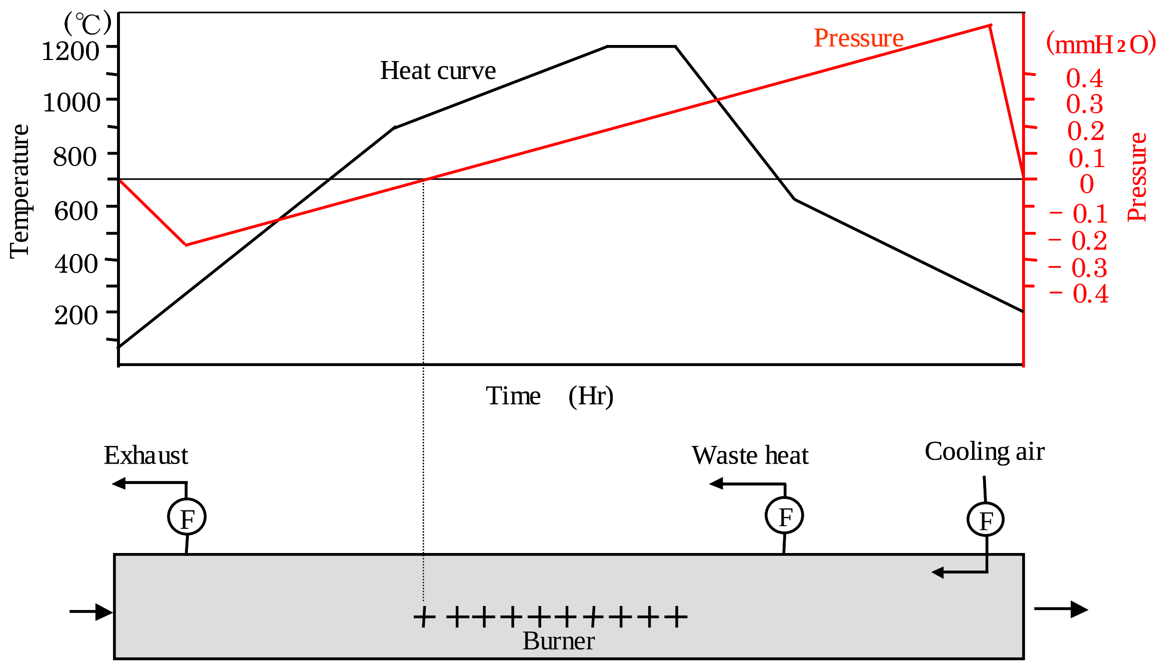


Figure 2.4.3-4 Pressure control in the kiln

3) Potential of the energy conservation

When the above-mentioned items are implemented, amount of fuel saving is 12% as expected effects.

2.4.4 Power receiving and distributing equipment, Motor

1) Management of Power receiving and distributing equipment

(1) Present condition and problems

Figure 2.4.4-1 shows power receiving and distributing system of the company.

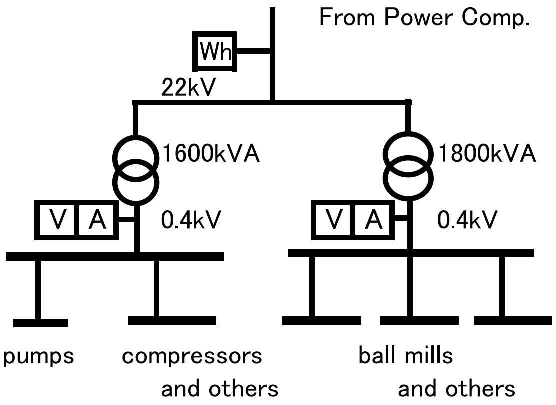


Figure 2.4.4-1 Single line diagram of power receiving system

Only voltage and current meters to monitor power receiving system are equipped, but sometimes current meter is malfunctioned.

Daily receiving power and current of each transformer are submitted and shown in Figure 2.4.4-2.

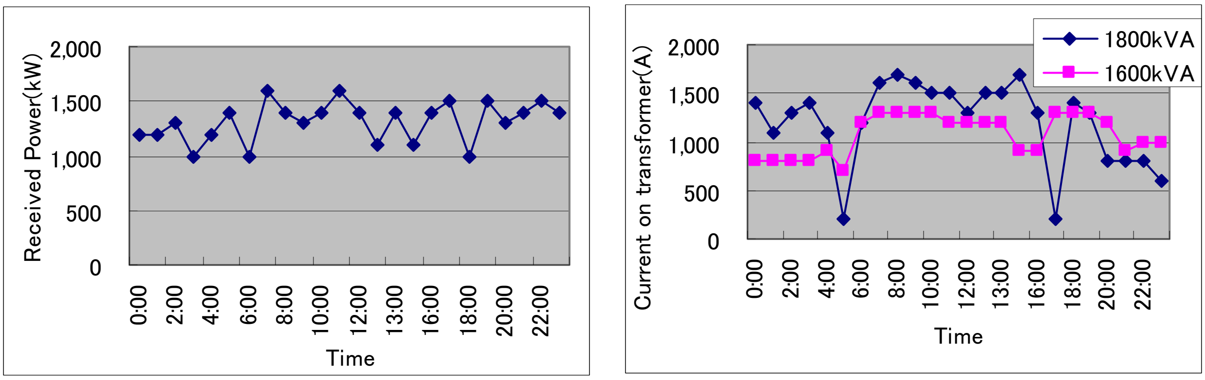


Figure 2.4.4-2 Received power and current of each transformer

Receiving power is about 1,500kW. Some equipment is scheduled to stop during on peek demand period (from 18:00 to 22:00) to save energy and money. However this activity does not appear clearly in Figure 2.4.4-2.

Static condenser to improve power factor is not equipped at the receiving point. By using the data of figure 2.4.4-2 excluding irregular data, receiving power factor throughout a day is calculated at 81%, which is so poor as to have risk of paying penalty for less than 84%.

Power consumption ratio is classified into the production process as shown in Figure 2.4.4-3.

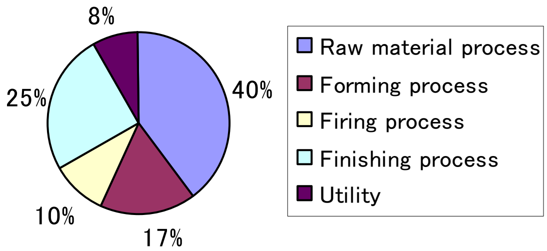


Figure 2.4.4-3 Power consumption classified into the production process

Material treatment process and finishing process are big consumers and then they are the first targets of energy conservation activity. Power consumption is checked with reports from power company, and so energy conservation activities are not developed.

(2) Measures for improvement and expected effects

It is recommended that static condensers are installed in the power receiving system in order to avoid penalty charge and to reduce power distribution loss. Power management system can be proposed with data logging system

The first of all, grasping of actual states of energy consumption should be required for effective energy conservation activities. And accuracy and reliability of the data are also essential.

For this purpose, automatic and mechanical system is useful. Whole power monitoring system may be suitable, which is measuring receiving power including power consumption of main branch feeders in the system. One of example is shown in Figure 2.4.4-4.

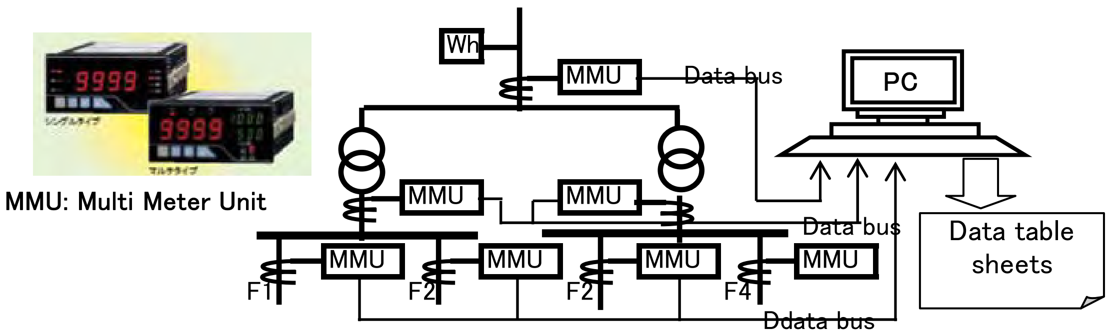


Figure 2.4.4-4 Image of electric power monitoring system.

Digital multi-meter-units are used to measure the receiving power and the data are transmitted to a personal computer that is used as data gathering and output device. The computer compiles tables of the monitoring data, which may be utilized for power management of the company.

With this system, hourly measurements of power consumption are available. This is the first step to fruitful and developing energy conservation activities.

By ensuring the actual management of power consumption during on-peak demand time and gasping nighttime power consumption, the relation between power consumption and state of equipment's working should be examined and analyzed. As the result, useless waiting power consumption will be recognized and eliminated. This is a typical example for the system utilization.

Expected effect largely depends on level of the system utilization and improvement of energy conservation activity. Power consumption can be saved by 5% to 10%.

Amount of power saving: 7,648,000kW × 5% = 382,400kWh/y

Annual power cost reduction: 382,400kWh/y × 870VND/kWh = 332,688 × 1,000VND/y

2) Operation management of motors

(1) Present condition and problems

As a big scale motor of low voltage requires larger current, much ohm loss are brought out through the supply cable line. A motor driving ball mill of 132kW is an example.

Power consumption of the motors are shown in Table 2.4.4-1.

Table 2.4.4-1 Power consumption of motors driving ball milling

Name of motor	Voltage (kV)	Current (A)	Power factor	Used power (kW)	Load factor (%)
Ball mill No. 1	0.382	120	0.85	67	46.0
Ball mill No. 4-1	0.37	220	0.9	127	86.5
Ball mill No. 4-2	0.37	100	0.85	54	37.1

(Note) Assumption: Motor efficiency = 90%

Motor current of ball mill No.4 is measured at both stage of beginning as No.4-1 and finishing as No.4-2 in milling process. Motor current is large at beginning and decrease to about 50% at finishing as shown in Table 2.4.4-1.

Current in supply cable and voltage at terminals are shown in Figure 2.4.4-5.

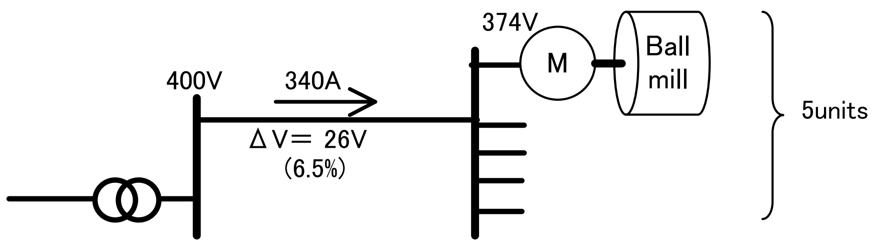


Figure 2.4.4-5 Current and voltage of trunk line for ball-milling machine

Voltage-drops though power supply cable is 26V, that is 6.5%. Although varying with cable length in yard, this value is recommended under 5%. Power loss in distribution line is calculated as follows.

Power loss: $3 \times r \times I^2 = 1.73 \times \Delta V \times I = 1.73 \times 26V \times 340A = 15.3kW$

Its amount is as much as 7.7% of necessary power for load equipment and this cannot be over looked.

(2) Measures for improvement and expected effects

Lowering voltage-drops by converting cable and installing static condenser in order to reduce reactive current should be proposed.

Power loss in delivery-line is calculated with cable resistance "r" and current "I" as follow.

Power loss in 3 phase line: $W = 3r \times I^2$

Then, improvement of delivery-line efficiency asks lowering "r" and "I". The former is treated with scaling up of cable and the other is achieved by improving power factor by static condenser.

The way to compensate reactive current with static condenser is shown in Figure 2.4.4-6.

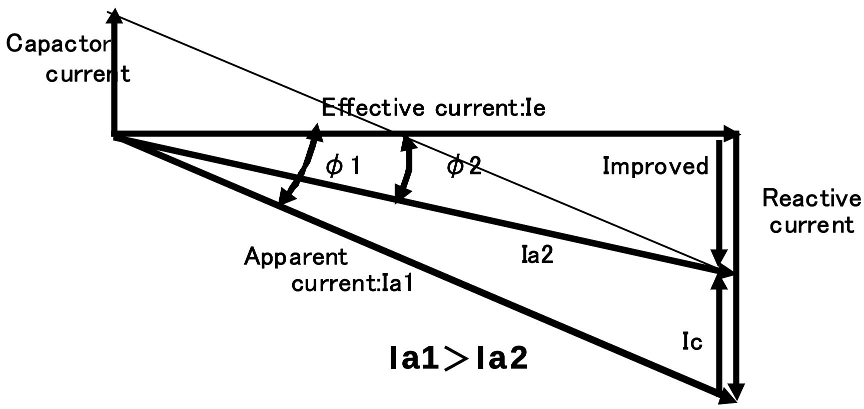


Figure 2.4.4-6 Compensation of reactive current by static condenser

Electric equipment produces generally lag-phase current, reactive current, which current is shown by $I \times \sin\varphi$, where I is lag-phase current, $\cos\varphi$ is power factor.

Current through static condenser flows in couture-phase to the reactive current and reduce the current "I" to almost as much as effective current "Ie". This also makes delivery-line's loss $r \times I^2$ smaller

Power factor of the motor is 90% under rated load and 85% under 85% load are assumed.

Reactive power is calculated on each case as shown in Table 2.4.4-1

Table 2.4.4-2 Calculation of reactive power

Name of motor	Current (A)	Power factor	Active current (A)	Reactive current (A)	Reactive power (kVar)
Ball mill No. 1	120	0.85	102	63	42
Ball mill No. 4 - 1	220	0.9	198	96	61
Ball mill No. 4 - 2	100	0.85	85	53	34

Judging from amounts of the reactive power, capacity of static condenser can be selected at 40 kVar.

The current will be reduced to 301A by the compensation.

Since power loss through cable is proportional to square of the current, the loss is estimated as follows:

Cable loss reduction: $(301A / 340A)^2 = 78.4\%$

Under assumption that ball mill operation hour is 20h/d × 330d/y, annual energy saving is estimated.

As the power consumption decreases along with the running time as above-mentioned, average current per unit may be supposed to about 500A in the case that 3 units are working simultaneously,

According to proportional relation between voltage-drop and current, the voltage drop through supply cable is calculated as 6.5% × (500A / 310A) = 9.5% and loss of the line is also as $15.3kW \times (500A / 310A)^2 = 33.1kW$.

As far as limited to a delivery-line inside a work-yard, power loss on the line can be estimated by a following equation.

$W = S \times (\Delta V/V) \times 1 / \cos\varphi$

Where W: distribution line loss, S: surface power.

This equation shows that rate of voltage-drop is nearly equal to rate of the loss, i.e. voltage dorps are really an indicator of delivery power loss.

If voltage-drop is improved to $\Delta V/V = 5\%$,

the distribution loss can be estimated as W = 320kVA × 5% × 1/90% = 17.8kW

by substituting surface power $S = \sqrt{3} \times 370V \times 500A = 320kVA$

and power factor of 90% to the equation,

Then, the power loss reduces to 33.1kW – 17.8kW =15.3kW

Moreover, by taking account of the reduction of power loss with static condenser,

1 – 78.5% = 21.6%, improved amount is estimated at 17.8kW × 21.6% = 3.3kW

Summarizing each effect, 15.3kW + 3.3kW = 18.6kW are calculated.

Amount of power saving: 18.6kW × 20h/d × 330d/y = 124,300kWh/y

Annual power cost reduction: 124,300kWh/y × 870VND/kWh = 108,141 × 1,000VND/y

3. Cement Factory C

3.1 Introduction

1) Factory name: Cement factory C
2) Location: Da Nang City
3) Description of business
   (1) Type of industry: Cement manufacturing industry
   (2) Main product: Portland mixture cement PCB 30 (28-day strength: 30 N/mm2)
   (3) Production capacity: Cement 140,000 ton/year
   (4) Annual production: 110,000 ton/year in 2007
   (5) Number of employees: 305 persons
4) Person in charge for energy on-site survey: Vice General Manager
5) Outline of the factory

   This factory built a vertical type cement shaft kiln imported from China in 1992, and it started production in 1995. In 2003, the company was reorganized from a state-own enterprise to a private company.

   Its production equipment consists of one vertical type cement shaft kiln with production capacity of 300 ton/day, one ball mill for raw material crushing, and two ball mills for cement finishing. The main material (limestone) is conveyed from a mine owned by the company, which is 50 km away from the factory. In accordance with the government policy announced in September 2008, the company has a plan to replace the shaft kiln by a rotary kiln with a production capacity of 1,000 ton/day. The present production equipment can manufacture Portland mixture cement PCB30, but it can not manufacture high-strength Portland cement PC50 (28-day strength is 50 N/mm^2).

3.2 Outline of energy on-site survey

1) Survey team member

   JICA Study Team: Mr. Norio Fukushima, Mr. Wataru Ishikawa, Mr. Hisashi Amano

   Institute of Energy: Mr. Hung, Mr. Song, Mr. Hau

   ECC Da Nang: Mr. Van Ban, Mr. Vy
2) Survey period: October 6 to 8, 2008
3) Surveyed equipment: cement shaft kiln, rotary drier for raw material, ball mill for raw material and finishing, fan for cement shaft kiln, exhaust blower for cement shaft kiln, and power receiving equipment
4) Request of the factory

   The factory requested study of power consumption to JICA Study Team, and especially requested the measures for power saving of exhaust fan motor (90kW) of cement kiln

3.3 Results of energy on-site survey

1) Improvement proposal items and the expected effect after improvement measure implementation are shown in Table 3.3-1 and expected effects by replacement of shaft kiln with NSP dry rotary kiln are shown in Table 3.3-2.

   The EE&C potential in the present shaft kiln is 4%, but EE&C potential by the replacement to dry rotary kiln with NSP is 28%.

Table 3.3-1 Improvement proposal items and the expected effect after improvement measure implementation

No.	Item No.	Improvement items	Expected effects: Kind of Energy	Expected effects: Amount of energy conservation (kL/y, kWh/y, etc)	Expected effects: Amount of energy saving (×1,000VND/y)
1	3.4.2.3)	Cement kiln: Repair of kiln lining refractory (Scheduled relining in the end of 2009)	Coal	49 ton/y	39,200
2	3.4.5.1)	Exhaust gas fan of kiln: Reduction of dilution air volume	Power	79,100 kWh /y	70,795
3	3.4.5.2)	Exhaust gas fan of kiln: Reduction of pressure loss by maintenance of bag filter	Power	50,200 kWh /y	44,929
4	3.4.5.3)	Exhaust gas fan of kiln: Introduction of VSD to control gas volume	Power	338,300 kWh /y	302,779
5	3.4.6.1)	Air blower of kiln: Introduction of VSD to control gas volume	Power	335,600 kWh /y	300,362
6	3.4.6.2)	Air blower of kiln: Reduction of bleed air volume at low air volume operation	Power	43,800 kWh /y	39,201
7	3.4.7.1)	Power receiving system: Introduction of power monitoring system	Power	354,100 kWh /y	316,920
8	3.4.7.2)	Large size motor: Installation of capacitance and review of cable size	Power	88,500 kWh /y	79,208
Total of expected results			Fuel (total)	49ton/y (34 toe/y)	39,200
			Electric power (total)	1,289,600kWh/y (351.6 toe/y)	1,154,200
Crude-oil equivalent of fuel and electric power (total) (Reduced volume of carbon dioxide (CO_2))				385.6 toe/y (ton-CO_2)	
Annual energy consumption			Fuel (total)		11,000 ton-coal/y
			Electric power (total)		7,081 MWh/y
			Total in factory		9,606 toe/y
Energy conservation rate of the whole factory			Fuel (total)		0.4 %
			Electric power (total)		17.7 %
			Total in factory		4.0 %

Table 3.3-2 Expected effect after replacement of cement kiln

No.	Item No.	Improvement items	Expected effects: Kind of Energy	Expected effects: Amount of energy conservation (kL/y, kWh/y etc.)	Expected effects: Amount of energy saving (×1,000 Dong/y)
1	3.4.8.1)	Cement kiln: Replacement of shaft kiln with NSP rotary kiln	Coal	3,880 ton/y	3,104,000
Total of expected results			Fuel (total)	3,880 ton/y (2,697 toe/y)	3,104,000
Crude-oil equivalent of fuel and electric power (total) (Reduced volume of carbon dioxide (CO2))				2,697 toe/y (ton-CO_2)	
Annual energy consumption			Fuel (total)		11,000 ton-coal/y
			Electric power (total)		7,081 MWh/y
			Total in factory		9,606 toe/y
Energy conservation rate of the whole factory			Fuel (total)		35.2 %
			Electric power (total)		0 %
			Total in factory		28.0 %

2) Annual energy consumption and energy intensity

(1) The Amount of annual energy consumption (C+D) B = 9,606 toe

(in which) The amount of crude-oil equivalent of electric power: C = 1,961 toe

(Purchased electric power E = 7,081 MWh) × 0.277

The conversion factor to primary energy of electric power is calculated according to 31% of thermal efficiency of thermal power generation station in Vietnam.

Conversion factor to primary energy = 860 / 0.31 = 2,770 Mcal/MWh = 0.277 toe/MWh

1 toe = 10,000 Mcal

Amount of crude-oil equivalent of all fuel consumption D = 7,645 toe

(sum total which carried out the crude-oil conversion of each amount of fuel)

Details (before conversion) Coal: 11,000 ton

Heat value = 6,950 kcal/kg

(2) Energy intensity (Energy consumption per annual shipment amount etc.)

Electric power intensity per production (E / production)

= 48.6 kWh/t-cement in 2006, and 64.4 kWh/t-cement in 2007

Fuel intensity per production (D / production)

= 916kcal/kg-clinker in 2006, and 993kcal/kg-clinker in 2007

Energy intensity is shown in Table 3.3-3.

Table 3.3-3 Production and energy intensity

Item	2004	2005	2006	2007
Cement production (t/y)	80,000	110,000	130,000	110,000
Clinker production (t/y)	56,000	77,000	91,000	77,000
Fuel coal consumption (t/y)	10,000	12,000	12,000	11,000
Fuel consumption (Gcal/y)	69,500	83,400	83,400	76,450
Fuel intensity (Mcal/t-clinker)	1,241	1,083	916	993
Electricity consumption (MWh/y)	5,500	5,940	6,322	7,081
Electricity intensity (kWh/t-cement)	68.8	54.0	48.6	64.4
Electricity rate (VND/kWh)	895	895	895	895

Trend of cement production and energy intensity are shown in Figure 3.3-1. Power intensity changes in proportion to cement production, but Fuel intensity is improved except in 2005.

The reasons of change of power intensity are as follows:

- Installation of bag filter type dust collector in exhaust gas line of cement kiln in 2006
- Installation of 2nd finishing line with new cement mill in 2007

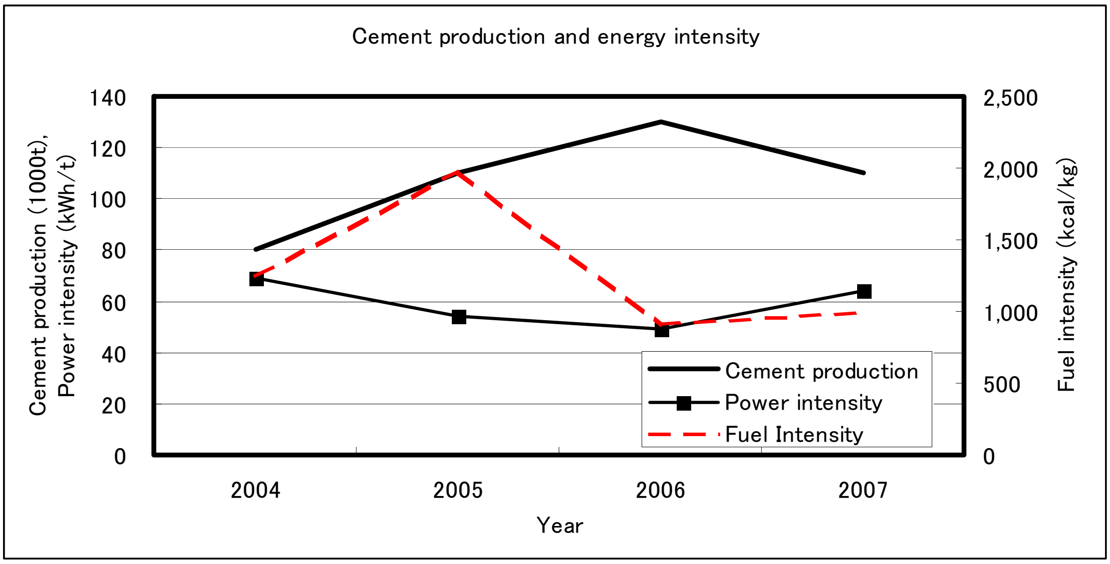


Figure 3.3-1 Trend of cement production and energy intensity

3) Remarks

(1) Energy price

Coal: 800 VND/kg, Heat value: 6,950kcal/kg

Electricity: 895 VND/kWh

(2) Annual operation hours

Cement kiln: 334 days × 24h = 8,016 h/y

Rotary dryer for material drying: 334days × 16h = 5,344 h/y

4) Equipment

Specifications of cement manufacturing equipment are shown in Table 3.3-4.

Table 3.3-4 Specifications of cement manufacturing equipment

No.	Equipment	Q'ty	Main specifications
1	Crusher for raw material	3	1 set of Joe crusher 1 set of Roll mill 1 set of Ball mill: 4m diameter×7m length, 16～18t/h, Motor: 380kW
2	Dryer	1	Type: Rotary dryer Drying material: coal and clay
3	Cement kiln	1	Type: Shaft kiln Size: 4m diameter x 10m height Fuel: Coal
4	Blower for cement kiln	1	Type: Root blower Motor: 250kW
5	Exhaust gas fan for cement kiln	1	Type: Turbo fan Motor: 90 kW
6	Clinker cooler	1	Type: water cooled,
7	Dust collector	1	Type: Bag filter Max. temperature: 120°C
8	Ball mill for cement	2 sets	No.1 Finishing mill: 2.2m diameter×7m length, 16～18t/h, 380kW, No.2 Finishing mill: 2.2m diameter×7m length, 16～18t/h,250kW
9	Air compressor	2	Discharge air volume: $4m^3$/min Pressure: 0.1MPa, Motor: 22kW
10	Pump	2	Motor: 7.5kW
11	Power receiving transformer	2	Capacity: 4,000 kVA, Receiving voltage: 35kV Power factor: 0.85

5) Process flow sheet and measurement data of Cement manufacturing process are shown in Figure 3.3-2.

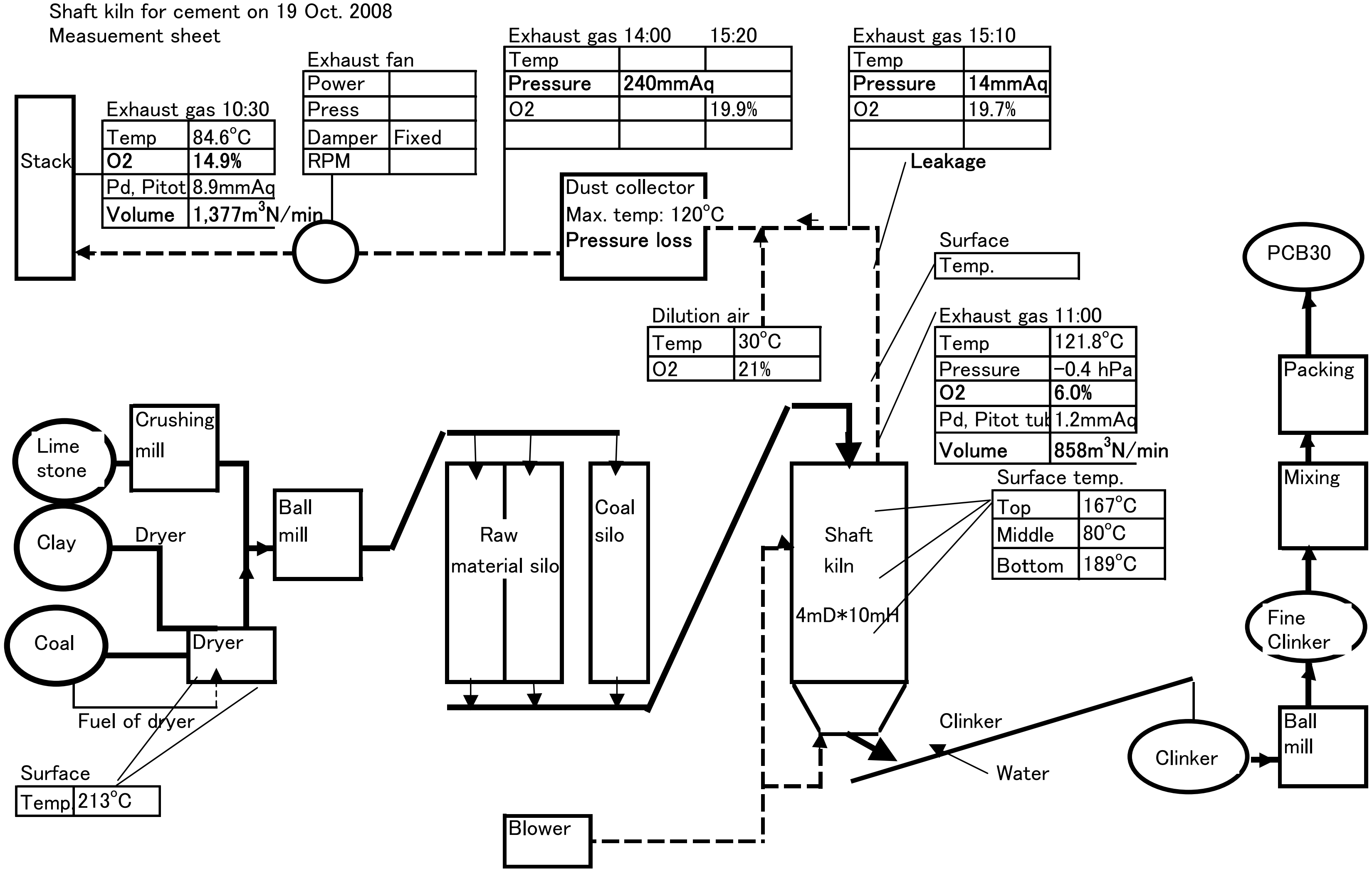


Figure 3.3-2 Process flow sheet and measurement data of Cement manufacturing process

6) Energy use of factory

99% of Coal is used for cement kiln and 1% of coal is used for rotary dryer of material treatment line. Use of electricity is shown in Figure 3.3-3.

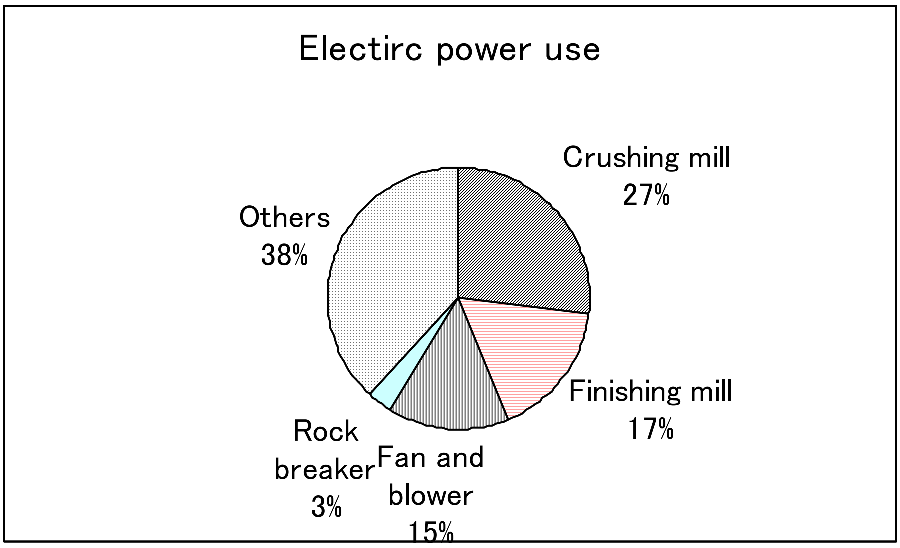


Figure 3.3-3 Use of electricity

3.4 Energy on-site survey of factory

3.4.1 Activity of energy management

1) Energy management organization

(1) Present condition and problems

Since the factory is close to private houses, environment measures such as dust prevention are important. Fuel consumption of cement kiln is changed by troubles of operation. Electricity saving is focused due to electricity tariff raising. Standardization of management has not progressed.

(2) Measures for improvement

Since 99 % of fuel (coal) is used for the cement shaft kiln, operation control of cement kiln is nothing less than energy management. The stability of operation contributes to energy saving.

2) Implementation of measurement and record

(1) Present condition and problems

Some measuring instruments of cement shaft kiln are damaged and do not read values. Some glasses of pressure gage are not clear. Energy management is not conducted by measurement and recording.

(2) Measures for improvement

Instrumentation is to be managed with priority of importance. Standardization of action by measurement data is to be conducted.

3) Maintenance management of equipment

(1) Present condition and problems

Road in the factory is rough with cement dust, and so walking and transportation are difficult. Equipment is not well cleaned.

(2) Measures for improvement

Since cement factory is dusty, equipment is dirty. Cleaning of equipment is required for good maintenance.

4) Energy consumption management

(1) Present condition and problems

Coal consumption of cement kiln is measured at the discharge port of coal stock bin, but collected data is not shown as graph or tables in operation control room. Receiving power is recorded periodically, but it is not clear how the data is utilized in electric energy management. Consumed power is recorded every 10 days, and voltage and current of feeders are recorded once a day

(2) Measures for improvement

Daily report and record of cement kiln is to be enforced.

Record of receiving power is to be used to power consumption management.

5) Energy intensity management

(1) Present condition and problems

Fuel consumption intensity is calculated monthly at present.

(2) Measures for improvement

Energy intensity is to be calculated once a day at least.

6) PDCA management cycle

(1) Present condition and problems

The PDCA management cycle is not carried out.

(2) Measures for improvement

PDCA management is to be used for energy intensity management and improvement of equipment.

7) Evaluation of energy management activity

Evaluation of energy management activity is shown in Figure 3.4.1-1.

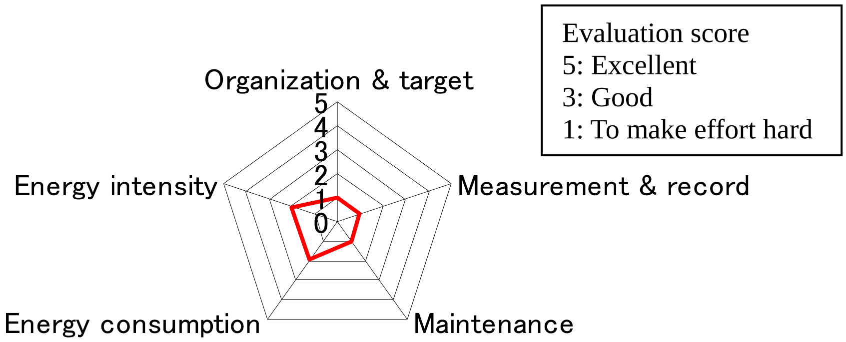


Figure 3.4.1-1 Evaluation of energy management activity

3.4.2 Shaft type cement kiln

1) Combustion control

(1) Present condition and problems

Fuel coal is mixed with limestone, clay, etc., charged into the top of kiln and fired in the kiln to calcine limestone and to make cement during sinking for 10m height. Some part of coal is un-burnt in the kiln.

Coal combustion condition is changed widely due to material hanging inside kiln and troubles of peripheral equipment.

(2) Measures for improvement and expected effects

Stabilization of operation is necessary.

2) Operation and efficiency management

(1) Present condition and problems

When clinker cooler stops by machine troubles, air volume of root type air blower is controlled with damper control and air blow control from bleeder valve.

(2) Measures for improvement and expected effects

When VSD with inverter is introduced to root type air blower to control air volume, air volume an d pressure can be controlled according to kiln operation.

3) Insulation of kiln

(1) Present condition and problems

Measurement data of surface temperature of cement kiln are shown in Figure 3.4.2-1.

Maximum temperature is 232ºC and average temperature is 145ºC. Refractory of cement kiln is relined every 2 years. Previous relining was implemented at the end of 2007.

Dissipative heat is as follows:

- Circumstance temperature: 30ºC

- Average surface temperature: 145ºC
- Convection coefficient: 7.2kcal/m^2hC
- Annual operation hours: 8,000 h/y
- Surface area of kiln: 125m^2
- Annual dissipative heat: Q = 7.2 × 125 × (145 – 30) × 8,000 = 828,000,000 kcal/y

(2) Measures for improvement and expected effects

Since bottom and upper shaft area are high temperature, refractory of kiln is to be repaired in the next relining work. When refractory is repaired so that surface temperature is less than 100ºC, dissipative heat is reduced as follows:

- Circumstance temperature: 30ºC,
- Average surface temperature: 145ºC,
- Convection coefficient: 6.2kcal/m^2hC
- Annual operation hours: 8,000 h/y,
- Surface area of kiln: 125m^2
- Annual dissipative heat: Q = 6.2 × 125 × (93 – 30) × 8,000 = 390,600,000 kcal/y
- Annual saved energy: Q1 = 828,000,000 – 390,600,000 = 437,400,000 kcal/y
- Heat value of coal: Hv = 6,950 kcal/kg
- Amount of fuel saving: Qc = 437,400,000 / 6,950 = 62,935 kg/y = 63 t/y
- Annual energy cost reduction: 49 × 800,000 = 39,200,000 VND/y

Shaft kiln surface temperature
Date: 2008-10-7
Measurement device: Radiation thermometer
Kiln size: 4m dia x 10m height
Surface area cylinderical part: 125 m2

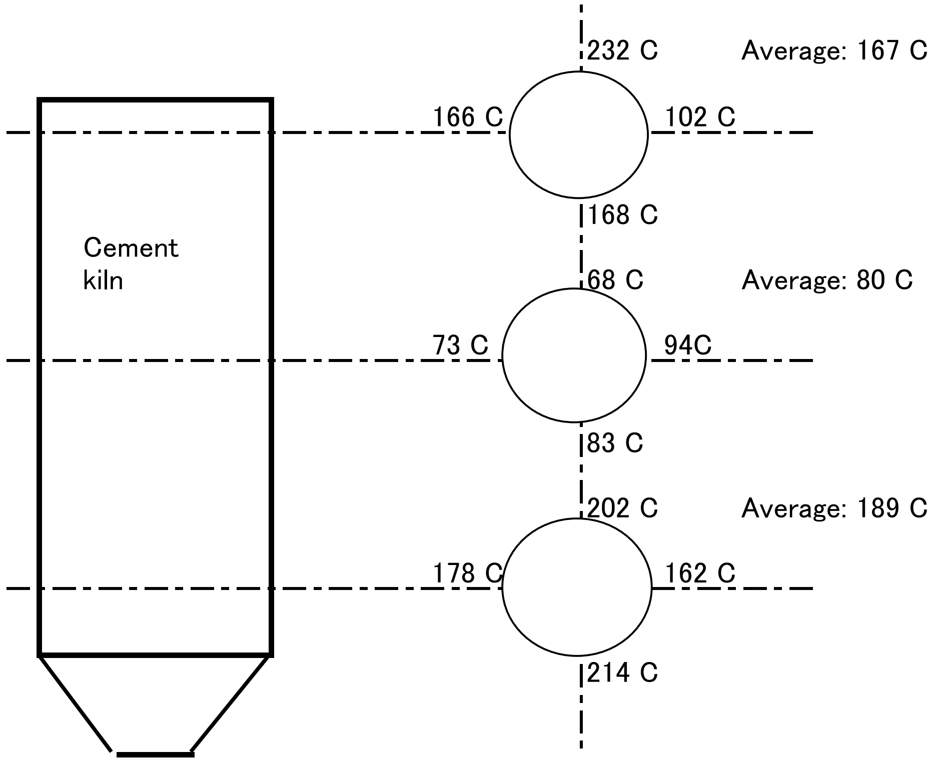


Figure 3.4.2-1 Surface temperature of cement kiln body

4) Exhaust gas temperature control

(1) Present condition and problems

Temperature of exhaust gas of cement kiln is 120ºC to150ºC, and so exhaust heat loss is small. The reason of small heat loss is that exhaust gas of high temperature in the furnace heats charged material at the kiln top and exchange heat.

(2) Measures for improvement and expected effects

Recovery of sensible heat of exhaust gas is possible, but possibility of heat recovery is small considering to dust in exhaust gas and use of recovered heat

3.4.3 Rotary dryer

1) Insulation

(1) Present condition and problems

Rotary dryer is used for drying clay and coal before crushing process in raw material treatment. Dryer is a cylinder type shell drum of 1.3m in diameter and 12m in length, rotates in low speed and dries charged material with coal firing. Refractory lining is not worked inside of dryer drum. Measurement data of surface temperature of rotary dryer are shown in Figure 3.4.3-1. Maximum temperature of surface of dryer is 274ºC and average temperature is 213ºC.

Dissipative heat of dryer is as follow:

Circumstance temperature: 30ºC

Surface temperature of dryer: 213ºC

Convection coefficient: 7.2 kcal/m^{2}hC

Annual operation hours: 5,340 h/y

Surface area of dryer: 49 m^2

Annual dissipative heat: Q = 7.2 × 49 × (213 – 30) × 5,340 = 344,760,000 kcal/y

(2) Measures for improvement and expected effects

Although insulation work is planned which glass wool or rock wool of heat resistance temperature of 600ºC is lined outside surface of dryer, refractory inside of dryer is more effective considering deformation of dryer shell by heat in outside lining. However possibility of inside lining is small considering refractory work cost.

Investment in additional inner lining with fire-resistant refractory is not financially efficient. The rotary drier will become unnecessary if a vertical type roller mill is introduced when the cement kiln is replaced.

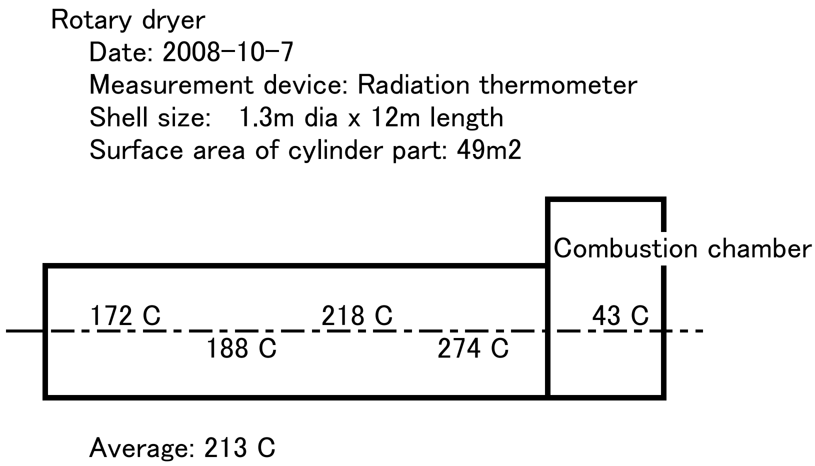


Figure 3.4.3-1 Surface temperature of rotary dryer

3.4.4 Exhaust gas dust collector

1) Pressure loss of dust collector

(1) Present condition and problems

Since exhaust gas of shaft cement kiln contains much dust, cyclone type dust collectors are installed at the top of shaft kiln, but emitted dust is not collected sufficiently. High performance bag filter type dust collector is installed in 2006, and so emitted dust is reduced and environment is improved.

Increase of pressure loss of bag filter with plugging of filter bag causes increase of required power of exhaust fan motor. Pressure measurement data at the inlet and outlet of bag filter are shown in Figure 3.3-2.

Exhaust gas pressure at the inlet of bag filter: 14 mmAq

Exhaust gas pressure at the outlet of bag filter: 240 mmAq

Pressure loss of dust collector: 226 mmAq

Although specifications and design data of dust collector are not supplied from the factory, pressure loss of bag filter is less than 150 mmAq in general. We guess that pressure loss of 226 mmAq is higher than design value.

(2) Measures for improvement and expected effects

The causes of increase of pressure loss of a bag filter are as follows:

a. Plugging of filter bags by troubles of de-dusting device of filter bag

b. Plugging of filter bags by troubles of aging

c. Increase of flow rate of gas

At the repairing time of cement kiln, inspection is to be conducted.

Reduction of pressure loss bag filter makes to reduce exhaust fan motor power. If the pressure loss of the dust collector is improved to 150 mmAq by maintenance of filter and reduction of exhaust gas volume, electricity consumption will be improved by 16 % as shown in Item 3.4.5-2).

2) Gas leakage of dust collector

(1) Present condition and problems

Oxygen content data of exhaust gas at the inlet and outlet of bag filter type dust collector are shown in Figure 3.3-2.

Oxygen content of exhaust gas at the inlet of bag filter: 19.7%

Oxygen content of exhaust gas at the outlet of bag filter: 19.9%

Difference of oxygen content: 0.2%

Difference of oxygen content between inlet and outlet of bag filter is 0.2%, therefore gas leakage of bag filter does not occur.

Piping between the top of cement kiln and dust collector has many holes by wearing.

3.4.5 Exhaust Fan of Cement Kiln

1) Reduction of air infiltration

(1) Present condition and problems

In order to investigate air intake to the exhaust gas tube, oxygen content in air at the top of the kiln and at inlet of the exhaust fan were measured. The data were as follow.

Oxygen content in air at top of the kiln: 6.0%

Oxygen content in air at inlet of the exhaust fan: 14.9%

Exhaust gas flow was modeled as Figure 3.4.5-1

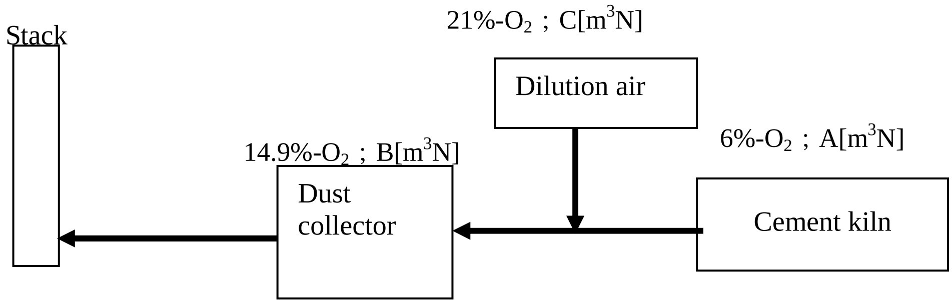


Figure 3.4.5-1 Exhaust gas modeling

From Figure 3.4.5-1, following simultaneous equations are considered.

A + C = B

0.06 × A + 0.21 × C = 0.149 × B

By solving the equation, C = 1.46 × A, B = 2.46 × A are obtained, that is, 1.46 times of the air volume more than the kiln exhausts gas infiltrates into the exhaust gas pipe.

Although maximum design gas temperature of bag filter is 120ºC, exhaust gas temperature at the inlet of bag filter lowers to 90ºC by infiltrated air.

Air infiltration parts are holes of exhaust gas pipe by wearing, holes of cyclone type dust collectors at the top of kiln, and openings for dilution air at the inlet of bag filter.

(2) Measures for improvement and expected effects

Reduction of air infiltration into the exhaust gas pipe can be proposed.

Repairing of cyclone type dust collector may not be started soon, because repairing work requires long time stoppage of the kiln. However repairing work of holes of the exhaust gas pipe and closing of damper of dilution opening are to be implemented. These repairing work should be implemented with observing gas temperature at the inlet of bag filter. In the consideration of high temperature gas from the kiln due to gas blow, suitable gas temperature is 100ºC.

If the air infiltration can be reduced by 30% with repairing work mentioned above, suction air volume of exhaust fan can be reduced as follow.

Suction air volume: A + 1.46 × 0.7 × A = 2.0 × A

Reduction ratio of suction air volume: (2.46 – 2) / 2.46 = 18.7%

Axial power of fan is estimated by an equation as follow,

Axial power = intake air volume × total pressure / fan efficiency

If suction air volume is reduced by 18.7%, axial power can be reduced by 18.7% by VSD control with inverter.

Measured power consumption of the fan was 52.8kW.

Amount of power saving: 52.8kW × 24h/d × 334d/y × 18.7% = 79,100kWh/y

Annual power cost reduction: 79,100kWh/y × 895VND/kWh = 70,795,000VND/y

2) Lowering suction air pressure of fan

(1) Present condition and problems

As described above Item 3.4.4-1), pressure loss in the dust collector is 226mmAq. Because pressure loss in air flow is proportional with the flow volume, in the case that suction air volume is reduced by 18.7%, the loss would be reduced by 18.7% and to 226mmAq × (1 – 0.187) = 183mmAq.

(2) Measures for improvement and expected effects

By cleaning of filter bags in bag filter, the pressure loss can be reduced by 30mmAq.

If intake air pressure of exhaust fan lowers to 153mmAq from 183mmAq, required axial power of the fan can be reduced by 16% by VSD control with inverter. And also considering the effects of Item 3.4.5-1), power saving is shown below.

Amount of power saving: 52.8kW × (1 – 0.187) × 0.813 × 24h/d × 334d/y × 16% = 50,200kWh/y

Annual power cost reduction: 50,200kWh/y × 895VND/kWh = 44,929,000VND/y

3) VSD Control for kiln exhaust gas fan

(1) Present condition and problems

Kiln exhaust gas fan worked on constant speed (damper opening was about 50% and fixed.). Assumed that motor rated power 90kW and capacity margin to fan 20%, rated value of fan is estimated by 90kW / (1 + 20%) = 75kW.

Measured power consumption of fan driving motor was 52.8kW. If efficiency of the motor is assumed at 90%, load factor of the fan is calculated to 52.8kW × 90% / 75kW = 63%. From the loan factor due to the result from damper closing, amount of the airflow corresponds to 48% of the fan rated value. (See Figure 3.4.5-2)

(2) Measures for improvement and expected effects

Installing VSD control to motor driving can be proposed.

Relations between shaft power and load factor under damper control and VSD control are shown in Figure 3.4.5-2.

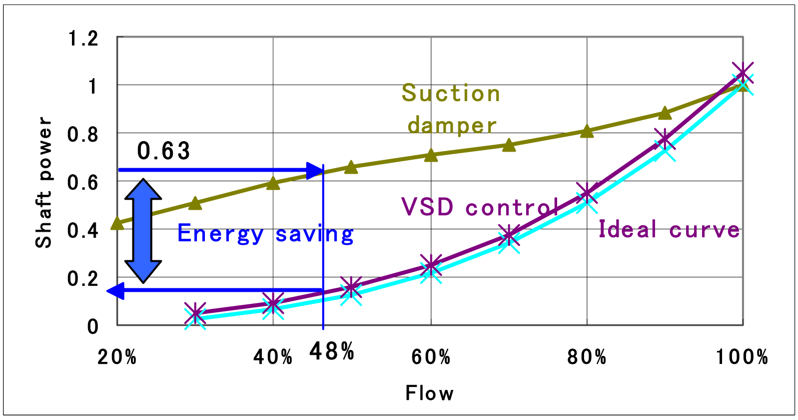


Figure 3.4.5-2 Damper control and VSD control

The gap between the two characteristic-curves shows effect of energy saving.

In the case of airflow rate 48%, power consumption of fan under VSD control is estimated by the cubic rule as follow.

$(48\%)^3$ / (95% × 81%) × 75kW = 14% × 75kW = 10.6kW

Inverter efficiency 95% and degradation of fan and motor efficiency 81% are assumed.

Then amount of annual saving energy is below

Amount of power saving: (52.8kW – 10.6kW) × 24h/d × 334d/y = 338,300 kWh/y

Annual power cost reduction: 338,300kWh/y × 895VND/kWh = 302,779,000VND/y

3.4.6 Kiln blower (Root blower)

1) Optimizing airflow volume

(1) Present condition and problems

A root blower, which has constant airflow volume characteristic, is used for kiln blower. Considering driver motor 250kW, rated power of the blower is estimated at 200kW.

During on-site survey of Oct.6th to 8th power consumption was measured randomly. With assumption of motor efficiency 90%, load factor (ratio to the rated power) of the blower are calculated as shown in Table 3.4.6-1.

Table 3.4.6-1 Power consumption and load factor of the blower

Measurement No.	Voltage (V)	Current (A)	Power factor *	Power con (kW)	Load factor of fan
#1	360	240	0.85	127	57 %
#2	360	380	0.87	206	93 %
#3	362	383	0.87	209	94 %
#4	360	220	0.85	117	52 %
5%	365	283	0.85	152	69 %

Note: Power factors are assumed

Load factors of 93% and 94% in the case of #2 and #3 are measured in normal operation of cement kiln, and so blower run on full load. Due to its constant airflow characteristic, effective capacity control is difficult. Therefore, under the present arrangement between kiln and blower, the blower is likely to take too much capacity margins for the kiln operation.

(2) Measures for improvement and expected effects

VSD control can be applied in order to make root blower capacity suitable to the kiln operation.

To estimate the effect, 10% reduction of air flow-rate is assumed.

Pressure (P) is proportion to square of air flow-rate (Q), i.e. $P \propto Q^2$. Shaft power of blower (W) is shown as product between pressure and air flow-rate (Q), then is proportion to cubic of air flow-rate, that is , $W \propto P \times Q = Q^3$.

10% reduction of air flow-rate makes shaft power $(1 – 10\%)^3$ = 73%.

Moreover by taking adiabatic efficiency up 2% into account, required shaft power is estimated as follow.

Shaft power of the blower: (200kW / 1.02) × 73% = 143kW

With assumption that inverter efficiency is 95% and motor efficiency 90%, required input power is calculated as 143kW / (95% × 90%) = 167kW.

By supposing that hour ratio of the kiln operation with normal load is 80% of annual working hours, saving power is estimated as bellow.

Amount of power saving: (222kW – 167kW) × 24h/d × 334d/y × 80% = 355,600 kWh/y

Annual power cost reduction: 355,600kWh/y × 895VND/kWh = 318,262,000VND/y

2) Rduction of air blow from kiln

(1) Present condition and problems

Considering from load factors shown on the Table 3.4.6-1, the kiln was in blow-operation at timing of #1 and #4. Blow-out-operation is taken in order to reduce air volume to the kiln. The operation was observed several times during on-site surbey.

(2) Measures for improvement and expected effects

Applying VSD control on the root blower is proposed in order to reduce energy loss by blow-operations.

By taking average of the #1, #2, #4, #5 data in the Table 3.4.6-1, the blower load factor is 60% and the power consumption is 130kW.

A model for the estimation is shown in Figure 3.4.6-1.

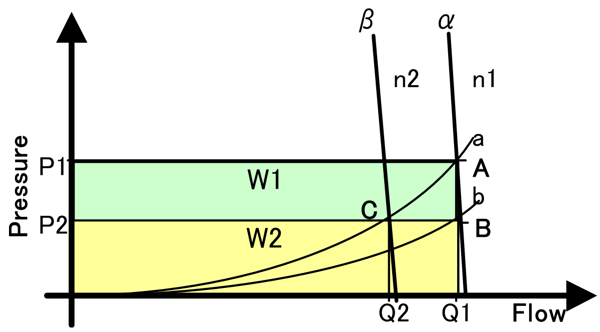


Figure 3.4.6-1 Flow control model of roots blower

The model shows that root blower has constant air flow-rate characteristic and resistance to pipe line corresponds to square of the volume.

Solid and direct line α shows air flow-rate characteristics of the root blower with speed n1. Area W1 defined by P1 × Q1 corresponds to power consumption at operation point A.

When the blow starts, resistant curve moves to line b and operation point change to B. Under the condition, air pressure is P2 and power required is nearly Area W2 defined P2 × Q1.

Under VSD control, resistance curve changes to β with speed n2 and operation point moves to

C.

The air flow-rate decreases to Q2 and power consumption reduces to P2 × Q2.

As the resistance curve is 2nd order curve, the air flow-rate at operation point C will be √60% = 77%.

According to cubic rule of fan power consumption and adiabatic efficiency increase of 6%, shaft power of the blower is calculated as ($77\%^3$ / 1.06) × 200kW = 88kW.

Moreover, by assumptions of inverter efficiency of 95% and motor efficiency of 90% , required input power to the motor is calculated as 88kW / (95% × 90%) = 103kW and the amount of power saving is 130kW – 103kW = 27kW.

If blow-out-operation hour is 20% of the kiln working hours, annual power saving is as follow

Amount of power saving: 27kW × 24h/d × 334d/y × 20% = 43,800kWh/y

Annual power cost reduction: 43,800kWh/y × 0.895kVND/kWh = 39,201,000VND/y

3.4.7 Electricity receiving and distributing equipment, motor

1) Management of electricity receiving and distributing equipment

(1) Present condition and problems

Figure 3.4.7-1 shows power receiving and distributing system of the company.

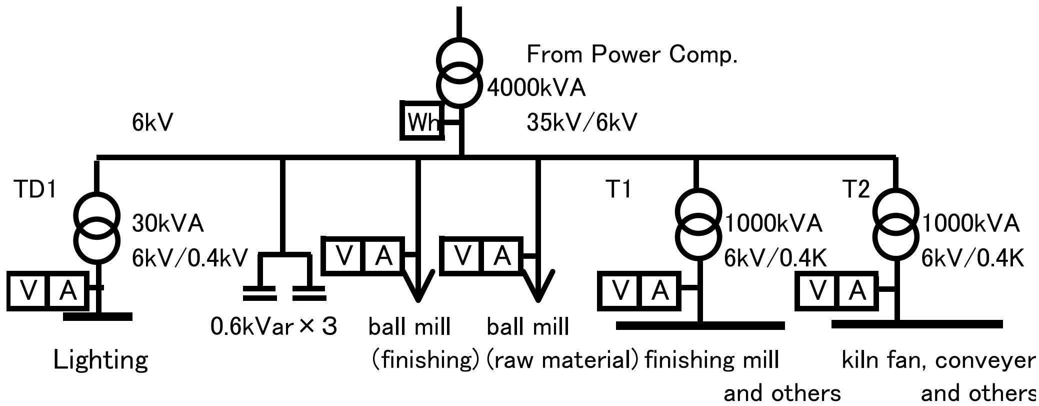


Figure 3.4.7-1 Single line diagram of power receiving system

Amount of receiving power was measured about 1,500kW at the daytime of on-site survey day. From the record, power factor at the receiving point was calculated at 93% to 95% on average a day.

Power for two big ball mills are supplied separately through high voltage line each and two transformers feed low voltage power to the other equipment.

Effective power and reactive power were measured and recorded with a power meter at the 2nd winding terminal of an ultra high voltage transformer. But for each feeder, only voltage and current were monitored without recording. Power consumption of every 10 days and voltage and current of everyday were recorded manually. Unnatural and failure records are found among them, effective use to the energy conservation activities are not clear.

(2) Measures for improvement and expected effects

The first of all, grasping precise and present states of energy consumption should be required for effective energy conservation activities. And accuracy and reliability of the data are also essential.

For this purpose, a kind of automatic and mechanical system is useful. Whole power monitoring system, which is measuring receiving power and power consumption of main branch feeders in the system, may be suitable. One of examples is shown in Figure 3.4.7-2.

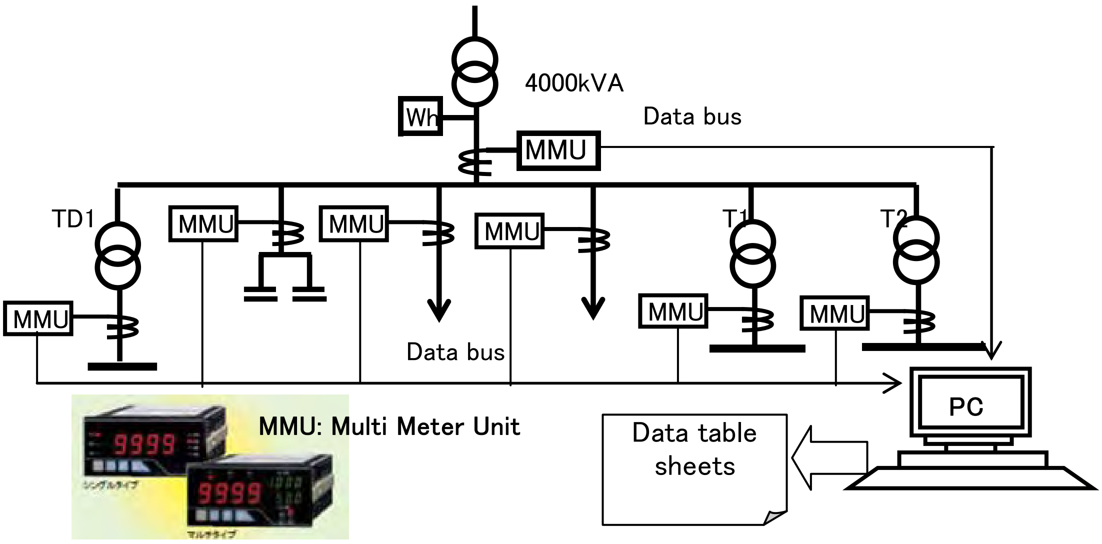


Figure 3.4.7-2 Image of power monitoring system

Digital multi-meter-units for measuring the receiving power are used and the data are transmitted to a personal computer that is used as data gathering and output device. The computer compiles tables of the monitoring data, which may be utilized for power management of the company.

With this system, hourly measurements of power consumption are available. This is the first step to fruitful and developing energy conservation activities.

By ensuring the actual management of power consumption during on-peak demand time and grasping night-time power consumption, the relation between power consumption and state of equipment's working should be examined and analyzed. As the result, unnecessary waiting power consumption will be recognized and eliminated. This is a typical example for the system utilization.

Expected effect largely depends on level of the system utilization and improvement of energy conservation activity. But saving about 5 to 10% of the power consumption may be expectable.

Amount of power saving: 7,081,000 kW × 5% = 3 82,400 kWh/y

Annual power cost reduction: 382,400 kWh/y × 895VND/kWh = 3 32,688 × 1,000VND/y

2) Efficient use of energy saving regarding motors

(1) Present condition and problems

As a low voltage big size motor requires larger current, much ohm loss are brought out through the supply cable line. Motor for ball mill and kiln blower are in these cases.

Voltage at supply-end, 2nd terminal of the transformer for distribution, is 390 to 400V and voltage at load-end is 360 to 365 V. Then voltage drops in factory was 8%, which is large.

(2) Measures for improvement

Voltage-drops by reviewing of cable size and installation of static condensers in order to reduce reactive current may be proposed.

Power loss in distribution line is calculated with cable resistance "r" and current "I" as follows.

Power loss in 3 phase line: $W = 3r \times I^2$

Then, improvement of distribution line efficiency requires lowering "r" and "I". The former is increase of cable size and the latter is improvement of power factor with static condenser.

Compensation of reactive current with static condenser is shown in Figure 3.4.7-3.

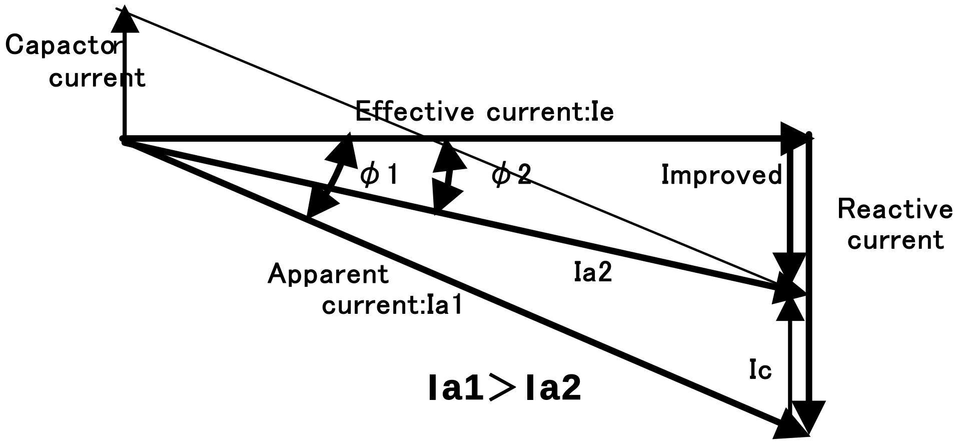


Figure 3.4.7-3 Compensation of reactive current by static condenser

Generally electric equipment produces generally lag-phase current as reactive current, which is shown as $I \times \sin\varphi$, where "I" is lag-phase current, $\cos\varphi$ is power factor.

Current through static condenser flows in couture-phase to the reactive current and reduces the current "I" to almost as much as effective current "Ic". As a result, distribution line loss of $r \times I^2$ becomes smaller.

Kiln blower and exhaust fan are examined here as examples and amounts of static condenser effect are estimated.

Voltage at 2nd terminal of transformer was 390V and voltage at load-end terminal of selected two equipment was 360V. Then voltage drop ratio is calculated as (390V – 360V) / 360V = 8.3%.

Each reactive power was also calculated and shown in Table 3.4.7-1.

Table 3.4.7-1 Reactive power of motor for kiln blower and exhaust fan motor

Name of motor	Current (A)	Power factor	Active current (A)	Reactive current (A)	Reactive power (kVar)
Exhaust fan	104	81%	84	61	38
Kiln blower	380	87%	331	187	117

Capacity of static condenser is selected in order to compensate the reactive power 38kVar and 117kVar each. Then power factor improvement and its effect are calculated and shown in Table 3.4.7-2.

Table 3.4.7-2 Power factor improvements and its effect

Name of motor	Static condenser		Reactive current (A)	Surface current (A)	Before (kW)	After (kW)	Saving (kW)
	MF	kVar					
Exhaust fan	900	37	2	84	5.4	3.6	1.8
Kiln fan	2,500	102	24	331	19.7	15.0	4.7

The static condensers reduce power loss in distribution cables by 1.8kW and 4.7 kW and voltage drop through the lines are improved by 24V (6.7%) and 26V (7.8%).

By enlarging of cable size in order to improve voltage drop to 5%, voltage drop is reduced to 4.9V and 6.7V respectively. Distribution power loss on each line is improved by 0.7kW and 3.8kW with these repairing.

Total improvement of each line is summarized as follow.

Exhaust fan line: 1.8kW + 0.7kW = 2.5kW

Kiln blower line: 4.7kW + 3.8kW = 8.5kW

Then,

Amount of power saving: (2.5+8.5) × 24h/d × 334d/y = 88,500kWh/y

Annual power cost reduction: 88,500kWh/y × 895VND/kWh = 79,208 × 1,000VND/y

As far as limited in a factory, following equations can be used for estimation of distribution power loss.

$$W = S \times (\Delta V/V) \times 1/\cos\varphi$$

Where, W: power loss, S: apparent power.

Voltage drop of ΔV/V shows a rough index of the loss, which is ratio of loss in a supply cable to necessary power for load. The value of larger than 5% should be examined and improved.

3.4.8 Improvement of process

1) Review of line

(1) Present condition and problems

In the case of vertical type cement shaft kilns, since preheating of material, quick-liming and clinker generation progress in a furnace of 10m in height, fuel intensity is relatively good such as 993 kcal/kg-clinker. But, stable operation for ensuring quality is difficult, therefore products clinker is used to low strength cement by the deviation of strength and quality of clinker. In the present vertical type cement shaft kiln, fuel intensity is 1,302 kcal/kg-clinker as shown in Table 3.4.8-1 to produce clinker for PC50 cement. Ball mills for material crushing and rotary dryer consume energy much.

(2) Measures for improvement and expected effects

We recommend that the factory replace his shaft kiln by a rotary kiln with a new suspension pre-heater (NSP) taking account of production of clinker for high strength cement and improvement of fuel intensity.

When present shat kiln of 300 t/d is replaced by rotary kiln with NSP of 1000 t/d, Fuel intensity can be improved from 1,302 kcal/kg-clinker to 836 kcal/kg-clinker and high strength cement of PC50 can be produced. Fuel intensity can be improved by 35.6%.

When ball mills for material crushing and rotary dryer are replaced by vertical roller mill, electric power consumption increases, but fuel consumption decreases. Electric power intensity is same as shown in Table 3.4.8-1.

Figure 3.4.8-1 shows rotary kiln with NSP.

Figure 3.4.8-1 Rotary kiln with NSP.

a) Investment size: Big size investment (Replacement of cement production plant)

b) Expected effects:
- Improvement of fuel intensity by 36%
- Production of Portland cement of high strength: Production of clinker for PC50
- Environmental improvement of work shop and surrounding of factory
- Conversion of fuel coal of lower price: Possibility of use of coal of low heat value, used tire, waste material

c) Amount of energy saving:

Clinker production of present shat kiln of 300t/d: 77,000 ton/y, Coal consumption: 11,000 × 99%

Saved energy: 11,000 × 0.99 × 35.6% = 3,880 ton/y

d) Annual Energy cost reduction: 3,880t/y × 800,000 VND/t = 3,104,000,000VND/y

e) Investment cost of rotary kiln with NSP of 1,000t/d:

Clinker production: 1,000 ton/d, 330,000ton/y

Unit cost of rotary kiln plant: US$501/ton-clinker/y from Table 3.4.8-1

Investment cost of rotary kiln with NSP is estimated as follows:

330,000 × 501 = US$165,330,000.

165,330,000 × 16,000 VND/US$ = VND2,645,000,000,000.

Table 3.4.8-1 Energy consumption and installation cost of cement plant

	Fossil fuel intensity	Power intensity	Plant cost
	(Mcal/t-clinker)	(kWhl/t-clinker)	(USD/t-clinker/y)
Small size plant（1,000t-cl/d or less）			
Type 1: Shaft kiln	1,302	148	324.9
Type 2: Wet type rotary kiln	1,481	146	438.5
Type 3: Dry type rotary kiln	955	146	526.9
Type 4: Dry type rotary kiln (SP/NSP)	836	141	501.7
Type 5: new type fluidization shaft kiln	714	110	473.3
Large size plant (2,000t-cl/d or over)			
Type 6: Wet type rotary kiln	1,182	146	409.1
Type 7: Dry type rotary kiln	855	139	542.8
Type 8: Dry type rotary kiln (SP/NSP)	712	134	267.9
Type 9: Dry type rotary kiln (SP/NSP) BAT	576	88	307.8

Source: Research Institute of Innovative Technology for the Earth (RITE), Japan, August 2008

4. Ceramic Factory D

4.1 Introduction

1) Name: Ceramic Factory D
2) Address: Danang city
3) Business
   (1) Type: Ceramics
   (2) Main product: Sanitary ware
       Amount of product: 100,000 pcs in 2007
       Export: none
   (3) Employee: 281 persons
4) Attendee: President, Factory manager, Maintenance, Mechanical engineer, Quality control
5) Outline of factory

   The equipment was introduced from Italy in 2001 and production began in 2003. Originally, this company was a state-run enterprise, but it was privatized in 2006. All raw material is domestics, and products are not exported. The tunnel kiln is sometime stopped because the volume of sales is smaller than production capacity.

4.2 Energy on-site Survey

1) Survey member

   JICA team: N. Fukushima, M. Ishikawa, N. Amano, T. Onoguchi

   Institute of Energy: Mr.Song, Mr. Hau

   ECC-Danang: Mr.Ban Duong, Mr. Vy
2) Date: 9 -10th October 2008
3) Request of energy conservation

   How to improve energy conservation

   How much is energy conservation effect

4.3 Result of energy on-site Survey

1) Improvement item and effect of forecast after improvement

   Improvement item and effect of forecast after improvement by on-site survey is shown in Table 4.3-1. Energy conservation potential is 18.3%

Table 4.3-1 Improvement item and effect of forecast after improvement

No.	Item No.	Improvement item	Effect of forecast		
			Energy	Quantity of energy conservation (ton-LPG/y, kWh/y)	Effect (×1,000 VND/y)
1	4.4.2.1)	Tunnel kiln: space between kiln ceiling and firing product	LPG	9.7ton-LPG	174,600
2	4.4.2.2)	Tunnel kiln: space between car-top and slab	LPG	9.7ton-LPG	174,600
3	4.4.2.3)	Tunnel kiln: slab shape	LPG	9.7ton-LPG	174,600
4	4.4.2.4)	Tunnel kiln: number of operation burners	LPG	24.2 ton-LPG	435,600
5	4.4.2.5)	Tunnel kiln: blows in to the preheating zone of waste heat (rejection heat)	LPG	24.2 ton-LPG	435,600
6	4.4.2.6)	Tunnel kiln: the sensible heat of the exhaust gas is recovered	LPG	4.8 ton-LPG	86,400
7	4.4.2.7)	Tunnel kiln: pressure in the kiln is to be negative	LPG	4.8 ton-LPG	86,400
8	4.4.2.8)	Tunnel kiln: seal of kiln car joint	LPG	9.7ton-LPG	174,600
9	4.4.3.1)	Tunnel kiln: applying variable speed driving (VSD) control to adjust airflow	Power	96,000kWh	96,960
10	4.4.3.2)	Air compressor: lowering discharge air pressure by adopting loop type piping	Power	42,600kWh	43,2026
11	4.4.4.1)	Power receiving: changing to 1-transformer operation from 2-transformer operation	Power	14,100kWh	14,241
12	4.4.4.2)	Power distribution: installing power-monitoring system.	Power	74,500 kWh	75,245
13	4.4.4.3)	Large low voltage motor: installing static condenser to improve power factor.	Power	15,100kWh	15,251
Effect of forecast (total)			Fuel	96.8 ton-LPG /y (105 toe/y)	1,742,400
			Power	242,300kWh/y (67 toe/y)	244,723
Crude oil conversion value of fuel and power				172 toe/y	
Energy consumption			Fuel	483.9 ton-LPG/y	
			Power	1,489,000 kwh/y	
			Total	939 toekL/y	
Energy conservation rate for the entire company			Fuel	20%	
			Power	16.3%	
			Total	18.3%	

2) Energy consumption, energy ratio and energy intensity

(1) Amount of the energy consumption for year (fuel+electricity) and crude oil equivalent = 939 toe

The conversion factor to primary energy of electric power is calculated according to 31% of thermal efficiency of thermal power generation station in Vietnam.

Conversion factor to primary energy = 860 / 0.31 = 2,770 Mcal/MWh = 0.277 toe/MWh

1 toe = 10,000 Mcal

fuel (LPG) = 483.9ton/y × 1.088 = 526 toe/y (1.088 = conversion coefficient of LPG for crude oil)

electricity = 1,489 Mwh/y × 0.277 = 412 toe/y

(2) Energy intensity (Energy consumption per annual production)

Power intensity = 14.9 kWh/piece

Fuel intensity = 4.8 kg/piece

Trend of energy intensity is shown in Table 4.3-2

Table 4.3-2 Production and energy intensity

	2006	2007
Production (pcs/y)	58,049	100,000
Fuel consumption (LPGton)	300	483.9
Fuel intensity (kg/piece)	5.2	4.8
Fuel unit price (VND/kg-LPG)	16,000	18,000
Electricity consumption (MWh/y)	1,050	1,489
Electricity intensity (KWh/piece)	18.1	14.9
Electricity rate (VND/kWh)		1,010

3) Remarks

(1) Energy price

LPG: 18,000 VND/kg

Electicity: 1,010 VND/kWh

4) Facility

Specifications of sanitary ware production equipment are shown in Table 4.3-3.

Table 4.3-3 Specifications of sanitary ware production equipment

No.	Equipment	Q'ty	Specifications
1	Tunnel kiln	1	size: 70m long manufacturer: Italy SACMI capacity (ton/hr): fuel: LPG, max temperature: 1,210°C firing hour (in to out): 21.6 min/car = 18hr
2	Forming machine	4	automatic machine 4 set, drain and solid casting
3	Dryer	4	
4	Air compressor	1 set	110kW Screw type

5) Manufacturing process

Flow-sheet of sanitary ware production process is shown in Figure 4.3-1.

(1) Raw material

Materials is domestic (feldspar, clay, kaolin, ball clay)

Ball mill for body slip 2 sets

Ball mill for glaze 2 sets

(2) Forming

Automatic casting machine, drain and solid casting

(3) Glazing

5 color glazes by spray

(4) Firing

(5) Inspection, packing, delivery

Flow sheet

Row material → Grinding → Adjusting → Storage → Casting →

→ Forming → Drying → Smoothing → Glazing → Firing →

→ Inspection → Delivery

Figure 4.3-1 Flow-sheet of sanitary ware production process

4.4 On-site survey report

4.4.1 General

1) Energy management organization

(1) Present condition and problems

There is no energy management organization, and also there are no target of energy intensity, the energy conservation activity too. The modern machines are introduced and there is especially no problem for the machines. But it is a problem how to introduce the firing technology and the management technique such as soft ware.

(2) Measures for improvement

Top management of the company should implement energy conservation as well as cost reduction by overcoming these problems and introducing soft ware.

2) Implementation of measurement and record

(1) Present condition and problems

The equipment is the same as that in Japan, and the equipment and measurement instrumentation is also sufficient for operation. Measurement record is insufficient but minimum requirement is implemented for electric power monitoring and recording.

(2) Measures for improvement

Watt-hour meter is installed at the secondary side of receiving transformer. Power consumption can be grasped by using the watt-hour meter. Power consumption management can be implemented by reading the indicated values of watt-hour meter peroidically.

3) Maintenance of facility

(1) Present condition and problems

The equipment is new, but purpose and necessity of the maintenance does not be understood. Especially filter of fan is not cleaned. It is necessary to make management items, maintenance cycle and the purpose of all fan, and motor and to implement periodical inspection.

(2) Measures for improvement

Filters of fans should be cleaned. Equipment management standard should be prepared including management items, purpose and maintenance cycle, and periodic inspection should be implemented.

4) Energy consumption management

(1) Present condition and problems

Fuel consumption for tunnel kiln which is energy intensive equipment, but energy management is not implemented by measurement data of fuel consumption. Power consumption is not grasped sufficiently.

(2) Measures for improvement

Energy consumption data should be shown with graphs in the factory, and All the employees should have awareness of energy conservation.

5) Energy intensity management

(1) Present condition and problems

The energy intensity and thermal efficiency are not managed, and employees do not recognize energy conservation

(2) Measures for improvement

Energy intensity per production volume should be managed. Energy cost should be reduced with awareness of energy conservation.

6) PDCA management cycle

(1) Present condition and problems

Energy consumption is recorded but is not managed.

(2) measures for improvement

At first, it is necessary to have energy conservation awareness and PDCA cycle should be started.

7) Evaluation of energy management situation

Evaluation of energy management situation is shown in Figure 4.4.1.-1.

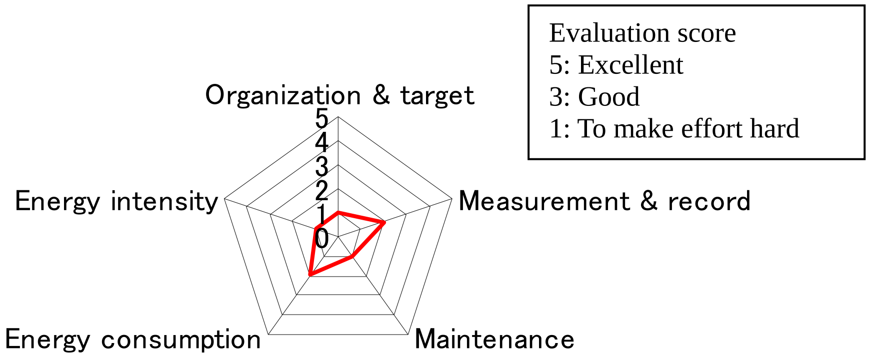


Figure 4.4.1.-1 Evaluation of energy management situation

4.4.2 Improvement item of tunnel kiln

1) Operation of heat balance

The heat balance was executed to know heat input and output and heat efficiency.

Thermal efficiency: 37.7%

Energy intensity (calorie necessary for firing product kg): 1,828kcal/kg

These figures are average as the tunnel kiln of the sanitary ware.

The heat balance is shown in Table 4.4.2-1.

Table 4.4.2-1 Heat balance of tunnel kiln

		Heat input		Heat output	
		× 10^3kcal	%	× 10^3kcal	%
Heat input	heat from combustion of fuel	1,356.0	99.3	--	--
	heat carried in from pre-firing goods	2.4	0.2	--	--
	heat carried in from kiln furniture	0.9	0	--	--
	heat carried in from refractory	5.1	0.4	--	--
	heat carried in from iron parts	1.0	0.1	--	--
Heat output	heat carried by firing goods	--	--	7.4	0.5
	heat carried by kiln furniture	--	--	5.7	0.4
	heat carried by refractory	--	--	31.1	2.3
	heat carried by iron parts	--	--	2.4	0.2
	heat carried by waste heat	--	--	493.0	36.1
	heat carried by exhaust gas	--	--	423.0	31.0
	heat carried by steam evaporating from water in the pre-firing goods	--	--	70.0	5.1
	heat loss due to radiation, conduction and so forth	--	--	333.4	24.4
Total		1,366.0	100	1,366.0	100
Effective heat	effective heat par ton of firing goods				
	heat required for evaporating the water adhered	6.6 × 10^3kcal			
	heat required for evaporating the crystallized	90.4			
	heat required for decomposing the clay	193.4			
	heat required for firing of pre-firing goods	373.8			
	Total	664.2 × 10^3kcal/t			
	thermal efficiency of firing goods	37.7%			
	energy intensity	1,828 kcal/kg			

2) Improvement items of tunnel kiln

It proposes the following energy conservation about the tunnel kiln that consumes most of energy in the manufacturing process.

(1) Space between kiln ceiling and products

Present condition and problems

The space between the kiln ceiling and the products is large.

Measures for improvement

If the space between ceiling and firing products and between car top and shelf, and shelf design are improved, the difference of upper and lower temperatures becomes small and fuel consumption can be reduced as shown in Figure 4.4.2-1.

Expected effects: 2% reduction (9.7ton, 174.6 million VND)

Amount of fuel saving: 483.9 t/y × 0.02 = 9.7 t/y

Annual fuel cost reduction: 9.7t/y × 18,000 VND/kg = 174.6 million VND/y

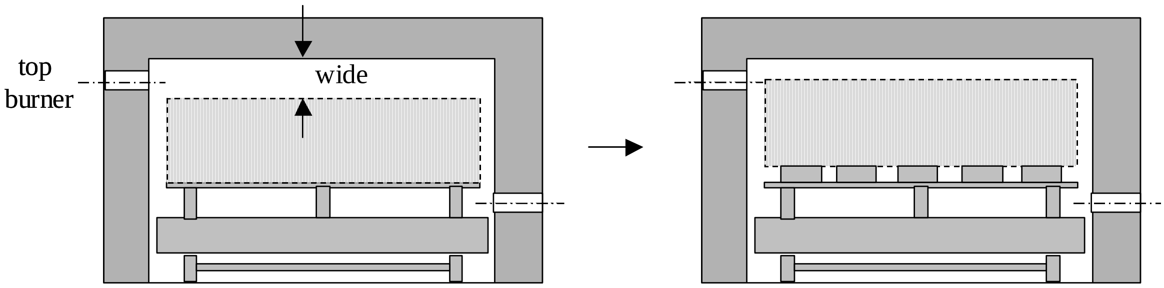


Figure 4.4.2-1 Space between ceiling and products

(2) Space between car-top and slab

Present condition and problems

The space between car-top and the slab is 280mm, which is large.

Measures for improvement

Upper and lower temperature can be smaller by putting bricks every five cars for obstructing flow of combustion gas, and the fuel consumption can be reduced as shown in Figure 4.4.2-2.

Expected effects: 2% reduction (9.7ton, 174.6 million VND)

Amount of fuel saving: 483.9 t/y × 0.02 = 9.7 t/y

Annual fuel cost reduction: 9.7t/y × 18,000 VND/kg = 174.6 million VND/y

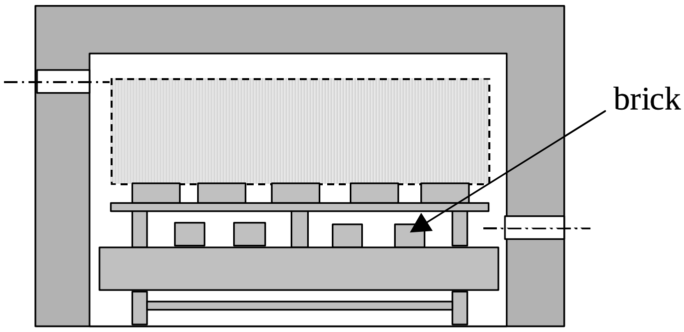


Figure 4.4.2-2 Space between car-top and slab

(3) Slab shape

Present condition and problems

Combustion gases cannot come up, because holes are not opened in the slab.

Measures for improvement

If holes are opened in the slab, difference of temperature between upper and lower parts can be smaller, combustion gas comes up and fuel consumption can be reduced as shown in Figure 4.4.2-3.

Expected effects: 2% reduction (9.7ton, 174.6 million VND)

Amount of fuel saving: 483.9 t/y × 0.02 = 9.7 t/y

Annual fuel cost reduction: 9.7t/y × 18,000 VND/kg = 174.6 million VND

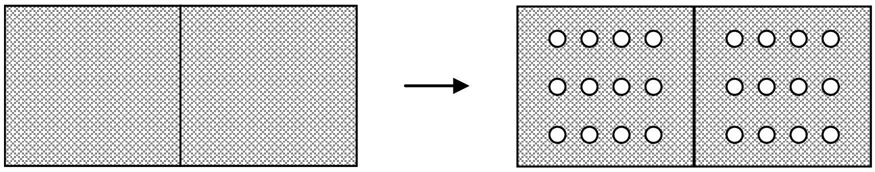


Figure 4.4.2-3 Slab shape

(4) Numbers of operation burners

Present condition and problems

A lot of numbers of burners are operated compared with production volume.

Measures for Improvement

The fuel consumption is reduced by extinguishing the several numbers of operation burners for production near the charging side and upper side burners as shown in Figure 4.4.2-4.

Expected effects: 5% reduction (24.2ton, 435.6 million VND)

Amount of fuel saving: 483.9 t/y × 0.05 = 24.2 t/y

Annual fuel cost reduction: 24.2t/y × 18,000 VND/kg = 435.6 million VND/y

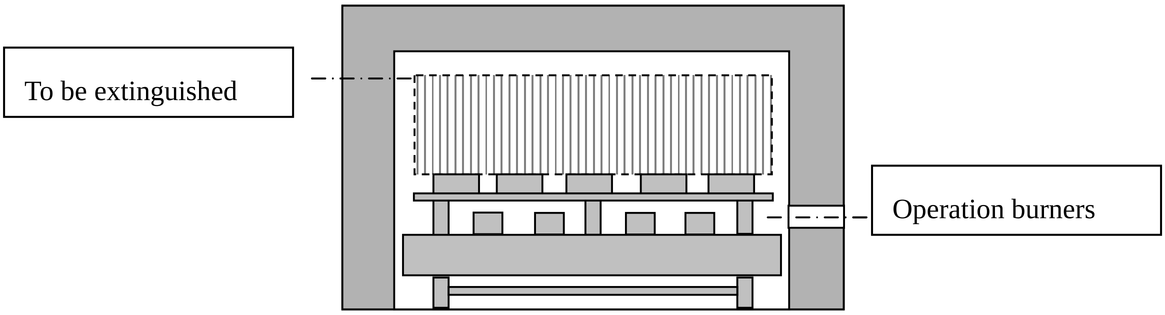


Figure 4.4.2-4 Numbers of operation burner

(5) Blows into pre-firing zone of waste heat (rejection heat)

Present condition and problems

All waste heat is used for dryers.

Measures for improvement

The amount of waste heat for dryers is reduced and the blowing in pre-firing zone it because of string air in preheating zone and the fuel is reduced as shown in Figure 4.4.2-5.

Expected effects: 5% reduction (24.2 ton, 435.6 million VND)

Amount of fuel saving: 483.9 t/y × 0.05 = 24.2 t/y

Annual fuel cost reduction: 24.2 t/y × 18,000 VND/kg = 435.6 million VND/y

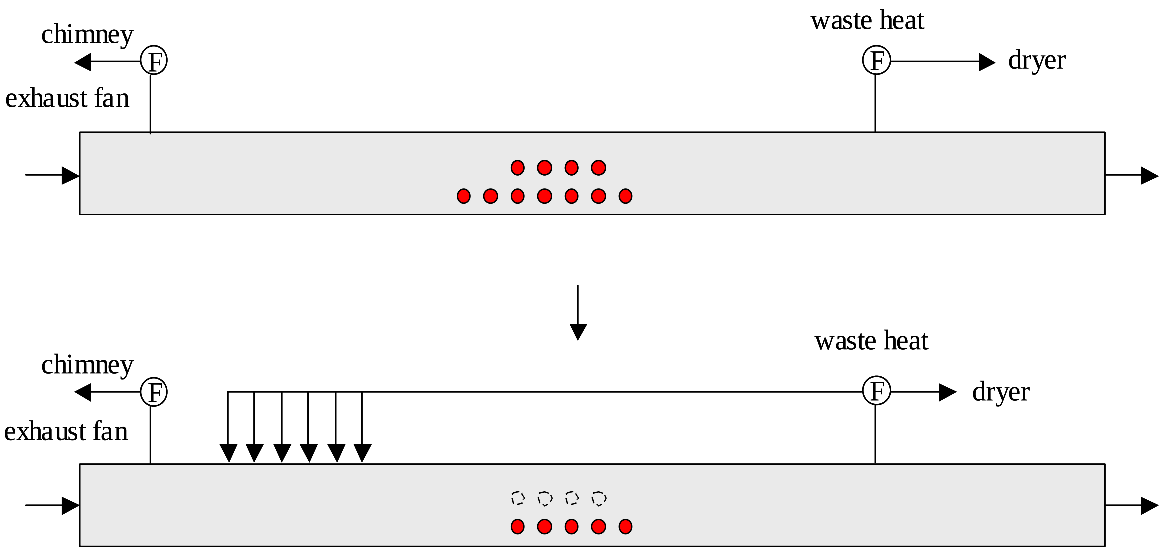


Figure 4.4.2-5 Blowing of waste heat into pre-firing zone

(6) Recovery of sensible heat of exhaust gas

<u>Present condition and problems</u>

Temperature of exhaust gas is higher than normal temperature of 150^{0}C or less.

<u>Measures for improvement</u>

Sensible heat of exhaust gas is recovered with heat exchanger and used for preheating of combustion air because of reducing fuel consumption as shown in Figure 4.4.2-6.

Expected effects: 1% reduction (4.8 ton, 86.4 million VND)

Amount of fuel saving: 483.9 t/y × 0.01 = 4.8 t/y

Annual fuel cost reduction: 4.8 t/y × 18,000 VND/kg = 86.4 million VND/y

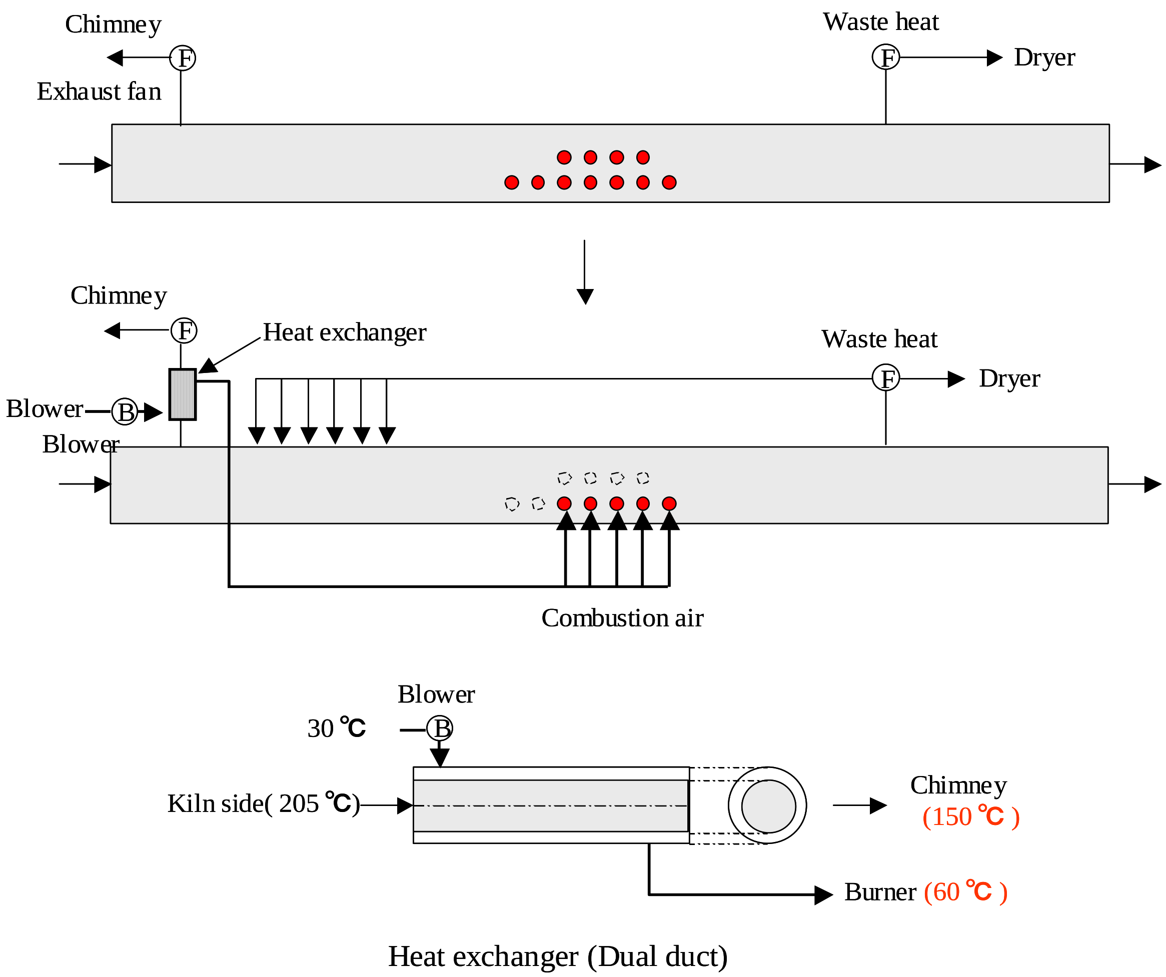


Figure 4.4.2-6 Heat exchange system of waste heat

(7) Pressure control in the kiln with negative prsssure

Present condition and problems

Pressure in the kiln is positive and a lot of dissipative heat loss is generated by the positive inner pressure.

Measures for Improvement

If inner pressure is set at ±0mmH_2O at the first burner from charging side, fuel consumption can be reduced as shown in Figure 4.4.2-7.

Expected effects: 1% reduction (4.8 ton, 86.4 million VND)

Amount of fuel saving: 483.9 t/y × 0.01 = 4.8 t/y

Annual fuel cost reduction: 4.8 t/y × 18,000 VND/kg = 86.4 million VND/y

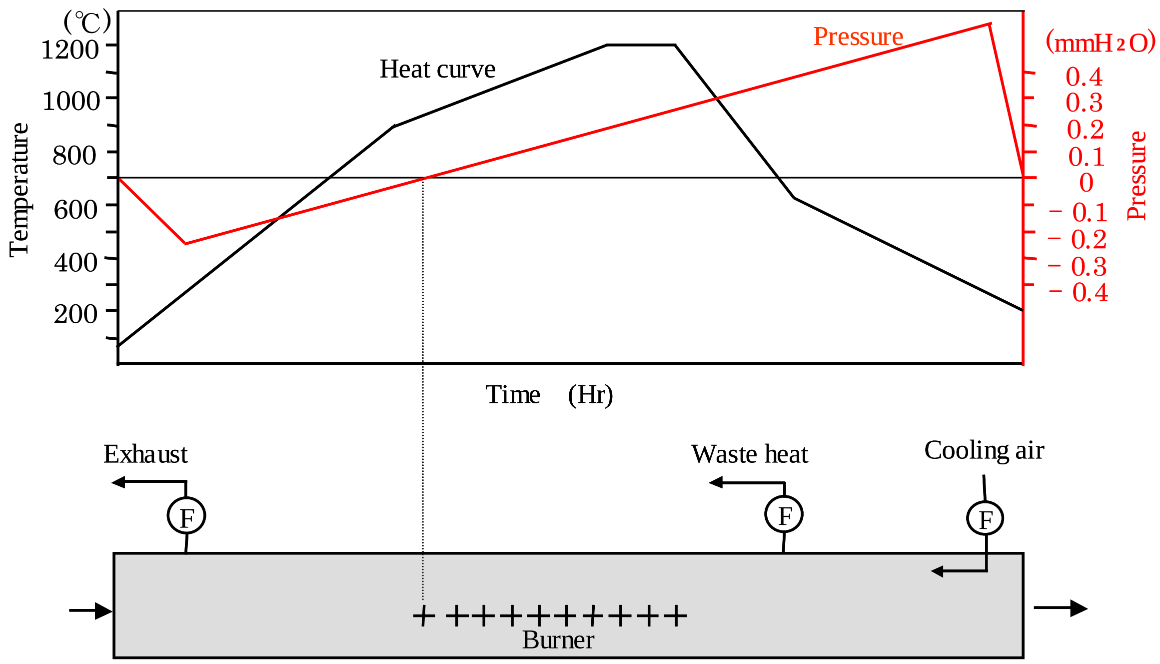


Figure 4.4.2-7 Kiln pressure

(8) Maintenance of seal of kiln car joint

<u>Present condition and problems</u>

The seal of the kiln car joint is defective.

<u>Measures for improvement</u>

Seal parts of the kiln car joint should be exchanged to new parts once a year for reducing leak air, so that fuel consumption can be reduced as shown in Figure 4.4.2-8

Expected effects: 2% reduction (9.7 ton, 174.6 million VND)

Amount of fuel saving: 483.9 t/y × 0.02 = 9.7 t/y

Annual fuel cost reduction: 9.7 t/y × 18,000 VND/kg = 174.6 million VND/y

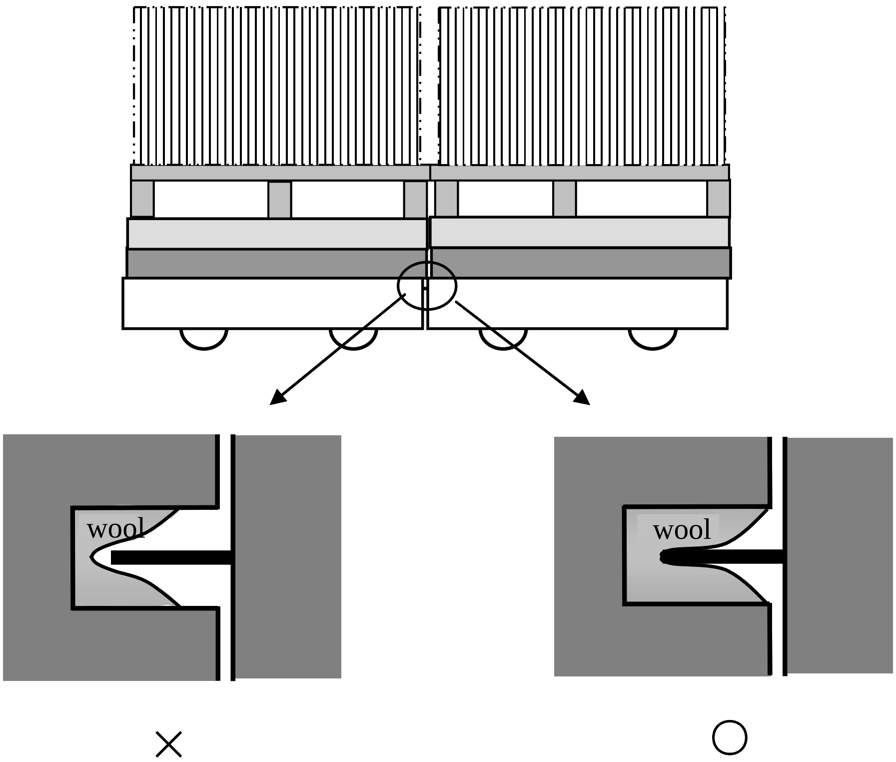


Figure 4.4.2-8 Seal of kiln car joint

3) Potential of the energy conservation

When the above-mentioned items are executed, energy conservation is performed by 20% as expected effects.

4.4.3 Fan, air compressor and etc.

1) Efficient use of energy regarding fan equipment

(1) Present condition and problems

Power consumption and load factor of each motor, which drives exhaust fan or hot air suction fan for the tunnel kiln, are shown in Table 4.4.3-1.

Table 4.4.3-1 Power consumption and load factor of motors for the kiln fans

Motor for	Rated output (kW)	Power consumption (kW)	Load factor (%)
Hot air suction fan	22	11.9	49.0
Fumes suction fan	22	13.1	53.0

Judging from load factors in Table 4.4.3-1, capacity of fan seems to be too big. As damper control does not have enough flexibility, it is hard to control the air flow suitable for kiln operation.

As air filter is dusty, filters have to be keep clean.

(2) measures for improvement

Changing of suction damper control to VSD control can be proposed.

As both energy saving and remote control of fan are available with VSD control, air flow volume can be controlled suitably along with the kiln operation.

Partial load performances on damper control and VSD control are shown in Figure 4.4.3-1

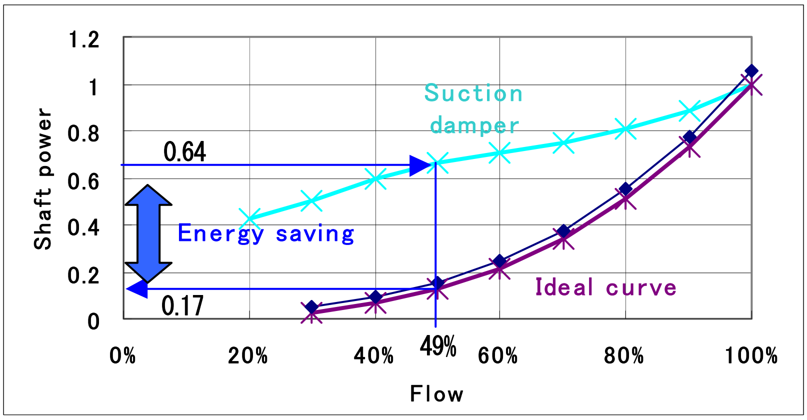


Figure 4.4.3-1 Performance about damper control and VSD control

The gap between the two curves shows energy saving.

The case of exhaust fan is taken as an example and concerned value and arrow lines to show estimation process appear in the figure.

By assuming rated power of the motor of 22kW and design margin of 20%, rated shaft power of fan is estimated at 22kW / (1 + 20%) = 18.3kW.

From power consumption of the exhaust fan of 13.1kW and motor efficiency of 90%, input shaft power ratio to the rated value is calculated as 13.1kW × 90% / 18.3kW = 64%.

By reading the damper control performance curve, the air flow ratio corresponds to 49%, which requires 17% of shaft power under VSD control. 17% of shaft power means 18.3kW × 17% = 3.1kW.

In the case of exhaust fan, the amount of energy saving is also estimated by the same procedure. Results are shown in Table 4.4.3-2.

Table 4.4.3-2 Required power under damper control and VSD control

Motor for	Damper control		Flow rate	VSD control	
	(kW)		(%)		kW
Hot air suction fan	10.7	59%	40%	10%	1.9
Fumes suction fan	11.8	64%	49%	17%	3.1

Amount of power saving about exhaust fan and hot air suction fan are summarized by (11.9kW + 13.1 kW) – (1.9 kW +3.1 kW) = 20.0kW.

About other fans attached to the tunnel kiln can be calculated by the same approach.

Amount of power saving: 20.0kW × 24h/d × 200d/y = 96,000kWh/y

Annual power cost reduction: 96,000kWh/y × 1,010VND/kWh =96,960 ×1,000VND/y

2) Efficient use of energy regarding air compressor

(1) Present condition and problems

Compressed air piping formation is shown in Figure 4.4.3-2.

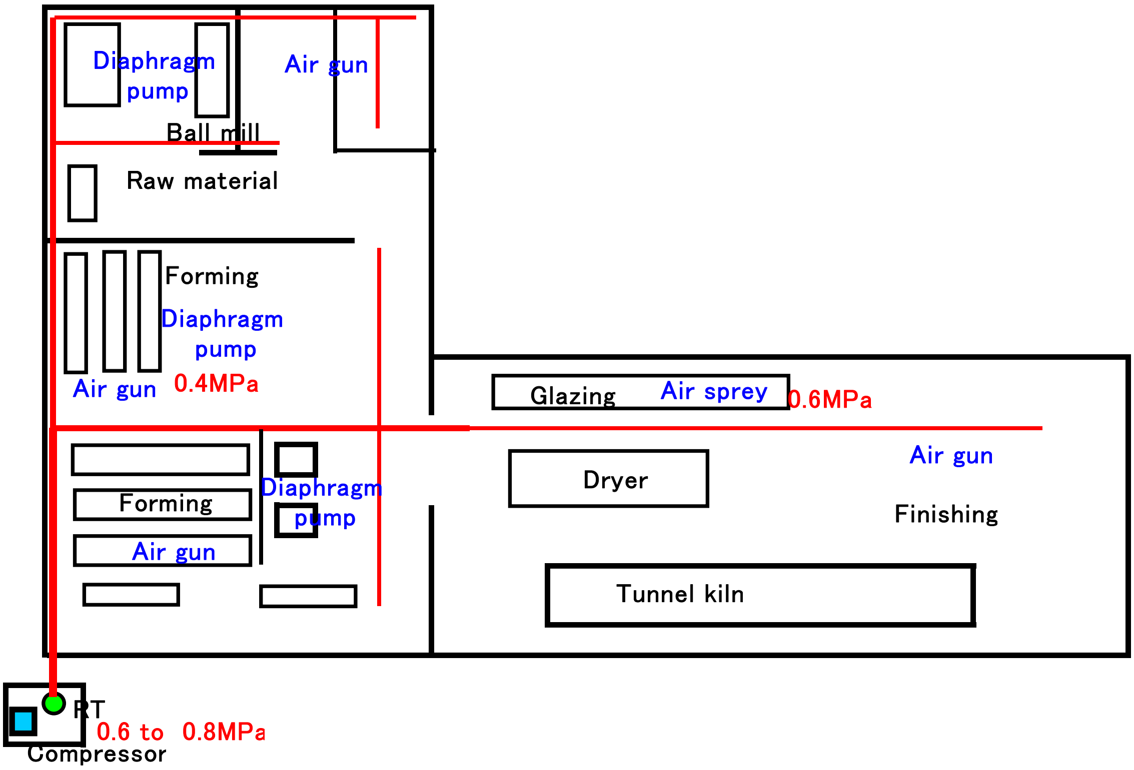


Figure 4.4.3-2 Compressed air piping layout and related load

Discharged air pressure is 0.6 to 0.8MPa and regulator valves of loads end set the pressure at 0.4 or 0.6MPa.

Other than air guns and sprays, there are many diaphragm pumps for transportation of resin and/or slip.

A part of power consumption data of air compressors is shown in Figure 4.4.3-3. Repeating between load state and unload state are observed in every about 2 minutes.

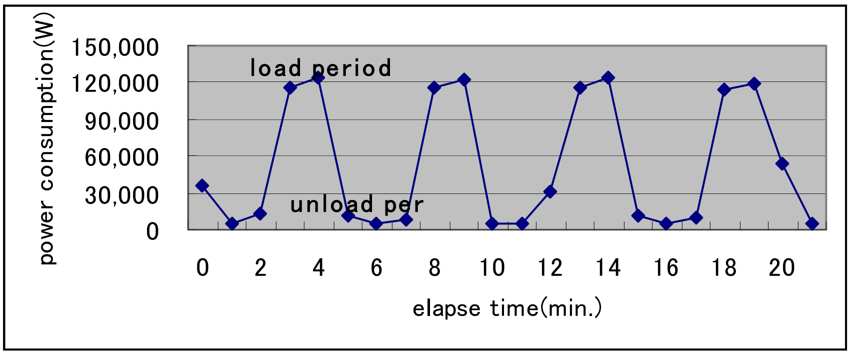


Figure 4.4.3-3 Load and unload operation of compressor

On the conditions, it is estimated that compressed air supply volume is about 7m^3/min and the load factor is about 40%. As for unload condition, power consumption is very small by reason of low speed motor revolution due to 10Hz AC delivered by inverter. Then, even though lower load factor operation, the efficiency is good with more than 80%.

However load and unload mode operation makes discharge pressure higher and pressure regulation gap wider.

(2) Measures for improvement

Lowering discharge pressure can be proposed.

Figure 4.4.3-4 shows relation between discharge pressure and power consumption based on 0.7MPa, which corresponds to the center value of the regulation.

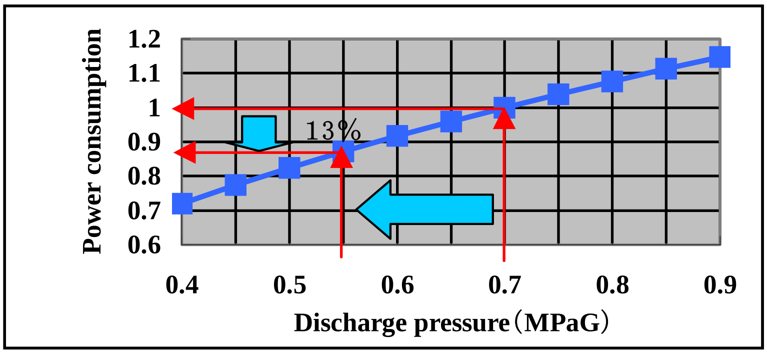


Figure 4.4.3-4 Relation between discharge air pressure and input power

Lowering the discharge pressure at air compressor from 0.7MPa to 0.55MPa saves power consumption by 13%.

Following measures are considered to lower the pressure loss through the pipe.

- Converting the pipe formation to loop shape type piping formation for minimizing pressure loss,
- Setting pressure regulating range of discharging pressure of air compressor narrow as far as at 0.1MPa, which is applied generally, and lowering the upper limits pressure.
- Studying the way to lower pressure at load end. For a machine that requires higher

pressure solely, setting booster is useful.

As shown in Figure 4.4.3-5, present piping formation of tree branch type brings about pressure loss at the end of piping. But loop shape piping decreases pressure loss.

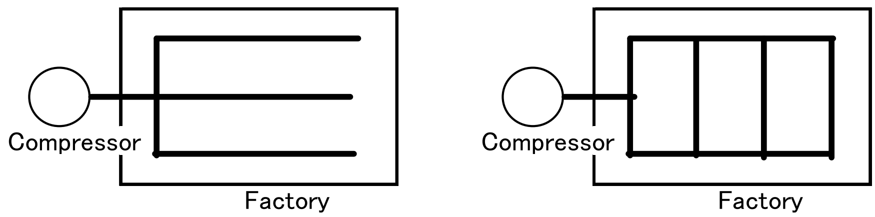


Figure 4.4.3-5 Tree branch type piping and loop shape piping

As power consumption ratio of the compressor is 22%, from Figure 4.4.3-3, annual power consumption is calculated as 1,482MWh/y × 22% = 3 27,580kWh/y.

Therefore, 13% power saving corresponds to as follow.

Amount of power saving: 327,580kWh × 13% = 42,600kWh/y

Annual power cost reduction: 42,600kWh/y × 1.010k VND/kWh = 43,026 × 1,000VND/y

4.4.4 Power receiving and distributing equipment, motor

1) Management of power receiving transformers

(1) Present condition and problems

Figure 4.4.4-1 shows a single line diagram of power receiving system.

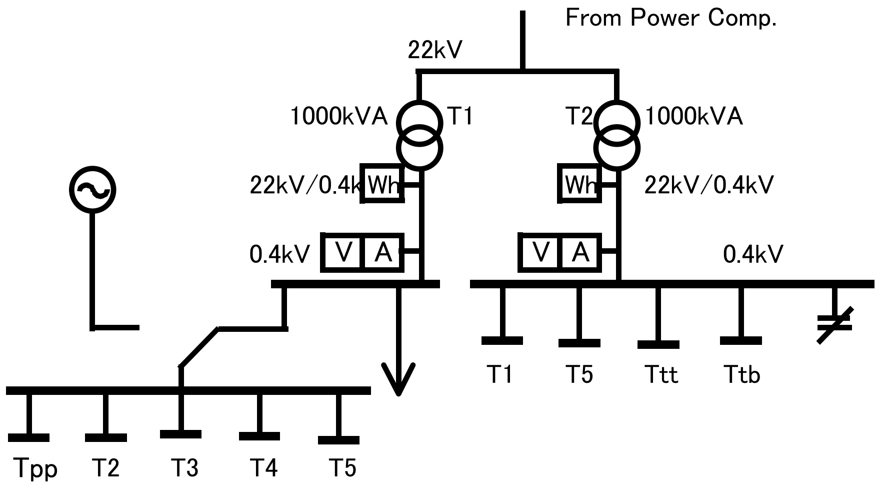


Figure 4.4.4-1 Single line diagram of power receiving system

Amount of receiving power is 330kW, T1: 130kW, T2: 200kW, on the daytime of on-site survey. Power factor is about 90%, which value is set by variable power condensers.

For each transformer, ratio of apparent power to rated capacity is T1: 22%, T2: 14%, which is rather low, therefore transformers are operated in low efficiency.

(2) Measures for improvement

Changing to one-transformer operation from 2-transformer operation by cutting one unit off the line is proposed. This measure can be done by only a few circuit-breaker-operations, incase that low voltage-switching- gear configuration is applied to the system.

In order to estimate the effect, daily pattern of power consumption is assumed as shown in Figure 4.4.4-2.

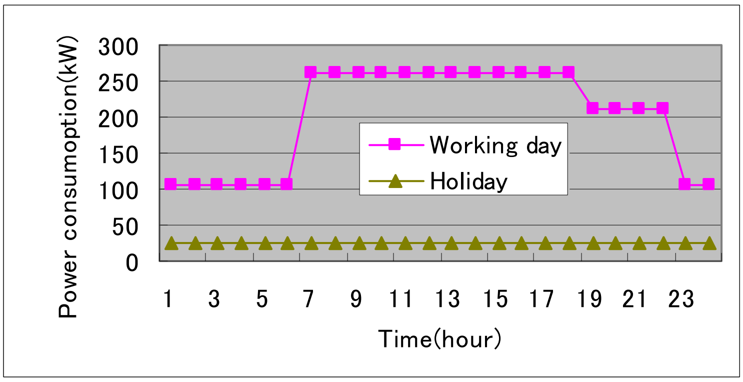


Figure 4.4.4-2 Assumed daily pattern of power consumption

Annual power consumption which is assumed to have pattern in Figure 4.4.4-2 is equal to actual consumption in 2007 as for 300 working days and 56 holidays per year.

Power loss in a transformer (Wt) is calculated by a following equation with no-load loss (Wi) and load loss (Wc).

$$Wt = Wi + P^2 \times Wc$$

Where, Wi; no-load loss [kW], Wc; load loss [kW] and P; ratio of apparent power for loads to rated value of transformer, that is load factor.

For estimation of power loss of transformer during a certain time frame like an year, equivalent average load factor, that is an average loaded with the time, is useful. The equivalent average load factor, Pe, is defined as follows:

$$Pe = \sqrt{\frac{1}{T}\sum_{t=1}^{N}\left(\frac{S(t)}{M}\right)^2 \Delta t}$$

where, M: transformer’s rated capacity [kVA], S(t): load value [kVA], T: time frame to be concerned [h], $\Delta t = T/N$: time slot[h] divided by N.

Annual power loss of Ploss [kWh] is calculated with annual equivalent average load factor of Pe, and expanded equation,

$$Ploss = (Wi + Pe^2 \times Wc) \times 8,760.$$

Where, constant of 8,760 means hours in a year, 24 h/day × 365days/year.

No-load-loss of 1,880W and load-loss of 11,890W are used for the loss estimation. These are typical losses of Japanese normal type transformer.

The equivalent load factors of working day and holiday are calculated and shown in Table 4.4.4-1.

Table 4.4.4-1 Calculation of equivalent load factor

Hour	Power consumption		(Load factor)^2×1 (t=1h)			
	Working day	Holiday	1 transeformer		2 transeformer	
	kW	kW	Working day	Holiday	Working day	Holiday
1	105	26	0.014	0.0008	0.003	0.0002
2	105	26	0.014	0.0008	0.003	0.0002
3	105	26	0.014	0.0008	0.003	0.0002
4	105	26	0.014	0.0008	0.003	0.0002
5	105	26	0.014	0.0008	0.003	0.0002
6	105	26	0.014	0.0008	0.003	0.0002
7	262	26	0.085	0.0008	0.021	0.0002
8	262	26	0.085	0.0008	0.021	0.0002
9	262	26	0.085	0.0008	0.021	0.0002
10	262	26	0.085	0.0008	0.021	0.0002
11	262	26	0.085	0.0008	0.021	0.0002
12	262	26	0.085	0.0008	0.021	0.0002
13	262	26	0.085	0.0008	0.021	0.0002
14	262	26	0.085	0.0008	0.021	0.0002
15	262	26	0.085	0.0008	0.021	0.0002
16	262	26	0.085	0.0008	0.021	0.0002
17	262	26	0.085	0.0008	0.021	0.0002
18	262	26	0.085	0.0008	0.021	0.0002
19	210	26	0.054	0.0008	0.014	0.0002
20	210	26	0.054	0.0008	0.014	0.0002
21	210	26	0.054	0.0008	0.014	0.0002
22	210	26	0.054	0.0008	0.014	0.0002
23	105	26	0.014	0.0008	0.003	0.0002
24	105	26	0.014	0.0008	0.003	0.0002
Total of 24h's			1.346	0.0204	0.336	0.0051
Equivarent load factor		Pe	0.237	0.029	0.118	0.015

Using values in Table 4.4.4-1, annual equivalent load factors are calculated as 0.108 for 2-transformer system and 0.215 for 1-transformer system.

Losses calculated are shown in Table 4.4.4-2.

Table 4.4.4.-2 Transformer loss

r	Pe	Load loss (W/unit)	No load loss (W/unit)	Units of transformer	Total loss (kWh/year)
2 transformer system	0.108	137	1,880	2	35,346
1 transformer system	0.215	550	1,880	1	21,285
Saving					14,061

As shown in Table 4.4.4-2, total loss of 2-transformer system with doubled no-load loss is larger than 1-transformer system. The effect of proposed system, 1-transformer system with higher load factor is as follow.

Amount of power saving: 35,346 kWh – 21,285 kWh = 14,100kWh/y

Annual power cost reduction: 14,100kWh/year × 1.010k VND/kWh = 14,241 × 1,000VND/y

2) Power monitoring system

(1) Present condition and problems

394 [V] at 2nd terminal of the transformer and 385 [V] at tunnel kiln terminal are measured. Voltage drop rate of the distribution line is less than 3%, which means small loss and good at power distribution.

Main power users and their consumption are shown in Figure 4.4.4-3.

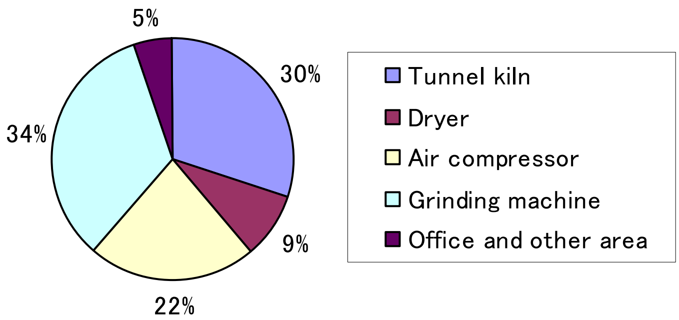


Figure 4.4.4-3 Power users and their consumption

The tunnel kiln and drying room are working all day long but ball mills, mixers and like these heavy load machines are operating during the time frame except for on-peak time of 18:00 to 22:00.

Machine operation planning seems to be considered efficiently but the present state that information of the power consumption relies on only bills from the power-company is not enough for energy conservation activities.

(2) Measures for improvement

The first of all, grasping precise and actual states of energy consumption should be required for effective energy conservation activities. And accuracy and reliability of the data are also essential.

For this purpose, a kind of automatic and mechanical system is useful. Whole power monitoring system, which measures receiving power and power consumption of main branch feeders in the system, may be suitable. One of examples is shown in Figure 4.4.4-4

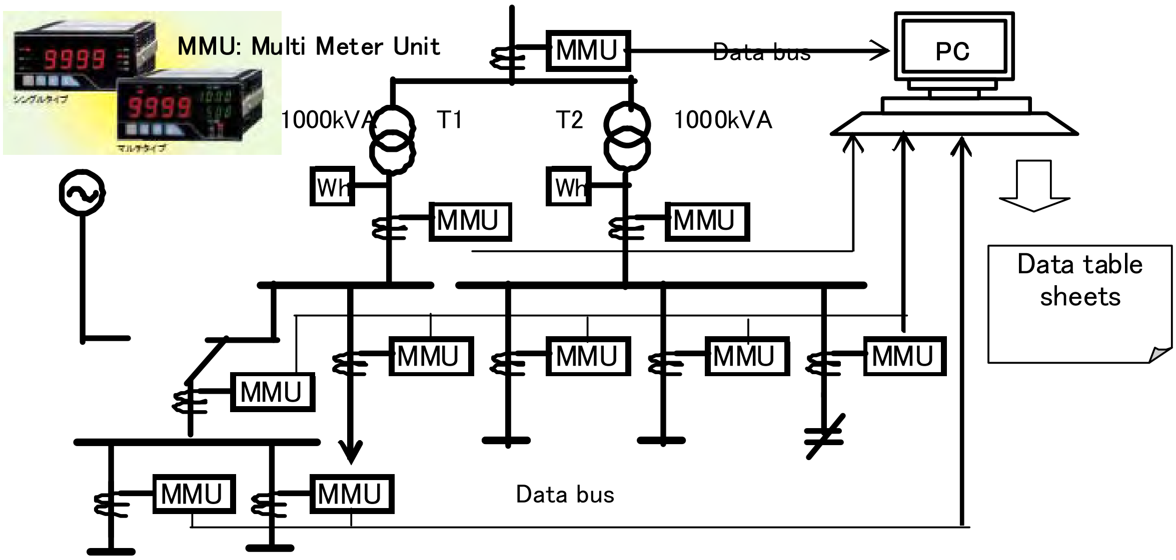


Figure 4.4.4-4 Image of power monitoring system

Digital multi-meter-units for measuring the receiving power are used and the data are transmitted to a personal computer that is used as data gathering and output device. The computer compiles tables of the monitoring data, which may be utilized for power management of the company.

With this system, hourly measurements of power consumption are available. This is the first step to fruitful and developing energy conservation activities.

By ensuring the actual management of power consumption during on-peak demand time and grasping night-time power consumption, the relation between power consumption and state of equipment's working should be examined and analyzed. As the result, unnecessary waiting power consumption will be recognized and eliminated. This is a typical example for the system utilization.

Expected effect largely depends on level of the system utilization and improvement of energy conservation activity. But saving about 5 to 10% of the power consumption may be expectable.

Amount of power saving: 1,487,000kW/y × 5% = 74,500kWh/y

Annual power cost reduction: 74,500kWh/y × 1,010VND/kWh = 75,245 × 1,000VND/y

3) Efficient use of energy saving regarding motors

(1) Present condition and problems

As a low voltage big size motor requires larger current, much ohm loss are brought out through the supply cable line. Motor driving tunnel kiln equipment, air compressor and ball mill are in these cases.

(2) Measures for improvement

Reduction of voltage-drops by converting cables and installing static condensers in order to reduce reactive current may be proposed.

Power loss in distribution line is calculated with cable resistance "r" and current "I" as follows.

Power loss in 3 phase line: $W = 3r \times I^2$

Then, improvement of distribution line efficiency requires lowering "r" and "I". The former is increase of cable size and the latter is improvement of power factor with static condenser.

Compensation of reactive current with static condenser is shown in Figure 4.4.4-5.

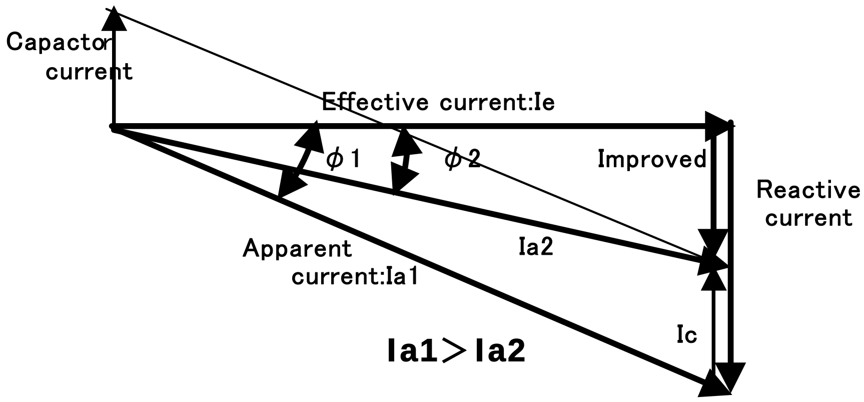


Figure 4.4.4-5 Compensation of reactive current by static condenser

Generally electric equipment produces generally lag-phase current as reactive current, which is shown as I × sinφ, where "I" is lag-phase current, cosφ is power factor.

Current through static condenser flows in couture-phase to the reactive current and reduces the current "I" to almost as much as effective current "Ic". As a result, distribution line loss of $r \times I^2$ becomes smaller.

As far as limited in factory yard, following equations can be used for estimation of power loss of distribution line.

$$W = S \times (\Delta V/V) \times 1 / \cos\varphi$$

Where, W: power distribution loss, S: apparent power.

Voltage drop of ΔV/V shows a rough index of the loss, which is ratio of loss in a supply cable to necessary power for load.

With installing static condenser at load terminal, apparent power of S decreases and power factor of cosφ also approaches to 1. As the result, cable line loss of W is improved.

Typical loads are selected and the effect of static condenser installation is estimated as follow. With assuming present voltage drop as ΔV/V = 3%, data of equipment are calculated as shown in Table 4.4.4-3.

Table 4.4.4-3 Power factor and surface power of equipment

Equipment	Voltage (V)	Current (A)	Power factor	Active current (A)	Reactive current (A)	Surface power (kVA)	Reactive power (kVar)	Active power (kW)
Tunnel kiln	384	108	87%	94	53	71.8	35.4	62.5
Compressor	396	89.3	79%	71	55	61.2	37.6	48.4
Ball mill	398	65.9	82%	54	38	45.4	26.0	37.3

The improvements of distribution loss by static condenser are listed on table 4.4.4-4.

Table 4.4.4-4 Improvement of distribution loss by static condenser

Equipment	Static condenser		Present (kW)	With static condenser (kW)	Saving (kW)
	(μF)	(kVar)			
Tunnel kiln	700	32	2.48	1.64	0.84
Compressor	700	34	2.33	1.15	1.17
Ball mill	500	25	1.66	0.92	0.74

Installing static condenser improves the power factor at 100% and the current decreases nearly to the effective current. As the result, voltage drop is improved at 2.5 to 2.6%.

With assuming annual working hours, following effects are estimated

Amount of power saving: 0.84kW × 24h/day × 200days/y +1.17kW × 24h/day × 300days/y + 0.74kW × 12h/day × 300days/y = 15,100kWh/y

Annual power cost reduction: 15,100kWh/y × 1,010VND/kWh =15,251 × 1,000VND/y

5. Textile Factory E

5.1 Introduction

1) Factory name: Textile Factory E
2) Location: Ho Chi Minh City
3) Description of business
   (1) Sub-sector of industry: Textile industry of weaving, dyeing and sewing
   (2) Main product: cloth, T-shirt and sport shirt
   (3) Annual production: cloth: 1,400,000 m^2/year, T-shirt: 250 ton/year, Shirt: 580 ton/year in 2007
   (4) Export ratio: 50%, Export to Japan, EU and USA
   (5) Number of employees: 420 persons
4) Person in charge of energy on-site survey: Deputy General Director
5) Outline of factory

   This factory is a medium-scale textiles, dyeing and sewing factory, which began production in 1992 as a state-run enterprise, and it was privatized in January 2008. Since the surrounding area has been urbanized, the factory is directed by the local government to move to the suburbs in two years. An energy audit of this factory was carried out in December 2007 as a project of Ho Chi Minh City.

5.2 Outline of energy on-site survey

1) Survey team member

   JICA Study Team: Mr. Norio Fukushima, Mr. Wataru Ishikawa, Mr. Hisashi Amano

   Institute of Energy: Mr. Hung, Mr. Hoang Anh

   ENERTEAM: Mr. Hien, Mr. Linh
2) Survey period: November 6th to 7th and 13th, 2008
3) Surveyed equipment: heat medium boiler, steam piping, power receiving equipment, tenter (drying and heat set), motor load, and illuminance of sewing shop

5.3 Results of energy on-site survey

1) Improvement proposal items and the expected effect after improvement measure implementation are shown in Table 5.3-1

   The EE&C potential in the present equipment is 13.7%

Table 5.3-1 Improvement proposal items and the expected effect after improvement measure implementation

No.	Item No.	Improvement items	Expected effects		
			Kind of Energy	Amount of energy conservation (kL/y, kWh/y etc)	Amount of energy saving (×1,000VND/y)
1	5.4.2-1)	Heat medium boiler: Improvement of air ratio; Change of air ratio of 1.9 to 1.2	Fuel oil	17 ton/y	204,000
2	5.4.2-2)	Heat medium piping: Reinforcement of heat insulation	Fuel oil	1.3 ton/y	15,400
3	5.4.2-3)	Steam piping: Repairing of steam leakage	Fuel oil	43.6 ton/y	523,200
4	5.4.2-4)	Steam system: recovery of steam condensate	Fuel oil	30.3 ton/y	363,600
5	5.4.2-5)	Steam trap: inspection and repairing	Fuel oil		
6	5.4.3-1)	Jet dyeing machine: Applying VSD control of circulation pump	Power	220,668 kWh/y	219,679
7	5.4.3-2)	Stenter: Improvement of control of exhaust fan	Power		
8	5.4.4-1)	Power receiving system: installing power monitoring system	Power	142,150 kWh/y	141,513
9	5.4.5	Lighting: installing of reflection plate for fluorescent tube	Power	68,232 kWh/y	67,926
Total of expected results			Fuel (total)	92.2ton/y (92 toe/y)	1,106,000
			Electric power (total)	431,050 kWh/y (119 toe/y)	429,000
Crude-oil equivalent of fuel and electric power (total) (Reduced volume of carbon dioxide (CO_2))				211 toe/y (ton CO_2)	
Annual energy consumption			Fuel (total)		747.3 ton/y
			Electric power (total)		2,843 MWh/y
			Total in factory		1,535 toe/y
Energy conservation rate of the whole factory			Fuel (total)		12.3 %
			Electric power (total)		15.1 %
			Total in factory		13.7 %

2) Annual energy consumption and energy intensity

(1) The Amount of annual energy consumption (C+D), B= 1,535 toe

(in which) The amount of crude-oil equivalent of electric power: C = 788 toe

(Purchased electric power E = 2,843 MWh) × 0.277

The conversion factor to primary energy of electric power is calculated according to 31% of thermal efficiency of thermal power generation station in Vietnam.

Conversion factor to primary energy = 860 / 0.31 = 2,770 Mcal/MWh = 0.277 toe/MWh

1 toe = 10,000 Mcal

Amount of crude-oil equivalent of all fuel consumption D = 747 toe

(sum total which carried out the crude-oil conversion of each amount of fuel)

Details (before conversion) Heavy oil ( ): 747 ton in 2006

Heat value = 10,000 kcal/kg

(2) Energy intensity (Energy consumption per annual shipment amount etc.)

Energy intensity is shown in Table 5.3-3.

Table 5.3-3 Production and Energy intensity

	2006	2007
Production (ton/y)	1,483,000 kg	Cloth: 1,400,00 m^2 T-shirt: 250 ton Shirt: 580 ton
Fuel consumption (Fuel oil ton/y)	930	747.3
Fuel intensity (kcal/ton)		
Electricity consumption (MWh/y)	2,823	2,843
Electricity intensity (kWh/ton)		

3) Remarks

(1) Energy price

Fuel oil: 12,000 VND/kg (2008),

Electricity: 04:00 - 18:00 896.5 VND/kWh

18:00 - 22:00 1,809.5 VND/kWh

22:00 - 04:00 489.5 VND/kWh

Average: 800VND/kWh

(2) Operation hours

Annual operation days: 303 days

Daily operation hours: Weaving machine: 24 hours

Dyeing process: 16 hours

Sewing and finishing: 10 hours

(3) Use of energy

Fuel oil ----- Heat medium boile r-------------- Stenter

Coal --------------- Steam boiler (Outside) ----- Steam (Purchased) ----- Jet dyeing machine

Peanut shell --- --- Yarn dyeing machine

Electricity ----- Yarn twist machine, Weaving machine, Dyeing machine, Stenter, Sewing machine, Iron, Lighting

(4) Past energy audit

Energy audit of HCMC EE&C Program was conducted by ENERTEAM in December 2007. Proposals of EE&C measures are as follows:

(a) Introduction of high efficient lighting system: EE&C effects: 75.2 MWh

(b) Circumstance improvement of air compressors in dyeing shop with high humidity:
EE&C effects: 3.2 MWh

(c) Recovery and re-use of steam condensate of dyeing machine

(d) Shifting of electricity load: A part of load is to be move from on-peak time to off-peak time.

(e) Establishment and improvement of energy management system:
EE&C effects: 209 MWh, 84.6 kL-fuel oil

The above EE&C measures are not yet implemented so far November 2008.

4) Equipment

Equipment and machine are made in Italy, China and Japan.

Specifications of production equipment in the factory are shown in Table 5.3-3

Table 5.3-3 Specifications of production equipment

No.	Equipment	Q'ty	Main specifications
1	Steam Boiler	3	No.1, No.2 boiler (Operation stop) Manufacturer: Takao (Japan), Babcock Installation year: 1998, 2000 Type: Flue tube boiler Capacity: 7.2 t/h, 10 t/h Fuel: Heavy oil Max Pressure: 4 bar, 6.5 bar Max temperature 200ºC
			No.3 boiler: Manufacturer: China (In operation) Installation year: Oct. 2000 Type: Flue tube boiler Capacity: 10 t/h Fuel: Coal + Peanut shell Max Pressure: 1.3Mpa Max temperature 200ºC
2	Heat media boiler	1	Type: Vertical type tube boiler Manufacturer: German Capacity: 1,744 kW Fuel: heavy oil Heat medium: Thermo-oil Minimum flow rate: 135m^3/hr Allowable pressure: 10 bar Allowable temperature 300ºC
3	Twisting machine	17	Manufacturer: Japan Motor: 22kW, 15kW
4	Weaving machine	54	Manufacturer: Ishikawa (Japan), Somat (Italy), Nuove Prgmme (Italy)
5	Dyeing machine for cloth	10	Type: Jet dyeing machine Manufacturer: Hisaka (Japan), Taiwan, German Pressure and temperature: 2.83 bar, 130^{o}C
6	Dyeing machine for thread	4	
7	Stenter machine	2	Manufacturer: Bruckner (German)

5) Manufacturing process

(1) Spinning (a)

Two yarns are twisted and suited.

(2) Heat-treatment (Vacuum Heat Setter)

Twisted yarn is prevented from returning in the steam heating.(80 to 90ºC) in the autoclave (45 minute/batch)

(3) Spinning (b)

Yarns are winded up to a big roll of yarns.

(4) Dyeing of yarn

Use of yarn dyeing machine

(5) Knitting machine

Knits for cloths of various pattern

(6) Dyeing of cloth

Dyeing cloth for 5 to 10 hours by using of hot water of 120 to 130ºC heated through heat exchanger with steam

(7) Dehydration, drying (wrinkle removing)

dehydrates with the centrifugal separator

drying, wrinkle removing through stenter and dryer

(8) Sewing

T-shirt, sport- wear, underwear

(9) Inspection and delivery

Yarn → Spinning (a) → heat treatment → Spinning (b) → Dyeing of yarn →

→ Weaving machine → Cloth → Dyeing → Dehydration and Drying → Cloth →

→ Inspection → Delivery

→ Sewing → T-shirt → Inspection → Delivery

Figure 5.3-1 Flow sheet of textile and apparel manufacturing process

5.4 Energy On-site Survey of Factory

5.4.1 Activity of energy management

1) Energy management organization

(1) Present condition and problems

Energy management organization is not established.

(2) Measures for improvement

As top management does not have awareness of EE&C, top management has to establish the energy management organization and promote awareness of EE&C.

2) Implementation of measurement and recording

(1) Present condition and problems

Most of instrument meter is out of service, and so gathering and measurement of data are not implemented.

(2) Measures for improvement

Instrumentation meter has to be repaired for measurement.

3) Maintenance management of equipment

(1) Present condition and problems

Many leakage points of steam and water are found. Heat insulation material of steam piping is broken in some place and is not repaired.

(2) Measures for improvement

Broken insulation material is to be repaired soon, and periodical inspection is to be conducted with checklist.

4) Energy consumption management

(1) Present condition and problems

Recording of energy consumption is not conducted.

(2) Measures for improvement

It is necessary for managers to have awareness in energy conservation.

5) Energy intensity management

(1) Present condition and problems

Energy intensity management is not conducted.

(2) Measures for improvement

Water intensity is important as well as fuel and electricity intensity.

6) PDCA management cycle

(1) Present condition and problems

PDCA management is not conducted.

(2) Measures for improvement

PDCA management cycle is important element for energy management and small group activities. PDCA management is evaluated with measurement data, and so measurement system is to be established.

7) Evaluation of energy management activity

Evaluation of energy management activity is shown in Figure 5.4.1-1.

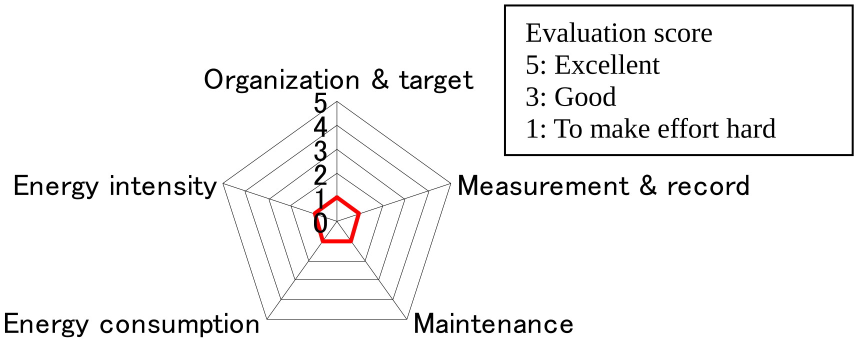


Figure 5.4.1-1 Evaluation of energy management activity

5.4.2 Heat medium boiler and steam system

Oil firing heat medium boilers and coal firing steam boilers are installed in this factory. Heat medium boilers supply heat source to a stenter with the temperature of heat medium of 235 to 240ºC. Stenter makes cloth dry and heat set, and is operated in high operation rate. Fuel of the boiler is fuel oil. Combustion control is automatic operation control by the temperature setting of heat medium at the outlet of the boiler. The section of heat medium boiler is shown in Figure 5.4.2-1.

1 set of coal firing boiler with stoker is installed in 2008 against higher oil price, which is made in China. Fuel of the boiler is coal and peanut shell. The boiler is operated by a subsidiary company and steam is supplied to the factory. Coal firing boiler is out of scope of on-site survey.

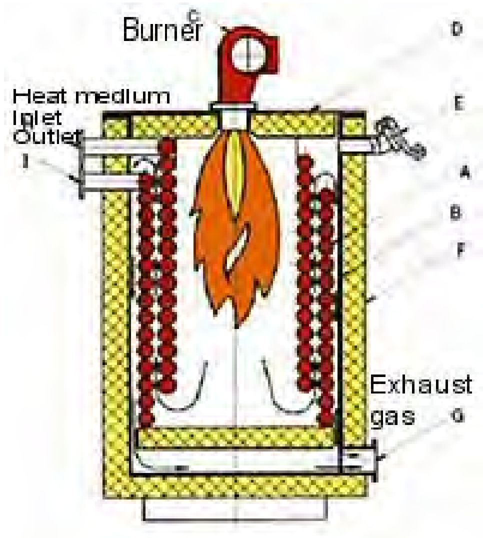


Figure 5.4.2-1 Section of heat medium boiler

1) Combustion control of heat medium boiler

(1) Present condition and problems

Measurement of heat balance of the boiler is planed, but measurement of boiler efficiency of loss method is conducted due to lack of heat medium flow rate signal of orifice plate at the outlet of boiler. Boiler efficiency by loss method is 79.2%, that is very low value. Oxygen content of exhaust gas is 9.7 to 10.2%, which means air ratio of 1.9 and exhaust gas heat loss of 17.8%.

Measurement value and thermal efficiency of heat medium boiler are shown in Table 5.4.2-1.

(2) Measures for improvement and expected effect

When air ratio is set at 1.2 to 1.3 from 1.9, boiler efficiency can be improved from 79.2% to 85.9% by 6.7%.

Characteristic value of heat medium is assumed as follows:

Density: 0.8 kg/m^3 at 200ºC

Specific heat: 2.5 kJ/kgºC at 200ºC

Fuel oil consumption is calculated with operation condition of heat medium boiler as follows:

Flow rate of heat medium: 100 ton/h

Difference of temperature of heat medium at the inlet and outlet: 6ºC

Boiler efficiency: 80%

Annual operation hours: 24h/d × 303d/y = 7,272 h/y

Heat value of fuel oil: 10,000 kcal/kg = 41,860 kJ/kg

Fuel consumption of heat medium boiler:

100t/h × 0.8 × 6ºC × 2.5kJ/ kgºC / 0.8 / 41,860kJ/kg × 72,727h/y = 260 ton/y

Saving energy by air ratio improvement is as follows:

Saving energy: 260ton/y × 0.067 = 17 ton/y

Energy cost saving: 17 ton/y × 12,000,000 VND/ton = 204,000,000 VND/y

Table 5.4.2-1 Measurement value and thermal efficiency of heat medium boiler

Heat medium boiler		Start	15 min	30 min	45 min	Average	
Measuring time		10:34	10:50	11:05	11:20		
Rated capacity	MJ/h					1744kW	
Inlet heat medium temperature	deg-C	233	231	229	228	233	
Outlet heat medium temperature	deg-C	239	237	235	235	237	
Setting outlet heat medium temperature	deg-C	270	270	270	270	270	
Difference temperature of inlet and outlet	deg-C	6	6	6	7	6.3	
Differential pressure of heat medium		0.29	0.29	0.29	0.285	0.3	
Heat medium pressure	Bar	4.8	4.82	4.85	5	4.8	
							Improved
Lower calorific value of fuel oil	kcal/kg	10,000				10,000	10,000
Exhaust gas temperature (outlet of boiler)	deg-C	300	290	290	290	293.0	293.0
Oxygen concentration of exhaust gas	%	9.7	10.3	9.7	10.2	10.0	3.0
Excess air ratio		1.9	2.0	1.9	1.9	1.91	1.2
Outside air temperature	deg-C	32				32.0	32.0
A0: theoretical air volume	m^3N/kg					10.5	10.5
G0: Theoretical exhaust gas volume	m^3N/kg					11.1	11.1
G: Dry exhaust gas volume	m^3N/kg					20.6	12.9
Exhaust gas heat loss	kcal/kg					1775	1107
Exhaust gas heat loss	%					17.8	11.1
Boiler efficiency							
Input heat							
Fuel combustion heat	100						100
Output heat							
Exhaust gas heat loss	17.8	to be improve to 5 - 8%					11.1
Radiation heat loss	3						3
Effective heat for heating of heat medium	79.2	Very low					85.9
Total	100						100

2) Heat insulation of heat medium piping

(1) Present condition and problems

Many broken parts of insulation material are found in heat medium boiler and heat medium piping. As temperature of heat medium is 237ºC, dissipative heat loss of piping is very large. The broken parts of insulation material are shown in Table 5.4.2-2.

Table 5.4.2-2 Dissipative heat loss from not-insulated part

No.	Place	Not-insulated equipment	Q'ty	Size	Outer diameter (m)	Not-insulated pipe length (m)	Surface temperature (C)	Surface area (m2)	Heat loss (kcal/h)
1	Boiler	Heat medium pipe	1	200A	0.22	1.0	166		970
2	Stenter	Heat medium valve	3	25	0.03	3.6	191		299
3	Stenter	Heat medium valve	3	25	0.03	3.6	175		263
4	Main pipe	Heat medium pipe end plate	2	200A			205	0.10	137
	Total								1670

(2) Measures for improvement and expected effect

When not-insulated piping is covered with glass wool material of 25mm thickness, 90% of heat loss can be recovered.

Annual operation hours: 24h/d × 303d/y = 7,272 h/y

Heat value of fuel oil: 10,000 kcal/kg

Boiler efficiency of heat medium boiler: 85%

Saving energy: 1,670 × 0.9 × 7,272 / 10,000 / 0.85 = 1,286 kg/y

Energy cost saving: 1.286 ton/y × 12,000,000 VND/ton = 15,432,000 VND/y

3) Steam piping

(1) Present condition and problems

The factory installed 1 set of coal firing steam boiler in October 2008 instead of oil firing steam boilers due to oil price rising. Steam is used for dyeing process and yarn heat set equipment. Steam leakage from steam piping is found much. When steam leaks from a hole of 3mm in diameter, leaked steam volume is 25kg/h at steam pressure of 0.7MPa. Leakage steam volume from 6 holes is 180kg/h. Steam leakage parts are shown in Table 5.4.2-3.

(2) Measures for improvement and expected effect

Steam leakage can be stopped with the replacement of flange gasket and grand packing.

Annual operation hours: 16h/d × 303d/y = 4.848 h/y

Steam saving volume: 150kg/h × 4,848h/y = 727,200 kg/y

Conversion calculation of steam to fuel oil: Steam rating heat = 480kcal/kg, Boiler efficiency = 80%,

Converted fuel oil saving: 727,200 × 480 / 0.8 / 10,000 = 43,600 kg-coal/y

Fuel cost saving: 43,600 kg-coal/y × 12,000 = 523,200,000 VND/y

Table 5.4.2-3 Steam leakage parts

No.	Steam leakage place	Equipment	Q'ty	Size	Surface temperature (ºC)	Steam leakage volume (kg/h)
1	Thread dyeing	Elbow	1	20A	130	25
2	Thread dyeing	Check valve	1	50A	130	25
4	Jet dyeing No.1	Glove valve	2	25A	130	50
5	Jet dyeing No.4	Glove valve	1	25A	130	25
6	Jet dyeing No.6	Glove valve	1	25A	130	25
7	Total					150

4) Recovery steam condensate

(1) Present condition and problems

Large amount of steam are consumed to heat dyeing process water through heat exchangers in dyeing process, but all the steam condensate is not recovered. When steam condensate is recovered, recovery of condensate heat and use of hot water can be saved.

(2) Measures for improvement and expected effect

In this factory, it is effective that condensate is used to soaping water after dyeing step, because the distance of dyeing shop and boiler room is long. The measures which recovered condensate is used for dyeing process are proposed in the energy audit report conducted by ENERTEAM in 2007

When 1 ton/h of condensate is recovered and is used to soaping water, recovered energy is as follows:

Dyeing shop operation hours: 16h/d, Annual operation days: 303d/y

Condensate temperature: 80ºC, Feed water temperature: 30ºC

Recovery heat of condensate: 1,000kg/h × 16h/d × 303d/y × (80 – 30) = 242,400,000 kcal/y

Boiler efficiency: 80%, Fuel oil heat value: 10,000kcal/kg

Converted fuel oil saving: 242,400,000 / 0.8 / 10000 = 30,300 kg/y

Energy cost saving: 30,300 × 12,000 = 363,600,000 VND/y

5) Maintenance of steam traps

(1) Present condition and problems

Steam traps are installed in steam piping and heat exchanger of dyeing machines. Plugging of s steam trap is found at steam header in boiler room and drainage of header is blown with manual open of stop valve. Steam traps of dyeing machine in operation are in normal condition. Function of steam trap can be judged with temperature measurement of inlet and outlet of steam trap and delivered drain condition.

(2) Measures for improvement and expected effect

When steam traps are inspected and overhauled every 2 years, steam consumption loss can be reduced.

5.4.3 Effective use of energy regarding pump, fan, etc.

1) Dyeing facility (Jet dyeing system)

(1) Present conditions and problems

In Jet dyeing system which treats cloth with bleaching, dyeing, bathing process in series continuously after setting, 30kW pump works for supply and circulation of water inside the machine. As water flow volume changes along with cloth material, weight per square-meter and its treatments, operator adjusts manually the flow by controlling delivery valve of pump.

Power consumption, load factor and other related values are as follow.

Rated axial power: 30kW, speed: 3,000rpm, power consumption: 26.9 to 34.3kW, load factor: 78 to 99%.

Kinds of textile products from the factory and their rates are as follow.

Cotton: 20%, Polyester: 20%, mixture of cotton and Polyester: 60%.

Polyester cloth requires less volume of circulating water in treatments than cotton cloth.

Figure 5.4.3-1 shows an overview of jet dyeing machine.

Figure 5.4.3-1 Jet dying machine

(2) Measures for improvement and expected effects

By applying VSD control with inverter, which regulates effectively the motor speed along with cloth material, weight per square-meter and its treatments, the power consumption can be saved.

Comparison between VSD control and valve control is shown in Figure 5.4.3-2. Difference between two curves corresponds to amount of energy saving.

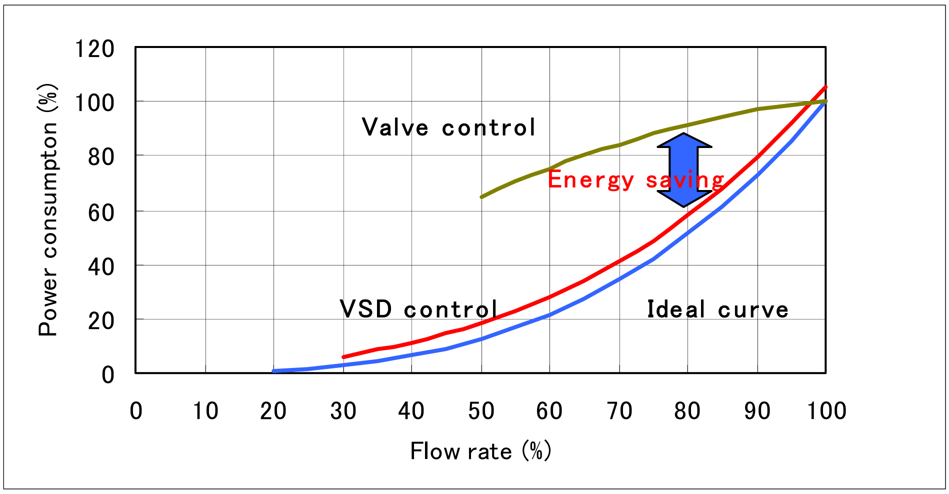


Figure 5.4.3-2 Power consumption with valve control and VSD control

Power consumption of jet dyeing system by valve control, which is removed cyclic element from original measured data with moving average treatment, and the one by VSD control, estimated, are shown on figure 5.4.3-3.

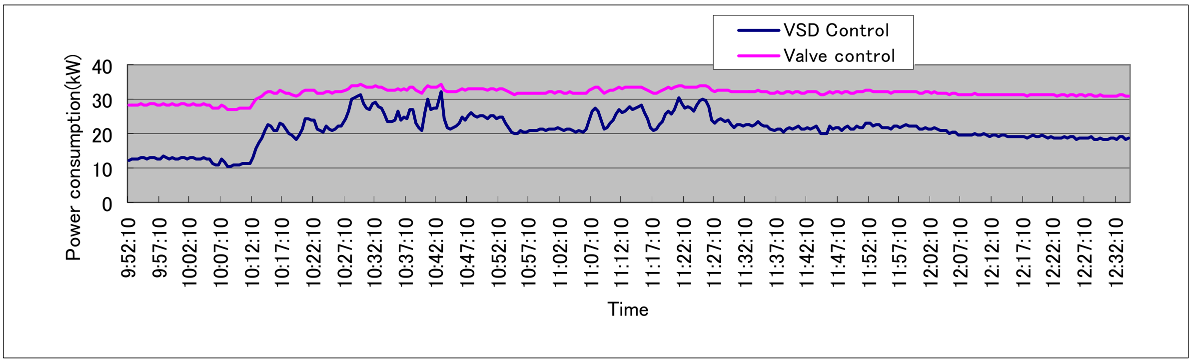


Figure 5.4.3-3 Power consumption of jet dyeing machine in case of valve control and VSD control

Power consumption during this time frame was 85.8kWh with valve control and it is estimated at 57.4kWh with VSD control. As the result, VSD control reduces the power to 67%.

In the factory, 8 units of same type jet dyeing machine are installed and these units work in 2 shifts, 15 hours a day. By assuming that operation rate is 50%, factory working days are 303 days a year and motor efficiency is 97%, annual power consumption can be calculated as follows.

Power consumption of jet dyeing machine:

30kW / 97% × 8units × 16hours/d × 303days/y × 50% = 668,690kWh/y

Therefore, power saving is 33% (= 1 – 67%) of this consumption.

Amount of power saving by VSD control: 668,690kWh/y × 33% = 220,700kWh/y

This corresponds to 7.8% of 2,843MWh/y, which is annual power consumption of the factory.

Annual power cost reduction: 220,700kWh/y × 996VND/kWh = 219,780 × 1,000VND/y

2) Stenter system (cloth drying and heat set equipment)

(1) Present conditions and expected problems

Stenter has such functions as drying cloth and heat-setting with heated air. Heat source for stenter installed at the factory is heat medium, which is heated more than 250ºC by heat medium boiler.

Some fans circulate hot air in the drying section and an exhaust fan is operated for discharging moisture. All of these fans are under VSD control with inverter. However, they are set by hand and run in constant speed. Their speed is not controlled by any signals related to temperature and moisture control.

Especially, inverter frequency setting for exhaust fan is 22.4 Hz, which is the minimum frequency in its control range, as the result, exhaust fans do not work and stop for the exhaustion.

(2) Measures for improvement and expected effects

Temperature and humidity in the drying section should be adjusted along with material and/or thickness of cloth, which is cotton or polyester like these. Normally, the conditions that the temperature is 120ºC and humidity is 65%RH are ideal. In condition that the humidity is higher than 80%, dehydrate speed reduces and its treatment takes longer time. This makes cloth movement slower and the heat loss more.

In order to control humidity of less than 65% in drying section, humidity sensor is installed at the inlet of duct for exhaustion and then exhaust fan speed is controlled with inverter along with the sensor signals.

Figure 5.4.3-4 shows structure of stenter.

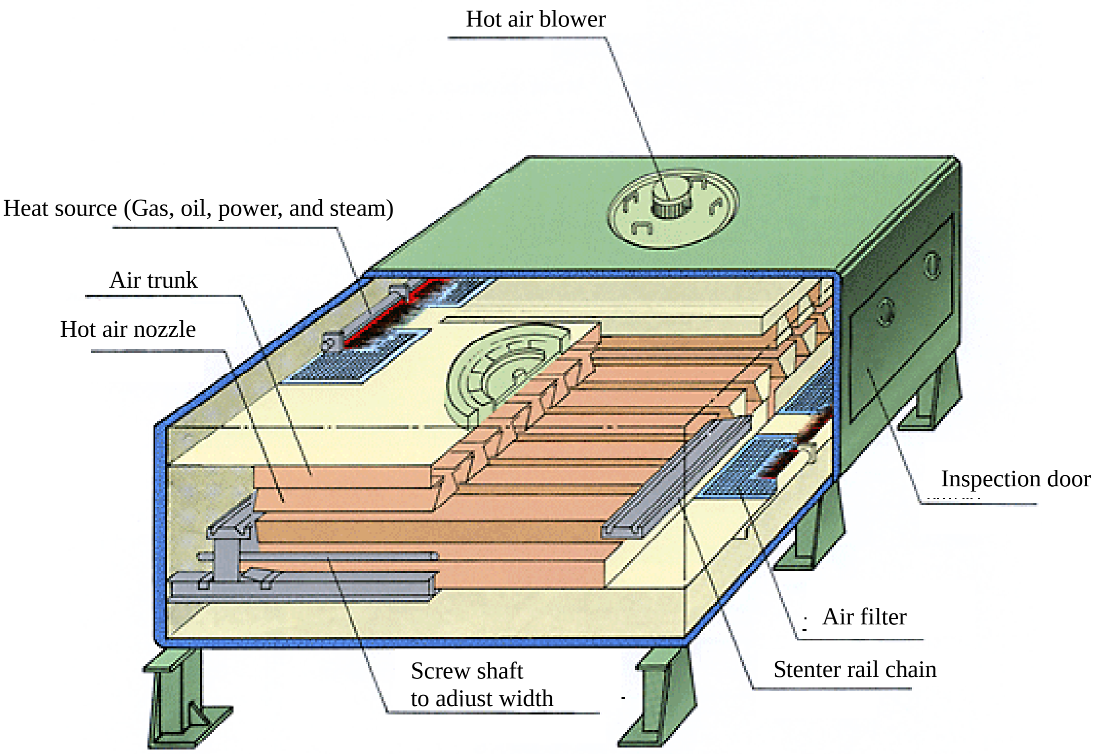


Figure 5.4.3-4 Structure of stenter

5.4.4 Power receiving and distributing equipment and motor

1) Management of power receiving and distributing equipment

(1) Present conditions and problems

Figure 5.4.4-1shows a single line diagram of power receiving system.

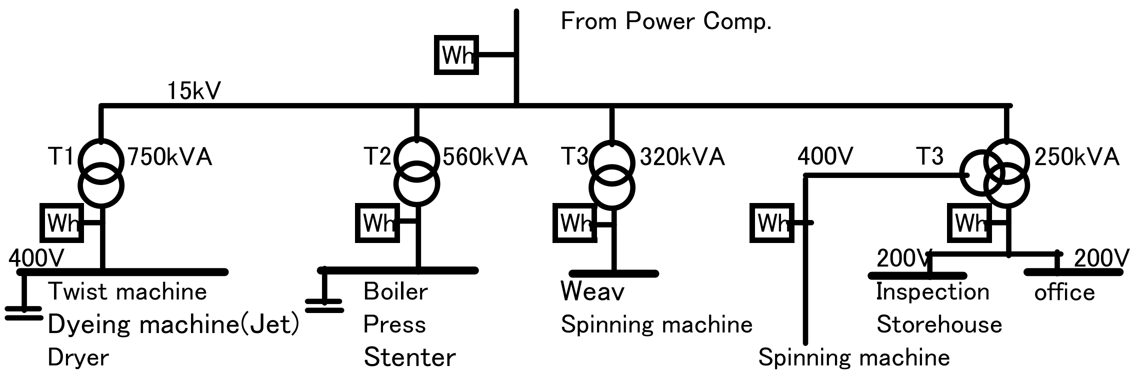


Figure 5.4.4-1 Single line diagram of power receiving system

Watt-hour meters at 2nd terminal of transformers measure monthly power consumption.

Furthermore, a watt-hour meter that is connected next to the switch box in main working shops measures power consumption of the shop. For effective energy conservation activities, grasping real state of energy consumption is essential and the first step. This measuring system should be appreciated. However, it is very regrettable that usage of the system to the activity is not clear.

Power condensers installed at main trunk lines suppress surface power on the line smaller. However, there is a problem in the way to operate the condenser, i.e. power factor control.

Figure 5.4.4-2 shows power factor of 750kVA-transformer line that was measured through night.

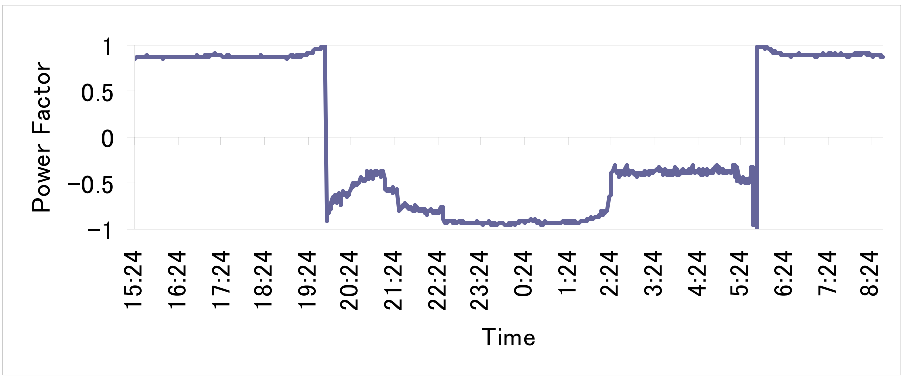


Figure 5.4.4-2 Power factor of 750kVA-transforemer line

Due to capacitance of the power condenser, extreme lead-phase power factors are observed during night, which is lighter load time frame. This might cause too high voltage at power receiving point. Timer control and/or capacitance control is proposed to cut off the power condenser from the line in light load condition.

(2) Measures for improvement and expected effects

The first of all, grasping precise and actual states of energy consumption should be required for effective energy conservation activities. And accuracy and reliability of the data are also essential.

For this purpose, a kind of automatic and mechanical system is useful. One of examples is shown in Figure 5.4.4-3.

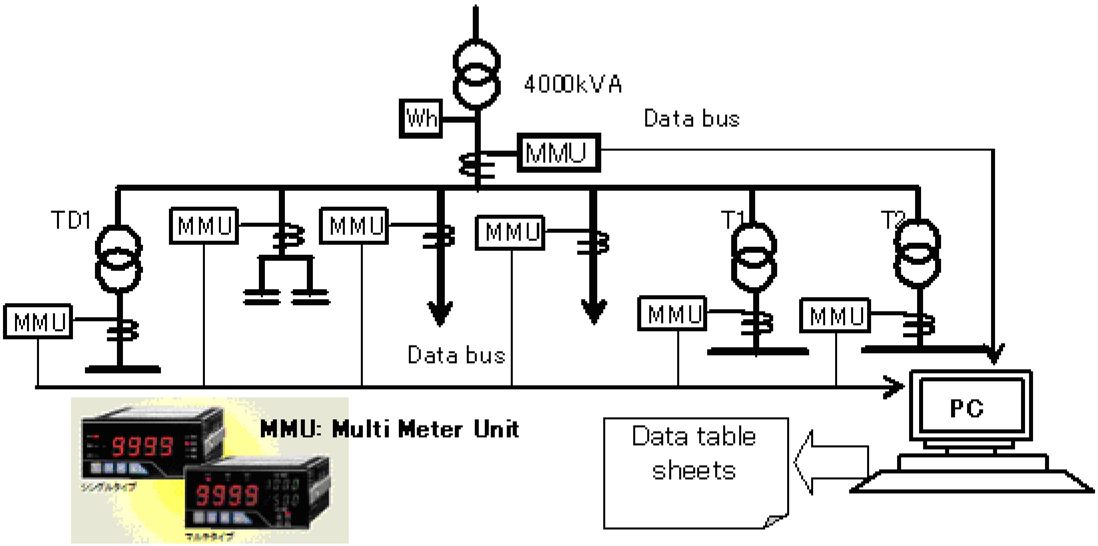


Figure 5.4.4-3 Image of power monitoring system

Digital multi-meter-units for measuring the receiving power are used and the data are transmitted to a personal computer that is used as data gathering and output device. The computer compiles tables of the monitoring data, which may be utilized for power management of the company.

With this system, hourly measurements of power consumption are available. This is the first step to fruitful and developing energy conservation activities.

By ensuring the actual management of power consumption during on-peak demand time and grasping night-time power consumption, the relation between power consumption and state of equipment's working should be examined and analyzed. As the result, unnecessary waiting power consumption will be recognized and eliminated. This is a typical example for the system utilization.

Expected effect largely depends on level of the system utilization and improvement of energy conservation activity. But saving about 5 to 10% of the power consumption may be expectable.

Amount of power saving: 2,843,000kWh/y × 5% = 142,200kWh/y

Annual power cost reduction: 142,200kWh/y × 996VND/kWh = 141,562 × 1,000VND/y

2) Power consumption management

(1) Present conditions and expected effects

Figure 5.4.4-4 shows a pattern of daily power consumption, which is reported in questionnaire, and one in the report of energy audit in 2007.

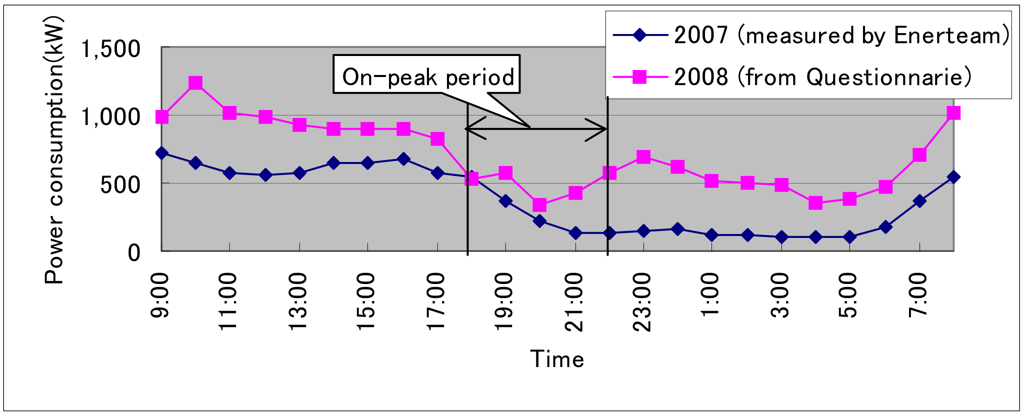


Figure 5.4.4-4 Daily power consumption pattern

There is a little difference between them in night pattern. Both patters may be existing normally.

Facility management that thinks about peak demand time frame can be observed a little, however it is not enough. Power consumed by 750kVA-transformer load in peak demand timeframe and nighttime is studied precisely. The results are shown on Figure 5.4.4-5.

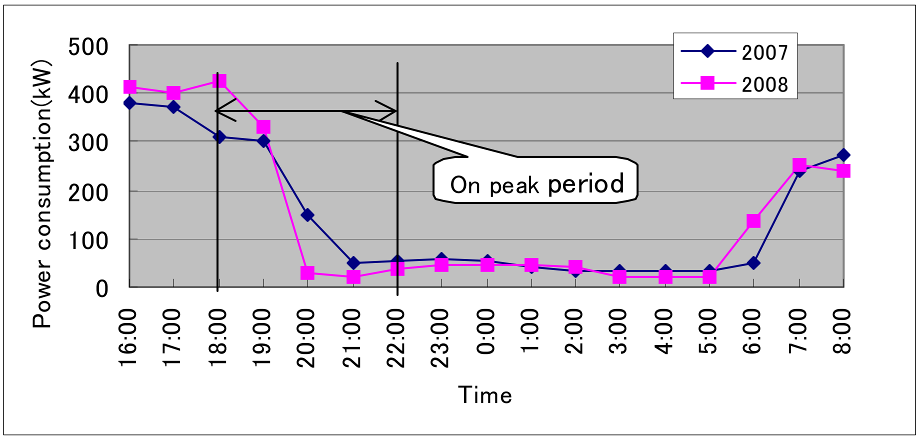


Figure 5.4.4-5 Power consumption of 750kVA-transformer's load

Measured data is almost the same to the one of the energy audit in 2007. From this, the last time recommendation, improving machine operation to be free from on peak period, has not yet been applied in the management.

(2) Measures for improvement and expected effects

Power management by the planned machine operation should be hopeful.

The energy audit report in 2007 was estimated saving money worthy of 237,000VND/y.

5.4.5 Efficient use of energy regarding motor

1) Motor size and its operation management

(1) Present condition and problems

Measured power consumption and calculated load factor of motors are listed in Table 5.4.5-1.

Table 5.4.5-1 Power consumption and load factor of motors

	Rated output (kW)	Frequency (Hz)	Power consumption (kW)	Load factor
Stenter circulate fan No. 1-2 stage	4 × 2	35	3.2	36%
Stenter circulate fan No. 3-6 stage	4 × 2	49.5	6.9 - 7.5	78% - 84%
Thread dyeing pump motor	37	35.2	13.8	34%
Jet dyeing pump motor	30	50	26.9 - 34.3	78% - 99%

Motors with VSD control driven by inverter are used for various load conditions.

However, inverter drive with 49.5 Hz is meaningless and just takes in only inverter loss.

(2) Measures for improvement and expected effects

In jet dyeing machine, valve control is used for flow volume control. VSD control is useful to save energy, which is mentioned in Item 5.4.3 1).

Inverter deriving with 49.5Hz should be improved to being by-passed or resetting suitable frequency.

5.4.6 Efficient use of energy regarding lighting system

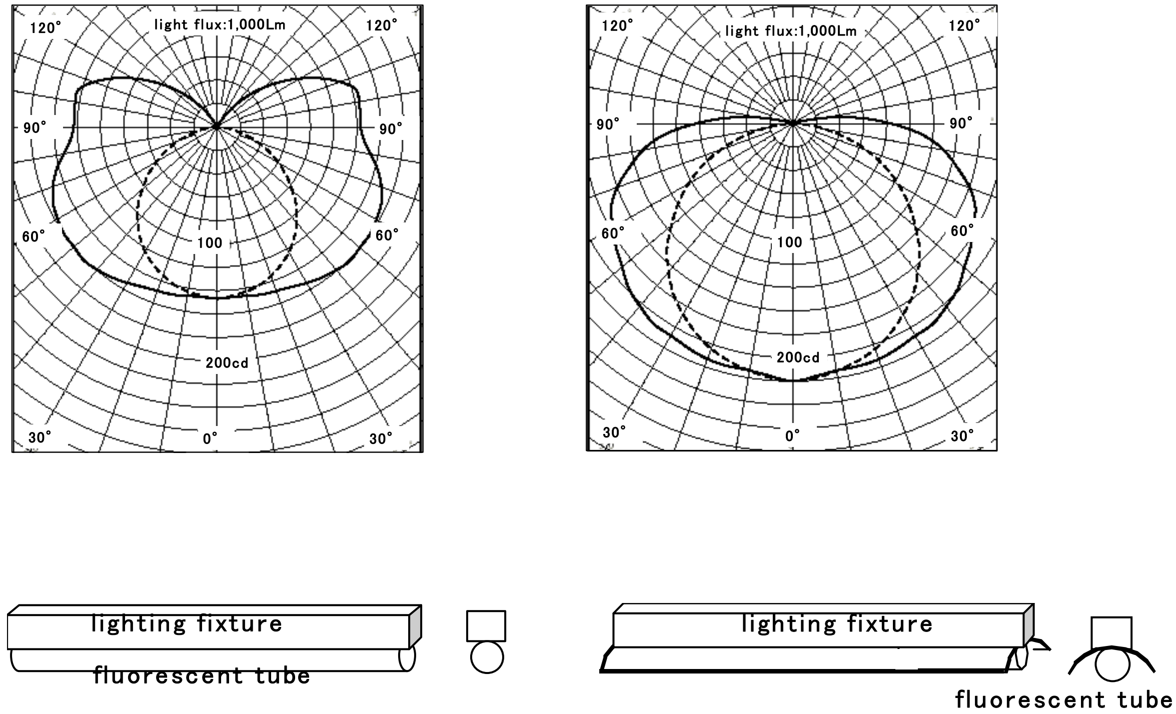
1) Lighting system management

(1) Present condition and problems

Trough-shape lighting fixture with 40W × 1 fluorescent lamp is equipped for sewing shop and ironing shop. Trough-shape lighting fixture has an illuminous intensity distribution curve as shown Figure 5.4.6-1 and its light flux goes upper direction too. This upper-going light flux does not contribute to illuminance of working table, that is waste light flux.

Therefore, the fixture losses effective illuminance and is not suitable for lighting of working place.

Energy conservation activities are the activities to discover waste like this and to remove it.



a) trough-shape lighting fixture b) Fixture with shade

Figure 5.4.6-1 Illuminous intensity distribution curve of two type lighting fixture

Table 5.4.6-1 shows measured illuminance of working shops.

Table 5.4.6-1 illumination of working place

No.	Place	Position	Illumination (Lx)	Lighting condition	Lamp
1-1	Ironing shop	On the table	500	Normal	Fluorescent lamp Straight, 40W No reflector plate
1-2			490		
1-3			520	2 lamps are crossed	
2-1	Sewing shop	On the table	510	2 lamps are crossed	
2-2			450	Normal	
2-3			400	Fluorescent lamp is off	

Illuminance on a sewing machine on a working table is 450 to 510 Lx, which is lower illuminance and rather dark for fine works like sewing.

(2) Measures for improvement and expected effects)

Improving the illuminous intensity distribution curve by a shade, changing to lighting fixture with a shade, can be proposed.

By the improvement, the illuminance on a just down-side table increases by as much as 1.5 times. The effect is estimated with distribution curve in Figure 5.4.6-1.

A condition that height of the lamp with total light flux 3,000 Lm is 1 meter above from worktable is assumed.

In case of trough-shape lighting fixture;

From Figure 5.4.6-1 a), luminance of lamp with light flux 1,000 Lm is 145 cd for 0-degree direction.

Illuminace by lamp with total light flux 3,000 Lm is calculated as follows.

Illuminance: $3 \times 145cd / (1m)^2 = 435Lx$

In case of fixture with shade;

From Figure 5.4.6-1 b), luminance of lamp with light flux 1,000 Lm is 220 cd for 0-degree direction.

Illuminace by lamp with total light flux 3,000 Lm is calculated as follows.

Illuminance: $3 \times 220cd / (1m)^2 = 660Lx$

The illluminance is improved by 660Lx / 435Lx = 1.5.

Illuminance on worktable is estimated as 680 to 760 Lx by referring to measured data.

Here, evaluation of energy conservation is studied.

Energy intensity is used as a standard of evaluation. Energy intensity is defined as following equation.

Energy intensity = amount of energy consumption / amount of production or like this

There are two ways for improving the energy intensity.

a) Decreasing value of the denominator: “reducing energy consumption”

b) Increasing value of the numerator: “increasing production”

Only the reducing and/or saving are likely taken account when it comes to energy conservation.

However, especially in factory case, activities with a viewpoint of increasing the productivity bring sometimes more fruitful effect in general.

Which of these is selected as strategy depends on manager’s attitude and opinion.

Many lighting fixtures and lamps in not only sewing shop and ironing shop but also other shops are not clean enough. Scheduled cleaning should be necessary.

As an effective countermeasure that enhances illuminances and makes cleaning works easier, putting a reflection plate on a fluorescent lamp can be introduced. Figure 5.4.6-2 shows an overview of a refractor attached on a lamp.

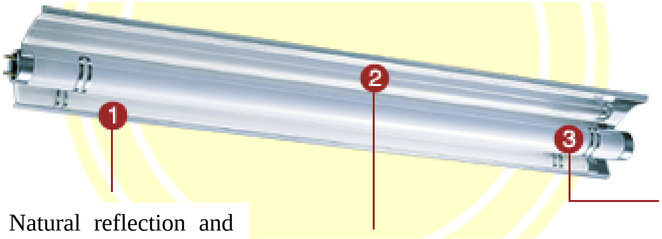


Figure 5.4.6-2 Reflection plate for fluorescent tube

Other than a merit of raising illuminance, attaching the reflection plate makes cleaning work very easy to handle by removing lamp and its fixture together in the case. According to dealer's report, iluminance increase as much as 1.5 times by attaching it. I.e. number of lighting fixture and light power can be reduced to 1 / 1.5 = 67% in condition of as same illuminance as present. Judging from the capacity of transformer for lighting, present consumption rate of lighting power is assumed as 10% of the total consumption.

Lighting power: 2,843,000 × 10% = 284,300kWh/y

Concerned lighting power 80% and saving rate 30% are assumed.

Amount of power saving: 284,300kWh/y × 80% × 30% = 68,200kWh/y

Annual power cost reduction: 68,200kWh/y × 996VND/kWh = 67,894 × 1,000VND/y

6. Food Processing Factory F

6.1 Introduction

1) Name: Food Processing Factory F
2) Address: HCM City
3) Description of Business
   (1) Su-sector of industry: Food processing
   (2) Main product: Fresh Milk, Yoghurt, Canned Milk, Plastic Spoon,
   (3) Start of operation: 2003
   (4) Amount of product: 28,418kL (2007)
   (5) Export: none
   (6) Employee: 300
4) Person in charge of energy on-site survey: Vice-president, 1 - Machinery engineer
5) Outline of factory

   This factory belongs to a group of the state-run enterprise and collects milk from the farm around Ho Chi Minh City, and manufactures fresh milk and yogurt.

   The Factory manufactures container and spoon of lactic acid drink with plastic injection machines besides fresh milk and has a manufacturing line for canned milk.

   This factory introduced from Denmark, France and Germany in 2003.

6.2 Outline of energy on-site Survey

1) Survey member

   JICA Study Team: Mr. Norio Fukushima, Mr. Wataru Ishikawa, Mr. Hisashi Amano

   Institute of Energy: Mr.Hung, Mr. Auh

   ENERTEAM: Mr.Vinh
2) Survey period: November 10th and 11th, 2008

6.3 Results of energy on-site survey

1) Improvement proposal items and the expected effect after improvement measure implementation are shown in Table 6.3-1

   The EE&C potential in the present equipment is 16.2%

Table 6.3-1 Improvement proposal items and the expected effect after improvement measure implementation

No	Item No.	Improvement items	Expected effects		
			Kind of Energy	Amount of energy conservation (kL/y,kWh/y etc.)	Amount of energy saving (× 1,000VND/y)
1	6.4.2-1)	Chiller machine: Installing multiple-unit controller to improve efficiency	Power	208,900 kWh	184,877
2	6.4.2-2)	Cooling water pump: Applying VSD (Variable Speed Driving) to control pump speed	Power	151,500 kWh	134,078
3	6.4.3-1)	Supply water pump: Applying VSD to control water flow and moving sensor position to load-end	Power	67,500 kWh	59,738
4	6.4.3-2)	Air compressor: Changing operation plan under low loading in night	Power	52,600 kWh	46,551
5	6.4.3-3)	Air compressor: Lowering discharge air pressure	Power	104,800 kWh	92,748
6	6.4.4-1)	Steam boiler: Improvement of air ratio: Change of air ration from 1.4 to1.2	Fuel oil	11.4 ton	61,167
7	6.4.4-1)	Installation of small size once through boiler of 2 ton/h: a boiler of 5ton/h operation stop	Fuel oil	95.2 ton	531,857
8	6.4.4-2)	Steam pipe and valves: enforcement of insulation	Fuel oil	9.4 ton	52,506
9	6.4.5-1)	Power receiving system: Installing power-monitoring system	Power	323,400 kWh	286,209
Total of expected results			Fuel (total)	116 ton/y (118 toe/y)	645,532
			Electric power (total)	1,244.3MWh/y (345 toe/y)	1,122,500
	Crude-oil equivalent of fuel and electric power (total) (Reduced volume of carbon dioxide (CO_2))			463 toe/y (ton-CO_2)	
	Annual energy consumption		Fuel (total)		952 ton/y (1,068 toe/y)
			Electric power (total)		6,469 MWh/y (1,792 toe/y)
			Total in factory		2,860 toe/y
	Energy conservation rate of the whole factory		Fuel (total)		11.0 %
			Electric power (total)		19.3 %
			Total in factory		16.2 %

2) Annual energy consumption and energy intensity

(1) The Amount of annual energy consumption (C+D) B = 9,606 toe

(in which) The amount of crude-oil equivalent of electric power: C= 1,961 toe

(Purchased electric power E = 6,496 MWh × 0.277

The conversion factor to primary energy of electric power is calculated according to 31% of thermal efficiency of thermal power generation station in Vietnam.

Conversion factor to primary energy = 860 / 0.31 = 2,770 Mcal/MWh = 0.277 toe/MWh

1 toe = 10,000 Mcal

Amount of crude-oil equivalent of all fuel consumption D = 7,645 toe

(Sum total which carried out the crude-oil conversion of each amount of fuel)

Details (before conversion):

- Heavy oil ( ): 952 ton in 2007 (Heat value = 10,000 kcal/kg, Specific weight = 0.925 kg/liter)
- LPG: 260 ton (Heat value = 10,880 kcal/kg)

(2) Energy intensity (Energy consumption per annual shipment amount, etc.)

Power intensity (E / production volume) = 0.227 kWh/Liter-milk in 2007

Fuel intensity (D / production volume) = 375 kcal/Liter-milk in 2007

Energy intensity is shown in Table 6.3.1-2.

Table 6.3.1-2 Production and energy intensity

	2006	2007
Production (Milk kL/y)	22,050	28,418
Fuel consumption (Fuel oil kL)	768	952
Fuel consumption (Fuel oil Mcal)	7,211,000	8,938,000
Fuel consumption (LPG ton)	199	160
Fuel consumption (LPG Mcal)	2,165,000	1,741,000
Fuel consumption (Mcal)	9,376,000	10,679,000
Fuel intensity (kcal/Liter-milk)	425	375
Electricity consumption (kWh/y)		6,469,000
Electricity intensity (kWh/Liter-milk)		0.227

3) Remarks

It integrates with group company in the Ho Chi Minh district in 2010, and the fresh milk production line is transferred to another factory.

(1) Energy cost

Fuel oil: 5,475VND/kg (2007)

Electricity: 04:00 - 18:00 896.5VND/kWh

18:00 - 22:00 1,809.5VND/kWh

22:00 - 04:00 489.5VND/kWh

Average: 885VND/kWh

(2) Use of energy

Fuel oil --------- Steam boiler----------- steam ----------- heating and sterilization of milk

Electricity ------- Chiller, air conditioner, lighting, etc.

(3) Past energy audit

Energy audit of HCMC EE&C Program was conducted by a consultant company in December 2007. Proposals of EE&C measures are as follows:

a) Introduction of high efficient lighting system
b) Proper outlet pressure of air compressor by VSD control
c) Shift of electric power load: storing of cold water and operation of cold water supply pump at the off-peak period.
d) Establishment and improvement of energy management system

The above-mentioned EE&C measures are not implemented yet.

4) Equipment

Specifications of milk processing equipment are shown in Table 6.3.1-3.

Table 6.3.1-3 specifications of milk processing equipment

No.	Equipment	Q'ty	specifications
1	Steam Boiler	2	Type: Flue and smoke tube boiler Installation: 2003 Manufacturer: Germany Capacity: 5 ton/h Fuel: Fuel oil Steam pressure: 9 kg/cm^2
2	Air Compressor	3	Type: Screw compressor No. 1 & 2: Motor power: 45kW, 1 set of 75kW Pressure: 5.9-6.8 bar No. 3: Motor power: 75kW
3	Chiller	3	Type: NH3 Motor: 150 kW
4	Power receiving transformer	2	Total capacity: 2 sets of 1,250 kVA Voltage: 15/0.4 kV Power factor: 0.9
5	In-house generator	2	Type: Diesel engine driving Capacity : 2 sets of 1,036KVA Voltage : 380 V

5) Manufacturing process

(1) Raw milk

Cows are imported from Australia for raw milk.

(2) Adjustment and sterilization

Heating and sterilization (55ºC --- 75ºC --- 4ºC --- 60ºC --- 140ºC --- 20ºC) are repeatedly conducted.

(3) Pour into the can, bottle and plastic bag

(4) Inspection, packing and delivery

Original milk (milk, sugar, butter) → Mixing → pasteurization, homogenizing →

→ Cool storage → Pasteurization, homogenizing → Pour into can, bottle →

→ Packing → Delivery

Figure 6.3.1-4 Flow sheet of milk processing process

6.4 On-site survey report

6.4.1 Activity of energy management

1) Energy management organization

(1) Present condition and problems

Organized communication is held smoothly with 4 heat engineers and 12 electrical engineers, though energy management organization is not established.

Target of energy conservation is not set up due to low energy price.

Awareness on energy conservation of manager is low, and energy conservation measures of the energy audit executed in November, 2007 are not implemented.

(2) Measures for improvement

It is important that top management of the factory has awareness of EE&C and implement energy conservation activities.

2) Implementation of measurement and record

(1) Present condition and problems

Collection and management of data of operation is regularly implemented, and management criteria on operation are set up.

3) Maintenance management of equipment

(1) Present condition and problems

Fuel leakage and steam leakage of boilers and steam piping and malfunction of steam traps are found and equipment is not managed enough though inspection and maintenance of equipment is conducted.

Energy saving and automation of main equipment are advanced because of modern equipment, but engineering of overall factory is not implemented sufficiently such as pressure control of compressed air and the pressure setting of the feed-water pump. Piping system diagram of water and compressed air are not maintained.

4) Energy consumption management

(1) Present condition and problems

Record of energy consumption is regularly implemented, but recorded data are not used for energy consumption management.

(2) Measures for improvement

Trend graphs are made from record of the energy consumption, and change in the energy consumption is monitored for earlier detection of the unexpected value.

5) Energy intensity management

(1) Present condition and problems

Energy intensity is not managed, and awareness on energy conservation is low.

(2) Measures for improvement

It is important for top management to recognize energy conservation through energy intensity management.

6) PDCA management cycle

(1) Present condition and problems

Activities are not implemented yet.

(2) Measures for improvement

At first, it is necessary for top management to have awareness on energy conservation and to start PDCA management cycle.

7) Evaluation of energy management situation

Evaluation of energy management activity is shown in Figure 6.4.1-1.

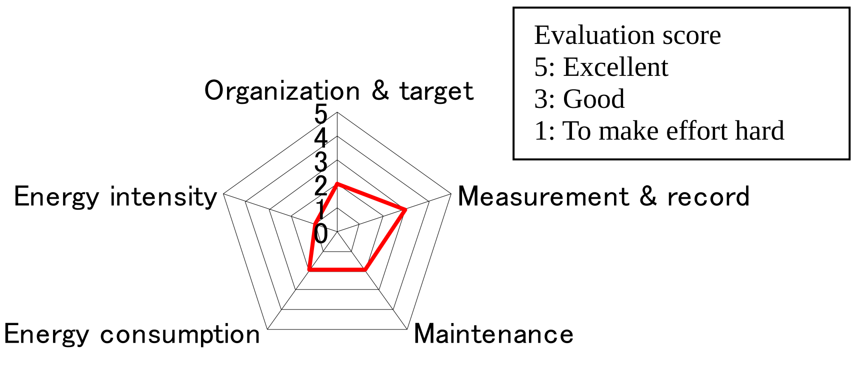


Figure 6.4.1-1 Evaluation of energy management

6.4.2 Efficient use of energy regarding chiller system

1) Chiller system

(1) Present conditions and problems

3 units of 150kW chiller are installed and usually 2 units are in operation. Figure 6.4.2-1 shows power consumption pattern in a day that is recorded in a report of energy audit conducted on the factory in 2007.

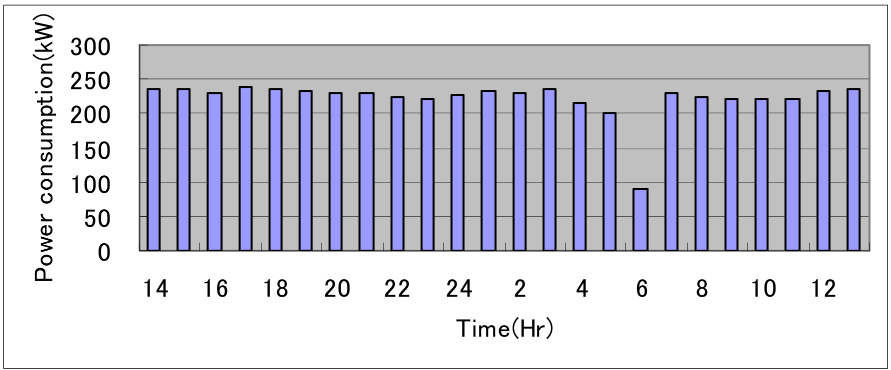


Figure 6.4.2-1 Daily power consumption of chiller system

The chiller system consumes power constantly almost all day around except 6:00 AM when the consumption decreases to a half. Power consumption and load factors of the motors, which drive the chillers, are listed on Table 6.4.2-1.

Table 6.4.2-1 Power consumption and load factor of chillers

	Rated power (kW)	Current (A)	Power (kW)	Load factor
Chiller 1	150	203	114	66%
Chiller 2	150	208	116	67%

Power consumption is almost equal each other as shown in Figure 6.4.2-1 and Table 6.4.2-1, and so the both may show a normal chiller operation state.

According to these data, following issues can be listed up about chiller system operation.

a) The system has about 30% margin to the rated capacity and 2 systems are working in partial load condition.

b) The power consumption is almost the same during a day. This means operation independent to the demand and wasteful load spending on the load side.

Under a partial running, machine efficiency goes down. A relation between load factor and efficiency of capacious type chiller machine is shown on Figure 6.4.2-2.

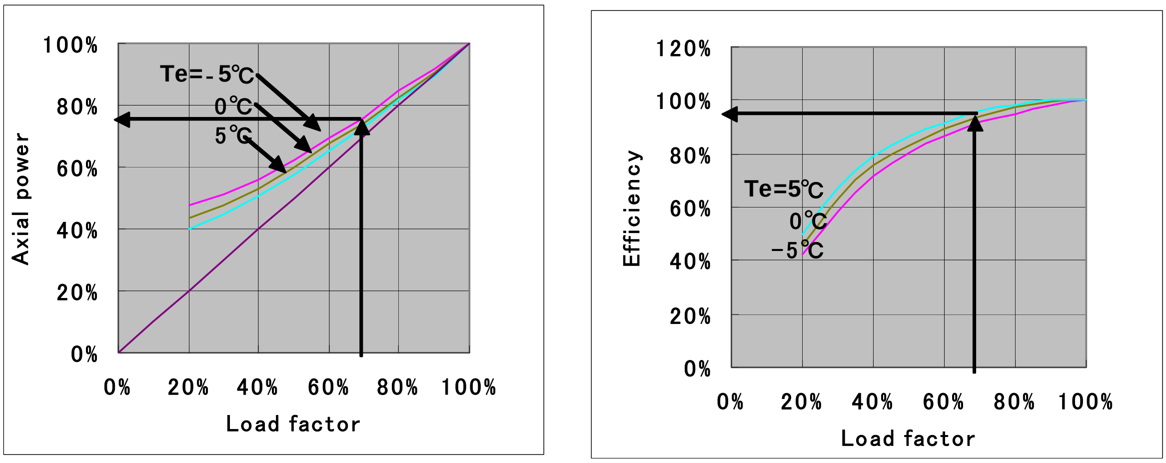


Figure 6.4.2-2 Partial load characteristics of chiller

According to characteristic curve of evaporation temperature of Te = 0ºC, the efficiency lowers by about 6% at load factor of 70%.

(2) Measures for improvement and expected effects

As for issue a), introduction of on/off operation by multiple-unit control along with the demand can be proposed.

Load survey should be implemented first for the issue b). Some studies are expected, because it is really a model for energy conservation activities.

In on/off operation, a chiller is operated in load factor of 100% during on-mode, and so a chiller can be avoided low efficiency operation in partial load.

Necessary data for control are “Chilled water flow rate × Temperature difference between supply and return water” and/or temperature of cold water in related tank are considered as information in order to control. Figure 6.4.3-3 shows one example for the control system.

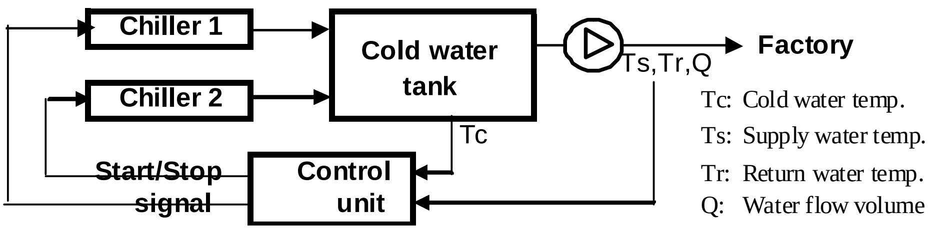


Figure 6.4.2-3 Example of multiple-unit control for chiller system

Chiller’s work volume is estimated by referring to its running pattern as shown in Figure 6.4.2-1 and partial load characteristics as shown in Figure 6.4.2-2.

As the result, chiller work volume is equal to the one of combination that is a full load running machine and a 30% partial load running machine which is controlled with on/off operation, and so the volume is the same as 1.3 units running. In this case, auxiliary machine such as condensing fans and pumps also could be stopped in the way that depends on the chiller operation.

Under these conditions just mentioned before, amount of energy saving is estimated and shown in Figure 6.4.2-2. In the estimation, running hours of the utilities are assumed as much long as 1.5 units running hours.

Table6.4.2-2 Energy saving by multiple-unit control

	Present (kWh/d)	Proposed (kWh/d)	Energy saving	
			(kWh/d)	(kWh/y)
Chiller	5,336	4,917	419	153,042
Fan & pump	612	439	153	55,868
Total	5,948	5,376	572	208,909

Amount of saving power by the multiple-unit control is as follow.

Amount of power saving: 208,900kWh/y

Annual power cost reduction: 208,900kWh/y × 885VND/kWh = 184,877 × 1,000VND/y

(3) Remarks

A relation between equipment's scale, capacity, and load volume, demand, is modeled as shown in Figure 6.4.2-4.

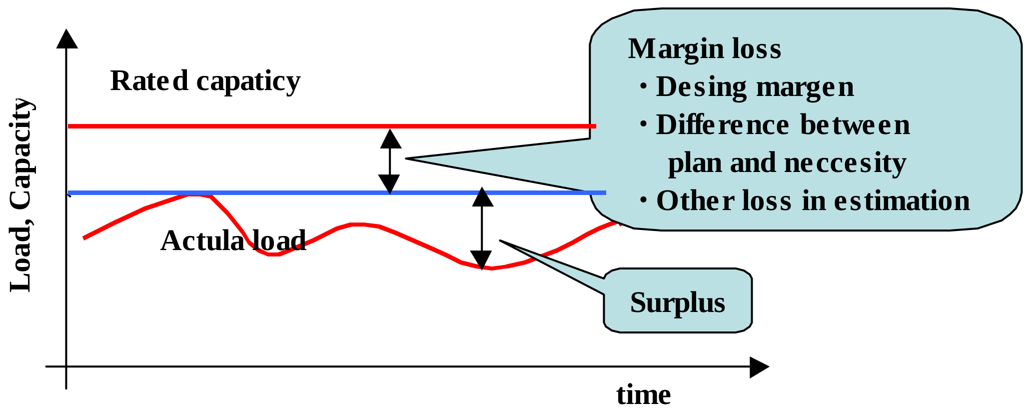


Figure 6.4.2-4 Relation between equipment scale and its load

The capacity will be selected as much as to meet its maximum load volume. However on the design step, many margin items are included, such as design margin, specification margin, scale margin in machine selection and other margins for confidence. As a result of these, the machine is going to be bigger and bigger and have a too huge fixed margin.

Load volume varies with production mass and items and machine's capacity that changes by circumstance conditions like temperature and its age. These become a variable margin.

The fixed margin can be estimated through studying load factor. Investigating each machine's working state and/or improving the process conditions could minimize amount of variable margin.

Energy conservation is the activities to cope with these margins through efficient and effective management.

2) Cold water pump

(1) Present conditions and problems

Cold water chilled by chilling water is supplied to each production line from cold water tank by cold water pumps. Normally 2-units of cold water pump are working in constant water volume.

Their power consumption and load factors are shown in Table 6.4.2-3.

Table 6.4.2-3 Power consumption and load factor of cold water pump

	Rated power (kW)	Measured current (A)	Measured power (kW)	Load factor
Pump 1	15	25.4	14	85%
Pump 2	15	28.5	16	96%

Load factors are nearly 100%. Judging from these, flow rate seems to be rated volume.

On the other hand, as load factor of chiller is about 70%, water flow-rate is considered to be also about 70%. “Cold water temperature difference × Flow-rate” of $\Delta T \times Q$ is guessed as 70% of design value. Since flow-rate of cold water of Q is rated volume, cold water temperature difference of ΔT is 70% of design value.

Energy saving of cold water transportation system is achieved by making the temperature difference larger and flow-rate smaller. But conditions of present system are vice versa.

(2) Measurements for improvement and expected effects

VSD control can be proposed, which controls pump operation by information of cooling water temperature difference between supply and return line and water flow-rate. An example of cooling water pump system with VSD control is shown in Figure 6.4.2-5.

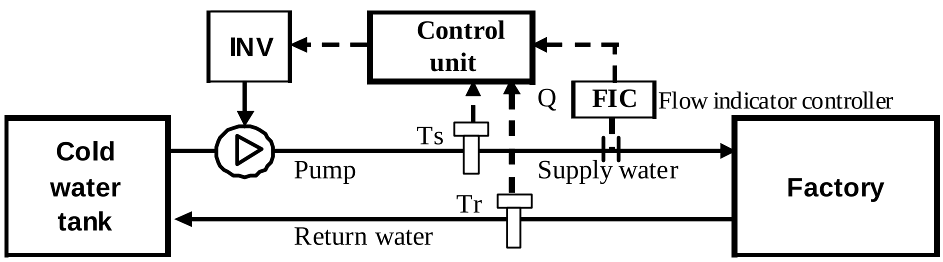


Figure 6.4.2-5 An example of cooling water pump system with VSD control

VSD control unit refers to supply water temperature (Ts), return water temperature (Tr), and water flow-rate (Q) or pressure (P) and regulates water flow rate to keep maximum temperature difference.

Shaft power of pump relates with water flow-rate in cubic rule. Shaft power is proportional to cubic of pump-speed.

By increasing the temperature difference as much as 1.4 times, 3.4ºC to 5ºC and squeezing the water volume down to 1 / 1.47 = 68%, the pump shaft power decreases theoretically to cubic of 68%.

With assuming of inverter efficiency of 95%, degradation of pump and motor efficiency of 91% and 93% respectively, and motor efficiency of 90%, power consumption for 68% of rated water flow volume is calculated as

15kW × 2 / 90% × $(68\%)^3$ / (95% × 91% × 93%) = 12.9kW,

Saving power: (15kW/unit × 2uints) / 90% – 12.9kW = 17.3kW

Amount of power saving: 17.3kW × 24h/d × 3 65days/y = 151,500kWh/y

Annual power cost reduction: 151,500kWh/y × 885VND/kWh = 134,078 × 1,000VND/y

6.4.3 Efficient use of energy regarding pump, fan, compressor, etc.

1) Supply water pump

(1) Present conditions and problems

3 units of water pump supply water to the working place, which are 2 units of 18.5kW pump and one unit of 11kW auxiliary pump. Specifications of 18.5kW pump are as follows:

Rated lift: 53m and water flow capacity: $77m^3/h$

Delivery pressure of pumps is 0.7Mpa, which is a little bit higher setting.

Measured data of the power consumption are as original data shown in Figure 6.4.3-1.

Normally, the system works with 1-unit pump, however transiently with 2-units operation of spiky electric current flow, less than 1 minuet cycle.

Moving average treatment, n=10, removes the cyclic components to make variation of the power consumption easy to observe. After this treatment, the power consumption noted as moving average is also shown in Figure 6.4.3-1.

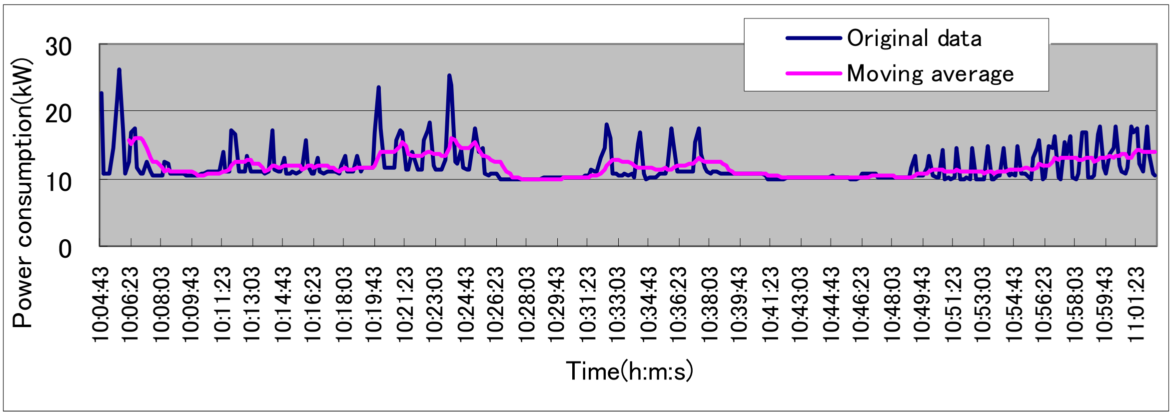


Figure 6.4.3-1 Power consumption of supply water pump system

Maximum power consumption among moving average data is about 18.5kW. From this, only 1 unit of 18.5kW pump seems to be enough for the water demand. However, actually 2nd pumps and even an auxiliary pump repeats to start and stop many times.

(2) Measures for improvement and expected effects

Introduction of VSD control of pump operation and pressure control at load end can be proposed.

Instantaneous starts and stops of the 2nd pump and spiky rise and down in the power consumption may be caused from the way of control that is higher pressure setting at the outlet of pumps and control delay due to long water pipe.

By adoption of proposed measures, the trouble may be solved. Figure 6.4.3-2 shows a sample of load-side-end pressure control system and inverters.

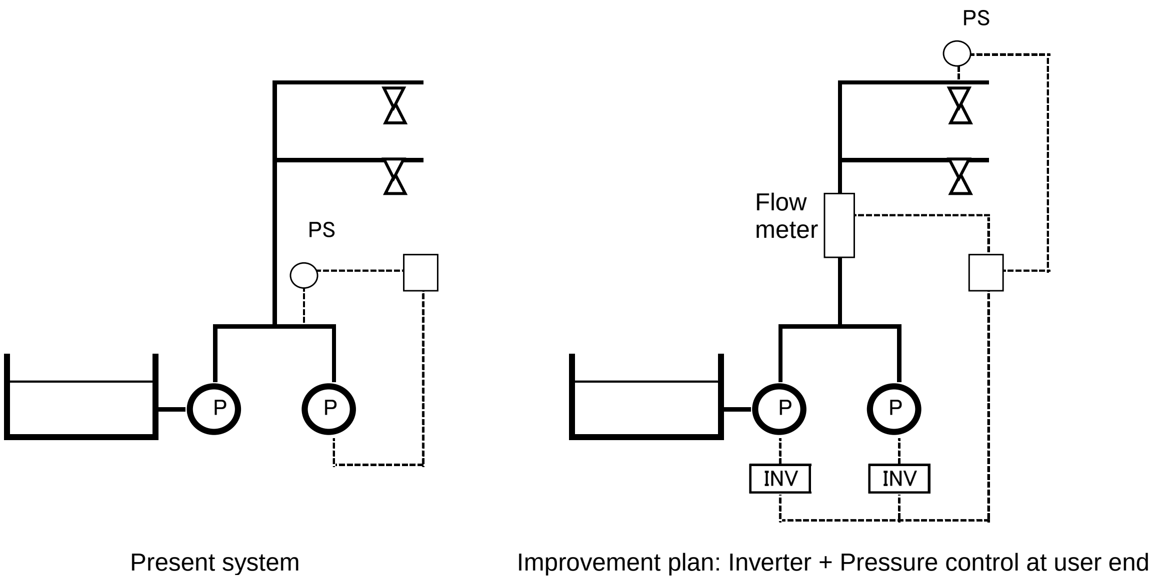


Figure 6.4.3-2 Present condition and improved systems

Number of running units is determined through multiple-unit control along with water flow-rate measured by flow meter. The way of parallel running of pumps should be made their pumping-up load and height to be equal. All pumps should be driven by inverter and with same frequency.

If actual water head is assumed about 5m which is 10% of rated head of the pump, power consumption with VSD control and valve control is shown in Figure 6.4.3-3.

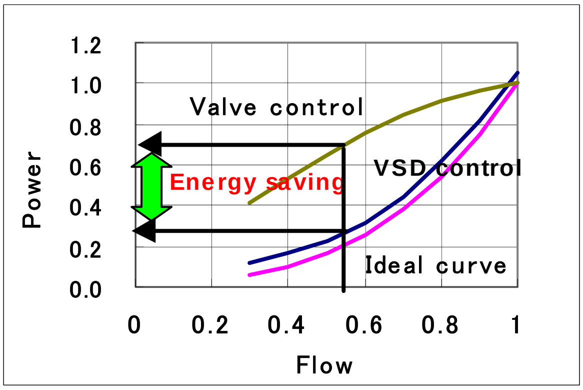


Figure 6.4.3-3 Power consumption with valve control and VSD control

VSD control saves the power a lot and the saving amount is shown as difference between two curves. Power consumption by VSD control is calculated and shown in Figure 6.4.3-4 along with present consumption.

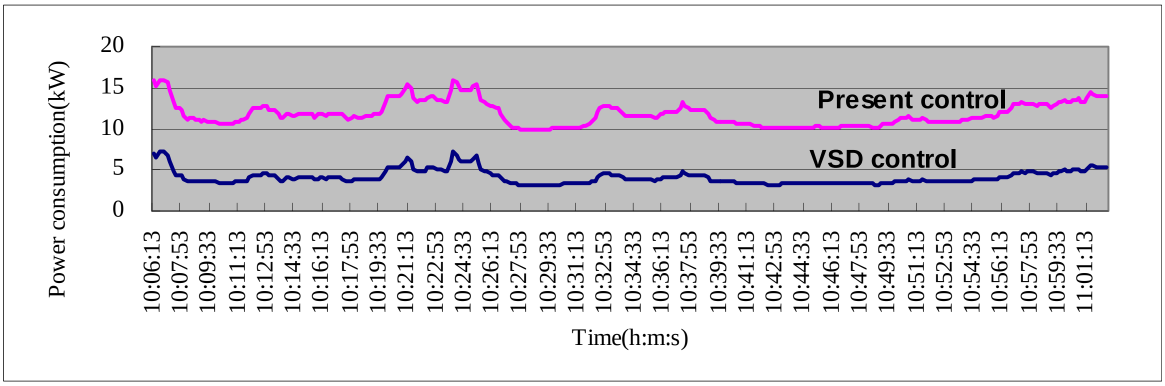


Figure 6.4.3-4 Power consumption by VSD control and present control

Power consumption is 11.8kWh/h in average at present and the consumption will be reduced to 4.1kWh/h by VSD control.

Amount of power saving: (11.8-4.1)kWh/h × 24h/d × 365days/y = 67,500kWh/y

Annual power cost reduction: 67,500kWh/y × 885VND/kWh = 59,738 × 1,000VND/y

2) Air compressor

(1) Present conditions and problems

Figure 6.4.3-6 shows configuration of compressors and compressed air supply lines of the factory.

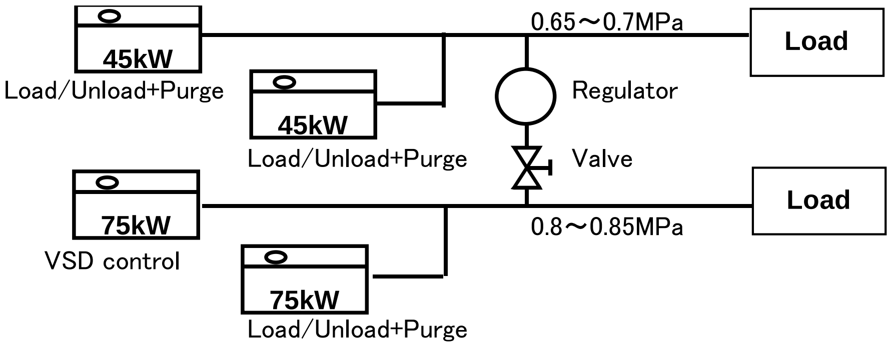


Figure 6.4.3-5 Compressed air and supply lines

Compressed air supply system consists of two lines, which are a high-pressure line of 0.8 to 0.85Mpa and a low-pressure line of 0.65 to 0.7MPa. 2 units of 45kW compressor and 2 units of 75kW compressor, which are screw type, are installed. Without multiple-units control system, numbers of running unit are controlled manually. It seems that normally each one unit of 45kW units and 75kW units runs and the other units are in stand-by.

VSD control for one 75kW unit and load/unload control for the other 75kWunit and 45kW units are basic operation mode, and purge mode and/or on/off mode are operated at lighter load conditions.

VSD control works for a countermeasure against load variations but its control range, which seems as far as 50% load factor, is rather narrower. Long term running with low load may need some consideration.

A part of the current measuring data for 45kW unit is shown in Figure 6.4.3-6.

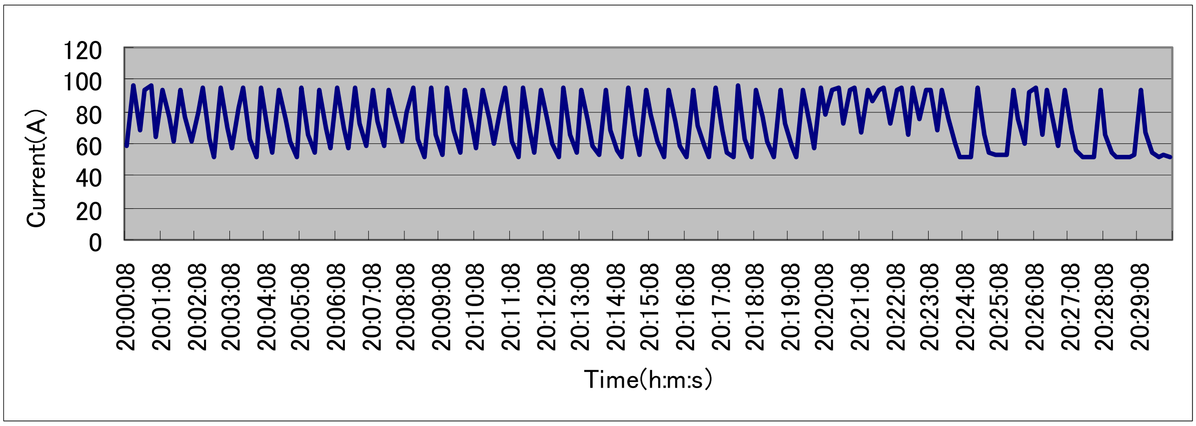


Figure 6.4.3-6 Electric current variation of compressor with load/unload control (45kW unit)

Load/unload and /or purge control mode copes with partial load, however more than 50% of rated power are consumed, which is not small amount of power. This power does not contribute to supply compressed air, so to speak, belongs to stand-by power and is a kind of waste power consumption. After the treatment that categorizes the power consumption into working power, which is consumed in order to generate compressed air, and stand-by power, which is consumed during unload and /or purge mode, two types of power consumption are shown in Figure 6.4.3-7.

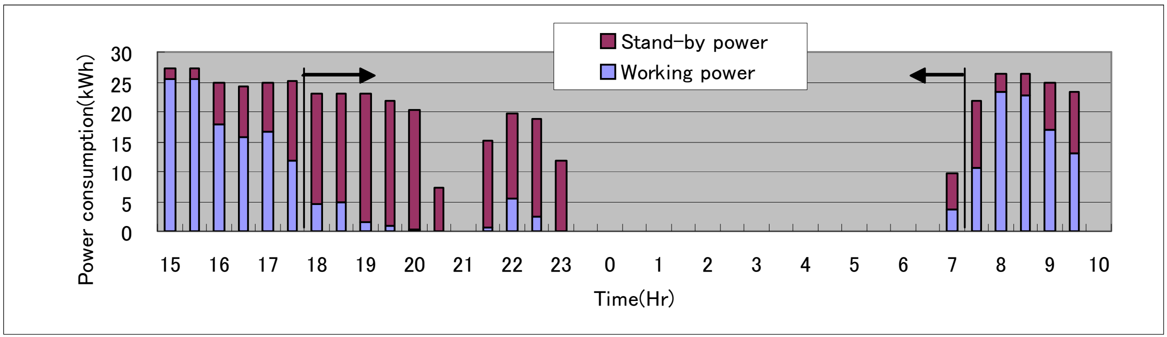


Figure 6.4.3-7 Categorized power consumption of compressor

Much power consumption can be seen during lighter loading time frame, after 18:00 and before 8:00.

(2) Measures for improvement and expected effects

During lighter loading time frame, the operation that stops 45kW compressor and opens valve between 2 pipelines can be proposed.

Under these measures, 75kW compressor with VSD control supplies all the necessary air to the works.

Power consumption during 18:00 to 8:00 is listed in Table 6.4.3-1.

Table 6.4.3-1 Working power and stand-by power (18:00 - 8:00)

Working power	35.4 kWh
Stand-by power	179.8 kWh
Saving power	144.4 kWh

In the case of proposed operation, 180kWh stand-by power for the time frame just discussed can be saved. On the other hand, 75kW compressor with VSD control owes additional air volumes which correspond to 35kWh/day. Therefore, the differences of them is power saving.

Amount of power saving: 144kWh/d × 365days/y = 52,600kWh/y

Annual power cost reduction: 52,600kWh/y × 885VND/kWh = 46,551 × 1,000VND/y

(3) Remarks

Although there is a little difference according to suppliers, power consumption along with its load factor is generally shown in Figure 6.4.3-8.

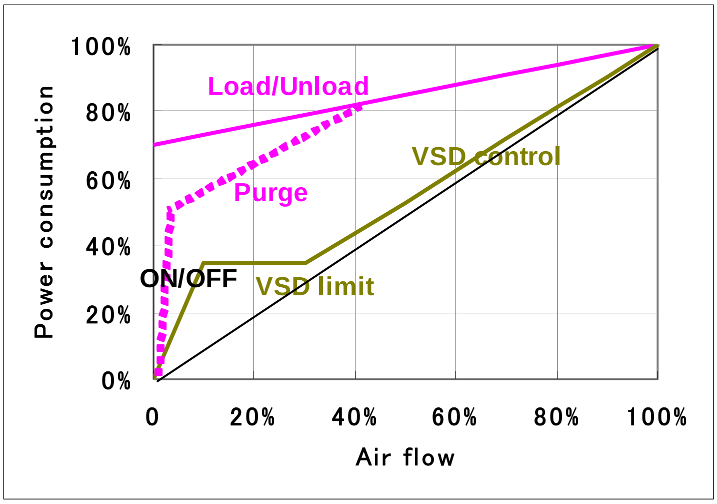


Figure 6.4.3-8 Compressor control and its power consumption

Load/unload control is commonly used and also some machine with purge function for low load condition can be seen. Compressor with VSD control by inverter shows ideal load to power characteristics that its power consumption decreases to correspond with its load factor.

But, VSD control has a lower limit in its speed control, under which the effect of its good control can not be expected. For operation that is near to zero load-factor, on/off function is used.

3) Discharge air pressure management

(1) Present conditions and problems

Rather higher discharge air pressure is set at 0.65 to 7MPa for low-pressure line, and 0.8 to 0.85MPa for high-pressure line.

Main user of compressed air and its rated pressure are as follow.

Switch valve in fresh milk process line: 0.4 to 0.6MPa

Diaphragm pump for transporting milk: 0.2 to 0.7MPa

For these users, supply air pressure is set at 0.62MPa. However, for switch valves, the pressure can lower to 0.5Mpa and for diaphragm, the inlet air pressure can be reduced too along with its actual pumping-up height.

(2) Measures for improvement and expected effects

Studying necessary air pressure for load equipment and then lowering discharge air pressure to suitable setting can be proposed.

Processes to achieve proposals are as follows:

a) Grasping the lower limit of air pressure at each load end by lowering delivery pressure of air compressor gradually step by step a setting value of regulator, which stabilizes air pressure for load.

b) And then setting a new lower limit by topping some suitable margin on it.

c) For a machine requiring higher air pressure, booster and/or air supply through a dedicated line can be applicable.

Figure 6.4.3-9 shows the relation between discharge pressure and input power to compressor.

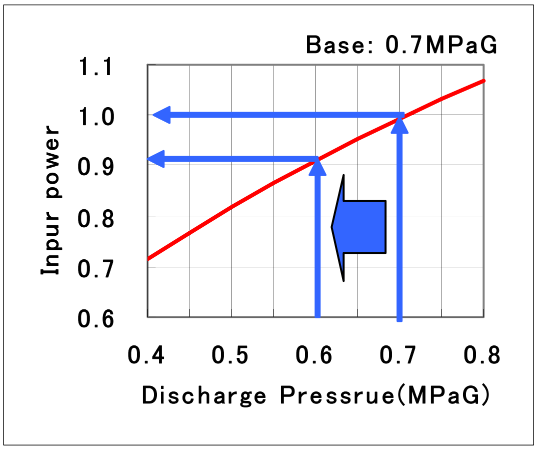


Figure 6.4.3-9 Discharge air pressure and input power

As shown in Figure 6.4.3-9, lowering air pressure from 0.7MPa to 0.6MPa saves as much as 9% of power consumption.

The compressor system consumes 18% of power of the factory as shown in Figure 6.4.3-9, so amount of the power consumption is estimated as 6,468,974kWh/y × 18% = 1,164,415kWh/y.

The effect of lowering air pressure by 0.1MPa is calculated as follow.

Amount of power saving: 1,164,415kWh/y × 9% = 104,800kWh/y

Annual power cost reduction: 104,800kWh/y × 885VND/kWh = 92,748 × 1,000VND/y

6.4.4 Steam boiler, steam system, heat exchanger, waste heat and waste water etc.

1) Combustion control of steam boiler

(1) Present conditions and problems

2 sets of steam boiler of 5 tons/h are installed, and 1 set of boiler is operated normally. Measurement of operation data was conducted for the survey of combustion condition of boiler No.1. Measurement data and heat balance sheet are shown in Table 6.4.4-1 and Table 6.4.4-2. Since boiler is operated at an air ratio of 1.4, exhaust gas loss is 8.2 %.

Table 6.4.4-1 Measurement data of steam boiler

Steam boiler No.1: Rated capacity: 5 ton/h

Item		Start	15 min	30 min	45min	60 min	Average
Measuring time		10:28	10:43	10:58	11:13	11:28	
Steam pressure	Bar	8.00	8.40	8.00	8.20	8.00	8.1
Amount of feed water	m^3	9.00	9.36	9.78	10.04	10.31	1.31
Fuel oil temperature	deg-C	80	81	80	79	79	79.8
Amount of fuel (reading of oil flow meter)	Liter	2561079	2561101	2561138	2561160	2561186	
Amount of fuel (Fuel oil + water)	L/h		86	150	90	101	107
Amount of fuel oil	L/h						104
Amount of fuel oil	kg/h						102
Exhaust gas temperature (outlet of boiler)	degC	218	195	188	185	186	194.3
Oxygen concentration of exhaust gas	%	5.1	4.5	6.9	6.6	6.6	5.9
Excess air ratio =21/(21-[O2])		1.32	1.27	1.49	1.46	1.46	1.4
Circumstance temperature	degC	32	32	32	33	33	32.5
Theoretical air volume (A0)	m^3N/kg						10.5
Theoretical ex gas volume (G0)	m^3N/kg						11.1
Actual ex gas volume (G)	m^3N/kg						15.3
Exhaust gas heat loss	kcal/kg						816
Exhaust gas heat loss	%						8.2
Generated steam volume	t/h						1.2

Table 6.4.4-2 Heat balance sheet of steam boiler

Input heat	%	Output heat	%
Fuel heat	100	Generated steam heat	80.5
		Exhaust gas heat loss	8.2
		Radiation heat loss from surface	3
		Others	8.3
Output heat total	100	Output heat in total	100

Load factor of boiler No.1 is 24%, and boiler efficiency is 80.5%.

Since fuel consumption is 952 kL in 2007, average fuel consumption is 109 liter/hour. Assuming that evaporation ratio is 13, average generated steam volume is 1.4 ton/h , and so boiler capacity of 5 ton/h. is too big.

(2) Measures for improvement and expected effects

a) Improvement of air ratio

If the air ratio of steam boiler is set at 1.2 from 1.4, exhaust gas heat loss is 7.0% and thermal efficiency of boiler can be improved by 1.2%.

Annual fuel oil consumption: 952 ton/y

Amount of fuel saving: 952ton/y × 0.012 = 11.4 ton/y

Annual fuel cost reduction: 11,400kg/y × 5,475VND/L / 0.98kg/L = 61,16 7 × 1,000VND/y

b) Introduction of small size once-through boiler

At present 2 sets of steam boiler of 5 ton/h are installed, but average load factor is 28% and thermal efficiency is 80.5%. When 1 set of small size once through steam boiler of 2 tons/h, annual fuel oil saving amount stands for 92 tons. A steam boiler of 5 ton/h is stopped as stand-by equipment. Section drawing of small size once through steam boiler is shown in Figure 6.4.4-1. A small size once through steam boiler can be operated in high efficiency of 90% or more at low load operation, and so thermal efficiency of boilers can be improved by about 10% at the present operation condition..

Amount of fuel saving: 952ton × 0.1 = 95.2 ton/y

Annual fuel cost reduction:

95,200kg/y × 5,475VND/L / 0.98kg/L = 531,857 × 1,000VND/y

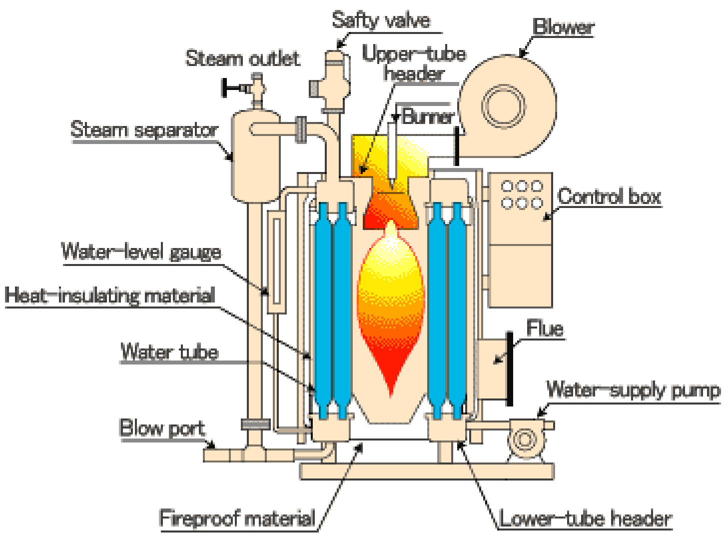


Figure 6.4.4-1 Section of small size once through steam boiler

2) Insulation enforcement of steam piping and valve

(1) Present conditions and problems

As the results of survey of insulation condition of steam piping and valves in boiler room, many steam pipes and valves are not heat-insulated. 1 set of steam valve is insulated in the steam header, but other 4 sets of valves are not insulated. Many steam valves in the factory buildings are not insulated, and so dissipative heat loss increases and room temperature rises. Not-insulated parts of steam pipes and valves on the boiler room are shown in Table 6.4.4-3. Dissipative heat loss from not-insulated parts is 8,583 kcal/h.

Table 6.4.4-3 Not-insulated parts of steam pipes and valves on the boiler room

No.	Place	Equipment	Q'ty	Pipe size	Not-insulated pipe length (m)	Surface temperature (deg C)	Equivalent pipe length (m)	Dissipative heat loss (kcal/h)
1	Steam header	Valve	1	100A		154	1.58	847
2	Steam header	Valve	1	100A		156	1.58	865
3	Steam header	Valve	1	100A		156	1.58	865
4	Steam header	Valve	1	25A		156	1.21	267
5	Boiler	Valve	2	100A		156	3.16	1,729
6	Boiler	Valve	2	25A		156	2.42	533
7	Oil heater	Valve	6	15A		150	6.36	942
8	Feed water	Valve	2	40A		90	2.22	253
9	Feed water	Pipe	1	40A	6	90		684
10	Feed water	Pipe	1	65A	10	90		1,599
	Total							8,583

(2) Measures for improvement and expected effects

When not-insulated pipes and valves are covered with glass wool material of 25mm thickness, 90% of heat loss can be recovered. Annual fuel oil saving stands for 9 tons by insulation works.

Annual operation hours: 8760 h/y

Fuel oil heat value: 10,000 kcal/kg

Boiler efficiency: 80%

Amount of fuel saving: 8,583kcal/h × 8,760h/y / 0.8 / 10,000kcal/kg = 9,398 kg-oil/y

Annual fuel cost reduction: 9,398kg/y × 5,475VND/L / 0.98kg/L = 52,506 × 1,000VND/y

3) Maintenance of steam traps

(1) Present conditions and problems

Function condition of 5 sets of steam traps is checked with surface thermometer and blowing condensate condition. One of 5 sets of steam trap is mal-function in boiler room. Troubles of steam trap causes quality troubles of products. Troubles of steam traps are not found in fresh milk process line. Steam traps are not inspected periodically. Inspection results of steam trap are shown in Table 6.4.4-4

Table 6.4.4-4 Inspection results of steam trap

No.	Place	Type of steam trap	Pipe diameter	Temperature at inlet	Temperature at outlet	Steam pressure	Judgment
1	Boiler room	Float	20	44.8	42.5	0.85 MPa	Plugging
2	Fresh milk shop	Disk	20	110	80		Good

(2) Measures for improvement and expected effects

Steam traps are inspected from outside every 1 or 2 years, and mal-function steam trap is to be replaced or overhauled.

6.4.5 Efficient use of energy regarding electricity Receiving and distributing equipment and motor

1) Electricity receiving and distributing equipment

(1) Present conditions and problems

Figure 6.4.5-1 shows a single line diagram of power receiving system.

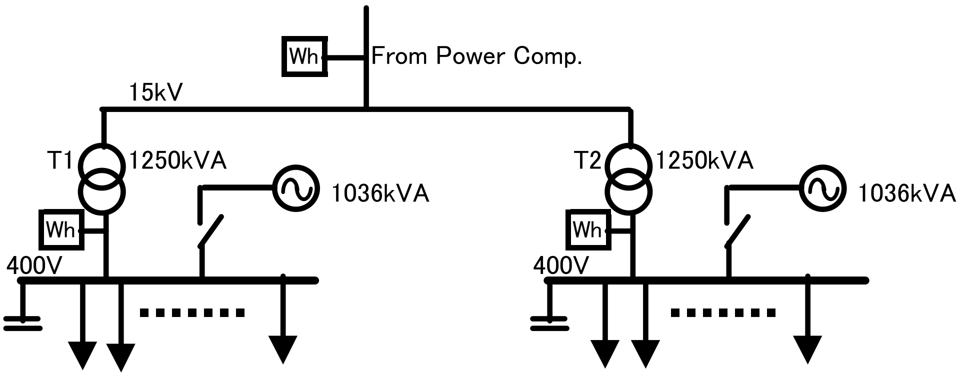


Figure 6.4.5-1 Single line diagram of power receiving system

The power meters at 2nd terminal of two transformers measure monthly power consumption. Power condenser with a function to adjust capacitor value, are inatalled at each bank and the power factor is controlled at about 90%. Facilities in power receiving room are kept in good conditions.

Figure 6.4.5-2 shows the receiving power of each transformer.

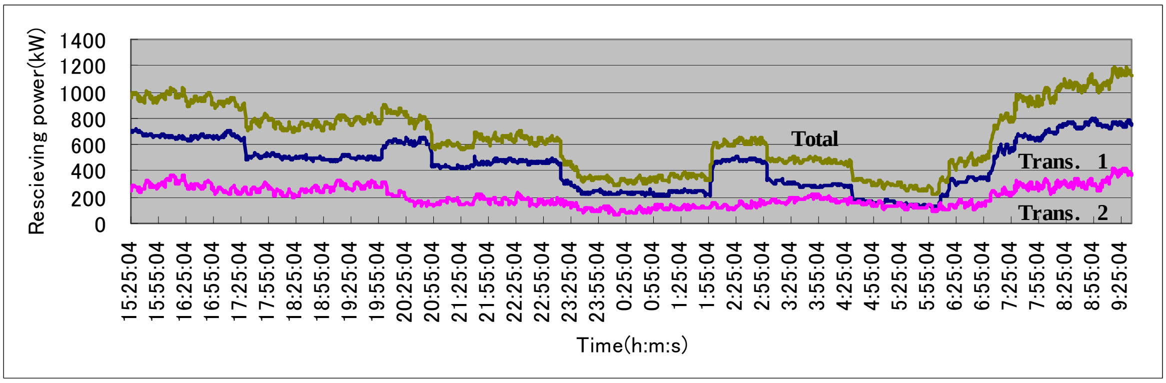


Figure 6.4.5-2 Receiving power of each transformer

Each measured power pattern is almost the same to the one of the energy audit in 2007. Demand factors of two transformers are 66% and 40%. Transformer No.1 owes heavier than transfer No.2, but this imbalance is in permissible range.

(2) Measures for improvement and expected effects

The first of all, grasping precise and actual states of energy consumption should be required for effective energy conservation activities. And accuracy and reliability of the data are also essential.

For this purpose, a kind of automatic and mechanical system is useful. One of examples is shown in Figure 6.4.5-3.

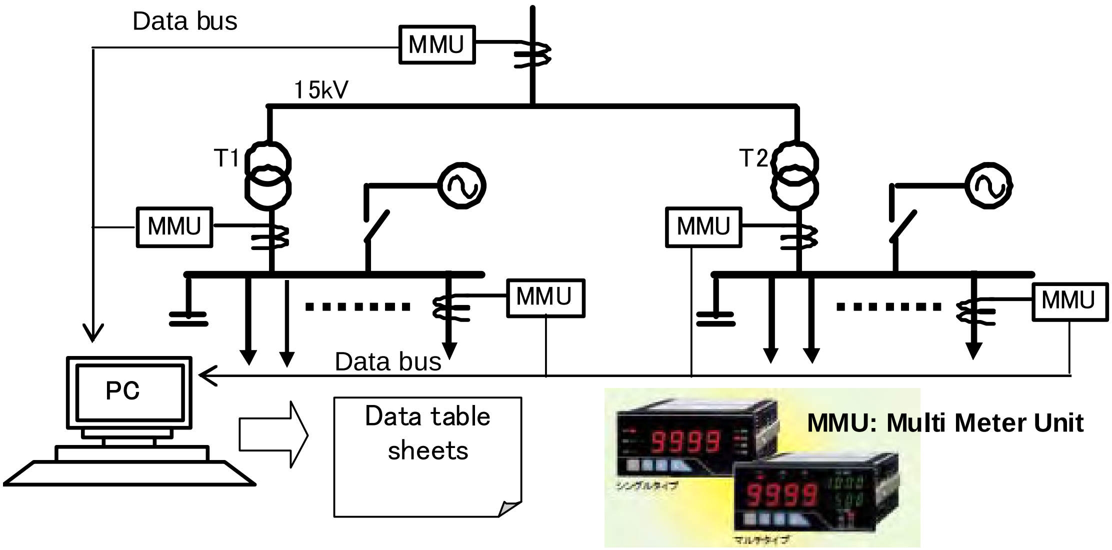


Figure 6.4.5-3 Image of power monitoring system

Digital multi-meter-units for measuring the receiving power are used and the data are transmitted to a personal computer that is used as data gathering and output device. The computer compiles tables of the monitoring data, which may be utilized for power management of the company.

With this system, hourly measurements of power consumption are available. This is the first step to fruitful and developing energy conservation activities.

By ensuring the actual management of power consumption during on-peak demand time and grasping night-time power consumption, the relation between power consumption and state of equipment's working should be examined and analyzed. As the result, unnecessary waiting power consumption will be recognized and eliminated. This is a typical example for the system utilization.

Expected effect largely depends on level of the system utilization and improvement of energy conservation activity. But saving about 5 to 10% of the power consumption may be expectable.

Amount of power saving: 6,068,974kWh/y × 5% = 323,400kWh/y

Annual power cost reduction: 323,400kWh/y × 885VND/kWh = 286,209 × 1,000VND/y

2) Power consumption management

(1) Present conditions and problems

Figure 6.4.5-4 shows daily power consumption pattern conducted from the measured current data and the one on a report of the last audit in 2007.

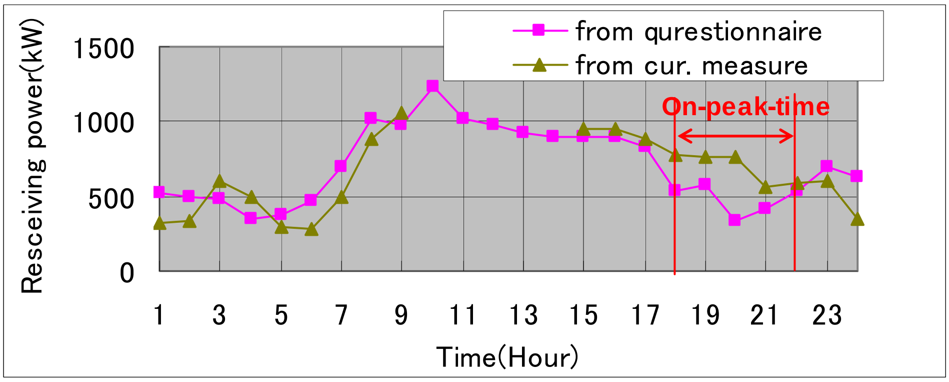


Figure 6.4.5-4 Daily power consumption pattern

Facility management considering the peak demand timeframe can be observed. Figure 6.4.5-5 shows power consumption rate by users.

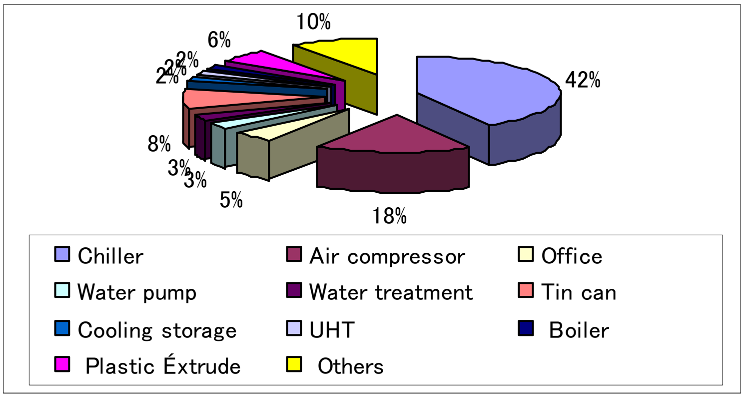


Figure 6.4.5-5 Power users and their consumption rate

It is really appreciating that the factory grasps own power users and their consumption rate as shown in Figure 6.4.5-5.

From Figure 6.4.5-5, the chiller and the air compressors are selected as the first targets for the energy conservation activities.

Amount of chilled water and/or compressed air consumed in these facilities should be analyzed and kept reasonable. These treatments are recommended as the first step to developing energy conservation activities.

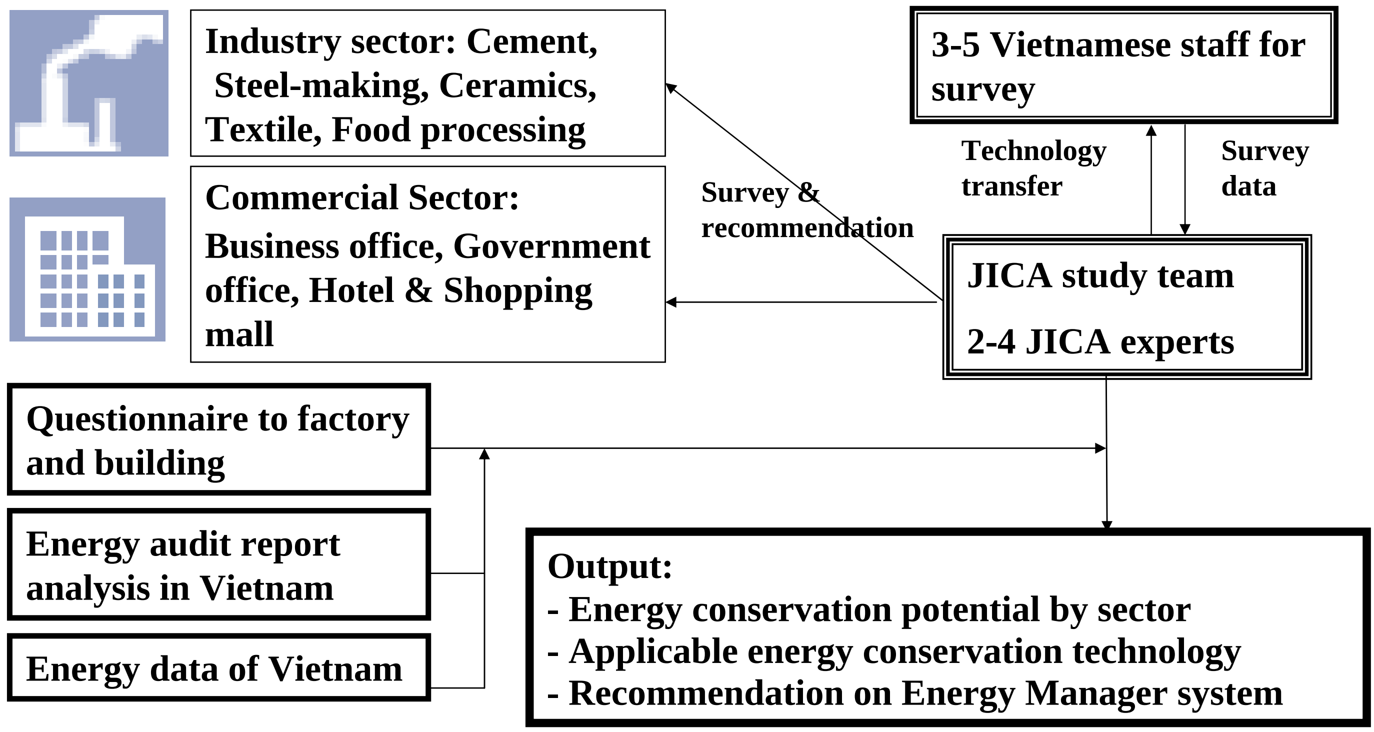
ANNEX 11

ON-SITE SURVEY PRESENTATION MATERIALS (BUILDING)

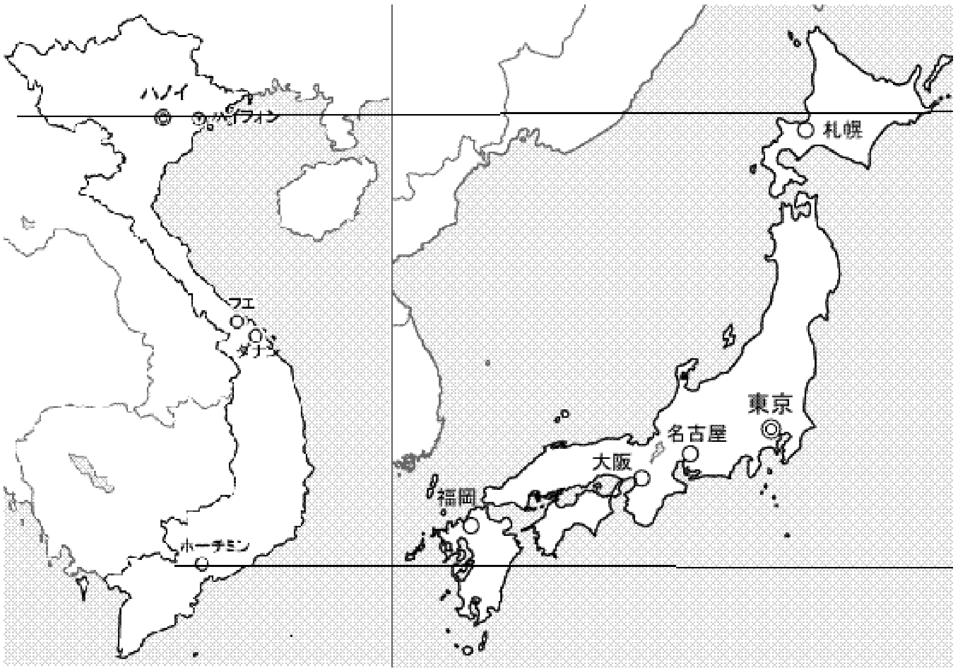
Findings from On-site Survey

Buildings 2008 in Viet Nam

On-Site and Questionnaire Survey

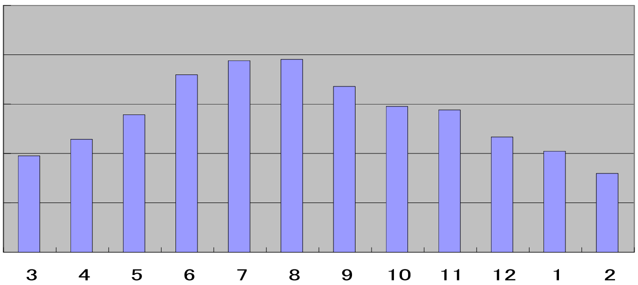


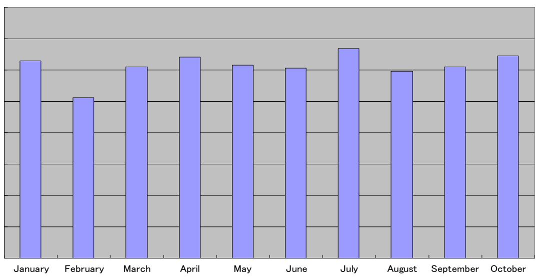
For our understanding



Electricity Yearly Demand Comparison

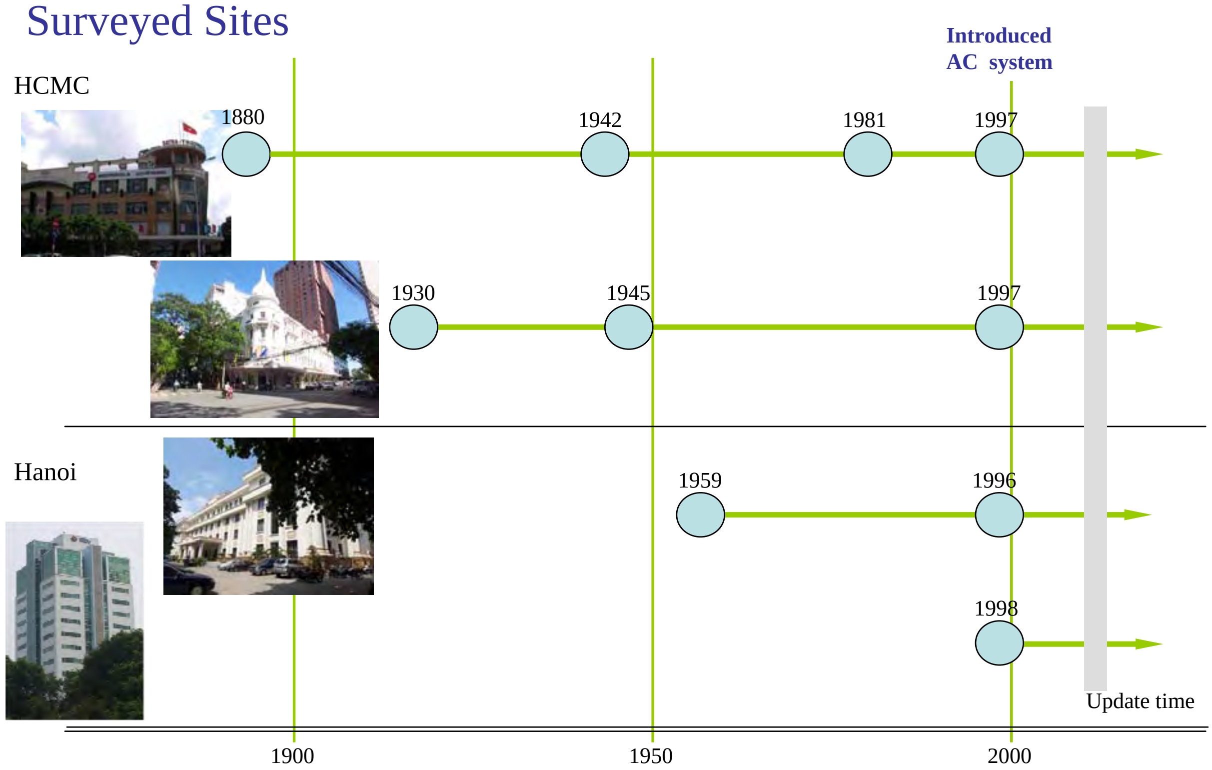
Hanoi



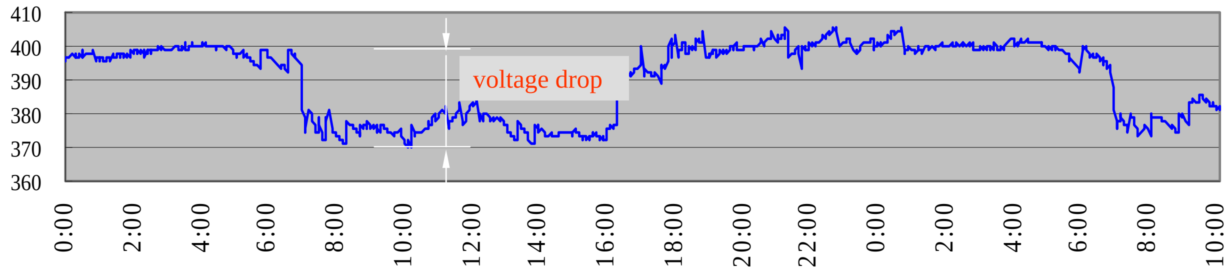


HCMC

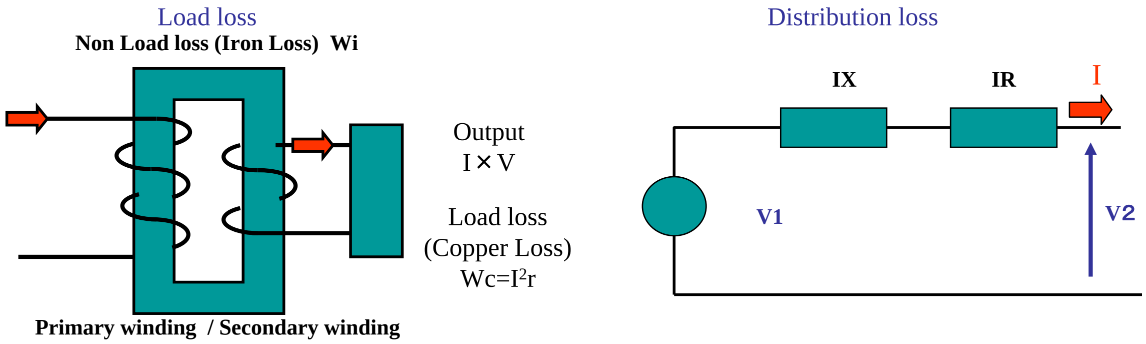
Surveyed Sites



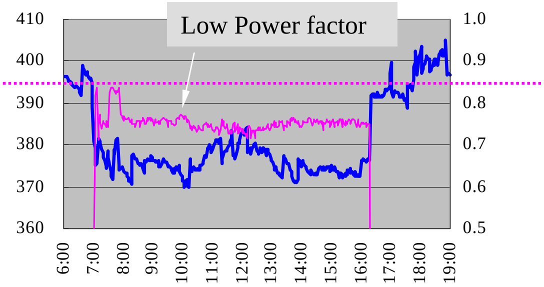
Finding 1: Voltage Fluctuation



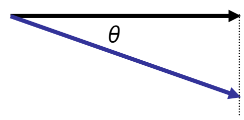
Voltage drop= **Impedance** ***Current**



Finding 2: Low Power Factor



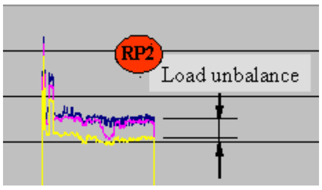
Power Factor shall be more than 0.85 (in Japan)



Low power factor may cause voltage drop

Finding 3: Load Unbalance

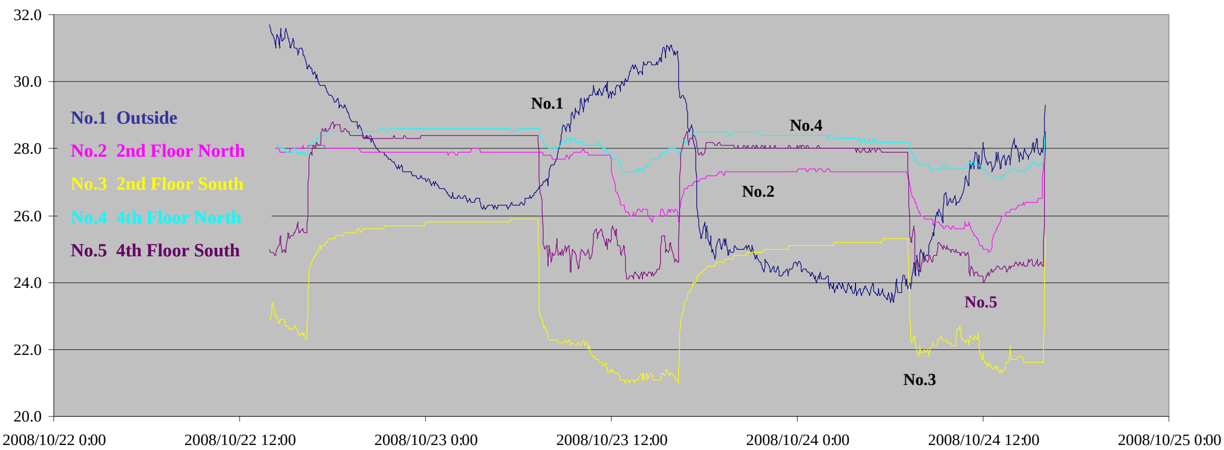
Max. 30A difference of Current consumption among each phase.



Finding 4: Adequate Maintenance and Adjustment of AC system

Big difference of room temperature among rooms.

Inside temp. (especiallyNo.2,No.4&No.5) is higher than outside in night time.



Grounds of these Found Issues

Finding 1: Voltage Fluctuation

Finding 2: Low Power Factor

Finding 3: Load Unbalance

Finding 4: Adequate Maintenance and Adjustment of AC system

Changing Conditions from the original design

Short of systematic redesign

And in the other hand

Update time of AC system is coming

Who?

How?

What?

When?

What is Air Conditioning system in Vietnam?

Cooling — Sensible heat

or / and — or / and

Dehumidification / Desiccation — Latent heat: Aerification, Condensing

http://www.daikin.com/

COP: Coefficient Of Performance

APF: Annual Performance Factor

Other Potential Technologies and Know How

1: **Night Purge**

2: Variable Speed Control (Inverter)

3: Amorphous transformer

4: Transformer Bank

5: BEMS (Building Energy Management System)

6: Lighting Control system

7: High Energy Efficiency Server system

8: Inlet Temperature Control

9: Co-Generatoion

⋮

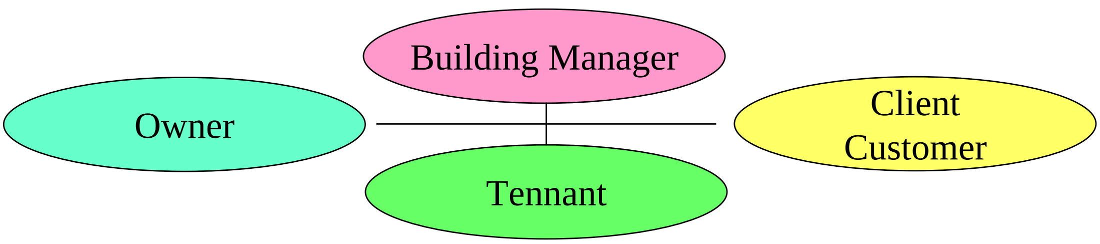
EC on Building is not so difficult but too complicated

(Reason 1)

Energy Consumption=f (Building Design, Equipment, Operation,
Management, Activity,
Endemic Weather, etc.)

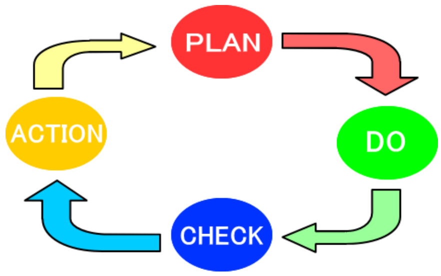
(Reason 2)

Many Parties (Stakeholders)



Daily PDCA Cycle Activity is important

Planning
- Set Objectives and goals
- Set Management Criteria
- Make improvement programs



Execution of the Improvement
- Point out energy wasted place
- Carry out improvement **according to Plan and program**
- Education and training

Review
- Management Criteria
- Programs

Evaluation of the efficiency
- Administration and control of the programs
- Grasp the improvement effect
- Measuring and record

Recommendation;

1.Enhance Energy Management Activity (PDCA cycle)

2. Enforcement of Building Code on New buildings

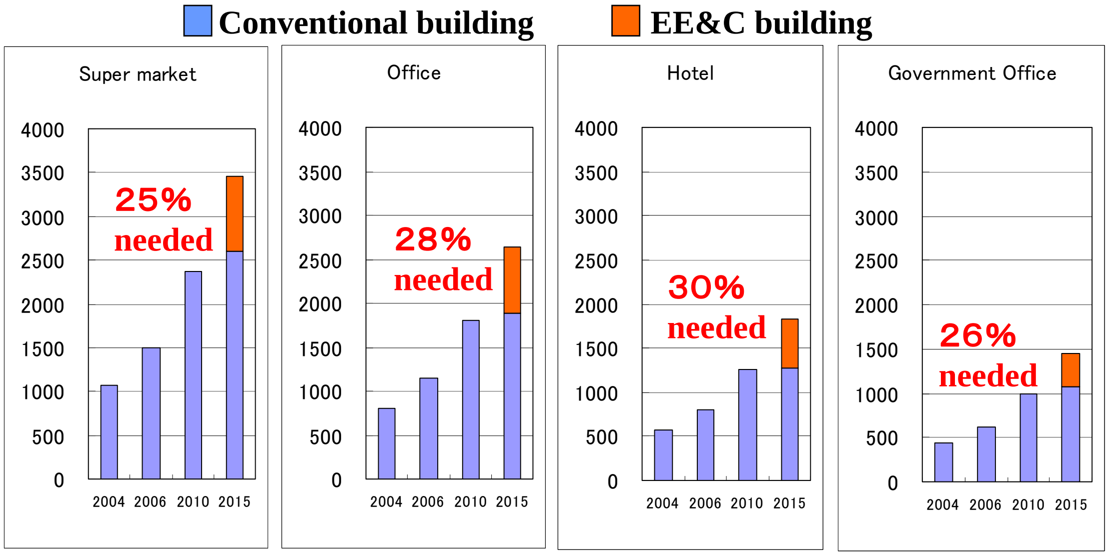
Especially;

1) Introduction of High Efficiency Air Conditioning system, expected effect 15-30 %

2) Introduction of Electronic Ballast in lighting

How many EE&C buildings needed for -5%?

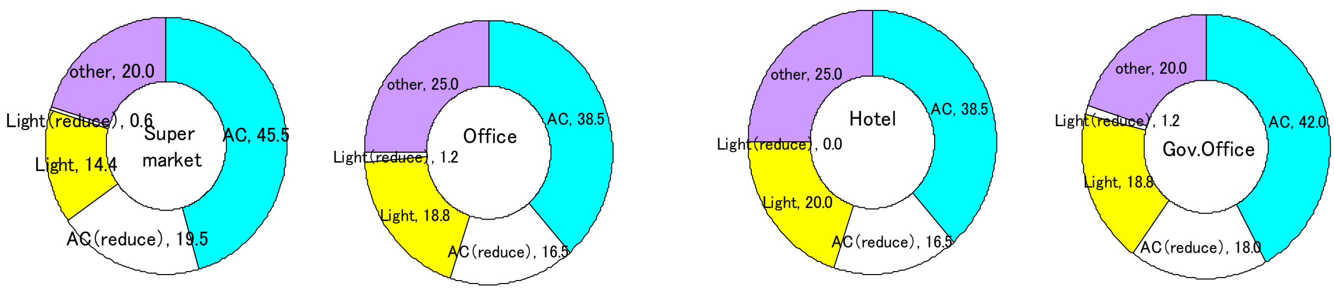
Stock Penetration (unit: GWh/year) in 4 sector building



All EE&C buildings shall install High Efficient Air Conditioning system and be replaced to Electronic ballasts in lighting at least, by Building code

What kind of EE&C Equipment is needed (effective) for EE&C Building?

Pie-Chart by Equipment (unit: %) in Electricity use in 4 sector EE&C building



High Efficient Air Conditioning system is necessary and effective!!

How much for EE&C on Building?

Cost & Benefit (total for 5 years, 2011~2015）by High efficiency AC and electronic ballast in 4 sector EE&C building

Sub-sector (Building usage)				Super market	Office	Hotel	Government office	Total
Cost	Unit cost [US$/KW]	AC	Conventional	600	600	600	600	−
			EE&C	1000	1000	1000	1000	−
		Lighting	Conventional	150	150	150	150	−
			EE&C	250	250	250	250	−
	Total input [KW] 1)	AC	Conventional	127,907	93,342	69,721	51,500	342,470
			EE&C	89,535	65,340	48,804	36,050	239,729
		Lighting	Conventional	29,517	33,943	25,353	17,167	105,979
			EE&C	28,415	31,906	25,353	16,137	101,811
	Cost up [million US$]	AC		12.79	9.33	6.97	5.15	34.25
		Lighting		2.68	2.89	2.54	1.46	9.56
	Total			15.47	12.22	9.51	6.61	43.80
Benefit	Electricity reduced	[GWh]	2)	475	362	252	198	1,287
	Expense reduced	[millionUS$]	3)	36.64	27.88	19.41	15.30	99.23

Notice; 1) [W] converted from [Wh] by 50% work among 8,760 hour a year
2) Total reduced from 2011 "1%" to 2015 "-5%"
3) 0.077US$ (1,359VND) per KW as average in Commercial building

ANNEX 12

CURRICULUM OF EE&C TRAINING IN JAPAN

Counter training course under "Study on Master plan for Energy Conservation and Effective Use (2009)

Schedule

Date		Curriculum	Place	Comments
8/17 (Mon)	Night	Hanoi Departure		
8/18 (Tue)	AM PM	Narita Arrival Registration & briefing 13:30-15:30 Schedule 16:00-16:45 (Okamoto)	 JICE Room 5	JICA JICA J-POWER
8/19 (Wed)	AM PM	10:00-12:00 (ECCJ Mr. Kazuki Tanabe) "Outline of Japanese EE&C policy & strategy, Energy manager System (Including Periodical Reporting and Middle and Long Term Plan Submission Procedure)" 13:30-16:30 (ECCJ Mr. Kazuki Tanabe) "Function of Energy Conservation Center, Benchmarking"	J-POWER Room 521	ECCJ ECCJ
8/20 (Thu)	AM PM	10:00-12:00 (Yoshida) "Basic concept to promote EE&C" 13:00-14:00 (Yoshida) "Potential EE&C Technology" 14:00-16:00 DAIKIN (Mr.Hiromichi Nakano, Yukio Manabe) "Air Conditioning Technology"	J-POWER Room 521	J-POWER Daikin
8/21 (Fri)	AM PM	10:00-12:00 (Yoshida) "Basic information/Economic Analysis Methodology" 13:30-16:0 (Yoshida, Mimura, Okamoto, Tanabe) "Group Work","Additional Information" 17:30-19:30 Business table	J-POWER Room 521 J-POWER	J-POWER J-POWER
8/22 (Sat)				
8/23 (Sun)				
8/24 (Mon)	AM PM	10:00-12:00 (Yoshida, Tanabe) "Group Discussion/ Work" 14:00-16:00 (JICA, J-POWER: Yoshida, Onoguchi, Tanabe) "Presentation by trainees"	J-POWER Room 521	J-POWER J-POWER
8/25 (Tue)	AM PM	10:00-12:00 (Isogo PS)(Onoguchi, Tanabe) Visiting Isogo Thermal P/S (high efficiency) 15:00-17:00 (JICE) JICA Evaluation& closing ceremony (Onoguchi, Tanabe)	JICA Bus picks up trainees at Washington Hotel in Shinjuku Seminar Room B	J-POWER JICA
8/26 (wed)	AM PM	Narita Departure Arriving Hanoi		

10 trainees, 10days