

# INDIA

## Technologies Customized List

&

Technologies One by One Sheets

**2025 version Part 1: BF-BOF (v.5.2)**

*Recommended technologies for  
energy-saving, environmental  
protection and recycling in  
Indian iron and steel industry*



*Supported by  
The Japan Iron and Steel Federation*



# Introduction

## Overview

“Technologies Customized List” is a technology reference containing energy-saving, environmental-protection and recycling technologies, developed under a collaborative scheme of “The Public and Private Collaborative Meeting between Indian and Japanese Iron and Steel Industry”. The list is aimed at identifying appropriate technologies for the Indian steel industry in order to encourage energy saving and sustainable development of Indian steel industry.

The list reflects the knowledge acquired from public and private experiences of the Japanese steel industry, which achieves the highest energy efficiency in the world, and the technology needs of Indian steel industry. In this context, contents of the list are informative for public sectors for development of policies and measures, as well as for private sectors for the plan of the technology introduction and improvement of energy management activities in steel plants.

After the publication of the Technologies Customized List version 1 (2013), version 2 (2014), version 3 (2017), and version 4 (2019), the list was employed on many occasions such as Steel Plant Diagnosis and Public and Private Collaborative Meetings and Workshops. Based on the discussion at the 8<sup>th</sup> PPC meeting on the growing importance of small and medium size steel plants, it was proposed to update Technologies Customized List to include technologies for EAF plants. Thus, Technologies Customized List version 4 (2019) was compiled as two-part series: Part-1 for BF-BOF plants, and Part-2 for EAF plants.

The 2025 version of the Technologies Customized List is developed as part of ERIA (Economic Research Institute for ASEAN and East Asia)’s project, “Research on the Future Outlook for the Decarbonisation of the Steel Industry in Asia (Phase 1)” and incorporates the latest supplier information and factor changes such as energy costs and plant costs.

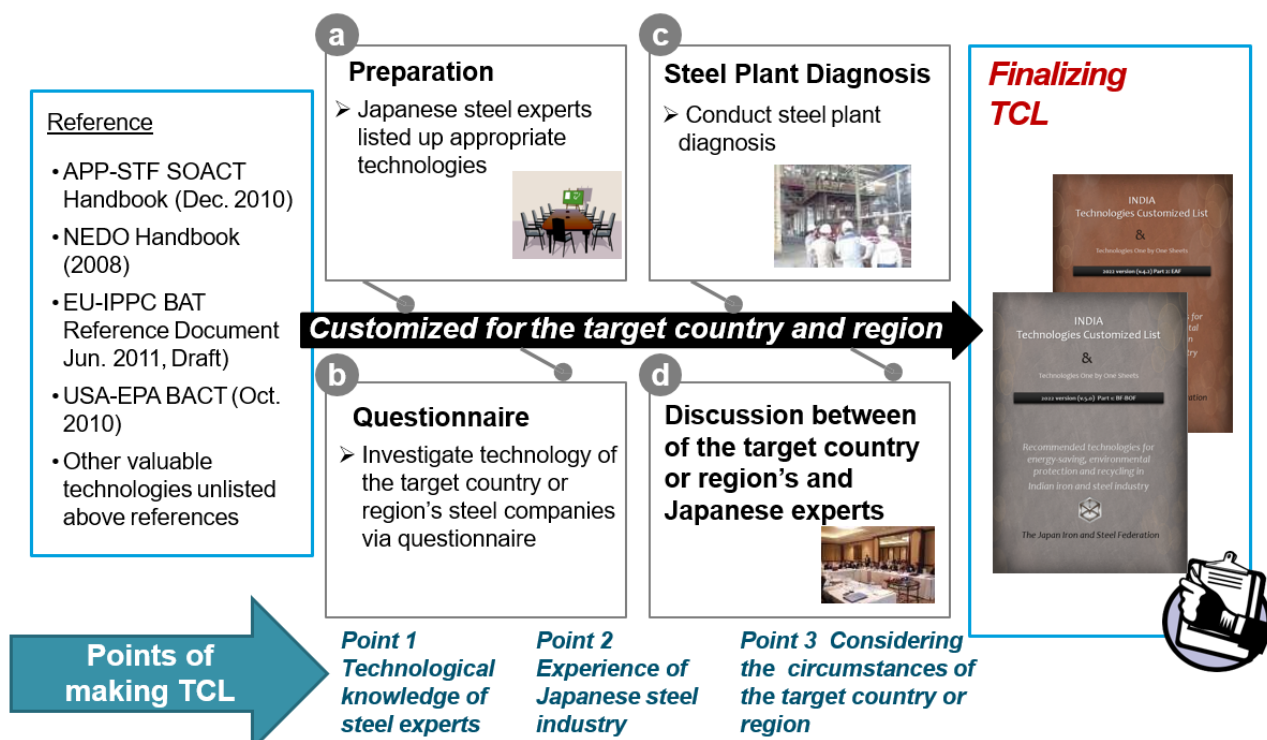


## Development process of Technologies Customized List

Technologies on the Technologies Customized List are considered to contribute to energy saving and environmental protection in Indian steel industry. They were chosen from several technology references\*1 in the world, based on the following criteria.

1. **Coverage:** Technologies Customized List contains the technologies for energy saving, environmental protection and recycling in the steel plants in India. Technologies for other purposes, such as quality improvement and production increase, are not covered in Technologies Customized List.
2. **Availability:** Target technologies should be commercially available. Technologies under development in Japan, which the supplier companies are not ready to diffuse in India, are not eligible for Technologies Customized List.
3. **Experience:** Steel experts in Japan have technological knowledge and experiences.

## Development of Technologies Customized List



Technologies Customized List 2025 version  
September, 2025

### \*1 Reference List

- The State-of-the-Art Clean Technologies (SOACT) for Steelmaking Handbook
- NEDO Handbook
- EU-IPCC BAT
- USA-EPA-BACT

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# **1. Energy-Saving Technologies**

## **1-1. Technologies Customized List**

## Used Values and applied preconditions

	Items	unit	Value	Reference
<b>1. Electricity (Power) Conversion Factor</b>	<b>Electricity</b>	GJ/MWh (kcal/kWh)	<b>11.4 (2,717)</b>	PAT_Rules_English.pdf(2012/3), p37
<b>2. Fuel Calorific Value</b>	<b>Oil (Crude Oil)</b>	kcal/kg	<b>10,000</b>	Ministry of Power Notification S.O.394(E), 12th March, 2007
	<b>Coal</b>	kcal/kg	<b>6917 *</b>	referred to Answer Sheet from India
<b>3. Energy Cost</b>	<b>Electricity</b>	unit/kWh	<b>4.48Rs **</b>	Annual Report 2011-2012 on the working of State Power Utilities & Electricity Departments, Planning Commission, Government of INDIA October, 2011, p150
	<b>C Heavy Oil</b>	unit/Mcal	<b>2.04Rs</b>	Energy Prices and Taxes/IEA Statistics/2012
	<b>Coal</b>	unit/Mcal	<b>1.4Rs *</b>	referred to Answer Sheet from India
<b>4. CO2 Emission Factor</b>	<b>Electricity</b>	t-CO2/MWh	<b>0.905</b>	average of combined margin from CDM projects, IGES website (2024.2.29)
	<b>Coke Oven Gas</b>	t-CO2/GJ	<b>0.044</b>	referred to Answer Sheet from India
	<b>Coke</b>	t-CO2/t-coke	<b>3.257</b>	
	<b>Coal</b>	t-CO2/GJ	<b>0.095</b>	
	<b>Steam</b>	t-CO2/t-steam	<b>0.195</b>	
	<b>Natural Gas</b>	kg-CO2/GJ	<b>56.1</b>	worldsteel CO2 data collection userguide version 11
	<b>Unspecified Fuel</b>	t-CO2/GJ	<b>0.095</b>	referred to Answer Sheet from India
<b>5. Currency Exchange Rate</b>		Rs/¥	<b>0.59</b>	at the exchange rate in 20th Jan., 2013
		Rs/\$	<b>53.7</b>	
		Rs/Won	<b>0.05</b>	

## Technologies Customized List of Energy Saving Technologies for Indian Steel Industry 2025 version part-1: BF-BOF (v.5.2)

No.	Title of Technology	Technical Description	Expected Effects of Introduction						Diffusion Rate of Technology in 7 Major Steel Companies, % [*1]
			Electricity Savings	Fuel Savings	CO2 Reduction	Emission factor of fuel	Estimation Details	Co- benefits	
			kWh/t of product	GJ/t of product	kg- CO2/t of product				
<b>Sintering (product: sinter)</b>									
A-1	Sinter Plant Heat Recovery (Steam Recovery from Sinter Cooler Waste Heat)	The device recovers the sensible heat in the hot air with temperature of 250C to 450C from a sinter cooler.	-	0.25	23.85	steam coal	-	SOx, NOx, Dust	23
A-2	Sinter Plant Heat Recovery (Power Generation from Sinter Cooler Waste Heat)	This is a waste gas sensible heat recovery system from sinter cooler to generate electric energy.	22.1	-	20.00	-	-	-	8
A-3	High Efficient (COG) Burner in Ignition Furnace for Sinter Plant	The multi-slit burner can form a successive and uniform flame in the ignition furnace using coke oven gas.	-	0.01	0.44	Coke Oven Gas	-	-	53
<b>Cokemaking (product: coke)</b>									
A-4	Coke Dry Quenching (CDQ)	The heat recovered by inert gas from the hot coke is used to produce steam, which may be used on-site or to generate electricity.	-	1.90	97.47	steam	assuming steam substitution	-	22
			150	-	135.75	-	assuming electricity substitution		
A-5	Coal Moisture Control (CMC)	Coal moisture control uses the waste heat from the coke oven gas to dry the coal used for coke making. Coal moisture is changed from 8-9% to 3-5%, which reduces fuel consumption in the coke oven.	-	0.29	27.55	steam coal	-	-	2
<b>Ironmaking (product: pig iron)</b>									
A-6	Top Pressure Recovery Turbine (TRT)	This system generates electric power by employing blast furnace top gas to drive a turbine generator. Blast furnace gas passed through TRT is used as a fuel in iron and steel making processes.	50	-	45.25	-	-	-	42
A-8	Pulverized Coal Injection (PCI) System	This technology is for injecting pulverized coal directly through the blast furnace tuyeres as a partial substitute for the coke used in the blast furnace.	-	1.55	147.25	steam coal	assuming 125kg coal injection	-	91
A-9	Hot Stove Waste Gas Heat Recovery	This device recovers the sensible heat of the flue gas generated in heating the hot stoves which supply hot blast to the blast furnace and uses this heat to preheat combustion air and/or combustion gas for the hot stoves.	-	-	-	-	-	-	46
A-10	Top Fired Hot Stove	- This hot stove is equipped with a ceramic burner installed at the top of the Hot Stove. The Top Fired Hot Stove has a in comparison to an External Combustion Chamber Stove with the same performance a much lower footprint.	-	-	-	-	-	-	-

No.	Title of Technology	Technical Description	Expected Effects of Introduction						Diffusion Rate of Technology in 7 Major Steel Companies, % [*1]
			Electricity Savings	Fuel Savings	CO2 Reduction	Emission factor of fuel	Estimation Details	Co- benefits	
			kWh/t of product	GJ/t of product	kg- CO2/t of product				
<b>Steelmaking (product: steel)</b>									
A-11	Converter Gas Recovery Device	This device recovers and uses the high temperature waste gas generated during blowing in the converter (basic oxygen furnace).	-	0.84	79.80	steam coal	-	-	88 [*2]
A-12	Low NOx regenerative burner system for ladle preheating	- Regenerating burner use - High Energy Saving (about 40 %) - Automatic control - FDI Combustion	-	0.20	12.62	Liquid Petroleum Gas	-	Contribute to better atmosphere around at workfloor	-
A-13	Converter Gas Sensible Heat Recovery Device	This device recovers and uses the high temperature waste gas generated during blowing in the converter (basic oxygen furnace). This device burns the converter waste gas to transform latent heat to sensible heat and recovers the sensible heat.	-	0.13	11.97	steam coal	-	-	0
<b>Processing (product: steel products)</b>									
A-15	Process control for reheating furnace	- Setting furnace temperature by targeted billet temperature curve - Precise air ratio control and O2 analysis in exhaust gas	-	0.05	3.16	Liquid Petroleum Gas	-	-	-
A-16	Regenerative Burner Total System for reheating furnace	While one of the burners is burning, the other burner will work as an exhaust outlet. The combustion air will be preheated to a superhigh temperature.	-	0.19	10.66	natural gas	Fuel saving and CO2 reduction are average values	NOx	31
A-17	High temperature recuperator for reheating furnace	- Heat transfer area is expanded - Special material tube is used instead of stainless	-	0.10	6.31	Liquid Petroleum Gas	-	-	-
A-18	Fiber block for insulation of reheating furnace	- Low thermal conductivity - High temperature change response (low thermal-inertia)	-	0.04	2.46	Liquid Petroleum Gas	-	-	-
A-19	Induction type billet heater for direct rolling	Compensate temperature drop of billets transferred from CC to rolling mill (from 950 degC to 1050 degC). Advantages : - Automatic control - Less exhaust gas (without reheating furnace)	-40	1.45	55.30	Liquid Petroleum Gas	-	-	-
A-20	Oxygen enrichment for combustion air	Silicon-carbide parts are inserted into the radiant tube to promote heat transfer from hot gas to the tube, which improve thermal efficiency of the furnace. Production of the target plant is assumed as 594,000 ton/y (CGL) with natural gas use.	-23.6	0.26	-4.95	Liquid Petroleum Gas	-	-	-
A-21	Highly efficient combustion system for radiant tube burner	Silicon-carbide parts are inserted into the radiant tube to promote heat transfer from hot gas to the tube, which improve thermal efficiency of the furnace. Production of the target plant is assumed as 594,000 ton/y (CGL) with natural gas use.	-	0.09	5.03	natural gas	-	-	-

No.	Title of Technology	Technical Description	Expected Effects of Introduction						Diffusion Rate of Technology in 7 Major Steel Companies, % [*1]
			Electricity Savings	Fuel Savings	CO2 Reduction	Emission factor of fuel	Estimation Details	Co- benefits	
			kWh/t of product	GJ/t of product	kg- CO2/t of product				
<b>General Energy Saving &amp; Environmental Measures</b>									
A-22	Inverter (VVVF; Variable Voltage Valuable Frequency) Drive for Motors	An inverter is a variable speed device controlling frequency and voltage to allow precise control of rotation of a motor.	13%	-	-	-	-	-	-
A-23	Energy Monitoring and Management Systems	This measure includes site energy management systems for optimal energy recovery and distribution between various processes and plants	-	0.12	11.40	steam coal	-	-	89
A-24	Cogeneration (include Gas Turbine Combined Cycle (GTCC))	This equipment is a high efficiency combined generator set using the by-product gas produced during iron and steel making process.	1.1 GJ/t	-	135.91	-	-	-	-
A-25	Management of Compressed Air Delivery Pressure Optimization	Energy saving in compressors requires consideration of the points like (1) selection of the appropriate capacity, (2) reduction in delivery pressure.	285 MWh/y	-	-	-	-	-	No data
A-26	Power Recovery by Installation of Steam Turbine in Steam Pressure Reducing Line	This technology reduces refrigerator power consumption by installing a steam turning in place of the steam pressure reducing valve and driving the refrigerator with the power recovered by the steam turbine.	4,308 MWh/y	-	-	-	-	-	No data

\*1) Diffusion rate is calculated from the answer for questionnaire of 7 major steel companies in 2016.

\*2) Diffusion rate of OG boiler is Zero.

# **1. Energy-Saving Technologies**

**1-2. Technologies One by One Sheet**

# A-1

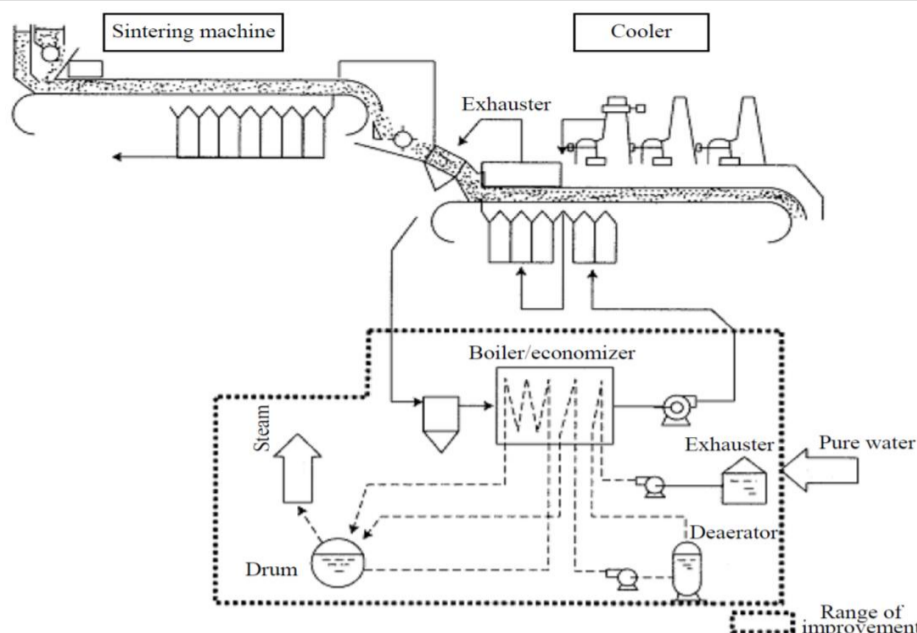
## Sintering

### Sinter Plant Heat Recovery (Steam Recovery from Sinter Cooler Waste Heat)

Item

Content

#### 1. Process Flow



Steam recovery system

#### 2. Technology Definition/Specification

This device recovers the sensible heat in the hot air with temperature of 250 C to 450 C from a sinter cooler. It comprises mainly;

- boiler/economizer,
- pure water feed device,
- deaerator
- steam drum, etc.

After heat exchange with sintered ores of 500 C to 700 C in the cooler, the exhaust gas is introduced to the boiler/economizer to generate steam and is recycled to the cooler. Unit recovery of waste heat is on the order of 60,000 kcal/t-sinter

The sensitive heat can be recovered by one or more of the following ways:

- steam generation in a waste heat boiler
- hot water generation for local heating
- preheating combustion air in the ignition furnace
- power generation

#### 3. Investment Cost & Operating Life

Equipment cost : approx. ¥3,000 million (annual sinter production : 1 mil. ton/y) **【177 Crore】**  
Construction cost: approx. ¥500 million **【30 Crore】**

#### 4. Effect of Technology Introduction

•Reduction of CO2 Emission  
•Fuel Savings

23.85kg-CO2/t-sinter  
0.251GJ/t-sinter [NEDO] : 60,000 kcal/t-sinter/ 1,000,000 \* 4.186

#### 5. Direct Effect (Annual Operating Cost)

•Economic Effect (payback time)

payback time [NEDO]  
: Equipment only : approx. 22.1 years **【11.6 years】**  
: Including construction cost : approx. 25.8 years **【13.5 years】**  
Annual steam recovery : 60,000 \* 10<sup>6</sup> kcal/y  
Reduction in crude oil equivalent : 7,500 t-crude oil/y  
Economic effect : ¥135.8 mil./y (=60,000 \* (1.81/0.8) / 1,000) **【153 Crore】**

•Productivity Improvement

Not announced

•Maintenance Cost Reduction

Not announced

#### 6. Indirect Effect (Co-benefits)

•Product Quality Improvement  
•SOx, Dust Decrease

Not announced

Not announced

#### 7. Diffusion Rate of Technology in Japan

widely spread and mostly applied

#### 8. Japanese Main Supplier

JP Steel Plantech Co.

#### 9. Technologies Reference:

Nippon Kokan Technical Report, 1980, No.84, 25

#### 10. Preconditions

\* Important values were revised with referring to various values in "1-4. Used values and applied preconditions." Especially as for investment cost and payback time for the case of India, revised values were indicated in **【】**.  
\* Payback time was defined as (Investment cost / Economical merit) in this project.  
\* annual sinter production : 1 mil. ton/y  
\* CO2 emission factor of coal : 0.095  
\* unit cost of C heavy oil : ¥1.81/ 1,000 kcal [NEDO]  
overall boiler efficiency : 0.8  
Economic effect : 60,000 \* 1.81 /0.80 = ¥136 mil./y

# A-2

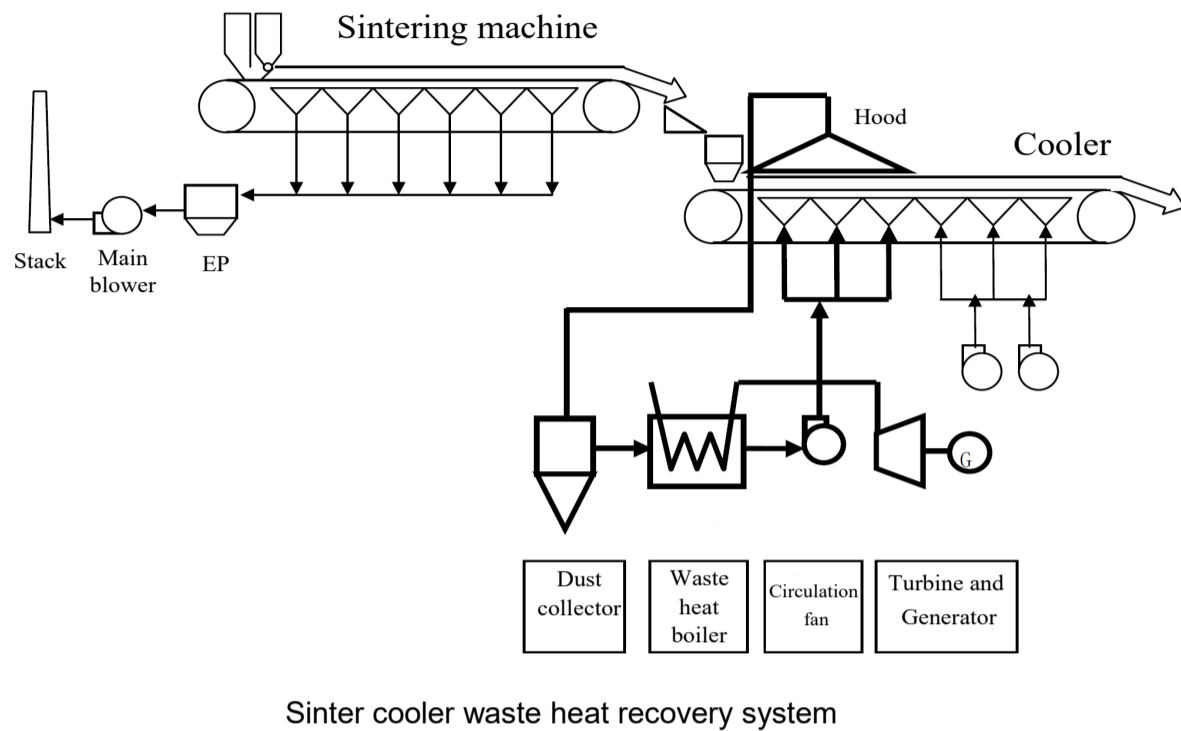
## Sintering

### Sinter Plant Heat Recovery (Power Generation from Sinter Cooler Waste Heat)

Item

Content

#### 1. Process Flow



#### 2. Technology Definition/Specification

This is a waste gas sensible heat recovery system from sinter cooler to generate electric energy. The system is composed of dust collector, waste heat recovery boiler as steam, circulation fan and power generator by steam turbine. The figures listed below are obtained from a system configuration of two identical sintering machines, coolers each equipped with waste heat recovery boiler and one unit of electric power generator, to which the steam from two boilers is led.

#### 3. Investment Cost & Operating Life

approx. ¥5 billion at 5.9Mt/y 【295 Crore】

#### 4. Effect of Technology Introduction

- Reduction of CO2 Emission
- Fuel Savings
- Electricity Savings

20.00 kg-CO2/t-sinter  
 0.253GJ/t-sinter  
 = 17,400kWh/h \* 2,717kcal/kWh /1,000,000 /(393 t-Sr/h \* 2) \* 4.186 GJ/Gcal  
 22.1 kWh/t-sinter  
 = 17,400 kWh/(393t-Sr/h \* 2)

#### 5. Direct Effect ( Annual Operating Cost )

- Economic Effect (payback time)
- Productivity Improvement
- Maintenance Cost Reduction

2.9 years 【5.5 years】  
 (Reduction in crude oil equivalent : 32,500 Toe/y = 17,400 kWh/h \* 24h/D \* 365 D/Y \* 0.85 \* 0.95 \* 2,646 kcal/kWh /10,000 kcal)  
 Not announced  
 Not announced

#### 6. Indirect Effect (Co-benefits)

- Product Quality Improvement
- SOx, Dust Decrease

Not announced  
 Not announced

#### 7. Diffusion Rate of Technology in Japan

well known and familiarized

#### 8. Japanese Main Supplier

JP Steel Plantech Co.

#### 9. Technologies Reference:

2006 NEDO project report, No.06002211-0

#### 10. Preconditions

\* Important values were revised with referring to various values in "1-4. Used values and applied preconditions." Especially as for investment cost and payback time for the case of India, revised values were indicated in 【】.  
 \* Payback time is defined as (Investment cost / Economical merit) in this project.

- Sinter operation conditions
  - production 393 t/h × 2 units
  - sinter qty in cooler 540 t/h × 2 units
  - sinter surface temperature at cooler exit < 125 C
  - sinter layer height in cooler 1,000 mm
  - circulating waste gas volume 650,000 Mm3/h × 2 units
- Electricity recovered 17,400 kWh / 2 units or 129,560,400 kWh/y (equivalent to 310 days)
- Reduction in crude oil equivalent 32,500 Toe/y
- Electricity savings ¥1.7 billion/y (Electricity price : 14 ¥/kWh = 0.123 US\$/kWh \* 113 ¥/US\$)
- Payback time 2.9 years (Investment cost /(Ele. savings running cost))

# A-3

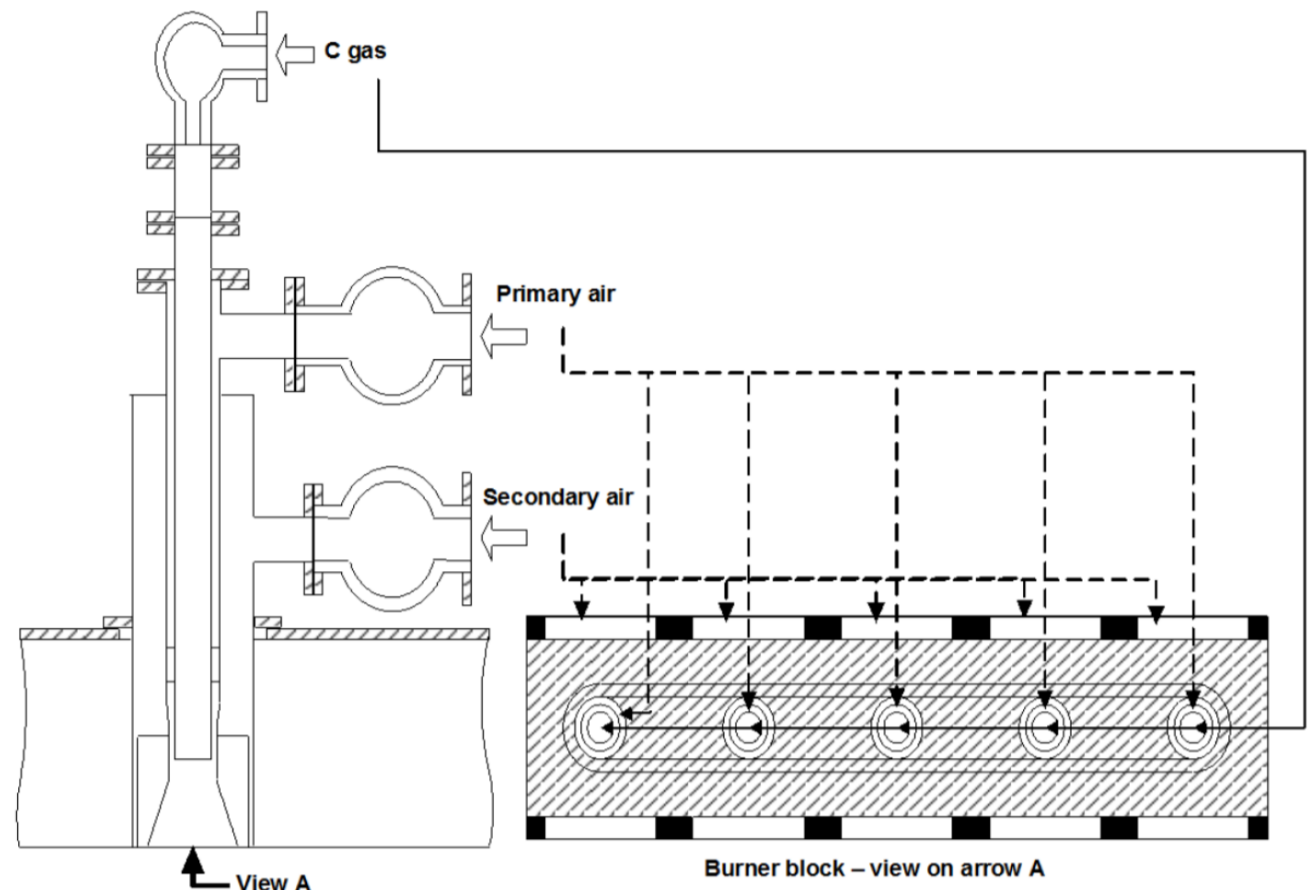
## Sintering

### High Efficient (COG) Burner in Ignition Furnace for Sinter Plant

Item

Content

#### 1. Process Flow



Outline of multi-slit burner

#### 2. Technology Definition/Specification

The multi-slit burner is designed to form a successive and uniform frame along a pallet width direction in the ignition furnace. It consists of fuel exhaust nozzles and a slit-like burner tile containing these nozzles.

The fuel, coke oven gas, supplied from the fuel exhaust nozzles reacts with the primary air inside the burner tile, then with the secondary air supplied to the periphery area of the frame.

By lining up the burner block, the frame can cover the whole surface of the bed along the width direction.

By controlling the primary/secondary air ratio, the length of the frame can be controlled to minimize the energy consumption for ignition.

#### 3. Investment Cost & Operating Life

No data

#### 4. Effect of Technology Introduction

•Reduction of CO2 Emission

0.44kg-CO2/t-sinter

•Fuel Savings

0.010GJ/t-sinter : 2.5Mcal/t-sinter/1,000 \* 4.186 [NEDO]  
30% decrease in heat input for ignition [SOACT]

#### 5. Direct Effect (Annual Operating Cost)

•Economic Effect (payback time)

Not announced

•Productivity Improvement

Not announced

•Maintenance Cost Reduction

Not announced

#### 6. Indirect Effect (Co-benefits)

•Product Quality Improvement

Not announced

•SOx, Dust Decrease

Not announced

#### 7. Diffusion Rate of Technology in Japan

well known and familiarized

#### 8. Japanese Main Supplier

JP Steel Plantech Co.

#### 9. Technologies Reference:

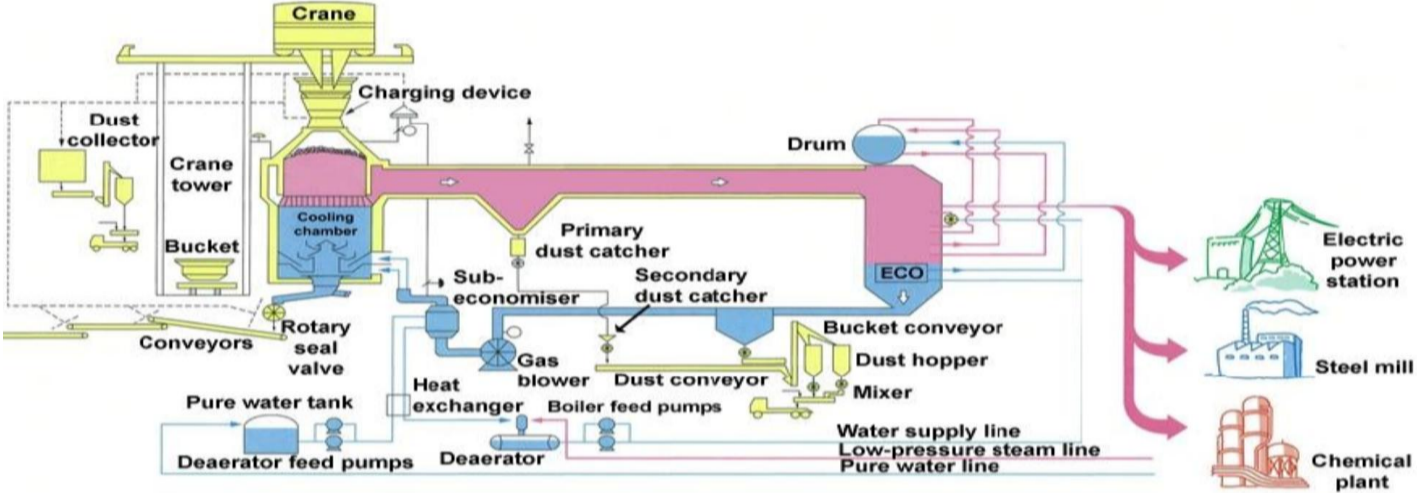
Refer to <http://asiapacificpartnership.org/japanese/soact2nd.aspx> and "Japanese Technologies for Energy Savings/ GHG Emissions Reduction 《2008 Revised Edition》 (NEDO, 2008)"

#### 10. Preconditions

\* Payback time is defined as (Investment cost / Economical merit) in this project.

# A-4

## Cokemaking Coke Dry Quenching

Item	Content
1. Process Flow	
2. Technology Definition/Specification	<p>The heat recovered by inert gas is used to produce steam, which may be used on-site or to generate electricity. Hot coke from the coke oven is cooled in specially designed refractory lined steel cooling chambers by counter-currently circulating an inert gas media in a closed circuit consisting of</p> <ol style="list-style-type: none"> <li>1) cooling chamber</li> <li>2) dust collecting bunker</li> <li>3) waste heat boiler</li> <li>4) dust cyclones</li> <li>5) mill fan</li> <li>6) blowing device (to introduce the cold air from the bottom)</li> <li>7) circulating ducts</li> <li>8) Capacity ;The nominal capacity of a typical CDQ plant is less than 100 t/h/chamber.(EU-BAT)[*1] 260t/h(China/ Shougang Jingtang/NSC-ENG) [*3]</li> </ol>
3. Investment Cost & Operating Life	<p>New plant costs are estimated to be \$50/t coke, based on the construction costs of a recently built plant in Germany.[SOACT]          Equipment cost: ¥3,000 million (approx.) [177 Crore]; construction cost: ¥500 million (approx.) [30 Crore] [NEDO]          Operating Life : increased life by regular maintenance</p>
4. Effect of Technology Introduction	<ul style="list-style-type: none"> <li>• Reduction of CO2 Emission: 97.47 kg-CO2/t-coke (assuming fuel substitution) 135.75 kg-CO2/t-coke (assuming electricity substitution)</li> <li>• Fuel Savings: 1.9 GJ/t-coke : heat usage (500 kg-steam/t-coke) = 0.5 t-steam/t-coke * 3.8 GJ/t-steam (Energy conversion factor of water vapor : 3.8 GJ/t-steam)</li> <li>• Electricity Savings: 150kWh/t-coke : electric usage(300KWh/t-steam)( 500kg-steam/t-coke)[NEDO]</li> </ul>
5. Direct Effect ( Annual Operating Cost )	<ul style="list-style-type: none"> <li>• Economic Effect (payback time): payback time [NEDO] : Equipment only : approx. 3.1 years : Including construction cost : approx. 3.6 years (annual coke production : 450000 t, electricity price : 17.99 ¥/kWh) [4.7years] 4.4 years [EU BAT](Payback is rather sensitive to electricity prices and can vary within the EU-27 between 3 and 8 years. In addition, taking into account some European energy saving schemes such as 'Tradable Certificates for Energy savings', which have been implemented in some European countries,the above payback is expected to be much shorter)[ *3]</li> <li>• Productivity Improvement: Not announced</li> <li>• Maintenance Cost Reduction: According to an actual operational record in Japan, Maintenance is usually carried out during the periodic maintenance of the coke ovens. Only a small amount of additional maintenance time is required.[EU][ *1]</li> </ul>
6. Indirect Effect (Co-benefits)	<ul style="list-style-type: none"> <li>• Product Quality Improvement: Better quality coke produced, improved strength of coke by 4%[SOACT] Nippon Steel's performance record shows that the use of coke manufactured by dry quenching reduces the amount of coke consumption in the blast furnace by 0.24 MMBtu/ton molten iron./EPA [*4]</li> <li>• SOx, Dust Decrease: During final collecting by bag filters, emission factors of dust of less than 3 g/t coke are achievable, corresponding to less than 20 mg/Nm3. SO2 emissions are at a level of 200 mg/Nm3. Emissions to surface water are close to zero. Collected coke dust is supplied as fuel to the sinter plant.[SOACT] The handling of dry quenched coke can cause more dust emissions than the handling of wet quenched coke.The electrical power consumption of fans, the operation of various dedusting devices, etc. is not negligible. However, net energy output will be rather positive, due to the recovery of waste heat which is usually transferred into the electrical power.[EU ][*1]</li> <li>• Water-saving: Increased water efficiency[SOACT]</li> </ul>
7. Proficiency Level of Technology in Japan	widely spread and mostly applied
8. Japanese Main Supplier	*JP Steel Plantech Co. * Nippon Steel Engineering Co., Ltd * Paul Wurth IHI Co., Ltd.
9. Technologies Reference:	<p>*1 : EU BAT5.3.14 *2 : Reference : 290 / NSC-ENG Personal Communication, 2008.          *3 : "Establishment of coke dry quenching technology with a maximum coke throughput of 200T/H". KATAOKA S, et.,al : Proc 6th Int Iron Steel Congr 1990 Vol 2 Page.337-344 (1990)          *4 EPA "AVAILABLE AND EMERGING TECHNOLOGIES FOR REDUCING GHG EMISSIONS FROM THE IRON &amp; STEEL INDUSTRY": IV.A2.p.21</p>
10. Preconditions	<p>* Important values were revised with referring to various values in "1-4. Used values and applied preconditions." Especially as for investment cost and payback time for the case of India, revised values were indicated in [ ] .          * Payback time is defined as (Investment cost / Economical merit) in this project.          * Refer to <a href="http://asiapacificpartnership.org/japanese/soact2nd.aspx">http://asiapacificpartnership.org/japanese/soact2nd.aspx</a> and "Japanese Technologies for Energy Savings/ GHG Emissions Reduction 《2008 Revised Edition》 (NEDO, 2008)"</p>

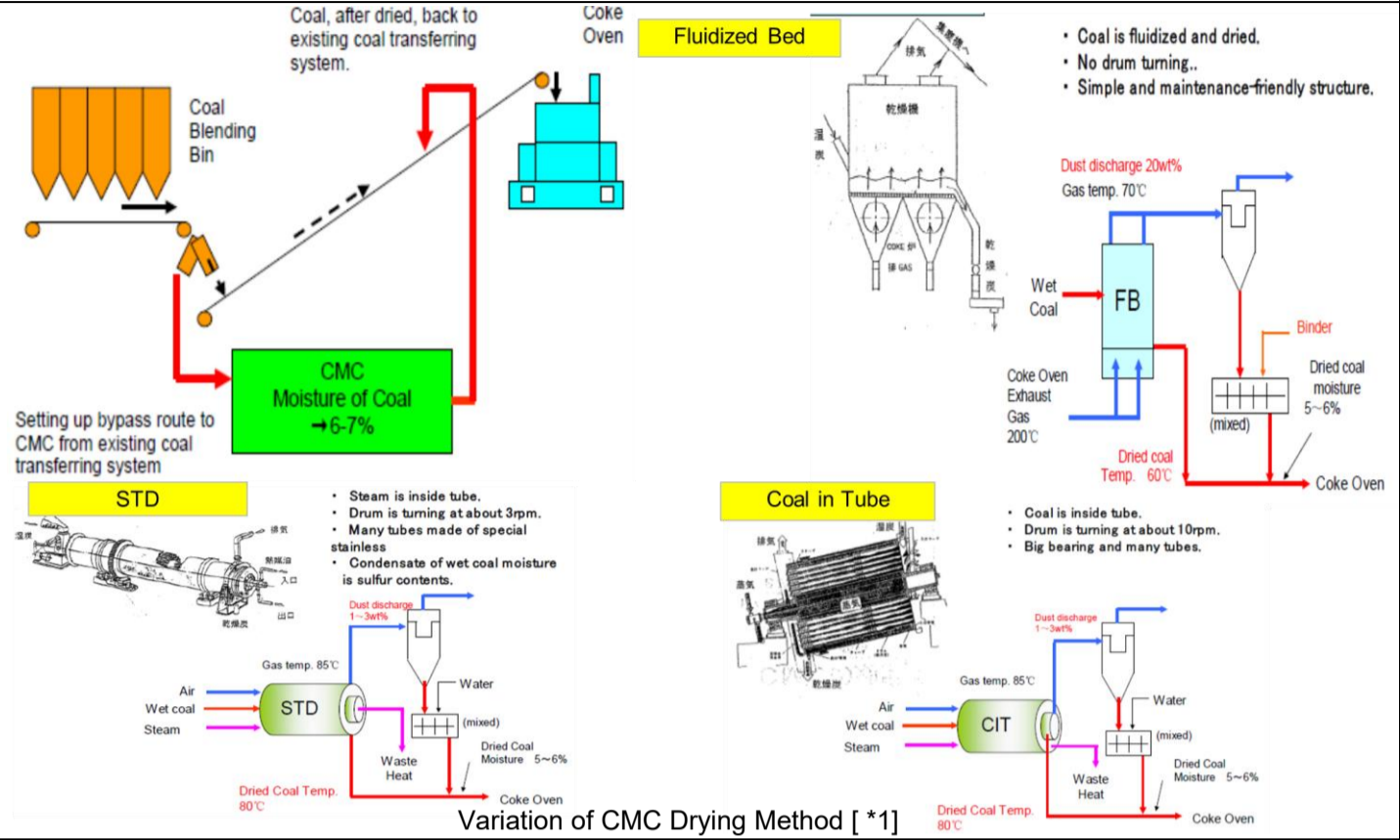
# A-5

## Cokemaking Coal Moisture Control

Item

Content

### 1. Process Flow



### 2. Technology Definition/Specification

Coal moisture control uses the waste heat from the coke oven gas to dry the coal used for coke making. The moisture content of coal varies, but it is generally around 8-9% for good coking coal. Drying further reduces the coal moisture content to a constant 3-5%, which in turn reduces fuel consumption in the coke oven. The coal can be dried using the heat content of the coke oven gas or other waste heat sources.[SOACT]Generally, low-pressure steam is used as the humidity control heat source.[NEDO]

#### Comparison of CMC Drying Method

Type	Steam Tube Dryer 1st generation	Coal In Tube 2nd generation	Fluidized Bed 3rd generation
Drying method	Multi-tube, steam inside, indirect heat transfer	Multi-tube, coal inside, indirect heat transfer	Fluidized Bed, direct heat transfer
Heat resource	Steam	Steam	Coke oven Exhaust gas
Material	Special stainless steel	Carbon steel and usual stainless	Carbon steel and usual stainless
Electricity	Only for drum turning	Only for drum turning	For blowers
Steam	Using as heat source	Using as heat source	Only for steam trace
Maintenance	Maintenance against colosion and abrasion	Maintenance against abrasion	Easy usual maintenance
Installtaion in Japan	6 units	4 units	1 unit (FB type DAPS : 3units)
Notes	Effective using for surplus steam	Effective using for surplus steam	Reasonable investment and heat recovery

### 3. Investment Cost & Operating Life

Coal humidity control cost in Japan: Approx. \$21.9/t-steel[SOACT,NEDO]  
Equipment cost: ¥2,000 million [118 Crore]; construction cost: ¥500 million [30 Crore]/450,000t-coke/y[NEDO]  
Operating Life : increased life by regular maintenance

### 4. Effect of Technology Introduction

• Reduction of CO2 Emission	27.55 kg-CO2-/t-coke
• Fuel Savings	Fuel savings of approximately 0.29 GJ/t-coke[SOACT]
• Electricity Savings	Not announced

### 5. Direct Effect ( Annual Operating Cost )

•Economic Effect (payback time)	Cheaper lean coal blend ratio increase[ *1] payback time: Not announced
• Productivity Improvement	Coke production increase (about 10%)/Shorter cooking times[SOACT,NEDO]
• Maintenance Cost Reduction	Careful attention needed to corrosion znd abrasion for STD and CIT

### 6. Indirect Effect (Co-benefits)

• Product Quality Improvement	Coke quality improvement (about 1.7%)[SOACT,NEDO]
• SOx, Dust Decrease	Not announced
•Water-saving	Decrease in water pollution (ammonia reduction)[SOACT]

### 7. Proficiency Level of Technology in Japan

well known and familiarized

### 8. Japanese Main Supplier

\* Nippon Steel Engineering Co., Ltd \* Tsukishima Kikai CO., LTD.

### 9. Technologies Reference:

\*1 : SOACT Appendix2a

### 10. Preconditions

\* Important values were revised with referring to various values in "1-4. Used values and applied preconditions." Especially as for investment cost and payback time for the case of India, revised values were indicated in 【】 .  
\* Refer to <http://asiapacificpartnership.org/japanese/soact2nd.aspx> and "Japanese Technologies for Energy Savings/ GHG Emissions Reduction 《2008 Revised Edition》 (NEDO, 2008)"

# A-6

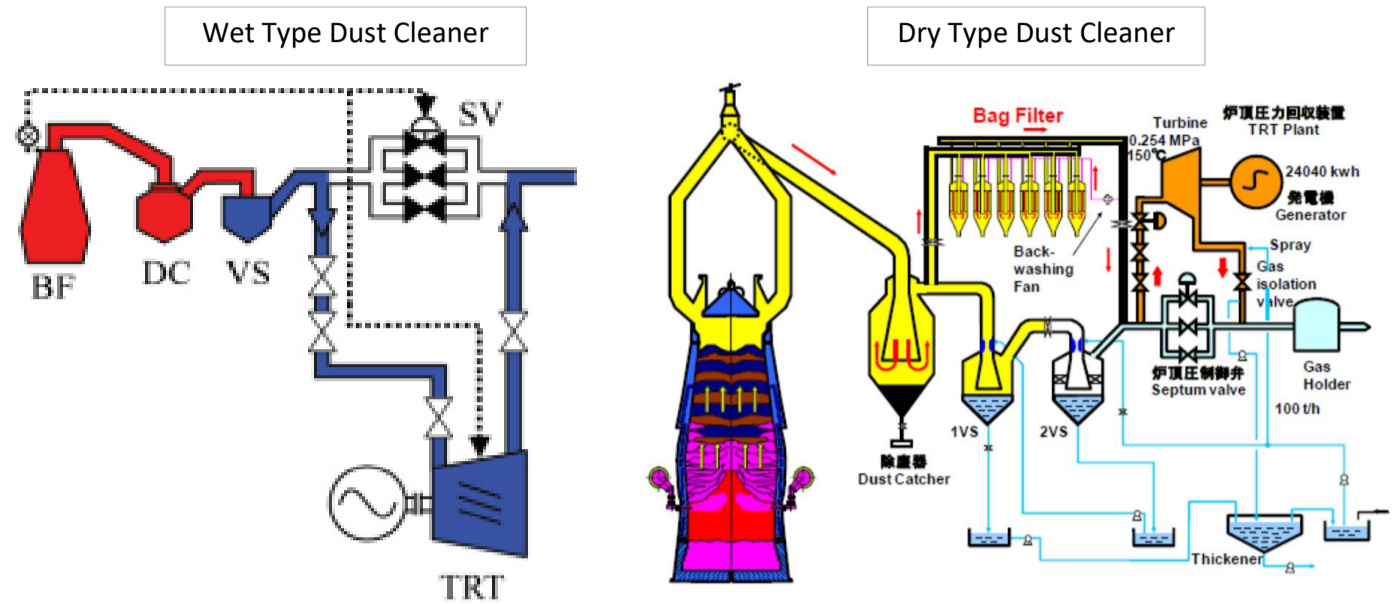
## Ironmaking

### Top Pressure Recovery Turbine

Item

Content

#### 1. Process Flow



Assuming pig iron production of 1 million t/y, the blast furnace capacity is 1,500m<sup>3</sup> (daily production scale: 3,000t) and B-gas generation is 212,500m<sup>3</sup>/h. The possible generating capacity with the gas volume is approximately 7,000kW (dry type). [ NEDO ]

#### 2. Technology Definition/Specification

This system generates electric power by employing blast furnace top gas to drive a turbinegenerator. After the blast furnace gas is used in power generation, it is used as a fuel in iron and steel manufacturing processes. Blast furnace gas (BFG) has a pressure of 0.2-0.236MPa (2-2.41 kg/cm<sup>2</sup>) and temperature of approximately 200°C at the furnace top. This technology is a method of generating power by employing this heat and pressure to drive a turbinegenerator. The system comprises dust collecting equipment, a gas turbine, and a generator. Generating methods are classified as (1) wet or (2) dry depending on the B-gas purification method. Dust is removed by Venturi scrubbers in the wet method and by a dry-type dust collector in the dry method. When dust is treated by the dry method, the gas temperature drop is small in comparison with the wet method, and as a result, generated output is at maximum 1.6 times greater than with the wet method[NEDO]

#### 3. Investment Cost & Operating Life

Equipment cost : 7,000kW Generator ; ¥1,400million (approx.) [83 Crore],  
Construction cost : ¥400million (approx.) [24 Crore][NEDO]  
Operating Life : increased life by regular maintenance

#### 4. Effect of Technology Introduction

- Reduction of CO<sub>2</sub> Emission : 45.25 kg-CO<sub>2</sub>/t-PI
- Fuel Savings : -
- Electricity Savings : 50 kWh/t-PI (= (40+60)/2 kWh/t-PI) [SOACT]

#### 5. Direct Effect ( Annual Operating Cost )

- Economic Effect (payback time) : More expensive than wet type, \$28/t hot metal. NEDO from Japan gives 1.8 years for the payback period of VS-ESCS (Venturi Scrubber- Electrostatic Space Clear Super) (including the construction costs)[SOACT]  
payback time [NEDO]  
: Equipment only : approx. 1.4 years  
: Including construction cost : approx. 1.8 years (=1.8billion/(7000\*24\*330\*17.99)) [3.6 years]
- Productivity Improvement : Not announced
- Maintenance Cost Reduction : Excellent operational reliability, abrasion resistant[SOACT]

#### 6. Indirect Effect (Co-benefits)

- Product Quality Improvement : Not announced
- SO<sub>x</sub>, Dust Decrease : Not announced
- Water-saving : Lower water consumption compared with wet type[SOACT]

#### 7. Proficiency Level of Technology in Japan

widely spread and mostly applied

#### 8. Japanese Main Supplier

\* Mitsui E&S Machinery Co., Ltd.

#### 9. Technologies Reference:

Refer to "Japanese Technologies for Energy Savings/ GHG Emissions Reduction 《2008 Revised Edition》 (NEDO, 2008)"

#### 10. Preconditions

\* Important values were revised with referring to various values in "1-4. Used values and applied preconditions." Especially as for investment cost and payback time for the case of India, revised values were indicated in [ ].  
\* Payback time is defined as (Investment cost / Economical merit) in this project.

# A-8

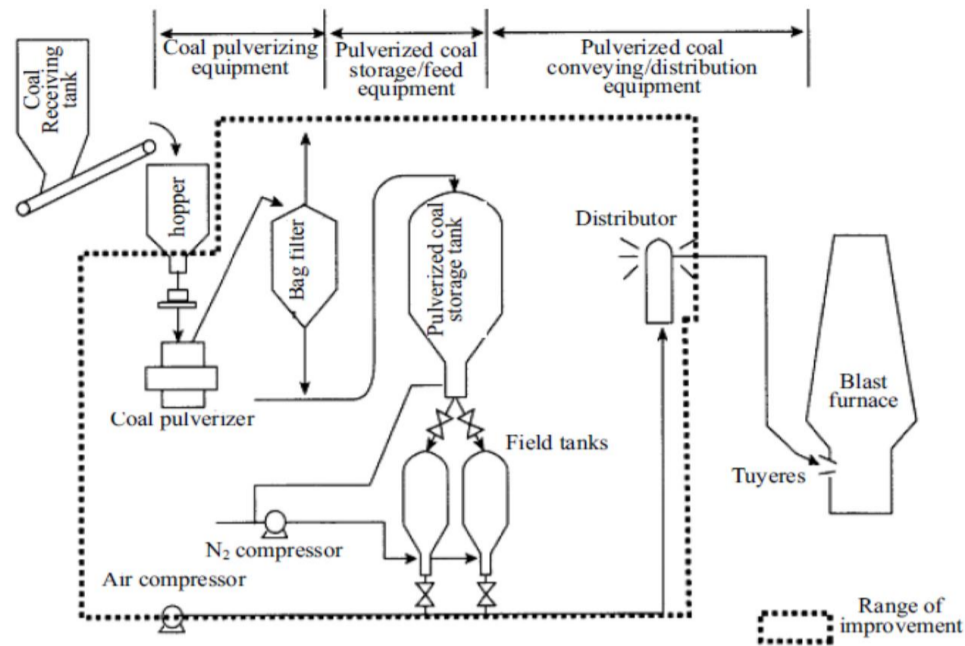
## Ironmaking

### Pulverized Coal Injection (PCI) System

Item

Content

#### 1. Process Flow



System diagram of PCI equipment [NEDO]

#### 2. Technology Definition/Specification

This system comprises a technology and equipment for injecting pulverized coal directly through the blast furnace tuyeres as a partial substitute for the coke used in the blast furnace. Because pulverized coal is injected directly, the corresponding amount of coke is unnecessary, making it possible to reduce energy consumption for coke making (coke dry distillation energy).

This equipment comprises (1) coal receiving equipment, (2) pulverizing/drying equipment, (3) pulverized coal injection equipment and the instrumentation system.

Noncoking coal is used as a partial substitute for coke (i.e., for coking coal). This coal is pulverized to a size of approximately 74 $\mu$ m, classified using a bag filter, and conveyed to the pulverized coal storage silo. It is then supplied at the timing of injection in accordance with the injection rate. The injection tank is pressurized with a compressor, and the pulverized coal is conveyed to the blast furnace tuyeres (charging holes) and injected into the blast furnace using this pressure. However, the type of coal used and the size of the pulverized coal will differ depending on the injection equipment and the blast furnace.

#### 3. Investment Cost & Operating Life

Equipment cost: ¥1,500 million ; construction cost: ¥500 million (approx.) / Based on blast furnace with 1 million t/y production[NEDO]  
 (Investment of coal grinding equipment estimated at \$50-55/t coal injected [SOACT])  
 Operating Life : increased life by regular maintenance

#### 4. Effect of Technology Introduction

- Reduction of CO<sub>2</sub> Emission
- Fuel Savings
- Electricity Savings

147 kg CO<sub>2</sub>/t-PI (at 125 kg/t-PI)

1.55 GJ/t-PI  
 $=125 \times (1/0.7-1) \times 6917 \times 4.186 / 1000000$   
 (PCI rate: 125  $(=(50+200)/2)$  kg/t-PI / coke yield : 0.7 / coal heat : 6,917 kcal/kg-coal)

-

#### 5. Direct Effect ( Annual Operating Cost )

- Economic Effect (payback time)
- Productivity Improvement
- Maintenance Cost Reduction

Increased costs of oxygen injection and maintenance of BF and coal grinding equipment offset by lower maintenance costs of existing coke batteries and/or reduced coke purchase costs, yielding a net decrease in operating and maintenance costs..[SOACT]  
 Furthermore, coal injection can allow the use of coals of a lower quality compared to coking coals. [\*1]  
 payback time; 15.3 years at 125 kg/t-PI years [NEDO] 【20 years】

Increased productivity[SOACT]

High reliability and easy operation[SOACT]  
 Decreased frequency of BF relining[SOACT]

#### 6. Indirect Effect (Co-benefits)

- Product Quality Improvement
- SO<sub>x</sub>, Dust Decrease
- Water-saving

Not announced

Not announced

Not announced

#### 7. Diffusion Rate of Technology in Japan

well known and familiarized

#### 8. Japanese Main Supplier

\* JP Steel Plantech Co.

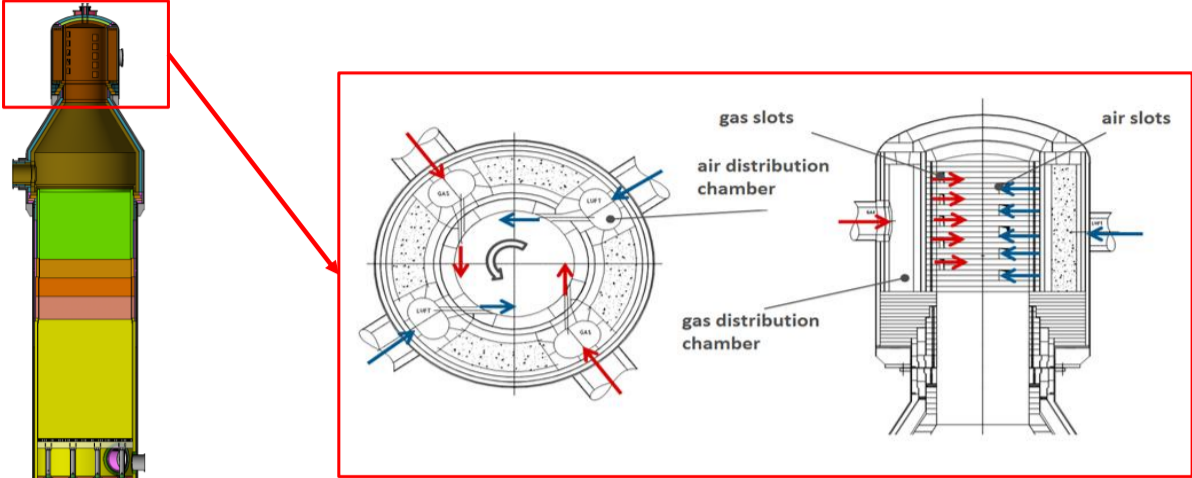
#### 9. Technologies Reference:

\*1 EU-BAT : 6.3.12.1

#### 10. Preconditions

\* Important values were revised with referring to various values in "1-4. Used values and applied preconditions." Especially as for investment cost and payback time for the case of India, revised values were indicated in 【】.  
 \* Payback time is defined as (Investment cost / Economical merit) in this project.  
 \*Average unit cost of power; ¥15.3/kWh  
 \* Refer to "Japanese Technologies for Energy Savings/ GHG Emissions Reduction 《2008 Revised Edition》 (NEDO, 2008)"

<h1>A-9</h1>		<h2>Ironmaking</h2>
		<h3>Hot Stove Waste Gas Heat Recovery</h3>
Item	Content	
<b>1. Process Flow</b>		
<b>2. Technology Definition/Specification</b>	<p>This device recovers the sensible heat of the flue gas generated in heating the hot stoves which supply hot blast to the blast furnace and uses this heat to preheat combustion air and/or combustion gas for the hot stoves. Installation of this device improves the combustion efficiency of the hot stoves and thereby saves energy.</p> <p>This system comprises heat exchanger with a heat-receiving side which receives the flue gas discharged from the hot stove; the second is a heating side which preheats the combustion air and/or fuel using the sensible heat of the flue gas received by the heat-receiving side of the heat exchanger. The preheated combustion air and/or combustion gas are supplied to the hot stoves. Heat exchange methods are classified as heat recovery with carrier medium (oil type) or heat pipe type, depending on the type of heat exchanger.</p>	
<b>3. Investment Cost &amp; Operating Life</b>	<p>Equipment: ¥300 million - ¥1,5 billion (approx.) depending on Blast Furnace size  Operating Life: typically &gt;10 years, increased by regular maintenance</p>	
<b>4. Effect of Technology Introduction</b>	<ul style="list-style-type: none"> <li>• Reduction of CO2 Emission</li> </ul>	-
	<ul style="list-style-type: none"> <li>• Fuel Savings</li> </ul>	<ul style="list-style-type: none"> <li>• Replacement of expensive energy from high calorific gas with thermal energy and cheaper low calorific gas</li> <li>• Reduction of operational costs</li> <li>• Reduction of CO2 emissions</li> </ul>
	<ul style="list-style-type: none"> <li>• Electricity Savings</li> </ul>	-
<b>5. Direct Effect ( Annual Operating Cost )</b>	<ul style="list-style-type: none"> <li>• Economic Effect (payback time)</li> </ul>	<ul style="list-style-type: none"> <li>• Reduction of consumption of high calorific gas</li> <li>• Reduction of operational costs</li> <li>• Typical payback time ~1 year, depending on the prices for blast furnace gas and high calorific gas</li> <li>• Savings in OPEX costs of several million JPY per year are possible, depending on price difference between blast furnace gas and high calorific gas.</li> </ul>
	<ul style="list-style-type: none"> <li>• Productivity Improvement</li> </ul>	<ul style="list-style-type: none"> <li>• Improved heating may allow higher hot blast temperature</li> </ul>
	<ul style="list-style-type: none"> <li>• Maintenance Cost Reduction</li> </ul>	<ul style="list-style-type: none"> <li>• Improved lifetime of refractory linings due to dry gas</li> </ul>
<b>6. Indirect Effect (Co-benefits)</b>	<ul style="list-style-type: none"> <li>• Product Quality Improvement</li> </ul>	-
	<ul style="list-style-type: none"> <li>• SOx, Dust Decrease</li> </ul>	<p>If COG as high calorific gas is substituted, application of heat recovery systems lead typically also to a reduction of the SOx emission, since SOx is normally only related to the COG resp. the sulphur, coming with the COG.</p>
	<ul style="list-style-type: none"> <li>• Water-saving</li> </ul>	-
<b>7. Diffusion Rate of Technology in Japan</b>	Widely spread use of different Heat Recovery Technologies	
<b>8. Japanese Main Supplier</b>	Paul Wurth IHI Co., Ltd	
<b>9. Technologies Reference:</b>	-	
<b>10. Preconditions</b>	-	

<h1>A-10</h1>		<h2>Ironmaking</h2>	
		<h3>Top Fired Hot Stove</h3>	
Item	Content		
1. Process Flow			
2. Technology Definition/Specification	<p>This hot stove is equipped with a ceramic burner installed at the top of the Hot Stove. The Top Fired Hot Stove has a in comparison to an External Combustion Chamber Stove with the same performance a much lower footprint. Additionally the implementation of a ceramic burner at the top of stove makes it possible to convert existing Internal and External Combustion Chamber Stoves into Top Fired Stoves and make use of existing structures and facilities. The top fired stove with ceramic burner offers best in class combustion performance with very low emissions.</p>		
3. Investment Cost & Operating Life	<p>&lt;Low Cost &gt; Most compact Hot Stove in comparison with all other types due to burner arrangement on top. Typically lower CAPEX than for other stove types but depending on the plant and project configuration (e.g. green field vs. replacement)</p> <p>&lt;Long Life&gt; Stable operation over 40 years. Paul Wurth has supplied over 500 Hot Stoves throughout the world. Based on these experiences, Paul Wurth IHI has extensive know-how and capabilities in stove design for exceptional performance and long service life. (1) Refractory Design: Unique know-how of refractory design and supply (2) Hot Stove Shell: Special steel with anti SCC coating</p>		
4. Effect of Technology Introduction	• Reduction of CO2 Emission	-	
	• Fuel Savings	-	
	• Electricity Savings	-	
5. Direct Effect ( Annual Operating Cost )	• Economic Effect (payback time)	-	
	• Productivity Improvement	-	
	• Maintenance Cost Reduction	-	
6. Indirect Effect (Co-benefits)	• Product Quality Improvement	-	
	• SOx, Dust Decrease	<ul style="list-style-type: none"> <li>• Perfect combustion quality</li> <li>• Very low CO emissions, &lt;20ppm at the waste gas outlet</li> <li>• Low NOx emissions</li> </ul>	
	• Water-saving	-	
7. Diffusion Rate of Technology in Japan	-		
8. Japanese Main Supplier	Paul Wurth IHI Co., Ltd		
9. Technologies Reference:	-		
10. Preconditions	-		

# A-11

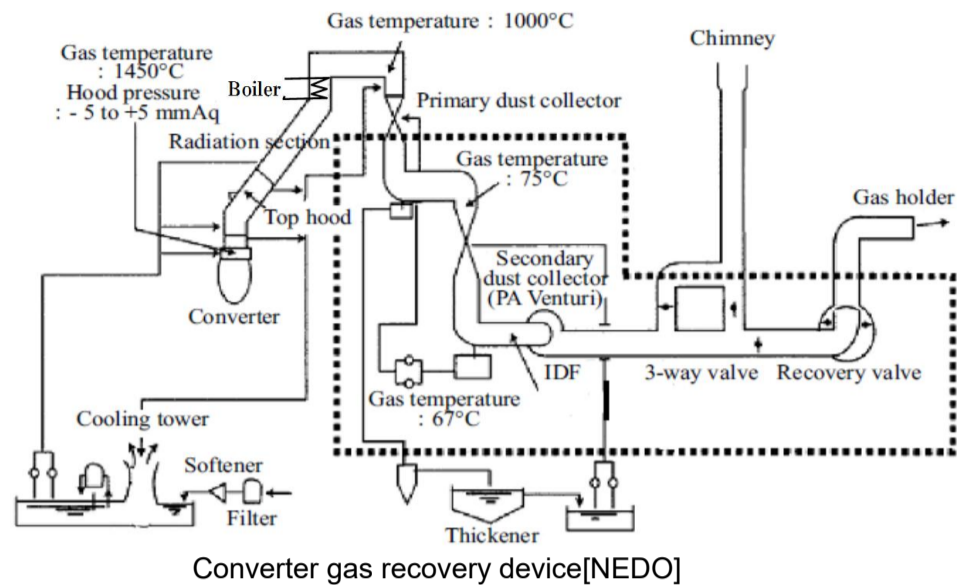
## Steelmaking

### Converter Gas Recovery Device

Item

Content

#### 1. Process Flow



#### 2. Technology Definition/Specification

Molten steel is produced by the converter process. This device recovers and uses the high temperature waste gas generated in large quantity during blowing in the converter (basic oxygen furnace: equipment used to produce crude steel from pig iron, steel scrap, etc.)  
 Accompanying this process, about 100Nm<sup>3</sup> of high temperature gas (CO) with a heating value of approximately 2,000 kcal/Nm<sup>3</sup> is generated.  
 Heat recovery methods are classified as (1) combustion method (boiler method) and (2) non-combustion method (method of recovering gas in an unburned condition: OG method. The advanced type is called the closed OG method). Recently, the closed OG method has become the main stream. The OG facilities are designed to recover about 70% of the latent heat and sensible heat. The converter gas recovered is mixed with other by-product gases (coke oven gas, blast furnace gas), then used by the heating equipment of the ironworks. Steam is mainly used by the degassing equipment of the steel making factory.

#### 3. Investment Cost & Operating Life

Equipment cost: ¥600-1,100 million 【35~65 Crore】  
 (equipment for 110 t/charge converter scale; includes construction cost)  
 converter capacity: 110 t/charge.[NEDO]  
 Operating Life : increased life by regular maintenance

#### 4. Effect of Technology Introduction

• Reduction of CO <sub>2</sub> Emission	79.8 kg-CO <sub>2</sub> /t-CS
• Fuel Savings	0.84 GJ/t-CS [NEDO] =100*2000*4.186/1000000 LDG : 100Nm <sup>3</sup> /t-CS 2,000kcal/Nm <sup>3</sup> -OG
• Electricity Savings	-

#### 5. Direct Effect (Annual Operating Cost)

• Economic Effect (payback time)	Payback time : 8.3~15.2 years (annual crude steel production : 200000 t) [NEDO] The investment required in 2007 was EUR 30.5 million for an ongoing project consisting of a gasholder of 80,000 m <sup>3</sup> , blower fans, gas ducts, three way valves in the off-gas systems, security measures, erection and engineering, etc. About 80 % of the BOF gas will be recovered resulting in an annual energy savings of 2600 TJ/yr = approximately EUR 12/GJ investment. Payback is about five years taking into account the savings in the purchase of natural gas, exploitation costs. (EU-BAT)
• Productivity Improvement	Not announced
• Maintenance Cost Reduction	* The OG-type system is frequently used because of its operational stability. The OG-type cooling system makes it possible not only to recover the sensible heat of exhaust gas as steam, but also to increase the IDF efficiency by lowering the temperature of the exhaust gas by use of a cooling device. * As the steam is produced discontinuously, it cannot always be fully utilized. The use of recovered BOF gas with suppressed combustion is much more flexible. The use of BOF gas in conjunction with blast furnace gas and coke oven gas, allows for the replacement of considerable amounts of primary energy resources, such as natural gas.
• Effect for converter operations	Increases the IDF efficiency by lowering the temperature of the exhaust gas, achieving high-speed oxygen feeding[SOACT]

#### 6. Indirect Effect (Co-benefits)

• Product Quality Improvement	Not announced
• SO <sub>x</sub> , Dust Decrease	* suppressed combustion reduces the quantity of flue-gas and thus reduces the cost of fans and dust removal.[*1]
• Water-saving	Reduced water requirement for off-gas cooling[ *1]

#### 7. Proficiency Level of Technology in Japan

Widely spread and mostly applied

#### 8. Japanese Main Supplier

\* JP Steel Plantech Co.

#### 9. Technologies Reference:

\*1 EU-BAT : 7.3.7

#### 10. Preconditions

\* Important values were revised with referring to various values in "1-4. Used values and applied preconditions."  
 Especially as for investment cost and payback time for the case of India, revised values were indicated in 【】.  
 \* Payback time is defined as (Investment cost / Economical merit) in this project.

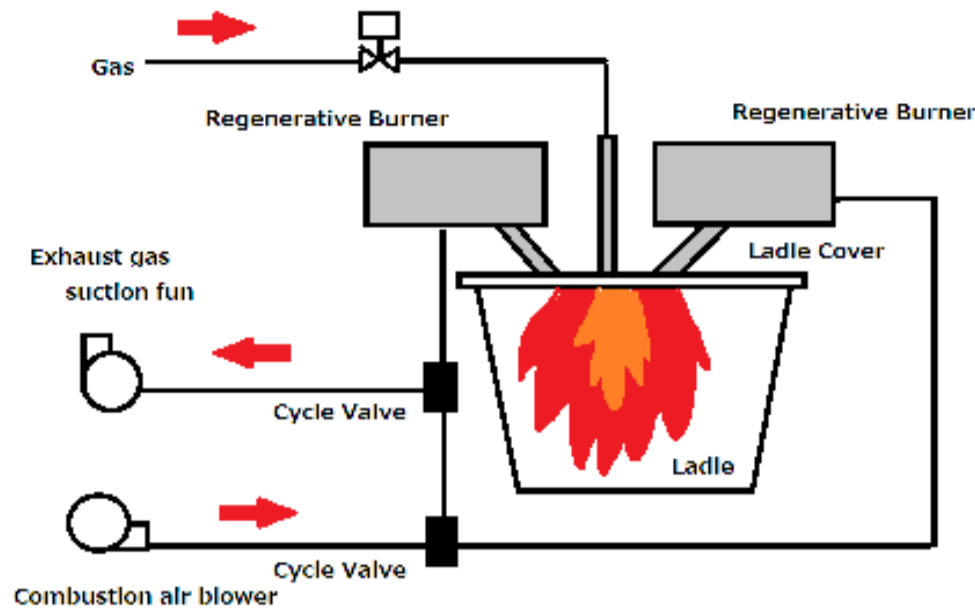
# A-12

## Steelmaking

### Low NOx regenerative burner system for ladle preheating

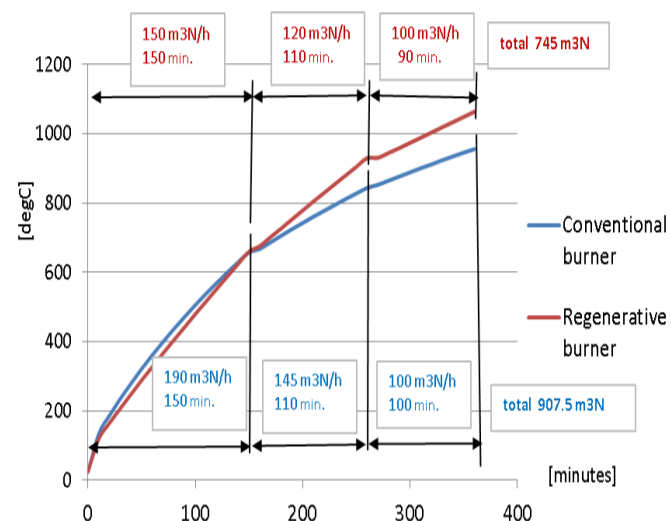
Item

Content



#### 1. Process Flow or Diagram

Fire brick inner temperature with natural gas



#### 2. Technology Definition/Specification

While one of the burners is burning, the other burner will work as an exhaust outlet. The exhaust gas is discharged from the system after the waste heat of the gas is recovered so that the temperature of the gas will be lowered to the extent that there will be no condensation in the regenerator. The combustion air receives heat from the regenerator. Therefore, the combustion air will be preheated to a super-high temperature (i.e., 90% of the temperature of the exhaust gas or over) before the combustion air is supplied to the burner. When the preset cycle time elapses, the burners exchange their roles of combustion and exhaustion.

#### 3. Expected Effect of Technology Introduction

- Electricity Saving
- Thermal Energy Savings
- Environmental benefits
- Co-benefits

-

40 % fuel saving is expected comparing to existing preheater with conventional burner.  
900 m<sup>3</sup>N natural gas in 6 hour burning for 80 ton ladle consumes about 40 GJ ---> 0.5 GJ/ton-steel x 40 % = 0.2 GJ/ton-steel save

Low NO<sub>x</sub>

Higher brick temperature can allow lower tapping temperature for energy saving at EAF.  
Improving meltshop atmosphere by reducing hot gas which disturbs dirty gas suction at the canopy

#### 4. Japanese Main Supplier

Chugai Ro Co., Ltd. Nippon Furnace CO., LTD

#### 5. Technologies Reference

#### 6. Comments

-

# A-13

## Steelmaking

### Converter Gas Sensible Heat Recovery Device

Item	Content	
1. Process Flow	<p style="text-align: center;">Converter gas sensible heat recovery device[NEDO]</p>	
2. Technology Definition/Specification	<p>Molten steel is produced by the converter process. This device recovers and uses the high temperature waste gas generated in large quantity during blowing in the converter (basic oxygen furnace: equipment used to produce crude steel from pig iron, steel scrap, etc.)</p> <p>Accompanying this process, about 100Nm<sup>3</sup> of high temperature gas (CO) with a heating value of approximately 2,000 kcal/Nm<sup>3</sup> is generated.</p> <p>This device recovers and makes efficient use of the converter gas sensible heat. While the converter waste gas recovery device recovers the waste gas itself, this device burns the converter waste gas to transform latent heat to sensible heat and recovers the energy as sensible heat. Therefore, it is structured to have a sufficient space between the converter and the hood so that sufficient air can be supplied from the secondary air blower for combustion. Principal equipments are the brackish water drum, the accumulator, and the boiler etc.</p>	
3. Investment Cost & Operating Life	<p>Equipment cost: ¥600 million 【35 Crore】 (equipment for 110 t/charge converter scale; includes construction cost)</p> <p>converter capacity: 110 t/charge.[NEDO]</p> <p>Operating Life : increased life by regular maintenance</p>	
4. Effect of Technology Introduction	• Reduction of CO <sub>2</sub> Emission	11.97kg-CO <sub>2</sub> /t-CS
	• Fuel Savings	0.126 GJ/t-CS [NEDO] = 30000*4.186/1000000 LDG : 100Nm <sup>3</sup> /t-CS 30,000kcal/t-cs
	• Electricity Savings	-
5. Direct Effect ( Annual Operating Cost )	• Economic Effect (payback time)	Payback time : 44years [NEDO] Energy recovery by means of full combustion systems or suppressed combustion systems is widely applied at oxygen steel plants around the world. There is a tendency towards suppressed combustion systems, mainly because of logistic advantages compared to full combustion systems.(EU-BAT <sup>[*1]</sup> )
	• Productivity Improvement	Not announced
	• Maintenance Cost Reduction	• No need for additional components other than conventional waste heat boiler. • Additional safety engineering measures are not needed other than conventional boiler technologies.
	• Effect for converter operations	Not announced
6. Indirect Effect (Co-benefits)	• Product Quality Improvement	Not announced
	• SO <sub>x</sub> , Dust Decrease	
	• Water-saving	Reduce temperature of waste water for off-gas cooling
7. Proficiency Level of Technology in Japan	Gas sensible heat recovery system are commonly installed combined with converter gas recovery in Japan.	
8. Japanese Main Supplier	JP Steel Plantech Co.	
9. Technologies Reference:	*1 EU-BAT : 7.3.7	
10. Preconditions	<p>* Important values were revised with referring to various values in "1-4. Used values and applied preconditions." Especially as for investment cost and payback time for the case of India, revised values were indicated in 【 】 .</p> <p>* Payback time is defined as (Investment cost / Economical merit) in this project.</p> <p>* Refer to "Japanese Technologies for Energy Savings/ GHG Emissions Reduction 《2008 Revised Edition》 (NEDO, 2008)"</p>	

# A-15

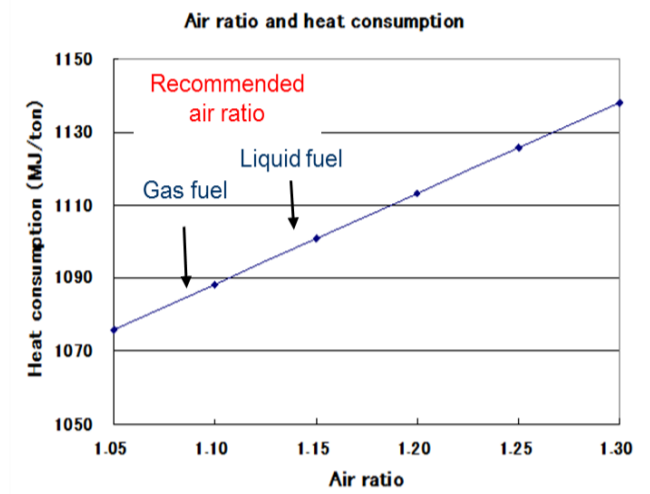
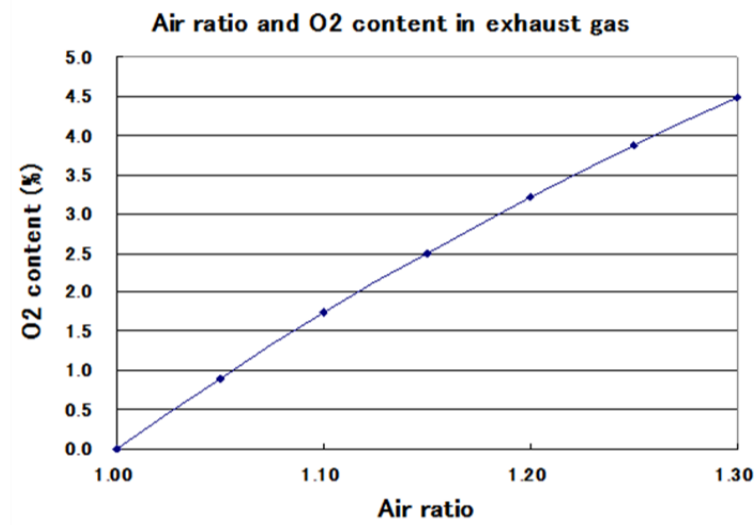
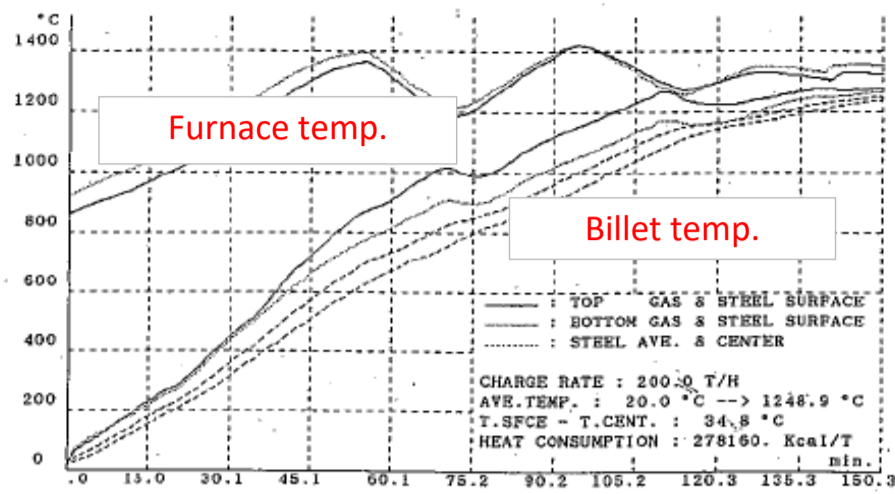
## Processing

### Process control for reheating furnace

Item

Content

#### 1. Process Flow or Diagram



#### 2. Technology Definition/Specification

- Setting furnace temperature by targeted billet temperature curve
- Precise air ratio control and O2 analysis in exhaust gas

#### 3. Expected Effect of Technology Introduction

- Electricity Saving
- Thermal Energy Savings
- Environmental benefits
- Co-benefits

-

0.05 GJ/ton-product (3.5 % fuel saving from the base line of 1,450 MJ/ton)

-

-

#### 4. Japanese Main Supplier

Chugai Ro Co., Ltd. Rozai Kogyo Kaisha Ltd.

#### 5. Technologies Reference

May contact to Chugai-Ro

#### 6. Comments

-

# A-16

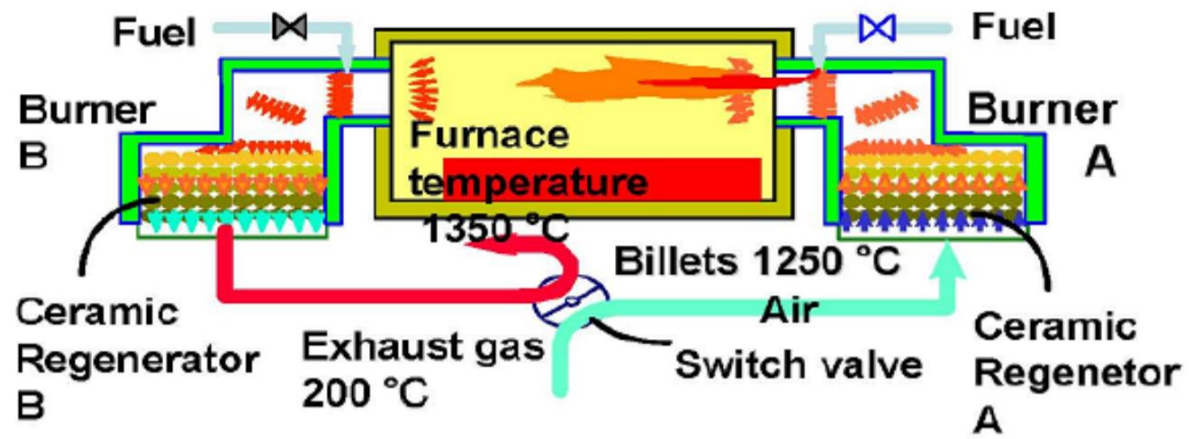
## Processing

### Regenerative Burner Total System for reheating furnace

Item

Content

1. Process Flow



Application of regenerative burner [SOACT]

2. Technology Definition/Specification

An unit, Burner with Regenerator, ensures highly efficient, selectable thermal storage:

- The burner body is compact and of mono-block construction incorporating a valve to select air or exhaust gas.
- The whole system can be downsized with a reduction in cost.
- This product is applicable to compact high-temperature furnaces where the introduction of conventional regenerative systems is difficult.
- The regenerative media uses an alumina ball that is economical and excellent in heat resistance and corrosion resistance.
- The product is ideal for forge furnaces, open flame heat treatment furnaces, nonferrous metal melting furnaces, and other high-temperature furnaces that are comparatively compact in capacity.

3. Investment Cost & Operating Life

Not announced

4. Effect of Technology Introduction

•Reduction of CO2 Emission

10.66 kg-CO2/t-CS

•Fuel Savings

0.19  $(=(0.17+0.21)/2)$  GJ/t-CS 【1.9 Crore】

5. Direct Effect ( Annual Operating Cost )

•Economic Effect (payback time)

Not announced

•Productivity Improvement

Expected

6. Indirect Effect (Co-benefits)

•Environmental effect

•Quiet operation [\*1]  
•NOx decrease

7. Diffusion Rate of Technology in Japan

well known and familiarized

8. Japanese Main Supplier

Chugai Ro Co., Ltd. [\*1]  
Nippon Furnace CO., LTD [\*2]  
Rozai Kogyo Kaisha Ltd.

9. Technologies Reference:

\*1: <http://www.chugai.co.jp/>  
\*2: <http://www.furnace.co.jp/>

10. Preconditions

•Basic condition; amount of production is 0.2 million ton of billet per year at EAF plant  
\* Important values were revised with referring to various values in "1-4. Used values and applied preconditions." Especially as for investment cost and payback time for the case of India, revised values were indicated in 【】.  
\* Payback time is defined as (Investment cost / Economical merit) in this project.

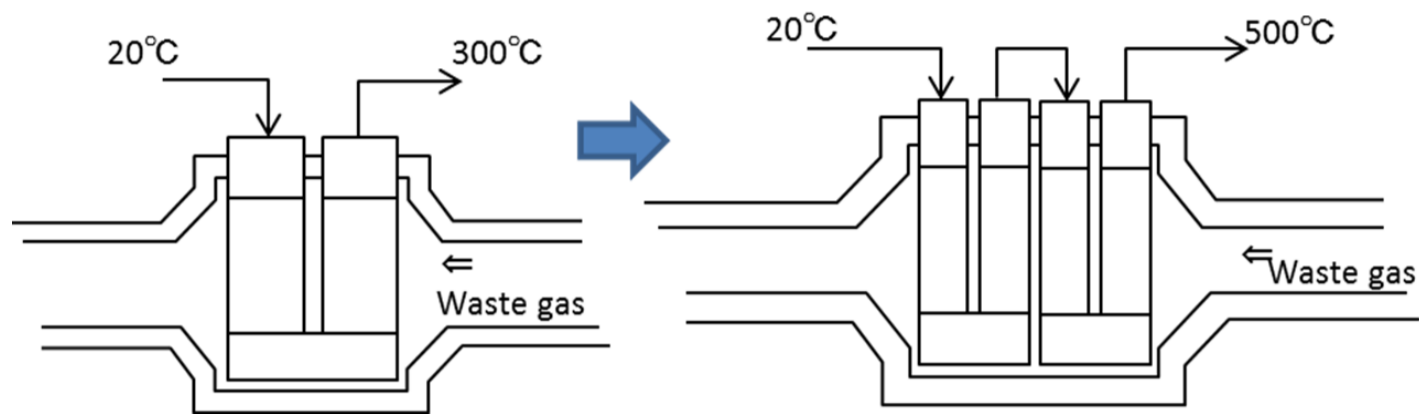
# A-17

## Processing

### High temperature recuperator for reheating furnace

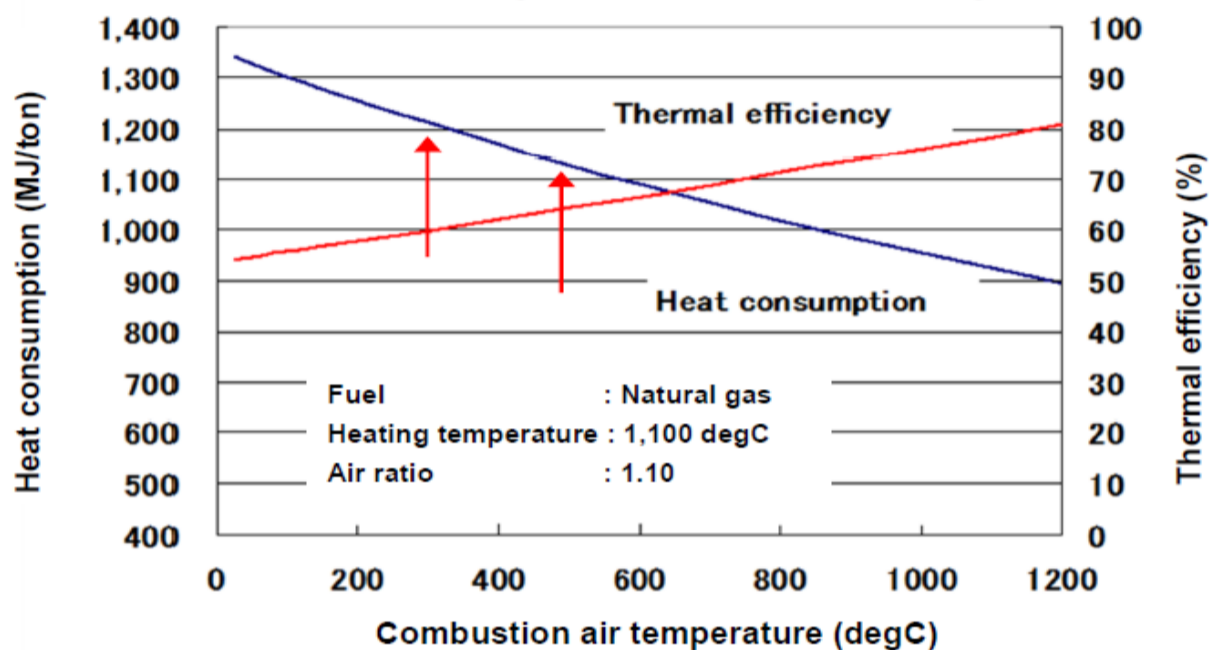
Item

Content



1. Process Flow or Diagram

Preheated air temperature and heat consumption



2. Technology Definition/Specification

Heat transfer area of the existing recuperator shall be increased (for example, by changing two-pass to four-pass) in order to raise the preheated combustion air temperature.

For this purpose, the followings may or may not be needed.

- Modification of Recuperator room
- Change of air duct
- Increase in discharge pressure of blower
- High grade recuperator material

3. Expected Effect of Technology Introduction

- Electricity Saving
- Thermal Energy Savings
- Environmental benefits
- Co-benefits

-  
0.100 GJ/t (about -7%)  
CO2 Reduction

4. Japanese Main Supplier

Chugai Ro Co., Ltd. Rozai Kogyo Kaisha Ltd.

5. Technologies Reference

Diagram from Chugai Ro

6. Comments

<Preconditions on calculating effects>  
When 300 degC air temperature is raised to 500 degC

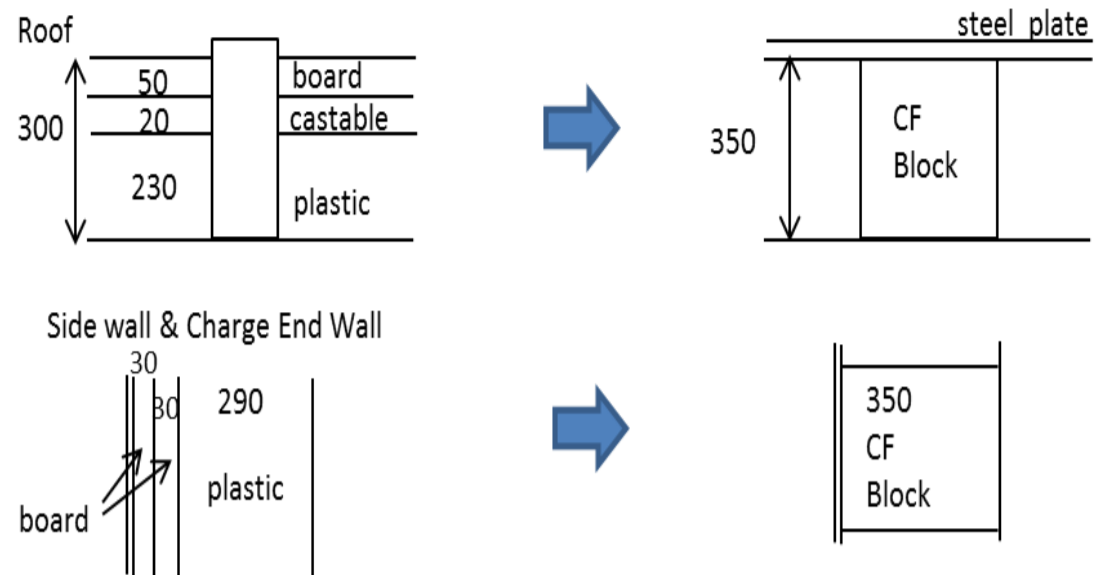
# A-18

## Processing

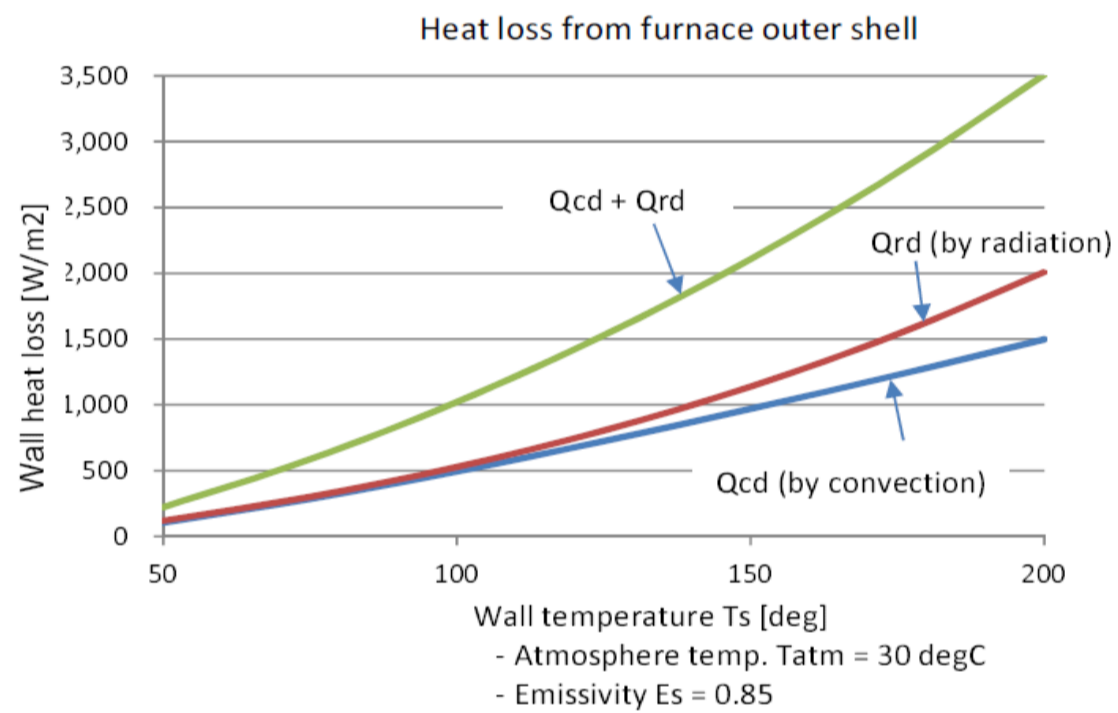
### Fiber block for insulation of reheating furnace

Item

Content



#### 1. Process Flow or Diagram



#### 2. Technology Definition/Specification

Ceramic fiber is lighter in weight and has the lower thermal conductivity than conventional brick or castable. Ceramic fiber can be used for the insulation of furnace roof and side wall.

#### 3. Expected Effect of Technology Introduction

• Electricity Saving	-
• Thermal Energy Savings	0.039 GJ/t (about 2.7 %)
• Environmental benefits	Reduction of Heat accumulation
• Co-benefits	Quick heat-up and cool-down of the furnace temperature for smooth and energy-saving operation.

#### 4. Japanese Main Supplier

Chugai Ro Co., Ltd. Rozai Kogyo Kaisha Ltd.

#### 5. Technologies Reference

Diagram from Chugai Ro and JP Steel Plantech

#### 6. Comments

<Preconditions on calculating effects>  
 assumed surface area of 100 ton/h furnace : 1350 m<sup>2</sup>  
 atmosphere temperature : 30 degC  
 surface temp. and heat loss of brick lining case : 130 degC, 7.96 GJ/h  
 surface temp. and heat loss of brick lining case : 90 degC, 4.08 GJ/h  
 (7.96 - 4.08) / 100 (ton/h) = 0.0388 GJ/ton ---> 0.039 GJ/ton saving  
 <Notice>  
 High-sulphur fuel may cause problem due to the corrosion of fixing pins.

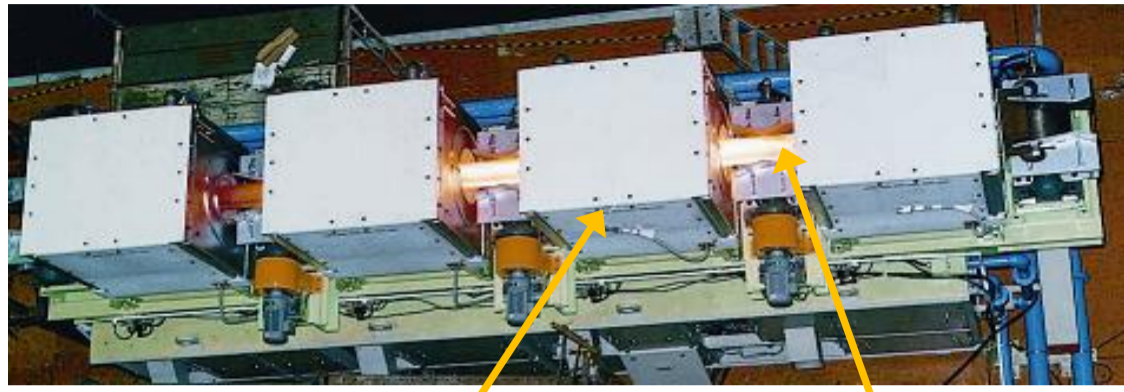
# A-19

## Processing

### Induction type billet heater for direct rolling

Item

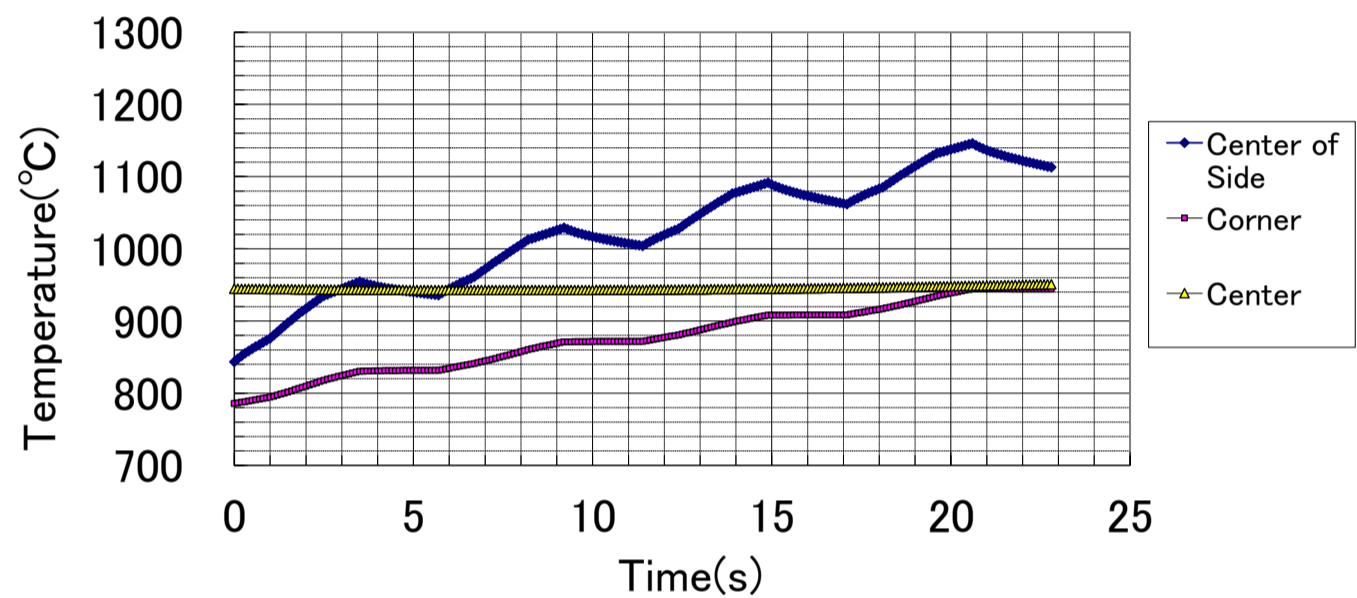
Content



Induction coil

Hot billet

### Heating Curve



#### 1. Process Flow or Diagram

#### 2. Technology Definition/Specification

Compensate temperature drop of billets transferred from CC to rolling mill (from 950 degC to 1050 degC).  
 Advantages :  
 - Automatic control  
 - Less exhaust gas (without reheating furnace)

#### 3. Expected Effect of Technology Introduction

- Electricity Saving 40 kWh/ton-product increase (electrical energy for billet heating)
- Thermal Energy Savings 1.45 GJ/ton-product (Cold charge to reheating furnace is replaced.)
- Environmental benefits Better working floor and atmosphere
- Co-benefits -

#### 4. Japanese Main Supplier

Mitsui E&S Power Systems Inc.

#### 5. Technologies Reference

-

#### 6. Comments

MESPS Tokyo Office:  
 TEL 03-6806-1075  
 FAX 03-5294-1121

# A-20

## Processing

### Oxygen enrichment for combustion air

Item

Content

#### 1. Process Flow or Diagram

When oxygen is mixed into combustion air to increase the O2 percentage, thermal energy will be reduced with the decrease in the volume of exhaust gas. In many EAF plants, oxygen is generated by PSA or VPSA process, therefore, new equipment for oxygen generation is not considered in this sheet. Only the electric power to generate oxygen is studied to estimate its economical effect.

#### 2. Technology Definition/Specification

Effects of oxygen enrichment are studied for the model RHF of 100 ton/h 1,100 degC billet heating (500,000 ton/y). The upper list shows the required fuel (thermal energy) and volume of oxygen. When oxygen percentage is raised to 42 %, exhaust gas volume from the furnace reduces to 45 % with 19.5 % fuel saving. The list also shows the required oxygen volume. The oxygen is assumed to be generated by VPSA process, with the purity of 93 %. The bottom list shows the economical effect of oxygen enrichment. Required electric power is assumed as 0.5 kWh/m<sup>3</sup>N-O<sub>2</sub> of 0.1 MPa pressure. Energy price is based on the latest Japanese values of 17.11 US\$/GJ and 0.123 US\$/kWh.

O2 in com. air	Unit heat cons.	Rate	Fuel gas flow rate	Oxygen flow rate	Ex. gas flow rate from furnace	Power to produce O2
21 %	1,330 MJ/ton	100.0 %	3,930 m <sup>3</sup> N/h	0 m <sup>3</sup> N/h	48,890 m <sup>3</sup> N/h	0 kWh/ton
24 %	1,230 MJ/ton	92.5 %	3,638 m <sup>3</sup> N/h	1,613 m <sup>3</sup> N/h	39,720 m <sup>3</sup> N/h	8.1 kWh/ton
27 %	1,182 MJ/ton	88.9 %	3,483 m <sup>3</sup> N/h	2,585 m <sup>3</sup> N/h	34,440 m <sup>3</sup> N/h	12.9 kWh/ton
30 %	1,140 MJ/ton	85.7 %	3,363 m <sup>3</sup> N/h	3,300 m <sup>3</sup> N/h	30,480 m <sup>3</sup> N/h	16.5 kWh/ton
33 %	1,120 MJ/ton	84.2 %	3,298 m <sup>3</sup> N/h	3,883 m <sup>3</sup> N/h	27,660 m <sup>3</sup> N/h	19.4 kWh/ton
36 %	1,100 MJ/ton	82.7 %	3,236 m <sup>3</sup> N/h	4,338 m <sup>3</sup> N/h	25,320 m <sup>3</sup> N/h	21.7 kWh/ton
39 %	1,080 MJ/ton	81.2 %	3,190 m <sup>3</sup> N/h	4,715 m <sup>3</sup> N/h	23,430 m <sup>3</sup> N/h	23.6 kWh/ton
42 %	1,070 MJ/ton	80.5 %	3,150 m <sup>3</sup> N/h	5,029 m <sup>3</sup> N/h	21,850 m <sup>3</sup> N/h	25.1 kWh/ton

O2 in com. air	Required thermal energy	Fuel cost	Power to produce O2	Electricity cost produce O2	Sum of energy cost	Rate of cost
21 %	665,000 GJ/y	11.38 mill. US\$/y	0 MWh/y	0 mill. US\$/y	11.38 mill. US\$/y	100.0 %
24 %	615,000 GJ/y	10.52 mill. US\$/y	4,050 MWh/y	0.50 mill. US\$/y	11.02 mill. US\$/y	96.8 %
27 %	591,000 GJ/y	10.11 mill. US\$/y	6,465 MWh/y	0.79 mill. US\$/y	10.90 mill. US\$/y	95.8 %
30 %	570,000 GJ/y	9.75 mill. US\$/y	8,250 MWh/y	1.01 mill. US\$/y	10.76 mill. US\$/y	94.6 %
36 %	560,000 GJ/y	9.58 mill. US\$/y	9,710 MWh/y	1.19 mill. US\$/y	10.77 mill. US\$/y	94.6 %
39 %	550,000 GJ/y	9.41 mill. US\$/y	10,845 MWh/y	1.33 mill. US\$/y	10.74 mill. US\$/y	94.3 %
39 %	540,000 GJ/y	9.24 mill. US\$/y	11,800 MWh/y	1.45 mill. US\$/y	10.69 mill. US\$/y	93.9 %
42 %	535,000 GJ/y	9.15 mill. US\$/y	12,550 MWh/y	1.54 mill. US\$/y	10.69 mill. US\$/y	93.9 %

#### 3. Expected Effect of Technology Introduction

- Electricity Saving
- Thermal Energy Savings
- Environmental benefits
- Co-benefits

When oxygen percentage is raised to 39 %, 23.6 kWh/ton of electricity is needed.

When oxygen percentage is raised to 39 %, 0.26 GJ/ton of thermal energy is saved.

-

-

#### 4. Japanese Main Supplier

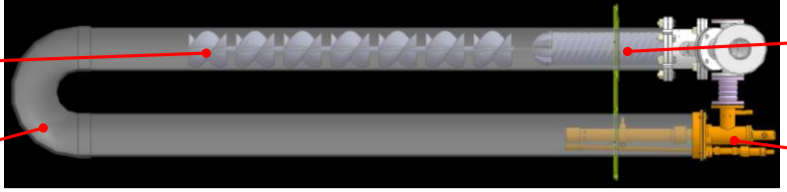
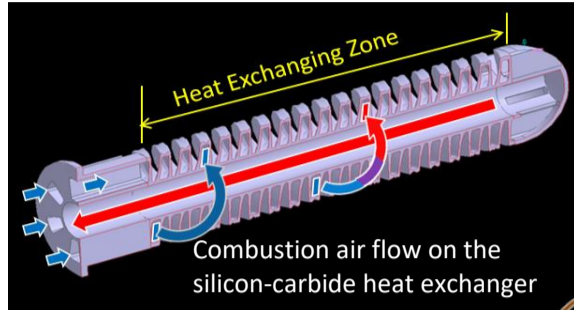
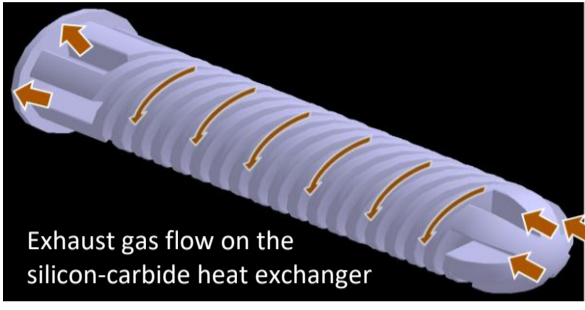
Chugai Ro Co., Ltd. Nippon Furnace CO., LTD

#### 5. Technologies Reference

-

#### 6. Comments

Furnace manufactureres can arrange the oxygen control system and piping revamping.

<h1>A-21</h1>		<h2>Processing</h2>	
		<h3>Highly efficient combustion system for radiant tube burner</h3>	
Item	Content		
1. Process Flow	<div style="display: flex; justify-content: space-between;"> <div style="width: 30%;"> <p>Silicon-Carbide Inserts for heat radiation</p> <p>Radiant Tube</p> </div> <div style="width: 40%; text-align: center;">  </div> <div style="width: 30%; text-align: right;"> <p>Silicon Carbide Heat Exchanger</p> <p>Burner</p> </div> </div> <div style="display: flex; justify-content: space-around; margin-top: 10px;"> <div style="width: 45%;">  <p>Heat Exchanging Zone</p> <p>Combustion air flow on the silicon-carbide heat exchanger</p> </div> <div style="width: 45%;">  <p>Exhaust gas flow on the silicon-carbide heat exchanger</p> </div> </div>		
2. Technology Definition/Specification	<p>Radiant tube burner which consists of 1)Radiant tube(U shape or W shape), 2)Gas Burner, 3)3-D formed silicon-carbide Inserts for heat radiation, and 4)Heat exchanger made of 3-D formed silicon carbide.</p> <p>These 3-D formed silicon carbide elements have high thermal conductivity and wide surface area, which allow approx. 10% improvement in heat recovery compared to conventional radiant tube burners with heat exchanger made of steel.</p> <p>Any industrial furnace with radiant tube burner will potentially be applicable and typical applicable furnace will be CGL, Continuous Galvalizing Line or CAL, Continuous Annealing Line, with approx. 100-200 radiant tube burners of 210-420MJ/hour of rated combustion volume.</p> <p>*Radiant tube burner is often used for the industrial furnaces such as heat treatment furnace which requires indirect heating.</p>		
3. Investment Cost & Operating Life	<p>The cost of adding this system into existing furnace will be approximately 1.6 million JPY for one burner which have 420MJ/hour of combustion rate. This includes the cost for installation work and combustion adjustments.</p> <p>Operating life for silicon carbide elements is considered to be semipermanently.</p>		
4. Effect of Technology Introduction	• Reduction of CO2 Emission	<p>2,654t-CO2/year under assumptions below.</p> <p>1) 10% of Fuel substitution will be achieved by replacing conventional recuperator into DINCS (Daido Innovative Neo Combustion System) to the CGL with 200 radiant tube burners.</p> <p>2) Each burners have 420MJ/h of rated combustion volume, and combusted at 80% rate on average.</p> <p>3) Furnace operation is 330days/year, 24 hours/day.</p> <p>Production capacity is assumed as 594,000 ton/y (75 ton/h x 24h x 330 day/y)</p> <p>4) The effect is calculated as comparison with steel heat exchanger system</p> <p>5) Natural gas is used as for combustion.</p> $53222(GJ/year) \times 0.0136(tC/GJ) \times \frac{44}{12} = 2,654(tCO2/year)$	
	• Fuel Savings	<p>53,222GJ/year under assumptions same as above</p> <p>0.0896 GJ/ton saving (= 53,222 GJ/y / 594,000 ton-product/y)</p>	
	• Electricity Savings	N/A	
5. Direct Effect ( Annual Operating Cost )	• Economic Effect (payback time)	<p>Approx. 4.9 years under assumptions same as above.</p> <p>Cost for installation work and combustion adjustment are included (1,600,000JPY) and the price of thermal energy is assumed to be 19.11 US\$/GJ (2,100 JPY/GJ).</p> <p>Annual profit = 53,222 GJ/y x 19.11 US\$/GJ / 594,000 ton/y = 1.71 US\$/ton-product</p> <p>&lt;Calculation&gt;</p> <p>Payback time = (1,600,000 JPY x 200 units) / (53,222 GJ/y x 2,100 JPY/GJ) = 2.86 year</p>	
	• Productivity Improvement	<p>Since this system transfers the heat effectively into the furnace or into product, line speed of the furnace can be increased which results in productivity improvement, if there is no restrictions for the equipment other than the combustion system.</p>	
	• Maintenance Cost Reduction	<p>Conventional heat exchanger made of steel usually requires replacement every 3-4 years, but silicon carbide elements will not deteriorate over time and last semipermanently.</p>	
6. Indirect Effect (Co-benefits)	• Product Quality Improvement	N/A	
	• SOx, Dust Decrease	N/A	
	• Water-saving	N/A	
7. Proficiency Level of Technology in Japan	Applied to more than 30 heat treatment furnaces.		
8. Japanese Main Supplier	Daido Steel Co., Ltd.		
9. Technologies Reference:	<p>Japanese patent No.6587411 (Radiant tube type heating device)</p> <p>Japanese patent No.6790554 (Radiant tube type heating device)</p>		
10. Preconditions	Investment cost and benefit vary depending on furnace specification, operation condition, fuel cost, etc of each customer.		

# A-22

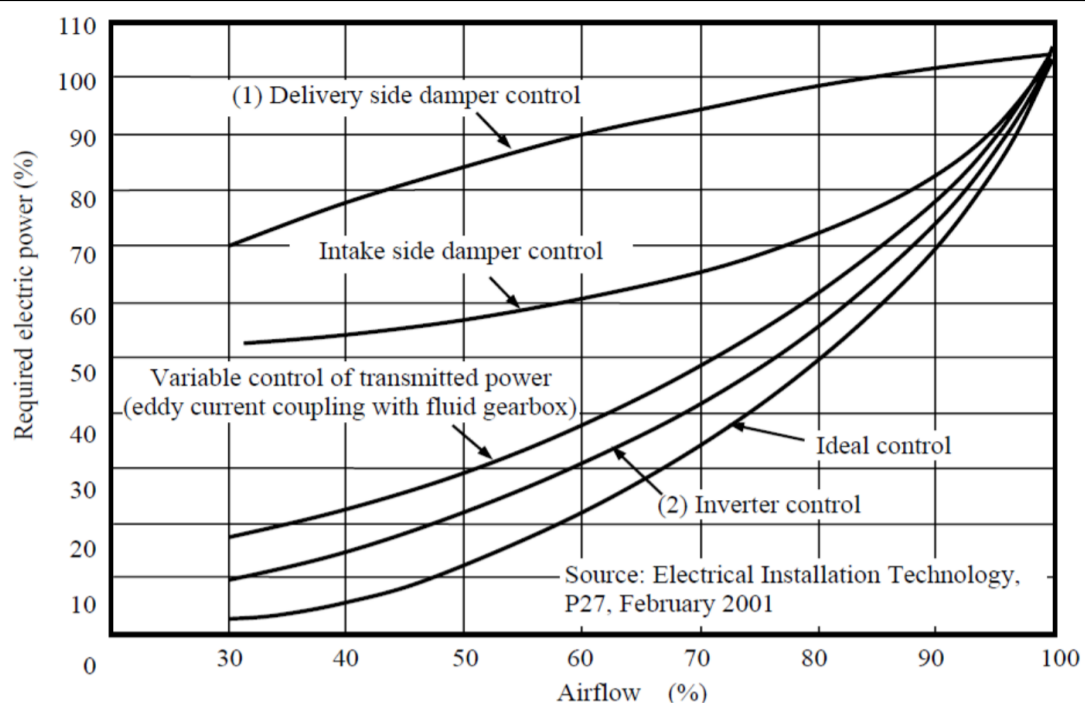
## General Energy Saving & Environmental Measures

### Inverter (VVVF; Variable Voltage Valuable Frequency) Drive for Motors

Item

Content

#### 1. Process Flow



Relationship between airflow under airflow control and the required Electric power

#### 2. Technology Definition/Specification

An inverter is a variable speed device controlling frequency and voltage to allow precise control of rotation. The commercial AC voltage is converted to DC in the converter control unit, which then controls the inverter to generate a three-phase variable voltage and variable frequency current. A high-pressure inverter as an energy-saving device can directly drive a high-speed electric motor without using a booster transformer. High-pressure IGBT (Insulated Gate Bipolar Transistor) inverter device outputs high voltage of 3.3kV and 6.6kV, depending on the single-phase inverter multiple connection technology.

Energy saving effect : Conversion of six 55kW electric motors with eddy current coupling, and reduction in power consumption

Calculation conditions/NEDO :

- \* Overall efficiency of conventional electric motors with eddy current coupling : 0.65
- \* Overall efficiency of electric motors converted to inverter control : 0.80
- \* Reduction in power consumption by lowering motor speed : 15% (assumed)
- \* Annual operation : 3,600 h/y
- \* Unit cost of power : ¥15/kWh

#### 3. Investment Cost & Operating Life

¥2,000,000/unit(assumed) [NEDO] 【0.12 Crore/unit】

#### 4. Effect of Technology Introduction

•Reduction of CO2 Emission

Not announced

•Electricity Savings

90,000 kWh/y [NEDO] 【0.04 Crore/unit】

#### 5. Direct Effect (Annual Operating Cost)

•Economic Effect (payback time)

1.5 years [NEDO] 【2.9 years】

•Productivity Improvement

Not announced

•Maintenance Cost Reduction

Not announced

#### 6. Indirect Effect (Co-benefits)

•Product Quality Improvement

Not announced

#### 7. Diffusion Rate of Technology in Japan

No data

#### 8. Japanese Main Supplier

major electric equipment suppliers

#### 9. Technologies Reference:

Energy savings Diagnosis Examples-Common Equipment Volume', Energy conservation Center, Japan Sumiyasu Kodama, et al. "High-performance AC Drive Series for Industrial Use", Toshiba Review, 52, 9, 1997, p.36-39

#### 10. Preconditions

- \* Important values were revised with referring to various values in "1-4. Used values and applied preconditions." Especially as for investment cost and payback time for the case of India, revised values were indicated in 【】.
- \* Payback time is defined as (Investment cost / Economical merit) in this project.
- \* annual operation : 3,600 h/y
- \* unit cost of power : ¥15/kWh
- \* Note : SOACT data
  - Electricity savings 42 %
  - payback time : 3.4 years ( 3 pence/kWh under US 1994 conditions)
- \* Refer to <http://asiapacificpartnership.org/japanese/soact2nd.aspx> and "Japanese Technologies for Energy Savings/ GHG Emissions Reduction 《2008 Revised Edition》 (NEDO, 2008)"

# A-23

## General Energy Saving & Environmental Measures

### Energy Monitoring and Management Systems

Item	Content						
1. Process Flow	<p style="text-align: center;">Energy Monitoring and Management Systems</p>						
2. Technology Definition/Specification [*1]	<p>This measure includes site energy management systems for optimal energy recovery and distribution between various processes and plants.</p> <p>The aim of energy management should be to maximize the productive use of gases arising from the processes, thereby minimizing the necessity of importing supplementary energy sources into the system and optimizing the specific energy consumption within the inherent constraints of the system. In order to achieve the goal, there must be an adequate system dealing with the technical possibilities and costs on the one hand, and on the organization on the other hand.</p> <ol style="list-style-type: none"> <li>1. Optimizing energy consumption: Typically, a change in the energy supply of one process in the steel plant influences several other processes (e.g. the use of coke oven gas in the blast furnace can result in a higher caloric value in the BF top gas). Optimizing tools that consider the whole integrated site may be preferable to ones that consider each process as a standalone unit.</li> <li>2. Online monitoring.: This is often used for the most important energy flows and combustion processes at the site. The data are stored for a long time so that typical situations may be analyzed. Very important is the online monitoring for all gas flares. It is the main technique used to avoid energy losses in the flares and combustion processes.</li> <li>3. Continuous monitoring systems: For all energy-related process parameters can be used to optimize process control and enable instant maintenance, thus achieving an uninterrupted production.</li> <li>4. Reporting and analyzing tools.: Reporting tools are often used to check the average energy consumption of each process. In connection with cost controlling, controlling energy is the basis for optimizing energy consumption and cost savings. An energy controlling system offers the possibility of comparing actual data with historical data (e.g. charts)</li> <li>5. Techniques to optimize process gas utilization: Some potential process-integrated techniques used to improve energy efficiency in an integrated steelworks by optimizing process gas utilization include:             <ol style="list-style-type: none"> <li>(1) the use of gas holders for all by-product gases or other adequate systems for short-term storage and pressure holding facilities for maximizing the recovery of process gases.</li> <li>(2) increasing pressure in the gas grid if there are energy losses in the flares – in order to utilize more process gases with the resulting increase in the utilization rate.</li> <li>(3) reheating fire furnaces with process gas in order to maximize the use of process gases and reduce the need to purchase natural gas or electrical power.</li> <li>(4) use of a computer-controlled caloric value control system. This measure includes site energy management systems for optimal energy recovery and distribution between various processes and plants.</li> </ol> </li> </ol>						
3. Investment Cost & Operating Life	It depends on system structure, from data monitoring network to whole control computer system. One example in Netherlands (was acquired by Tata Steel, and nominal capacity is 6.3Mt/y.) is \$0.8M. 【4.3 Crore】						
4. Effect of Technology Introduction	<table border="1"> <tr> <td>•Reduction of CO2 Emission</td> <td>11.4 kg-CO2/t-steel</td> </tr> <tr> <td>•Fuel Savings</td> <td>0.12 GJ/t-steel [*2, 3]</td> </tr> <tr> <td>•Electricity Savings</td> <td>Not announced</td> </tr> </table>	•Reduction of CO2 Emission	11.4 kg-CO2/t-steel	•Fuel Savings	0.12 GJ/t-steel [*2, 3]	•Electricity Savings	Not announced
•Reduction of CO2 Emission	11.4 kg-CO2/t-steel						
•Fuel Savings	0.12 GJ/t-steel [*2, 3]						
•Electricity Savings	Not announced						
5. Direct Effect (Annual Operating Cost)	<table border="1"> <tr> <td>•Economic Effect (payback time)</td> <td>Depends on cost of fuel and electricity of each site.</td> </tr> <tr> <td>•Maintenance Cost Reduction</td> <td>Not announced</td> </tr> </table>	•Economic Effect (payback time)	Depends on cost of fuel and electricity of each site.	•Maintenance Cost Reduction	Not announced		
•Economic Effect (payback time)	Depends on cost of fuel and electricity of each site.						
•Maintenance Cost Reduction	Not announced						
6. Indirect Effect (Co-benefits)	<table border="1"> <tr> <td>•Product Quality Improvement</td> <td>Not announced</td> </tr> </table>	•Product Quality Improvement	Not announced				
•Product Quality Improvement	Not announced						
7. Diffusion Rate of Technology in Japan	widely spread and mostly applied						
8. Japanese Main Supplier	Fuji Electric CO., LTD.						
9. Technologies Reference:	<p>*1 EU-BAT 2.5.2.1 9.1.2, USA-BAT IV.A9.2</p> <p>*2 Farla, J.C.M., E. Worrell, L. Hein, and K. Blok, 1998. Actual Implementation of Energy Conservation Measures in the Manufacturing Industry 1980-1994, The Netherlands: Dept. of Science, Technology &amp; Society, Utrecht University.</p> <p>*3 ETSU, 1992. "Reduction of Costs Using an Advanced Energy Management System," Best Practice Programme, R&amp;D Profile 33, Harwell, UK:ETSU</p>						
10. Preconditions	* Important values were revised with referring to various values in "1-4. Used values and applied preconditions." Especially as for investment cost and payback time for the case of India, revised values were indicated in 【】.						

# A-24

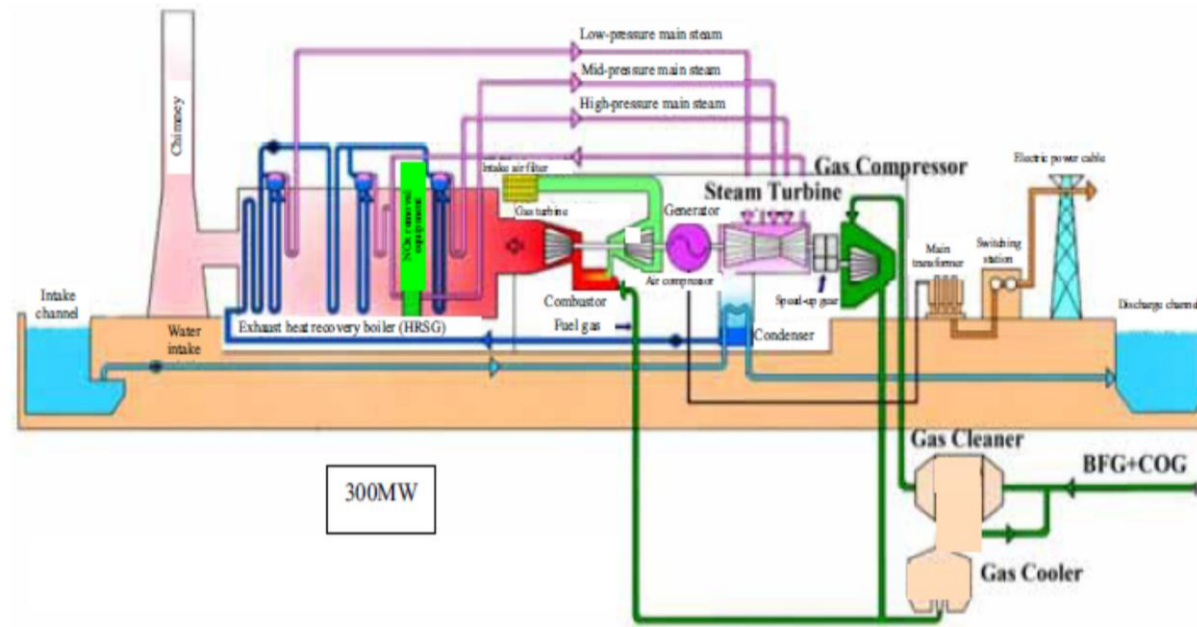
## General Energy Saving & Environmental

### Low Calorie Fired Gas Turbine Combined Cycle Plant

Item

Content

#### 1. Process Flow



Ironworks by-product gas, single-fuel-firing, high-efficiency, combined generator set

#### 2. Technology Definition/Specification

This equipment is a high-efficiency(47.5%, HHV Base) combined generator set using the by-product gas produced during iron and steel manufacturing process as the fuel.  
This equipment is an iron and steel by-product gas fired combined generator set, in which the gas turbine is operated by high-temperature gas (1,300°C) generated by mixing the blast furnace gas with the coke oven gas to be gas with a heat amount of 4,400kJ/m<sup>3</sup>-dry(LHV) and burning it after the pressure is increased to about 1.6MPa. At the same time the steam turbine is operated by the steam generated by directing the high-temperature (approx. 535°C) gas discharged from the gas turbine to the exhaust heat recovery boiler. [\*1]

#### 3. Investment Cost & Operating Life

Turbine systems : approx. \$1000/kW. Total investment costs estimated to be \$14.5/t crude steel.[SOACT]  
The type and size of CHP system utilized depends on a variety of site-specific factors including the amount and quality of off-gases from the coke oven, blast furnace, and BOF; the steam requirements of the facility, and the economics of generating power on-site versus purchasing power from the grid.(CHP;combined heat and power)  
CHP capital costs can range from \$900 to \$2,500/kW depending on size and technology. [\*2]  
Operating Life : increased life by regular maintenance

#### 4. Effect of Technology Introduction

- Reduction of CO<sub>2</sub> Emission: 135.91kg-CO<sub>2</sub>/t-steel (@5 Mil ton production, 300MW. See 10. Preconditions)
- Fuel Savings: -
- Electricity Savings: Increased electricity generation of 1.14 GJ/t crude steel (calculated based on 10. Preconditions)

#### 5. Direct Effect ( Annual Operating Cost )

- Economic Effect (payback time): Reduction of power purchase.
- Productivity Improvement: Not announced
- Maintenance Cost Reduction: World-largest gas turbine: Achieved an inlet gas temperature of 1,300°C and realized the world-largest output as a blast furnace gas fired gas turbine by employing the most advanced technology to provide the vane with a forced cooling structure and anti-corrosion coating [\*1]

#### 6. Indirect Effect (Co-benefits)

- Product Quality Improvement: Not announced
- SO<sub>x</sub>, NO<sub>x</sub>, Dust Decrease: Low NO<sub>x</sub> emissions of 25 ppm (O<sub>2</sub>, 16% dry) [SOACT]
- Water-saving: Not announced

#### 7. Proficiency Level of Technology in Japan

well known and familiarized

#### 8. Japanese Main Supplier

Mitsubishi Heavy Industries Environmental & Chemical Engineering Co., Ltd.

#### 9. Technologies Reference:

\*1 Practical example: Kimitsu Cooperative Thermal Power Company, Inc  
4,400 kJ/m<sup>3</sup>-N dry (LHV) (by COG heat increased BFG)  
<http://www.tgn.or.jp/kmk/plant/machine05.html> (Japanese)

#### 10. Preconditions

**[Reduction of CO<sub>2</sub> Emission]**  
Efficiency of conventional equipment 35% → increase rate of electricity (3.6/35\*100) / (3.6/47.5\*100) = 1.36 (times)  
Equipment capacity: 300 MW → (1.36-1) \* 300MW = 107.1 (MWh/h)  
Utilization rate: 80% → 107.1 \* 8760 (h) \* 80% = 750,857 (MWh/year)  
CO<sub>2</sub> emission factor of India: 0.905 t-CO<sub>2</sub>/MWh → 750,857 \* 0.905 = 679,526 (t-CO<sub>2</sub>/year)  
Crude steel production: 5 Mil tons/year → 679,526/5,000,000\*1000 = 135.91 (kg-CO<sub>2</sub>/t-steel)

**[Electricity Savings]**  
Efficiency of conventional equipment 35% → calorific difference (3.6/35\*100) - (3.6/47.5\*100) = 2.7 (MJ/kWh)  
Equipment capacity: 300 MW, Utilization rate: 80% → yearly electricity savings 2.7 \* 300(MW) \* 8760(h) \* 80% = 5,676,480 (GJ/year)  
Crude steel production: 5 Mil tons/year → electricity savings per steel production 5,676,480 / 5,000,000 = 1.14 (GJ/t-steel)

# A-25

## General Energy Saving & Environmental Measures

### Management of Compressed Air Delivery Pressure Optimization

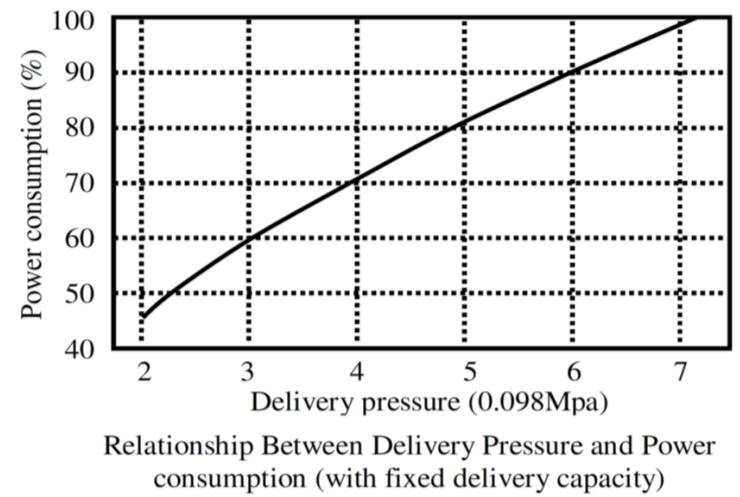
Item

Content

#### 1. Process Flow

Types of Compressors Available, and Range of Applications

Type	Range of application	
	Air capacity (m <sup>3</sup> /min)	Delivery pressure (0.098MPa)
Turbo type		
Axial flow	600~20,000	Up to 10
Centrifugal	20~6,000	Up to 50
Displacement type		
Screw	Up to 600	Up to 35
Reciprocating	Up to 50	Up to 30



#### 2. Technology Definition/Specification

The delivery pressure of compressors is generally 100 kPa or higher. Compressors have been developed for a variety of applications. Table shows the types of compressors available, and their range of applications. Energy saving in compressors requires consideration of the following points.

- \* Selection of the appropriate capacity
- \* Reduction in delivery pressure

Since the required motive power increases with increased delivery pressure, delivery pressure should be reduced as much as possible, while at the same time being sufficient for the receiving equipment (Fig. ), however it should be noted that motive power does not decrease with delivery pressure in the case of turbo compressors.

- \* Prevention of leakage
- \* Reduction in temperature of the compressed air
- \* Reduction in intake air resistance

Intake air resistance increases with intake filters, silencers, and valves in piping etc, and will increase the required motive power if excessive. Care is required to reduce pressure losses in the intake air system through periodic cleaning of filters to eliminate clogging.

- \* Reduction in piping resistance

Calculation conditions;

- \*Number of compressors; Total of 17,
- \*Equipment capacity; 823 kW,
- \*Daily operation; 24 h/d,
- \*Delivery pressure; 0.8MPa,
- \*On-load operation load; 60%,
- \*Annual operation; 241 days

#### 3. Investment Cost & Operating Life

Not announced

#### 4. Effect of Technology Introduction

•Reduction of CO2 Emission

Not announced

•Electricity Savings

285 MWh/y (=823 kW \* 60 % \* 10 % \* 24 h/d \* 241 days/y)

#### 5. Direct Effect (Annual Operating Cost)

•Economic Effect (payback time)

Not announced

•Monetary equivalent of energy savings

¥4,370,000/y 【0.5 Crore/year】

•Maintenance Cost Reduction

Not announced

#### 6. Indirect Effect (Co-benefits)

•Product Quality Improvement

Not announced

#### 7. Diffusion Rate of Technology in Japan

well known and familiarized

#### 8. Japanese Main Supplier

Major electric equipment suppliers

#### 9. Technologies Reference:

'Energy saving Diagnosis Examples – Common Equipment Volume', Energy conservation Center, Japan

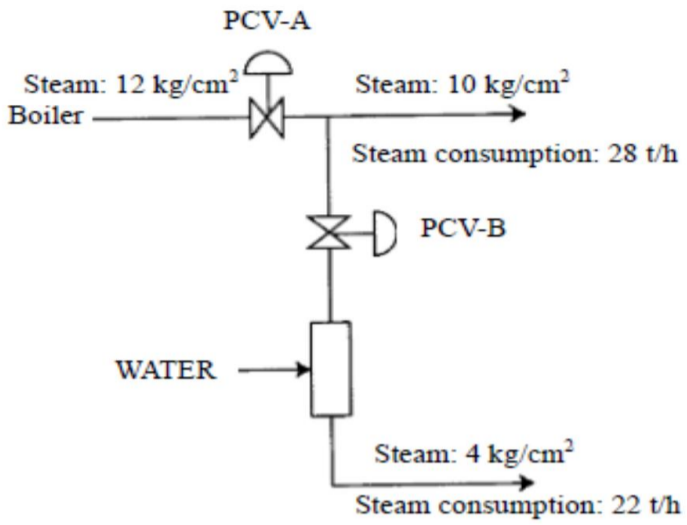
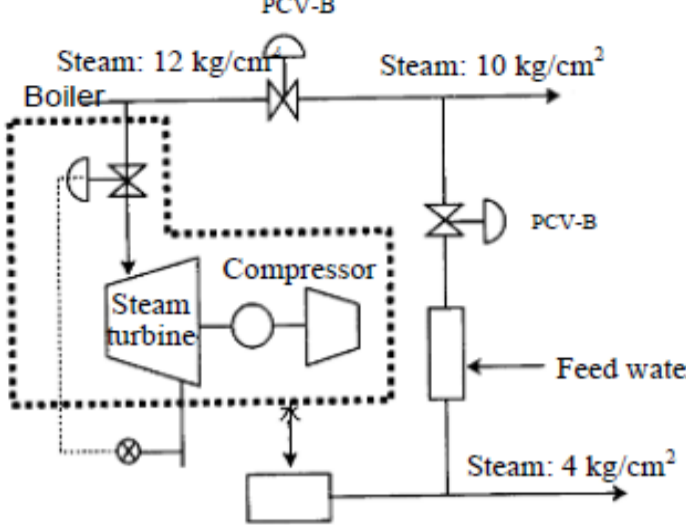
#### 10. Preconditions

- \* Important values were revised with referring to various values in "1-4. Used values and applied preconditions." Especially as for investment cost and payback time for the case of India, revised values were indicated in 【】.
- \* Payback time is defined as (Investment cost / Economical merit) in this project.
- \* Average unit cost of power; ¥15.3/kWh

# A-26

## General Energy Saving & Environmental Measures

### Power Recovery by Installation of Steam Turbine in Steam Pressure Reducing Line

Item	Content
1. Process Flow	  <p>Fig. 1 Steam pressure reducing system before improvement</p> <p>Fig. 2 System after improvement by introduction of steam turbine</p>
2. Technology Definition/Specification	<p><b>Outline :</b> In cases where high pressure steam generated by a boiler is used by pressure reduction, this technology reduces refrigerator power consumption by installing a steam turbine in place of the steam pressure reducing valve and driving the refrigerator with the power recovered by the steam turbine. Although steam consumption is increased somewhat, a total energy saving is achieved.</p> <p><b>Principle, operation and features of technology:</b> In this example in Fig.1, the capacity of the boiler which had been installed was approximately steam pressure: 12 kg/cm<sup>2</sup> and steam output: 50 t/h. However, this steam was used as process steam after pressure reduction. In one case, the reduced-pressure conditions were 10 kg/cm<sup>2</sup> and 28t/h, and in another, 4 kg/cm<sup>2</sup> and 22t/h (approximate values). That is, steam at a pressure of 12 kg/cm<sup>2</sup> was reduced to 10 kg/cm<sup>2</sup> and 4 kg/cm<sup>2</sup> by pressure reducing valves. In this example in Fig.2, a steam turbine is used in place of a pressure reducing valve, and the system was modified so that a refrigerator is driven by the rotational force of the turbine using steam as a power source. Pressure reducing valves reduce pressure by causing a pressure loss when the valve port in the valve is restricted, utilizing the difference in enthalpy drop due to adiabatic restriction. The principle of the steam turbine is the same as this, in that power is generated by utilizing the difference in enthalpy drop. The energy saving by adoption of this system is as follows: Reduction of electric power consumption – fuel for increase of steam consumption = Energy saving</p>
3. Investment Cost & Operating Life	approx. 50 million (Equipment), approx. 20million (Construction)
4. Effect of Technology Introduction	<ul style="list-style-type: none"> <li>•Reduction of CO2 Emission: Not announced</li> <li>•Electricity Savings: 544 (approx.) kW → 544kW*24h*330d/y=4308 MWh/y Demerit: Increase of steam consumption, approx.0.8 (t-steam/h)</li> </ul>
5. Direct Effect (Annual Operating Cost)	<ul style="list-style-type: none"> <li>•Economic Effect (payback time): 6,197.6(Gcal/y)=(Electricity Savings : 114,00.2Gcal/y)-(Increase of Steam consumption : 5,202.6Gcal/y) Reduction in crude oil equivalent: 619.8 t-crude oil/y (approx.) Equipment only : 0.7 years (approx.)【5.8 years】, Including construction cost: 1.0 years (approx.)【8.1 years】</li> <li>•Monetary equivalent of energy savings: ¥68 million/y 【0.5 Crore/y】</li> <li>•Maintenance Cost Reduction: Not announced</li> </ul>
6. Indirect Effect (Co-benefits)	•Product Quality Improvement: Not announced
7. Diffusion Rate of Technology in Japan	Numerous examples of implementation of similar technologies at main plants in Japan.
8. Japanese Main Supplier	Kobe Steel, Ltd.
9. Technologies Reference:	<ul style="list-style-type: none"> <li>•FY2000 Study Report “Survey of Energy Saving in Japan,” New Energy and Industrial Technology Development Organization (NEDO), March 2001</li> <li>•“Collected Examples of Energy Saving,” p. 1,095, 1984 (in Japanese)</li> </ul>
10. Preconditions	<p>* Important values were revised with referring to various values in "1-4. Used values and applied preconditions." Especially as for investment cost and payback time for the case of India, revised values were indicated in 【】.</p> <p>* "Japanese Technologies for Energy Savings/ GHG Emissions Reduction 《2008 Revised Edition》 (NEDO, 2008)"</p> <p>Cost of power : ¥17.99/kWh            Cost of C heavy oil : ¥1.81/1,000kcal            Overall boiler efficiency: 0.8            Electricity conversion factor: 2646kcal/kWh            Steam conversion factor: 656.9kcal/kg-steam</p>

# **2. Environmental Protection Technologies**

## **2-1. Technologies Customized List**

## Technologies Customized List of Environmental Protection Technologies for Indian Steel Industry 2025 version part 1:BF-BOF (v.5.2)

No.	Title of Technology	Technical Description	Expected Effects of Introduction
<b>Waste Water Treatment</b>			
B-1	High-Speed Coagulating Sedimentation Equipment	- Injection of polymer and optimized agitating time to produce high density pellets	- Removing suspended solids (SS)
B-4	High-Speed Air Flotation System	- Ten times larger upflow velocity than the conventional system, leading to drastic reduction in installation space	- Removing oily and suspended matters
B-6	Electrochlorination System	- This system reduces the volume of acid cleaning waste water, with the recycle system of MGPS	- Reduction of acid cleaning waste water
<b>Dust Emissions Control</b>			
B-8	Wet type Electrostatic Precipitator for COG	- Tar separation from COG with stable performance and continuous operation	- Low outlet dust (tar) concentration < 1 mg/Nm <sup>3</sup>
B-9	Dry type Electrostatic Precipitator	- The precipitator structure and dimensions have been standardized to uniform the gas flow distribution	- Low outlet dust concentration < 10-50 mg-dust/Nm <sup>3</sup>
B-10	Moving Electrode Electrostatic Precipitator: MEEP	- A moving electrode mechanism and a new method that removes dust by means of brushes were developed	- Cleaning exhaust gas (dust and ultrafine dust) from sintering machines
B-11	Wet type Electrostatic Precipitator for Scarfing Machine	- Dust, mist and submicron particulate are collected on collecting plates and washed away by water sprays	- Cleaning exhaust gas (dust and mist) from scarfing machines to less than 1 mg/m <sup>3</sup>
B-12	Wet type Electrostatic Precipitator for By-Produced Gas Turbine	- Using water in removing the collected dust, the wet EP can achieve high dust removal efficiency less than 1 mg/Nm <sup>3</sup>	- Effective for SO <sub>3</sub> , PM 2.5 and heavy metals
<b>Exhaust Gas Treatment through Denitrification, Desulphurization</b>			
B-13	Dry Activated Coke Exhaust Gas Treatment Facilities	- This method is capable of eliminating DXNs and heavy metals such as Hg in exhaust gas	- Eliminating DXNs and heavy metals such as Hg in exhaust gases
<b>Blast Furnace Gas and Cast House Dedusting</b>			
B-15	Ring Slit Washer (RSW) Wet Gas Scrubber	- Achieved excellent dust collection performance with its low load differential pressure and liquid-gas ratio	- Realizing the dust content at the outlet of 5 mg/Nm <sup>3</sup> for BFG or 20 mg/Nm <sup>3</sup> for LDG
B-16	Pulse type Bag Filter	- Compressed air is discharged through the pulsing nozzle and creates shock wave breaking the dust cake deposition	- Eliminating dust, DXNs and others
B-17	High temperature filter bag(nanolof HT)	- High temperature resistance up to Max 350°C - Non-flammable material (High resistance for sparks) - High strength (approximately 30% stronger than regular filter bag) - Easy handling and installation compared to ceramic forming filter bag.	- Less damage from sparks. - Energy and utility cost saving can be achieved due to omission or downside of existing cooling facility.
<b>General Technology</b>			
B-18	Gas Analyzer	- Measures the NO, SO <sub>2</sub> , CO <sub>2</sub> , CO, CH <sub>4</sub> , N <sub>2</sub> O and O <sub>2</sub> components in sample gas by detecting the amount of infrared rays absorbed by a Measuring cell, with Mass flow sensor.	- Quantitative grasp of substances of atmosphere that cause global warming

# **2. Environmental Protection Technologies**

## **2-2. Technologies One by One Sheet**

# B-1

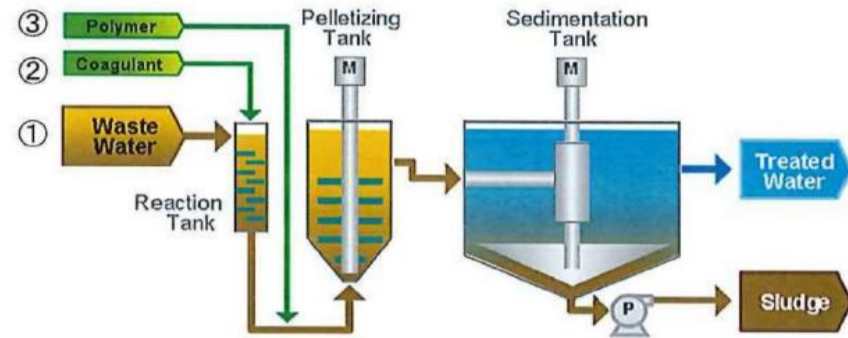
## Waste Water Treatment

### High-Speed Coagulating Sedimentation Equipment

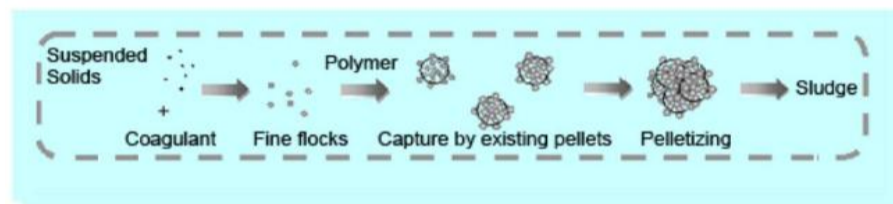
Item

Content

1. Process Flow or Diagram



Flow of High-Speed Sedimentation Treatment



2. Technology Definition/Specification

1. Suitable coagulants are selected according to wastewater property in order to generate high-density flocks.
  2. Injection of polymer and optimized agitating time to produce high-density pellets.
  3. Sedimentation & settlement process
- A slurry blanket layer is formed to quicken the sedimentation of the consolidated pellets

3. Field of Application

Removing SS from various types of wastewater

4. Regulatory and/or administrative frameworks in Japan

(Basic Environment Law)  
Environmental Water Quality Standard  
<http://www.env.go.jp/en/water/>

5. Benefits

Not Announced

6. Co-benefits

• No sludge thickener is required. Sludge is thickened to a high concentration (approx. 30,000 milligram/liter) by consolidation.

7. Japanese Main Supplier

Mitsubishi Heavy Industries Power Environmental Solutions, Ltd.

8. Technologies Reference

<https://power.mhi.com/group/es/products/rainwater/outline>

# B-4

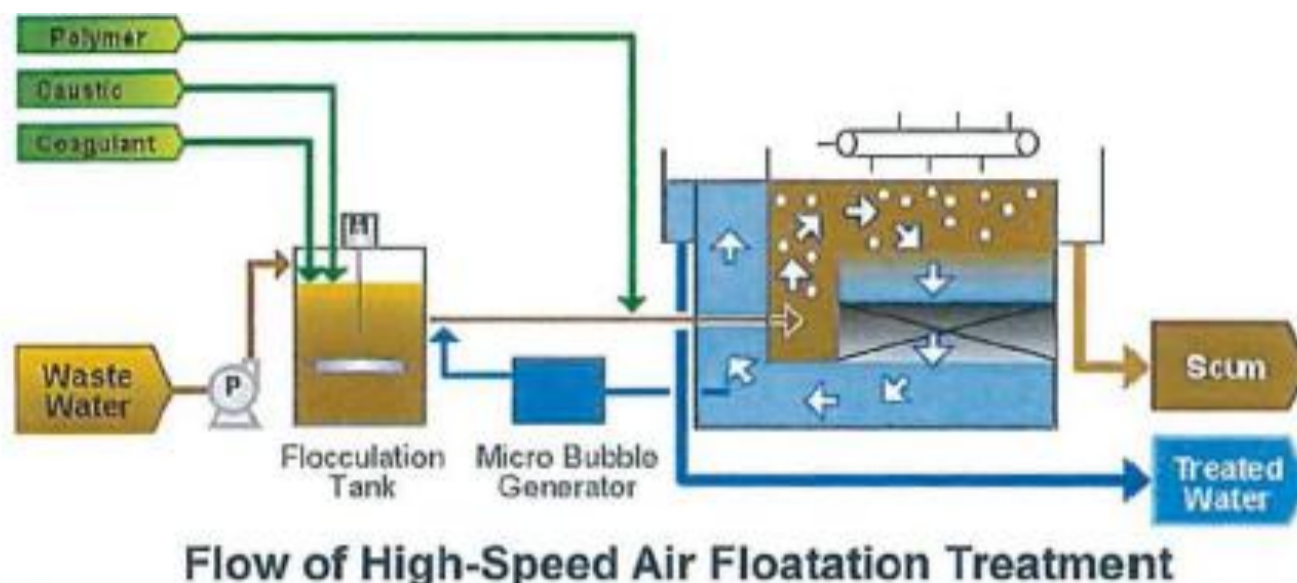
## Waste Water Treatment

### High-Speed Air Flotation System

Item

Content

1. Process Flow or Diagram



2. Technology Definition/Specification

As a result of the improvement of the structure of the floatation tank, we achieved ten times larger upflow velocity than the conventional system, leading to drastic reduction in installation space required for the unit. It could cut install space by 90%. As specification of the system, easy bubble generation control and fewer components to achieve easy Operations & Maintenance

3. Field of Application

- \* High Performance
- \* High dissolving efficiency by Micro Bubble Generator
- \* High efficient floatation of oily and suspended matters

4. Regulatory and/or administrative frameworks in Japan

(Basic Environment Law)  
Environmental Water Quality Standard  
<http://www.env.go.jp/en/water/wq/wp.pdf>

5. Benefits

Not Announced

6. Co-benefits


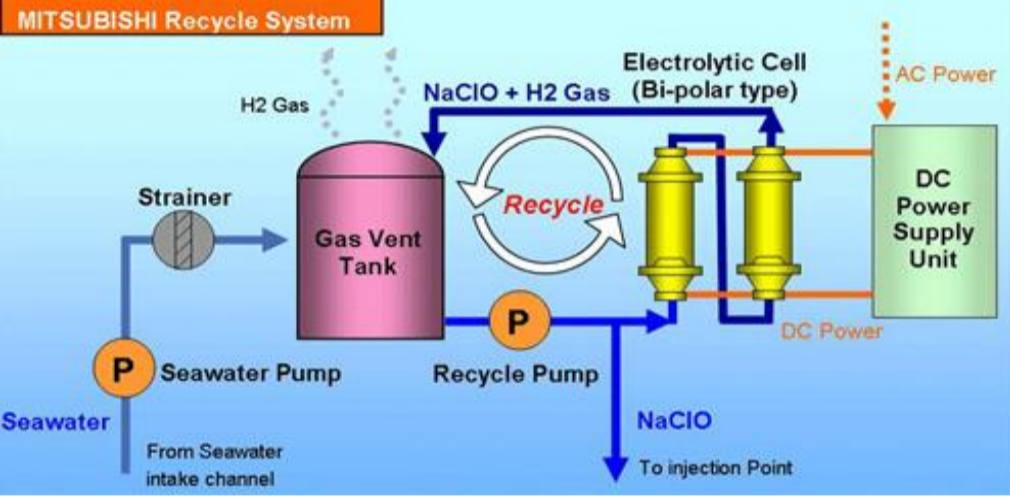

Not Announced

7. Japanese Main Supplier

Mitsubishi Heavy Industries Power Environmental Solutions, Ltd.

8. Technologies Reference

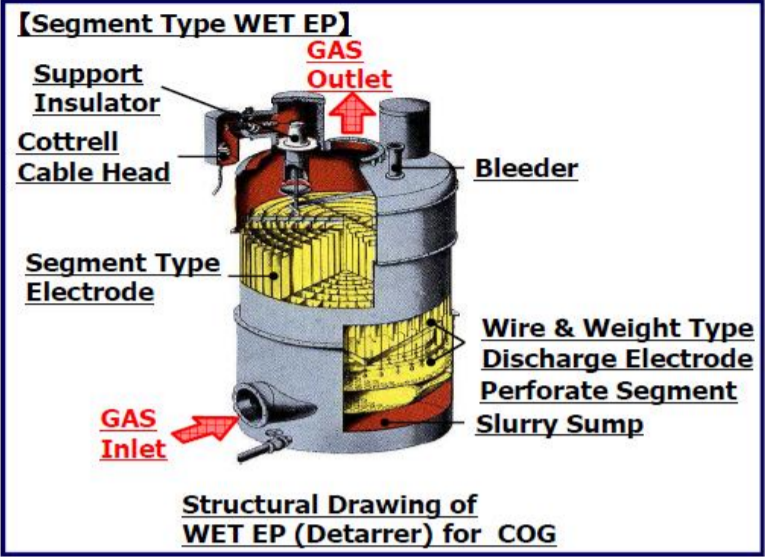
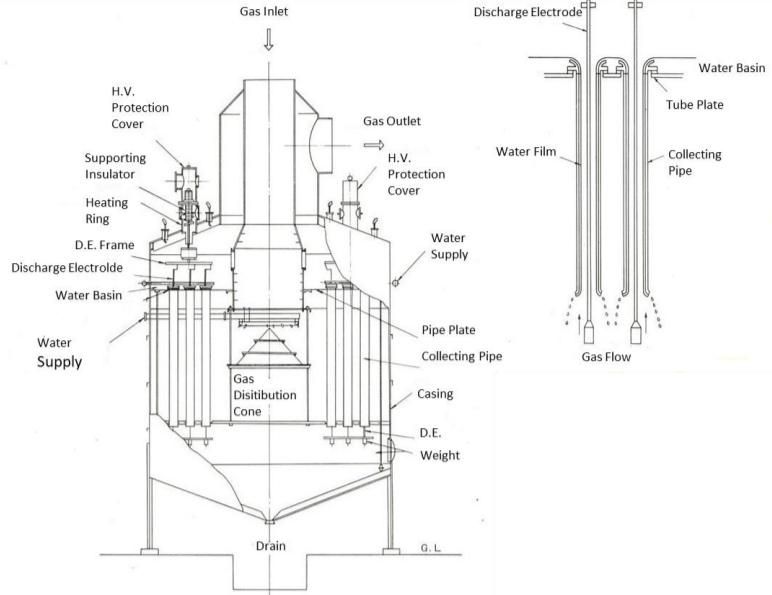
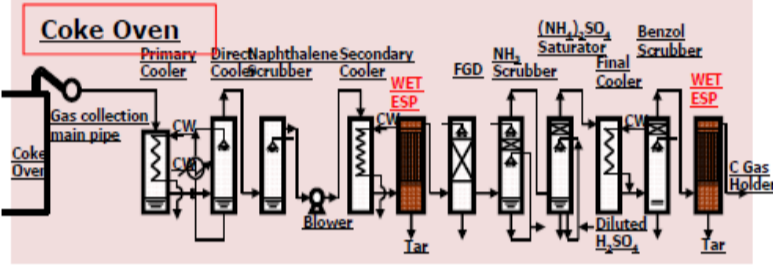
<https://power.mhi.com/group/es/products/rainwater/outline>

B-6	Waste Water Treatment Electrochlorination System
Item	Content
1. Process Flow or Diagram	<p><b>Mitsubishi MGPS® (Marine Growth Preventing System), a representative technology of electrochlorination system, has the environmental friendly process. Sodium hypochlorite solution produced in the Bi-polar cell unit is transported to the cell unit again with seawater, while some portion of it is discharged into the seawater inlet channel.</b></p>    <p><b>MITSUBISHI Recycle System</b></p> <p>The diagram illustrates the process flow: Seawater from the intake channel passes through a strainer and a seawater pump (P) into a gas vent tank. From there, it goes to a recycle pump (P) and then to an electrolytic cell (Bi-polar type). The cell is powered by a DC Power Supply Unit (DC Power) and produces NaClO + H<sub>2</sub> Gas. A portion of this solution is recycled back to the gas vent tank, while another portion is sent to an injection point. The electrolytic cell also receives AC Power.</p> <p>The schematic diagram shows the electrolytic cell with an Anode (+) and a Cathode (-). At the anode, Cl<sup>-</sup> is oxidized to Cl<sub>2</sub>. At the cathode, H<sub>2</sub>O is reduced to H<sub>2</sub> and OH<sup>-</sup>. The overall reaction produces NaClO and H<sub>2</sub> Gas.</p>
2. Technology Definition/Specification	<p><b>Mitsubishi MGPS® is the best solution for maintaining the efficiency of cooling systems in your plant !</b></p> <ul style="list-style-type: none"> <li>① <b>Proven Technology</b> MITSUBISHI MGPS® has over 50 years experience since 1965.</li> <li>② <b>Safety and harmless</b> Produced sodium hypochlorite is almost consumed and discharged into the seawater</li> <li>③ <b>High Durability</b> High chlorine generation efficiency achieved for a long time by original highly durable electrode coating.</li> <li>④ <b>High Availability &amp; Maintainability</b> Mitsubishi MGPS® can reduce the frequency of acid cleaning to 1/12.</li> </ul>
3. Field of Application	<p><b>Mitsubishi MGPS® can be applied to various kinds of plants on the sea! Wide capacity for any scales of plants</b></p> <ul style="list-style-type: none"> <li>● <b>Iron Mills</b></li> <li>● Coal-fired Thermal Power Plant</li> <li>● Gas Turbine Combind Cycle Thermal Power Plant</li> <li>● Nuclear Power Plant</li> <li>● LNG/LPG Terminals</li> <li>● Seawater Desalination Plants</li> <li>● Oil Refinery Plants</li> <li>● Chemical Plants (Fertilizer, Ammonia, Methanol, etc.)</li> <li>● Coastal Sewage Treatment Plants</li> <li>● Offshore Structure ( Offshore Oil Platform, etc.)</li> </ul>
4. Regulatory and/or administrative frameworks in Japan	<p>(Basic Environment Law) / Ministry of Environment ambient air quality standard <a href="http://www.env.go.jp/en/air/aq/aq.html">http://www.env.go.jp/en/air/aq/aq.html</a></p>
5. Benefits	<ul style="list-style-type: none"> <li>• <b>Reliable adhesion prevention</b> by electro chrolination technology</li> <li>• <b>Stable and improved plant operation rate</b> by protection of cooling system</li> <li>• <b>Reduction of LCC (Life Cycle Cost)</b> through energy-saving and chemical-saving technologies. Waste liquid treatment costs also can be reduced by over 90%.</li> </ul>
6. Co-benefits	<ul style="list-style-type: none"> <li>• <b>Eco-Technology for the local environment</b></li> <li>• <b>Safe Operation for plant operators</b></li> </ul>
7. Japanese Main Supplier	Mitsubishi Heavy Industries Environmental & Chemical Engineering Co., Ltd.
8. Technologies Reference	<p><b>Trackrecord : More than 165 Plants all over the world.</b> <a href="https://www.mhiec.co.jp/products/electrolysis/menes/menes_technologie.html">https://www.mhiec.co.jp/products/electrolysis/menes/menes_technologie.html</a></p>

# B-8

## Dust Emissions Control

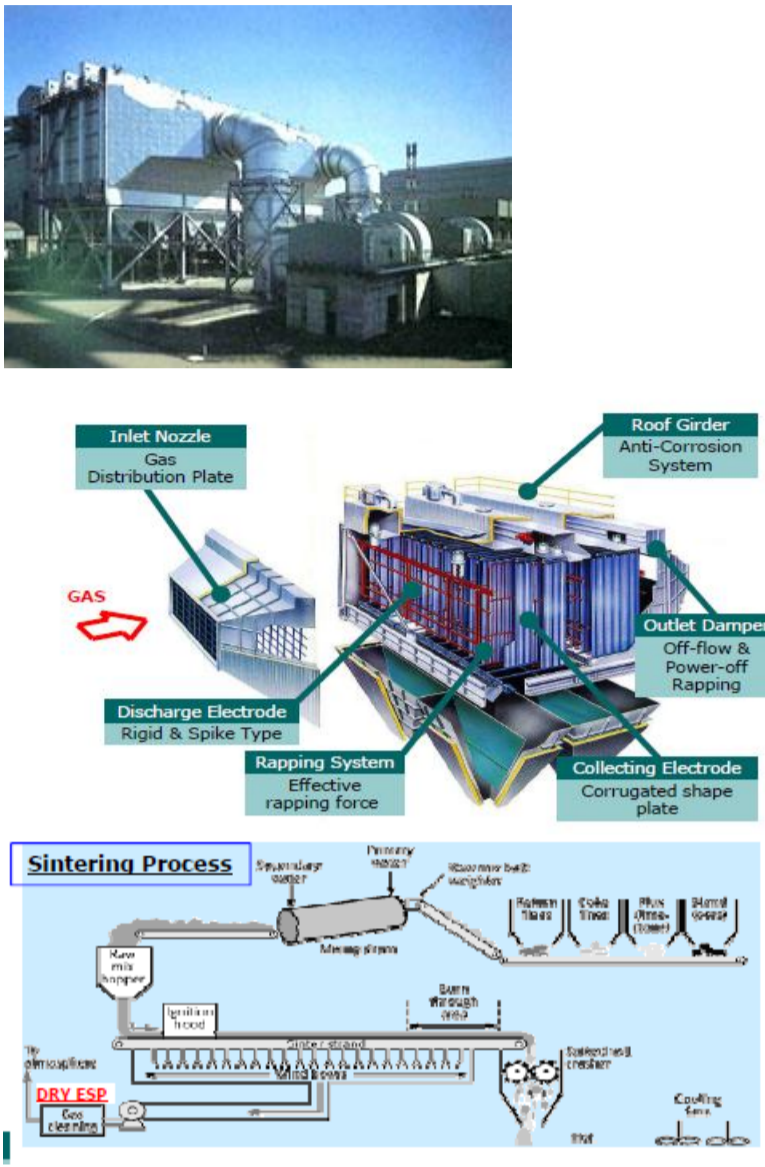
### Wet type Electrostatic Precipitator for COG

Item	Content	
1. Process Flow or Diagram	<div style="display: flex; justify-content: space-between;"> <div style="width: 45%;">  <p><b>Structural Drawing of WET EP (Detarrer) for COG</b></p> </div> <div style="width: 50%;">  </div> </div> <div style="margin-top: 10px;">  </div>	
2. Technology Definition/Specification	Low outlet dust(Tar) concentration < 1mg/Nm3 Wire & Weight Type Discharge Electrode Perforate Segment Slurry Sump	
3. Field of Application	Tar separation from coke oven gas Stable performance and continuous operation with countermeasures for corrosion, explosive and high pressure gas (1,500mmAq ~ 2,000mmAq)	
4. Regulatory and/or administrative frameworks in Japan	(Basic Environment Law) Environmental Water Quality Standard <a href="http://www.env.go.jp/en/water/wq/wp.pdf">http://www.env.go.jp/en/water/wq/wp.pdf</a>	
5. Benefits	Not Announced	
6. Co-benefits	Not Announced	
7. Japanese Main Supplier	Mitsubishi Heavy Industries Power Environmental Solutions, Ltd.	Sumitomo Heavy Industries, Ltd.
8. Technologies Reference	<a href="https://www.shi.co.jp/english/products/environment/electricity/index.html">https://www.shi.co.jp/english/products/environment/electricity/index.html</a>	

# B-9

## Dust Emissions Control

### Dry type Electrostatic Precipitator

Item	Content	
<p><b>1. Process Flow or Diagram</b></p>		
<p><b>2. Technology Definition/Specification</b></p>	<ul style="list-style-type: none"> <li>* The precipitator structure and dimensions have been standardized to actualize the gas flow distribution to be uniform, so that flow distribution test at site is not needed</li> <li>* Unique lattice-type gas distribution plate, which is configured to prevent dust adhesion and clogging, can be used without rapping</li> <li>* The discharge electrodes of high mechanical strength and superior discharging properties are used according to dust concentration and properties in each section, to ensure optimum energization conditions</li> <li>* Component except for the driving motor are built in, thus no noise is emitted.</li> <li>* Support insulators are protected at all times by seal air and heater, avoiding damage caused by dust sticking or moisture condensation.</li> <li>* Discharge electrodes are extremely strong specially-molded electrodes, short in length and fixed to the support frame (pipe), so as to prevent energization failure due to vibration or breakage due to fatigue.</li> </ul>	
<p><b>3. Field of Application</b></p>	<p>* Sinter main gas treatment are highly evaluated by customers under strict conditions such as high negative pressure (-1,000~2,500mmAq), high dust resistivity, flammable, corrosive, etc  <math>\Rightarrow 10 \sim 50 \text{mg-dust/Nm}^3</math></p>	
<p><b>4. Regulatory and/or administrative frameworks in Japan</b></p>	<p>(Basic Environment Law) / Ministry of Environment          ambient air quality standard  <a href="http://www.env.go.jp/en/air/qa/qa.htm">http://www.env.go.jp/en/air/qa/qa.htm</a></p>	
<p><b>5. Benefits</b></p>	<p>Not Announced</p>	
<p><b>6. Co-benefits</b></p>	<p>Not Announced</p>	
<p><b>7. Japanese Main Supplier</b></p>	<p>Mitsubishi Heavy Industries Power Environmental Solutions, Ltd.</p>	<p>Sumitomo Heavy Industries, Ltd.</p>
<p><b>8. Technologies Reference</b></p>	<p><a href="https://power.mhi.com/products/aqcs/lineup/dust-collector">https://power.mhi.com/products/aqcs/lineup/dust-collector</a></p>	<p><a href="https://www.shi.co.jp/english/products/environment/electricity/index.html">https://www.shi.co.jp/english/products/environment/electricity/index.html</a></p>

# B-10

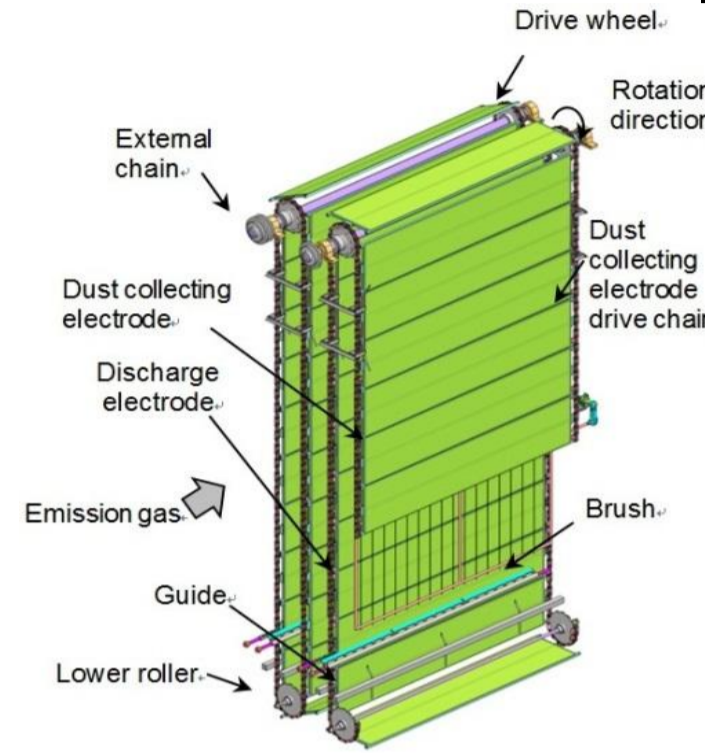
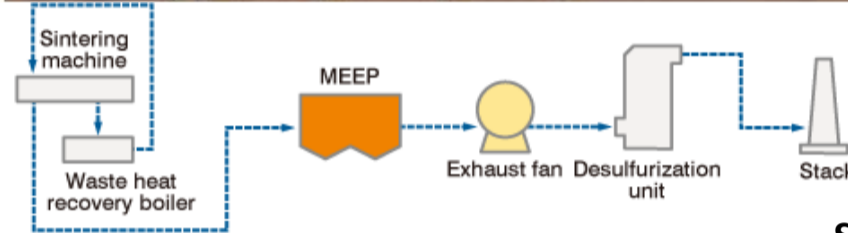
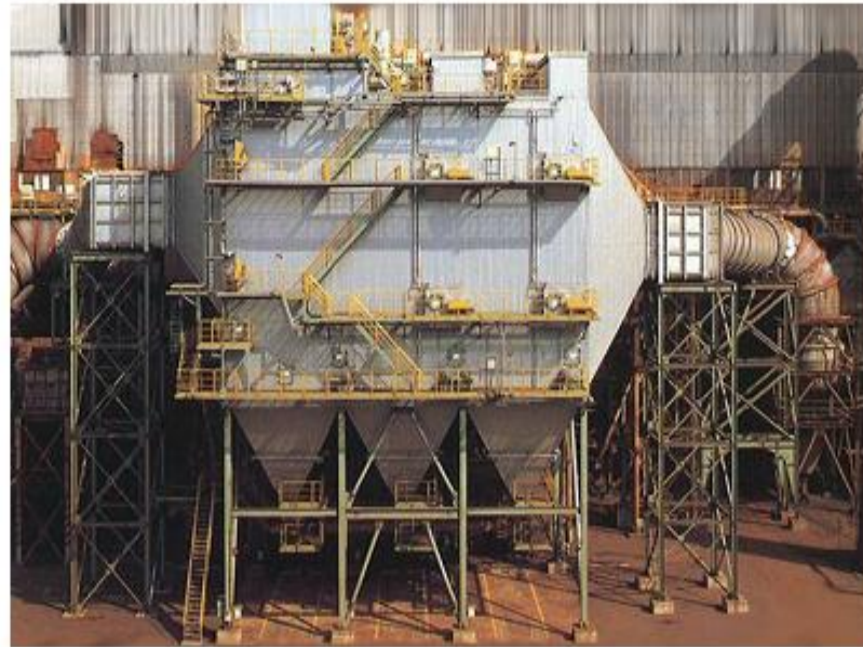
## Dust Emissions Control

### Moving Electrode Electrostatic Precipitator : MEEP

Item

Content

1. Process Flow or Diagram



Structural Diagram of Moving Electrode Unit

2. Technology Definition/Specification

Electrostatic precipitators are devices that collect dust by drawing it to the dust collecting electrode by using a discharge electrode to electrostatically charge the dust in the gas included in the flue emissions. With conventional fixed electrode electrostatic precipitators, the collection plate is hammered at regular intervals to knock off the collected dust. However, it is difficult to sufficiently remove highly adhesive, high resistivity dust from the plate. As a result, the surface of the collecting plate becomes covered by layers of adhered high-resistivity dust. If operation continues under these conditions, high-resistance obstruction and the back corona phenomenon will occur due to the dust covering the collecting plate. The corona current from the discharge electrode will be abated, and the dust deposited on the collecting electrode will cause dielectric breakdown, seriously degrading the dust collection performance.

For the moving electrode electrostatic precipitator, a moving electrode mechanism and a new method that removes dust by means of brushes were developed, enabling the efficient collection of high-resistivity dust and a space-saving footprint.

\* High performance

Since high-resistivity dust and ultrafine dust collected on the collecting electrode can be efficiently removed by brushes, dust collection efficiency is high. Also, because dust removal takes place outside of the dust collection area, there is no reentrainment and high performance can be maintained.

\* Space saving and power saving

Since dust collection efficiency is high, the apparatus can be made significantly smaller and power consumption can be reduced, enabling energy-saving operation.

3. Field of Application

Cleaning exhaust gas from sintering machines

4. Regulatory and/or administrative frameworks in Japan

(Basic Environment Law) / Ministry of Environment ambient air quality standard  
<http://www.env.go.jp/en/air/aq/aq.html>

5. Benefits

Not Announced

6. Co-benefits

Not Announced

7. Japanese Main Supplier

Mitsubishi Heavy Industries Power Environmental Solutions, Ltd.

8. Technologies Reference

<https://power.mhi.com/products/aqcs/lineup/dust-collector>

# B-11

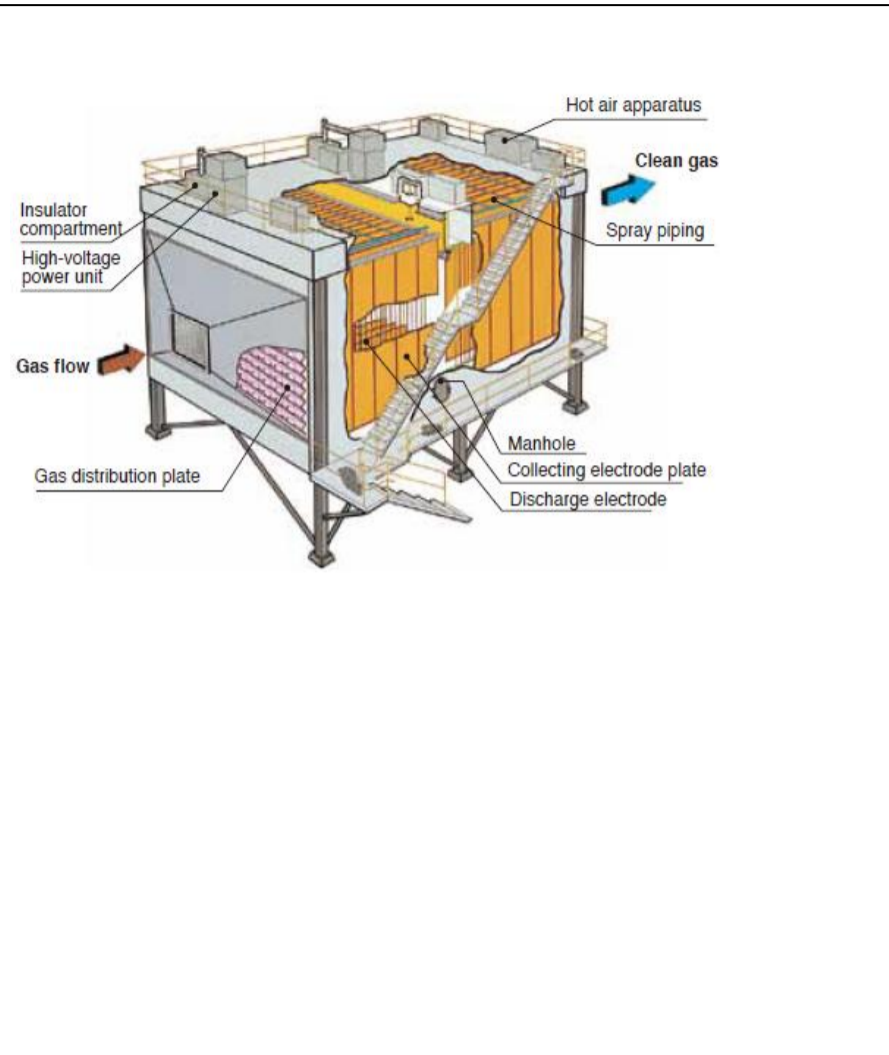
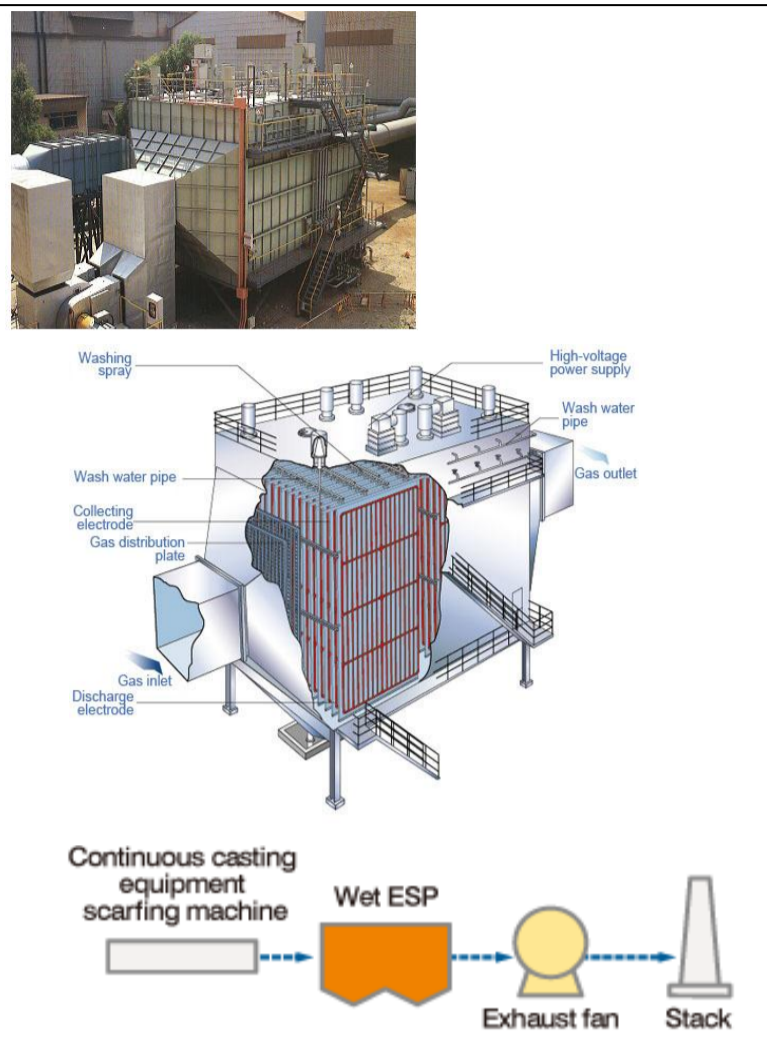
## Dust Emissions Control

### Wet type Electrostatic Precipitator for Scarfing Machine and Gas Cutting Machine

Item

Content

#### 1. Process Flow or Diagram



#### 2. Technology Definition/Specification

Dust and mist, including submicron particulate, are collected on collecting plates and then washed away by water sprays. Offering minimal water consumption, the Hitachi Plant Construction's wet ESP is designed with the configuration that is optimal for the customer's specific system. This enables high performance - reducing the outlet dust concentration to less than 1 mg/m<sup>3</sup> - from a compact wet ESP capable of handling high gas velocity. In addition, this system has following specification;

- (1) Reduced outlet dust concentration
- (2) Compact configuration
- (3) Reduced water consumption for washing the collecting electrodes and effectiveness with high gas velocity
- (4) Reduced use of industrial water
- (5) Total water treatment planning

Dust and mist, including submicron particulate, are collected on collecting plates and then washed away by water sprays. The Wet Electrostatic Precipitator(WESP), which was developed by Sumitomo Heavy Industries, Ltd.(SHI), has following specification;

- (1) Excellent dust removal performance.
- (2) Wide range of applications under such the corrosive and explosive conditions
- (3) Less breakdowns considering the structure with disconnecting of discharge electrode and breakage of insulators
- (4) Low running cost regarding the optimum energization control system and water consumption
- (5) Space-saving, Compact considering the properties of the waste flue gas and the lack of reentrainment.

#### 3. Field of Application

Cleaning exhaust gas from scarfing machines, Wet type ESP for gas cutting machine

#### 4. Regulatory and/or administrative frameworks in Japan

(Basic Environment Law) / Ministry of Environment ambient air quality standard  
<http://www.env.go.jp/en/air/aaq/aaq.html>

#### 5. Benefits

Not Announced

#### 6. Co-benefits

Not Announced

#### 7. Japanese Main Supplier

Mitsubishi Heavy Industries Power Environmental Solutions, Ltd.

Sumitomo Heavy Industries, Ltd.

#### 8. Technologies Reference

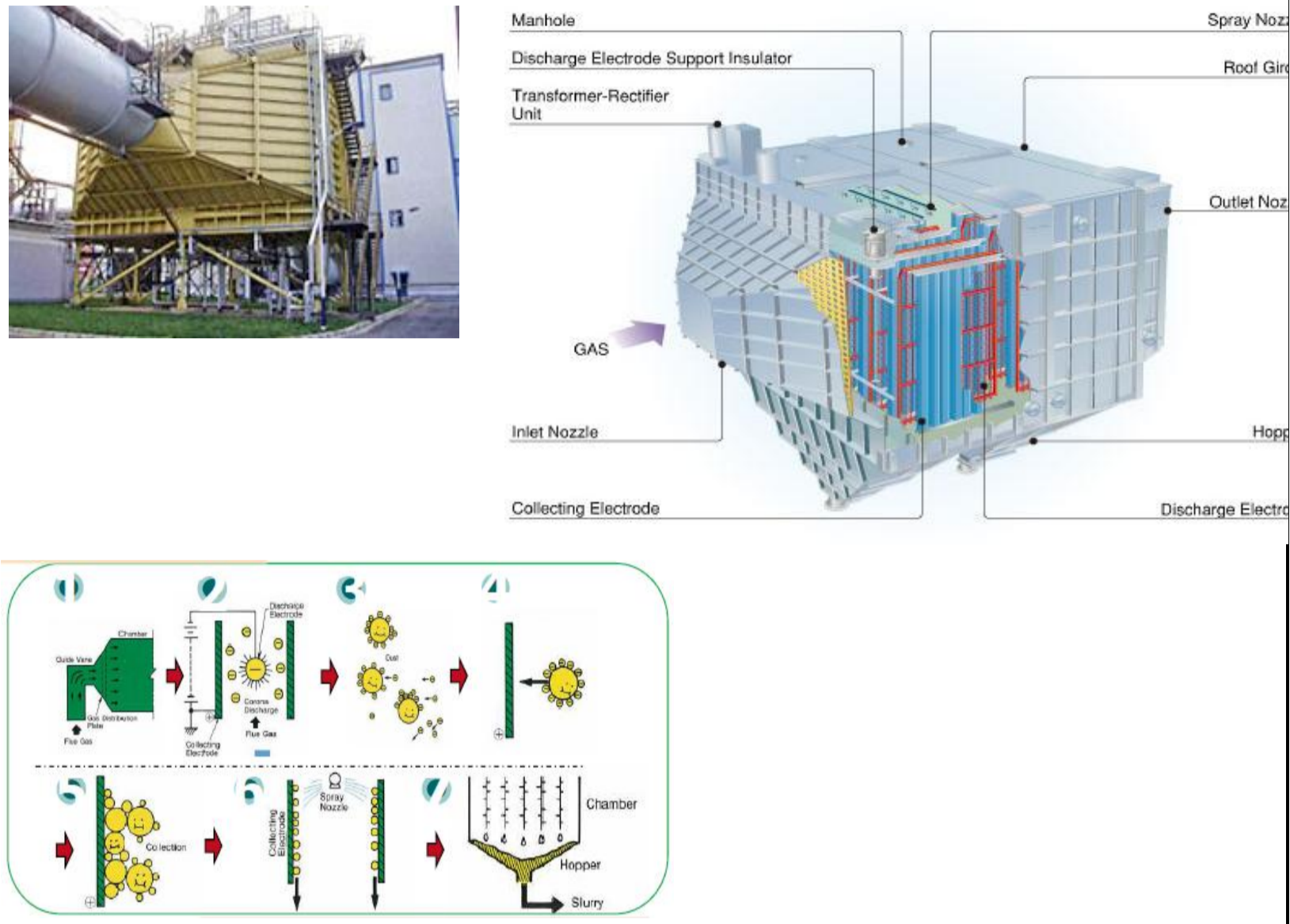
<https://power.mhi.com/products/aqcs/lineup/dust-collector>

<https://www.shi.co.jp/english/products/environment/electricity/index.html>

# B-12

## Dust Emissions Control

### Wet type Electrostatic Precipitator for By-Produced Gas Turbine

Item	Content
<p><b>1. Process Flow or Diagram</b></p>	
<p><b>2. Technology Definition/Specification</b></p>	<ul style="list-style-type: none"> <li>* Using water in removing the collected dust, the wet EP can achieve high dust removal efficiency (less than over equal to 1mg/m<sup>3</sup>N at wet type EP outlet is also possible) without being affected by the high or low electrical resistivity of dust.</li> <li>* Using an excellent atomization electrode washing nozzle, the discharge electrodes and collecting electrodes can be washed</li> <li>* In case significant corrosion is evident due to the gas property or quality of water, corrosion-resistant design such as stainless steel, FRP, and flake lining is being considered.</li> </ul>
<p><b>3. Field of Application</b></p>	<ul style="list-style-type: none"> <li>* Wet type EP for by-produced gas turbine for power generation remove solid particulate matters contained in the fuel, actualizing ultralow concentration in order to protect compressors for gas turbines.</li> <li>* Effective for SO<sub>3</sub>, PM<sub>2.5</sub>, and Heavy metals</li> </ul>
<p><b>4. Regulatory and/or administrative frameworks in Japan</b></p>	<p>(Basic Environment Law) / Ministry of Environment          ambient air quality standard  <a href="http://www.env.go.jp/en/air/aq/aq.html">http://www.env.go.jp/en/air/aq/aq.html</a></p>
<p><b>5. Benefits</b></p>	<p>Not Announced</p>
<p><b>6. Co-benefits</b></p>	<p>Not Announced</p>
<p><b>7. Japanese Main Supplier</b></p>	<p>Mitsubishi Heavy Industries Power Environmental Solutions, Ltd.</p>
<p><b>8. Technologies Reference</b></p>	<p><a href="https://power.mhi.com/products/aqcs/lineup/dust-collector">https://power.mhi.com/products/aqcs/lineup/dust-collector</a></p>

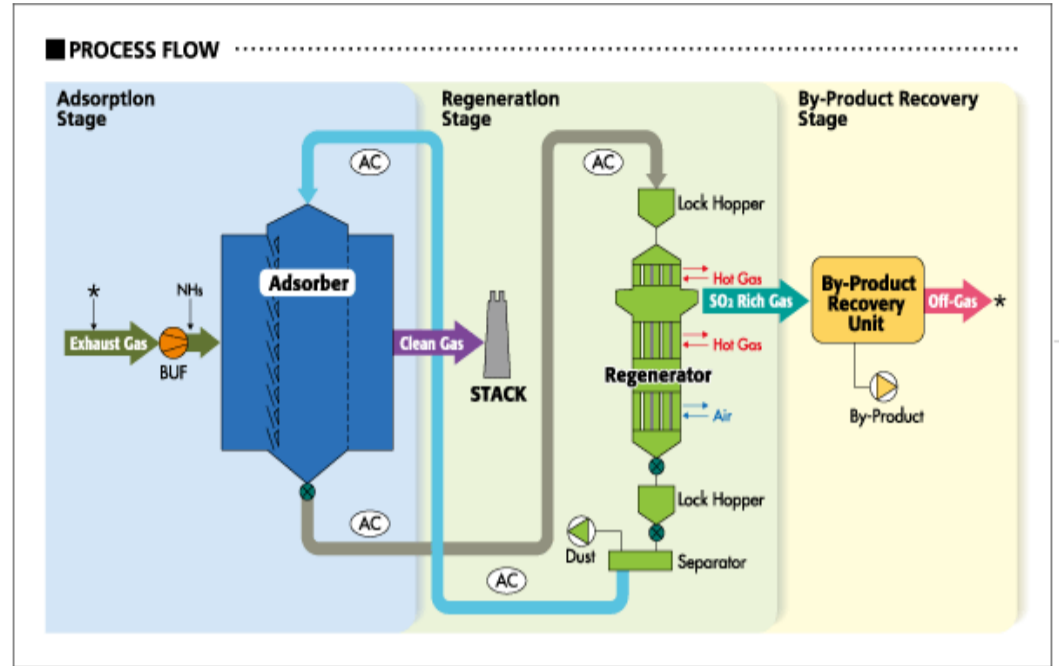
# B-13

## Exhaust Gas Treatment through Denitrification, Desulfurization Dry Activated Coke Exhaust Gas Treatment Facilities

Item

Content

### 1. Process Flow or Diagram



### 2. Technology Definition/Specification

The activated coke in the moving bed moves slowly in a vertical direction (top to bottom). As it moves it comes into contact with the exhaust gases that flow in a horizontal direction, eliminating pollutants. This method is referred to as the cross flow moving bed method and also provides a dust collecting function. This method is capable of eliminating DXNs and Heavy Metals such as Hg in exhaust gases.

### 3. Field of Application

- \* Sintering Machines in steel plants
- \* Pulverixed coal fired power plants
- \* Incinerater

### 4. Regulatory and/or administrative frameworks in Japan

(Basic Environment Law) / Ministry of Environment  
ambient air quality standard  
<http://www.env.go.jp/en/air/aq/aq.html>

### 5. Benefits

Not Announced

### 6. Co-benefits

- Various harmful components included in exhaust gases can be eliminated
- No changes to the temperature of exhaust gases
- Small amount of service water used
- Byproducts (sulfuric acid, gypsum, etc.) can be selected to suit the installation location
- Small amount of waste materials generated

### 7. Japanese Main Supplier

J-POWER EnTech, Inc.

### 8. Technologies Reference

# B-15

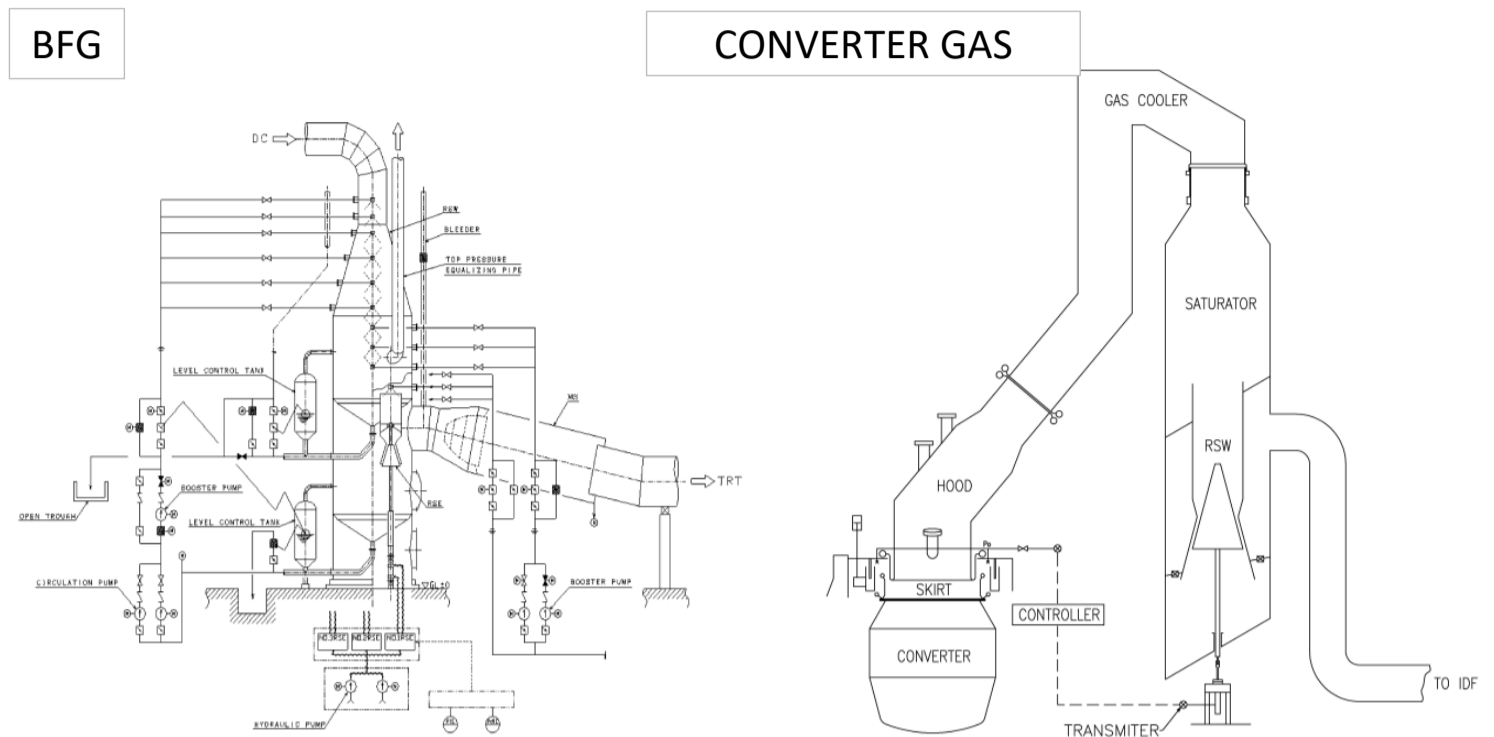
## Blast Furnace Gas and Cast House Dedusting

### Ring Slit Washer (RSW) Wet Gas Scrubber

Item

Content

#### 1. Process Flow or Diagram



#### 2. Technology Definition/Specification

The RSW jointly contains an auxiliary spray tower-type scrubber in its upper part and a variable throat-type venturi scrubber called RSE in its lower part.

When this system is applied to the blast furnace, an axis flow mist separator is installed in the downstream to separate air and liquid and realizes the dust content at the outlet of the system of 5 mg/Nm<sup>3</sup> or lower.

When this system is applied to the converter, gas from the gas cooler is cooled down again to 70 deg C by the saturator and 99.9% of dust, which is contained high concentrated in the gas, is removed at dust collector(RSE)

In addition, this system has following specification;

- \* Compact, space-saving system.
- \* Achieved excellent dust collection performance with its low load differential pressure and liquid-gas ratio.
- \* When this system applied to BF, the load differential pressure is 30 kPa, and the dust content at the outlet of the RSW is 5 mg/Nm<sup>3</sup> or lower .
- \* When this system applied Converter, the load differential pressure is 15 - 20 kPa, and the dust content at the outlet of the RSW is 20 mg/Nm<sup>3</sup> or lower.
- \* Realized excellent blast furnace top pressure control performance.
- \* Realized excellent converter throat pressure control performance, results high gas recovery efficiency(70-90%)

#### 3. Field of Application

The Ring Slit Washer (RSW) wet gas scrubber is used widely with various dust collection devices, including its use for cleaning the gas emitted by blast and converter furnaces.

#### 4. Regulatory and/or administrative frameworks in Japan

Strategic Energy Plan  
Act on Promotion of Global Warming Countermeasures

#### 5. Benefits

Not Announced

#### 6. Co-benefits

Not Announced

#### 7. Japanese Main Supplier

JP Steel Plantech Co. (SPCO)

#### 8. Technologies Reference

<http://steelplantech.com/product/rsw/>

# B-16

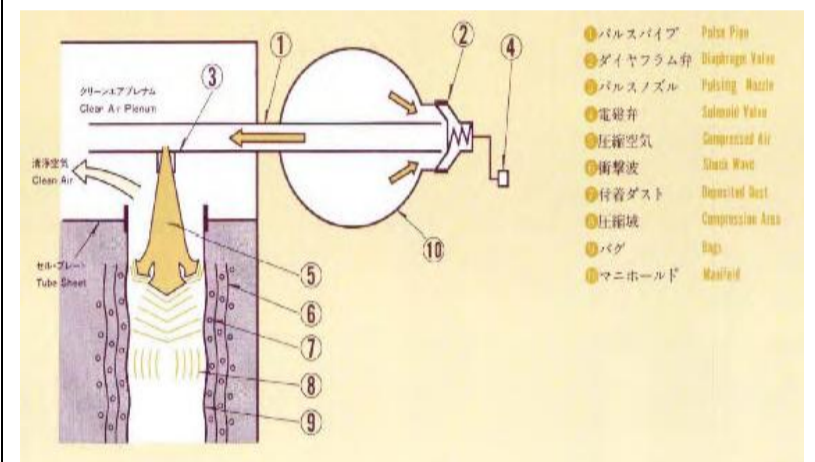
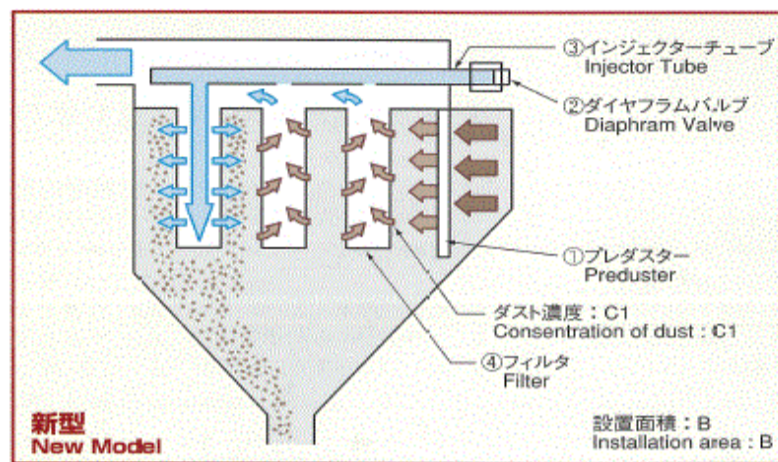
## Blast Furnace Gas and Cast House Dedusting

### Pulse type Bag Filter

Item

Content

#### 1. Process Flow or Diagram

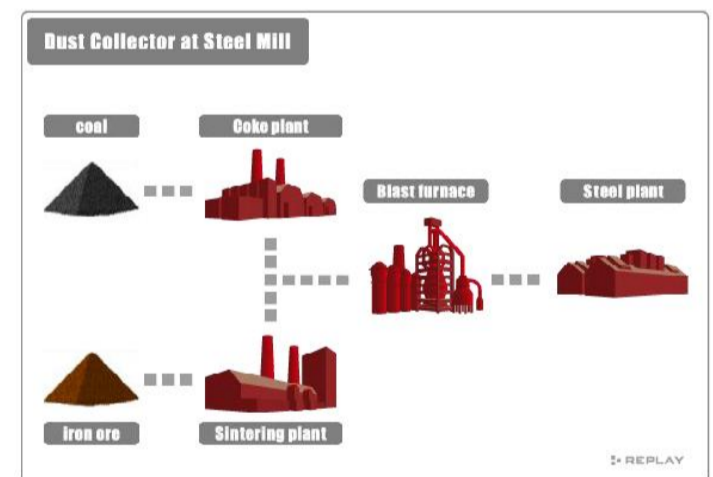


#### 2. Technology Definition/Specification

When the diaphragm valve is opened, compressed air is discharged through the pulsing nozzle. It creates shock wave which break the deposition of dust cake.  
Reduction in the number of parts and components, such as the filtering cloth, leads to a reduced number of replacement parts and therefore the costs involved in work for exchanging parts and components are reduced.  
Also, the adoption of a high-speed filtration and long length filtering cloth achieved space saving.

#### 3. Field of Application

- \* Coke Plant
  - Coal charging car
  - Coke guide
  - Pusher
  - Flue gases from coke oven
- \* Sintering Plant
  - Sinter cooler
- \* Blast Furnace
  - Coal Pulverization for BF Injection
- \* House dedusting



#### 4. Regulatory and/or administrative frameworks in Japan

(Basic Environment Law) / Ministry of Environment  
ambient air quality standard  
<http://www.env.go.jp/en/air/aq/aq.html>

#### 5. Benefits

Not Announced

#### 6. Co-benefits

Not Announced

#### 7. Japanese Main Supplier

Nihon Spindle Manufacturing, Sumitomo Heavy Industries, Ltd

Shinwa Corporation

#### 8. Technologies Reference

<http://www.spindle.co.jp/product/dust.html>  
<http://www.shi.co.jp/english/products/environment/dust/index.html>

[https://www.shinwatec.co.jp/products/air\\_pollution\\_control\\_systems/](https://www.shinwatec.co.jp/products/air_pollution_control_systems/)  
<https://www.shinwatec.co.jp/en/pollution/>

# B-17

## Blast Furnace Gas and Cast House Dedusting

### High temperature filter bag(nanolof HT)

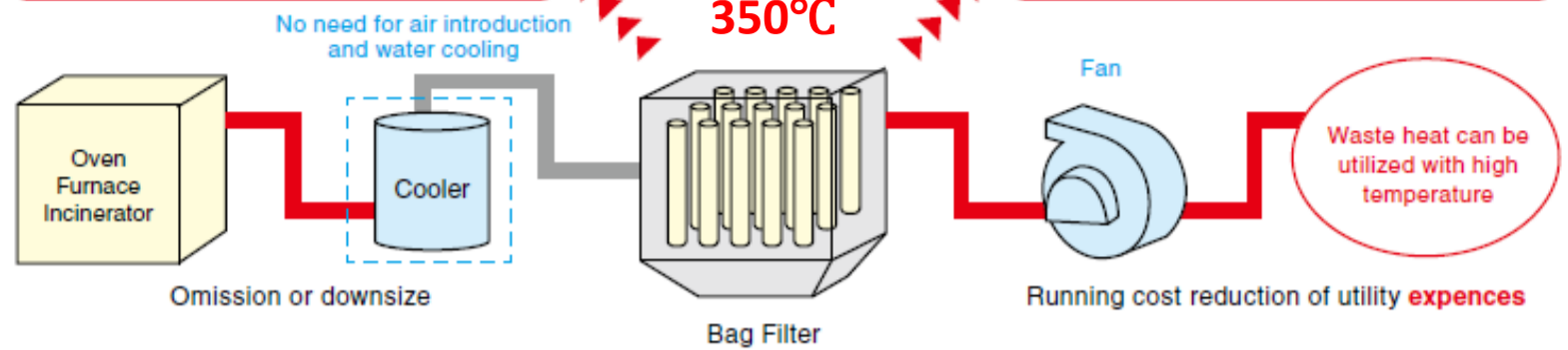
Item

Content

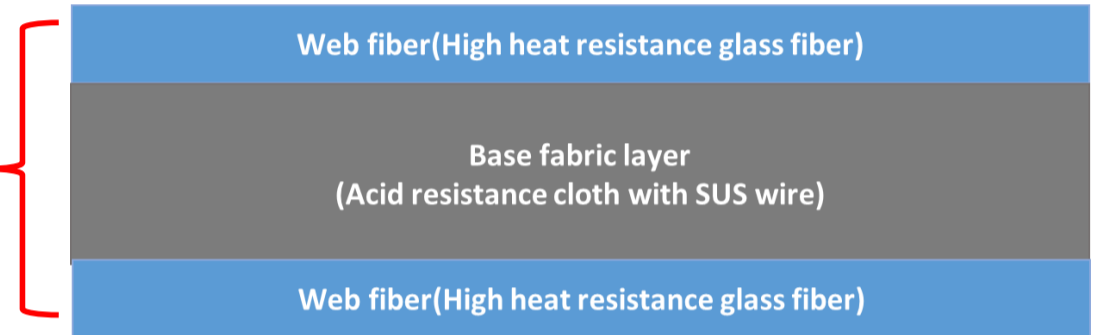
#### INTRODUCTION EFFECTS

Energy saving by omission or downside of ancillary facilities.

Energy saving by secondary use of waste heat.



Using nanolof HT, it is NOT necessary to lower the gas temperature below 200°C by cooling equipment before dedusting system.  
(Normal filter bags can be used only at 200°C for regular use, and up to 230°C for a moment.)



#### 1. Process Flow or Diagram

#### 2. Technology Definition/Specification

- High temperature resistance up to Max 350°C
- Non-flammable material (High resistance for sparks)
- High strength (approximately 30% stronger than regular filter bag)
- Easy handling and installation compared to ceramic forming filter bag.

#### 3. Field of Application

Waste gas treatment facilities relating to incinerator, steel factory, power plant, waste treatment plant and chemical plant.

#### 4. Regulatory and/or administrative frameworks in Japan

#### 5. Benefits

Bag filter can be operated at high temperature condition (300°C or more) and less damage from sparks. Energy and utility cost saving can be achieved due to omission or downside of existing cooling facility.

#### 6. Co-benefits

More waste heat recovery can be achieved after dedusting.

#### 7. Japanese Main Supplier

Shinwa corporation

#### 8. Technologies Reference

# B-18

## General Technology

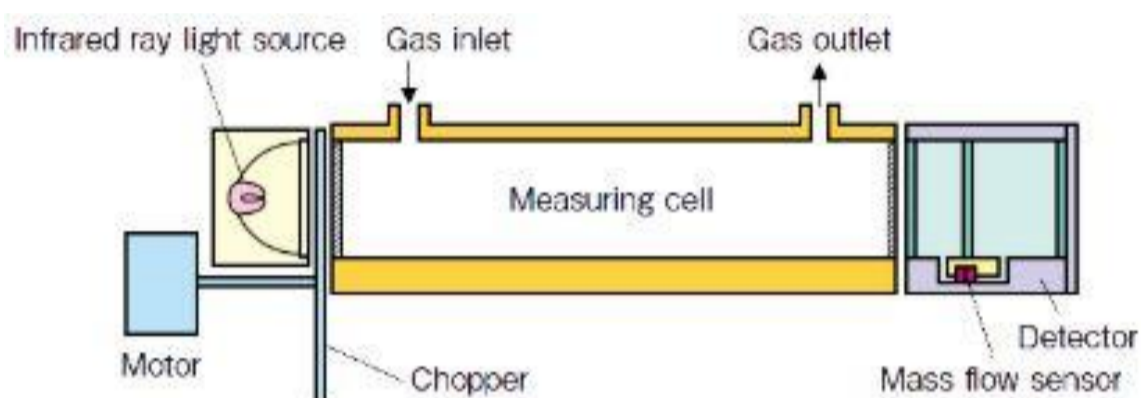
### Gas Analyzer

Item

Content



#### 1. Process Flow or Diagram



#### 2. Technology Definition/Specification

Gas Analyzer is capable of measuring the NO, SO<sub>2</sub>, CO<sub>2</sub>, CO, CH<sub>4</sub>, N<sub>2</sub>O and O<sub>2</sub> components in sample gas by detecting the amount of infrared rays absorbed by a Measuring cell, with Mass flow sensor. There are various types of gas analyzers for each applications and it is used to support environmental preservation and control atmospheric pollution as well as monitor the atmosphere to help maintain a cleaner natural environment. Fuji Electric produce the whole equipment including the sensor, which is an important part of Gas Analyzer.

#### 3. Field of Application

Blast furnace, Converter funacer, Heat treatment furnace, Sintering (pallet equipment), Coke oven (CDQ)

#### 4. Regulatory and/or administrative frameworks in Japan

(The Basic Environment Law) / Ministry of Environment  
Environmental Quality Standards  
<http://www.env.go.jp/en/air/aq/aq.html>

#### 5. Benefits

Quantitative grasp of substances of atmosphere that cause global warming

#### 6. Co-benefits

Balancing economic activities and environmental conservation by a basic data provided by Gas Analyzer

#### 7. Japanese Main Supplier

Major electric equipment suppliers

#### 8. Technologies Reference

[https://www.fujielectric.com/products/instruments/products/anlz\\_gas/top.html](https://www.fujielectric.com/products/instruments/products/anlz_gas/top.html)

# Contact Points of Suppliers

Company	Contact Points	Energy-Saving Technologies	Environmental Protection Technologies
Chugai Ro Co., Ltd.	2-4 Chikko-shinmachi, Nishi-ku, Sakai 592-8331, Japan TEL:+81-72-247-2108 FAX:+81-72-247-2174 <a href="https://chugai.co.jp/en/">https://chugai.co.jp/en/</a>	A-12: Low NOx regenerative burner system for ladle preheating A-15: Process control for reheating furnace A-16: Regenerative Burner Total system for reheating furnace A-17: High temperature recuperator for reheating furnace A-18: Fiber block for insulation of reheating furnace A-20: Oxygen enrichment for combustion air	
Daido Steel Co., Ltd.	1-10, Higashisakura 1-chome, Higashi-ku, Nagoya, Aichi, 461-8581, Japan TEL:+81-52-963-7501 FAX: +81-52-963-4386 <a href="https://www.daido.co.jp/en/index.html">https://www.daido.co.jp/en/index.html</a>	A-21: Highly efficient combustion system for radiant tube burner	
Fuji Electric CO., LTD.	Gate City Ohsaki, East Tower, 11-2, Osaki 1-chome, Shinagawa-ku, Tokyo 141-0032, Japan <a href="https://www.fujielectric.com/contact/?ui_medium=gl_gnavi">https://www.fujielectric.com/contact/?ui_medium=gl_gnavi</a>	A-23: Energy Monitoring and Management Systems	B-18: Gas Analyzer
JP Steel Plantech Co.	Kaneko 2nd Building 4-9F 2-6-23 Shin-yokohama, Kohoku-ku, Yokohama 222-0033 JAPAN TEL:+81-45-471-3911 Fax:+81-45-471-4002 <a href="https://steelplantech.com/en/">https://steelplantech.com/en/</a>	A-1: Sinter Plant Heat Recovery (Steam Recovery from Sinter Cooler Waste Heat) A-2: Sinter Plant Heat Recovery (Power Generation from Sinter Cooler Waste Heat) A-3: High Efficient (COG) Burner in Ignition Furnace for Sinter Plant A-4: Coke Dry Quenching (CDQ) A-8: Pulverized Coal Injection (PCI) System A-11: Converter Gas Recovery Device A-13: Converter Gas Sensible Heat Recovery Device A-25: Management of Compressed Air Delivery Pressure Optimization	B-15: Ring Slit Washer (RSW) Wet Gas Scrubber
J-POWER EnTech, Inc.	Daiwa NishiShimbashi Building (4F), 3-2-1, Nishi-shimbashi, Minato-ku, Tokyo, 105-0003 Japan TEL:+81-3-3434-7081 FAX:+81-3-3434-7086 Email:mail-box@jp-entech.co.jp <a href="https://www.jp-entech.co.jp/en/">https://www.jp-entech.co.jp/en/</a>		B-13: Dry Activated Coke Exhaust Gas Treatment Facilities
Kobe Steel, Ltd.	ON Building, 9-12, Kita-Shinagawa 5-chome, Shinagawa-ku, Tokyo, 141-8688, Japan TEL:+81-3-5739-6000 FAX:+81-3-5739-6903 <a href="http://www.kobelco.co.jp/english/machinery/inquiry/">http://www.kobelco.co.jp/english/machinery/inquiry/</a>	A-26: Power Recovery by Installation of Steam Turbine in Steam Pressure Reducing Line	
Mitsubishi Heavy Industries Environmental & Chemical Engineering Co., Ltd.	Yokohama Blue Avenue Bldg., 4-4-2, Minatomirai, Nishi-ku Yokohama, Kanagawa 220-0012, Japan Tel: +81-45-227-1280	A-24: Low Calorie Fired Gas Turbine Combined Cycle Plant	B-6: Electro Chlorination System(MGPS)
Mitsubishi Heavy Industries Power Environmental Solutions, Ltd.	NISSEKI YOKOHAMA Bldg. 1-8, Sakuragicho 1-Chome Naka-Ku, Yokohama 231-0062, Japan TEL: +81-(0)45-232-4948 FAX: +81-(0)45-307-3400 URL: <a href="https://power.mhi.com/jp/group/es/">https://power.mhi.com/jp/group/es/</a>		B-1: High-Speed Coagulating Sedimentation Equipment B-4: High-Speed Air Floatation System B-8: Wet type Electrostatic Precipitator B-9: Dry type Electrostatic Precipitator B-10: Moving Electrode Electrostatic Precipitator(MEEP) B-11: Wet type Electrostatic precipitator for Scarfing Machine and Gas Cutting Machine B-12: Wet type Electrostatic Precipitator for By-Produced Gas Turbine
Mitsui E&S Co., Ltd.	6-4 Tsukiji 5-chome, Chuo-ku, Tokyo, JAPAN Overseas Sales Gr., Sales Dept., New Business Development Div. TEL: +81-3-3544-3951 <a href="https://www.mes.co.jp/english/">https://www.mes.co.jp/english/</a>	A-6: Top Pressure Recovery Turbine (TRT)	
Mitsui E&S Power Systems Inc.	MESPS Nihonbashi Office: TEL:+81-3-6665-6435 FAX:+81-3-6665-6436 sales@mesps.mes.co.jp	A-19: Induction type billet heater for direct rolling	
Nihon Spindle Manufacturing Co., Ltd.	Sumitomo Fudosan Ueno Building No. 5, 1-10-14 Kita-Ueno Taito-ku, Tokyo 110-0014 TEL: +81-3-5246-5610 <a href="http://www.spindle.co.jp/en/index.html">http://www.spindle.co.jp/en/index.html</a>		B-16: Pulse type Bag Filter
Nippon Furnace CO., LTD	2-1-53, Shitte, Tsurumi-ku, Yokohama City, Kanagawa Prefecture, 230-8666 Japan TEL:+81-45-575-8111 FAX:+81-6-5534-8046 Email:webmaster@furnace.co.jp <a href="http://www.furnace.co.jp/en.html">http://www.furnace.co.jp/en.html</a>	A-12: Low NOx regenerative burner system for ladle preheating A-16: Regenerative Burner Total system for reheating furnace A-20: Oxygen enrichment for combustion air	
Nippon Steel Engineering Co., Ltd.	Osaki Center Building, 1-5-1 Osaki, Shinagawa-ku, Tokyo 141-8604 Japan TEL: +81-3-6665-2000 <a href="https://www.eng.nipponsteel.com/english/">https://www.eng.nipponsteel.com/english/</a>	A-4: Coke Dry Quenching (CDQ) A-5: Coal Moisture Control (CMC)	
Paul Wurth IHI Co., Ltd.	Toyosu Center Bldg. 9F, 3-3 Toyosu 3-chome, Koto-ku, Tokyo 135-6009 Japan TEL:+81-3-6630-4786 FAX:+81-3-3536-4014 Email:contact@ihi-pw.jp <a href="https://www.ihi.co.jp/hipw/en/index.html">https://www.ihi.co.jp/hipw/en/index.html</a>	A-4: Coke Dry Quenching (CDQ) A-9: Hot Stove Waste Gas Heat Recovery A-10: Top Fired Hot Stove	
Rozai Kogyo Kaisha Ltd.	2-14, Minamihorie 1-chome, Nishiku, Osaka, Japan 550-0015 TEL:+81-6-6534-3609 Fax:+81-6-6534-3602 <a href="http://www.rozai.co.jp/en/company/index.html">http://www.rozai.co.jp/en/company/index.html</a>	A-15: Process control for reheating furnace A-16: Regenerative Burner Total system for reheating furnace A-17: High temperature recuperator for reheating furnace A-18: Fiber block for insulation of reheating furnace	
Shinwa Corporation	Harmony Tower, 1-32-2 Honmachi, Nakano-ku, Tokyo 164-0012 JAPAN Email:info@shinwatec.co.jp <a href="https://www.shinwatec.co.jp/en/">https://www.shinwatec.co.jp/en/</a>		B-16: Pulse type Bag Filter B-17: High temperature filter bag

Sumitomo Heavy Industries, Ltd.	Sumitomo Fudosan Osaki Garden Tower, 1-1, 1-chome, Nishishinagawa, Shinagawa-ku, Tokyo 141-0033, Japan <a href="https://www.shi.co.jp/english/index.html">https://www.shi.co.jp/english/index.html</a>		B-8: Wet type Electrostatic Precipitator B-9: Dry type Electrostatic Precipitator B-11: Wet type Electrostatic precipitator for Scarfing Machine and Gas Cutting Machine
Tsukishima Kikai CO., LTD.	Industrial Sales Dept. 3-5-1, Harumi, Chuo-ku, Tokyo 104-0053 TEL: +81-3-5560-6535 FAX: +81-3-3536-0575 <a href="https://www.tsukishimakikai.co.jp/en/">https://www.tsukishimakikai.co.jp/en/</a>	A-5: Coal Moisture Control (CMC)	

