2006 Grand Prize of Minister of Economy, Trade and Industry

Challenge to company-wide ESCO Shifting energy conservation improvement from supplier to user

Toyota Motor Corporation, Motomachi Plant
Plant Engineering Division, Global Promotion Department, ESCO Group

◎ **Keywords: Rationalization of heating, cooling, and heat transmission (air-conditioning facilities, hot water supply facilities etc.)**
Recovery and use of waste heat
Others (Standardization of ESCO)

◎ Outline of Theme

Our workplace, Energy Conservation Group, Plant Engineering Division (former organization name), worked mainly on improvement of efficiency, reduction and effective use of energy in engine facilities. And beyond borders of organizations we evolved to “Company-wide ESCO” starting collaboration with panting process in the latter part of fiscal year 2004. Our organization name was changed to “ESCO Group”. We would like to introduce our energy conservation activities we have worked on in cooperation with Manufacturing Department.

◎ Implementation Period for the said Example

- Planning period January, 2005 - currently ongoing
- Implementation period January, 2005 - currently ongoing
- Effect verification period January, 2005 - currently ongoing

◎ Outline of the Business Establishment

Business description, produced items: Manufacturing of automobiles (Crown, Majesta, Mark X, Estima, etc.)

Number of employees: About 6,000

Annual energy consumption:

Fuel (heavy oil): 9,904KL/year

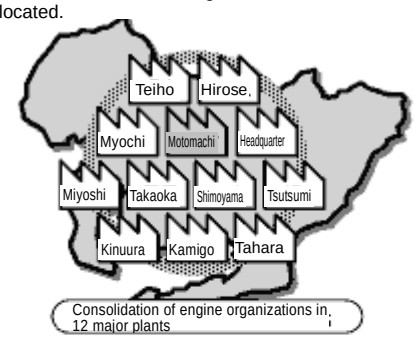
Electricity: 157,672Mwh/year

LNG: 10,088,000 Nm^3/year

(Motomachi Plant CO2 equivalent: 122,000 t/year, major 12 plants CO2 equivalent: 1,775,000 t/year)

◎ Introduction of the workplace

During 2004 and 2005, engine operation and maintenance organization that belonged to respective plants were consolidated into the "Engine Center" established in Motomachi Plant, in which Company-wide ESCO group was located.

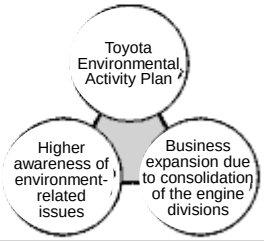


<Major jobs of Engine Center>
- Operation and maintenance of engine facilities in 12 major plants
- Development of operation and monitoring control system for engine facilities
- Operation and maintenance of Environment Center (waste processing facility)
- Support of new establishment of engine facilities in overseas plants
- Technical education on engine facilities
- Maintenance diagnostic and improvement of large-scale engine facilities
- Company-wide ESCO
- Environmental measurement, analysis, and test

1979 Energy conservation group was established (5 members)
- In 1979, when Energy Conservation Center, Japan was established, Energy conservation group was established.
- Located in the headquarters and its major jobs were energy conservation improvements in engine facilities.

Recent circumstances surrounding environment-related issues

- Environment is positioned as the most important issue for management.
  Enhanced efforts to reduce CO2 in "Environmental Activity Plan"
- Higher social awareness of environment-related issues and increased responsibility as a company
- Business expansion due to consolidation of chains of command and organizations in the engine divisions in our 12 major plants



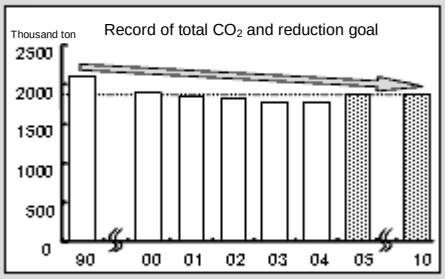
2004 ESCO group was established (11 members)
- Jan. 2004: Organization name was changed to "ESCO Group"
- Jan. 2005: As engine divisions were consolidated, location was moved from the headquarters to Motomachi.

1. Reasons for Theme Selection

▽ Our energy conservation goal and plan of activities << as of end of FY 2004 >>

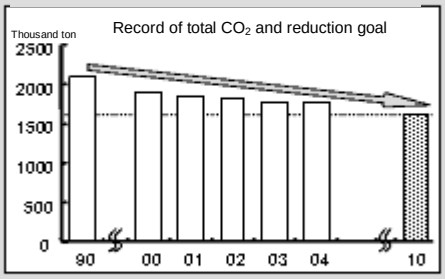
-- Toyota Environmental Activity Plan --
Mid to long term goals to promote environment conservation activities according to "Toyota Earth Charter" instituted to show the policy on global environment in 1992

Third stage "Toyota Environmental Activity Plan"
[Plan for FY 2001 - end of FY 2005]



Reduction of 5% compared to 1990 by the end of FY 2005.
(Reduction of 10% compared to 1990 by the end of FY 2010)

Fourth stage "Toyota Environmental Activity Plan"
[Plan for FY 2005 - end of FY 2010]



Reduction of 20% compared to 1990 by the end of FY 2010)

The goal in the third stage was achieved in the end of FY 2004. The newly published goal in the fourth stage is very high considering that increase of production and increased production of hybrid car lines.

2. Target Settings

Although we started activity for the fourth activity plan “reduction of 20% compared to FY 1990”

<Manufacturing field>

- We have done any thing we can do to conserve energy! (frequently turn off lights, preset air-conditioning temperature, etc.)
- Not enough technologies/man power for energy conservation on the field

<ESCO group>

- Due to consolidation of engines, business expansion as ESCO is essential.
- Even though BMC is done, there is no ESCO that can take care of the entire automobile manufacturing lines.

-- Goal of ESCO Group in FY 2005 --
Utilizing the know-how that we have, we aim for the number one company-wide ESCO in Japan through energy conservation activities in cooperation with the production field!
<Reduction of CO_2> 5000 ton/year **<Monetary amount of effect> 100 million yen/year**

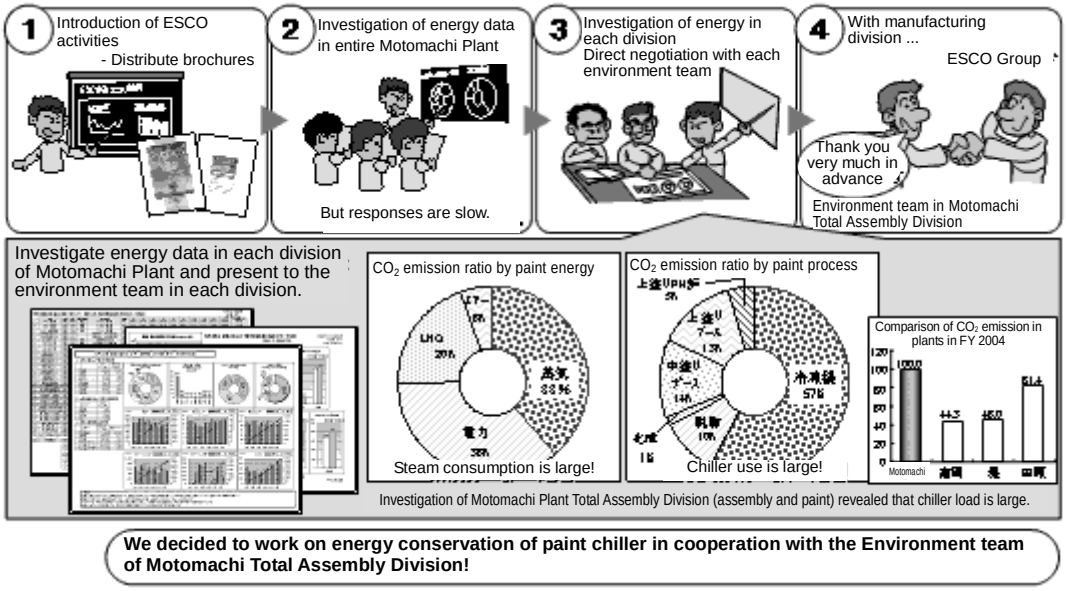
3. Current Situation and Background of the Activity

▽ Although we started energy conservation efforts in the manufacturing field
- It is hard for ESCO members to be accepted in the manufacturing division
- "ESCO" name is not recognized in the company at all!!

→ There is a high wall between the manufacturing division and there is no job for ESCO!!

- To work on energy conservation in Manufacturing Division -

▽ ESCO internal sales activity (start from "Motomachi Plant" in the home territory)



4. Case Example of Energy Conservation Activity [1]

Diagnosis step

(1) Meeting → (2) Initial diagnosis → (3) Detailed diagnosis → (4) Proposal of improvements → (5) Work plan, implementatio → (6) Report of result

Energy conservation of Motomachi absorption chiller for painting

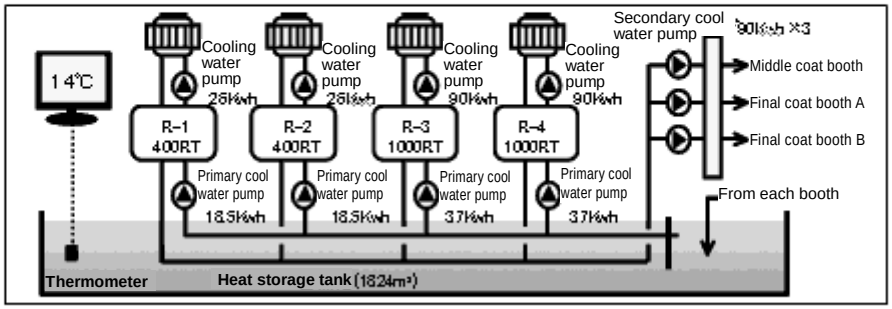
Activity schedule

Complete measures by mid summer when the load of chiller become maximum.

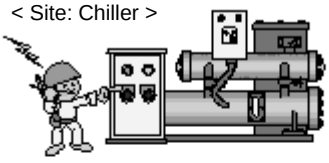
Classification	March	April	May	June
Plan	Meeting, Initial diagnosis	Detailed diagnosis	Proposal of improvements, Work plan, implementation	Verification of result and report

"Initial diagnosis" -- Understanding facilities and investigation of current situation --

STEP1 "Investigation of process overview" ... Investigate facility overview and ratings etc.



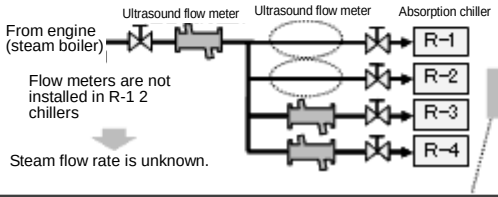
STEP 2 "Verify the actual facility on-site"
STEP 3 "Investigation using process/facility drawings"
STEP 4 "Hearing from operation/maintenance divisions" ... Hearing from operation/maintenance divisions on start/stop patterns of facilities

Operation division	Maintenance division
<Central control room>  (1) Constantly monitor the temperature of the heat storage tank (14 ℃ or lower) (2) Ask maintenance division to start/stop chiller	< Site: Chiller >  (1) Constantly take walkie-talkie along (2) On demand from operation division, move to the site to start/stop chiller

STEP 5 "Investigation and inquiry of manufacturers"

STEP 6 "Investigation of energy data" ... Investigate steam consumption of absorption chiller

<Steam plumbing chart>



Flow meters are not installed in R-1 2 chillers

Steam flow rate is unknown.

Discussed how to measure steam volume ...
<Discussed measuring using steam flow meter>
- No portable type, but only pipe installation type is available. Delivery period and price are problematic.
- They may be used in other facilities in the future

Gave up using steam flow meter

Discussed the method to grasp steam volume at the drain

Measurement using a cup

Absorption chiller

Steam

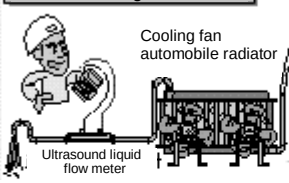
Manually measure steam consumption by measuring chiller drain using a measuring cup and a stopwatch

<<Problems>>
- Data quality is not good because it is measured by a cup
- A person must stay there; man-hour is large and long time continuous measurement is impossible.

Devise drain flow rate measuring device

Steam

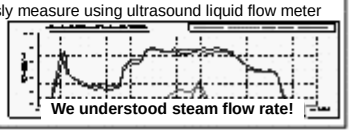
Cooling fan automobile radiator



Ultrasound liquid flow meter

Awarded best originality and ingenuity award and obtained 50,000 yen

Cool high temperature drain using automobile radiator and cooling fan and continuously measure using ultrasound liquid flow meter that ESCO has!



We understood steam flow rate!

Diagnosis step	**Energy conservation of Motomachi absorption chiller for painting**

(1) Meeting → (2) Initial diagnosis → (3) Detailed diagnosis →

"Detailed diagnosis" -- Data analysis / sort out the seed --

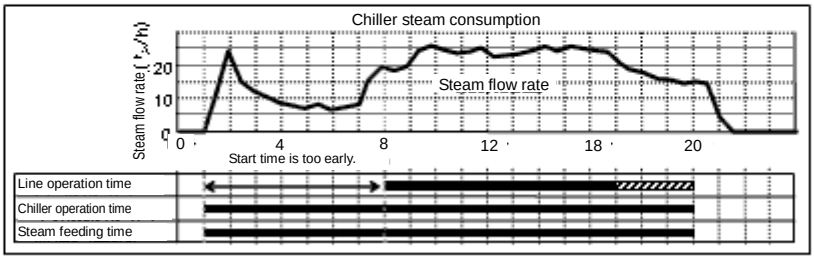
Point of ESCO's observation

Eliminate	Correct	**Stop**	Decrease	Pick up	Change

JIT (Just in Time)

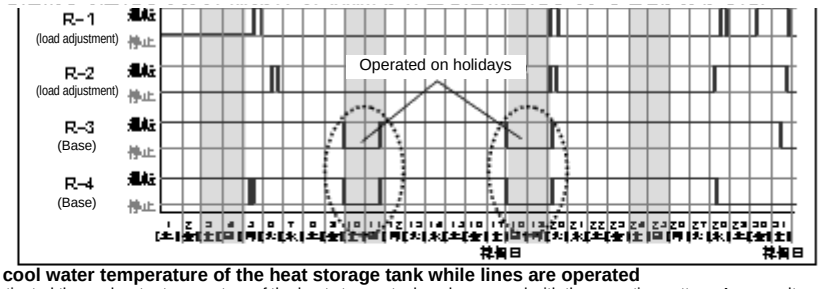
1. Comparison of chiller steam consumption and line operation time

Measured steam consumption of chiller using "steam drain measuring device" devised by ESCO. Analyzed the data linking it to manufacturing data such as line operation time, chiller operation time, and steam feeding time, etc. We found a problem that the time to start chiller might be too early compared to line operation.



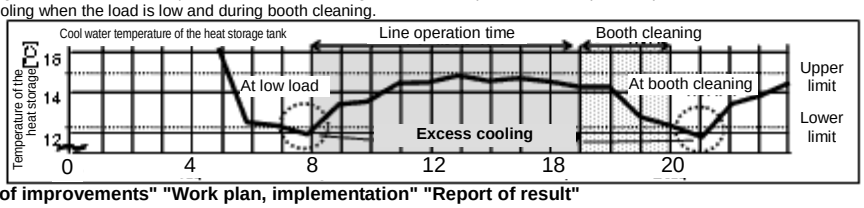
2. Check chiller operation pattern (automatic energy measurement system)

Investigate the start signal of chiller from TEM (Toyota Energy Management system) to check operation pattern of chiller.
We found that they are continuously operated on holidays and accessories (pumps etc.) are continuously operated on holidays.



3. Check cool water temperature of the heat storage tank while lines are operated

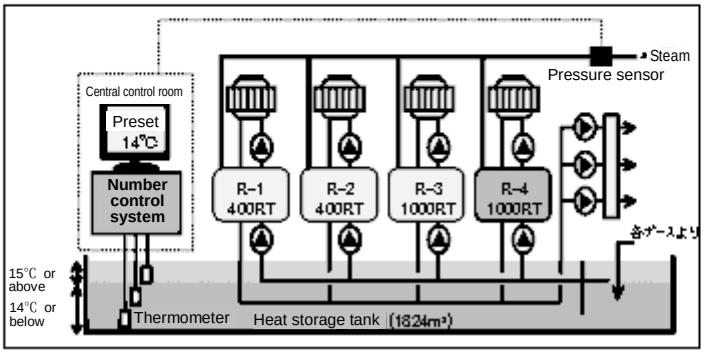
We investigated the cool water temperature of the heat storage tank and compared with the operation pattern. As a result we found excess cooling when the load is low and during booth cleaning.



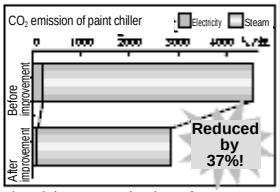
(4) Proposal of improvements → (5) Work plan, implementatio → (6) Report of result

"Proposal of improvements" "Work plan, implementation" "Report of result"

Problem	Measures	
Start time is too earl	(1) Review start time	Calculate the refrigeration performance and heat storage tank calories and reduced the chiller operation time and steam feeding time.
Operated on holidays	(2) Automatic start/stop of chiller	Automatic start/stop using calendar timer + Entire facility is stopped when steam pressure is not detected (failsafe device)
Excess cooling	(3) Number control of chillers	Add number control system based on the heat storage tank temperature control



<Reduction effect>



Electricity: reduction of 374Mwh/year
Steam: reduction of 7,466 ton/year
CO_2 emission: reduction of 1,688 ton/year
Monetary amount of effect: reduction of 25,264,000 yen/year

5. Looking Back the Activity on Motomachi Paint Chillers

Diagnosis step

- (1) Meeting
- (2) Initial diagnosis
- (3) Detailed diagnosis
- (4) Proposal of improvements
- (5) Work plan, implementatio
- (6) Report of result

"Initial diagnosis" -- Initial diagnosis step and progress --

Classification	March	April	May	June	July	August
Plan	Initial diagnosis	Detailed diagnosis	Proposal of improvements		Verification of result and report	
	:Meeting		Work plan, implementation			
Actual						

▽Delay in the initial diagnosis phase
-- Check progress in the initial diagnosis step --

Plan ⟷ Actual

No.	Diagnosis item	March	April	May
STEP1	Description of overview			
STEP2	Verify the actual facility on-site		Delay from the plan	
STEP3	Investigation using facility drawings			
STEP4	Hearing from operation/maintenance divisions			
STEP5	Investigation and inquiry of manufacturers			
STEP6	Investigation of energy data			

▽Clarification of causes of delay and discussion of measures

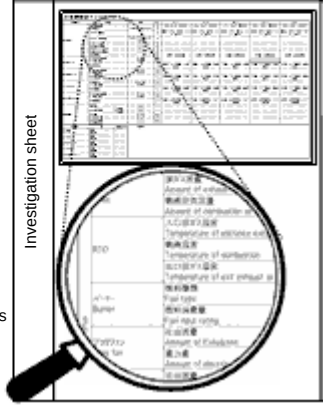
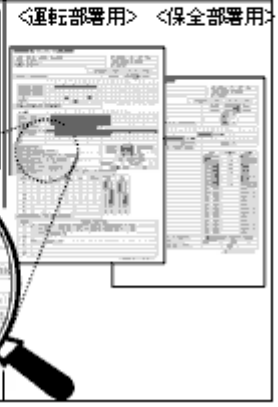
Diagnosis item	Problem	Measure
STEP 3 Investigation using facility drawings	Among the large volume of data such as performances and specifications of production facilities, required investigation items are unclear.	Summarize items by facilities -> Measure (1) Create facility investigation sheet
STEP 4 Hearing from operation/maintenance divisions	Production flow and functions are unknown; Result of investigation cannot be fully utilized.	Put the result of investigation into a map -> Measure (2) Create facility map sheet
	Hearing items are not thorough; hearing had to be repeated.	List hearing items -> Measure (3) Create hearing sheet
STEP 5 Investigation of energy data	There are no measuring devices and measuring took time.	Create drain flow rate measuring device during initial diagnosis and measurement is finished.

Measure is done!

▽Measures -- Standardization of ESCO initial diagnosis STEPS --

Used step

- Choose target process/ facility
- Complete investigation sheet (manufacturing division)
- Check the content of the sheet (ESCO)
- Analyze and clarify problems
- Proceed to detailed diagnosis

	Measure (1) Create facility investigation sheet	Measure (2) Create facility map sheet	Measure (3) Create hearing sheet
Investigation	- Performance of the facility - Types and consumption of energy - Motor and fan power - Load adjusting method - Pump discharge flow rate, supply water volume, etc.	- Process flow - Functions and purpose of the facilities - Ratings and capacities of facilities - Types and consumption of energy - Target products, etc.	- Line and facility operation time - Standard for starting and stopping, check system - Facility stop pattern during non-operation hours - Facility maintenance plan, implementation status - How history of problem is utilized, etc.
Investigation sheet			

6. Case Example of Energy Conservation Activity [2]

Diagnosis step	Exhaust heat recovery of Motomachi paint deodorizing furnace

(1) Meeting → (2) Initial diagnosis → (3) Detailed diagnosis → (4) Proposal of improvements → (5) Work plan, implementatio → (6) Report of result

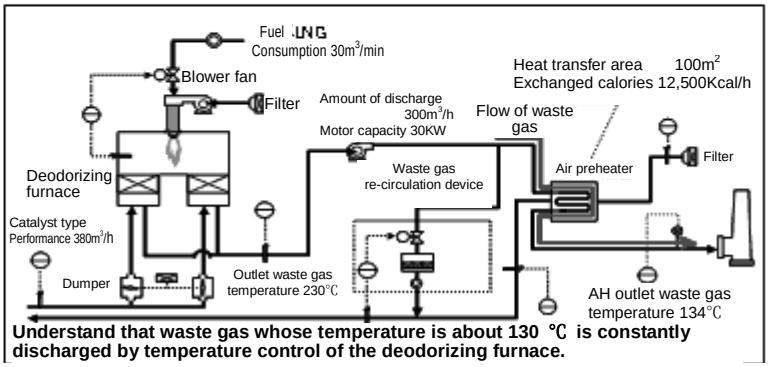
"Initial diagnosis" -- Start investigation based on the diagnosis standard document --

Facility investigation sheet

Based on the result of investigation of the actual facility on-site and facility drawings and specifications, understand overview and control methods of all the involved facilities including accessories, not only the target facility.

Facility map

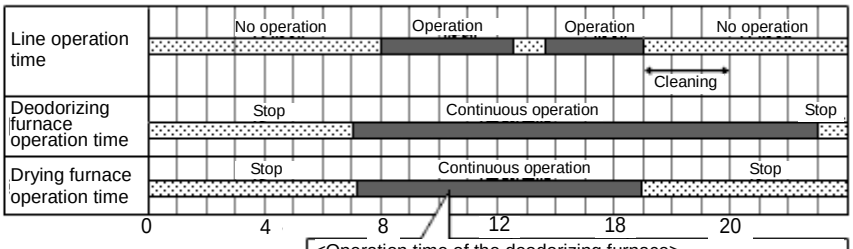
Based on the facility investigation sheet, create facility overview chart that contains facility specifications etc.



Understand that waste gas whose temperature is about 130 ℃ is constantly discharged by temperature control of the deodorizing furnace.

Hearing sheet

Interview field operators and maintenance personnel to investigate actual facility operation patterns and management methods etc. and clarify seeds of improvement.



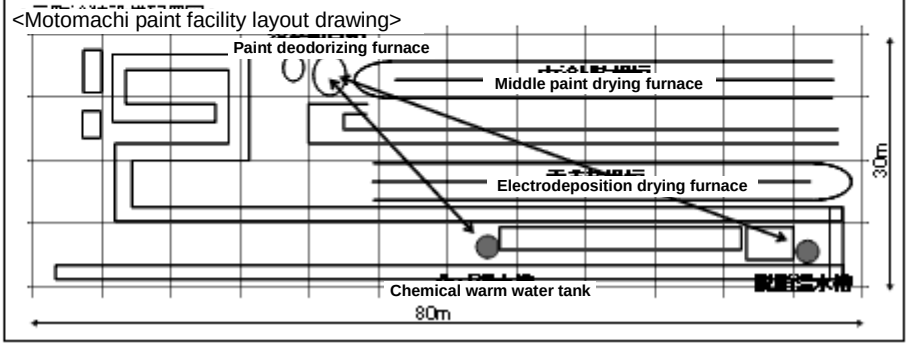
<Operation time of the deodorizing furnace>
▽ Operation method ... Start deodorizing furnace 10 minutes after drying furnace is started. Automatically stops 6 hours after drying furnace is stopped.
▽ Start/stop time ... Start: 7:10, Stop: 23:00

While deodorizing furnace is operated (7:10 - 23:00), both temperature and discharged gas are constant.

With environment team of Motomachi total assembly division and operators and maintenance personnel on the site, we investigated and discussed the way to effectively use calories using facility drawings and layout drawings, etc.

Discuss using in the "chemical warm water tank" that is close to the paint deodorizing furnace!

<Motomachi paint facility layout drawing>



Diagnosis step

Exhaust heat recovery of Motomachi paint deodorizing furnace

(1) Meeting

(2) Initial diagnosis

(3) Detailed diagnosis

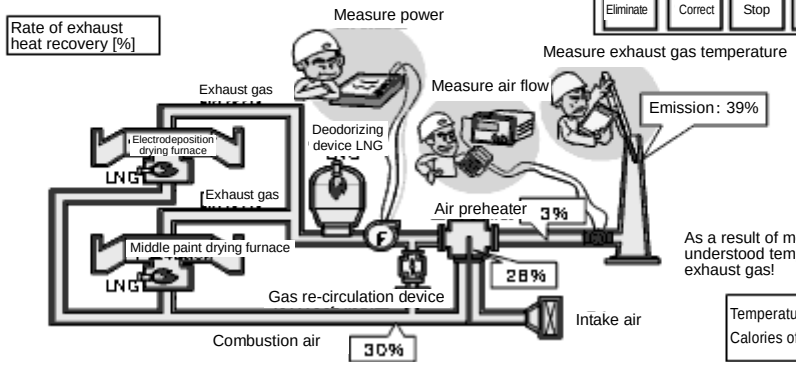
(4) Proposal of improvements

(5) Work plan, implementatio

(6) Report of result

"Detailed diagnosis"
<Measurement of paint deodorizing furnace facility>

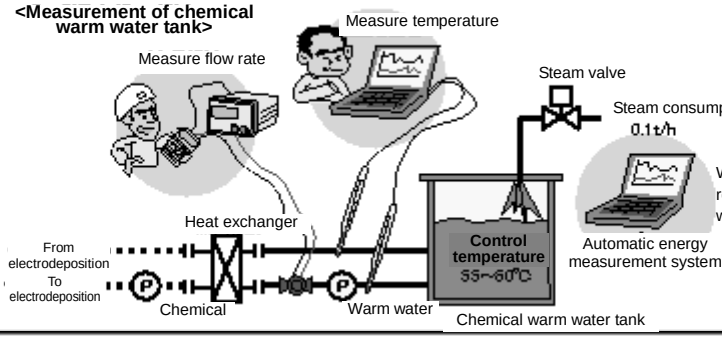
ESCO Point of ESCO's observation: Eliminate | Correct | Stop | Decrease | Pick up | Change



As a result of measurements, we understood temperature and calories of exhaust gas!

Temperature of exhaust gas:139℃
Calories of exhaust gas: 2,580MJ/H

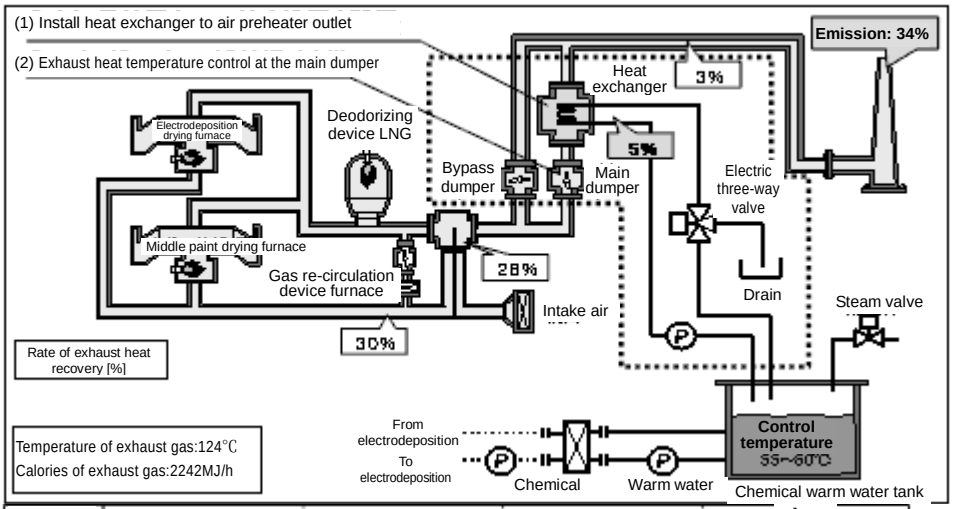
<Measurement of chemical warm water tank>



We understand calorie that is required to maintain the warm water tank!

Calorie required to control the warm water tank: 270MJ/H

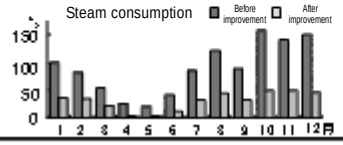
"Proposal of improvements" "Work plan, implementation"



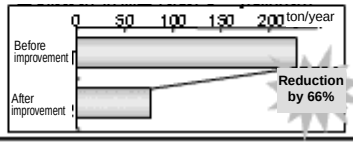
Temperature of exhaust gas:124℃
Calories of exhaust gas:2242MJ/h

Classification	March	April	May	June
Plan	Meeting / Initial diagnosis	Detailed diagnosis	Proposal of improvements / Work plan, implementation	Verification of result and report
Actual				

"Report of result"

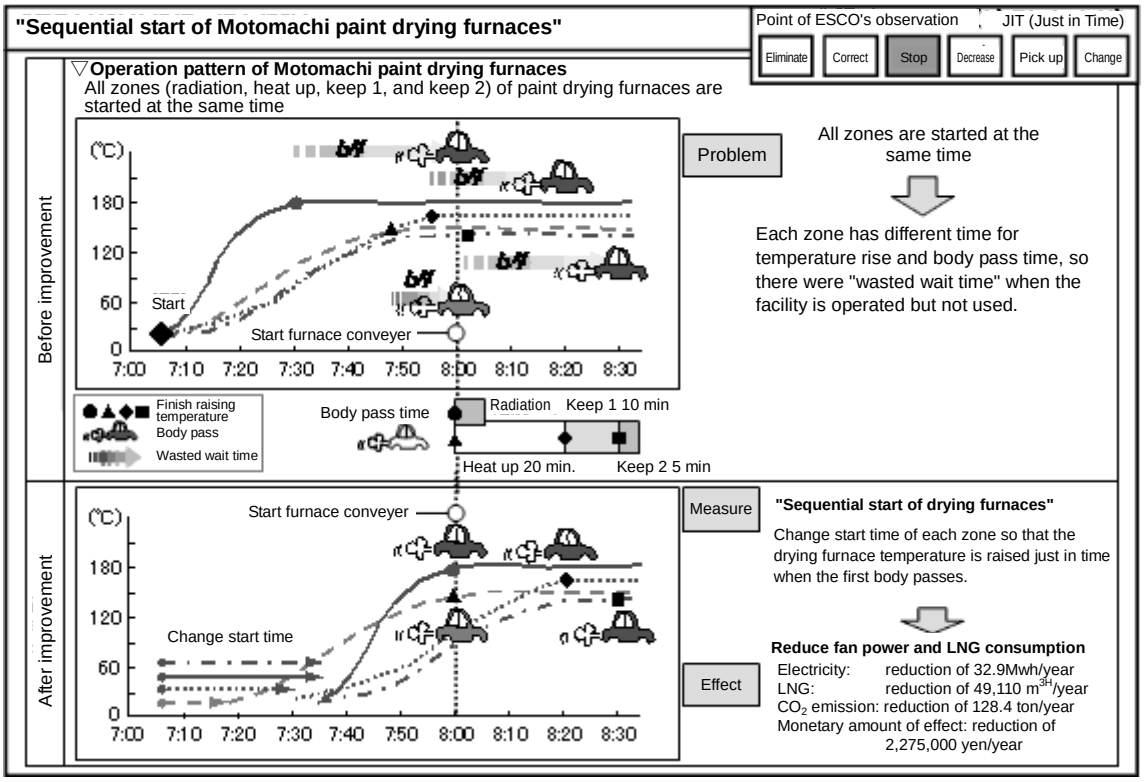


CO_2 reduction effect by recovery of exhaust heat from paint deodorizing furnace



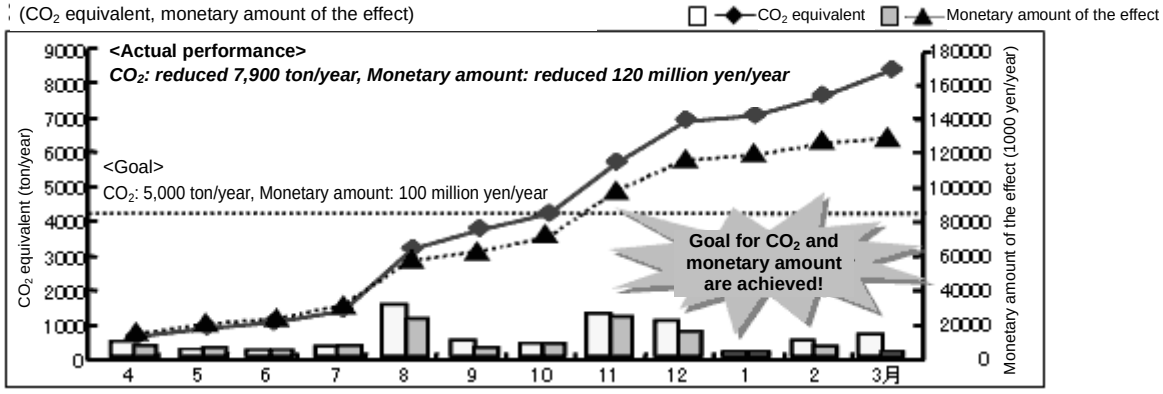
Steam: reduction of 726.8 ton/year
CO_2 emission: reduction of 150 ton/year
Monetary amount of effect: reduction of 2,123,000 yen/year

7. Case Example of Energy Conservation Activity [3] - Found from Energy Conservation Survey on Exhaust Heat Recovery in Paint Deodorizing Furnace -



8. Verification of Effects of the Activity

ESCO Group Energy conservation effect in FY 2005
(CO_2 equivalent, monetary amount of the effect)



9. Summary and Future Plan

FY 2004 (before activities) -> FY 2005 (after activities)

Increased offers from manufacturing division, expanded business area and improved knowledge of manufacturing facilities

<Supported plants (domestic)>
3 plants -> **5** plants (2006: **8** plants)

<Number of facility processes>
1 process -> **6** processes (2006: **11** processes)

Engine — Engines, assembly, paint, machining, plating, body, cast, electronic manufacturing, engines, press, ???

Improved investigation man-hour and work efficiency due to ESCO standardization

<Standardization>
7 cases -> **30** cases

<Detail of standardization>
- Standardization of detailed steps based on the ESCO diagnosis steps
- Create check sheet and investigation sheet for each step

<Shorter delivery period due to improved work efficiency>
From initial diagnosis to completion of measures
6 months -> **4** months

Support of overseas entities for independence of ESCO
<Develop ESCO knowhow (standardization) to overseas entities>

<Supported plants of overseas entities>
0 plants -> **1** plant (2006: **6** plants)

<Support of independent energy conservation activities>
- Energy conservation methods
- How to see energy, analysis
- How to discover seeds of energy conservation

<Establishing mechanism for continuous activities>
- How to continue PDCA
- Establishing organization and mechanism to promote energy conservation>

We have developed energy conservation activities in cooperation with Manufacturing Division as “Challenge to Company-wide ESCO”. As a result, we achieved various effects including reduced delivery time due to improvement of knowledge on manufacturing facilities, business expansion, standardization, and improved work efficiency as well as reduction of CO2 cost.

In addition, thanks to standardization, we deployed energy conservation activities to not only domestic locations but overseas entities.

We plan to promote further standardization and promote “company-wide ESCO” in a more efficient way to continue and promote activities as “Global Toyota” including domestic and overseas entities.