2005 Prize of the Chairman of ECCJ

The Ultimate Energy Conservation Line-making I have worked on

ASMO Co., Ltd., Head Office Plant
Production Engineering Section 2, Body Device Manufacturing Department

◎ **Keywords: Others (To minimize number of equipment, to make associated equipment 0, to make equipment operation rate 100%)**

◎ Outline of Theme

Our company is planning to change the type of the "power seat motor", one of the main products of the company, from C type to N type (Fig. 1, right) and introduce it as a new product into the market in FY2005. I, one of the staff members engaged in the activities of this case study, as identified above, would like to introduce the activities which my staff members and I did at the primary production line for the N type power seat to make an energy conservation line

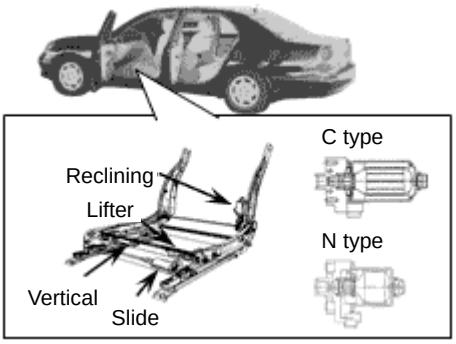


Fig. 1 Power Seat Motor

◎ Implementation Period of the Said Example

April 2004 – July 2005 Total of 16 months

- Project Planning Period April 2004 – January 2005 Total of 10 months
- Measures Implementation Period September 2004 – April 2005 Total of 7 months
- Measures Effect Verification Period May 2005 – July 2005 Total of 10 months

◎ Outline of ASMO Co., Ltd., Head Office Plant

- Scope of Business Development, manufacturing and sales of small motors and system products for cars and OA equipment, etc.
- Main Products Small motors of power seats, power windows, wipers, etc.
- No. of Employees 4,410 (As of April, 2005)
- Annual Energy Usage Amount: 12,050 tC/year (Actual results for fiscal year 2005)

Electricity	70,320 Mwh
Heavy oil	10,042 kL
LPG gas	251 tons

◎ Process Flow of Target Facility

The production line for the power seat motors was built as an energy conservation line as shown in Fig. 2 below during the period from FY2004 until today. It was realized by gathering the processing and developing technologies of the divisions concerned, while aiming to make an ultimate energy conservation line from the “planning and designing” phase of the product.

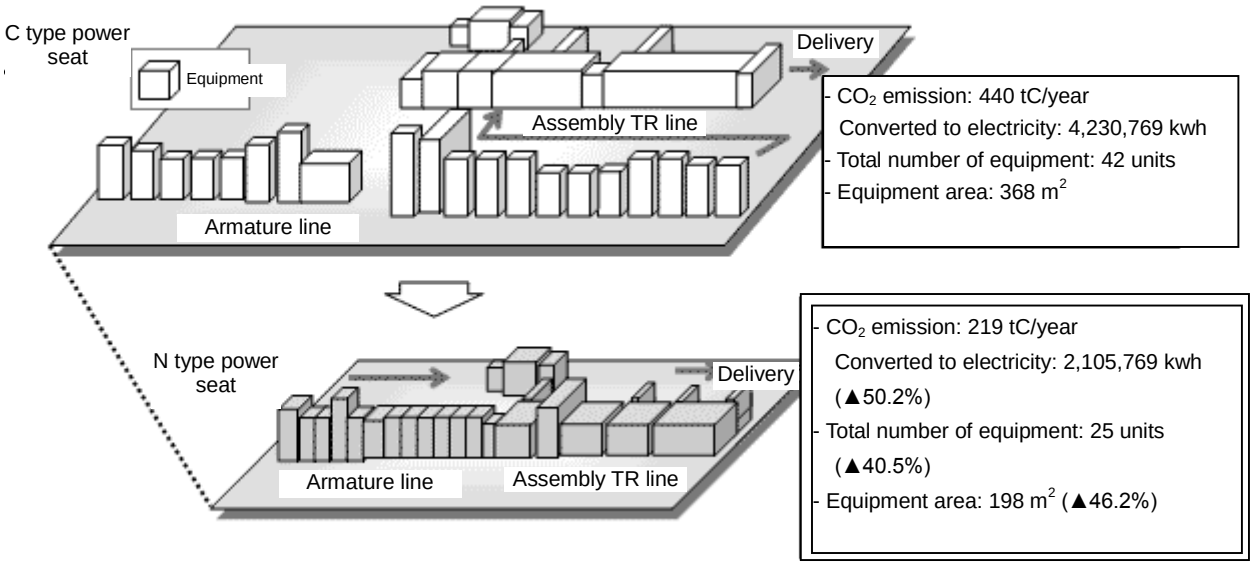


Fig. 2 Structure of Power Seat Motor Production Line

1. Reasons for Theme Selection

(1) Activities of Body Device Manufacturing Group

The energy conservation activity organization of the company consists of 6 working groups including the Body Device Manufacturing Group which are working under the Energy Sub Committee. The Body Device Manufacturing Group promotes the energy conservation activities focusing on three major themes, “enhancement of awareness”, “development of processing technologies for new lines” and “improvement of MP of existing lines” (Fig. 3).
The Production Engineering Office aims at an ultimate energy conservation line by

"minimizing the number of equipment", "making associated equipment 0" and "making the equipment operation rate 100%" (Fig. 4 below. Hereinafter, the power seat motor is abbreviated as P/S and the power window motor is abbreviated as P/W).

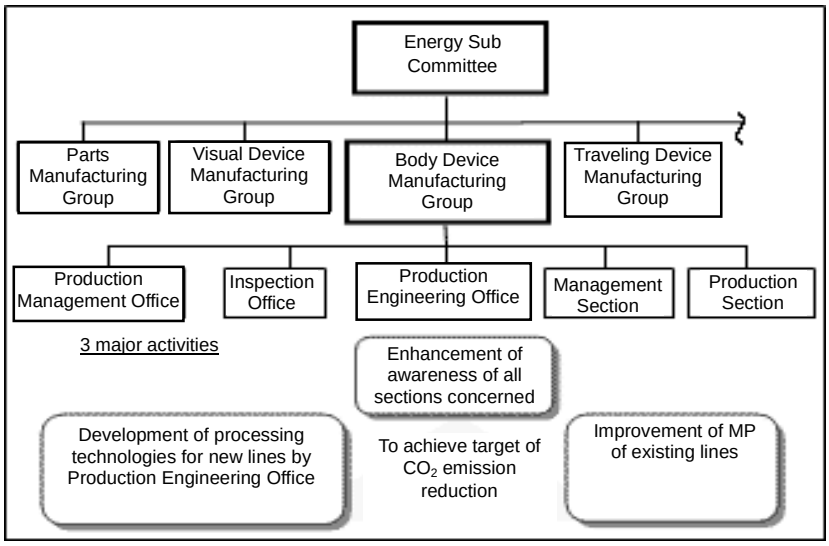


Fig. 3 Organizational Structure of Energy Conservation Activities, Higher Level

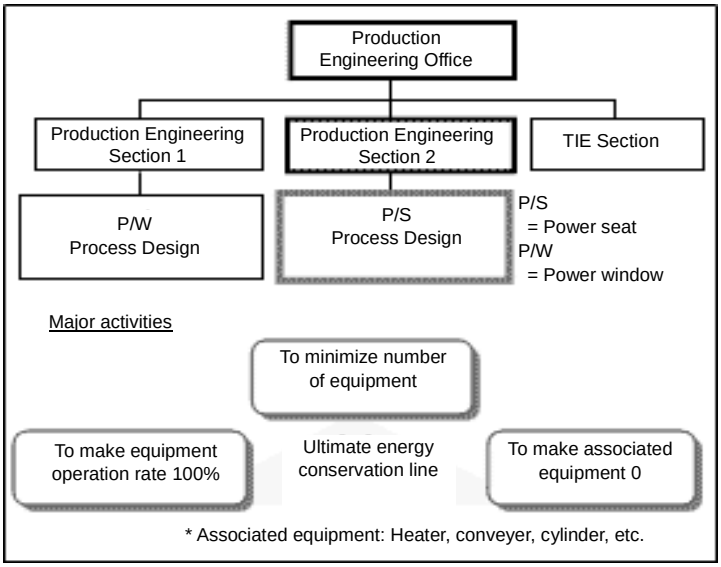


Fig. 4 Organizations and Activities of Production Engineering

(2) Activities so far implemented by Production Engineering Office

When the P/W was changed from 40M type to GS34 type in FY2002, the Production Engineering Office installed an energy conservation line reducing CO_2 emission amount to

half (awarded the Director-General Prize) and installed further leveled-up energy conservation lines by FY2004.

The product model of the P/S is expected to be renewed in the end of FY2005 and the process design for the new model is expected to start in FY2004, so we decided to make an ultimate energy conservation line for the N type P/S which is better than the line for the GS34P/W (Fig. 5) and take it as our theme.

Fig. 6 shows the activities so far implemented to make the energy conservation lines and the ultimate energy conservation line we aimed at.

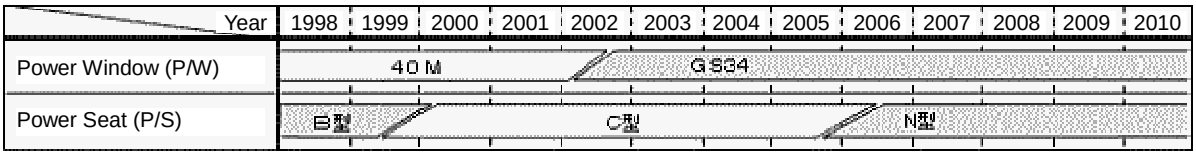


Fig. 5 Plan to Change Main Products

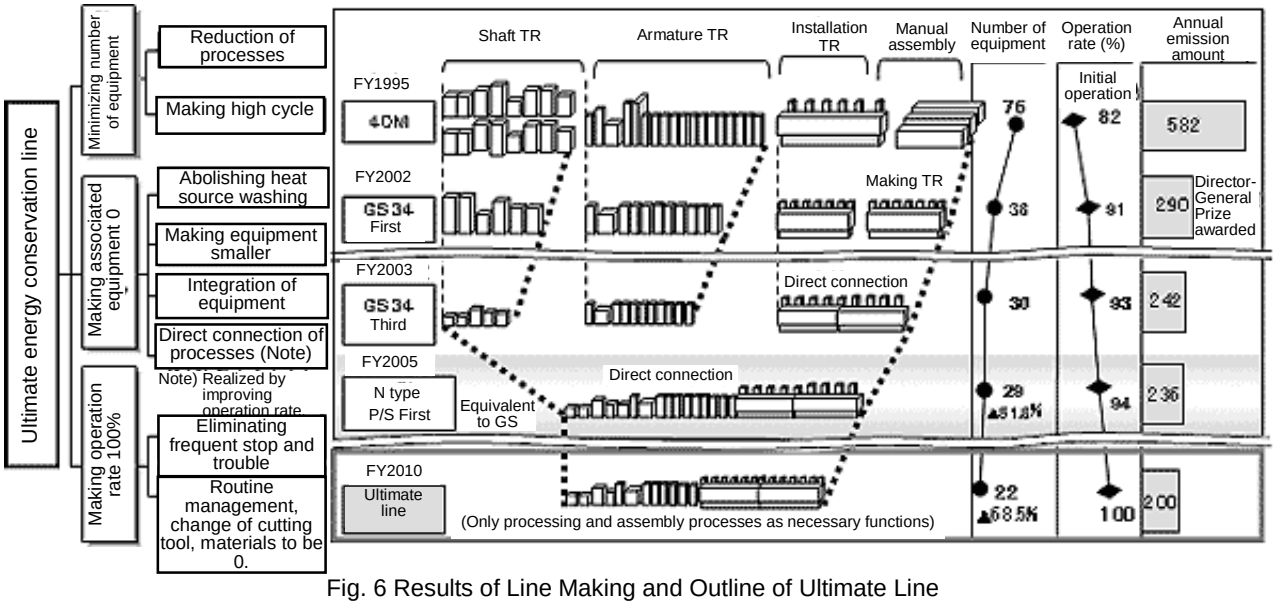


Fig. 6 Results of Line Making and Outline of Ultimate Line

2. Target Settings

(1) Target of the Company

The company has set a target aiming to reduce the company's total CO_2 emission by 10% from the FY1990 level, i.e. to make it 15,400 tC/year or less, by FY2010.

The target for the total CO_2 emission of this

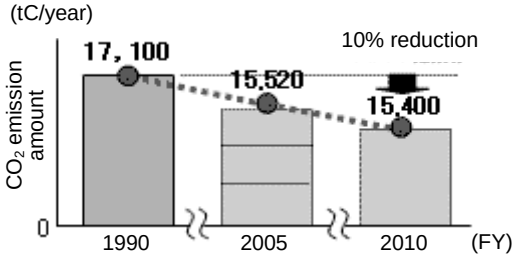


Fig. 7 Long Term target for Total CO_2 Emission Reduction by the Company

year is 15,520 tC/year or less and, to achieve this, each working group is doing the CO_2 emission reduction activities (Fig. 7, right).

(2) Target of Body Device Manufacturing Group

Although the target for the CO_2 emission for FY2005 is 1,721 tC/year or less, it is actually expected to be 1,753 tC/year. So it is necessary to reduce 32 tC/year or more.
It is expected that this working group achieve the target this year by turning the GS34-Third line into an energy conservation line and by integrating or abolishing old lines (Fig. 8, right).

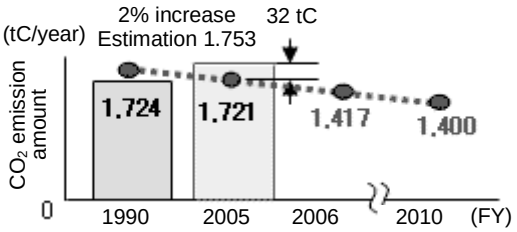


Fig. 8 CO_2 Reduction Target of Body Device Manufacturing Group

(3) Understanding of Current Situation

If we look into the production and the plans to make new lines since 2005, it is known that the lines were planned for both P/W and P/S following the expansion of the market (Fig. 9 below).
According to this tendency, if we estimate the CO_2 emission amount of each year, it is known that the amount is likely to exceed that target by 16 tC after FY2006 (Fig. 10 below).

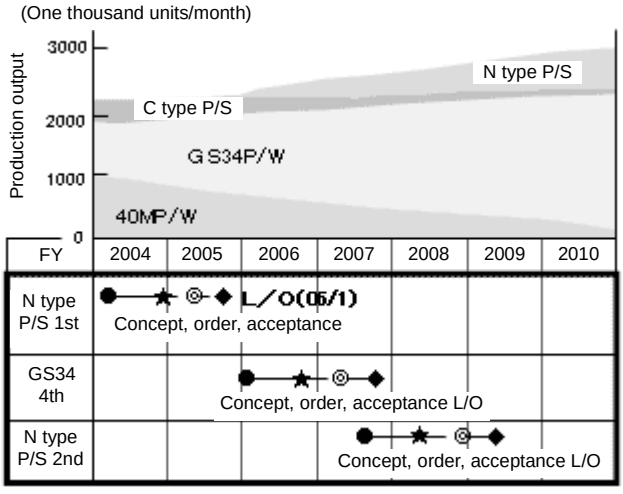


Fig. 9 Production Tendency of Main Products and Plan to Make New Lines

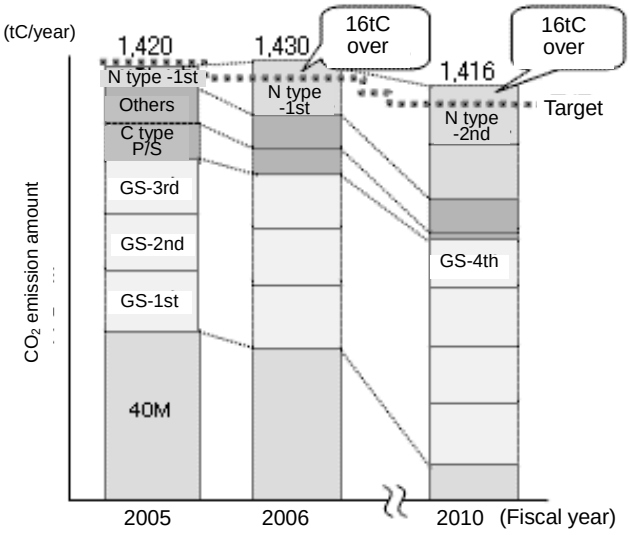


Fig. 10 Estimation of Emission Amount

(4) CO2 Emission Target for N Type P/S

At first, the annual CO_2 emission target for the N type P/S had been set as 236 tC based on the line structure equivalent to the GS34-Third line, but it was set anew as 220 tC, deducting further 16 tC based on the understanding of the current situation.

If we can satisfy this additional target each year, we can achieve the CO_2 emission target of FY2010 too, so we decided to challenge the 16 tC reduction of CO_2 emission amount by promoting the energy conservation process designing such as new development of processing technologies.

This target value “220 tC” is the value that reduced the annual CO_2 emission amount of the current C type P/S line by 50% (Fig. 11 below).

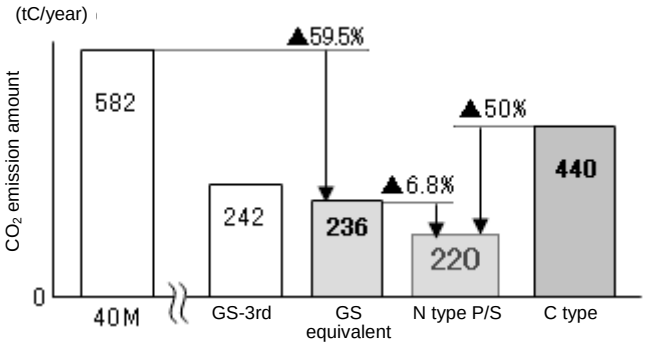


Fig. 11 CO_2 Emission Target for N Type P/S

3. Activity Plan for N type P/S

When making the energy conservation line for the N type P/S, in order to achieve the CO_2 emission target up to FY2010 and to make the line closer to the ultimate line envisioned by the Production Engineering Office, we focused our activities on the “minimizing the number of equipment”, “making the associated equipment 0” and “making the operation rate 100%”and took the following measures, aiming to make the annual CO_2 emission 220 tC or less.

[1] To minimize the number of equipment

- To make the press-fitting and coating process complex by developing new processing technologies using insulators and to get rid of the E ring assembling process.
- To reduce the number of assembling stations (S.T) by doing simultaneous assembling, etc.

[2] To make the number of associated equipment and devices less as much as possible.

- To get rid of the conveyor, transfer device, etc. by directly combining the equipment and lines.

[3] To improve the operation rate by eliminating the causes of non-operation.

- To shorten the time during which the equipment is stopped to check the quality of the product and to change the spare parts, etc.

As a result, we could make the annual CO_2 emission amount 219cT.

Table 12 shows the details of the activities and Fig. 13 shows the comparison of the lines.

The “development of new processing technologies using insulators” challenged in minimizing the number of equipment is described in the case example 1 below and the “activities to make the operation rate 100%” is described in the case example 2 below.

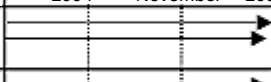
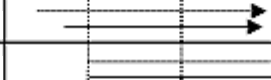
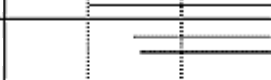
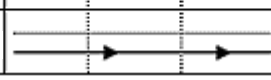
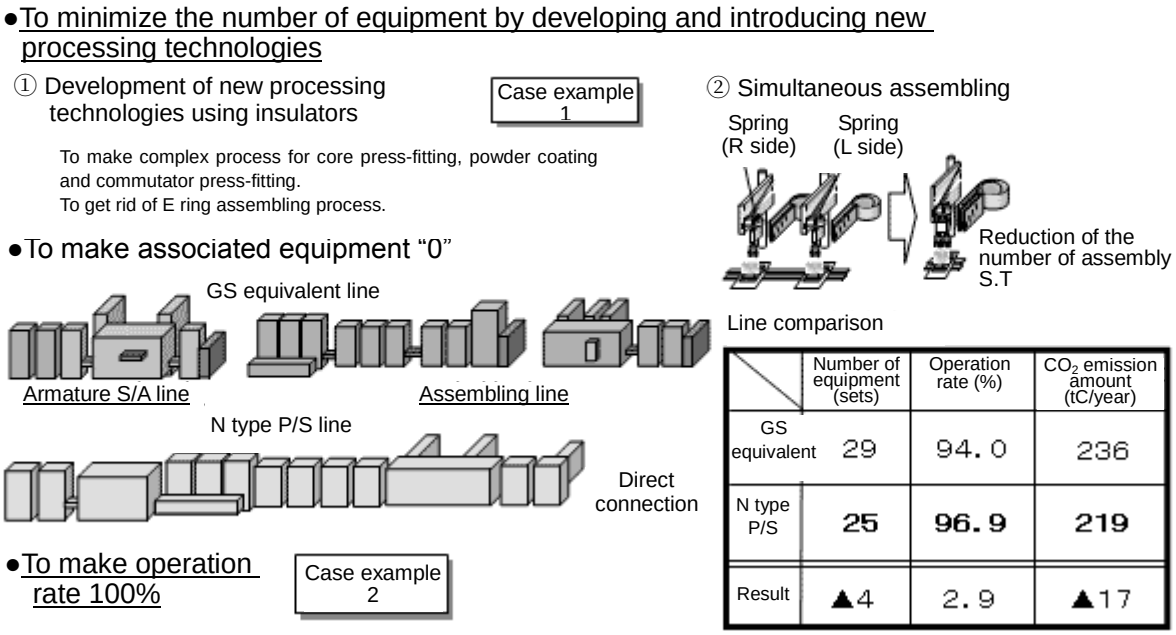
	Items to be taken		CO2 reduction amount	September, 2004 / November / January, 2005 / March (Month)
(1) Minimizing the number of equipment	Development of new processing technologies using insulators	To make complex process for core press-fitting, powder coating and commutator pres-fitting.	7.6t-C/year	
		To get rid of E ring assembling process	1.8t-C/year	
	Simultaneous assembling	To reduce spring assembling ST	1.0t-C/year	
(2) Making associated equipment 0	Direct connections of lines	To directly connect armature and assembling lines. (To get rid of conveyor, transfer equipment)	0.8t-C/year	
(3) Making operation rate 100%	To eliminate cause of non-operation	– Not to stop to change winding wire packs.	4.8t-C/year	

Table 12 Activity Plan for N Type P/S



	Number of equipment (sets)	Operation rate (%)	CO_2 emission amount (tC/year)
GS equivalent	29	94.0	236
N type P/S	25	96.9	219
Result	▲4	2.9	▲17

Fig. 13 Specific Activities for N Type P/S

Case example 1:

Development of new processing technologies using insulators

(1) Outline of Process

The CO_2 emission amount of the powder coating process is especially high in the armature processing processes, because it does washing and drying using the heater and coating and cooling using air (Fig. 14 & Fig. 15).

If we can get rid of the powder coating, we can reduce the use of the heater and air. So we tried to realize it.

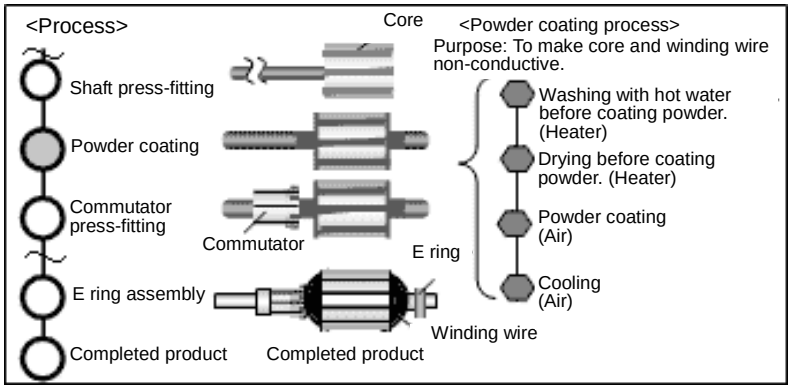


Fig. 14 Outline of products and processes

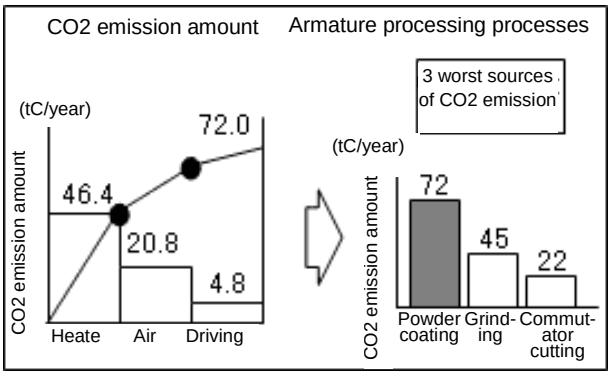


Fig. 15 CO_2 Emission Amount of Powder Coating Process

(2) Details of Measures

We studied new ways to insulate which can replace the powder coating, including the way to insulate with insulators or insulation paper and the method, material, assembling quality, etc. As a result, we found that the insulator A was most suited as the insulation material (Fig. 16). When changing the insulation to the insulator A, there was a problematic possibility that the winding wire might touch the core (Fig. 17), so we reviewed the maximum gap, board thickness, etc. of the insulator to be reflected on the design. As a result, we could secure the safe size which can prevent the winding wire and core from touching each other and it became possible for us to change the insulation from the powder coating to the insulator.

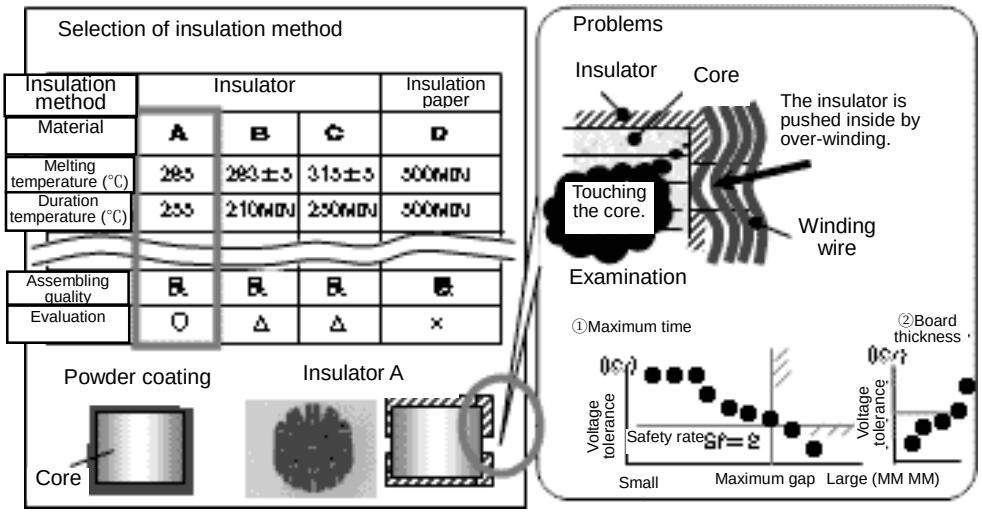


Fig. 16 Study of Material Fig. 17 Confirmation of Quality

(3) Effects of Measures

By abolishing the powder coating process and changing it to the insulator assembling process, we could have the following effects.

[1] Reduction of processes

- As the resin's edge surface started to sustain the thrust weight directly, we could get rid of the E ring and the E ring assembling process.
  Effect: The number of equipment reduced from 29 units to 28 units.
  We could remove 1 unit (Fog. 18 below).

[2] Complex process was made

- As the insulation was changed from coating to assembling, the processes before and after that (assembling processes for press-fitting the shaft and press-fitting the commutator) were integrated to make a complex process (Fig. 18).

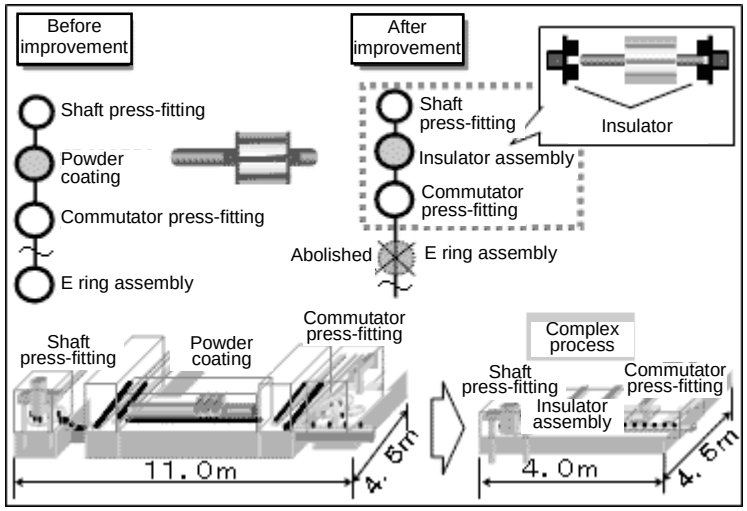


Fig. 18 Outline of Process after Improvement

[3] Area

- If compared with GS equivalent line:
  49.5 m^2 ⇒ 18 m^2
  Effect: 31.5 m^2 (63.6% reduction)

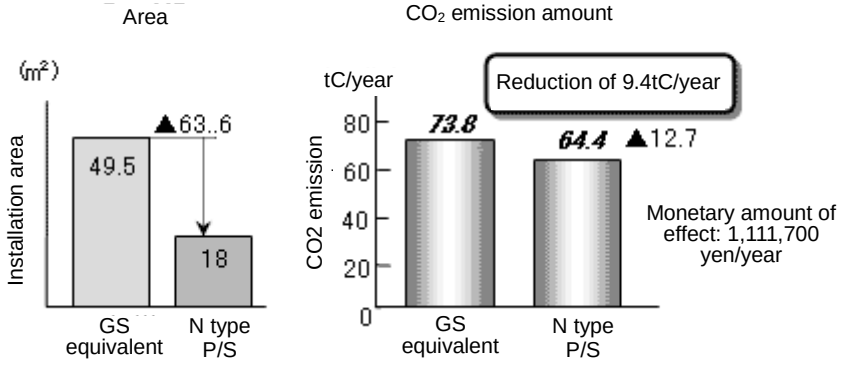
[4] Annual CO2 emission amount

- Powder coating ⇒ Insulator
  72 tC/year ⇒ 64.4 tC/year
  Effect：Reduction of 7.6 tC (10.5% reduction)

- By abolishing E ring assembly process

  1.8 tC/year ⇒ “0” (Reduction of 1.8 tC)

  * Total: Reduction of 9.4 tC/year (Converted to electricity: 90,385 kwh)



Case example 2: Activities to make operation rate 100%

(1) Understanding of Current Situation and Problems

We looked into the breakdown of the non-operation rate which caused the operation rate of the current line (GS34-Third) to decrease and we realized that there were non-operative causes of 6% left. They happen when changing materials or cutting tools, when the line stops or there is trouble, when inspecting the line or checking the quality of the product, and when setting up or adjusting the line, etc. (Fig. 19).

So we decided to try to reduce the non-operation rate of the line for the N type P/S by 2% and operate it with the operation rate of 96% or more (with CO_2 emission amount of 231.2 tC/year reduced by 4.8 tC) (Fig. 20).

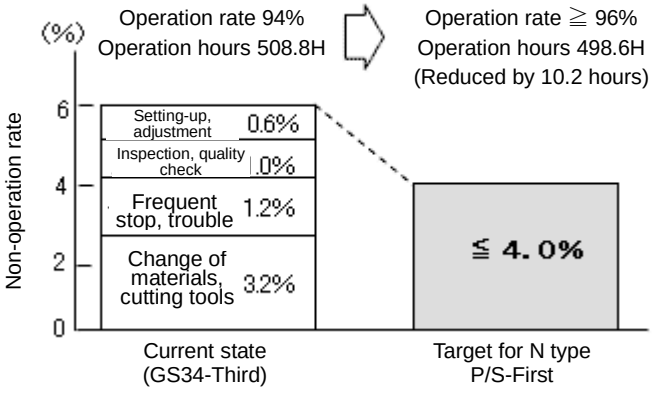


Fig. 19 Examination of Non-operative Causes

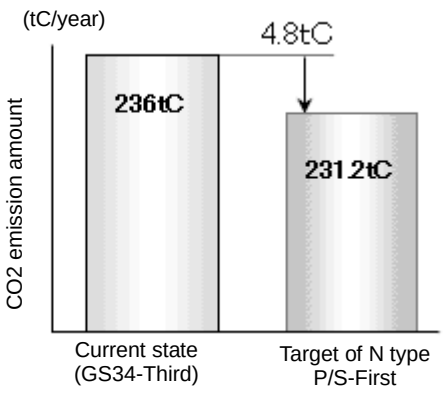


Fig. 20 Emission Amount Target

(2) Details of Activities

To improve the operation rate in which 0.1% is critical, experts specialized in each field had meetings regularly to share the information and problems and solve each non-operative cause, as shown in Fig. 21, right.

As a result, we could take measures for 24 non-operative causes including not only frequent stop and trouble of the line but also change of materials and cutting tools and quality check, setting-up and adjustment of the line, and we could reduce the non-operation rate by 2.9%, i.e. from 6.0% to 3.1%.

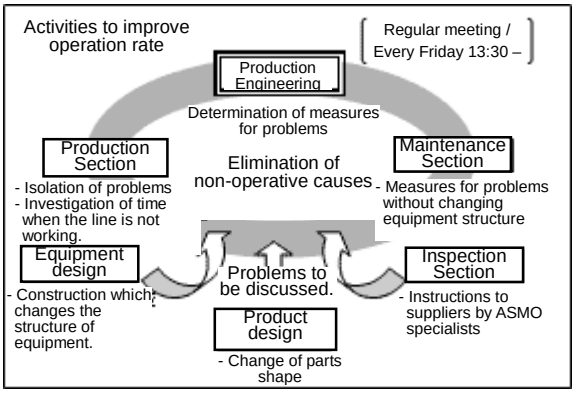


Fig. 21 Activity Structure

* A case example in which we tried not to stop the line when changing the winding wire packs is described below.

Details of measures for non-operative causes

Causes		Problems of GS	Non-operation rate	Measures	Results
Change of materials of cutting tools	1	Loss associated with the change of commutator cutting bite	0.4%	To make bite change period longer.	0.2%
	2	Loss associated with the change of winding wire packs	2.0%	Not to stop the line when changing the winding wire packs.	0 %
	3	Loss associated with the stop caused by cutting stone dress	0.2%	To make the dress interval longer when changing grinding stones.	0.1%
Frequent stop, trouble	10	Wrong assembly of stater	0.1%	To integrate the centering of armature.	0 %
Inspection, quality check	20	Loss associated with stop caused by check of grease amount to be coated.	0.1%	Automatically check using image sensors.	0 %
Setting-up, adjustment	24	Loss associated with setting-up and adjustment for sending multiple models.	0.6%	To cope with one model by making vehicle assembly section common.	0 %
			6.0%		3.1%

Table 22 Details of Measures for Non-operative Causes

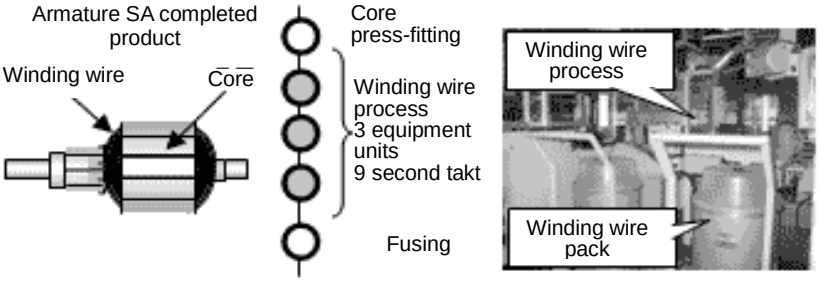
Specific Example:

Not to stop the line when changing “winding wire” packs

(1) Outline of Process

As Table 23 shows, there are 3 units of equipment for the wire winding process in the armature TR line (3 second takt), and the winding wire packs are changed 3 times a day while the line is running for 24 hours a day.

The time necessary for changing the winding wire packs is 5 minutes a time, and it amounts to 5 hours in a month during which the equipment is not working (Table 24).
So we decided to try to shorten the time for changing the winding wire packs (not to stop the line).



Operating hours	Production quantity	Pack change interval	Frequency
24 hours/day	27,000 pieces/day	Once/10,000 pieces	3 times/day (Once/unit)

Table 23 Outline of Product & Process

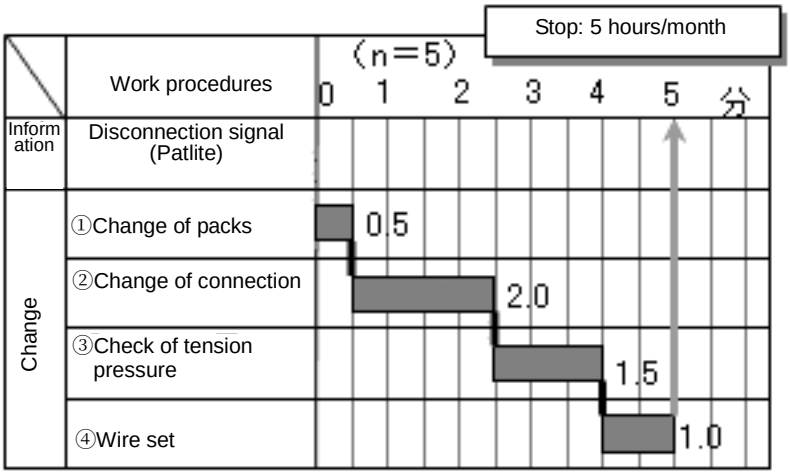


Table 24 Winding Wire Changing Procedures

(2) Details of Measures

We studied the measures with the divisions concerned and decided to adopt a terminal wire re-connection tool of press-connection system for the winding wire re-connection work (Table 25 and 26 below).
After repeatedly confirming the accuracy of connecting the terminal wire when the wire winding unit is working and verifying that there is no quality problem with the press-connection, we installed the tool and, as a result, we could make the time during which the equipment must be stopped to change the winding wire packs “0”.

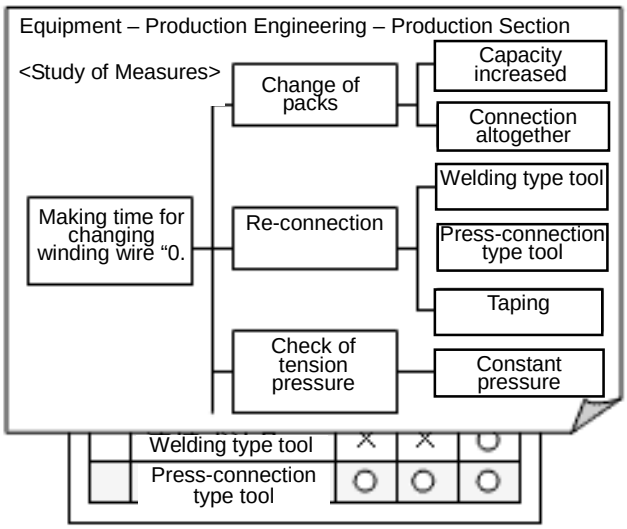


Table 25 Study of Measures

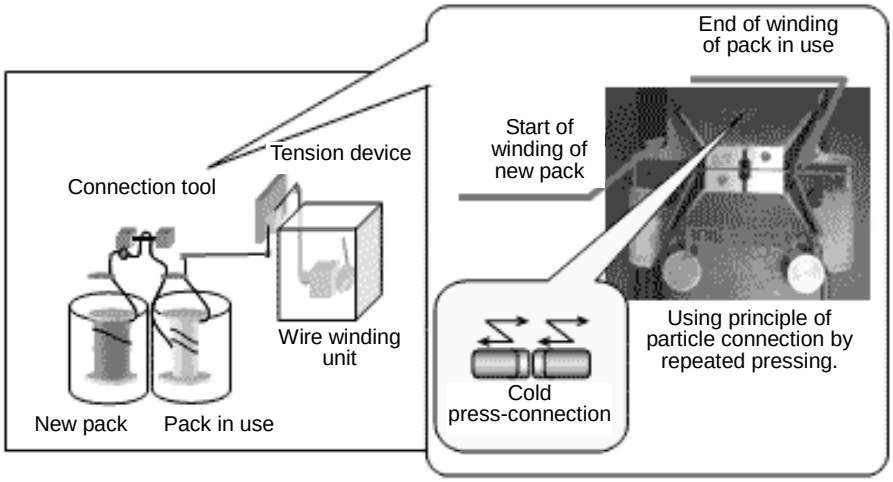
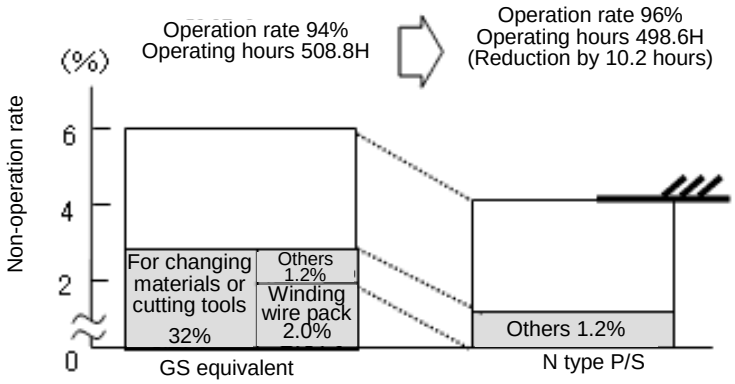


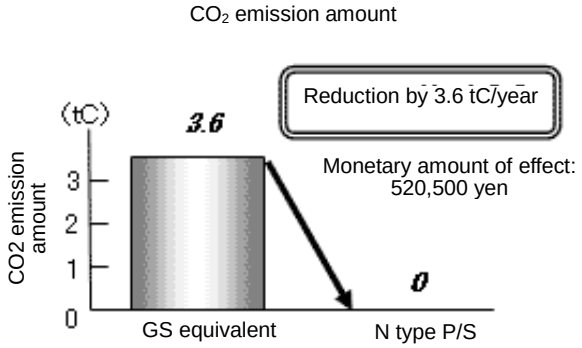
Fig. 26 Details of Measures

(3) Effects of Measures

As we made the time for changing the winding wire packs “0” by installing a connection tool, we could obtain the following effects.

- Non-operation rate : 3.2% → 1.2% Reduction by 2.0% (Operation rate 96% achieved)
- CO_2 emission amount : 3.6 tC/year → 0 tC Reduction of 3.6 tC/year (Converted to electricity: 34,615 kwh)





4. Total Effect of Activities

(1) Effect of New Making

If we compare the conventional line (GS equivalent line) which we had original made with the N type P/S line which had the measures implemented, we know we could have big effects as follows.

[1] Number of equipment : From 29 units to 25 units (reduced 4 units, reduction of 13.8%)

[2] Operation rate : From 94% to 96.9% (Improvement of 2.9%)

[3] Installation area : From 212 m2 to 198 m2 (Reduced by 14 m2, 6.6%)

Without being satisfied with these results, we will further promote the activities to make the ultimate energy conservation line.

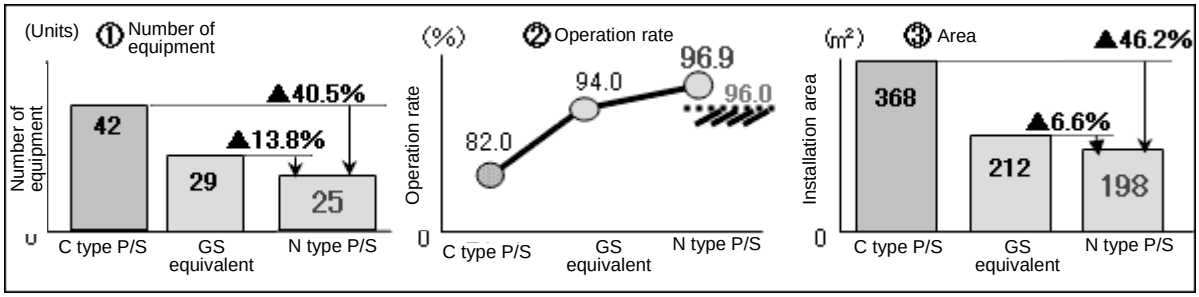


Fig. 27 Line Performance before and after Improvement

(2) Achievements of Energy Conservation

In the activities for the N type PS line of this case study, we estimated the CO_2 emission amount of the existing lines and new lines up to FY2010. Then, we included the technical themes or the themes for improving the operation rate which relevant divisions had intended to do in 2 to 3 years into the activities of this time earlier than the scheduled implementation. As a result, we could reduce the annual CO_2 emission amount to 219 tC (reduction of 7.2%) against the target 220 tC which had deducted 16 tC from the GS34 equivalent line.
Now, we are sure that we can achieve the target for the annual CO_2 emission amount of the Body Manufacturing Division for FY2010 (Fig. 28 below).

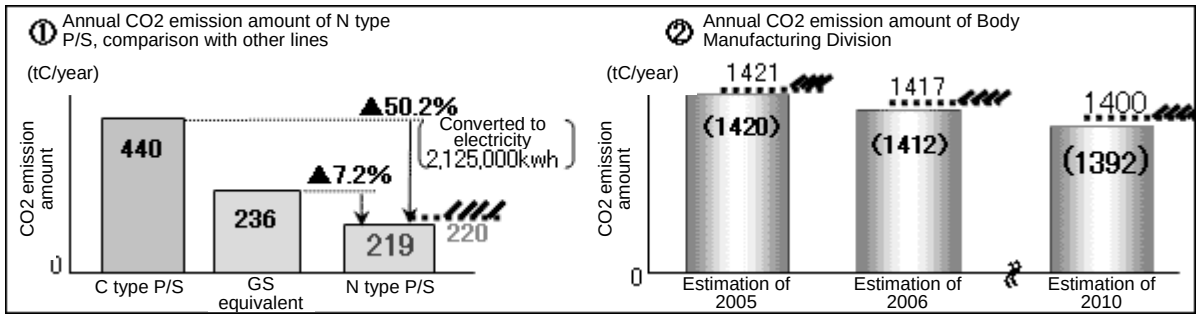
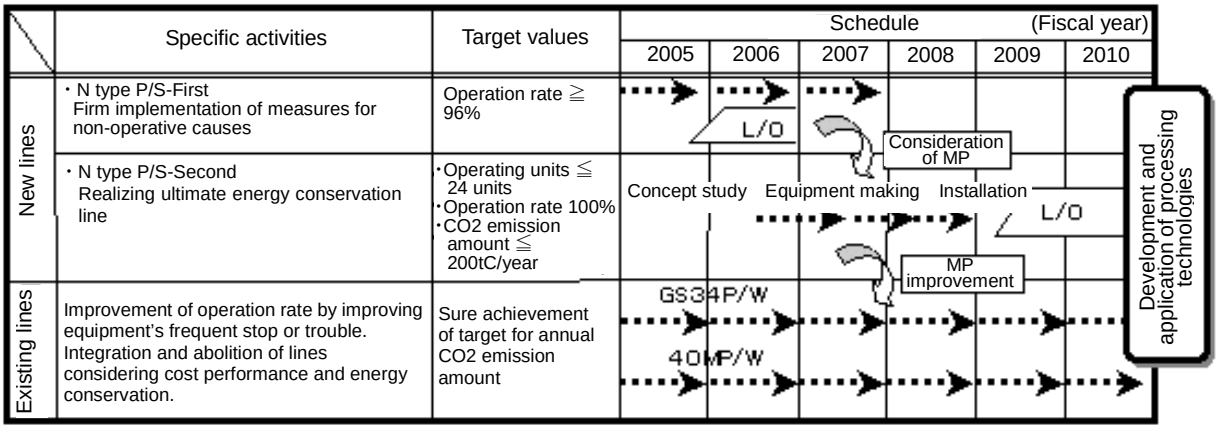


Fig. 28 Line Performance before and after Improvement

5. Summary of the Activities

We understood well how the reduction of the equipment cost, easiness of making and elimination of wasteful processes were combined to realize energy conservation. At the same time, we could realize big effects by piling up the operation rate improvement activities in which we knew the importance of improvement even if it is as small as 0.1%.

6. Future Challenges



Contributing to energy conservation by making ultimate lines