Activity Report 2007

International Project for Improving Infrastructure for Rationalization of Energy Use

(Energy Conservation in Major Industries in ASEAN Countries)

March 2008
The Energy Conservation Center, Japan

Preface

In recent years, efforts for preventing global warming have become a common issue for mankind, while sustainable economic development is continuingly demanded. Thus, we face a situation in which we must overcome two difficult challenges that completely contradict each other. What are required for overcoming these difficult challenges are technical innovations such as technologies for utilizing energy efficiently, and technologies for developing energy with minimum burden on the environment.

In order to contribute to a balanced development of economy and environment in developing countries, it is demanded to implement an acceptable and appropriate assistance to each country by assessing the reality of energy use and environmental conservation measures, and by thoroughly examining the situation of each country such as infrastructure and lifestyle.

Under this situation, we entered into a new phase (phase 2) in 2004, with an aim to implementing energy audits, taking improvement measures, and building the infrastructure for dissemination, based on the results of energy audit and resultant technology transfer acquired between 2000 and 2003 (phase 1). The year 2007 was a last year of phase 2, and various activities were made, with an aim to strengthening infrastructure and disseminating the results acquired in the first and second phases.

As an effective means of achieving these aims, we have made a continuous effort to create Technical Directory and Database/Benchmark for each industry.

On the other hand, in the effort to strengthen the infrastructure for disseminating our achievements, we conducted follow-up surveys in the factories that were audited in the past, to assess the implementation of recommended improvement measures. In addition, we made simple energy audits in new factories for propelling the transfer of energy audit technologies. This year, we implemented audits on the textile industry in Vietnam, food factories in the Philippines and Malaysia and the steel industry in Thailand. Additionally, we held seminar-workshops in each country, with the participation not only of people from the host country, but also people of foreign government authorities and factory personnel of different industries in other ASEAN countries. They were invited to present successful cases of energy conservation measures to share information in the ASEAN region and create a foundation for dissemination activities. Policies on concept and formulation regarding Technical Directory and In-house Database were also discussed in the seminar-workshops, and some illustrative examples were presented.

We are sure that activities implemented during the last year of phase 2 have been significantly meaningful in that they have contributed to the steady development of infrastructure for promoting energy conservation activities directed to achieving the above-mentioned goals.

We hope that this project contributes to energy and environmental conservation in industrial sectors in the ASEAN countries, allowing each country to achieve environmentally friendly and sustainable economic development. We also hope that this project serves as a bridge of technological exchanges and friendship between Japan and the ASEAN countries.

March 2008
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Contents

Abbreviations used in the text are as follows:

EE&C	Energy Efficiency and Conservation
TD	Technical Directory
IHDB	In-house Database
BM	Benchmark
OJT	On the Job Training
EMS	Energy Management System
SEC	Specific Energy Consumption
CSR	Corporate Social Responsibility
SCADA	Supervisory Control and Data Acquisition
COP	Coefficient of Performance
DHCR	Direct Hot Charge Rolling
EM H/B	Energy Management Handbook
S&T	Shell and Tube Heat Exchanger
PHE	Plate-type Heat Exchanger
CIP	Cleaning In Process

ACE	ASEAN Centre for Energy
METI	Ministry of Economy, Trade and Industry
ECCJ	The Energy Conservation Center, Japan

Vietnam

ECC-HCMC	Energy Conservation Center in Ho Chi Minh City
MOIT	Ministry of Industry and Technology
EECO	Energy Efficiency and Conservation Office
HUT	Hanoi University of Technology

Philippines

DOE	Department of Energy
PNOC	Philippines National Oil Corporation
PICERO	Philippines Council for Industry & Energy and Development
MERALCO	Manila Electric Railroad and Light Co.

Malaysia

PTM	Pusat Tenaga Malaysia

Thailand

DOE	Department of Energy
DEDE	Department of Alternative Energy Development and Efficiency
FTI/IIE	Federation of Thai Industries/Institute of Industrial Energy
MTEC	Metal & Materials Technology Center
ACMECS	Ayeyawady-Chao Phraya-Mekong Economic Cooperation Strategy

Overview

The ASEAN countries are continuing to make a rapid progress in economic development, and energy consumption is anticipated to dramatically increase in the future. It will therefore become increasingly necessary to utilize energy efficiently and to give due consideration to prevent global warming.

This project has now entered its eighth year, and the activities of our counterpart, the ASEAN Centre for Energy (ACE) and relevant parties of the ASEAN countries have expanded and taken its root firmly. Moreover, changes in consciousness have gradually taken place toward reducing energy consumption in those countries, facing with the recent rise in crude oil prices and the ratification of the Kyoto Protocol on February 16th 2005.

This year marked the final year of the phase 2 of PROMEEC project. It was regarded as a year for bringing together the results of phase 2 activities over the past three years, and for confirming implementation and disseminations of those results by means of further self-help efforts. In other words, this year was to establish infrastructure for disseminating results of the energy audits implemented in all ASEAN countries over the past seven years (phase 1 and phase 2).

Specifically, the following activities were implemented in four countries of Vietnam (textile industry), the Philippines (food industry), Malaysia (food industry), and Thailand (iron & steel industry):

- Follow-up surveys of factories audited in the past and simplified energy audits of new factories
  Implementation status of proposed improvement measures, identification of problems and barriers in dissemination and their solutions were reviewed.
- Creation of technical directory (TD)
  Information were shared in the ASEAN countries by introducing effective technologies and successful cases in textile, food and iron & steel industries, to promote implementation and dissemination of these technologies.
- Construction of in-house database (IHDB)
  The IHDB was formulated and put into practice in order to support energy conservation operations. In FY2007, formulation of IHDB in textile and food industries, and its actual implementation and dissemination in factories were

addressed.

Field surveys including energy audits and seminar-workshops were implemented in the above-mentioned countries. In conducting surveys in each country, practical guidance was provided to local relevant parties and activities for further ensuring the technology transfer, through following up the implementation of energy audit technologies that have been transferred by Japanese experts in the past. Moreover, in factories where implementation of proposed measures is slow in progress, discussions were held concerning barriers and solutions to implementation. Some useful clues were found for future implementation and dissemination of such measures.

Not only government and factory personnel in the host country but also government authorities from other ASEAN countries participated in seminar-workshops and presented energy conservation activities and examples of improvement measures in their countries. Seminar-workshops were very effective for sharing and disseminating information.

Activities of the project in FY2007 began with the Inception Workshop held in Ho Chi Minh City in August 2007 with participation of representatives (focal points) from the ASEAN countries. In the workshop, an implementation plan of FY2007 activities and necessary preparation for on-site activities were confirmed among representatives. Thereafter, field surveys including seminar-workshops in four countries were steadily implemented by the end of 2007. In February 2007, the Summary/Post Workshop was held as last activity of FY2007 in Bogor, Indonesia. Focal points from the ASEAN countries took part in this workshop. Reports were made to share information on the results of activities with the ASEAN countries. Intensive discussion was held on creation of TD and formulation of in-house DB. Lastly, the workshop was concluded with a discussion of concerning policies and initiatives for FY2008 and onward.

The following are specific activities implemented in FY2007 in the PROMEEC project (major industries).

I October 15 - 19, 2007
Local activities in Vietnam

1. A simplified energy audit was conducted at a textile plant in Ho Chi Minh City. An

local audit team was organized with engineers of the Energy Conservation Center in Ho Chi Minh City (ECC-HCMC). The audit was conducted as an OJT, and audit technologies were transferred to engineers of ECC-HCMC.

2. Eighty people participated in the seminar-workshop and an active exchange of information was held through the following presentations and discussions.
   (1) Presentation concerning energy conservation policies and programs by representatives from Vietnam and Japan.
   (2) Presentation of implementation examples of energy conservation by participants from various industries in Vietnam and other ASEAN countries.
   (3) Presentation of results of energy audit conducted at a textile plant in Vietnam.
   (4) Presentation by ACE and ECCJ on activities of TD creation and IHDB formulation.

Ⅱ December 3-7, 2007
Local activities in the Philippines

1. A simple energy audit was conducted at a food factory (beer) in the Philippines. Only three personnel from the Department of Energy (DOE) participated in the local audit team, and no one participated from food industry.
2. Thirty-four people participated in the seminar-workshop. Participants were mainly from companies related to energy services, and active discussion on a technological aspect was made. Examples of food industry, which was reported from other ASEAN countries, were very popular.

Ⅲ December 10-17, 2007
Local activities in Malaysia

1. A simple energy audit was implemented at a food plant (retort food) in Kuala Lumpur. A local audit team was organized with engineers of the Energy Conservation Center in Malaysia. The audit was conducted as an OJT, and audit technologies were transferred to engineers of the Energy Conservation Center.
2. Thirty-four people participated in the seminar-workshop. The seminar was considerably meaningful because there were a number of participants from food industry, and presentation of examples from other ASEAN countries was in accordance with interests of participants.

IV December 19-20, 2007

Local activities in Thailand

1. An one-day visit was made to B Steel Industry that was audited in 2006, and the implementation status of proposed measures was followed up.
2. Eighty-six people participated in the seminar-workshop. Themes of the seminar-workshop were “Energy conservation in steel industry” and “Energy conservation in textile industry.”

V February 26-27, 2007

Summary Workshop/Post Workshop held in Bogor, Indonesia (in conjunction with projects on buildings and energy management infrastructure development)

There were 22 participants, fifteen of whom came from all the ASEAN countries except Myanmar, including 6 from ACE, and 3 from ECCJ. First of all, an evaluation on phase 2 activities was made, and then successful projects, dissatisfactory projects and their reasons for success or failure were made clear. Based on the evaluation, basic policy of phase 3 including project strategy for FY2008 were discussed and agreed.

Lastly, this project has been made possible with full cooperation of ACE, relevant organizations in each country, and representatives of relevant companies. We would like to take this opportunity to express our deepest gratitude to them all.

Ⅰ. Purpose and Background of the Project

This project aims at contributing to energy conservation and promotion of environmental conservation in the ASEAN countries in order to help dissemination and promotion of energy conservation technologies in major industries. The purpose has been achieved through contributing to promotion of energy conservation measures in major industries in the ASEAN countries.
This project was commenced in 2000 under the leadership of the ASEAN Centre for Energy, with the objective of reducing ever-increasing energy consumption in the industrial sector in the ASEAN region. The ASEAN calls this project as PROMEEC (Major Industries), which is an abbreviation of "Promotion of Energy Efficiency and Conservation," and a cooperative project with the Ministry of Economy, Trade and Industry acknowledged by a conference of energy-related ministers of ten ASEAN countries. The Energy Conservation Center, Japan cooperates in supporting promotion of energy conservation in the industrial sector in the ASEAN countries from technical and operational aspects through the project.

Objectives of the project are as follows:

1. To strengthen cooperative relationships between the ASEAN countries and Japan in the energy sector.
2. To promote energy efficiency and energy conservation in major industrial sectors in the ASEAN countries.
3. To promote the transfer of energy conservation technologies and good practices from Japan to the ASEAN countries.
4. To develop capacity in energy efficiency and conservation of concerned engineers in the ASEAN countries through energy audits and OJT.
5. To formulate technical directory (TD), in-house database (IHDB), and benchmark (BM) in the ASEAN countries for energy management.

This cooperative project should be implemented over three phases mentioned below according to discussions with the ASEAN countries including ACE. FY2007 marked the fourth year of phase 2 activities. Based on activities conducted in all ASEAN countries in phase 1, infrastructure has been established for energy conservation activities to be deployed in all ASEAN countries on an equal basis.

Phase 1 Transfer of technologies and experiences from Japan to the ASEAN countries

(completed in FY2003)

Phase 2 Implementation of proposed improvement measures in each country and dissemination to other countries in collaboration among Japan and the ASEAN countries

(complete in FY2008)

Phase 3 Promotion of energy conservation by self-help efforts of the ASEAN countries

It has entered phase 2 in FY2004, and creation of infrastructure for promoting implementation and dissemination was commenced. Specifically, activities in phase 2 revolve around implementing follow-up surveys at factories where energy audits were implemented in the past, creating a technical directory (TD), and formulating an IHDB/BM for individual industries. During FY2007, activities in accordance with this line were implemented, targeting textile industry in Vietnam, food industry in the Philippines and Malaysia and iron & steel industry in Thailand. Activities include simple energy audits based on OJT, follow-up surveys at factories where energy audit was conducted in the past, and seminar-workshops.

Ⅱ. Vietnam (Textile Industry)

1. Activity Overview

October, 2007

15 (Monday)	ECC-HCMC technical guidance (audit technology)
16 (Tuesday)	OJT audit at T Textile & Garment
17 (Wednesday)	(Morning) OJT audit at T Textile & Garment
	(Afternoon) ECC-HCMC technical guidance (data analysis)
18 (Thursday)	ECC-HCMC technical guidance (data analysis/report writing)
19 (Friday)	Seminar-Workshop

2. OJT Audit at T Textile & Garment

(1) Participants

T Textile & Garment : 1

ECC-HCMC : 15 (Dr Nguyen Van Tuyen, and others)

ACE : 2 (Mr. Zamora, Mr. Ivan)

ECCJ : 3 (Mr. Taichiro Kawase, Mr. Hideyuki Tanaka, Mr. Kokichi Takeda)

(2) Outline of T Textile & Garment

Major products : Casual wear, children's wear, sportswear and intermediate products (cloth and yarn)

Major facilities : Facilities for spinning, weaving and knitting, dyeing/finishing, and sewing

Employees : 5,400

Area: 216,000m^2

Export ratio/destinations for export : 65%/USA (69%), EU (8%), Japan (23%)

Certifications acquired : ISO9000, ISO8000

(3) OJT Results

Lectures on textile process and energy conservation technology (textile process, boiler, rotary machine)

Preparation for audit work (audit team formation, pre-questionnaire, confirmation of measuring instruments)

Data collection and measurement (operation record, various measurements)

Data analysis (saving potential calculation, proposal of energy conservation measures)

Report making on audit results (preliminary report)

(4) Audit Results

Please refer to attachments in this chapter regarding details on calculating grounds, etc

	Energy Conservation Issues	Audit Results and Countermeasures	Energy Conservation Potential
Production Facilities			
(batch dyer)	Waste heat recovery of hot wastewater in batch dyer	Recover waste heat of hot wastewater in batch dyer (TG800/1) by installing plate-type heat exchanger.	Coal Saving: 279t/y
(batch dyer)	Thermal insulation of batch dyer hot surface	The average surface temperature was 80℃. Surface heat loss was calculated and turned out to be relatively small. The reason for small loss was that the duration of hot surface temperature is not so long in one dyeing cycle. Investment economics should be examined in more detail if cheap resin insulation material is available.	Coal Saving: 9.4t/h
(stenter)	Decrease of exhaust gas loss in stenter	Maintenance is necessary because humidity sensor may be out of order.	
Utility Facilities			
(boiler)	Reduction in boiler air ratio	Residual oxygen in exhaust gas was high, from 17 to 18%. Measures such as sealing at openings and closing of observation windows are necessary (#2 and #6 boilers). Moreover, adjustment of excess draft in combustion chamber is necessary, because draft is a little strong.	Coal saving: 34% (#2) and 28% (#6) on actual coal usage. However, saving is realized only during on-operation.
(boiler)	Waste heat recovery of boiler exhaust gas	The average temperature of exhaust gas was 200℃. Discussion was made on installation of air preheater for	Coal Saving: 13kg/h. However, saving is realized only during on-operation (#2)

		recovery of waste heat. However, the amount of heat recovery is too little to recover the investment.	
(steam system)	Condensate recovery	Condensate was scarcely recovered. It is necessary to investigate the recovery potential in each equipment where steam is used.	Investment recovery is achieved approximately within a year, although it varies with the distance between equipment and boiler room.
(compressed air)	Supply system of compressed air	Current system uses dendritic supply system. Further, compressor room is far from where a facility is used. Therefore, it is recommended to consider conversion of the system to ring-shaped supply system.	Please consult with ECC-HCMC
Energy Management			
(organization)	Energy management organization	Formulate policies on promotion for energy conservation, assign energy-responsible managers, organize energy committees, and enhance consciousness of employees on energy conservation	Please consult with ECC-HCMC
(monitoring)	Monitoring & recording of energy-related conditions	Monitor & record monthly usage of coal, electricity and water, and follow-up energy usage per product and steam generation efficiency	

3. Seminar-Workshop

Date: October 19 (Friday), 8:30-17:30

Venue: Liberty Hotel (Ho Chi Minh City)

Participants:

Vietnam

- Mr. Phuong Hoang Kim (Official of EECO, MOIT)
- Mr. Huynh Kim Tuoc (Director, ECC-HCMC)
- Dr. Nguyen Van Tuyen (Scientific Consultant, ECC-HCMC)
- Mr. Hoang Thien Kim (Senior Consultant, ECC-HCMC)
- Mr. Phan Nguyen Vinh (Specialist R&D Department, ECC-HCMC), and others
- Total of 60 people

ASEAN Centre for Energy (ACE)

- Dr. Weerawat Chantanakome (Executive Director)
- Mr. Christopher G. Zamora (Administration & Finance Manager)
- Mr. Ivan Ismed (Technical Expert)

Malaysia

- Mr. Ahmad Zairin (PTM)

Philippines

- Mr. Artemio Habitan (DOE)

ECCJ

- Mr. Hideyuki Tanaka
- Mr. Kokichi Takeda
- Mr. Taichiro Kawase

(1) Greetings from VIP

ACE

Dr. Weerawat Chantanakome introduced ACE activities, PROMEEC activities, and seminar-workshop programs and showed his appreciation for activities implemented by METI/ECCJ.

ECCJ

Mr. Kawase mentioned the meaning of the project, its background, and the current status, and Japan's cooperation and contribution to the ASEAN countries. He showed his appreciation for activities implemented by the Vietnam government, ECC-HCMC, and ACE.

Vietnam Government

Greetings from Mr. Phuong Hoang Kim of the Ministry of Industry and Technology (MOIT). He showed his appreciation for activities implemented by METI/ECCJ and ACE.

(2) Session 1: Policy and Initiatives on EE&C

Overview of EE&C Programs on ASEAN (Mr. Christopher G. Zamora, ACE)

Mr. Zamora introduced the position of ACE in ASEAN, its major EE&C activities such as EC-ASEAN and SOME-METI, and PROMEEC activities. He also called for participation in the PROMEEC award system, etc.

Initiatives and Programs on ECCJ on EE&C in Industry in Japan (Mr. Kawase, ECCJ)

Mr. Kawase introduced energy conservation policies in Japan and ECCJ activities. He also mentioned topics such as the harmonization of 3Es, energy conservation methods, designation of factories, qualified person for energy management, national examination, education/training, and the national convention of good practices of energy conservation

Overview of Plans & Programs on EE&C in Vietnam (Mr. Phuong Hoang Kim, MOIT)

Mr. Kim explained energy consumption is rapidly increasing in Vietnam due to the rapid economic growth. Laws concerning energy conservation are under formulation in order to further promote energy conservation based on high-price of crude oil.

(3) Session 2: EE&C Best Practices in Industries

Case Study 1 – EE&C in Cement Industry (Philippines DOE, Mr. Aretemio Habitan)

The cement industry has promoted an introduction of highly-efficient processes mainly by foreign capital, and now its specific energy consumption (SEC) reaches up to the global level. Therefore, general energy conservation measures have already been implemented, and Energy Management System (EMS) has been established. In EMS, SEC has been introduced process by process, for example, SEC of kiln section. Thirteen typical measures are named as Best Practices. Considering few measures such as power generation exhaust gas heat recovery remain unimplemented, further reduction in SEC is expected to be difficult in the future.

Case Study 2 – EE&C in Food Industry (Malaysia PTM, Mr. Ahmad Zairin)

PTM has audited 48 companies so far and identified energy conservation potential of 13 percent. In an audit at the palm oil maker (Cargill Kuantan. Co., Ltd.), energy conservation potential of 79,861GJ/year was found, and energy conservation of 24,000GJ/year of it was realized. PTM has independently suggested measures for such as condensate recovery and steam leakage. These low-cost measures are applicable to other companies.

Case Study 3 – EE&C in Iron & Steel Industry (Philippines DOE, Mr. Aretemio Habitan)

Currently, there are 50 facilities nationwide. Thirteen typical measures are named as Best Practices. Among them, a measure to install heat-resistant curtains at a furnace's opening was suggested by a Japanese specialist.

Case Study 4 – EE&C in Glass Industry (Malaysia PTM, Mr. Ahmad Zairin)

An old-model glass melting furnace constructed in 1992 showed SEC of 8GJ/ton of molten glass. This SEC has been reduced to the EU average of 4.8GJ/ton of molten glass by replacing the furnace with a new-type furnace. This is an example that replacement of old-type furnace for energy conservation was decided based on the EU average as a benchmark.

Results of Energy Audit in T Textile & Garment (Vietnam, Mr. Phan Nguyen Vinh (Specialist R&D Department, ECC-HCMC))

Audit results were reported, concerning batch-type dyer, stenter machine and boiler. As for the batch-type dyer, heat recovery of hot wastewater and thermal insulation on the hot surface were considered. Energy saving is so little that heat insulation seems not economical.

EE&C Technology and Energy Audit in Textile Factory (ECCJ, Mr. Hideyuki Tanaka)

The calculation process of boiler heat efficiency was explained, using the measured results. The residual oxygen in exhaust gas showed 17 to 18 percent, which is considerably high partly due to use of a coal-firing boiler. Chamber draft was thought to be excessively high, as were observed burning coal ashes soaring actively from the hearth bed. Recommendations were given to reduce chamber draft gradually.

EE&C Technology and Energy Audit of Electrical Facilities in Textile Factory (ECCJ, Kokichi Takeda)

Audit on a hot oil boiler's air fan and an air compressor were conducted. Though intended information could not be obtained, guidance on common energy conservation calculation method was given concerning adjusting revolution of fans. As for the air compressor, air supply piping system was investigated. Currently, the dendritic air supply system is employed. Recommendation was given to consider replacement of it with the loop-type air supply system.

(4) Session 3: The Way Forward

Barriers Identified in Energy Audit and its Measures (ECCJ, Mr. Taichiro Kawase)

Mr. Kawase explained six factors as barriers against promotion of energy conservation. They include policies, human resources, technologies and information, funds, manufacturing technology, and society & cultures. Taking observations at Thanh Cong Textile & Garment into consideration, those barriers and measures for overcoming them were explained

Updates on the Development of the Technical Directory (ACE, Mr. Ivan Ismed)

Mr. Ivan explained the purpose and contents, development method, format of the Technical Directory (TD), and an actual example of TD format.

Updates on the Development of In-house Database (ACE, Mr. Ivan Ismed)

Mr. Ivan explained the purpose and contents, etc., of the in-house database (IHDB) using input format of the cement industry as an example. A characteristic of the IHDB is that it includes production data, energy data, equipment data, and key operation parameters and energy efficiency indicators. They are used as reference information for energy conservation operation.

In-house Database for Textile Industry (ECCJ, Mr. Taichiro Kawase)

Mr. Kawase explained the content of a newly created input format of the textile industry. In addition, he asked the factories concerned to try this new format. In particular, he emphasized that the IHDB would be useful as a tool for promoting energy conservation in the factory, and never be disclosed outside the factory.

(5) Closing Address

The workshop was concluded with a closing address of Dr. Weerawat Chantanakome (ACE).

4. Comment and Advice

(1) Energy conservation activities in the textile factory we visited had been scarcely implemented. Executives of the factory did not appear to have much interest in energy conservation. Although policy measures like enforcement of energy efficiency regulations are steadily established at both governmental and municipal level, they have not sufficiently penetrated into individual industrial factories where energy conservation activities are demanded.

(2) Preliminary preparations for audit work by ECC-HCMC were excellent. Answers to preliminary questionnaire were sent in advance to Japanese specialists, and made formulation of an appropriate audit plan greatly easier. Moreover, measuring instruments were prepared completely as requested. On the other hand, regrettably closer arrangements were not made by the factory. For example, gas-sampling nozzles were not prepared in the stenter exhaust chimney, so that measurement of the humidity of exhaust gas had to be given up.

(3) On my giving an OJT guidance, I felt that the technical level of ECC-HCMC's engineers needs to be further enhanced, except for several capable engineers. Although they have a knowledge on respective equipment such as boiler and rotary machinery, they have a difficulty in relating them to the production facilities. Knowledge regarding processes should be strengthened. The lack of knowledes may be considerably improved by providing education, because people in this country are diligent and highly motivated.

(4) Presentations of successful cases in Malaysia and in the Philippines were excellent. Particularly, EMS is well established in the presented cases, and may become good examples for other industries. All of successful cases were examples of foreign-capitalized companies. It is a future task to spread these successful cases to small and medium-sized domestic companies and regional industries.

(5) Representatives from Thailand and Indonesia did not participate in the seminar. Their participation was strongly expected. Particularly, we expect Thailand to tell her

experiences to other countries, because she has an abundant accumulation of successful cases.

(6) A local team consisted of engineers of ECC-HCMC who had minimum necessary knowledge, so that transfer of audit technologies was smoothly carried out in the OJT. In the past OJT, most of participants came from management positions who did not generally have technical knowledge, and they got bored at times. This year there were not many people falling asleep in the OJT.

(7) Appropriate facilitation by Mr. Zamora greatly helped the audiences understand the presentations in the seminar. He interpreted and briefed meanings of every presentation based on purposes of the project.

(8) When I asked comments from engineers of ECC-HCMC in the end, some of them told me that they could learn a number of aspects such as knowledge, experiences, organization of audit team, data collection, observations of facilities and data analysis, and they expected an OJT duration to be extended longer. These comments were very encouraging to us.

5. Attachments

(1) Audit Report on T Textile & Garment
(2) Seminar-workshop Program

Attachment 1 Audit Report on T Textile & Garment

1. Audit Venue

T Textile Garment, HCMC, Vietnam

2. Audit Schedule

October 16, 2007 (Tuesday) 8:30 – 17:00

17, 2007 (Wednesday) 9:10 – 12:30

3. Participants

ECC-HCMC (Energy Conservation Center in Ho Chi Minh City)

Dr. Nguyen Van Tuyen (Scientific Consultant)

Mr. Hoang Thien Kim (Senior Consultant)

Mr. Phan Nguyen Vinh (Specialist R&D Department), and others

16 participants in total

ACE (ASEAN Centre for Energy)

Mr. Christopher G. Zamora (Administration & Finance Manager)

Mr. Ivan Ismed (Technical Expert)

ECCJ (Energy Conservation Center, Japan)

Mr. Hideyuki Tanaka

Mr. Kokichi Takeda

Mr. Taichiro Kawase

4. Factory Responder

Mr. T (Equipment Engineer)

5. Outline of T Textile and Garment

General Information

Major products: Casual wear, children's wear, sportswear and interim products (cloth and yarn)

Major facilities: Facilities for spinning, weaving and knitting, dyeing/finishing, and sewing

Employees: 5,400

Area: 216,000m^2

Export ratio/destinations for export: 65%/USA

Breakdown (69%), EU (8%), Japan (23%)

Certifications accredited: ISO9001, SA8000

Production Facilities/Production Capacity

Spinning Facilities: Carding frame, Comber, Roving Frame, Ring Spinning, Cone winder / 9000 tons per year

Knitting Facilities: Circulating knitting, Flat knitting / 10000 tons per year

Weaving Facilities: Sizing, Warping, Weaving (Rapier, Water jet, Air jet) / 8 million meters per year

Dyeing Facilities: Jet dyeing, Scouring, Open-edge, Drying, Mercerizing, Finishing, Inspection / 10000 tons per year for knitted cloths & 7 million meters per year for woven cloths

Sewing Facilities: Sewing / 20 million pieces per year

Most of facilities are made in Japan, the United States, Germany, Switzerland, Italy, Taiwan or Korea

Status of Energy Use

Energies used in T Textile & Garment are fuel oil, coal and electricity. The energy consumption in 2006 is shown in the table below.

Table 5-1 Annual production and energy consumption (2006)

Products, Energy		Volume	Toe	Energy price	
Casual Ware	Pieces	20,000,000			
Fuel Oil Coal	t/y t/y	7,932,676 4,889	7,989 toe/y 3,086 toe/y	5,300 VDN/kg 7,050 VDN/kg	US C37/kg US C10/kg
Electricity	MWh/y	45,307	3,086 toe/y	1,184 VDN/kWh	US C8.2/kWh
				1¥=125VDN	

6. Activities concerning Energy Conservation Promotion

Judging from answers to questionnaire sent to T Textile & Garment, present situation is as follows:

Energy Management

An energy conservation committee has not been organized and an energy manager has not been appointed. As for energy consumption, data is recorded only for payments. Employee education, award, and kaizen activities have not been adopted either.

Energy Conservation Measures

Measures have hardly been implemented except energy conservation options attached at the time of equipment delivery. Moreover, some of energy-related instruments have never been checked and maintained since their delivery. It is anticipated that training from equipment manufacturers has not been given.

Energy Conservation Measures with Non-Investment or Small-Investment

Improvement of operations such as reduction in operating temperature has not been performed, nor has addition of heat insulation for energy conservation been planned. Moreover, steam traps are not managed. The oxygen level in boiler exhaust gas is not measured routinely, and combustion management including air ratio adjustment is not performed.

As mentioned above, energy conservation activities have not been performed in the factory. It is anticipated that priority of energy conservation is relatively low in their management policies. If the factory takes energy conservation measures to the same extent as been done in Japan, the energy-related cost would be reduced presumably by half. The first thing is to help factory management understand how nice effect of energy conservation is. Considering energy conservation activities are not so active even in such an influential textile company like T Textile and Garment, it is anticipated that other textile companies in Vietnam face the same situation.

7. Procedures for Energy Audit

Considering this is an OJT audit, it was carried out according to the following procedures. We asked and encouraged participants repeatedly to remind that audit work had to be conducted mainly by the local team.

Lectures of textile process and energy conservation measures

Briefing on targeted equipment, data collection, and measurement

Confirmation of role of the local team (incl. selection of a leader)
Implementation of data collection and measurement
Data analysis and reporting

ECCJ specialists were responsible for the first two items for the purpose of providing starting information. As all of sixteen members of the local team were ECC-HCMC's engineers, a leader was smoothly selected. With coordination of Dr. Nguyen Van Tuyen, Mr. Phan Nguyen Vinh was selected as a leader, and Mr. Taon as a sub-leader. Two technical advisors (Dr. Nguyen Van Tuyen, Mr. Hoang Thien Kim) of ECC-HCMC worked as interpreter in addition to as engineering advisor, and their effort was highly helpful. The local team implemented data collection and measurement successfully without assistance of ECCJ experts. Mr. Phan Nguyen Vinh, the leader, reported audit results at the seminar-workshop, although data analysis was made substantially by ECCJ experts analyzed.

8. Summary of Audit Result

One batch dyer, one stenter machine, two boilers, and rotary machines (fans and compressors) were selected as audit targets.

<u>Batch Dyer</u>

Two measures (heat recovery of hot waste water and heat insulation of dyer's hot surface) were taken into examination. As for the former, ECCJ experts gave a lecture on how to calculate availability of hot waste water and recoverable waste heat. As for the latter, surface temperature was measured at various locations for calculating how much heat is lost from the hot surface. Results of heat loss calculation suggested that insulation is not economically attractive.

<u>Stenter Machine</u>

Measures for reducing exhaust gas loss were examined. It was planned to measure gas velocity and humidity at an exhaust gas chimney of one stenter, however, measurement was not carried out, because there were no sampling nozzles available. Unfortunately in spite of strong request, permission for perforation of nozzles could not be obtained. During factory walk-through a humidity sensor happened to be found installed on another stenter. The meter reading of the humidity sensor was 7g-H20/kg-Dry Air, which seemed unusually low. If this reading was true, it could be possible to reduce the amount of exhaust gas up to less than one-fifth of the current level. However, judging from other information like motor sound, etc, it was thought that the humidity sensor could be in disorder. According to a person in charge of the stenter, this sensor has never been calibrated and kept untouched since its installment in 1995. Probably the system has been operated with manual condition, because the system could not function properly without being examined for ten years. Calibration of the humidity sensor is strongly recommended.

Boilers

Two boilers (one hot oil boiler and one steam boiler) were audited. Gas analysis of exhaust gas and measurement of surface temperature were performed in both boilers. Both boilers showed abnormally high residual oxygen ranging from 17 to 18 percent, which means boiler efficiency was as low as 70 percent. In the OJT, calculation method of boiler efficiency was instructed in detail.

Rotary Machines (Fan, Compressor)

Flow rate of air fan in the hot oil boiler was measured by hot-wire velocity instrument. However, energy conservation effect failed to be calculated, because necessary data were not collected, for example, inlet and discharge pressures and fan performance curve were not available. Instead, calculation method of energy conservation effect concerning variable speed adjustment of pumps/fans was lectured. As for compressor effective energy conservation measures could not be proposed, mainly due to lack of information. However, the dendritic air supply system, which is currently used, seems inappropriate because factory has considerably big compound. Recommendation was given to consider a conversion to a ring air supply system.

Results of Audit (Summary)

	Energy Conservation Issues	Audit Results and Countermeasures	Energy Conservation Potential
Production Facilities			
(batch dyer)	Waste heat recovery of hot wastewater in batch dyer	Recover waste heat of hot wastewater in batch dyer (TG800/1) by installing plate-type heat exchanger.	Coal Saving: 279t/y
(batch dyer)	Thermal insulation of batch dyer hot surface	The average surface temperature was 80℃. Surface heat loss was calculated and turned out to be relatively small. The reason for small loss was that the duration of hot surface temperature is not so long in one dyeing cycle. Investment economics should be examined in more detail if cheap resin insulation material is available.	Coal Saving: 9.4t/h
(stenter)	Decrease of exhaust gas loss in stenter	Maintenance is necessary because humidity sensor may be out of order.	
Utility Facilities			
(boiler)	Reduction in boiler air ratio	Residual oxygen in exhaust gas was high, from 17 to 18%. Measures such as sealing at openings and closing of observation windows are necessary (#2 and #6 boilers). Moreover, adjustment of excess draft in combustion chamber is necessary, because draft is a little strong.	Coal saving: 34% (#2) and 28% (#6) on actual coal usage. However, saving is realized only during on-operation.
(boiler)	Waste heat recovery of boiler exhaust gas	The average temperature of exhaust gas was 200℃. Discussion was made on installation of air preheater for recovery of waste heat. However, the amount of heat recovery is too little to recover the investment.	Coal Saving: 13kg/h. However, saving is realized only during on-operation (#2)

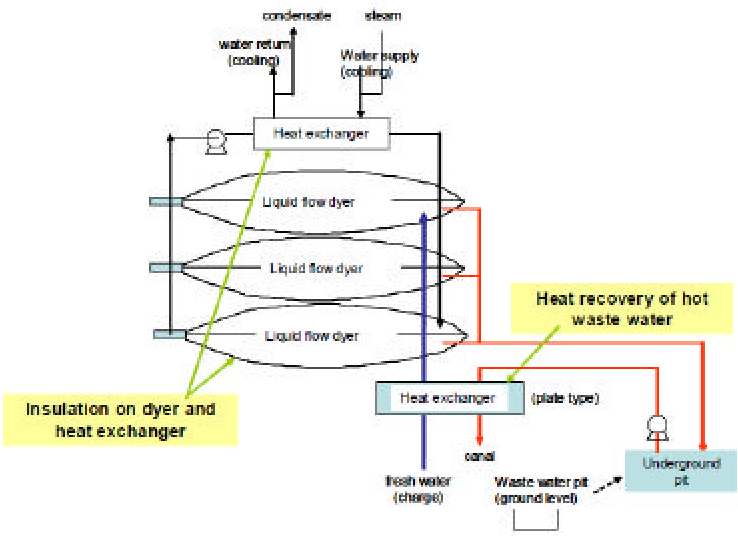
(steam system)	Condensate recovery	Condensate was scarcely recovered. It is necessary to investigate the recovery potential in each equipment where steam is used.	Investment recovery is achieved approximately within a year, although it varies with the distance between equipment and boiler room.
(compressed air)	Supply system of compressed air	Current system uses dendritic supply system. Further, compressor room is far from where a facility is used. Therefore, it is recommended to consider conversion of the system to ring-shaped supply system.	Please consult with ECC-HCMC
Energy Management			
(organization)	Energy management organization	Formulate policies on promotion for energy conservation, assign energy-responsible managers, organize energy committees, and enhance consciousness of employees on energy conservation	Please consult with ECC-HCMC
(monitoring)	Monitoring & recording of energy-related conditions	Monitor & record monthly usage of coal, electricity and water, and follow-up energy usage per product and steam generation efficiency	

9 Calculation of Energy Saving Effect

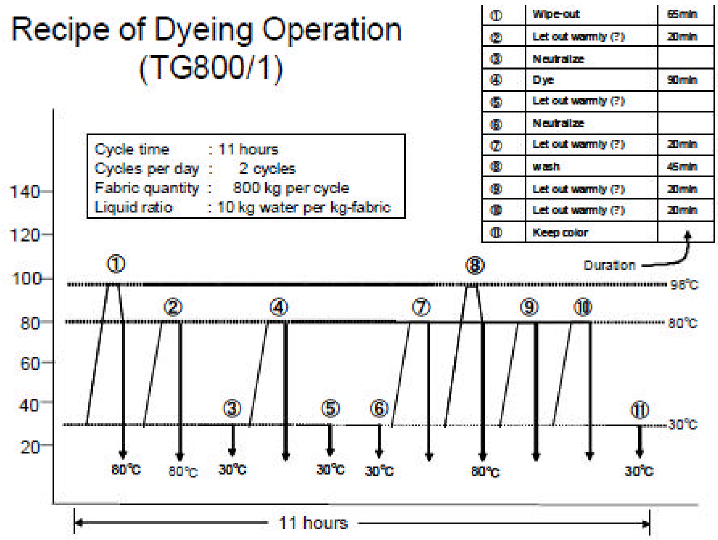
9-1 Batch Dyer

More than 100 batch dyers, including big and small, were installed, and three of them (TG800/1) were audited. An outline flow is shown in Figure 9-1. The machine consists of three dyers, heat exchangers for heating, pumps for feeding fresh water, and water circulation pumps. The figure also describes a heat exchanger for heat recovery of hot wastewater mentioned below.

Figure 9-1 Flow Diagram of Liquid Flow Dyeing Machine (TG801/1)



The dyer operates by batch of two cycles per day with eleven hours per cycle. Production capacity of cloth per cycle is 800kg. 10kg of dye liquor or washing water is used per cloth of 1kg (called bath ratio 10). Dyeing, neutralization and washing are repeated during one cycle according to the recipe in Figure 9-2.



Generally, the following four kinds of energy conservation measures are considered with respect to a batch dyer:

Heat recovery of hot wastewater

Reduction in heat loss from hot surface

Recovery of steam condensate

Reuse of hot wastewater

Heat recovery of hot wastewater and reduction in heat loss from hot surface are considered herein.

(1) Heat Recovery of Hot Wastewater

According to the recipe in Figure 9-2, hot wastewater is generated seven times from operations ? , ? , ? , ? , ? , ? and ? in one cycle. As shown in Figure 9-1, hot wastewater is firstly accumulated in the wastewater pit, and after being cooled in heat exchanger, discharged to the canal. At the same time fresh water is preheated in the heat exchanger to some extent and charged to dyers. A wastewater pit has to be installed underground so that hot wastewater flows gravitationally from dyers to pit. A plate-type heat exchanger is recommended as it is relatively cheap and space-saving. A filter should be installed upstream of the heat exchanger in order to remove textile lint entraining in the dyers.

Amount of coal saving is calculated as follows:

1) amount of hot wastewater

Operations which discharge hot wastewater : 7 operations/cycle

(operation : ? , ? , ? , ? , ? , ? and ?)

amount of hot wastewater per operation: amount of cloths × liquid ratio = 800kg × 10 = 8 ton/operation

amount of hot wastewater per cycle: 8 ton/operation × 7 operations/cycle
= 56 ton/cycle

amount of hot wastewater per day: 56 ton/cycle × 2 cycle/day = 112 ton/day

2) amount of heat recovery

temperature of hot wastewater: 80℃ (see the recipe)

temperature of fresh water: 30℃ (see the recipe)

temperature of hot wastewater at outlet of heat exchanger: 40℃

Temperature of hot wastewater at outlet of heat exchanger is decided by temperature of fresh water + temperature approach. The lower a temperature approach is, the more the amount of heat recovery increases, and, at the same time, required heat transfer area of heat exchanger increases. In the dyeing industry, temperature approach is normally set around 10℃. Therefore, the temperature at outlet was calculated as 30+10 = 40℃.

amount of heat recovery = 112,000kg/day × 1kcal/kg℃ × (80-40)℃
= 4,480,000kcal/day

3) amount of coal saving

efficiency of steam boiler: 70% (estimated value)

calorific value of coal: 7,000kcal/kg

operation days per year: 305 days

coal saving = 4,480,000kcal/day / 7000kcal /kg /0.7*305 days / 1,000
= 279 ton/year

<u>(2) Reduction in surface heat loss</u>

Heat loss from hot surface has two types; convection loss and radiation loss, and they can be calculated by the following formula:

Convection loss: qc = α*SA*(t1-t0) kcal/h

α heat transfer coefficient = 2.24*(t1-t0)^0.25

t1 surface temperature (℃)

t0 ambient temperature (℃)

SA surface area (m2)

Radiation loss: qr = 4.88 * e *SA *[{(t1+273)/100}^4-{(t0+273)/100}^4] kcal/h

e emissivity (0.3 in the case of stainless steel)

Generally, if surface temperature is over 50 degrees, heat insulation is regarded as economically feasible. If the temperature is under 140 degrees, pastable-type insulation material made of heat-resistant urethane is preferably used as an insulation material. This insulation material is easy to install and reasonable. An example of installation is shown in the photo below, where two candidate materials are trial-used for performance evaluation. Please see the website of maker for more information. (website : http://www.thaisekisui.co.th/)

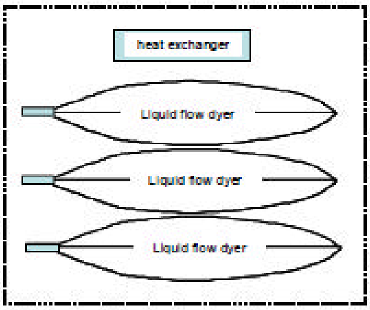
Test of Insulation Materials

Energy saving effect by heat insulation are calculated as follows:

<u>Measurement of surface area and surface temperature</u>

Surface temperature and surface area of the dyeing machine (incl. dyer, heat exchanger, valves, etc) were measured, and the following approximate value was obtained. Strictly

Surface Area and Temperature



Recipe

Inside temperature(℃)	80-98
Duration (min)	280

Measure

dyer temperature(℃)	76-90
Heat exchanger temperature(℃)	103

Surface Area

	L(m) x Dia(m)	SA(m2)
Dyer	6.0 x 0.6	83
Heat exchanger	2.0 x 0.4	

speaking, although measurement had to be made further on pipes and valves as well, they were omitted due to lack of time.

Calculation of surface heat loss

surface temperature : 80 degrees (average)

surface area: 83 m^2

qc = 2.24 * 83m^2 * (80-36) ℃ = 8,180 kcal/h

qr = 4.88 * 0.3 * 83 * [{(80+273)/100}^4-{(36+273)/100}^4] = 7,790 kcal/h

q = qc + qr = 15,970 kcal/h

Ambient temperature was 36 degrees herein. After heat insulation is done, surface temperature decreases down nearly to ambient temperature. Therefore, surface heat loss is regarded as almost similar to the previous value before performing heat insulation.

Amount of coal saving

Surface heat loss occurs when dye machine is operated at high temperatures, i.e., during operations ? , ? , ? , ? , ? , ? and ? . As shown in the recipe, total duration of them is 280 minutes per cycle and 9.4 hours per day. Now efficiency of steam boiler, calorific value of coal, and operation days per year are 70%, 7,000 kcal/kg, and 305 days, respectively, and coal saving is calculated as follows:

Coal saving = 15,970 kcal/h /7,000 kcal/kg /0.7 * 9.4 hours/day
* 305 days / 1000 = 9.4 ton/year

Energy saving effect is not so high. Economical justification seems difficult. It depends on prices of insulation material. Contact and discussion with insulation material supplier is recommended.

(3) Other Measures

Recovery of steam condensate and reuse of hot wastewater are also important energy conservation measures. Steam condensate is normally recovered to boiler feed water tank in the boiler room. It is expected that investment cost is paid out within three years unless dyeing machine is far from the boiler house. In case that it is distant long, as an alternative, condensate can be used as hot water source for dyeing machine.

Rinsing water used in operations ? and ? is relatively clean so that it can be reused in other dying processes such as mercerization. In addition, it can be used in the same facility such as operations ? and ? . In this case, a dyeing test is recommended to make sure there is no problem in dyeing operation.

9-2 Stenter

In the plant, there are ten dryers and six out of them are stenters. Stenter is a continuous-type cloth dryer, and normally the following energy conservation measures are adopted;

Reduction in exhaust gas loss

Reduction in moisture of charge cloth

Prevention of excessive drying

Heat recovery of exhaust gas

Measurement of exhaust gas loss was planned herein. It was planned to measure gas velocity and humidity at exhaust gas chimney, however, measurement was cancelled because there were no sampling nozzles available, and in addition permission for performing perforation of nozzles was not given.

During factory walk-through a humidity sensor happened to be found installed on another stenter. The meter reading of the humidity sensor was 7g-H20/kg-Dry Air, which seemed unusually low. If this reading was true, it could be possible to reduce the amount of exhaust gas up to less than one-fifth of the current level. However, judging from other information like motor sound, etc, it was thought that the humidity sensor could be in disorder. According to a person in charge of the stenter, this sensor has never been calibrated and kept untouched since its installment in 1995. Probably the system has been operated with manual condition, because the system could not function properly without being examined for ten years. Calibration of the humidity sensor is strongly recommended.

9-3 Boiler

As shown in Table 9-1, three steam boilers and three hot oil boilers were under operation. Two of them were selected as target for energy audit.

Table 9-1 Boiler Specification

Boiler name		Specification				User	Note
Steam boiler	#1	Fluidized bed boiler	Coal fired	20t/h	7kg/cm2	Dyer, Dryer, etc.	Without recuperator / economizer
	#2	Flue boiler	Coal fired	10t/h	7kg/cm2		

	#5		Coal fired	10t/h	7kg/cm2		
Hot oil boiler	#3		Coal fired	3.6GJ/h	250℃	Dryer, etc.	With recuperator only
	#4		Coal fired	3.6GJ/h	250℃		
	#6		Coal fired	3.6GJ/h	250℃		

Table 9-2 and Table 9-3 are results of measurement regarding the steam boiler (#2) and the hot oil boiler (#6). Exhaust gas analysis and surface temperature measurement were performed.

Table 9-2 Operation Data of #2 Steam Boiler

Measuring Items			Data
Fuel	Kind of fuel		Coal
	Supply temperature		℃
	Chemical component (weight percent)		(Water 8%)
	Higher colorific value		kJ/kg
	Lower colorific value (dried state)		7,300kcal/kg × 4.187kJ/kg
	Consumption	Total volume	kg
		Unit consumption	140kg/t-steam kg/h
Water	Feed water	Total volume	kg
		Unit consumption	(4,000kg/h)
		Unit consumption per fuel	(7.143kg-s/kg-f)
		Temp. at inlet of boiler	30℃
	Blow water	Flow rate	kg/h
Combustion air	Air volume supplied to boiler		m^3N/h
	Temperature	Inlet of boiler	35℃
Steam	Pressure		6.5bar(g)=0.75Mpa(a)
	Dryness of steam		%
	Steam generation		4,000kg/h
Exhaust gas	Gas volume		m^3N/h
	Temperature	Outlet of boiler	℃
		Suction side of fan	℃
		Discharge side of fan	123.6℃

	Gas analysis	Outlet of boiler	CO_2: 2.51%, O_2: 18.12%, CO: 102ppm
Boiler, duct surface temperature			℃
Boiler load factor			%

Table 9-3 Operation Data of #6 Hot Oil Boiler

Measuring Items			Data	
Fuel	Kind of fuel		Coal	
	Supply temperature		℃	
	Chemical component (weight percent)		(Water 8%)	
	Higher colorific value		kJ/kg	
	Lower colorific value (dried state)		7,300kcal/kg × 4.187kJ/kg	
	Consumption	Total volume	6,000kg/d	
		Unit consumption	250kg/h	
Oil	Feed oil	Total volume	kg	
		Feed rate	kg/h	
	Temperature	Inlet of boiler	233℃	Actual temp. difference = 7~12℃
		Outlet of boiler	250℃	
Combustion air	Air volume supplied to boiler		m^3N/h	
	Temperature	Inlet of boiler	℃	
Exhaust gas	Gas volume		m^3N/h	
	Temperature	Inside of boiler furnace	About 400℃	
		Outlet of boiler	℃	
		Suction side of fan	℃	
		Discharge side of fan	196℃	
	Gas analysis	Outlet of boiler	CO_2: 3.52%, O_2: 17.0%, CO: 88ppm	
Air heater	Air temp.	Inlet of air heater	35℃	
		Outlet of air heater		
	Gas temp.	Inlet of air heater	$(400-\alpha)$ ℃	
		Outlet of air heater	$(196+\beta)$ ℃	
Boiler, duct surface temperature			℃	
Boiler load factor			%	

Data analysis of #2 steam boiler

1) Theoretical amount of air and exhaust gas

- Components of coal C: 69.7%, H: 5.4%, S: 0.4%, N: 1.5%
- Theoretical amount of combustion air: A_0

A_0 = 8.89C + 26.7 (H – [0]/8 + 3.33S

= 8.89×0.679 + 26.7 (0.054 – 0.07/8) + 3.33×0.004 = 7.418$m^3{}_N$/kg

- Theoretical amount of combustion exhaust gas: G_0

G_0 = 0.79 A_0 + 1.867C + 11.2H + 0.7S + 0.8N + 1.244W

= 0.79×7.418 + 1.867×0.697 + 11.2×0.054 + 0.7×0.004 + 0.8×0.015 + 1.244×0.08 = 7.880$m^3{}_N$/kg

- Theoretical amount of dry combustion exhaust gas: G_{OD}

G_{OD} = G_0 – (11.2H + 1.244W) = 7.880 – 0.704 = 7.176 $m^3{}_N$/kg

- Oxygen level in exhaust gas: 18.12 %
- Air ratio: m

m = 21/(21-[O]) = 21/(21 – 18.12) = 7.3

2) Boiler Efficiency

- Calorific value of dry coal: 7,300 kcal/kg
- Moisture in wet coal: 8%
- Calorific value of wet coal: 7,300 × 4.186 × 0.92 = 28,120 kJ/kg
- Boiler feed-water enthalpy: @30 degrees = 125.8kJ/kg
- Steam enthalpy @0.75MPa (absolute) and saturated steam = 2,765.6kJ/kg
- Fuel consumption of boiler: 140kg-coal/kg-steam (according to T faxtoryC information)
- Boiler efficiency = [Generated steam enthalpy] / [calorific value of fuel]

= (1,000kg / 140kg) × (2,765.6 – 125.8) kJ/kg / 28,120 kJ/kg

= 0.6705 (=67.1%)

3) Coal saving by Reducing Air Ratio

Oxygen content at the time of measurement was 18.12% and air ratio was 7.3. In the Japanese energy conservation law, energy management standard is stipulated for major energy-consuming equipment such as boiler and motor, and it is demanded to observe. Regarding coal-fired boiler (stoker-type), standard value of air ratio is stipulated as 1.30~1.45 at 10t/h boiler. Temperature of exhaust gas was measured as

123.6°C, but seemed to be a measuring error. Considering saturated temperature at 0.75MPa (actual boiler pressure (absolute)) is 167.7°C, exhaust gas temperature should be higher than 167.7°C. In the following analysis, it is assumed to be 200°C.

Coal Saving at air ratio 2.0

Here, coal saving is estimated to be 34.1% with respect to the present consumption as estimated below;

Suppose that x kg-coal with respect to 1kg-coal can be reduced;

Theoretical air : 7.3A_0 at present operation

2.0A_0 at improved operation

Specific heat of air: 1.30kJ/m^3_NK

Specific heat of exhaust gas: 1.38kJ/m^3_NK

Temperature of combustion air: 35°C

Temperature of exhaust gas: 200°C (estimated)

The following formula is established as the heat quantity for heating excessive air and coal-firing exhaust gas of x kg up to 200°C is equivalent to the combustion calorific value of coal of x kg. However, the temperature of exhaust gas should not change.

Heat released in combustion of x kg-coal is used for raising temperature of both excess part of air ((5.3 + x) A_0) and theoretical combustion gas (G_0);

$$[(5.3 + x)\ A_0 m^3_N/kg \times 1.3\ kJ/m^3_N K + x \times G_0 m^3_N/kg \times 1.38\ kJ/m^3_N K] \times (200 - 35)\ ^\circ C = x \times 28{,}120 kJ/kg$$

x = 0.341kg (=34.1%).

4) Coal saving by waste heat recovery of exhaust gas

Waste heat of boiler exhaust gas is recovered for pre-heating combustion air or boiler feed water. Pre-heating of combustion air is considered herein.

There are two types of heat exchangers, co-current and countercurrent. In general, as countercurrent-type heat exchanger is considered herein because it has higher efficiency. In the calculation, it is assumed that air ratio m = 1.3, actual steam rate = 4t/h.

- Prerequisite

Coal rate: Wcoal = 140kg/t-steam×(1 – 0.386)×4t-steam/h

= 343.8kg/h

Air rate: $Gc = mA_0 \times Wcoal = 1.3 \times 7.418\ m^3_N/kg \times 343.8kg/h$

= 3.315m^3_N/h

Air temperature at inlet: 35℃ (=Tcl)

Exhaust gas rate : $Gh = [(1.3 - 1) \times A_0 + G_0] \times Wcoal$

$= [0.3 \times 7.418 + 7,880]\ m^3_N/kg \times 343.8kg/h = 3,474\ m^3_N/h$

Exhaust gas temperature at inlet: 200℃ (=Thl)

- Temperatures of air and exhaust gas at outlet of heat exchanger

This is calculated using the formula shown in Figure 9-4A.

$Q = Gh \times (Cph/3.6) \times (Th1 - Th2) = Gc \times (Cpc/3.6) \times (tc2 - tc1)$ [W]

$Gh = 4t\text{-steam/h} \times 140kg\text{-coal/t-steam} \times (1-0.386) \times$

$(G_0 + (m-1) \times A_0)\ m^3_N/kg\text{-c} = 3.474.6\ m^3_N/h$

$Gc = 4t\text{-steam/h} \times 140kg\text{-coal/t-steam} \times$

$(1-0.386) \times m \times A_0)\ m^3_N/kg\text{-coal} = 3,315.8\ m^3N/h$

$Q = 3.474.6\ m^3_N/h \times (1.38kJ/\ m^3_NK/3.6) \times (200 - Th2)$ ℃

$= 3,315.8\ m^3_N/h \times (1.3\ kJ/\ m^3_NK/3.6) \times (tc2 - 35)$

If Th2 is assumed to be the same as current temperature of 123.6℃, Q is 101,760W and tc2 is 120℃.

- calculation of required heat transfer area

Temperature difference, △Tm, is calculated as follows using the formula in Figure 9-4B. △Ta and △Tb are 88.6℃ and 80.0℃ respectively. Therefore, △Tm = (88.6 – 80.0) / Ln(88.6/80.0) = 84.2℃

K (overall heat transfer coefficient) of exhaust gas is assumed to be 30 W/m^2K herein, considering K of gases ranges normally in 12~35W/m^2K.

$Q = K \times A \times \triangle Tm = 30W/\ m^2K \times A \times 84.2$℃ = 101,760W, and therefore, the heat transfer area A is 40m^2.

- Recovered heat (101,760W) is equivalent to coal saving of approx. 13kg/h.

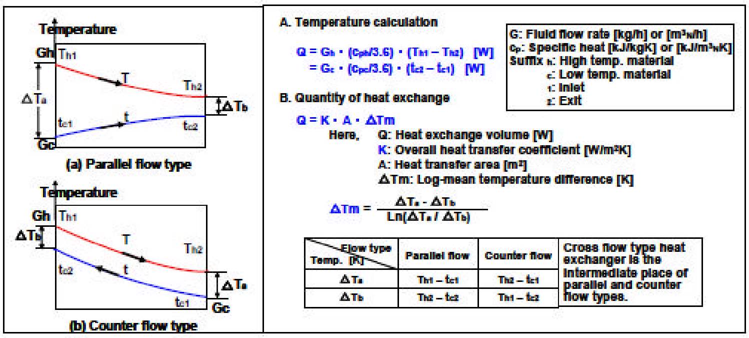


Figure 9-4 Countercurrent-type Heat Exchanger

5) Coal saving by condensate recovery

A calculation on effect of saving coal is carried out in the case that condensate generated in the plant is recovered as boiler feed water. Conventionally, open-type recovery system is used as shown in Figure 9-5. Suppose 1,000kg out of 4,000kg of boiler feed water to the boiler is coming from recovered condensate of 80℃,

(3,000kg×30℃+1,000kg×80℃) / 4,000kg = 42.5℃

That is to say, amount of coal saving is 7.4kg/h with respect to current consumption.

(42.5 – 30) ℃×4.187kJ/kgK×4,000kg/h/28,120kJ/kg = 7.4kg-coal/h

There are two types for condensate recovery; open-type and closed-type. Condensate temperature is 100℃ at the highest in open-type. On the other hand, in closed-type, it is much higher than 100℃ corresponding to boiler pressure, although system is more costly.

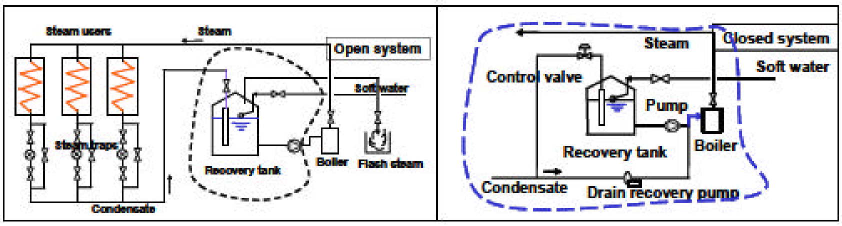


Figure 9-5 Condensate Recovery System (open-type vs closed-type)

<u>Data analysis of #6 hot oil boiler</u>

Coal is fired in #6 hot oil boiler. According to information from T factory, coal consumption is 250kg/h. Supply temperature of hot oil is 245~250℃, and return temperature is 233℃. Reduction of air ratio and waste heat recovery of exhaust gas are examined herein, as in the case of #2 steam boiler. #6 boiler has already been equipped with an air preheater.

1) Coal saving by decreasing air ratio

Residual oxygen level in boiler exhaust gas is 17%, and air ratio m is calculated as 5.25 according to the following formula;

$$m = 21 / (21-[O]) = 21 / (21 – 17) = 5.25$$

Suppose that x kg-coal with respect to 1kg-coal can be reduced;

Ambient temperature at inlet: 35℃

Exhaust gas temperature at outlet of air pre-heater: 200℃

(200℃ is an realistic estimation, considering exhaust gas temperature of 400℃)

Specific heat of air: 1.3kJ/m^3_NK

Exhaust gas temperature: 400℃ (according to information from T factory)

Specific heat of exhaust gas: 1.38kJ/m^3_NK

Heat released in combustion of x kg-coal is used for raising temperature of both excess part of air ((3.25 + x) A_0) and theoretical combustion gas (G_0);

Calculation of the amount of coal saved: x kg per 1kg of coal

Theoretical air : 5.25A_0 at present operation

2.0A_0 at improved operation

$$(3.25 + x) \times A_0 m^3_N/kg \times 1.3\ kJ/m^3_N K + x \times (400-200)°C + G_0 m^3_N/kg \times 1.38\ kJ/m^3_N K \times (400 - 35)\ °C = x \times 28{,}120 kJ/kg$$

x = 0.282kg (=28.2%).

2) Coal saving by waste heat recovery of exhaust gas

Currently, air pre-heater has already been installed, and waste heat of exhaust gas is utilized for preheating combustion air. Combustion air temperature is pre-heated up to around 200℃. In addition, considering high sulfur content of coal (0.4%), acid-dew point of combustion gas may be over 100℃. Further addition of air pre-heater may be difficult to be justified economically.

9-4 Strengthening of thermal insulation

1) Thermal insulation of valves and flanges

Although heat insulation of pipes around the boiler was well performed, most valves and flanges were not insulated.
Calculation of energy saving effect by thermal insulation of valves and flanges is described illustratively in the following example. As for calculation of heat loss in valves and flanges, equivalent pipe length (EQ) is conveniently utilized. Heat loss from pipe with length of EQ is the same as heat loss from valves and flanges. EQ is referred to a reference book or a handbook. Figure 9-6 shows heat loss per unit length (m) in a graph for various size of pipes.

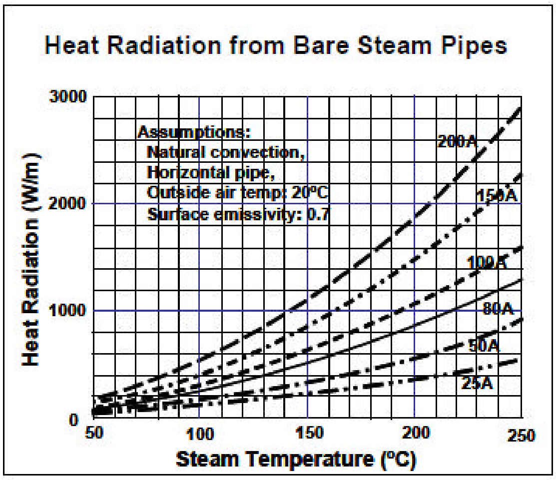
Calculation of energy saving effect by thermal insulation:
Suppose 6 valves and 4 flanges are thermally insulated as shown in the following table .

Equivalent pipe length of non-insulated valves and flanges

Fluid temp.	Pipe size	Piping length	Valves No. & EQ	Flanges No. & EQ	Total bare piping EQ
Steam: 150℃	50A	3m	6×1.28m	20×0.49m	20.48m
condensate: 90℃	25A	5m	4×1.21m	10×0.54m	15.24m

Heat loss per unit length of pipe : given in Figure 9-6
400W/m at pipe size of 50A and steam with 150℃
100W/m at pipe size of 25A and condensate with 90℃
Calculating conditions;
heat insulation efficiency was 80%,
boiler efficiency 80%,
operation time 20h/d×300d/y = 6,000h/y
Heat loss at non-insulation (bare steam pipe)
= 400W/m×20.48m + 100W/m×15.24m = 9,716W = 34,978kJ/h
Heat loss at insulation
= 34,978kJ/h×0.9 = 31,480kJ/h
Coal saving = 31,480kJ/h×6,000h/y/ (28,120kJ/kg×0.8) = 8,396kg/y

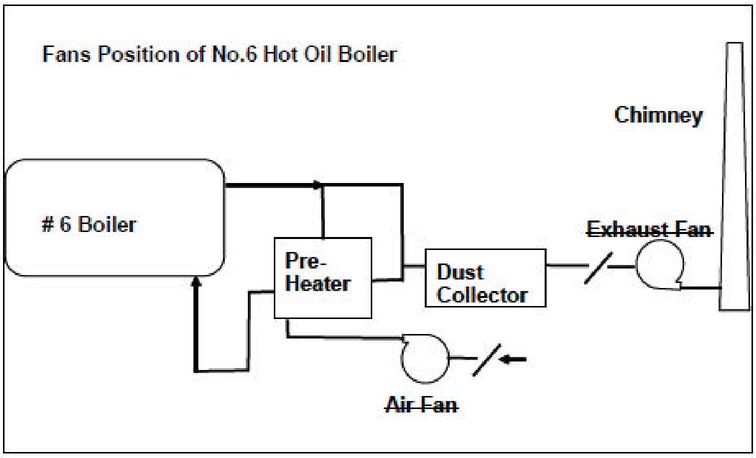
Figure 9-6 Heat loss per unit length (m) of various pipes



9-5 Fan and Air Compressor

1) #6 hot oil boiler air fan

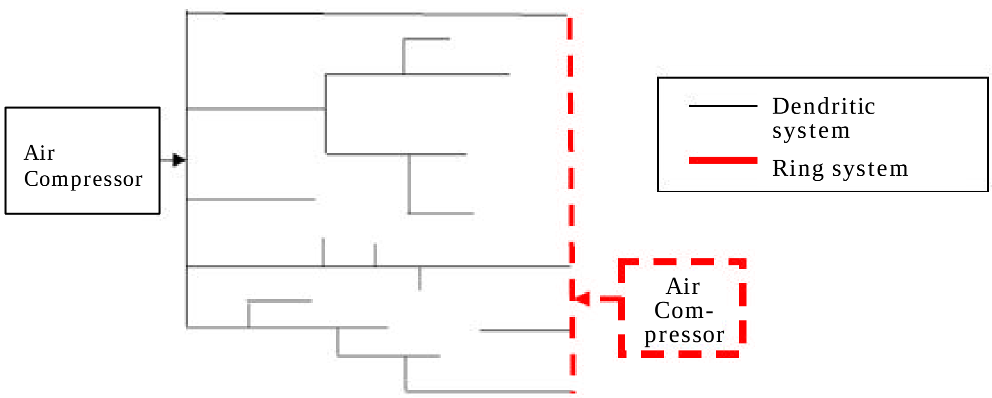
Flow rate of air fan in the hot oil boiler was measured by hot-wire velocity instrument. However, energy conservation effect failed to be calculated, because necessary data were not collected, for example, inlet and discharge pressures and fan performance curve were not available. Instead, calculation method of energy conservation effect concerning variable speed adjustment of pumps/fans was lectured.



2) Air Compressor

As for air compressor, effective energy conservation measures could not be proposed, mainly due to lack of information. However, the existing dendritic air supply system seems inappropriate because it has long pipelines over considerably big factory compound. Recommendation was given to consider a conversion to a ring air supply system.

Compressed air supply system (dendritic system vs ring system)



10. Impression on factory

It seemed that energy conservation activities were not implemented. Paradoxically speaking, this means that there is significantly large potential for energy conservation. 50% of energy conservation is not a dream. In case that energy cost accounts for 15% of total manufacturing cost, if 50% of energy conservation effect is achieved, 7.5% of cost reduction is achieved (7.5=15x0.5).

Although a part of facilities in the factory such as dyers and boilers was observed, it was untidy in the factory. Hot oil piping with 250℃ was installed around stenter machines and easily ignitable cloth lint were piled around them. It is very dangerous. Moreover, coal dust was fluttering in the boiler room and blue oil fumes were rising from flanges of hot oil pumps. They may also be risk factors, although ventilation was good. Employee education on safety management (e.g. 5Ss) is expected before implementing energy conservation measures.

Assistance to OJT audit by factory management was very simple. Only one person in charge of facilities responded to us, and we could not talk with executives. Moreover, the person in charge did not participate in the seminar-workshop where audit result was presented. Therefore, although these impressions may include misunderstanding, it seemed that factory management's concern about energy conservation was low. This may indicate that relationship of ECC-HCMC with industries is not so close than expected.

Attachment 2

Seminar-Workshop Program

ACE EE&C-S MTI METI ECCJ

Agenda

SEMINAR ON THE PROMOTION OF ENERGY EFFICIENCY AND CONSERVATION (PROMEEC) FOR MAJOR INDUSTRIES IN SOUTHEAST ASIA

19 October 2007, Liberty Hotel, Ho Chi Min City, Vietnam

8:00	-	8:20	Registration
8:20	-	8:30	Opening Remarks by Dr. Weerawat Chantanakome Representative from ASEAN Centre for Energy (ACE)
8:30	-	9:35	Opening Statement by Mr. Taichiro Kawase General Manager, Energy Conservation Center, Japan (ECCJ)
9:35	-	9:40	Welcome Remarks by Mr. Phuong Hoang Kim Representative from Ministry of Trade and Industry (MTI)
9:40	-	9:15	Group Photo Session and Coffee Break
Session 1 Policy and Initiatives on EE&C			
9:15	-	9:40	Overview of EE&C Programs of ASEAN: Presented by Mr. Christopher Zamora (ACE)
9:40	-	10:05	Initiatives and Programs of ECCJ on EE&C in the Industrial Sector in Japan: Mr. Taichiro Kawase, EECJ
10:05	-	10:30	Overview of Plans and Programs on EE&C in Vietnam: Representative from Ministry of Trade and Industry (MTI)
Session 2 EE&C Best Practices in Industries			
10:30	-	11:00	Presentation: Case Study 1 Cement (Philippines) Best Practices for Energy Efficiency and Conservation in Cement Industry in the Philippines-DOE – Mr. Artemio Habitan
11:00	-	11:30	Presentation: Case Study 2 Food (Malaysia) Best Practices for Energy Efficiency and Conservation for Food Industry in Malaysia-PTM – Mr. Ahmad Zairin
11:30	-	12:00	Q & A Session

Lunch			
13:00	-	13:25	Presentation: Case Study 3 Iron and Steel (Philippines) Best Practices for Energy Efficiency and Conservation in Steel/Iron Industry in the Philippines-DOE – Mr. Artemio Habitan
13:25	-	13:55	Presentation: Case Study 4 Glass (Malaysia) Best Practices for Energy Efficiency and Conservation for Glass Industry in Malaysia-PTM – Mr. Ahmad Zairin
13:55	-	14:20	Presentation: Result of the Energy audit in Textile Factory: Presented by Local Audit Team Mr. Vinh
14:20	-	14:45	Presentation: Result of the Energy audit in Textile Factory: Mr. Hideyuki Tanaka, ECCJ (Dyeing Machine & Dryer)
14:45	-	15:10	Presentation: Result of the Energy audit in Textile Factory: Mr. Kokichi Takeda, ECCJ (Electric Facilities)
15:10	-	15:20	Q & A Session
15:20	-	15:30	COFFEE BREAK
Session 3 The Way Forward			
15:30	-	15:50	Presentation: Barriers identified in Energy audit and Its Measures: Mr. Hideyuki Tanaka, ECCJ
15:50	-	16:10	Presentation: Updates on the Development of Technical Directory: Presented by Ivan Ismed (ACE)
16:10	-	16:30	Presentation: Updates on the Development of Database/Benchmark/Guideline for Industry: Presented by Ivan Ismed (ACE)
16:30	-	16:50	Presentation: In-house Database for Textile Industry: Mr. Taichiro Kawase, ECCJ
			Q & A Session
16:50	-	17:00	Awarding of Certificates of Attendance
17:00	-	17:10	Closing Remarks: ACE, ECCJ and Ministry of Industry, Vietnam

Ⅲ. Philippines (Food Industry)

1. Activity Overview

12/3 OJT Audit at S Brewing
12/4 Ditto
12/5 Data Analysis/Report making
12/6 Seminar-Workshop
12/7 Reporting to S Brewing

2. OJT Audit at S Brewing

(1) Participants

S Brewing: 5 (Technical Manager and 4 engineers)
PNOC Engineers: 2 (Geothermal related)
DOE: 1 (Mr. Domingo, focal point)
ACE: 2 (Mr. Zamora, Mr. Junianto)
ECCJ: 3 (Mr. Taichiro Kawase, Mr. Kokichi Takeda, Mr. Hiroshi Kuroda)

(2) Outline of S Brewing

S Brewing is the largest beer brewery in the Philippines and has five factories in the country and five factories in the neighboring countries such as China. Kirin Brewery Co. of Japan takes 20% stakes of the company.

Energy Consumption (2006):

Fuel 6,492 toe/y, Electricity 27.93 million kWh/y

Production Facilities: Two brewing lines

Operation: In operation on weekdays (not in operation on weekends), line for washing bottles is in operation for 24 hours

Energy Conservation Activities: Energy conservation committee has been organized. CSR activities are actively implemented

(3) OJT results

Lecture on food processing (beer processing, freezing, drying, sterilization)

Preparations for audit (forming of audit team, pre-questionnaire, confirmation of measuring instruments)

Data collection (SCADA/collection of operation record, various measurements)

Data analysis (screening of energy conservation measures/calculation)
Reporting audit results to the Factory (quick report)

(4) Energy conservation measures to be considered

a. Waste heat recovery in wort kettle and improvement of hot water balance

b. Improvement of COP of ammonia refrigerator (optimal operation of evaporative condenser)

c. Energy conservation of refrigerant circulation pumps (application of inverters)

d. Improvement of boiler efficiency

e. Strengthening of thermal insulation (especially around beer bottle sterilizer)

f. Strengthening of energy management (utilization of in-house DB)

(5) Audit Results (Summary)

Please refer to attachments in this chapter regarding details on calculating grounds, etc

Fields	Energy Conservation Issues	Audit Results and Measures	Energy Conservation Potential
Production Facilities			
	Strengthening of waste heat recovery from wort boiler	Calculating recoverable heat from kettle vapor and wort (in case that it is recovered as hot water, it is necessary to reconsider hot water balance of the entire factory) Early repair of kettle vapor condensers is necessary.	Recoverable heat (per one batch) Kettle vapor: 33,687MJ Wort: 49,371MJ Loss of wort heat (per one batch) 12,468MJ (oil equivalent 297L)
	Strengthening of thermal insulation of beer bottle sterilizer	Surface temperature measurements (℃) Preheating tank: 40, Sterilizing tank: 56, Cooling tank: 39 Hot surface with over 50℃ had better be insulated	Surface of sterilizing tank is insulated: Reduction of heat loss = 121.8MJ/h (oil equivalent 2.9L/h)
Utility Facilities			
	Improvement of boiler heat efficiency	Air ratio is ranging from 1.21 to 1.33. Boilers are operated in a good condition. Temperature of exhaust gas is from 170℃ to 176℃. Waste heat recovery of exhaust gas is not recommended as there is a concern of acid dew-point corrosion accompanying with fuel oil burning. Unrecovered condensate in the factory should be recovered.	
	Improvement of COP of ammonia refrigerator	Measurement of actual COP on refrigeration supply side: 4.1 and reasonable Evaporative condenser shows performance as it is designed.	

		Evaporative condenser facilities have a large capacity compared to process requirement, but they are operated efficiently by adjusting number of condensers in operation (constant-speed piston compressors are installed).	
	Energy conservation of rotary machines	Application of inverter to #3 glycol supply pump were examined and performance was confirmed as expected.	
Energy Management			
	In-house DB	Constructing in-house DB in order to monitor data related to energy conservation operations such as temperatures at heat exchanger outputs which are index of the heat recovery rate.	Reference examples of reference input formats were provided
	Energy conservation checklists	Utilizing checklists for housekeeping items in both operation and maintenance, and avoiding inefficient operation	Example of checklists were provided

3. Seminar-Workshop

(1) Participants: 34

Philippines (26 participants)

Government (DOE: 8, PNOC: 2, PCIERO: 1, MERALCO: 2)

Mr. Annunciacion (DOE), Mr. Domingo (DOE)

Private Sector (13, most of them were energy service consultants.

There were no participants from food companies as the seminar was coincided with the energy week)

ASEAN (3 participants)

Indonesia: Mr. Guanwan (PERSERO, Indonesia)

Vietnam: Dr. Luong (HUT, Vietnam)

Malaysia: Mr. Phubalan (PTM, Malaysia)

Others (5 participants)

ACE: Mr. Zamora, Mr. Junianto M

ECCJ: Mr. Kawase, Mr. Takeda, Mr. Kuroda

(2) Overview of Presentations

1) "Overview and Activities of PROMEEC Projects" (ACE, Mr. Zamora)

Mr. Zamora introduced the position of ACE in ASEAN region, major EE&C activities such as EC-ASEAN and SOME-METI, and PROMEEC activities. He also called for participation in the award system.

2) "Energy Conservation Policies in Japan and Activities of ECCJ" (Mr. Taichiro Kawase: ECCJ)

Mr. Kawase introduced energy conservation policies in Japan and ECCJ's activities. He also discussed topics such as harmonization of 3Es, the Energy Conservation Law, designation of factories, energy managers, national examination, education and training, and national convention of successful cases.

3) "Energy Audit Activities at Food Factories in Indonesia" (Mr. Gunawan: PERSERO ,Indonesia, former KONEBA)

PERSERO audited so far 31 food factories including factories of palm oil, flour milling, and bakery. As a result, it was revealed that there was total energy conservation potential of 12.86%, and that, as shown below, there are important energy conservation opportunities in such areas as drying and waste heat recovery.

Reduction in drying energy:	3.58%
Waste heat recovery of exhaust gas:	2.97%
Replacement of inefficient boiler:	2.52%
Operation improvement of boilers:	1.15%
Increase of output in diesel power generation:	0.97%
Strengthening of condensate recovery:	0.90%
Total including others items:	12.85%

4) "Overview of the Food Industry in Vietnam and Energy Conservation Case in Brewery Factory" (Dr. Pham Hoang Luong, HUT)

There are 232,000 food factories in Vietnam and most of them are SME. Beverages, dairy products, cooking oil, confectionary products, frozen foods, and ready-to-cook foods are major products. Issues of the food industry are old-fashioned domestic machineries and emission of environment-polluting wastes.

Audit at Phu Minh Brewery Factory in Phu Yen Province was implemented by the Energy Conservation Centre in Ho Chi Minh City (ECC-HCMC). Production in FY2006 was 146,100 hectoliter. 53.2% of energy consumption was electricity for refrigeration. It was found that COP of existing reciprocating compressor was 2.0 and efficiency was low. It was replaced by more efficient screw compressor with COP 4.0, manufactured by MAYEKAWA MFG. CO.(Japan). Investment was paid out within 3.2 years.

5) "Energy Conservation Activities in the Philippines' Food Industry" (Mr. Marlon Domingo: DOE (Philippines))

DOE is promoting energy conservation activities under a catchphrase of "EC ways." For example, Mr. Domingo explained activities such as measurement by instrument and electricity patrol. Few contents regarding food industry were presented except information on major products of the Philippines' food industry and an example of reduction in specific consumption at a pineapple factory.

6) "Energy Conservation Case at Glass Container Factory" (Mr. Phubalan Karunakaran: PTM (Malaysia))

JG Containers Co. was established in 1972 and produces glass containers for foods and medical products with 150 ton a day. 85% of energy is consumed for glass melting.

The specific energy consumption (SEC) of factory showed 8.0 GJ/ton, and this is extremely high compared to the European standard of 5.0 GJ/ton. Audits were implemented three times in the past, and the following measures were implemented based on results obtained from the former audits, finally the factory SEC was reduced to 5.7 GJ/ton.

- Modification of melting furnace (addition of furnace control system)
- Modification of annealing furnace
- Fuel conversion in annealing furnace
- Reuse of cullet washing water (installation of filter)

7) "Overview of Energy Conservation Measures in Food Factories" (Mr. Taichiro Kawase: ECCJ)

In the food industry there are a number of products produced. Energy conservation measures are conveniently dealt with, according to unit operations such as washing, steaming, sterilizing, freezing, and storing. Mr. Kawase explained that energy conservation measures for drying and freezing, the most energy-consuming processes in food industry, together with theory of mass transfer and heat transfer.

8) "Energy Conservation Activities in a Beer Factory in Japan" (Mr. Hiroshi Kuroda: ECCJ)

Mr. Kuroda reported energy conservation initiatives taken in Japanese brewing factories since the first oil crisis, including from daily management to the following state-of-the-art technologies;

- Small once-through boiler system
- Cogeneration system
- Absorption refrigerator with waste heat recovery
- Anaerobic digestion wastewater treatment system

9) "Energy Conservation Activities in Food Factories in Japan (Electricity-related matters)" (Mr. Kokichi Takeda: ECCJ)

Mr. Takeda reported the following cases as measures related to electricity in food factories:

- Adjustable speed drive of refrigerant circulation pumps in a beer factory (inverter)
- Cooling water circulation pumps in a starch factory
- Adjustable speed drive of dust collecting fans in a food factory (inverter)

10) "Development and Dissemination of Energy Management Tools" (Mr. Junianto M: ACE)

Mr. Junianto explained that purpose, preparation method, and format of the Technical Directory (TD), and also presented an actual example of TD input form. A similar explanation was given on the In-house DB.

11) "In-house DB Input Format for the Food Industry", and "Barriers against Promotion of Energy Conservation and Measures" (Mr. Taichiro Kawase: ECCJ)

Mr. Kawase explained that purpose and content of the In-house DB using an example of input format of the food industry. A characteristic of the In-house DB is that it includes important operation parameters and energy efficiency index as well as production data, energy data, and equipment data. They are used as reference information for energy conservation operations.

(3) Questions and Answers, and Comments

Q: The energy consumption in Japan had already reduced before enactment of the Energy Conservation Law in 1979. Is it not contradictory to the explanation that the Law has contributed to energy conservation in Japan?

A: Energy conservation in Japan has progressed by self-help efforts of companies. The Law was enforced in order to further promote energy conservation.

Q: What is the reason for replacing a reciprocating refrigerator with a screw-type one in the case of Vietnam (Brewery Factory)?

A: It was replaced with a screw-type having a higher COP, because COP dropped down to 2.0 due to machine aging.

Q: As for variable speed control of absorption chiller in the case of a beer brewery, was it installed at the time of delivery or was it added afterwards?

A: The control device was installed at the time of delivery. Variable speed control signifies adjustment of refrigerant flow rate by adjustable speed drive, for example, inverter.

Q: Why is it taking much time to enact laws in the Philippines?

A: There is not a straightforward answer, because each country faces different situations. In an example of Turkey, it took much time to make sure of a legislative harmony with EU regulations and to reach an agreement among related ministries concerning financial sources.

Q: What are systems in the ASEAN countries like with regard to discounts by power factor?

A: There were explanations from several countries. There is a discount system in Malaysia and Indonesia. Vietnam is considering its introduction. In Japan, a penalty is imposed if power factor is less than 85%.

Q What does ice slurry stand for?

A: Dr. Luong (Vietnam) answered. It is one of ice thermal storage methods. It is also called sherbet.

Q: I would like to know more regarding the explanation that cool temperature of -5℃ is realized by an absorption chiller presented in the report of the brewery's case.

A: The essence of this technology is to control strictly LiBr concentration to be enough high to attain -5℃ at higher-vacuum condition in a absorption chiller. In such low a temperature as -5℃, an icing problem is the biggest technical problem. To overcome icing problem, fluid-mechanical design in the absorption chiller was redesigned for LiBr aqueous solution to smoothly flow under high concentration and high viscosity.

(4) Photo Session and Certification Presentation
Certificates of seminar participation were given to fifteen participants from the Philippines.

4. Comment and Advice

(1) OJT audit was implemented in S Brewery Co., Ltd., an excellent company which won the second prize of the Industrial Energy Conservation Competition of PROMEEC. According to an application to the competition, almost all of energy conservation measures are adopted. In fact, the implementation of those measures was confirmed as stated in the application. We had an impression that this is an excellent factory in the ASEAN region. A large board with photos' of members of an energy conservation committee was put up in the factory. An introduction video was casted, more than half of which is used for CSR activities. It indicates the social status of S Brewery Group very high.

(2) Mr. Kuroda, who used to work in a beer brewery, participated in this audit. According to him, there is still much room remaining for improvement in comparison with Japanese breweries. There is a possibility of improvement from the standpoint of optimization of the entire factory. For example, unused waste heat from wort kettle is recovered in a form of hot water, and transported to bottle-washing unit and utilized as heating source. It reduces steam consumption which is generated in steam boiler. The measure has already been implemented in Japanese breweries.

(3) The factory has an excellent data collection and recording system, respectively SCADA system and hand-written operation record sheet. However, it was observed that the accumulated data were not fully utilized for activities such as daily operation and preventive maintenance. For example, activities to optimize operation of refrigerating system are not so active, while large amount of data are continuously accumulated. It seemed that some engineers were not sufficiently equipped with necessary knowledge. The In-house DB may be helpful for promoting energy management, including the above problems.

(4) When we pointed out the above-mentioned points in (2) and (3), engineers understood the importance of further pursuit of daily management activities. Mr. Kuroda handed over checklists on each process for daily management use, because they requested examples of these activities in Japan. They showed deep appreciation as they have not used these checklists in the past.

(5) Only two PNOC engineers participated in the audit activity from the Philippine side. Surprisingly no one participated in from food industry. Our activity was substantially not an OJT but an energy audit of S Brewery Co., Ltd. A person in charge of the

Philippine side said that it was very helpful in understanding the actual situation of industry. However, it is regrettable because we spent much effort to coordinate and prepare beforehand.

(6) A similar problem was found in the seminar-workshop. Although forty people were expected to participate, only twenty turned up. They explained that it was due to heavy rainfall and the energy week, but it became somewhat a small seminar in number. However, it was a good news that questions and answers were actively exchanged. Most of participants from the private sector were energy service consultants so that the question-and-answer session was very practical. We were able to discuss specific ideas, not general ideas regarding the audit.

(7) Selection of speakers from Indonesia, Vietnam and Malaysia was excellent. They are respectively a former engineer of fertilizer factory, a professor of thermal engineering faculty and an audit manager of the energy conservation center, and all of them have business experience in this field. I thought participants from the Philippine side were satisfied with the question-and-answer session. I have experiences of OJT audit twice in the past, but speakers of this seminar were one of the best.

5. Attachments

(1) Audit Report on S Brewing
(2) Seminar-Workshop Program

Attachment 1 Audit Report on S Brewing

1. Audit Venue

P factory of S Brewing, McArthur Hi-way, Valenzuela City, Philippines CMC

2. Audit Schedule

December 3, 2007 (Monday) 9:30 – 17:00
4, 2007 (Tuesday) 9:30 – 17:00
5, 2007 (Friday) 9:30 – 13:00

3. Participants:

Philippines Government
Mr. Marlon Rumulo Domingo (DOE)
Mr. Mmichaelle B. Anguluan (PNOC)
Mr. Rex Darell Vergel (PNOC)

ACE (ASEAN Center for Energy)
Mr. Christopher G. Zamora (Administration & Finance Manager)
Mr. Junianto M (Technical Expert)

ECCJ (Energy Conservation Center, Japan)
Mr. Hiroshi Kuroda
Mr. Kokichi Takeda
Mr. Taichiro Kawase

4. Responders

Factory Manager, Technical Manager, and five others

5. Overview of S Brewing

General Facts

S Brewing is the largest beer brewing company in the Philippines. P factory is one of five factories, and is located at the northernmost part of the metropolitan area in Manila. This factory has the second largest production capacity out of five factories of the company in the Philippines. Kirin Brewery Co. takes 20% of its share. The company has advanced into neighboring countries such as China. P factory hires 452 employees. Technical Department has 42 members and 12 out of them are engineers.

Production Facilities

P factory has two brewing lines and are in operation on weekdays (not in operation on weekends). The bottle-washing line is in operation for twenty-four hours.

Heating facilities: rice cooker, mash tun, wort kettle, CIP heat exchanger, yeast dryer (all of which are indirectly steam heated

Sterilizing facilities: bottle-sterilizing facilities-2, can-sterilizing facility-1, CIP facilities-2 (all of which use steam)

Cooling facilities: Glycol cooler (-2℃, S&T), beer cooler (1℃, S&T and PHE), water cooler (6-8℃, S&T and PHE)

Utility Facilities

Steam boilers: 6 (9.4t/h x 5, 12.55t/h x 1, 100psig, fuel (fuel oil and biogas))

Air compressors: 4 (screw x 193kW, water-cooling, piston x 2, 280kW each, water-cooling, centrifugal x 1, 261kW, water-cooling)

Facilities for receiving and distributing electricity: 5000KVA x 9 transformers (34500V/4160V)

Refrigeration facilities:

low-pressure system x 6 (screw, ammonia, suction/discharge 1.93-2.4 bar/12bar, motor 522kW x 4, 548kW x 1, 360kW x 1, each condenser is evaporative condenser, each evaporator is S&T),

high-pressure system x 3 (screw, ammonia, suction/discharge 3.79-4.14 bar/12bar, motor 746kW x 3, each condenser is evaporative condenser, each evaporator is S&T), high-pressure system is only for manufacturing chilled-water

Energy Consumption (2006)

Fuel: 6492 toe/year, electricity: 27.93 million kWH / year

Energy Conservation Activities

CSR activities have been actively implemented. Energy conservation activities have also been implemented in accordance with CSR activities. P factory has organized an energy conservation committee, assigned an energy manager, and has an award system for energy conservation suggestions. Monitoring, recording and reporting of energy consumption are implemented. Facilities are managed by preventive maintenance. TPM/KAIZEN is in place, and in-house energy audits are implemented, utilizing own employees or external consultants. In addition, The company has obtained ISO9000/ISO14000, and has won various awards such as the Don Emilio Award and the ASEAN Energy Conservation Award. As a conclusion, we can say the company carries out ideal energy conservation activities.

6. Investigation on Production Facilities

As P factory has implemented most of typical energy conservation measures, investigation was conducted except on the already-implemented measures. As a result, as for production facilities, heat recovery of wort kettles, improvement of hot water balance, and reduction in energy loss around the beer bottle sterilizer were investigated. As for utility facilities, considerations were given to improvement of boiler heat efficiency, enhancement of COP of ammonia refrigerator, and energy conservation of refrigerant circulation pump. Concerning energy management, introduction of the in-house database for utilizing operation data was recommended.

6-1 Heat Recovery from Wort Kettles and Improvement of Hot Water Balance

Wort kettles are the largest source of exhaust heat. Therefore, it will be a key of energy conservation how to increase the heat recovery rate for effectively utilizing it as a heat source in other places in the factory. Source of exhaust heat in wort kettles is "latent heat of vapor producing at the time of wort boiling" and "sensible heat of wort at the time when hot wort is cooled to fermentation-initiating temperature (pitching temperature)."

Recoverable Heat Quantity from Wort Kettles

☆ Heat recovery from vapor producing at the time of wort boiling (latent heat) per one batch

Amount of wort at the time of completion of boiling (cast wort): 1,340 hL
(←from data of wort cooling given by P factory)

Boiling rate (percentage evaporation): 10%
(←general manufacturing method, boiling time is supposed to be 90 minutes)

Amount of wort at the time of initiation of boiling (unboiled wort): x hL

$$(x-1{,}340) / x=10/100, \ x = 1{,}489$$

Amount of water evaporated: 1,489hL – 1,340 hL = 149 hL

Heat quantity of evaporation:

Heat of evaporation =540 kcal/kg (2,260kJ/kg)

149 hL x 540 kcal/kg = 8,046 x 10^3 kcal (33,687MJ)

☆Heat Recovery from Wort Cooling (sensible heat) per one batch

Amount of wort at the time of completion of boiling (cast wort): 1,340 hL

(←from data of wort cooling given by P factory)

Temperature of wort:

98℃ at inlet of plate-type heat exchanger

(←from data of wort cooling given by P factory)

10℃ at outlet of plate-type heat exchanger

(←from data of wort cooling given by P factory)

Heat quantity of wort cooling:

1,340 hL x 1 kcal/kg ℃ x (98-10) ℃ = 11,792 x 10^3 kcal (49,371MJ)

☆Total amount of recoverable heat:

8,046 x 10^3 kcal + 11,792 x 10^3 kcal =19,838 x 10^3 kcal (83,058MJ)

☆Heat quantity for heating up wort per one batch

Wort is charged from wort pre-run tank, then preheated by hot wort coming from the energy storage system. A part of heat quantity of evaporation is stored in the energy storage system.

Amount of wort at the time of onset of boiling : 1,489 hL

Heating temperature:

at inlet of plate-type heat exchanger 72℃ (←from data of P factory)

at outlet of plate-type heat exchanger 92℃ (←from data of P factory)

Heat quantity for wort heating:

1,489 hL x (92-72) ℃ = 2,978 x 10^3kcal (12,468MJ)

Ratio of heat quantity for wort heating to heat quantity of evaporation:

2,978 x 10^3kcal (12,468MJ) / 8,046 x 10^3kcal (33,687MJ) x 100 = 37%

☆Heat quantity available for other usages

19,838 x 10^3kcal - 2,978 x 10^3kcal = 16,860 x 10^3kcal

It is necessary to design an optimal system so that heat quantity available for other usages should be made maximum use of, with respect to heat demand in other processes in the factory. Specifically, it is important to separate heat quantity demand (temperature and quantity) and water quality demand by usage. A high water quality is demanded for processing raw materials, washing equipment, handling water which has a possibility to contact directly with beer liquor.

Current Situation of Heat Recovery from Wort Kettles

☆Heat recovery from hot wort cooling per one batch

Heat quantity of hot wort based on 10℃ (fermentation temperature)

1,340 hL x 1kcal/kg℃ x (98-10) ℃ = 11,792 x 10^3kcal (49,371MJ)

Wort is cooled from 98℃ to 10℃ through four stages. Heat of hot wort is recovered for preheating boiler feed-water and brewing water respectively in the first and the second stages. Then it is cooled in the cooling tower as the third stage, and finally cooled down to 10℃ by brine in the fourth stage.

First stage: recovered to boiler feed-water

Wort temperature (98? 90) ℃, recovered heat quantity 1,072 x 10^3kcal (4,488MJ), recovery rate 9.1%

Second stage: recovered to brewing water

Wort temperature (90? 45) ℃, recovered heat quantity 6,030 x 10^3kcal (25,246MJ), recovery rate 51.1%

Third Stage: discarded to environment in the cooling tower

Wort temperature (45? 35) ℃, discarded heat quantity 1,340 x 10^3kcal (25,246MJ), energy loss11.4%

Fourth stage: cooled by brine (supplied from refrigeration system)

Wort temperature (35? 10) ℃, cooling, 3,350 x 10^3kcal (14,026MJ), energy inputted 28.4%

☆Instability of Hot Water Balance

Current tank system for recovered hot water causes a phenomenon that hot water runs short due to imbalance of hot water supply and demand accompanied by delay of wort boiling. This causes wasteful situation when hot water is produced, but cannot be used.

☆Early Repair of Vapor Condenser

At the time of investigation, heat recovery of kettle vapor was stopped for a long time, because vapor condenser was left unrepaired due to delay of delivery of replacement parts. Though this did not affect beer production, significant heat energy was lost.

Suggestions for Improving Heat Recovery (short-term measures)

☆Reexamination of Hot Water Balance in the Entire Factory

Recoverable heat quantity from wort kettles was calculated as 19,838 x 10^3 kcal (83,058MJ) per one batch. It is a key of energy conservation how to enhance heat recovery rate from available heat quantity of 16,860 x 10^3 kcal (70,590MJ), and to make maximum use for heat demand in other processes in the factory.

In the factory, strengthening of steam condensate recovery is one of current goals. Moreover, change in hot water demand is forecasted along with energy conservation promotion. It is necessary to reconsider hot water balance in the entire factory taking the demand change into consideration.

☆Early Repair of Vapor Condenser

The vapor condenser which had not been utilized at the time of investigation should be repaired and re-operated at an early stage. Although it does not affect the beer production, at least 2,978 x 10^3kcal (12,468MJ) of recoverable heat quantity for wort pre-heating, which is equivalent to fuel oil of 297L, was lost to environment. It is important to maintain and manage not only vapor condenser but also energy conservation facilities.

Information on New Technologies (reducing the wort boiling rate from 10% to 4%)

☆Background of Reduction in Boiling Rate

Required hot water decreases as energy conservation progresses. In future, hot water balance may lean to excessive supply of hot water. In order to promote energy conservation further, innovative conversion of the brewing process may be required. Emerging technologies in the world brewery industry are shown below.

☆Internal Heating Wort Kettle

This is a technology to attain a predetermined wort quality at a boiling rate of 4% by an internal heater which forcefully agitates wort with a circulation pump ,while the boiling rate of 10% has been adopted stereotypically. This technology was studied at the Weihenstephan University in Germany, and put to practical use by German brewing machine manufacturer. Evaporation heat is recovered by the energy storage system as before, and used for pre-heating wort coming from the wort pre-run tank. It is not necessary to carry out heat recovery as hot water, because available heat quantity with boiling rate of 4% is approximately equivalent to heat quantity required for pre-heating wort. This is an energy conservation technology with which recovered heat is used out in the same process, not resulting in unused exhaust heat.

☆Modification of the Existing Wort Kettle

At the time of introduction of internal heating wort kettle, the existing wort kettle will be stopped during an extended period for modification work. Fortunately there will be little adverse effect of modification work on beer production, because there are brewing facilities with two lines.

6-2 Reduction in Energy Loss around Beer Bottle Sterilizer

Sterilizer (pasteurizer) consists of three parts, pre-heating, sterilization, and cooling. Beer bottles are sterilized when they pass through hot water shower to reach a prescribed temperature. Each part requires similar treatment time. Generally, a type in which water flows counter-currently between a preheating tank and a cooling tank is adopted for energy conservation purpose.

Results of Investigation of the Current Situation

☆Pasteurizer :

Type : Double Deck Tunnel Pasteurizer 1600 bpm(bottles per minutes)
(VORTEX-type made by BARRY-WEHMILLER CO., INC.)

Size of pasteurizer: width 6m x height 2.7m (water part 0.5m) x length 30m

Capacity of beer bottle: 320mL, throughput: 1,500 bpm

Beer temperature at inlet: 0~4℃, beer temperature at outlet: 35℃

Transit time (travel time): 50 minutes

Shower temperature: based on management of sterilizing intensity,
and it was approximately a standard temperature.

☆Measurement of surface temperature of pasteurizer

Temperature of pre-heat tank (fourth tank): 49℃, surface temperature: 40℃
Temperature of sterilizing tank (heating): 68℃, surface temperature: 56℃
Temperature of sterilizing tank (retention): 61℃, surface temperature: 51℃
Temperature of cooling tank (fourth tank): 44℃, surface temperature: 39℃

☆Situations Surrounding Pasteurizer

Steam leak was found at one part of a steam drain pipe. Although there was scattering of broken bottles on the floor, the factory was managed tidy overall.

☆Heat Loss from Surface of Pasteurizer

Heat loss from surface of pasteurizer is calculated as the following table;

Place		Upper surface	Side surface (circulation pump side)	Side surface (steam feeding side)
All surface area A(m2) (Each zone occupies 1/3)		6.0×30.0 (6.0×10.0)	2.7×30.0 (2.7×10.0)	2.7×30.0 (2.7×10.0)
Actual temperature Ta (℃): pre-heating		40	40	40
Actual temperature Ta (℃): sterilizing		56	56	56
Actual temperature Ta (℃): cooling		39	39	39
Ambient temperature T_0 (℃)		30	30	30
Calculation formula	Natural convection	$Qn = [hc \times (Ta-T0)^{0.25}] \times (Ta-T_0) \times A$ (W)		
	hc	3.26	2.56	2.56
	Radiation ε	$Qe = 5.68 \times \varepsilon \times \{[(273+Ta)/100]^4 - [(273+T_0)/100]^4\} \times A$(W)		
	Emissivity	0.95 (paintwork)	0.95 (paintwork)	0.95 (paintwork)
Current heat loss		Q1 = (Qn+Qe) = (30,741+33,853)W? 64,593kWh/h? 233MJ/h		

☆Generally, target of heat insulation is a surface with 50℃ and hotter. Heat insulation of sterilizing part is supposed to be carried out herein, and surface temperature after heat insulation is set as 35℃. Thickness of heat insulation is judged on economics, for example, payout year.

Current heat loss (only sterilizing part)	Q1 = (Qn+Qe) = (19,600+20,221)W? 39,821kWh/h? 143.4MJ/h
Heat loss after heat insulation	Surface temperature is assumed 35℃

	Q1 = (Qn+Qe) = (2,496+3,508)W ? 6,004kWh/h? 21.6MJ/h
Energy saving	143.4-21.6 = 121.8MJ/h ? in terms of fuel oil 121.8MJ/h/41,934MJ/L = 2.9L/h

Reference: Heat Quantity Required for Sterilization

Temperature of beer is set as approximately 2℃ in the state of bottle filled. The bottled beer is heated up to approximately 60℃ in the pasteurizer for sterilization, and then cooled. It is discharged at approximately 35℃.
Heat quantity for heating the bottled beer:

Beer: 320mL

Bottle : 335g, Specific heat: 0.265 cal/g℃

Throughput: 1,500bpm ? 90,000bph

Heat quantity for heating up to 60℃

(320 + 335 x 0.265) cal/℃ x (60-2) x 90,000/h

? 2,134 x 10^3 kcal/h ? 8,935 MJ/h ? 213.1 L/h

Recovered heat quantity :

(320 + 335 x 0.265) cal/℃ x (60-35) x 90,000/h

? 919.8 x 10^3 kcal/h ? 3,851 MJ/h ? 91.8 L/h

Heat quantity for heating bottled beer ? 213.1 L/h – 91.8 L/h = 121.3 L/h

Suggestions for Improving Heat Recovery (short-term measures)

Based on the above calculations, surface heat loss (233MJ/h) from pasteurizer is 5.6L/h in terms of fuel oil. This is equivalent to 4.6% of heat quantity required for pre-heating bottled beer. It is possible to reduce most of the heat loss by heat insulation, though it is said, in general, that heat insulation is economically feasible if surface temperature is over 50℃. Heat insulation of the sterilizing part was carried out herein, and there is energy conservation effect of 2.9L/h in terms of fuel oil. If temperature is less than around 140℃, a pasting-type insulation material made of heat-resistant urethane is preferably used as an insulation material. This insulation material is cheap and easy to attach. An example of installation is shown in the photo below. Please see the website of a manufacturer. Careful attention is necessary to attaching work of insulation material, because the surrounding of pasteurizer is congested with attachments like piping, valves, etc. It may be an option to avoid heat insulation of complex-shaped parts.

Performance Test of Insulation Materials
http://www.thaisekisui.co.th/

7 Investigation on Utility Facilities

7-1 Improvement of Boiler Heat Efficiency

Gas analysis and temperature measurement on exhaust gas in two boilers were implemented. Fuel oil with sulfur content of 1% was being burned. Residual oxygen level was 3.7-5.2%, and exhaust gas temperature was 170-176℃. The oxygen level was managed appropriate. It seems that there is no economics of introducing an air pre-heater, considering high sulfur content and relatively high gas temperature.

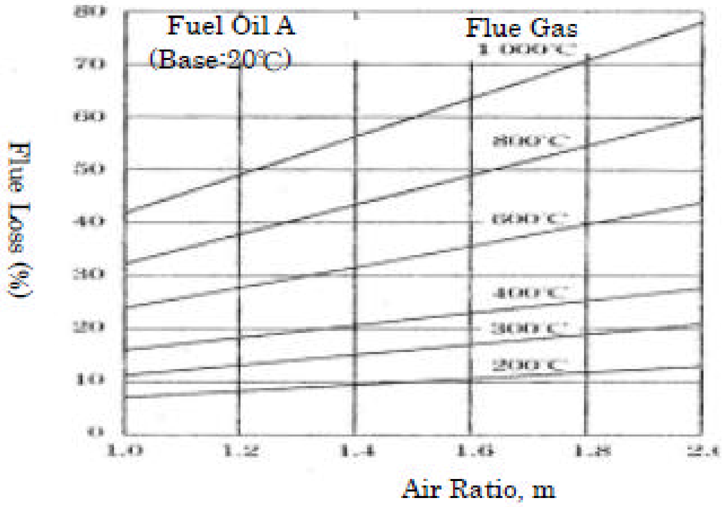
Boiler Specifications and Operation Data

	No.3 Boiler	No.6 Boiler
Steam pressure	6.7 bar	6.7 bar
Steam generated (rated)	9.4 t/h	12.5 t/h
Fuel	Fuel oil	Fuel oil
Exhaust gas temperature	170℃	176℃
Oxygen level in exhaust gas (O_2%)	5.2%	3.7%
Air ratio	1.33	1.21

Exhaust gas loss (%)	8.0%	7.5%

Air ratio is estimated from the following formula: Air ratio = 21 / (21-O_2%)

Exhaust gas loss was calculated from the figure below. This figure is used in a case of fuel oil A, however, it is also applicable approximately to other types of fuel oil.



Necessity in Energy Conservation Measures

The Energy Conservation Law in Japan requires to manage boiler air ratio and exhaust gas temperature under 1.3 and 200℃, respectively. This boiler meets these requirements so that it is not necessary to adopt energy conservation measures further.

7-2 Improvement of COP of Ammonia Refrigerator

Ammonia refrigeration system has six low-pressure stages and three high-pressure stages, and eight evaporating condensers are coping with refrigerating system. One or two of condensers are in operation under normal operation. Condensing pressure is controlled by adjusting number of operating compressors with on-off control.

Reference : COP Estimation on Refrigeration Supply Side

There are two kinds of COP : one is refrigeration supply side and the other is refrigeration demand side. COP of refrigeration supply side is defined as a ratio of refrigeration produced in the refrigeration plant to power input to refrigeration compressor. COP of refrigeration demand side is defined as a ratio of refrigeration supplied to process to all power input in the refrigeration plant. Refrigeration supplied to process should be measured in order to calculate COP of refrigeration demand side. However it is not so easy.

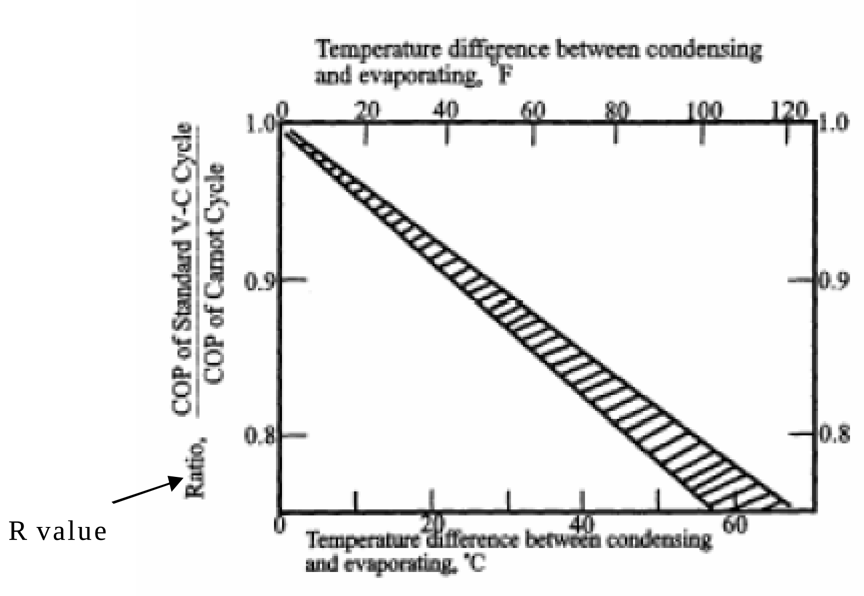
Condenser pressure / temperature: 12.2 bar(g) / 34.1℃

Evaporator pressure / temperature: 2.14 bar(g) / -8℃

Theoretical COP (Carnot's reversible cycle): (-8+273) / (34.1-(-8)) = 6.3

COP (standard cycle): 6.3 x 0.83 = 5.2

Calculated COP: 5.2 x 0.8 = 4.1 (COP of refrigeration supply side)



R value (ratio of COP of the standard cycle to COP of the Carnot's reversible cycle) was calculated based on the following figure. Refrigeration compressor efficiency was assumed to be 80%.

Evaluation on Performance of Evaporative Condenser

The fifth evaporative condenser was in operation at the time of investigation (December 4, 2007). Operation data is as follows:

Wet bulb temperature: 24℃

Circulation water temperature: 26.5℃

Temperature approach: 26.5-24 = 2.5℃

Generally, temperature approach in an evaporative condenser is designed to be 3℃, where temperature approach is defined as temperature difference between cooling water temperature and ammonia condensing temperature. As the evaporative condenser was in on-off operation, it is in operation with load of 100%, compared to rated capacity of a single evaporative condenser. Considering measured temperature approach is 2.5℃, it is thought that the evaporative condenser showed its performance as designed. Channeling of circulation water was not found nor generation of algae. It is in a good maintenance condition.

Effect of Increase in Evaporative Condensers in Operation

Currently, one or two out of eight evaporative condensers are in operation, meaning that there is redundant capacity in the existing facility. If number of evaporative condensers increases in operation, temperature of circulation water can be lowered. This indicates that ammonia condensing pressure can be lowered, and ammonia compression ratio can be also lowered, resulting in reduction of compressor power. However, in this facility, temperature approach has dropped to 2.5℃ as mentioned above. Therefore, it is difficult to expect a significant decrease in temperature approach even when adding more condensers in operation. On the other hand, there is a restriction that compressor-type is a constant-speed piston and it cannot perform continuous control. Therefore, it is difficult to carry out energy conservation operation, utilizing spare capacity of the evaporative condensers.

If compressors in the refrigeration plant are equipped with screws with inverters, it is possible to perform energy conservation operation utilizing spare capacity of the evaporative condensers. Power required for operating the evaporative condensers increase, but more saving of ammonia compressor's power can be expected. An estimation method of energy conservation potential in this case is shown below.

Basic formula of evaporative condenser: $Q = U \times A \times \Delta t$

Q: Quantity of heat exchanger duty (kcal/h)

U: Overall heat transfer coefficient

A: Area of heat transfer (m2)

Δt: Average temperature difference (℃)

G: Mass velocity in condenser tube (kg/m2h)

Between base operation and energy conservation operation, the following equation is set. Subscripts are described as $_1$ and $_2$.

$$Q = U_1 \times A_1 \times \Delta t_1 = U_2 \times A_2 \times \Delta t_2$$

$$U_1 / U_2 = (G_1/G_2)^{0.8}$$

It can be said that U is approximately proportional to the 0.8 power of ammonia flow rate in a condenser tube. If condensers increase from two to three, A_1/A_2 become two-third (2/3). At the same time, flow rate per evaporative condenser also becomes two-third. The current Δt_1 is a difference between 34.1℃ of ammonia condensation temperature and 26.5℃ of temperature of evaporative condenser's circulation water, that is, 34.1 – 26.5 = 7.6℃. Ammonia condensation temperature under energy conservation operation is estimated as 26.5 + 6.35 = 32.8℃ based on the following procedures.

$$\Delta t_2/\Delta t_1 = (U_1/U_2) \times (A_1/A_2) = (3/2)^{0.8} \times (2/3) = 0.92$$

$$\Delta t_2 = 6.9 \times 0.92 = 6.35℃$$

Ammonia property in condensers and evaporators in base operation and in energy conservation operation are as follows

	Base operation		Energy conservation operation	
	Condenser	Evaporator	Condenser	Evaporator
Pressure bar(g) (Mpa)	12.2	2.14	11.6	2.14
Temperature ℃	34.1	-8	26.5 + 6.3 = 32.8	-8

The compressor's power can be estimated as follows:

$$L = k/(k-1) \times (Ps \times Qs)/0.06 \times [(Pd/Ps)^{(k-1)/k}-1]/\eta$$

k: Specific heat ratio of ammonia

Ps: Suction pressure (MPa)

Pd: Discharge pressure (Mpa)

Qs: Compressor ammonia handling rate (m^3_N/min)

η: efficiency of compressor, normally 0.8

Here, Ps x Qs is a constant value herein in an ideal gas state, and this is supposed to be approximately valid.

Therefore,

$$L2/L1 = [(Pd/Ps)^{(k-1)/k}-1]_2 / [(Pd/Ps)^{(k-1)/k}-1]_2$$

$$= [(12.6/3.14)^{(1.31-1)/1.31}-1] / [(13.2/3.14)^{(1.31-1)/1.31}-1]$$

$$= 0.96 \text{ (4\% saving)}$$

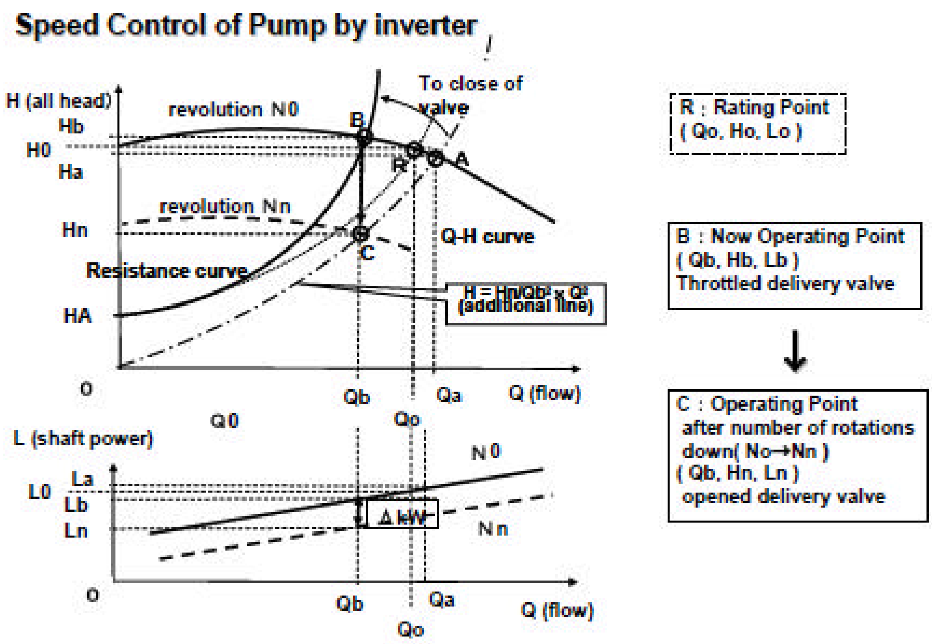
Ammonia compressor's power is saved by approximately 4%. However, its effect is low even if evaporative condensers are increased from two to three. Rather effort had better be made for reduction of process-side refrigeration load.

7-3 Investigation on Energy Conservation of Rotating Machine

Pumps were investigated by focusing specifically on glycol feed pumps. The #3 glycol pump (to Fassen PHE cooler) has already been equipped with an inverter. In order to evaluate a performance of inverter, realized electricity saving was estimated using the measured data. Effectiveness of the introduction of inverter was confirmed.

Energy Conservation Effect of Introduction of Inverter

a) Rationale of electricity conservation



b) Calculation example of glycol pump #3

Measured data in this investigation: Motor rating Lo 37.3kW (50HP)

Input power Lb’ 2.64 ~ 2.97kW (at 25Hz)

①Calculation of shaft power at point A and estimation of flow Qa and head Ha

One example of measured data of input power at point C : kWc = 2.81[kW]

Supposing pump efficiency is constant over normal operation range,

$$La = kWc/(Nn/No)^3/(\eta_{tc} \times \eta_{mc})$$

$$= 2.81/(25/60)^3/(0.95 \times 0.7) = 25.8[kW] = 34.6[HP]$$

Judging from intersection of La curve and pump performance curve, Qa 120[USGPM], Ha 340[ft]

②Calculation of head Hn' and Hn at points C' and C

$Hn' = (Nn/No)^2 \times Ha = (25/60)^2 \times 340 = 59.9$[ft]

Supposing pressure drop in the throttled discharge valve of glycol pump #3 is 30[ft],

Hn 59-30 = 29[ft]

③Calculation of flow Qb and shaft power Lb

$Qb = \sqrt{(Hn'/Ha)} \times Qa = \sqrt{(59/340)} \times 120$ [USGPM]

Lb 29.3[HP] = 21.8[kW] (read from the performance curve)

④Calculation of electricity saving

$?kW = Lb/\eta_{mb'} - kWc = 21.8/0.92 - 2.8 = 20.9$[kW]

8 Investigation on Energy Management System

8-1 Utilization of Operation Data and the In-house DB

P factory has introduced SCADA systems. The hand-written recording sheet is employed in each on-site department. Typical data are raw materials and products, energy consumption like fuel, electricity, specific energy consumptions, and key process parameters. Accumulated data are recorded and monitored every day. However, it seemed that there was still much room for more effective utilization of accumulated data. It is possible to find out a drop in the heat recovery rate due to tube fouling of vapor condenser or equipment failure in an early stage.

Thus, we recommended an introduction of in-house DB with specific examples. For the reference, we provided an example of input format of the in-house DB (See attachment).

8-2 Energy Conservation Checklist

Energy conservation checklist on each process in beer brewing was provided (See attachment). In the P factory, energy conservation measures in the packaging process seem to be behind, compared to those in the brewing process. It is expected, in the future, that energy conservation checklists are utilized as what is called score sheet to compare energy conservation performance among factories in S Brewing Co, Ltd.

Similarly, as for utility facilities, it is expected to create checklists (score sheets) and utilize them for promotion of energy conservation.

9 Results of audit (Summary)

Please refer to attachments in this chapter regarding details on calculating grounds, etc

Fields	Energy Conservation Issues	Audit Results and Measures	Energy Conservation Potential
Production Facilities			
	Strengthening of waste heat recovery from wort boiler	Calculating recoverable heat from kettle vapor and wort (in case that it is recovered as hot water, it is necessary to reconsider hot water balance of the entire factory) Early repair of kettle vapor condensers is necessary.	Recoverable heat (per one batch) Kettle vapor: 33,687MJ Wort: 49,371MJ Loss of wort heat (per one batch) 12,468MJ (oil equivalent 297L)
	Strengthening of thermal insulation of beer bottle sterilizer	Surface temperature measurements (℃) Preheating tank: 40, Sterilizing tank: 56, Cooling tank: 39 Hot surface with over 50℃ had better be insulated	Surface of sterilizing tank is insulated: Reduction of heat loss = 121.8MJ/h (oil equivalent 2.9L/h)
Utility Facilities			
	Improvement of boiler heat efficiency	Air ratio is ranging from 1.21 to 1.33. Boilers are operated in a good condition. Temperature of exhaust gas is from 170℃ to 176℃. Waste heat recovery of exhaust gas is not recommended as there is a concern of acid dew-point corrosion accompanying with fuel oil burning. Unrecovered condensate in the factory should be recovered.	
	Improvement of COP of ammonia refrigerator	Measurement of actual COP on refrigeration supply side: 4.1 and reasonable Evaporative condenser shows performance as it is designed. Evaporative condenser facilities have a large capacity compared to process requirement, but they are operated efficiently by adjusting number of condensers in operation	

		(constant-speed piston compressors are installed).	
	Energy conservation of rotary machines	Application of inverter to #3 glycol supply pump were examined and performance was confirmed as expected.	
Energy Management			
	In-house DB	Constructing in-house DB in order to monitor data related to energy conservation operations such as temperatures at heat exchanger outputs which are index of the heat recovery rate.	Reference examples of reference input formats were provided
	Energy conservation checklists	Utilizing checklists for housekeeping items in both operation and maintenance, and avoiding inefficient operation	Example of checklists were provided

Attachment 1 In-house DB(Reference Input Format)

Data Sheet for P factory of S Brewing Co, Ltd (Philippines)

Data & Time			
Heat recovery system in the wort cooler Cooler type Wort amount (m3/batch) No of batch a day Wort rate (m3/h) Inlet temp (°C) Outlet temp (°C) Water rate (m3/h) Inlet temp (°C) Outlet temp (°C) Performance curve of hot water pump (manufacturer) Flow sheet of heat recovery system around the wort cooler (SCADA)			
COP of new ammonia refrigeration system Compressor type No of compressors Electric power at design (kW) at actual (kW) Suction pressure at design (bar G) at actual (bar G) Suction temperature at design (°C) at actual (°C) Discharge pressure at design (bar G) at actual (bar G) Discharge temperature at design (°C) at actual (°C) Evaporative Condenser Type of condenser No of condensers Water temperature at cooling tower basin at design (°C) at actual (°C)			

Dry bulb temperature at design (℃) at actual (℃) Wet bulb temperature at design (℃) at actual (℃) <u>Evaporator</u> Type of evaporator No of evaporators Lowest temperature of refrigerated rooms at design (℃) at actual (℃) Glycol temperature at cooler inlet at design (℃) at actual (℃) Glycol temperature at cooler outlet at design (℃) at actual (℃) Flow sheet of new ammonia refrigeration system (SCADA)			
Variable frequency drive (VFD) for glycol supply pump Pump type No of pumps Glycol rate at design (m3/h) at actual (m3/h) Performance curve of glycol pump (Manufacturer) Flow sheet of glycol supply system (SCADA)			

Attachment 2　Energy Conservation Checklists for Brewing Factory

(http://www.oee.nrcan.gc.ca/industrial/technical-info/benchmarking/benchmarking_guides.cfm#b)

SOME BREWERY PROCESS-SPECIFIC ENERGY EFFICIENCY OPPORTUNITIES

Brewing:

*Processing beer at high gravity throughout all major energy-using activities will reduce overall specific energy consumption. In addition, the brewery will realize a de facto increase of production capacity (better utilization of process vessels and equipment)

*Gradual operation of steam valves on the kettle will modulate demand on the boiler. Control of steam use in wort boiling (programmable -logic controllers [PLC], personal computer [PC] applications) using steam mass flow control will prevent energy wastage.

*Verification of the evaporation rate may reveal that evaporator is well in excess of the adequate minimum (generally set by brewing researchers at between 6% to 8%) wasting energy and water.

* Volume-based rather than time-based control on burst rinses and CIP flows will reduce the volume of water used

* Reduction in boiling time (while still achieving the required evaporation rate) will give a corresponding decrease in energy use.

*Recovery of high-grade heat from kettle vapor, using either spray condensers or heat exchangers (spiral or plate), has significant energy conservation potential. However, hot water balance in the brewery must be carried out beforehand to determine best uses for recovered hot water. With the aid of PC or PLC, it is possible to obtain optimum recovery of the highest-grade heat possible and storage utilization. Benefits include energy savings, savings in water use and cost, and effluent cost savings. Heat recovery in the brewhouse is often a key to mo re effective energy use in the entire brewers.

*Recovered heat from the kettle can be used for hot water preparation, as well as for preheating of wort before boiling or with steam ejector or mechanical compressor for wort boiling.

*The brewery hot water line should be optimally based on recovered heat utilization rather than on heating cold water with steam or electricity. To optimize it, hot water balance should be calculated for the whole brewery.

*Using heat-recovered hot water for functions such as CIP, bottle washing, and sterilization should be investigated. Hot water storage tank capacities should be calculated carefully to avoid hot water overflows and sewering.

*Keeping refrigerated areas as dry as possible (avoiding hosing down surfaces) will significantly reduce the refrigeration load.

*Optimizing CIP, the reduction and re-use of rinse water and a reduction in temperature of cleaning solutions will bring about energy and water savings.

*Use of a low-pressure blower instead of high-pressure compressed air for conveying spent grains may be more economical.

Packaging:

*Insulate to economic thickness bottle washers and tunnel pasteurizers and steam and water pipes, valves, traps and the condensate system associated with their operation. Major savings in steam and water consumption will ensue, with reduced requirements on the HVAC load in the packaging hall and an improvement in the work environment.

*The (multiple) regenerative water circulation system in a pasteurizer requires optimum balancing. Consider using a cooling tower for cooling water conditioning to bring additional energy and water savings.

*Direct steam injection for heating water in pasteurizers and soakers results in loss of condensate.

*Heat from bottle washers and the bottle/can pasteurizer can be recovered.

*Water from soakers and pasteurizers can be recycled.

*Water from the filler vacuum pumps and cooling water from the baler hydraulic pumps can be recycled.

*Review brewery-specific pasteurization requirements to achieve safe minimum pasteurization units (P.U.). The review may result in a reduction of an unnecessarily high P.U. and in energy savings.

*Installation of a heat recovery system from keg washer will save 40% of keg cleaning energy and recovery 86% of heat required for heating incoming water.

*Use of low-pressure blowers, instead of air compressors, would enable tank pressurization during emptying without the use of CO_2 and without disturbing the protective blanket of CO_2 atop the beer.

*Optimize the rinsing section in the bottle washer; check the sizing and positioning of the nozzles; and tie the rinsing section function to the actual washer operation to avoid wasting water.

*Optimize packaging operations to achieve the best line efficiency possible. Line efficiency affects energy consumption to a great extent. Inefficient production results in higher specific energy consumption due to losses when the line is idle. Additionally, increased efficiency can result in a lesser number of shifts required to package the same volume of beer.

*Conveyors running without a load waste electrical energy, lubricants and water; contribute to accelerated wear and tear; and increase the power demand.

*Avoid using water hoses instead of brooms in areas where a broom and shovel will do a perfectly good job (e.g., on spilled solids such as spent grains; and on broken glass around fillers).

Attachment 3 Seminar-Workshop Program

AGENDA
INTENSIVE SEMINAR – WORKSHOP
PROMOTION OF ENERGY EFFICIENCY AND CONSERVATION (PROMEEC)
(MAJOR INDUSTRY) UNDER THE SOME-METI WORK PROGRAMME 2007-2008
City Garden Hotel, Makati, Philippines
December 6, 2007

08:30 – 09:00	**Registration**
09:00 – 09:10	Welcome Remarks by the Host Country
09:10 – 09:20	Opening Statement by ECCJ The Energy Conservation Center, Japan (ECCJ)
09:20 – 09:30	Opening Statement by ACE ASEAN Centre for Energy (ACE)
	Tea Break & Group Photo Session
09:50 – 10:40	**Session 1 : Seminar** **PROMEEC Project : Outline & Achievements**
09:50 – 10:20	Presented by ACE Outline and Achievements of PROMEEC Project
10:20 – 10:40	Presented by ACE Initiatives & Programs of ECCJ on EE&C in the Industrial Sector in Japan
10:40 – 12:00	**Session 2 : Seminar** **EE&C Best Practices in Food Industry (Part 1)**
10:40 – 11:00	Presented by Mr. Gunawan Wibisono, Energy Management Indonesia Best Practices in Food Industry in Indonesia
11:10 – 11:30	Presented by Mr. Phubalan Karunakan, Pusat Tenaga Malaysia Best Practices in Glass Industry in Malaysia
11:30 – 12:00	Presented by ECCJ Overview of Energy Saving Technologies in Food Industry (General)
	Lunch
13:30 – 15:10	**Session 3 : Seminar** **EE&C Best Practices in Food Industry (Part 2)**
13:30 – 13:50	Presented by Mr. Phubalan Karunakan, Pusat Tenaga Malaysia Best Practices in Food Industry in Malaysia
13:50 – 14:10	Presented by Dr. Pham Hoang Luong, Hanoi University of Technology Best Practices in Food Industry in Vietnam
14:10 – 14:40	Presented by ECCJ Best Practices in Japanese Food Industry (Brewery & Soft Drink)
14:40 – 15:10	Presented by ECCJ Best Practices in Japanese Food Industry (Electrical Saving)
	Tea Break
15:30 – 16:10	**Session 4 : Energy Management Tools**
15:30 – 15:50	Presented by ACE Updates on Development of Database/ Benchmark/ Guideline for Industry:
15:50 – 16:10	Presented by ECCJ In-house Database for Food Industry
16:10 – 17:00	**Session 5 : Discussion and Q&A**
16:10 – 17:00	Facilitated by ACE

IV. Malaysia (Food industry)

1. Activity Overview

12/10: Training on audit technology for food factories

12/12: OJT audit for D Food Industries (retort food)

12/13: ditto

12/14: Training on data analysis, reporting to D Food Industries

12/17: Seminar-workshop

2. OJT Audit of D Food Industries

(1) Participants

D Food Industries , 5 persons (factory manager, 3 others)

PTM, 5 persons (Mr. Zairin, Mr. Phubalan, 3 other engineers)

ACE, 2 persons (Mr. Zamora, Mr. Ivan)

ECCJ, 3 persons (Mr. Hiroshi Kuroda, Mr. Koukichi Takeda, Mr. Taichiro Kawase)

(2) Outline of D Food Industries

Main product: retort food

Employee: over 100

Energy consumption: 350toe/year in 2006,

Production equipment: cooker, sterilizer, filling machine, dryer, packing machine, freezer for production

Utility equipment: boiler (5t/h, 1unit), compressor (3 units), freezer for preservation

Operation: operation in daytime only of weekday (weekend off)

(3) Contents of OJT

Lecture on food processes (retort processes, freezing, drying, sterilization)

Preparation for audit (team formation, preliminary questionnaire, confirmation for measuring instruments)

Data collection (collection of operation records, measurement work)

Data analysis (screening of energy conservation measures, engineering calculation)

Reporting to D Food Industries (quick report)

(4) Energy Conservation Measures to be Reviewed

①Production facilities

Cooker / Sterilizer

Heat insulation of non-insulated parts

②Utility facilities

Boiler

Reduction of boiler air ratio

Enhancement of condensate recovery

Heat insulation of boiler outer surface

Freezing equipment

Energy saving for outdoor cold stores

Air compressors

Addition of receiver tank

Introduction of multiple compressors control

Change in aeration air supply method for water treatment

Decrease of intake air temperature

(5) Results of Audit (summary)

Please refer to attachments in this chapter regarding details on calculating grounds, etc

	Energy Conservation Issues	Audit Results and Countermeasures	Energy Conservation Potential
Production Facilities			
(cooker/sterilizer)	Insulation of hot surface	Both cooker and sterilizer are not insulation. Surface temperature is around 100-130℃. Insulation using easy-to-attach plastic insulation material is recommended.	Natural gas saving: 83,177m3N/y
Utility Facilities			
(boiler)	Reduction in boiler air ratio	O2 content and temperature in exhausted gas were 9.4% and 194℃, respectively. To adjust air/fuel ratio, re-tuning of link mechanism is necessary.	Energy saving effect when decreasing O2 content to 4% : Natural gas saving 12.8m3N/h (reduction rate, 4%)
	Heat insulation of boiler hot surface	Surface temperature: front side 46-63℃; rear side 140℃. Insulation of rear side is necessary.	Natural gas saving 0.78 m3N/h.
(steam system)	Enhancement of condensate recovery	Present recovery rate of condensate is estimated as low as 17%, and survey of condensate recovery is necessary in every steam consuming equipment.	Recovery of investment is within a year
(refrigeration)	Energy saving for outdoor freezer	Insulation is deteriorated (door seal, wall, refrigerant piping). Heat invasion due to sunlight is reduced (sunshade, etc.); Rearrangement of packages is necessary in cold store; Elimination of unnecessary heat generation is necessary in cold store.	Energy saving effect of repairing door seal insulation: freezer power saving, 3,464kWh/y

(air compressor)	Addition of receiver tank	Unloading time is long (around 50% of day). Although addition of receiver tank was considered, energy saving effect was low and investment recovery was difficult.	Energy saving effect: 6.2kW
	Adjustment of number of compressor in operation	To avoid operating 3 units all the time, number of compressors in operation was adjusted by changing control method.	Energy saving effect: 7.2kW
	Decrease of intake air temperature	Due to inappropriate location of suction, suction temperature is as high as 44-56℃, resulting in energy loss. Investment amount is a little.	Energy saving effect: 1.5kW
(waste water treatment)	Change in aeration air supply method	Air pressure of 1.0bar is enough, instead of existing air pressure (5.5bar). A roots-type blower is newly installed to this end.	Energy saving effect: 9.9kW
Energy Management			
	Introduction of In-house DB	Constructing in-house DB in order to monitor data such as condensing temperature in refrigeration system , which are helpful for energy efficient operations.	Reference input format was provided

3. Seminar-Workshop

(1) Participants: 34 persons

Malaysia (24 persons)

Mr. Ahmad Zairin (PTM)

Mr. Phubalan Karunakaran (PTM)

Ms. Norhasliza Mohd Mokhtar (PTM), others

ASEAN (5 persons)

Mr. Iswan Nurbaso (Eastern Pearl Flour Mills, Indonesia)

Mr. Teodoro Elma (San Miguel Polo Brewery, Philippines)

Mr. Tivakorn Jongmekwamsuk(CP Retailing Marketing, Thailand), others

Others (5 persons)

ACE Dr. Weerawat, Mr. Christopher Zamora, Mr. Ivan Ismed

ECCJ Mr. Kawase, Mr. Kuroda

(2) Outline of Presentation

1) "Japan's Energy Conservation Policy and Activities of The Energy Conservation Center, Japan (Mr. Taichiro Kawase: ECCJ)"

Mr. Kawase introduced Japan's Energy Conservation Policy and activities of ECCJ. Also referred to topics regarding harmony of 3E and energy conservation law, designated factories, energy manager system, national examinations, education and training, national convention on energy conservation successful cases, etc.

2) "Outline and Activities of the PROMEEC Project" (Mr.Weerawat Chantanakome: ACE)

Mr.Weerawat introduced a position of ACE in ASEAN, major EE&C activities such as EC-ASEAN, SOME-METI, etc., and PROMEEC activities. He also invited to participate in ASEAN energy award system, etc.

3) "Energy Conservation Measures in the Eastern Flour Mills" (Mr. Iswan Nurbaso: Indonesia)

Mr. Iswan introduced a flour mill located in Makassar City, Sulawesi Island (former Celebes), and producing 64,000 tons of flour per month. Its energy consumption is 5 million kWh of electric power per month and 55kL of fuel per month. Since electric power occupies 99 percent of the total energy, the company has been coping with energy saving, targeting unit consumption of electric power to be reduced less than 100kWh/ton.

The company has so far implemented such measures as power factor improvement, inverter lightings, high efficiency motors, etc. Major measures in process or under planning are as follows:

- Transfer from pneumatic air transport to elevator transport (under way)
- Introduction of inverter for the purpose of energy saving during idling time
- Transfer from blower to fan
- Automation of valve (under way)
- Simplification of transport piping (removal of bend pipe part?)
- Recovery of process exhaust heat for boiler water preheating
- Effective use of surplus cold sources

4) "Outline of energy conservation measures in food factories" (Mr. Taichiro Kawase: Japan ECCJ)

Due to a wide variety of products in food industry, it is inefficient to consider energy saving measures product by product. Accordingly, examination of measures is carried out for unit operations, for example, cleaning/washing, steam boiling, sterilizing/pasteurizing, cooling/freezing, preserving, which are popularly used in food industry. He explained energy conservation measures for drying and refrigerating that consume energy most, in connection with theories of mass and heat transfer.

5) "Energy conservation measures in a beer brewery in San Miguel Polo Brewery" (Dr. Teodoro Elma: Philippines)

San Miguel Polo Brewery was awarded second prize in the ASEAN energy conservation award system last year. The following energy conservation measures were rated high in selection committee.

- Waste heat recovery of hot wort (for preheating both boiler feed water and sparge water)
- Redesign for piping system (steam piping for boiler room, condensate recovery piping, glycol piping, CO_2 recovery piping, air compressor cooling piping)
- Introduction of high efficiency ammonia refrigerator and high efficiency air compressor
- Effective use of wastewater sludge digested gas (for boiler fuel)

- Introduction of variable speed control
- Recovery of steam condensate
- Improvement of automatic control system

6) "Energy conservation measures in the frozen food factory of CP Retailing & Marketing (Mr. Tivakorn: Thailand)

This is a large scale food processing factory with 2,700 employees, producing 42 tons of frozen food a day, located in 60km northwest of Bangkok. They have been putting a great deal of effort on energy conservation and awarded Thai Energy Conservation Prize for 2007. The presentation was well prepared, and its presentation technique with video show was excellent as well as its content.

66.7% of energy consumption is electric power purchased, and its 62% is consumed for refrigeration, which is a typical consumption in a frozen food factory. While specific consumption of electric power was targeted at a 10% decrease for 2006, the actual result was a 15.45% decrease. Of course, an electric power demand monitor is installed and a peak load is being watched. In the energy conservation activities, it is an honor student from a plenty of aspects. In view of energy management, textbook menus such as policy, organization, education, SGA and information were all carried out. He felt the company could be a model for other companies. Also in view of energy conservation technology, it classified measures into three steps and implemented them without fail. Major measures are as follows:

- Steady cleaning of heating coil in electric fryer (step 1)
- Condensing unit with cooling pad (step 2)
- High efficiency electronic ballast (step 2)
- Reinforcement of heaters for grilling harumaki dumpling (step 2)
- Integration of air compressors and number control (step 2)
- Temperature control of scalding equipment (step 2)
- Improvement of fermentation tank (step 2)
- Time-scheduled control of air conditioner (step 2)
- Improvement of pork BBQ production process (step 3)
- Automation for harumaki dumpling forming process (step 3)

7) "Energy conservation measures in the glass factory of JG Glass Containers" (Mr. Phubalan Karunakan: Malaysia)

JG Glass Containers was established in 1972 and has been producing 150tons of glass containers for food, medicines, etc. a day. The 85% of energy is occupied by fuel for melting glass. The company's specific consumption of fuel was 8.0GJ/ton that was higher than the European and American level of 5.0GJ/ton. Audits had been conducted three times in the past, and the following measures were carried out, and as a result, the specific consumption of fuel decreased to 5.7GJ/ton.

- Reform of melting furnace (adding furnace control system)
- Reform of annealing furnace
- Conversion of fuel for annealing furnace
- Reuse of cullet washing water (filter installed)

8) "Energy conservation measures in ready-to-eat lunch box factory" (Mr. Hiroshi Kuroda: ECCJ)

Mr. Kuroda gave a presentation associated with ready-to-eat lunch box factory run by Japan's large scale supermarket. Major operations of the factory are production of cooked rice and ready-to-eat lunch box. The workplace is kept at low temperature for preventing microbes' growth. Products are stored in refrigerated store. More than half of energy is electric power for refrigeration; the calculation method of refrigerating load and examples of energy conservation measures were introduced in this presentation. The following are examples of energy conservation measures:

- Reduction of refrigeration load (minimization of floor washing water and 7 others)
- Evaporative cooler (air is cooled through evaporation of sprayed water)
- Ice thermal storage facility
- Air curtain (prevention of outdoor air intrusion)

9) "Development and dissemination of energy management tools" (Mr. Ivan Ismed: ACE)

An explanation concerning the purpose of Technical Directory (TD), preparation method, formats, etc. and actual examples of TD sheets were made. In addition, a similar explanation for in-house database was given.

10) "In-house Database input formats for food industry" (Mr. Taichiro Kawase: ECCJ)

The purpose, content, etc. of in-house database were explained, drawing an example of draft input format for food industry. The characteristic of in-house database is to contain an important operation parameters and energy efficiency indices in addition to production data, energy data and equipment data. These are used as an operation guide toward energy efficient operation.

(3) Questions and Answers, and Comments:

Q: While Japan aims at one percent energy conservation per annum, is there any penalty? (There is no penalty because it is a target for effort to be made)

4. Comment and Advice

OJT Audit

1) Factory manager of D Food Industries expressed his gratitude, saying "So far I have carried out a maintenance for equipment from the standpoints of production and safety, I have never considered energy efficiency. I have become aware of the point of energy conservation in this opportunity. Thank you for offering me with a plenty of proposals."

2) Mr. Zairin of PTM said, "In the reporting to factory, I learned measures in refrigeration demand side concerning energy conservation of refrigeration system. Inasmuch as I have so far heard only of energy conservation of refrigeration supply side, it was a very good reference to us. " The measures of demand side (refrigeration used side) seem an important target in the technology transfer activities in the future.

3) When appealed that PTM's cooperation was important for implementing the proposed measures, Mr. Zairin promised that PTM would continue cooperation. In connection with this issue, the factory and PTM requested the Japanese side to give a quantitative information on capital investment along with energy saving amount. ECCJ experts replied that they would make an utmost effort to include them in the final report.

4) It seems that there are many small and medium sized factories in Malaysia, such as D Food Industries, which have not initiated any energy conservation activities.

5) In this audit the audit team proposed effective measures for compressed air system. It is largely owing to the excellent measurement service provided by PTM with three power monitors. This success should be enjoyed in other ASEAN countries. In order for that, it is helpful for ACE to purchase minimum-necessary instruments and utilize them if demanded.

6) This time, ECCJ experts made a sufficient preparation in advance of OJT audit. For example, they surveyed the present situation of energy conversation measures in Japan by taking a look into domestic retort food factories. Thanks to these efforts, they could propose heat insulation for cooker and pasteurizer, etc. with confidence.

Seminar-Workshop

1) A variety of examples were presented by four ASEAN countries. All presentations are dealing with instant food (RTE, ready to eat), on which information is difficult to collect in internet or literatures. They could become a good reference for the Malaysian participants. We would like to say thanks to the Malaysian focal point and concerned ACE personnel for excellent preparation.

2) The presentation made by CP Retailing & Marketing (Thailand) was impressive of both contents and presentation skills. It is nearly on a par with the advanced factory group of food sector in Japan. Although Thai's domestic average value seems to be still lower, it is realized that Thailand had at least some exemplary students at home who can disseminate their technologies to other factories.

3) In the presentation of this seminar, we had several of good practices worthwhile of registration in ASEAN technical directory. In particular, the examples presented by Indonesia, the Philippines, Japan and Thailand are expected to be compiled in TD. We would like ACE to do the job for implementation.

5. Attachments

1) Audit Report on D Food Industries
2) Seminar-Workshop Program

Attachment 1 Audit Report on D Food Industries

1. Audit Venue

    D Food Industries

2. Audit Schedule

    December 12, 2007 (Wednesday) 10:00 – 16:30
    13, 2007 (Thursday) 10:00 – 11:30
    14, 2007 (Friday) 10:00 – 12:00

3. Participants:

    PTM (Malaysia Energy Conservation Center)
    - Mr. Ahmad Zairin Ismail (Deputy Director)
    - Mr. Phubalan Karunakaran (Program Manager, Industrial Energy Efficiency)
    - Mr. Nor Hisham Sabran (Technical Assistant)
    - Mr. Mohd Ibrahim Bachik (Energy Engineer)
    - Ms. Norazean Mohd. Nor (Technical Assistant)

    ACE (ASEAN Energy Center)
    - Mr. Christopher G. Zamora (Administration & Finance Manager)
    - Mr. Junianto M (Technical Expert)

    ECCJ (Japan Energy Conservation Center)
    - Mr. Hiroshi Kuroda
    - Mr. Koukichi Takeda
    - Mr. Taichiro Kawase

4. Factory Responder

    Mr. M (General Manager)
    Mr. H (Senior Engineering Executive)
    Mr. S (Factory Manager), others
    Total: 5 persons

5. Outline of D Food International

<u>General Information</u>

Operation : started in 1988
Product : retort food of Brahims brand

Employees : over 100
Energy consumption: 350 toe/year (2006)
Location : vicinity to PTM (several hundreds of meter distant)

Production Facilities/Production Capacity

Cooker: 400kg kettle x 8 units
Pasteurizer: Retort equipment (hot water storage type, made in Japan)
Filling machine: 4 units made in Japan, addition of 1 unit scheduled
Refrigeration equipment: Freezer/refrigerator for indoor storage x 4 units, freezer/refrigerator for outdoor storage x 4 units

Utility Facilities

Boiler: 1 unit for production and 1 unit for outdoor storage
Boiler for production: Installed in 1987, 2 pass smoke-tube type, natural gas burning, capacity 4.5t/h, steam pressure (rating 12bar, normal 8-10bar)
Air compressor: 3 units
Refrigerator: Installed individually in each freezer/refrigerator

Energy Consumption (2006)

Natural gas: 114,048 Nm3/y (unit price 0.5 RM/Nm^3)
Electric power: 925,056 kWh/y (unit price 0.29 RM/kWh)

Energy Conservation Activities

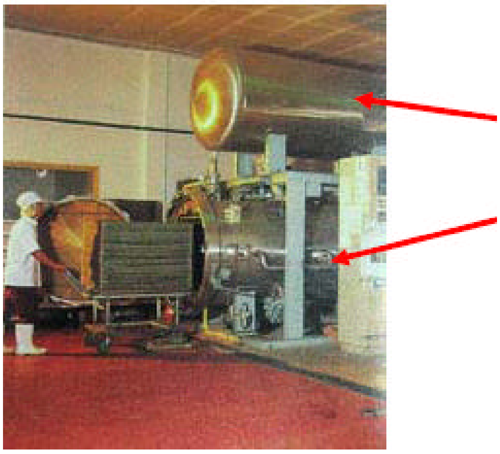
Not implemented yet, while implementing activities for environment and safety, they have not carried out energy conservation activities.

6. Survey for Production Facilities

6-1 Cooker/Pasteurizer

Both cooker and pasteurizer were not thermally insulated. It makes bad working environment with high temperature of the room. Surface temperature ranges in around 100-130℃. Heat insulation contributes not only to energy conservation but to improvement in working environment. Addition of insulation is strongly recommended because high energy saving potential is forecasted and insulation is implemented on these equipment in Japan.

According to a person in charge, the equipment supplier did not recommended insulation, although the reason is not clear. Since pasteurizer was repeatedly used from high temperature pasteurization to following rapid cooling, there is a risk of repetitive stress fatigue. We recommended them to consult the supplier one more time. According to comments by the Japanese supplier, "While no insulation is made on delivery, there are heat insulated cases according to customers' request. In accordance with a type of pasteurizer, there are many cases not to be insulated for the part where many accessories and measuring instruments are attached complicatedly," they say.



Hot water storage tank

pasteurizer (autoclave)

(1) Energy Saving Effect by Insulation of Pasteurizer Hot Surface

The pasteurizer is composed of the part of hot water storage tank and the part of autoclave. Heat loss of hot water storage tank is calculated. The following equations are applied for calculation of heat loss;

$$Q = Q_n + Q_e$$

$$Q_n = [hc \times (Ta - To)^{0.25}] \times (Ta - To) \times A \text{ (W)}$$

$$Q_e = 5.68 \times \varepsilon \times \{[(273+Ta)/100]^4 - [(273+To)/100]^4\} \times A \text{(W)}$$

Here, Q: Heat loss from hot surface (W)

Qn: Heat loss by convection from hot surface (W)

Q_e: Heat loss by radiation from hot surface (W)

Ta: Surface temperature (℃)

To: Temperature of outside air (℃)

A: Surface area (m2)

hc: Surface heat-transfer coefficient (W/m2K), use 2.56

ε : Emissivity(-) use 0.95 (stainless 0.35)

Outside air temperature 35℃ (dry bulb temperature)

Surface temperature: 120℃ (before insulation), 40℃ (after insulation)

Heat loss before insulation (suffix is 1)

$Qn1 = [hc \times (Ta - To)^{0.25}] \times (Ta - To)$

$= 2.56 \times (120 - 35)^{0.25} \times (120 - 35) = 660.7$ W/m2

$Qe1 = 5.68 \times \varepsilon \times \{[(273+Ta)/100]^4 - [(273+To)/100]^4$

$= 5.68 \times 0.35 \times \{[(273+120)/100]^4 - [(273+35)/100]^4\}$

= 295.2 W/m2h

Q1 = Qn1 + Qe1 = 660.7 + 295.2 = 945.9 W/m2

Heat loss after insulation (suffix is 2)

$Qn2 = hc \times (TA - To)^{0.25}] \times (Ta - To)$

$= 2.56 \times (35 - 30)^{0.25} \times (35 - 30) = 19.1$ W/m2

$Qe2 = 5.68 \times \varepsilon \times \{[273+Ta/100]^4 - [(273+To)/100]^4\}$

$= 5.68 \times 0.35 \times \{[(273+35)/100]^4 - [(273+30/100)]^4\}$

= 11.3 W/m2

Q2 = Qn1 + Qe1 = 19.1 + 11.3 = 30.4 W/m2

Energy saving effect by insulation

Dimension of hot water storage tank (estimation): L 5m x D 1.2m

Surface area: 5 x (3.14 x 1.2) = 18.8m2

(surface area of two heads is not included, however insulation is recommended)

Reduction of heat loss: $\Delta Q = (945.9 - 30.4) \times 18.8 = 17{,}211$ W

Pasteurizer operation: 16 batches/day, heating time: 40min/batch

Annual heating time: 40/60h/batch x 16 batch/d x 250d/y =2668h/y
Boiler efficiency: 85%
Natural gas low heating value: H1 = 43.96MJ/m^3_N
Annual reduction of heat loss:
17,211W/m2 x 18.8m2 x 2668h/y
= 863.2 x 10^6Wh/y = 863.2 x 10^3kWh/y = 3,108 x 10^3MJ/y
Annual natural gas saving: 3,108 x 10^3MJ/y / 0.85 / 43.96 = 83,177 $m3_N$/y

(2) Comment on heat insulation work

In order to make insulation work easy, we recommend to first insulate the part of hot water storage tank. As for the autoclave, insulation should be made for the part where insulation work is not difficult. In addition, not-insulated parts of cooker and hot water piping should also be insulated. In general, economical justification is expected when the surface temperature is 50℃ or higher. As an insulation material, the paste-type plastic insulation material such as heat resistant polyurethane is used preferably for hot surface with less than 140℃. The paste-type is simple to work and cheap in price. An example of the insulation work are shown in the following photo. Please refer to manufacturers' websites. For the autoclave, insulation work should be carried out carefully because many accessories are attached.

Test of Insulation Materials

参考ウェブサイト
http://www.thaisekisui.co.th/

7. Survey of Utility Facilities

7-1 Reduction of Boiler Air Ratio

Though exhaust gas temperature ranges relatively high as 187 to 208℃, it seems that installation of air pre-heater is difficult to be economically justified under the present condition of low operation load and long duration of off-operation.

Boiler operating condition

Boiler steam pressure:	8-10kg/cm^2 (on-off control)
Fuel consumption rate:	320 m^{3}N/h (Dec. 13, 2007)
Exhaust gas O2:	9.4%
Exhaust gas temperature:	194℃

Energy Saving Effect

The measured value of O2 content in exhaust gas was 9.4%. When natural gas is burned, generally O2 content can be decreased to as low as 4%. Re-tuning of mechanical link is necessary before changing the air ratio. It is safer to ask the boiler manufacturer to re-tune, rather than to do by yourself.

Low heating value of natural gas: H1 = 43,96MJ/m3N

Present air ratio: m = 21/(21-9.4) = 1.82

Theoretical air rate: A_0 = 0.268 x H1 = 0.268 x 43.96 = 11.78 m^{3}N/m^{3}N

Theoretical exhaust air rate: G_0 = 0.293 x H1 = 0.293 x 43.96 = 12.88 m^{3}N/m^{3}N

Actual exhaust gas rate: G = G_0 + (m – 1) x A_0

= 12.88 + (1.82 – 1) x 11.78 = 22.54 m^{3}N/m^{3}N

→ 7.213 m^{3}N/h

Air ratio after improvement: m = 1.2 (responding to O2% = 4%)

Actual exhaust gas rate: G = G0 + (m – 1) x A0

= 12.88 + (1.20 – 1) x 11.78 = 15.24 m^{3}N/m^{3}N

→ 4.877 m^{3}N/h

Fuel saving :

Precondition of calculation:

Exhaust gas temperature: 200℃

Exhaust gas specific heat: 1.306 kJ/ m^{3}NK

Outside air temperature: 30℃

Natural gas saving rate Ox m^{3}N/h:

{[(320 – Ox) m^{3}N/h/320m^{3}N/h] x (7.213 – 4.877) m^{3}N/h

+ Ox $m^3_N/h/320m^3_N/h$ x $7{,}213m^3_N/h\}$ x $1.306kJ/\ m^3_N \cdot K$

x (200 – 30)℃ = $43.96MJ/m^3_N$ x 10^3 x Ox m^3_N/h

Ox = $12.8m^3_N/h$

Saving effect: $12.8m^3_N/h$ / $320m^3_N/h$ = 0.04 (4%)

7-2 Strengthening of Condensate Recovery

In order to estimate the condensate recovery rate in the entire factory, heat balance was examined around the boiler water supply tank. As a result, the recovery rate of condensate was calculated to approximately 17%. To increase the recovery rate, all steam-consuming equipment should be individually inspected concerning an opportunity of condensate recovery. Cooperation with PTM is strongly recommended.

Calculation of Condensate Recovery Rate

As shown in the following figure, Soft water and condensate return from the factory enter into the boiler water supply tank, while boiler feed water leaves. Temperatures of the surfaces are measured as follows;

Soft water line: 29℃

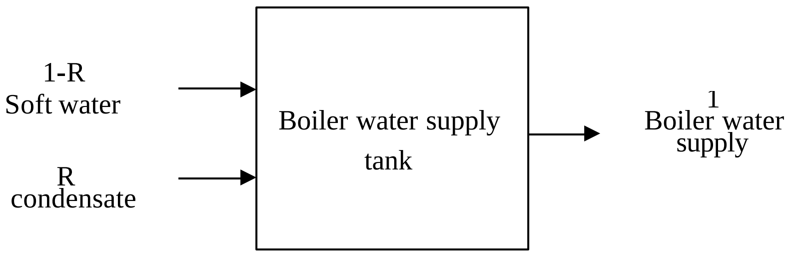
Condensate return line: 66℃

Boiler feed water line: 35℃

If condensate recovery rate is R, the following formula is set up.

$(1 - R) \times 29 + R \times 66 = 1 \times 35$

R = 0.17, therefore, recovery rate is 17%.



There are two types of condensate, clean and dirty. The clean condensate is a condensate generated from the steam used for indirect heating. It does not contact directly with process fluid, and becomes an object of recovery into the boiler water tank.

7-3 Heat Insulation of Boiler Hot Surface

The surface temperature of not-insulated rear side (exhaust side) was 140℃. A paste-type plastic insulation material is recommended because surface temperature of boiler rear side is below 140℃. The front side (burning side) and shell are insulated, and the surface temperature ranged from 43℃ to 63℃. No more insulation is necessary for the front side and shell.

☆Calculation of heat loss from boiler hot surface

Location		Front side (burner side)	Shell	Rear side (exhaust gas side)
Area, A (m^2)		3	25	4.9
Measured temperature Ta (℃)		61	51	139
Ambient temperature To (℃)		30	30	30
Equation	hc(natural convection)	$Qn = [hc \times (Ta - To)^{0.25}] \times (Ta - To) \times A$ (W)		
		2.56	2.56	2.56
	ε (emissivity)	$Qe = 5.68 \times \varepsilon \times \{[(273+Ta)/100]^4 - [(273+TO)/100]^4\} \times A$(W)		
		0.95 (painted surface)	0.95 (painted surface)	0.95 (painted surface)
Heat loss (present)	Qn (W) Qe (W) Qn + Qe (W) ↓ kW/h MJ/h (MJ/m^2h)	562 650 1212 1.2 4.36 (1.45)	2877 3495 6372 6.4 22.94 (0.92)	4418 5390 9808 9.8 36.31 (7.21)
Heat loss (after insulation)	Qn (W) Qe (W) Qn + Qe (W) ↓ kWh/h MJ/h			94 151 245 0.245 0.9

Fuel saving	Natural gas saving m3N/h		= 35.3-0.9 = 34.4/43.96	34.4 0.78

7-4 Energy Conservation for Outdoor Freezer/Refrigerator

Inasmuch as audit permission was not provided for refrigeration equipment in production area, only the outdoor refrigeration equipment was investigated, which is comprised of four container-type cold stores. The size of one cold store is 5m length x 3m height x 2m width, and each store is equipped with an individual condensing unit.

Findings and Energy Saving Measures

Insulation and door seal were severely deteriorated. The low temperature with around 8℃ was observed in the joint part of foundation/wall and the vicinity of door seal. Moreover, the surface of wall, which not exposed to wind, was wetting with a dew condensed. The surface temperature seemed to reach a dew point. As the progress in degradation of insulation is anticipated, a repair for insulation is necessary.

It was observed that the temperature of wall surface rose to 45 to 57℃ under sunshine in particular on the south and east sides. We recommended to install sunshades to the south and east sides. A simple sunshade is satisfactorily used ,for example, like a bamboo blind.

The insulation of cold piping around condensing unit was severely damaged and wetted deeply with water. Early repair for insulation, in particular, cold refrigerant piping is required.

There is a room of improvement in the package stacking in the cold store. The packages were stacked without clearance among packages. In order to accelerate heat transfer from cold air to packages, reasonable clearances should be provided. Otherwise, it takes long time to cool up to the prescribed temperature.

From the standpoint of energy conservation, it is important to minimize the heat generation in the cold stores. The room lighting should be turned off when closing. in addition, the inside fan should be a two-speed type, and run in the low speed or turned off when it is unnecessary.

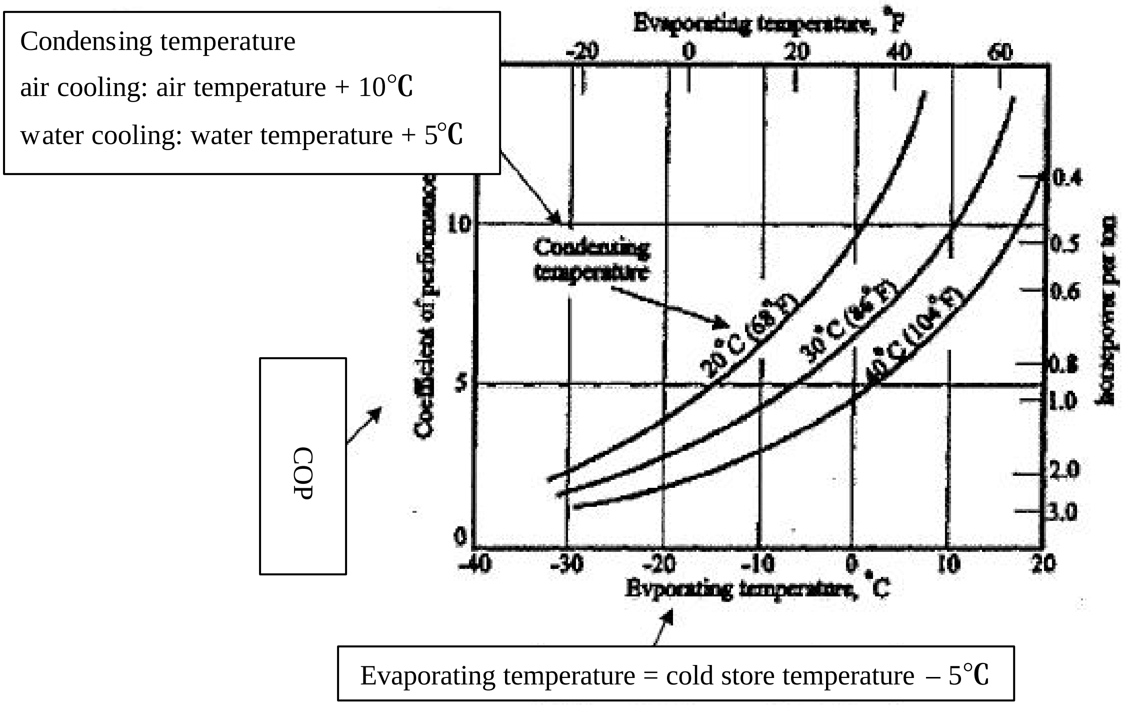
Energy Saving Possibility for Outdoor Freezer

Calculation of Energy Saving Effect

In the first step, calculate the reduction of heat input entering into the cold store (ΔQ, namely refrigeration load). In the second step, calculate the power saving in refrigeration compressor (ΔP). Power saving is calculated by the following equation:

$$\Delta P = \Delta Q + \Delta Q / COP$$

The first term of the right side is a saving corresponding to reduction of refrigeration load, and the second term is a saving of compressor power accompanied by the reduction of refrigeration load. The approximate value of COP can be given by dividing the COP value shown in the following figure by the compressor efficiency. 80% is typically used as compressor efficiency.



Repair of Insulation of Door Seal Part

Equations for heat loss from hot surface can be used approximately for low temperature surface.

$Q = Q_n + Q_e$

$Q_n = [hc \times (Ta - To)^{0.25}] \times (Ta - To) \times A$ (W)

$Q_e = 5.68 \times e \times \{[(273+Ta)/100]^4 - [(273+To)/100]^4\} \times A$(W)

Here, Q: Heat loss from hot surface (W)

Qn: Heat loss by convection from hot surface (W)

Q_e: Heat loss by radiation from hot surface (W)

Ta: Surface temperature (?)

To: Temperature of outdoor air (?)

A: Surface area (m2)

hc: Surface heat-transfer coefficient (W/m2K), use 2.56

e: Emissivity(-) use 0.95 (stainless 0.35)

In the door seal part of cold store, surface temperature was 8? and much lower than the temperature of outdoor air of 29? . Normal repair work of insulation can easily improve the surface temperature toward outdoor air temperature. In the following calculation, it is assumed that wall temperature becomes 2? lower than outdoor air temperature.

Outdoor air condition : 29? (dry bulb temperature) & 75% (relative humidity)

External surface temperature: 21? (before repair) & 27? (after repair)

Heat loss before insulation repair

$Qn1 = hc \times (Ta - T0)^{0.25}] \times (Ta - T0)$

$= 2.56 \times (29 - 21)^{0.25} \times (29 - 21) = 34.4$ W/m2

$Qe1 = 5.68 \times e \times \{[(273+Ta)/100]^4 - [(273+T0)/100]^4\}$

$= 5.68 \times 0.95 \times \{[(273+29)/100]^4 - [(273+21)/100]^4\}$

$= 45.7$ W/m2

$Q1 = Qn1 + Qe1 = 34.4 + 45.7 = 80.1$ W/m2

Heat loss after insulation repair

$Qn2 = hc \times (Ta - T0)^{0.25}] \times (Ta - T0)$

$= 2.56 \times (29 - 27)^{0.25} \times (29 - 27) = 6.1$ W/m2

$Qe2 = 5.68 \times e \times \{[(273+Ta)/100]^4 - [(273+T0)/100]^4\}$

$= 5.68 \times 0.95 \times \{[(273+29)/100]^4 - [(273+27)/100]^4\}$

$= 11.7$ W/m2

$Q2 = Qn2 + Qe2 = 6.1 + 11.7 = 17.8$ W/m2

Energy saving effect by insulation repair

Insulation repair area 1 m2/store x 4 store = 4 m2

Reduction of refrigeration load ⊿Q = 80.1 – 17.8 = 62.3 W/m2

Cold store temperature -20℃ ? Evaporating temperature -25℃

Outdoor air temperature 29℃ ? Condensing temperature 39℃

COP (excl compressor efficiency) 1.7

Reduction of compressor power ⊿P = ⊿Q + ⊿Q / COP

= 62.3 + 62.3/1.7 = 98.9 W/m2h

= 866 kWh/m2y

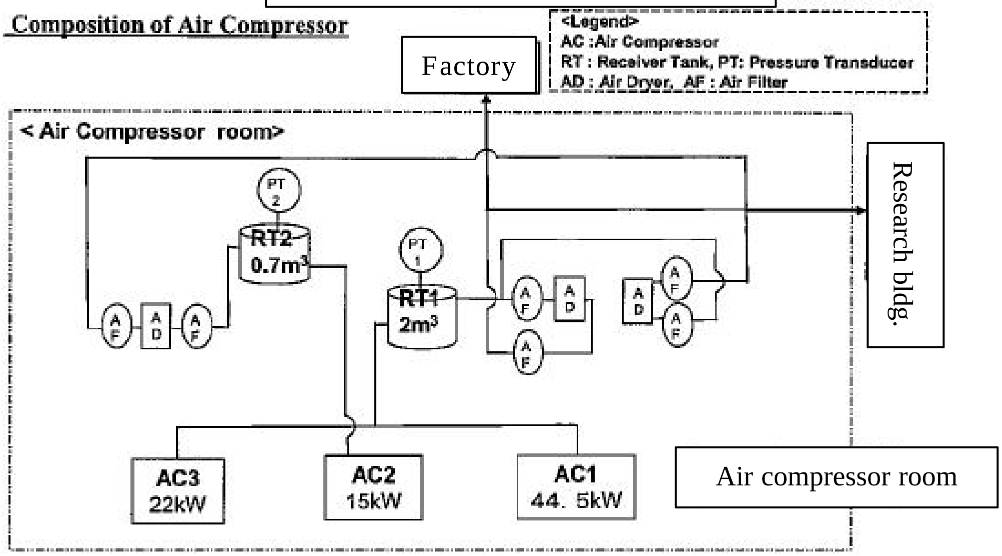
Old store (４room total) (4m2) = 866 x 4 = 3,464 kWh/y

7-5 Energy Saving in Air Compressors

Outline of Compressed Air System

Information concerning compressed air system was not provided. Based on name-plate information and interview with factory engineers, we obtained the following outline of compressed air system.

Compressed air supply flow chart



Air compressor specification and load/unload conditions

No.	Motor [kW]	Flow rate [m³/min]	Pres-sure [MPa]	Type of AC ／Cooling system	Variable Capacity method	Manufac-turing year	Manufacturer
AC1	44.5 (60HP)	5.4	0.85	Screw Air-cooling	load /unload	1992?	Ingersoll-Rand (UK)
AC2	15	2.424	0.75	Screw Air-cooling	load /unload	1993	ATLAS (USA)
AC3	22	3.6	0.75	Screw Air-cooling	load /unload	1995	ATLAS (USA)
Load at 0.55 MPa, Unload at 0.75 MPa Start & stop : manual on local panel							

Data Collection of Compressed Air System

In order to grasp the load distribution and distribution of load/unload, power consumption of three air compressor motors were measured by PTM engineers. Measurement was implemented for nineteen hours with one minute interval by using three portable-type power monitors.

Measurement of electric power and time

No.	Motor Mo [kW]	Load				Unload			Net $P_{on}\times T_{on}$ [kW]	P_{un}/Mo [%]
		Time		Ave.	Max.	Time		Ave.		
		t_{on}[min]	T_{on}[%]	P_{on}[kW]	[kW]	t_{un}[min]	T_{un}[%]	P_{un}[kW]		
AC1	44.5	318	49.0	39.67	40.87	331	51.0	17.11	19.44	38.4
AC2	15.0	325	50.1	14.70	15.52	324	49.9	7.41	7.36	49.4
AC3	22.0	315	48.5	20.19	21.32	334	51.5	11.91	9.79	54.1
Sum	81.5	–	–	–	–	–	–	–	36.59	–

Note: Measurement interval (1 min.), AC1, AC2: actual power

AC3: Calculated value (1.7321 x (A1 + A2 + A3)/3 x 436 x 0.7/1000[kW])

Load distribution when operating 3 units

Power range [kW]	Load				Remark (Operation machine)
	Time		Ave.	Max.	
	t_{on}[min]	T_{on}[%]	P_{on}[kW]	P_{max}[kW]	
0	45	6.9	–	–	all machines unload
1–15	58	8.9	14.85	15.46	AC2
16–30	106	16.3	20.30	21.32	AC3
31–45	245	37.8	37.31	44.49	AC1 or AC2+AC3
46–60	159	24.5	56.19	60.86	AC1+AC2 or AC1+AC3
61–75	36	5.6	74.16	75.63	AC1+AC2+AC3
total	649	100.0	–	–	

Loading & unloading when operating 1 unit

No.	Motor Mo [kW]	Load				Unload		
		Time		Ave.	Max.	Time		Ave.
		t_{on}[min]	T_{on}[%]	P_{on}[kW]	[kW]	t_{un}[min]	T_{un}[%]	P_{un}[kW]
AC2	15	385	88.7	15.60	16.03	49	11.3	5.35

Review on Measured Data

Load factor of 3 air compressors ranges from 48.5 to 50.1% and compressed air system has relatively wide allowance. Nevertheless, all 3 compressors are always operated except for nights and holidays.

Air compressor is operated in unloading mode during 49.9-51.5% of one day. Power usage during unloading time is completely wasted energy.

Number of air compressors in operation is the following; 1 compressor (AC1) operation: 63.0%, 2 compressors (AC1,AC3) operation: 24.5%, and 3 compressors (AC1,AC3,AC2) operation: 5.6%.

3 compressors operation continues for as short as 1-7 minutes, and irregularly.

One compressor (AC2) is operated even in night time and on weekend/holidays during which about 14.4kW of electricity is consumed for aeration of the activated sludge unit in the wastewater treatment facility.

Power Consumption during Unloading Operation

Power for load operation= 39.67x0.490+14.70x0.501+20.19x0.485 = 36.59[kW]

Power for unload operation = 17.11x0.510+7.41x0.499+11.91×0.515 = 18.56[kW]

Total kW0 = 36.6+18.6 =55.2[kW]

Unloading power ratio: 18.6/55.2 = 0.337 (33.7%)

Energy Conservation Measures for Reducing Unloading Operation

In order to reduce unloading operation which is a major source of energy loss, the following 4 measures are considered.

- Addition of receiver tank
- Change in pressure control system (adjustment of number of operating compressors)
- Change of aeration air supply method in the activated sludge unit
- Reduction of intake air temperature

Reduction of Unloading Loss by Addition of Receiver Tanks, etc.

3 compressors operation occupies only 5.6% of total time, and continues only in several minutes. Accordingly peak shaving is effective like receiver tank. When receiver tank is installed, 2 compressors (AC1 and AC3) are normally operated, while AC2 is standing-by.

Energy saving effect (kW_1) is estimated to be about 6.15[kW] as shown below;

$$kW_1 = (39.67 \times 0.79 + 20.19 \times 0.26) + (17.11 \times 0.21 + 11.91 \times 0.74)$$
$$= 36.6 + 12.4 = 49.0[kW]$$

Unload power ratio: 12.4/49.0 = 0.25 (25%)

Power saving: ΔkW = $kW_0 - kW_1$ = 55.2 – 49.0 = 6.2[kW]

→ <u>about 11% energy saving</u>

Power saving of 6.15[kW] seems too small to justify an installation of new receiver 5[m^3] .

For the reference, rough calculation of receiver tank capacity is shown below;

$V = R/(\Delta P \times 10^4) \times \Delta Q \times t \times 1.293 \times 273.16$

Provided that

R: gas constant 2.987, γ [kg/m3]: air density at temperature :T[K]

$\gamma = 1.293 \times 273.16/T$

ΔP[MPa]: unload pressure – load pressure

ΔQ[m^3]: air volume supplied from tank for t[min]

AC2 delivery capacity: 2.424[m^3/min]

$\Delta P = 0.75-0.55=0.2$[MPa]

t = 2[min],

$\Delta Q = 2.424[m^3/min] \times 2[min] = 4.848[m^3]$

$V = 2.987/(0.2 \times 10^4) \times 4.848 \times 2 \times 1.293 \times 273.16 = 5.11 \quad 5[m^3]$

<u>Change in Pressure Control System</u>

Considering that order of operation time is AC1, AC3, AC2, this order is most efficient from the standpoint of energy efficiency. In this case, AC1 is a base load compressor.

If the allowable frequency of start-stop in the electric motor is assumed to within 10 times per hour, percentage of stoppable times in AC2 and AC3 are respectively about 80% and about30%.

Accordingly, kW2 of this case is as follows:

$$kW2 = (39.67x0.49+14.7x0.2+20.19x0.7) + (17.11 \times 0.23 + 7.41 \times 0.95 \times 0.2 + 11.91 \times 0.74 \times 0.7) = 36.5 + 11.5 = 48.0[kW]$$

Unloading power ratio: 11.5/48.0 = 0.24 (24%)

Power saving: ΔkW = $kW_0 - kW_2$ = 55.2 – 48.0 = 7.2[kW]

→ <u>About 13% energy saving</u>

Change of aeration air supply method in the activated sludge unit

The activated sludge unit is operated for 24 hours, and compressed air with 5-7 bar(g) is provided as aeration air. However pressure requirement for aeration is only 1 bar(g) because liquid height of aeration tank is several meters. We proposed to change air supply from air compressor to new air blower with about one bar(g) of discharge pressure.

Energy saving effect is given as a difference of power decrease in air compressor and power increase of new air blower as shown below;

☆Power decrease of air compressor

Currently, power required for supplying compressed air to the activated sludge unit is about 14.4kW. If this air supply is replaced by blower air supply, it becomes feasible to stop one compressor (AC2), while 2 compressors operation (AC1, AC3) continue to be operated. Load factors of AC1 and AC3 become respectively about 54% and about 8%. Power consumption in this case (kW_3) becomes as follows;

kW_3 = (36.5 – 14.4) + (17.11 x 0.46 + 7.41 x 0 + 11.91 x 0.92)
= 22.1 + 18.8 = 40.9[kW]

Unloading power ratio: 18.8/40.9 = 0.46 (46%)

Power saving : $\Delta kW = kW_0 - kW_3$ = 55.2 -40.9 = 14.3[kW]

→ about 26% energy saving

☆Power increase of new air blower

Required power of air compressor is estimated by the following equation;

L = k/(k-1) x (Ps x Qs)/0.06 x [(Pd/Ps)^{(k-1)/k} - 1] /?

k : ratio of specific heat of air (1.4 at 15℃)

Ps : suction pressure (MPa)

Pd : discharge pressure (MPa)

Qs : air rate (m3/min)

? : compressor efficiency (usually 0.8)

Assuming air is ideal gas, Ps x Qs is constant value. This is approximately applied to both air compressor and blower.

Considering liquid depth of aeration tankis about 6m and control margin of air pressure control is 4m, blower discharge pressure is assumed to be 0.1 MPa(g), compared to 0.55MPa(g) of existing compressed air pressure.

$$L1 = 14.4$$

$$L2/L1 = [(Pd/Ps)^{(k-1)/k} - 1]2 / [(Pd/Ps)^{(k-1)/k} - 1]1$$

$$= [((0.1 + 0.1)/0.1)^{(1.4-1)/1.4} - 1] / [((0.55 + 0.1)/0.1)^{(1.4-1)/1.4} - 1]$$

$$= 0.219 / 0.708 = 0.31$$

$$L2 = 14.4 \times 0.31 = 4.5 \text{ kW}$$

$$\angle L = 14.4 - 4.5 = 9.9 \text{ kW}$$

Annual power saving: 9.9kW x 8,760 = 86,724 kWh

It is reminded that Activated sludge unit is run day and night throughout the year.

Reduction of Intake Air Temperature

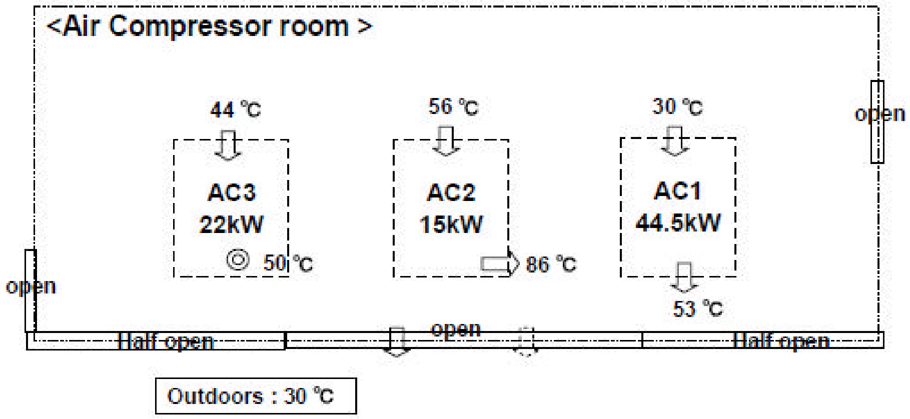
☆Measurement of air temperature

Condition of measurement

a) Measurement period : 12/12/2007, 16 o-clock, one point measurement

b) The measurement taking charge and preparation of measuring instrument : PTM

c) Ventilator was ½ running.



☆Calculation for compressor power reduction rate

Power requirement of air compression is approximately proportional to absolute temperature at the suction condition. Therefore intake-air temperature should be as low as possible. According to measurement data shown in the above figure, suction temperatures of AC2 and AC2 are very high compared to AC1. When suction temperature is lowered to 30? , energy saving effect is estimated in the following;

AC2: {(273+56)-(273+30) / (273+56) = 26/329 = 0.079

AC3: {(273+44)-(273+30) / (273+44) = 14/317 = 0.044

kW_4 = 55.2 - (14.70 x 0.501 + 7.41 x 0.499) x 0.079

- (20.19 x 0.485 + 11.91 x 0.515) x 0.044 = 55.2 – 1.5 = 53.7 [kW]

Power saving rate?kW = kW_0 – kW_4 = 1.5 [kW] about 3% energy saving

8. Energy Management

It turned out in this audit that D Food Industries has not carried out any energy saving activities so far. In the meeting of reporting audit result, one of factory management told to realize how wastefully they used energy, and to start an energy conservation activity from now on. We emphasized an importance of energy management such as daily housekeeping and timely maintenance of equipment and facilities. Before taking technological measures accompanying capital investment, we advised to start from the following activities as a first step.

- Declaration of energy management policy with written document
- Appointment of person responsible for energy management
- Collection, recording and analysis of energy-related data
- Target setting for goal of energy conservation activity
- Employee’s awareness to energy conservation through education, etc

9. Results of audit

Please refer to attachments in this chapter regarding details on calculating grounds, etc

	Energy Conservation Issues	Audit Results and Countermeasures	Energy Conservation Potential
Production Facilities			
(cooker/sterilizer)	Insulation of hot surface	Both cooker and sterilizer are not insulation. Surface temperature is around 100-130℃. Insulation using easy-to-attach plastic insulation material is recommended.	Natural gas saving: 83,177m3N/y
Utility Facilities			
(boiler)	Reduction in boiler air ratio	O2 content and temperature in exhausted gas were 9.4% and 194℃, respectively. To adjust air/fuel ratio, re-tuning of link mechanism is necessary.	Energy saving effect when decreasing O2 content to 4% : Natural gas saving 12.8m3N/h (reduction rate, 4%)
	Heat insulation of boiler hot surface	Surface temperature: front side 46-63℃; rear side 140℃. Insulation of rear side is necessary.	Natural gas saving 0.78 m3N/h.
(steam system)	Enhancement of condensate recovery	Present recovery rate of condensate is estimated as low as 17%, and survey of condensate recovery is necessary in every steam consuming equipment.	Recovery of investment is within a year
(refrigeration)	Energy saving for outdoor freezer	Insulation is deteriorated (door seal, wall, refrigerant piping). Heat invasion due to sunlight is reduced (sunshade, etc.); Rearrangement of packages is necessary in cold store; Elimination of unnecessary heat generation is necessary in cold store.	Energy saving effect of repairing door seal insulation: freezer power saving, 3,464kWh/y

(air compressor)	Addition of receiver tank	Unloading time is long (around 50% of day). Although addition of receiver tank was considered, energy saving effect was low and investment recovery was difficult.	Energy saving effect: 6.2kW
	Adjustment of number of compressor in operation	To avoid operating 3 units all the time, number of compressors in operation was adjusted by changing control method.	Energy saving effect: 7.2kW
	Decrease of intake air temperature	Due to inappropriate location of suction, suction temperature is as high as 44-56℃, resulting in energy loss. Investment amount is a little.	Energy saving effect: 1.5kW
(waste water treatment)	Change in aeration air supply method	Air pressure of 1.0bar is enough, instead of existing air pressure (5.5bar). A roots-type blower is newly installed to this end.	Energy saving effect: 9.9kW
Energy Management			
	Introduction of In-house DB	Constructing in-house DB in order to monitor data such as condensing temperature in refrigeration system , which are helpful for energy efficient operations.	Reference input format was provided

Attachment 2 Seminar-Workshop Program

PTM

BASIC AGENDA (DRAFT)

INTENSIVE SEMINOR – WORKSHOP

PROMOTION OF ENERGY EFFICIENCY AND CONSERVATION (PROMEEC)

(MAJOR INDUSTRY) UNDER THE SOME-METI WORK PROGRAMME 2007-2008

The Legend Hotel, Kualalumpur

December 17, 2007

08:30 – 09:00	**Registration**
09:00 – 09:10	Welcome Remarks by the Host Country
09:10 – 09:20	Opening Statement by Mr. Taichiro Kawase The Energy Conservation Center, Japan (ECCJ)
09:20 – 09:30	Opening Statement by Dr Weerawat Chantanakome ASEAN Centre for Energy (ACE)
09:30 – 10:00	**Tea Break & Group Photo Session**
	Session 1 : Seminar **PROMEEC Project : Outline & Achievements**
10:00 – 10:30	Presented by Mr. Christopher Zamora (ACE) Outline and Achievements of PROMEEC Project
10:30 – 11:00	Presented by Mr. Taichiro Kawase (ECCJ) Initiatives & Programs of ECCJ on EE&C in the Industrial Sector in Japan
	Session 2 : Seminar **EE&C Best Practices in Food Industry (Part 1)**
11:00 – 11:30	Presented by Mr. Iswan Nurbaso (Indonesia) Best Practices in PT. Eastern Pearl Flour Mills
11:30 – 12:00	Presented by Mr. Taichiro Kawase (ECCJ) Overview of Energy Saving Technologies in Food Industry (General)
12:00 – 12:30	Presented by Mr. Teodoro Elma (Philippines) Best Practices in San Miguel Polo Brewery
12:30 – 14:00	***Lunch***
	Session 3 : Seminar **EE&C Best Practices in Food Industry (Part 2)**
14:00 – 14:30	Presented by Mr. Tivakorn Jongmekwamsuk (Thailand) Best Practices in CP Retailing & Marketing Company
14:30 – 15:00	Presented by Mr. Phubalan Karunakan (PTM, Malaysia) Best Practices in JG Glass Containers Factory
15:00 – 15:30	Presented by Mr. Hiroshi Kuroda (ECCJ) Best Practice in Food Center (Cold Store)
	Tea Break
	Session 4 : Energy Management Tools
15:30 – 16:00	Presented by Mr. Ivan Ismed (ACE) Updates on Development of Database/ Benchmark/ Guideline for Industry:
16:00 – 16:30	Presented by Taichiro Kawase (ECCJ In-house Database for Food Industry
16:30 – 16:45	Closing Statement by Mr. Ahmad Zairin Pusat Tenaga Malaysia (PTM)
	COMPLETION of Activities

V. Thailand (Steel and Textile Industries)

1. Activity Overview

December, 2007

19 (Wednesday) Seminar-Workshop

20 (Thursday) Bangkok steel follow-up surveys

2. Seminar-Workshop

(1) Participants: 86 persons

Thailand (77 persons)

Mr. Thammayot Srichuai (Deputy Director General, DEDE)

Mr. Yosapong Khupthaboot (Head of Energy Regulatory in Building, DEDE)

Mr. Sarat Prakobchart (Senior Engineer, DEDE)

Many persons from private industries (textile, steel industries, etc)

ASEAN (4 persons)

Mr. Maximino Marques (DOE, Philippines)

Mr. Purnomo (Bhineka Karya Manunggal, Indonesia)

Mr. Phan Nguyen Vinh (ECC-HCMC, Vietnam)

Dr. Nguyen Van Tuyen (ECC-HCMC, Vietnam)

Others (5 persons)

ACE: 3 (Dr. Weerawat, Mr. Ivan, Ms. Evangeline)

ECCJ: 2 (Mr. Kawase, Mr.Tanaka)

(2) Outline of Presentations

1) "Outline and Activities of PROMEEC Project" (Ms. Evangeline: ACE)

She introduced major EE&C activities such as the position of ACE in ASEAN, the PROMEEC activities as well as the activities of EC-ASEAN and SOME-METI. Also she invited to participate in the ASEAN award system, etc.

2) "The energy conservation promotion scheme and activities of the Thailand Energy Ministry " (Mr. Yosapong Khupthaboot: DEDE, Thailand)

Concerning energy situation in Thailand, Mr. Yosapong reported that energy consumption increased 5% per annum for the past 5 years, industry and transportation are major consumption sectors, the energy cost occupied a 17% of GDP in 2006, petroleum occupied 88% of the energy cost and its import dependency was 63%.

With regard to energy conservation activities, major activities of DEDE were responsible for standards and regulations, technical assistance, financial incentives, information service and awareness raising. In the field of technical assistance, there are self-effort promotion of energy conservation by industry, improvement on SEC in the fields of industry and building, demonstration of new technologies, promotion of ESCO business. In self-help promotion by industry, house-keeping type activities were implemented in around 2000 facilities. As financial incentives, instruments such as revolving fund and tax reduction were mobilized. Tax reduction is applied for tax reduction for energy conservation investment, tax deduction for realized energy saving, tax exemption for imported facilities. In the field of information service, there are, for instance, publication of handbook and guideline, e-learning program, energy clinic service and energy display center.

3) "Energy Conservation Measures in the Steel Industry and Experiences in PROMEEC" (Mr. Hideyuki Tanaka: ECCJ, Japan)

Mr. Tanaka mentioned technologies adopted since 1985, and explained energy conservation effect of DHCR and regenerative burner which have recently become widespread showing successful examples. He also explained a process and energy efficiency of shaft furnaces adopted in Japan. He reviewed audits of steel factories performed in PROMEEC activity, drawing examples of Thailand and the Philippines.

4) "Development of Electric Furnace Operational Technology in Thailand"
(Dr. Kritsada Prapakorn: MTEC, Thailand)

Researchers of MTEC presented their study of energy conservation technology of electric furnace by stabilization of slag-foaming. It was reported that development of electric-arc stabilization detector, effect of slag composition, and maximization of chemical energy ratio are investigated in order to stabilize slag-foaming. Moreover, development of neural system and expert system with respect to electric furnace operation is carried out.

5) "Energy Conservation Measures in a Steel Factory in the Philippines" (Mr. Marquez:

DOE, the Philippines)

Mr. Marquez explained an activity implemented in steel factory which is located in south Luzon, the Philippines, and produces galvanized steel sheet and coil of 3.5 million ton per year. Energy management team was organized, which comprises of management-level leader and several staffs. The team proposed and implemented various energy conservation measures steadily. Most of them were very common measures such as variable speed control of motors, conversion to high efficient motors, reduction of boiler air ratio, and conversion to high-efficiency lamps. As a result of activity, great energy saving was achieved, for example, fuel oil 52kL/y, LPG 2,596 ton/y, and electricity 6.58 million kWh/y.

6) "Energy Conservation Measures in the Textile Industry and Experiences in PROMEEC" (Mr. Taichiro Kawase: ECCJ, Japan)

Mr. Kawase overviewed major energy conservation measures in the textile industry, and introduced actual audit cases including exhaust heat recovery from hot waste (dyeing) and from dryer exhaust gas (textile dryer) experienced in Japan and the ASEAN region. In addition, he reported specific energy consumption data in the Japanese textile industry, concerning fuel, electricity and water. He explained an importance of monitoring energy efficiency indicators, and asked to establish an in-house database system as a guide for energy-efficient operation of equipment and facilities..

7) "Case Study of Energy Conservation Measures in a Textile Factory in Indonesia" (Mr. Purnomo: Bhineka Karya Manunggal, Indonesia)

Mr. Purnomo explained an activity implemented in textile factory which is located in west Jawa, Indonesia, and produces cotton/polyester-based textile products. The factory is so called integrated textile factory, which covers from spinning and dyeing, to weaving. Production capacity is spinning 400 ton/month, weaving 1.4 million yard/month, dyeing 1.1 million yard/month, and printing 0.2 million yard/month respectively. A cost reduction program (CRP) was planned, and a project team was organized with Mr. Purnomo as its leader. It started its activities in 2003. Most of energy conservation measures are concentrated in utility facilities.

・Applying inverters to twenty-eight motors of spinning instruments
・Attaching roof windows to some buildings for utilizing daylight
・Downsizing of surface aeration motor of activated sludge unit
・ Shortening of steam pipes

・Periodic cleaning of condensers and evaporators of air-conditioning system

8) "Case Study of Energy Conservation Measures in a Textile Factory in Vietnam" (Mr. Phan Nguyen Vinh: ECC-HCMC, Vietnar V- 3

Mr. Phan Nguyen Vinh reported the result of energy audit implemented in Vietnam last October. The audit was projected for the OJT as one of the PROMEEC activity, and Mr. Phan served as a leader of the audit team. The venue of the OJT audit was Thanh Cong Textile and Garment located in Ho Chi Minh City, which was an integrated textile manufacturing factory. This large factory has 4,600 employees and its production capacity is 22,500 ton/year and energy consumption approximately 20,000kL/year. The audit team proposed several energy conservation measures concerning high-pressure batch dyer, continuous textile dryer and boilers. According to him, some of measures proposed in the audit have just started.

9) "Development and Dissemination of Energy Management Tools" (Mr. Ivan Ismed: ACE)

In the PROMEEC activity, development of energy management tools was projected, such as Technical Directory (TD), Energy management guideline (GL) and in-house database (IHDB). Mr. Ivan explained the purpose, input form and actual examples concerning the TD. Furthermore, he explained the progress in development of the IHDB using a draft input form prepared for the cement industry. Included are information necessary for factory energy management, for example, raw material and product, energy consumption, equipment and facilities, and key process parameters and energy efficiency indicators.

10) "In-house DB Input Format for the Textile Industry" (Mr. Taichiro Kawase, ECCJ, Japan)

Mr. Kawase explained about newly-drafted input form targeting for textile factory. He asked the participants of seminar to apply the new form to their factories, emphasizing that the IHDB is useful as a tool for promoting energy conservation in the factory.

(3) Questions and Answers

Q: Why is thermal efficiency of regenerative burner higher than conventional recuperator? How deep does regenerative burner penetrated into reheating furnaces and

ladle furnaces in Japan? How long is an investment recovery?
A: Mr. Tanaka gave a detailed answer using cases of NEDO demonstration project. Judging that such fundamental questions are raised, it seems that regenerative burners are not widely known in Thailand.

Q: What is a barrier in implementing energy conservation measures in the textile industry in the Philippines?
A: Support of factory top management is most important.

Q: Does heat insulation of batch dyer hot surface have any adverse effect on equipment or operation?
A: Any adverse news is not reported in spite of numerous application cases in Japan.

Q: The audit manual prepared for textile factories is very interesting. Can I have the manual?
A: The manual has now been developing in the FTI/JETRO cooperation project. You are asked the more in detail to FTI/IIE.

Q: Can I have information on energy consumption in the textile processes in Japan?
A: Recent data was not available because most jobs in the textile industry has shifted to China, etc. Regretfully, data in the today's presentation were given 10 years ago by the Japan Textile Finishers' Association.

(4) Comments and Advice

1) More than fifty persons participated in the seminar, most of whom came from the industries including iron and steel, and textile. It was successful six presentations were made by other ASEAN countries and Japan. Energy conservation activities presented by Mr.Yo sapong (DEDE), were worth listening, because each activity Thailand implemented could become a leading model for other ASEAN countries. Question and answer session was so active. We can evaluate this seminar had a success more than expected. The achievement owes much to careful planning and preparation by Mr. Sarat, a substitute focal point, and others.

2) Some successful cases, which were presented in the seminar, are worth registering in the technical directory. In particular, some cases of the Philippines and Indonesia

should be registered. I would like to ask ACE to do so.

3) "Research on energy conservation technologies of electric furnace by improving slag-foam stabilization" was introduced by Thailand researcher. Although this theme is important for energy conservation operation, it may deviate a little from the scope of PROMEEC project. It is reminded that the purpose of PROMEEC is establishment of energy management system and its dissemination.

3. Follow-up Survey of B Steel Industry

(1) Participants

BSI: 10 persons (Mr. Somchai, manufacturing manager, and nine engineers)
DEDE: 4 persons (Mr. Sarat and three engineers)
ACE: 2 persons (Mr. Ivan and Ms. Evangeline)
ECCJ: 2 persons (Mr. Tanaka and Mr. Kawase)

(2) Overview of Factory

The factory is located in the southern coast of the Gulf of Thailand, the 30 kilometers south-southeast of Bangkok. Rolling mill operation started in 1964 and electric furnace operation started in 1973.

Major facilities:

Two electric furnaces with capacity of 25 ton/batch (annual capacity 300,000 t/y), two continuous casting machines, two continuous heating furnaces, two rolling mills,

Production:

steel bar: 450,000 t/y, galvanized steel sheet: 130,000 t/y

Employees: 600

(3) Follow-up Results

There was an explanation from the factory concerning the implementation status of measures suggested in the audit of the previous year.

1) Heat Insulation of Wall Surfaces of Continuous Heating Furnace

Heat insulation has not been implemented so far, due to delay of permission from the factory management. According to the factory, energy saving effect of heat insulation was estimated by the Iron and Steel Institute of Thailand (ISIT).

Desirably calculation of heat insulation effect had better be done by engineers of the factory.

2) Heat Loss at Exit Opening of Continuous Heating Furnace

It was suggested in the previous audit to install an insulating cover at an exit opening. However, this has not been implemented. Prompt implementation is expected as it is easy to install and has a short investment recovery time. The furnace pressure was adjusted as suggested in the previous audit. It is now +0.4mm WC (water column) at a hearth position, while it was negative pressure in the previous audit. As a result, aspiration of cool air decreased, and also hot gas blowing was not observed around the exit opening.

3) Heat Insulation of LD Pre-heater

Heat insulation has fully been implemented. Specific energy consumption of LD furnace decreased from 5.32 litter/ton to 5.05 litter/ton.

4) Measures which have been implemented by the company's own initiative

The most effective measure was energy conservation by increasing EAF supply voltage. Voltage on the secondary side was increased by adjusting the tap location of primary transformer. As a result, processing time per batch was reduced and heat radiation loss was reduced, resulting in saving of electricity and diesel oil.

(4) Comments and advice

1) In the previous audit, most of suggestions belonged to operational improvement, however they are not implemented as expected. One reason of low implementation is that report of the previous audit had not reach the factory. In the PROMEEC project, audit report is prepared by ECCJ, and then distributed to factory through ACE and focal point in each country. At the same time audit report is disclosed on the home page of ACE. It may be one of solutions for ECCJ to unofficially send a draft report to factory, in parallel with the formal ACE route mentioned above.

2) There was a question about what is appropriate for an insulating material. There was a question of how and where to open a sampling hole with respect to measurement of the oxygen content in the continuous heating furnace. These are very basic knowledge for all engineers of industries including iron and steel industry to learn.

It shows a lack of basic knowledge of engineers, and more education is necessary.

3) The BSI are developing energy-conservation-related technologies in cooperation with MTEC (supervised by the Ministry of Science and Technology) and the Thailand Institute of Iron and Steel, etc. Development themes are "stabilization technology of EAF slag formation" and "tundish preheating technology". It is expected that understanding of process principles concerning electric furnace and heating furnace is deepened through the process of technology development. It will contribute to the proper implementation of energy conservation measures mentioned in 1) and 2), and other measures.

4. Discussion with Focal Point on PROMEEC Industry Project

ECCJ experts and Thai focal point including DEDE engineers exchanged opinions on the role of Thailand in the PROMEEC industry project. The following is major content:

(ECCJ) Thailand has accumulated a number of technologies and experiences in both energy conservation technologies and energy management, and is a step ahead of other ASEAN countries. We think it is a time now to disseminate the accumulated knowledge experiences to other ASEAN countries. For example, Dispatching Thai engineers to OJT audit activities in other countries and to carry out measurements are expected.

(DEDE) There is a cooperation program called ACMECS consisting of countries in the Mekong basin. Please refer to the website of the Thai Foreign Ministry for details. It is mainly funded by Thailand. It may be possible to invite engineers from other countries and hold a seminar in a training center under DEDE (Note: this training center is different from the training center of person responsible for energy (PRE) of Thailand).

(ECCJ) In the beginning, there was a request from the Thai focal point that they want to carry out production process-related audit in the glass factory. In the end, considering that process-specific energy conservation measures are beyond the scope of the PROMEEC project, audit of the glass factory had to be given up. We explained that process-specific technologies are under the NEDO's jurisdiction.

(DEDE) We understood the aim of the PROMEEC project in the discussion.

(ECCJ) We heard that "All Participation Project" completed successfully. What was the problem found?

(DEDE) In reality, there is a problem of sustainability. In the factory audit, almost all the jobs were conducted substantially by the dispatched outside experts. After they have gone, its activities have stopped in many factories. In order to raise sustainability we think that EM H/B is helpful in maintaining sustainability. (note:EM H/B is energy management handbook, which was provided in the other Thai/Japan cooperation project)

(ECCJ) The OJT audit of this project was also carried out by ECCJ experts in reality. It is not sustainable as long as ECCJ experts do. We hope that an audit is carried out by a host nation's initiative, but there is not a good idea. In the PROMEEC activity in Vietnam, engineers from the ECC-HCMC participated in the OJT audit. In the PROMEEC activity in Malaysia, engineers from the PTM participated in the OJT audit. We believe it contributes to increase sustainability if those engineers would participate in the next OJT audits with self-help efforts.

(ECCJ) Based on discussions today, we expect you to disclose opinions concerning the future role of Thailand in PROMEEC activities and achievement of after-project sustainability at the next post-workshop or the inception workshop.

Attachment 1 **Seminar-Workshop Program**

AGENDA

INTENSIVE SEMINAR

PROMOTION OF ENERGY EFFICIENCY AND CONSERVATION (PROMEEC)

(MAJOR INDUSTRY) UNDER THE SOME-METI WORK PROGRAMME 2007-2008

(Jaras Muang I, Twin Tower Hotel, Bangkok)

(December 19, 2007)

08:30 – 09:00	Registration
09:00 – 09:10	Opening Remarks from ASEAN Centre for Energy (ACE) Dr. Weerawat Chantanakome Executive Director, ACE
09:10 – 09:20	Opening Statement from Energy Conservation Centre of Japan (ECCJ) Mr. Taichiro Kawase, General Manager International Engineering Department , ECCJ
09:20 – 09:30	Welcome Address from Department of Alternative Energy Development and Efficiency (DEDE) Dr.Panich Pongpirodom Director General ,DEDE
09:30 – 09:50	Tea Break & Group Photo Session
09:50 – 10:20	Outline and Achievements of PROMEEC Industry Project (ACE) Presented by ACE
10:20 – 10:40	Incentive Programs to promote Energy Conservation for Thai Industry Presented by DEDE
10:40 – 11:30	Energy Conservation of Steel Industry in Japan & Experience from PROMEEC Programme Presented by Mr. Hideyuki Tanaka Energy Expert, ECCJ
11:30 – 12:00	Best Practice in Energy Conservation for Steel Industry from Thailand Presented by Dr. Kritsada Prapakorn Researcher, National Metal and Materials Technology Center (MTEC)
12:00 – 13:00	*Lunch*
13:00 – 13:30	Best Practice in Energy Conservation for Steel Industry from Philippines Presented by Mr. Max Marquez Department of Energy (DOE), Philippines
	Lunch
13:30 – 14:10	Energy Conservation of Textile Industry in Japan & Experience from PROMEEC Programme Presented by Mr. Taichiro Kawase General Manager, International Engineering Department , ECCJ
14:10 – 14:40	Best Practice in Energy Conservation for Textile Industry from Indonesia Presented by Mr. Purnomo General Manager of Engineering Dept. , PT. Bhineka Karya Manunggal 1
14:40 – 15:10	Best Practice in Energy Conservation for Textile Industry from Vietnam Presented by Mr. Phan Nguyen Vinh Specialist of Technology – R&D Dept., The Energy Conservation Centre of Vietnam
15:10 – 15:30	Tea Break
15:30 – 15:50	Updates on Development of Database/ Benchmark/ Guideline for

	Industry **Presented by ACE**
15:50 – 16:10	In-house Database for Industry Presented by ECCJ
16:10 -16:30	Q&A

VI. Summary & Post-Workshop

1. Overview of Workshop

Focal points from nine countries except Myanmar, representatives of ACE and ECCJ, and twenty-two persons from the host country participated in the workshop.

We frankly exchanged views and discussed on achievements and evaluation of the phase 2 of the PROMEEC project, including evaluation on activities of this year, following the discussion on how to direct the phase 3 activity. As a result, we had the conclusion that (1) many achievements were made through steady implementation, and (2) dissemination of energy conservation technologies were transferred in the phase 2, (3) further efforts for improvement are required in order to achieve a goal targeted in the phase 2. Furthermore, based on the conclusion, a consensus was formed by participants concerning future initiatives including a basic implementation plan for next year.

According to the consensus, individual proposals which each country plans in FY2009 will be submitted by the first week in May from each focal point to ACE as done last year. Then, these proposals will be reviewed at ECCJ-ACE to form an implementation plan, which will be finalized at the inception workshop scheduled to be held in early July this year.

(1) Summary & Post Workshop

February 26 (Tuesday) ~ 27 (Wednesday), 2008
Hotel Salak the Heritage, Bogor
J1. Ir. H. Juanda No.8, Bogor-16121, Indonesia

(2) Participants

The total of 22 persons participated in the workshops. Fifteen were from ten ASEAN countries, four from ACE, and three from ECCJ.

Representatives of ASEAN countries: 9 persons

Mr. Sarat Prakobchat (DEDE, MOE, Thailand, workshop chairman)
Mr. Amir Sharrifudin (Prime Minister's Office, Burnei)
Mr. Lien Vuthy (Head of Energy Efficiency & Standard Office, MINE, Cambodia)

Ms. Indarti (Head of EC Division, MEMR, Indonesia)
Mr. Khamso Kouphokham (Chief of Administration Division, MEM, Lao PDR)
Ms. Norhasliza Mohd Mokhtar (Program Manager, PTM, Malaysia)
Mr. Jesus C. Anunciacion (Chief Science Research Specialist, DOE, Philippines)
Mr. Abdul Rashid B. Ibrahim (Deputy Director, EMA, Singapore)
Mr. Phuong Hoang Kim (Official on Energy and Environment, MOIT, Vietnam)

ACE : 6 persons

Dr. Weerawat Chantanakome (Executive Director)
Mr. Christopher Zamora (Administration and Finance Manager)
Mr. Ivan Ismed (Project Officer)
Ms. Maureen C. Balamiento (Database and IT Specialist)
Mr. Junianto M. (IT Staff)
Ms. A. Desita Ekaputri (Statistics & Database Specialist)

Other representatives from Indonesia (DGEEU and ACE): 4 persons

ECCJ: 3 persons

Mr. Kazuhiko Yoshida (General Manager)
Mr. Yoshitaka Ushio (General Manager)
Mr. Hideyuki Tanaka (Technical Expert)

2. Summary of FY2007 Activities and Policy of FY2008 Activities

The followings were reported from countries which implemented activities in FY2007. Please refer to the other chapters concerning each country's activities for details. Then, ECCJ explained policy of FY2008 activities, and they were acknowledged by all participants.

Country and industry sub-sector	Achievement and evaluation	Policy of FY2008
Vietnam (textile) the Philippines (food) Malaysia (food) Thailand (steel)	1. Local audit team was organized in three countries. They actively performed OJT audit and deepened a basic understanding on the process. 2. Seminar-workshop was implemented aiming at	Proposals of FY2008 activities will be selected based on the following standpoints (policy): 1. Enhanced OJT - organization of local audit team - preparation before OJT audit (reply to pre-survey

	dissemination of achievements. Active discussions were made. 3. Thirty-five good practices were newly registered in TD and disclosed on the ACE website. Contents of the IIHDB were discussed concerning food and textile fields, and ACE is formulating it in line with the discussion. 4. Points of Improvement - As for participants from other countries, not only the number but also the industrial sub-sector should be considered. - Works for improvement and formulation of TD and IHDB should be speeded up.	questionnaire) - Countries where above two points are guaranteed. 2. Strengthening of basic knowledge on the process principle 3. Energy management tools - actual application in 3 sub-sectors (cement, textile, food) And formulation of IHDBs for iron & steel sector, etc - Enhancement of TD 4. Duration of activity in each country - maximum 7 working days - 4 working days in case of energy audit at one location - 2 working days in case of follow-up survey at one location - 1 working day in case of seminar workshop. 5. Priority of selection - maximum 3 countries - countries which were not visited this year.

3. Evaluation of Phase 2 Activities and Basic Policies for Phase 3

(1) Evaluation of Phase 2 Activities

Activities in the Phase 2 were completed as planned, and the results were accumulated as achievements. In particular, significant progress has been made that consciousness about the importance and effectiveness of energy conservation has been strengthened in the concerned parties throughout ASEAN countries. In addition, various tools and information systems were developed and disseminated for the purpose of sharing information and experiences accumulated in the PROMEEC project.

However, there is still room remaining for improvement from the standpoint of project aims of the Phase 2 such as establishment of self-help efforts and dissemination of technological experiences to the whole nation. In particular, future leaders and trainers, who are target persons of the OJT training, are not trained in a systematic way. Moreover, there are no projects planned in which they are made maximum use of, or no education and dissemination by themselves are not implemented now. There are no policy supports including financial support for assisting their activities. As for follow-up survey of the cooperative factories and establishment of energy management tools, support to ACE by each country is insufficient. This is a big problem against sustainability of the PROMEEC project.

(2) Basic Policies for Phase 3

In order to start the Phase 3, the above-mentioned issues need to be improved first of all. Activities of FY2008 should be carried out, considering these issues into consideration. It is important to choose activities to be strengthened and to clarify barriers against these activities and to eliminate them.

1) National policy measures for expanding achievements of the Phase 2 with self-help efforts. A bilateral cooperation with an advanced country including Japan may be considered if necessary.
2) Regional cooperation among ASEAN countries on the basis of mutual cooperation.
3) Selection of activities to be strengthened with clear criteria.
4) Collaboration among three projects in the award system (e.g. Focal Point – BOJ (Building) member – BOJ (EM) member)
5) Quantification of goals and results, and visualization of achievements for the purpose of quantitative evaluation.

Based on the above-mentioned discussions, a basic plan was confirmed and agreed. First priority is given to effort for improving the current activities toward the Phase 3. It is confirmed that selection of activities to be concentrated on, and strengthening of the collaboration among three projects and setting of a quantitative target are important.