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Energy Conservation Activities of Tachibana-wan Thermal Power Station

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◎ **Keywords: Rationalization of conversion to electromotive power, heat, etc. (Electric power application equipment, electric heating equipment, etc.)**

◎ Outline of Theme

Tachibana-wan Thermal Power Station is a relatively new coal burning thermal power station which started commercial operation in June, 2000. Having consumed about 30 brands of coal so far, it has been trying to establish methods for storing and burning coal, methods for efficiently using coal cinders (expansion of the application field) and methods for operating the environmental equipment (desulphurization, cinders processing, waste water treatment, etc.).

Besides the establishment of these operational methods, the station has also implemented energy conservation activities focusing on the difference (extra capacity) between the designed capacity and the actual operation of each system. We would like to present the results we achieved so far.

◎ Implementation Period of the Said Example

April 2004 – March 2005

● Project Planning Period	April 2004 – June 2004	Total of 3 months
● Measures Implementation Period	August 2004 – February 2005	Total of 7 months
● Measures Effect Verification Period	February 2005 – March 2005	Total of 2 months

◎ Outline of the Business Establishment

- Items Produced Electricity (Number of equipment: 1, Total output: 700 MW)
  Annual electricity amount generated 5,738,595 MWh
  (Actual result of FY2004)
- No. of Employees 92
- Annual Energy Usage Amount (Actual results for fiscal year 2004)
  Coal (Converted to crude oil) 1,332,605 kL
  Light oil (Converted to crude oil) 2,262 kL
  Electricity 318,080 MWh

◎ Overview of Target Facilities

Boiler	Type: Radial Reheating, Supercritical Pressure, Variable Pressure Operation, Once-through Type Evaporation Amount: 2,250 t/h (MCR) Pressure: 25.0 MPa Temperature: 570°C/595°C Fuel: Pulverized Coal
Turbine	Type: Skewer Type, 3 Cylinder, 4 Flow Exhaust Air, Reheat, Condensation Type Output: 700,000 KW Pressure: 24.1 MPa Temperature: 566°C/593°C Control System: Electrical Hydraulic
Electricity Generator	Type: Horizontal Cylindrical, Revolving Field, Alternate Current, Synchronization Generator Capacity: 780,000 kVA Voltage: 25 kV
Exhaust Smoke Denitration Unit	Type: Dry Ammonia Contact Reduction System Performance: 80%
Precipitator	Type: Dry Electrical System Performance: 99.95%
Exhaust Smoke Desulphurization Unit	Type: Wet Limestone – Plaster System Performance: 93.8%
Exhaust Water Treatment Unit	Type: Condensed Deposition, Filtration, Absorption System Exhaust Water Amount: Maximum 1,940 m^3/day
Cinders Treatment Equipment	Transportation System: ・ Fly Ash: Vacuum and Pressure Transportation System ・ Clinker: Freshwater Slurry Circulation System

1. Reasons for Theme Selection

In this case study, we will find out extra capacity in the designed capacity or room for improvement in the actual operation. By doing so, we will further improve or optimize the operational methods and promote energy conservation activities.

2. Progress of Activities

(1) Implementation Process

Activities	Implementation Month											
	April, 2004	May	June	July	August	Septembe	October	November	December	January, 2005	February	March
(1) Theme Selection	↔											
(2) Understanding of Current		←	—	→								
(3) Target Settings		←	→									
(4) Activity Plan		←	→									
(5) Study of Measures					←	—	→					
(6) Implementation of Measures								←	—	—	→	
(7) Confirmation of Effects											←	→
(8) Policy Hereafter											←	→

(2) Target Settings

Energy conservation for electricity: 461,000 kWh/year or more

3. Details of Measures

Table 1 shows the summary of the energy conservation measures we, as identified above, implemented so far based on the operational improvement. Each measure is described in detail below.

Table 1 Energy Conservation Measures

Classification	Measures
Reduction of Electricity Used in Station	Reduction of electricity used in the station by intermittently charging the electric precipitator (EP). Reduction of electricity of auxiliary machines by doing stop operation for the agitator of the absorbing liquid blow tank. Reduction of electricity used in the station by improving the limestone receiving system.

(1) Reduction of electricity used in the station by intermittently charging the electric precipitator (EP)

(Outline of equipment)

The electric precipitator (hereinafter, EP) is installed to catch the dust (cinders) in the exhaust gas generated by the boiler and purify the exhaust gas, and this station had adopted the very cold electric type for that. The reason we adopted the very cold electric type was that we could have high dust collection performance with it by decreasing the temperature of the processing gas to around 90℃ to greatly decrease the electricity resistance rate of the dust.

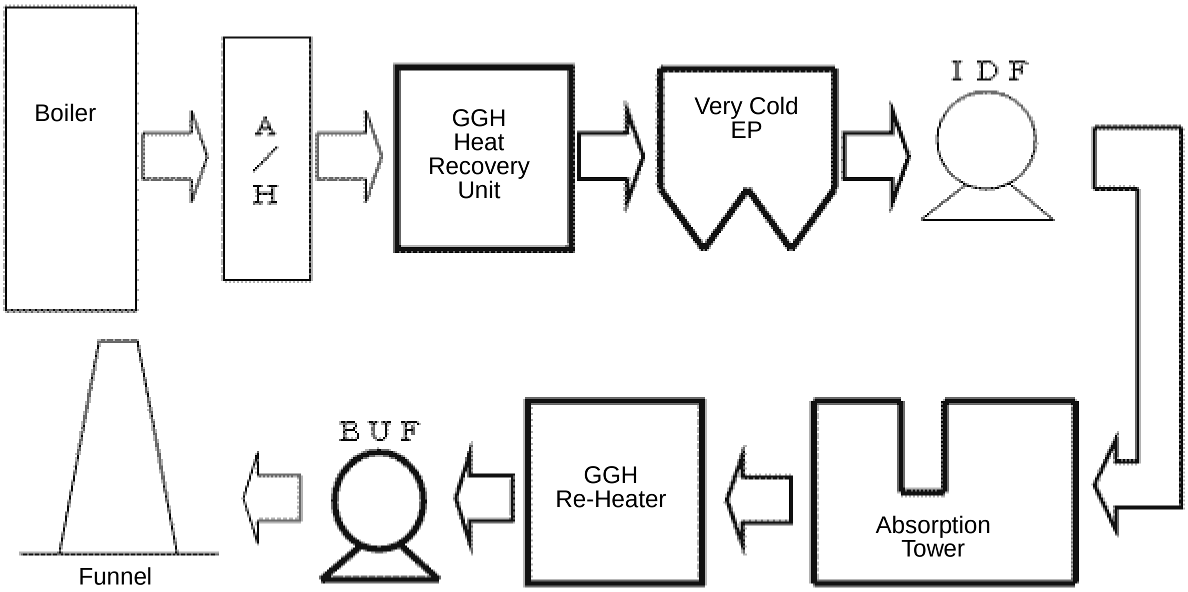

Fig. 1 Outline of Environmental Equipment System

(Detail)

The EP of this station had been operated at first by continual charging (100% full charging) to reuse the cinders 100% and maintain the quality of the plaster. Then, we conducted an intermittent charging test to know if the intermittent charging operation was possible with the current dust density and the quality of the plaster. To do the intermittent charging test, the EP charging ratio had to be chosen from 2/3・1/2・1/4・・・・1/31, so we chose 2/3 charging for this test.

(Test method)

We checked the density of the dust at the current EP's (100% charged) entrance and exit to see if the dust density, coal cinders, plaster, slurry, etc. at the exit of the EP was affected by the intermittent charging (2/3 charging).

[1] While charging continually, the dust density at all the points of the EP's entrance and exit (EP entrance A duct, B duct and EP exit) was measured and the representative point of the average dust density was determined.

[2] For the intermittent charging, the setting of the EP charging rate was gradually changed to 2/3 charging in the order of the front row and the middle row (the last row was fully charged so that the dust density did not increase).

[3] The dust density meter at the EP's exit conducted trend monitoring and status monitoring.

[4] After the dust density stabilized, the dust density was measured (at the representative point) and the operation data was collected (once/hour).

[5] After the state stabilized, the slurry, plaster, EP cinders of the absorption tower were sampled and analyzed.

Table 2 Dust Density Limitation Values and EP Setting Values

Environment Preservation Convention Value		10 mg/m^{3}N or less (At the entrance of the funnel)
Total Dust Removal Efficiency		99.95%
EP Efficiency Setting Value	EP Entrance Dust Density	20,000mg/m^{3}N
	EP Exit Dust Density	30 mg/m^{3}N or less
	EP Efficiency	99.85%

* Including the dust removal efficiency of the exhaust smoke desulphurization unit.

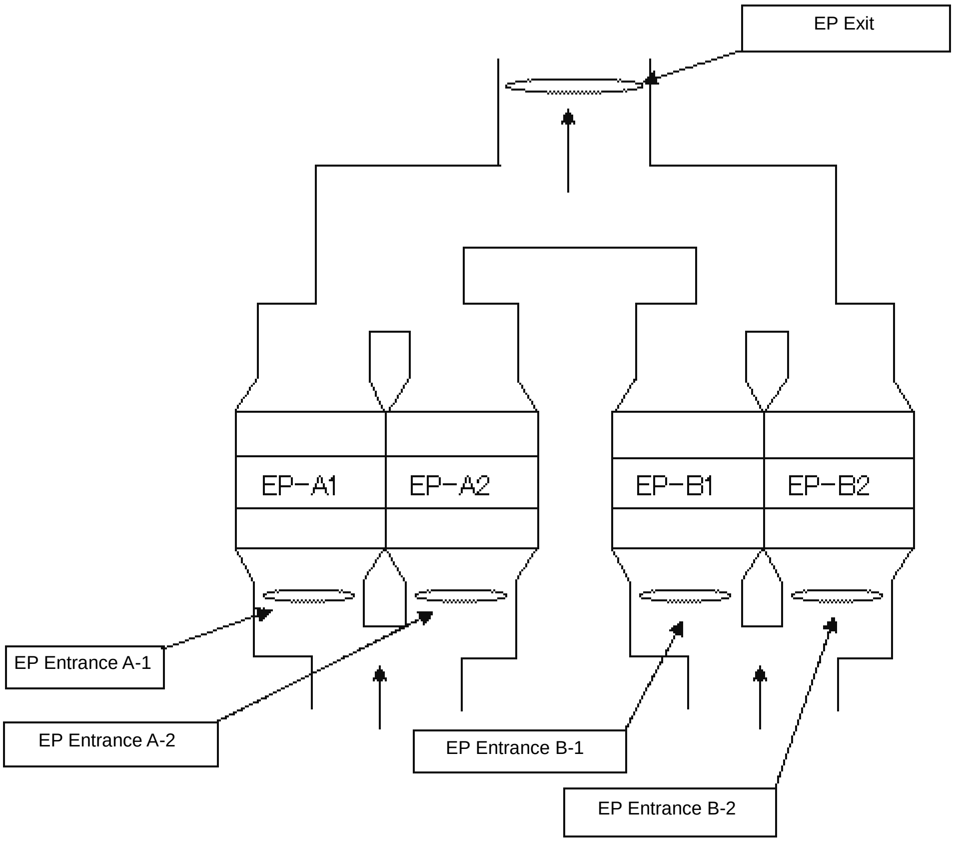

Fig. 2 EP System

(Test results)

Table-3 Dust Density and Efficiency

	Full Charge (1/1)	Intermittent Charge (Front and Middle Row 2/3 Charge)
EP Entrance Dust Density	10, 000mg/m^{3}N	5,723mg/m^{3}N
EP Exit Dust Density	2.2mg/m^{3}N	1.3mg/m^{3}N
EP Efficiency	99.98%	99.94%
Funnel Entrance Total Dust Removal Efficiency	99.99%	99.99%

[1] When intermittently charging, the dust density at the EP entrance sufficiently satisfies 30 mg/m^{3}N as EP designed value and there is no problem with the EP efficiency and the total dust removal efficiency. There is no problem with the performance.

[2] As regards the absorption tower’s slurry and plaster, there is no problem because all of the analyzed values are almost the same as the values at the time of full charging.

From the above mentioned results and because there was no problem with the plant operation even if the front and middle rows were charged by 2/3, we judged that the EP intermittent operation was possible.

(Effects)

Table 4 Electricity Consumption

	Full Charging (kWh)	Front and Middle Row 2/3 Charging (kWh)
EP－A	906	573
EP－B	901	572
Total Electricity	1,807	1,145

From the results above, the electricity consumption is calculated as follows.

- Electricity difference an hour 1,807 kW - 1,145 kW = 662 kW
- Electricity difference a year 662 kW x 24h x 322 days = 5,116,000 kWh

We confirmed that we could reduce the electricity used in the station by 5,116,000 kWh a year by implementing the EP's intermittent charging operation (only the front and middle rows are charged by 2/3).

(2) Reduction of electricity of auxiliary machine by doing stop operation for the agitator of the absorbing liquid blow tank

(Outline of equipment)

The absorbing liquid blow tank is installed to store the absorbing liquid when doing periodic maintenance or when the unit is in trouble. It is equipped with an agitator. When the unit is stopped for a long time for the periodic maintenance, etc., the slurry in the system is all collected and the agitator is operated to prevent the slurry from depositing.

Absorbing Liquid Blow Tank	Absorbing Liquid Blow Tank Agitator
Type: Cylindrical Solid Type	Type: Inclined Puddle Type
Specifications: Φ20 m x H11 m	Specifications: Φ4.96 m x 17 rpm

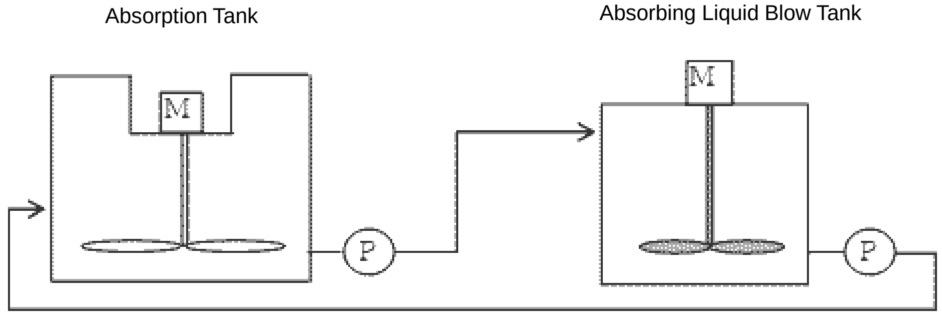

Fig. 3 Absorbing Liquid Blow Tank System

(Detail)

Currently, the absorbing liquid blow tank stores the minimum level of absorbing liquid slurry necessary for operating the agitator and the agitator is operated continually.

So, to reduce the electricity used in the station, we studied the possibility of stopping the agitator.

[1] To keep the volume of the absorbing liquid at the level (3 m) that does not swamp the agitator blade when the slurry sinks.

[2] To gradually extend the period when the agitator is stopped to make the operation once/week, once/2 weeks … once/month.

[3] To operate the agitator for 24 hours and measure the density of the slurry to confirm that the slurry is not solidified.

[4] To check the operation of the agitator and confirm that there is no problem.

Table 5 Test Results

Items		Before Test		Stop for 1 Week		Stop for 2 Weeks		Stop for 3 Weeks		Stop for 4 Weeks	
Agitator	Date and Time of Start	—	—	12/13	14:00	12/27	13:46	1/17	13:41	2/14	14:15
	Date and Time of Stop	12/6	14:55	12/14	16:30	12/28	15:57	1/18	16:39	2/15	16:10
	Electricity kW(A)	52(84)		51(82)		51(85)		52(85)		52(85)	
	Presence of Problem	No		No		No		No		No	
Slurry Density		8.0		7.0		7.4		8.1		7.7	
Result		—		Good		Good		Good		Good	

As Table 5 shows, the period when the agitator is stopped was extended from 1 week to 4 weeks but there was no trouble with the operation and the test result was good.

Based on this test result, we will use the agitator of the absorbing liquid blow tank by doing stop operation and test it to see how it starts at the monthly inspection (once/month). By doing this, we realize energy conservation and keep the agitator in good condition.

(Effects)

The electricity consumption in a year was as follows.

- Currently (Continual operation) 52 kW x 24h x 365 days = 455,520 kWh/year
- Stop operation 52 kW x 24h x (12 days/year + 30 days/year) = 52,416 kWh/year

We confirmed that the electricity used in the station could be reduced by 403,100 kWh in a year by changing the operation of the absorption tower blow tank's agitator from continual operation to stop operation.

(3) Reduction of electricity used in the station by improving the limestone receiving system

(Outline of equipment)

The limestone storage equipment which stores the limestone as raw material of the desulphurization unit also has functions to receives and supply the limestone. It consists of two systems, the one is the system which transports the limestone to the silo and stores it there, where the original limestone is brought in by limestone vessels or powder carrying vehicles. The other is the system that transports the limestone to the limestone supply tank.

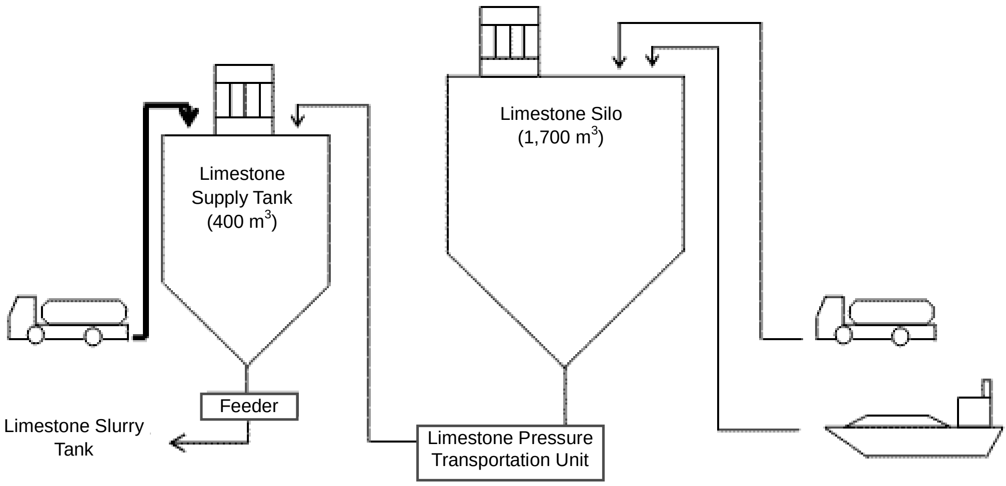

Fig. 4 System of Limestone Storage

(Detail)

To send the limestone from the silo to the supply tank, the limestone pressure transportation unit is started and stopped by the level signals of the supply tank.

So we conducted a test to see if the energy of the limestone pressure transportation unit could be reduced by receiving the limestone brought in by powder carrying vehicles directly into the supply tank.

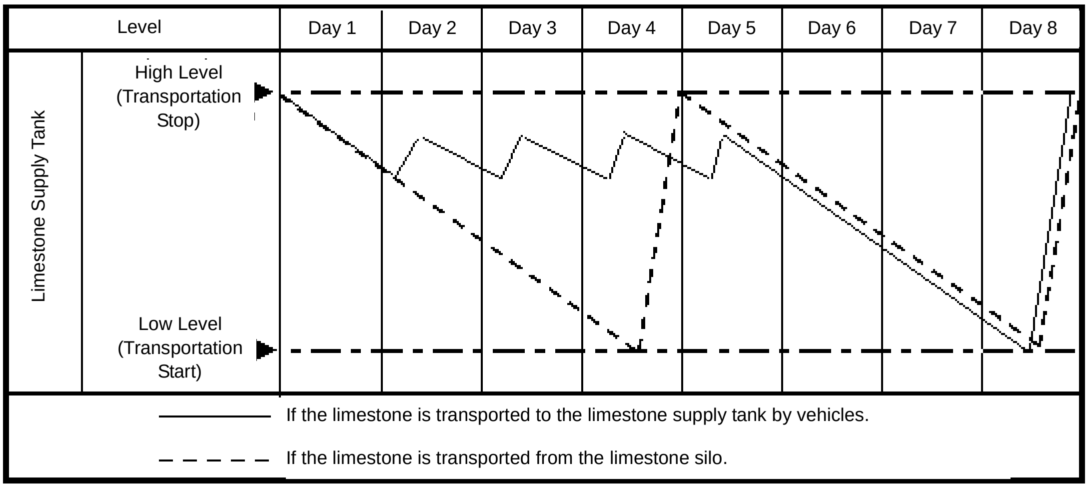

Fig. 5 Test Results

As Fig. 5 shows, the electricity for transporting the limestone from the silo directly to the supply tank could be reduced by having the limestone supply tank directly receive the limestone from the powder carrying vehicles.

Based on this result, we will further try to reduce the electricity used in the station by carefully planning the schedule of the powder carrying vehicles and operation of the supply tank.

(Effects)

The electricity consumption and the amount of the limestone received in FY2003 were as follows.

- Energy of the limestone pressure transportation unit 50 kW/10t
- Volume received from powder carrying vehicles in FY2003 6,180 t/year
- We do not receive the limestone on Saturdays and Sundays 5 days/7 days

It was confirmed that the electricity could be reduced by 22,070 kWh a year by changing the unit for receiving the limestone from the silo to the supply tank.

4. Effects Achieved after Implementing Measures

As Table 6 shows, it was confirmed that, by continually implementing the following 3 energy conservation measures, the electricity used in the station could be reduced by 5,541,170 kWh a year.

Table 6 Effects of Energy Conservation Activities

Theme	Main Measures	Energy Conservation Effects	Total
Reduction of Electricity Used in Station	・Reduction of electricity by intermittently charging the EP.	5,116,000 kWh/year	5,541,170 kWh/year
	・Reduction of electricity of auxiliary machines by doing stop operation of the absorbing liquid blow tank's agitator.	403,100 kWh/year	
	・Reduction of electricity by improving the method for receiving the limestone.	22,070 kWh/year	

5. Summary

It was a great achievement for us that we could have the energy conservation effects by doing operational improvement instead of equipment improvement. Hereinafter, we continue to do the operational improvement and energy conservation with the spirit of a challenger who does not take anything for granted and pays attention to any small things without thinking that the current operation is the best.

6. Future Plans

We are going to study and evaluate the possibilities of energy conservation of the following measures.

Table 7 Main Energy Conservation Measures Now Being Studied

Theme	Main Measures
Reduction of Electricity Used in Station	・Reduction of electricity by intermittent charging (1/2) of EP. ・Reduction of electricity of auxiliary machines by optimizing the number of circulation pumps of the desulphurization unit. ・Reduction of electricity by improving the EP's cinders transportation cycle. ・Reduction of electricity by improving the clinker processing cycle.