

# MHPS Technologies for FGD, ESP and SCR

**CEA – JCOAL Workshop at Delhi**

**8<sup>th</sup> November 2019**

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# Company Profile: History of MHPS



Thermal Power Generation systems of  
“Mitsubishi Heavy Industries ” and “Hitachi”,

are integrated on February 1, 2014  
as known of



## MITSUBISHI HITACHI POWER SYSTEMS

Capital: 1 Bil USD

Employees: app.15,100 (incl. 5,000 outside Japan)

# MHPS AQCS: Product Portfolio

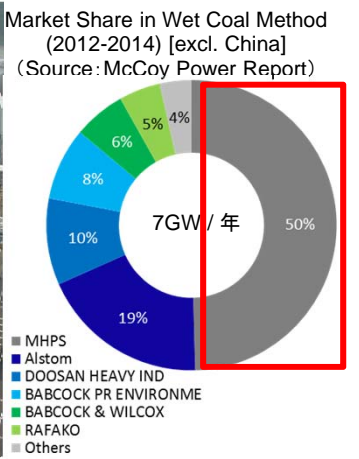
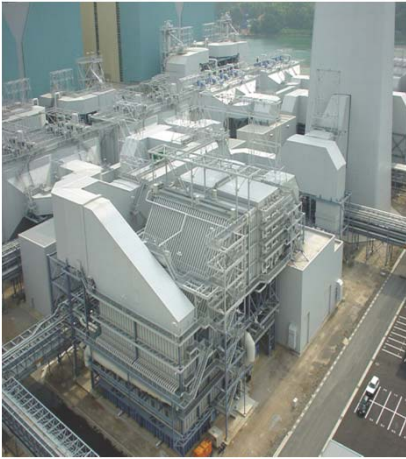


MHPS covers wide ranged AQCS products to offer systems which match the needs of customers.

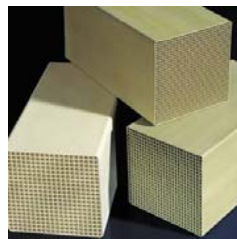
## Flue Gas Denitrification (SCR)



## Flue Gas Desulfurization (FGD)

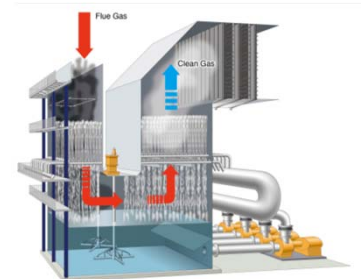
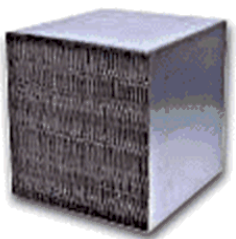


## Electrostatic Precipitators (ESP)



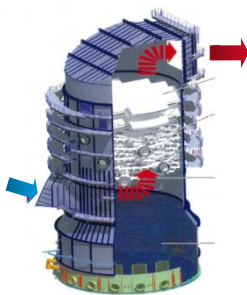
Honeycomb Catalyst

### Plate Catalyst

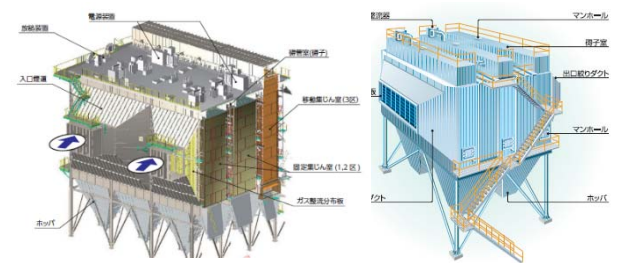


Double Contact Flow Scrubber (DCFS) Tower

### Spray Tower



### Conventional



Moving Electrode

# New Environmental Regulation issued on 7<sup>th</sup> Dec 2015



	TPP installed before 31 December 2003		TPP installed after January 2004 up to 31 <sup>st</sup> December 2016		New install from 1 <sup>st</sup> January 2017
<b>Capacity</b>	Smaller than 500MW	500MW & Above 500MW	Smaller than 500MW	500MW & Above 500MW	Any Size
<b>Particulate</b>	100mg/Nm <sup>3</sup>		50mg/Nm <sup>3</sup>		30mg/Nm <sup>3</sup>
<b>SO2</b>	600mg/Nm <sup>3</sup>	200mg/Nm <sup>3</sup>	600mg/Nm <sup>3</sup>	200mg/Nm <sup>3</sup>	100mg/Nm <sup>3</sup>
<b>NOx</b>	600mg/Nm <sup>3</sup>		300mg/Nm <sup>3</sup>		100mg/Nm <sup>3</sup>
<b>Mercury</b>	-	0.03 mg/Nm <sup>3</sup>	0.03 mg/Nm <sup>3</sup>		0.03mg/Nm <sup>3</sup>

- The new regulation may require application of state of art technologies
- **MHPS** has enough experience to comply with stringent requirements in Japan and **MHPS** can supply reliable technologies to meet Indian regulation.

# Present Scenario and Challenges Ahead



**New emission norms call for of DeSOx and NOx control technologies besides augmentation of ESPs.**

## **ESP**

- **In ESP R&M, space availability and layout are the major constraints**

## **FGD**

- **Selection of FGD Technologies - Wet Limestone, Sea Water and Dry.**
- **Units < 500 MW capacity do not have space to install FGD.**
- **Units > 500 MW have space provisions, but involve arrangement for supply and transport of limestone.**
- **Quality of limestone and its availability in India and logistics to be addressed.**
- **Disposal / utilization of Gypsum and tie-up with Cement plant would be required.**



## DeNOx

- Proposed standards of 600 mg/Nm<sup>3</sup> can be met using Low NOx burners.
- To meet 300 and 100 mg/Nm<sup>3</sup>, either SNCR or SCR technology is required.
- SCR for High ash Indian coal - Only a few suppliers like MHPS have the experience of high ash application.
- Pilot studies conducted by NTPC to establish the technology and catalyst.
- Selection of catalyst Honey Comb/Plate type, Ammonia availability, transportation, handling, storage are to be addressed.
- Catalyst Management.

# Present Scenario and Challenges Ahead



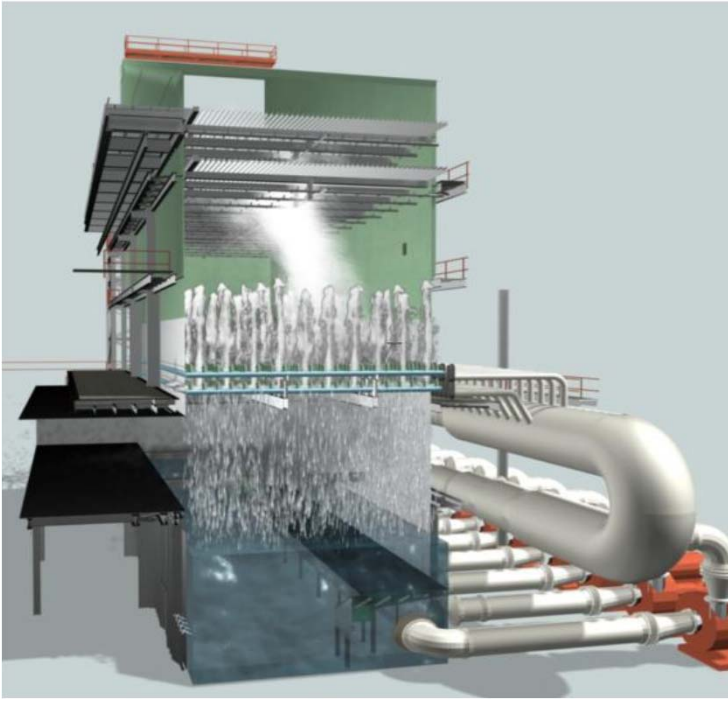
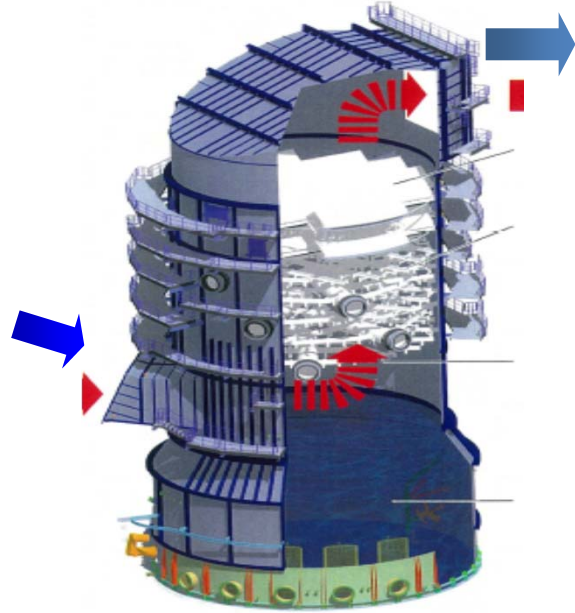
## General

- Selection of state of Art Technologies - Power plants, Customers and Consultants discuss with various suppliers for the proven state of art technologies.
- For R&M, space availability and layout are the major constraints
- Making Feasibility study to understand cost and time required for implementation
- Preparation of technical specification and availability of vendors in India or to be imported
- Financial assistance for implementation of the project



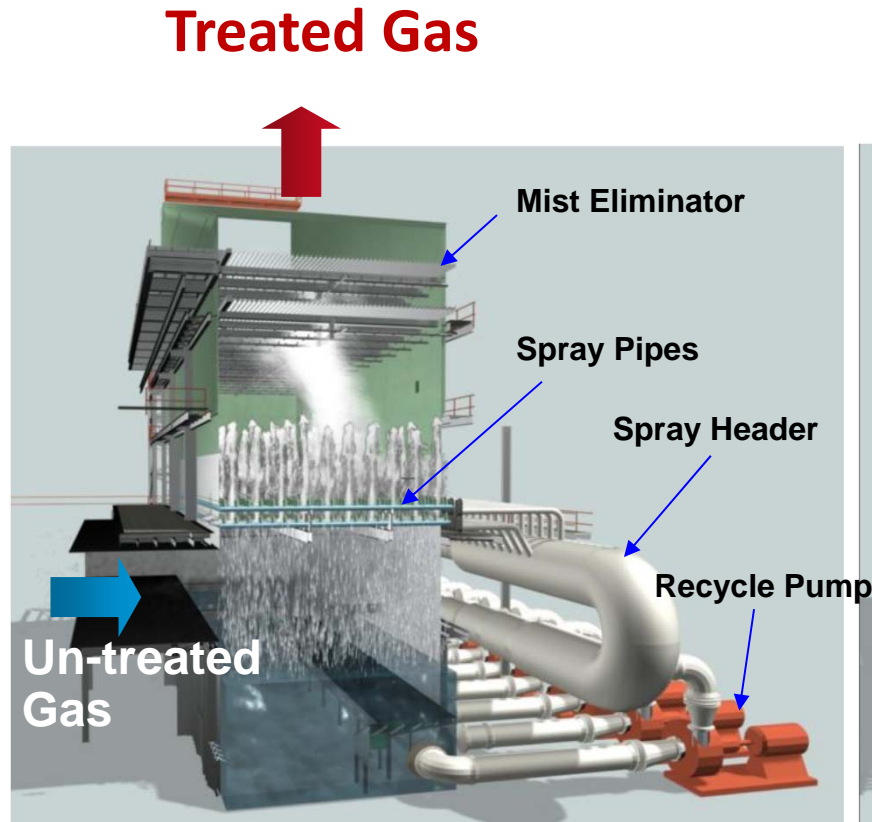
# MHPS Technologies for FGD



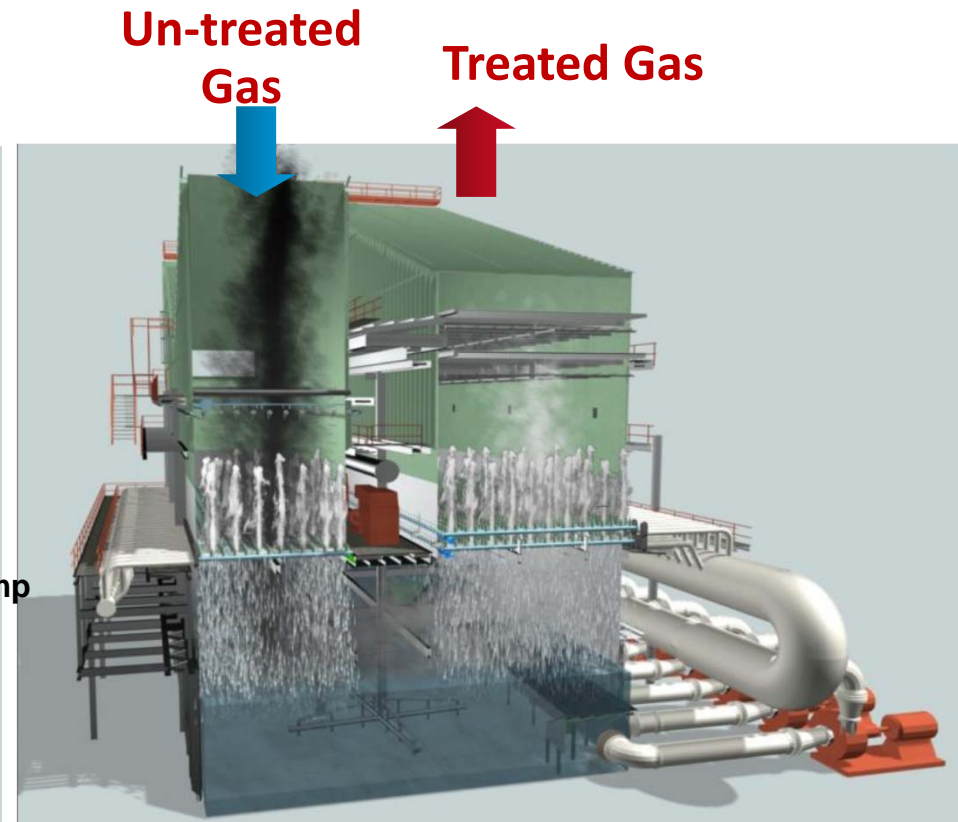
<b>Mitsubishi</b>	<b>Hitachi</b>
<p><b>DCFS</b></p> 	<p><b>Open Spray Tower</b></p> 
<p><b>Absorbent sprays upward like a fountain from lower side of Absorber</b></p>	<p><b>Absorbent sprays downward from upper side of Absorber</b></p>



# Wet Limestone Gypsum Process – DCFS Type Absorber

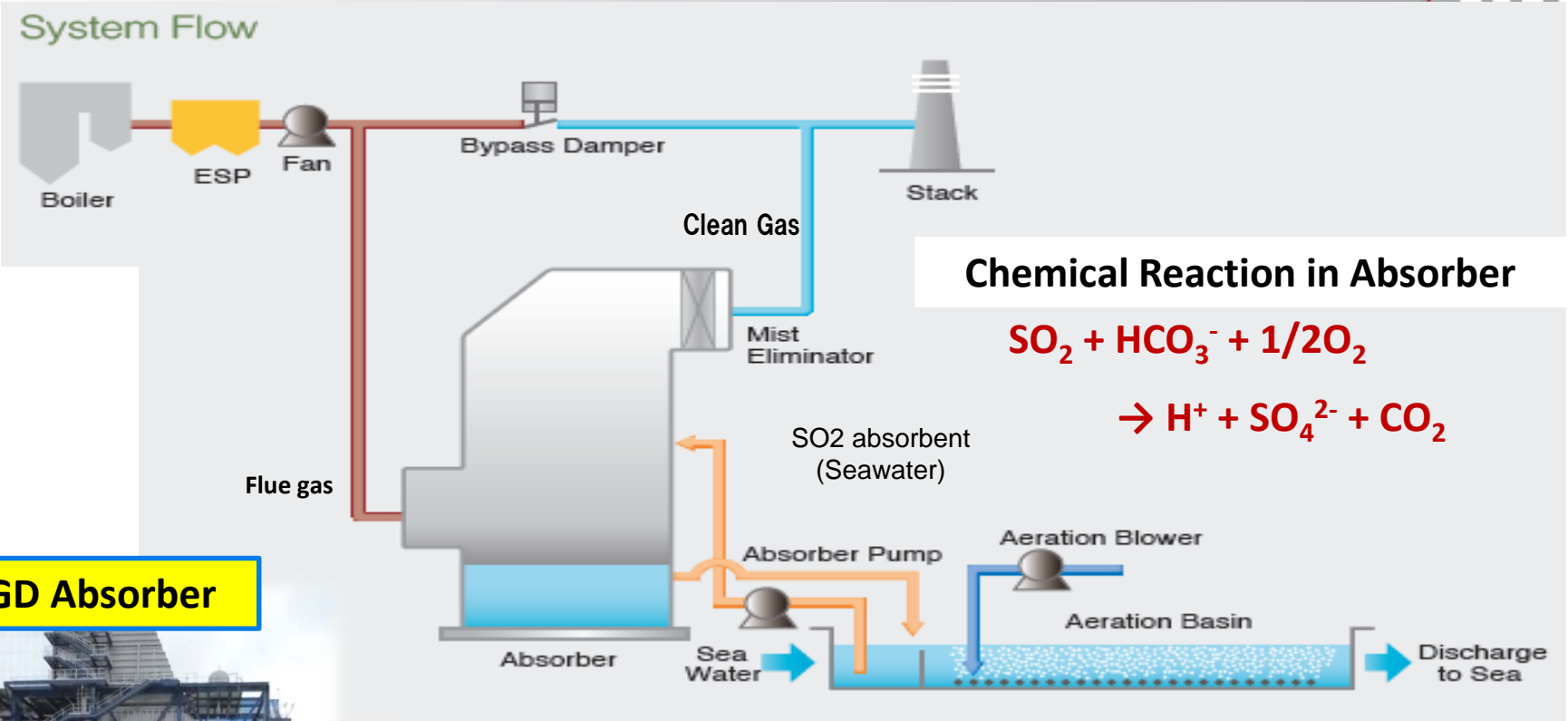


**Single Tower DCFS**

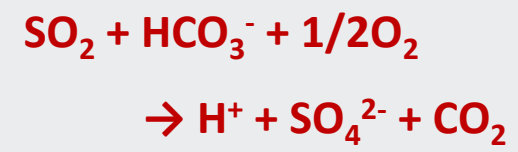


**Twin Tower DCFS**

# MHPS Seawater FGD System



## Chemical Reaction in Absorber



### FGD Absorber



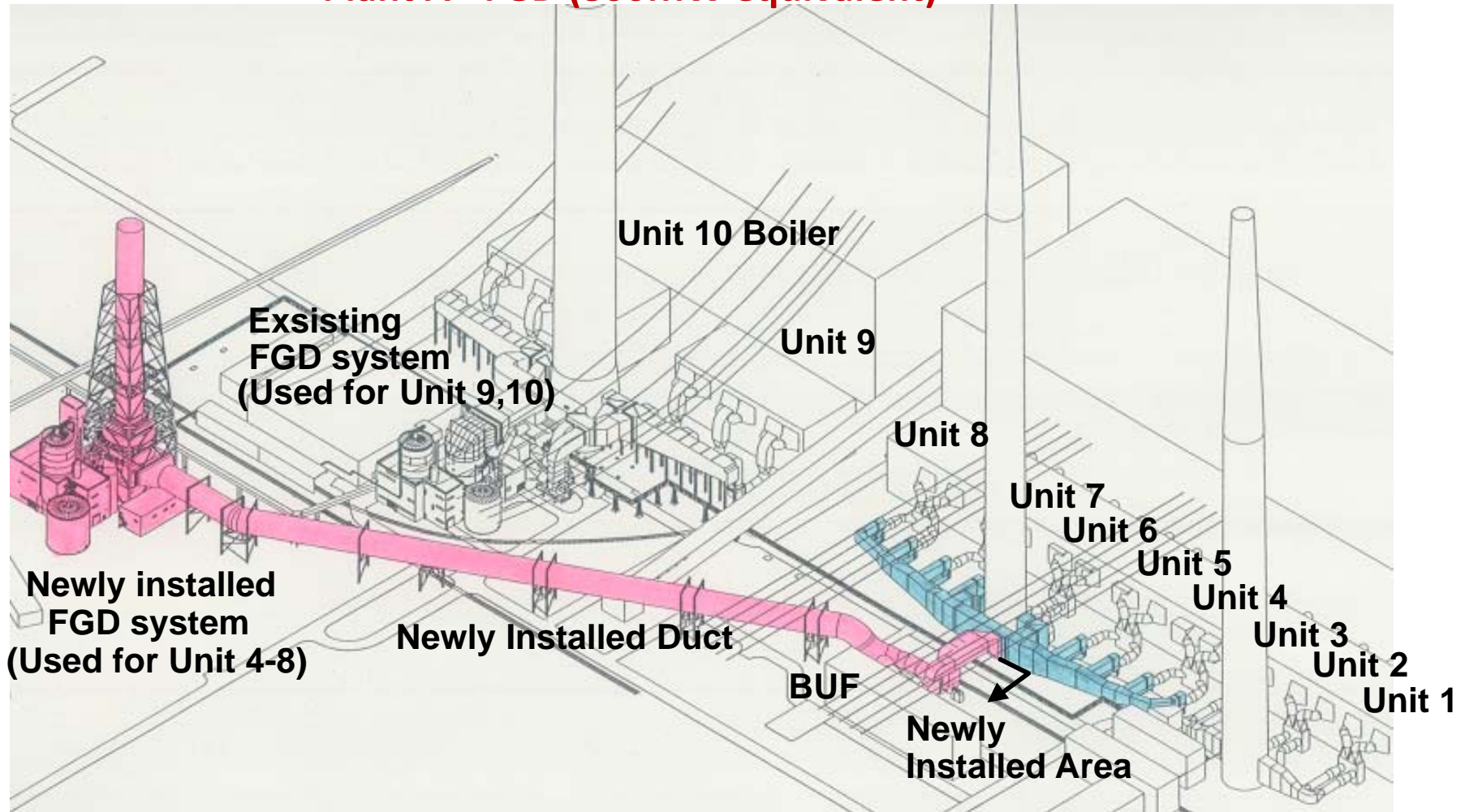
### Features

- Aeration Basin is required.
- Simple System(Only Seawater and Air)
- No additional Chemicals and No by-products.

Patented P4460975-JP

# Single Absorber with Multiple Boiler units- Experience

Plant A - FGD (800MW equivalent)

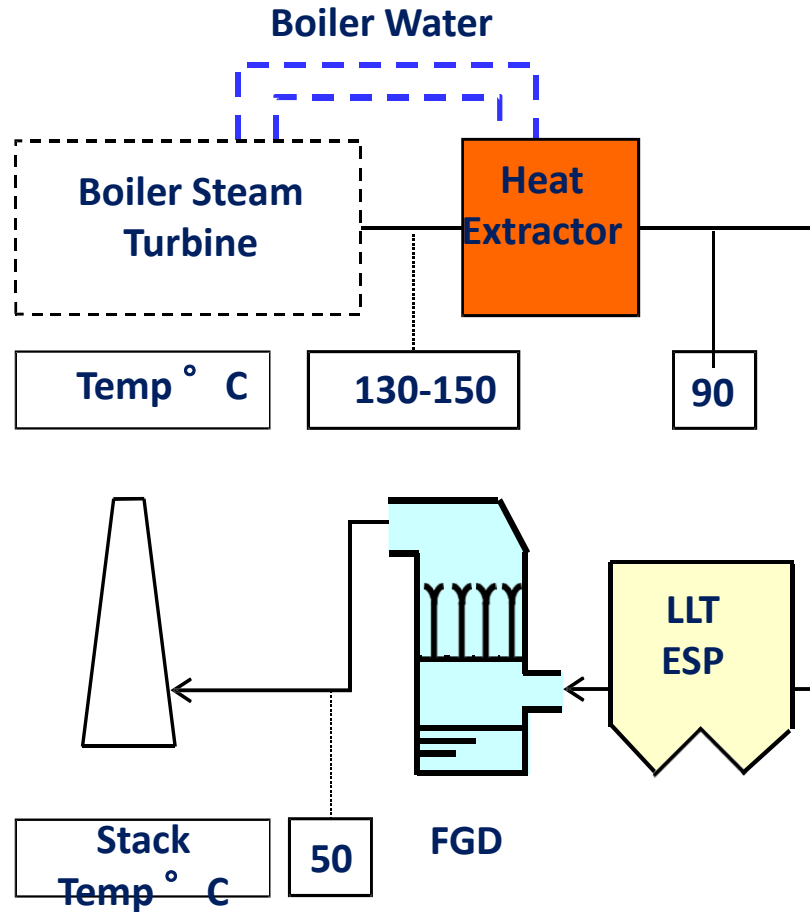


**Enough experiences of FGD application to multiple boilers**

# Use of Gas-Gas Heater (GGH)



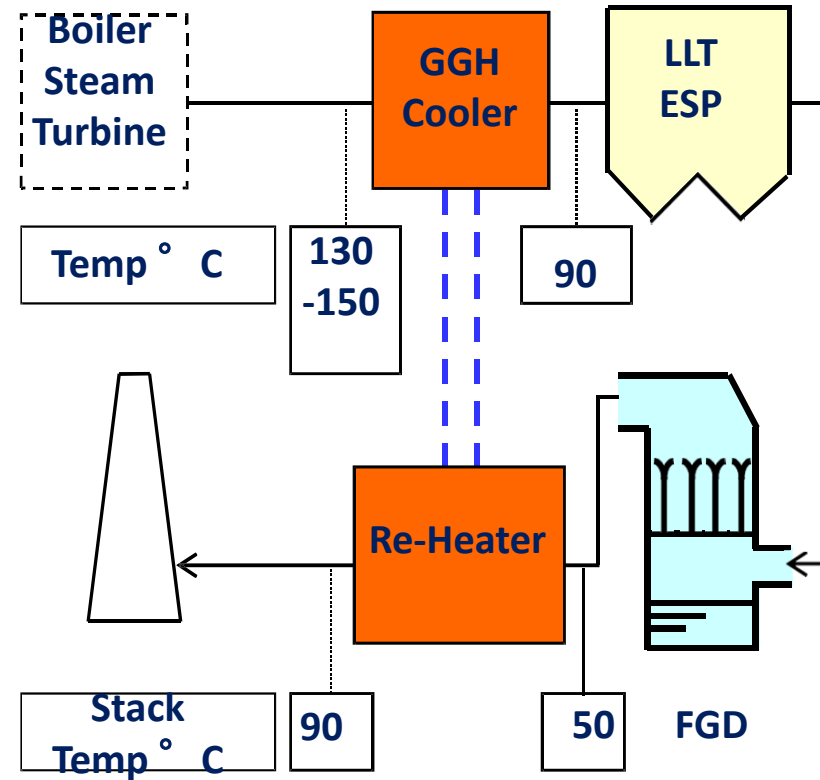
## Case 1- Recovered heat to Boiler Water



Improvement of Thermal Efficiency

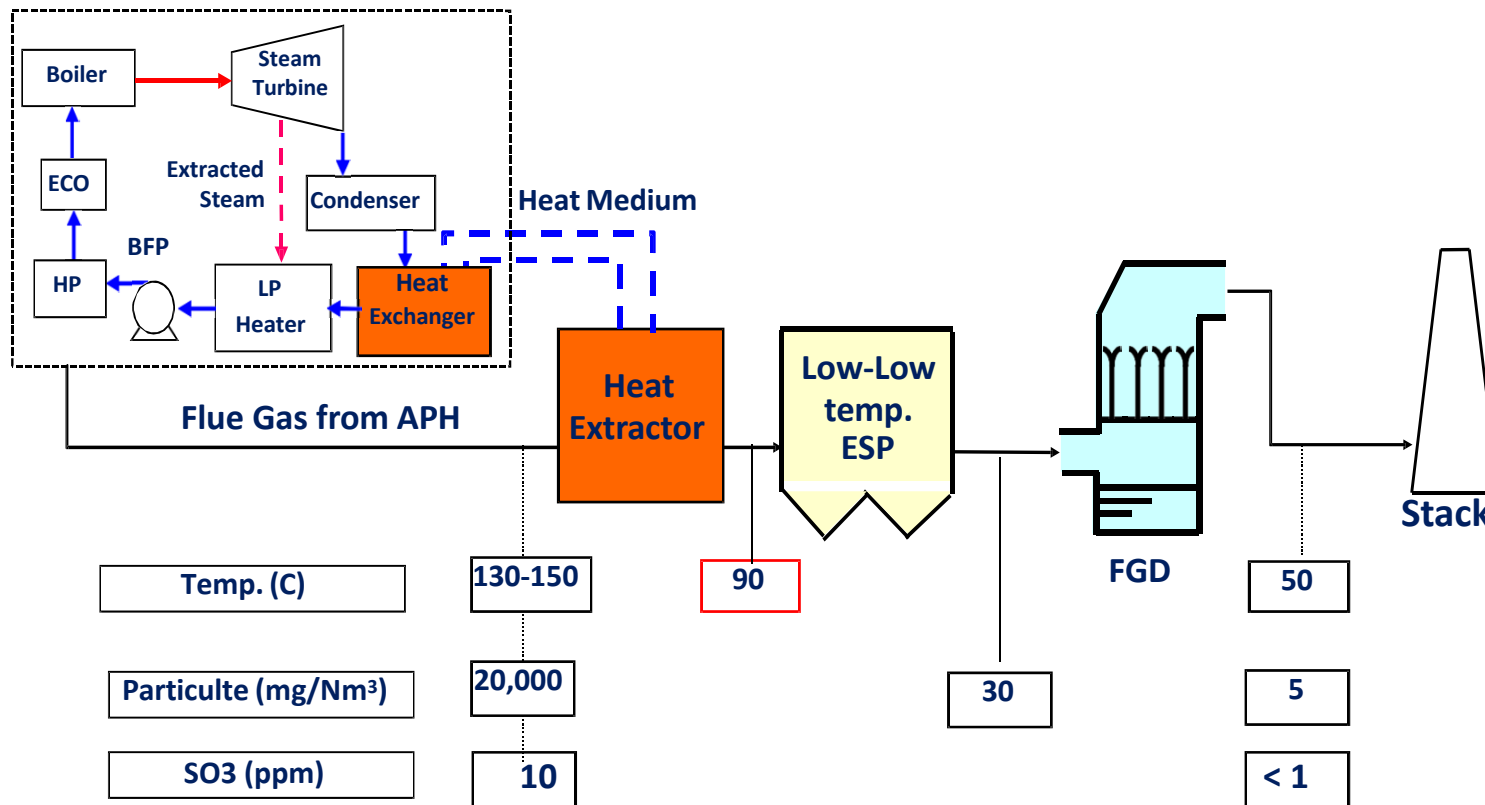
## Case 2

## Recovered heat to Flue Gas Outlet



- ✓ Dry stack can be used
- ✓ Better SO<sub>2</sub> dispersion to the atmosphere

# Recovered Heat to Boiler Water

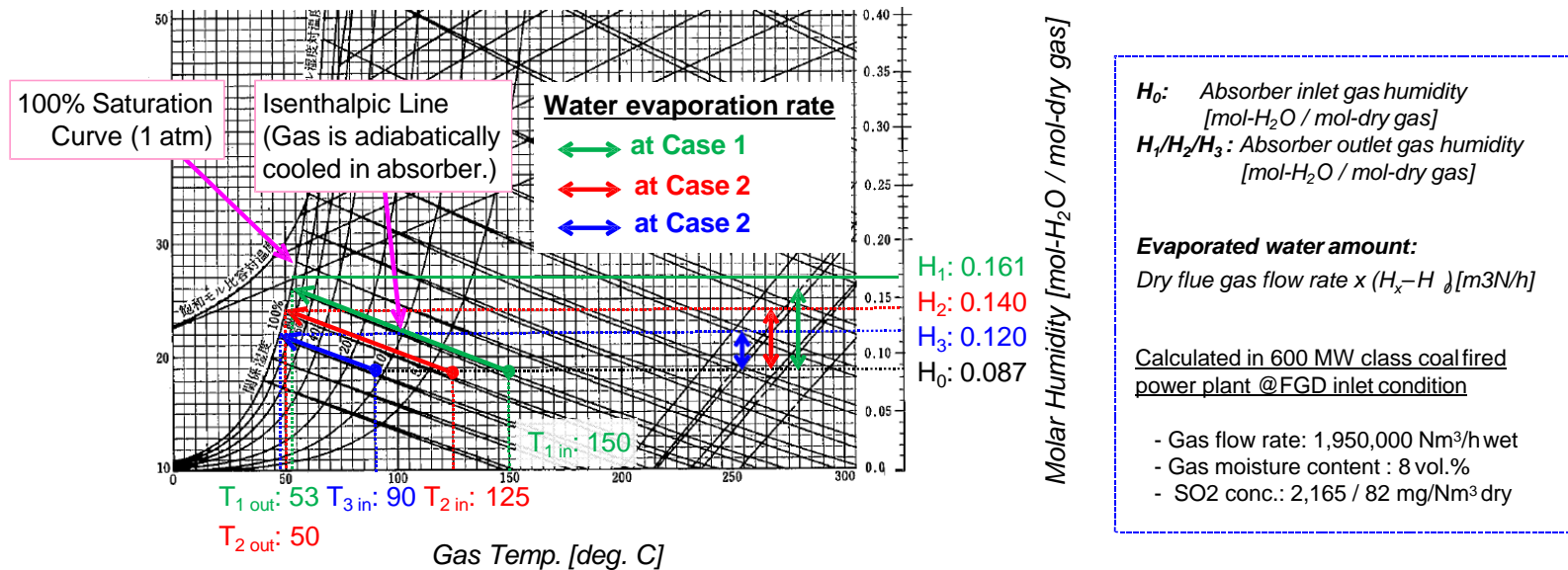


- ✓ Improvement of Plant Thermal Efficiency ( Increased by 0.3 – 0.5%)
- ✓ Low particulate matter/SO<sub>3</sub> emission
- ✓ MHPS has got a patent of this system (Patent application number 4959156)



# Recovered Heat to Boiler Water

## Theoretical Water Evaporation Amount from Psychrometric Chart



✓ **Approx. 50% Saving of Water consumption in FGD by reducing gas temp. to 90 Deg C**

Gas temp. APH outlet ↓ FGD inlet	150deg.C ↓ 150deg.C	150deg.C ↓ 125deg.C	150deg.C ↓ 90deg.C
Water consumption in whole process	123 t/h (Base: 100)	93 t/h (75)	64 t/h (52)

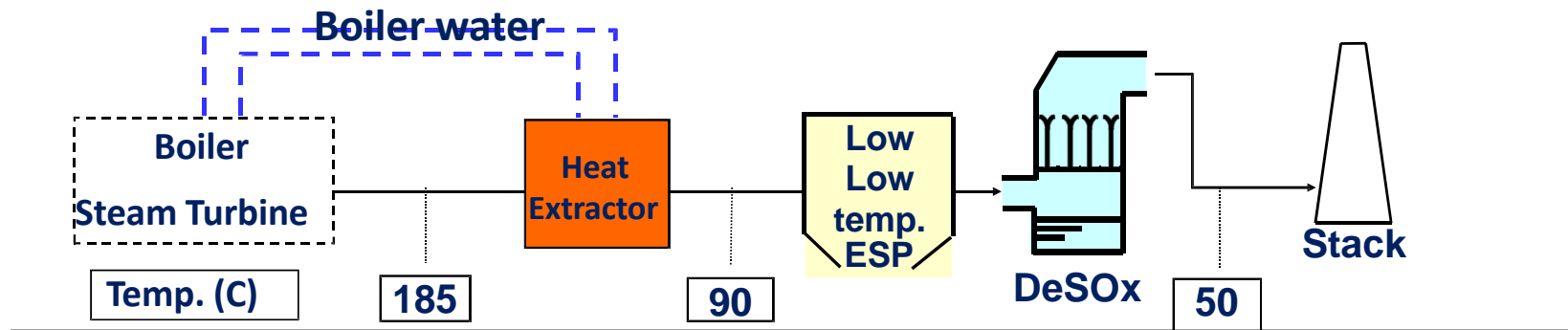
# Reference Plant



- Plant name : Plant B
- Capacity : 140MW
- Fuel : Heavy Oil
- Flue gas : 432,000m<sup>3</sup>N/h

(Fruitful results)

- ✓ Approx.3% saving of fuel consumption by improving plant thermal efficiency
- ✓ Approx. 3.5 MUSD saving a year







## Electrostatic Precipitator

- Fabric Filters
- Combination of ESP + Fabric Filters

## Retrofit options

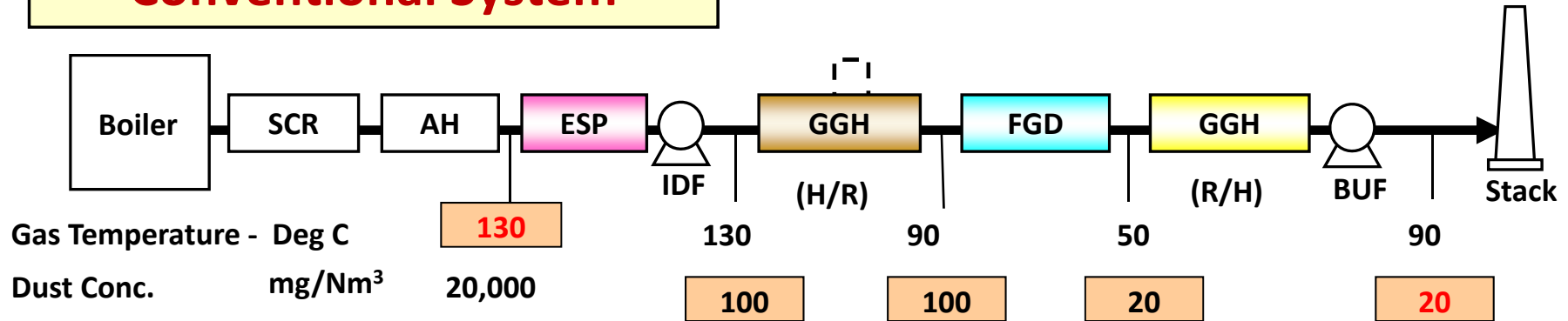
- Adding fields in series or in parallel
- Rebuilding existing precipitator with taller CE system
- Installing fabric filters
- Flue gas conditioning (Ammonia injection, SO<sub>3</sub> conditioning and water fogging)

## State of Art Technology by MHPS

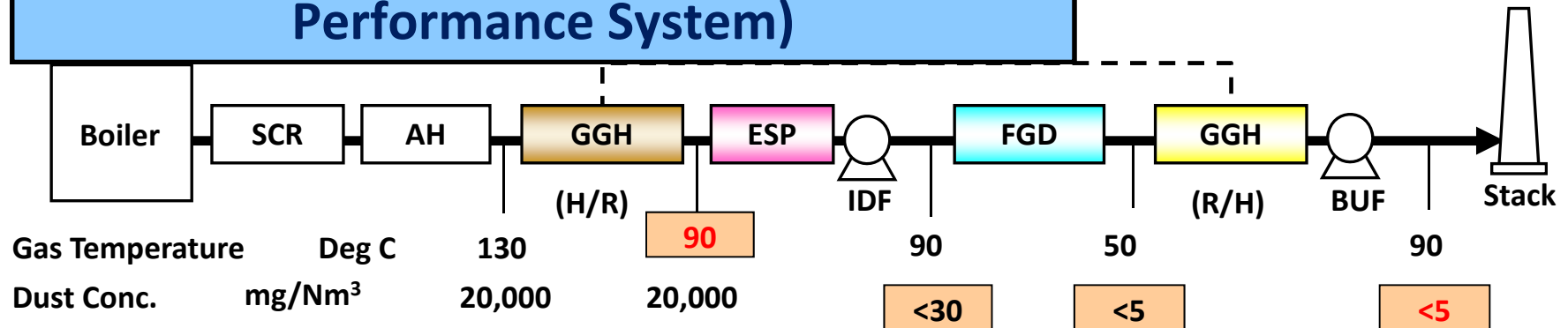
- Low-Low Temperature High Performance ESP system
- Moving Electrode Electrostatic Precipitator (MEEP)

# Low-Low Temperature High Performance ESP

## Conventional System

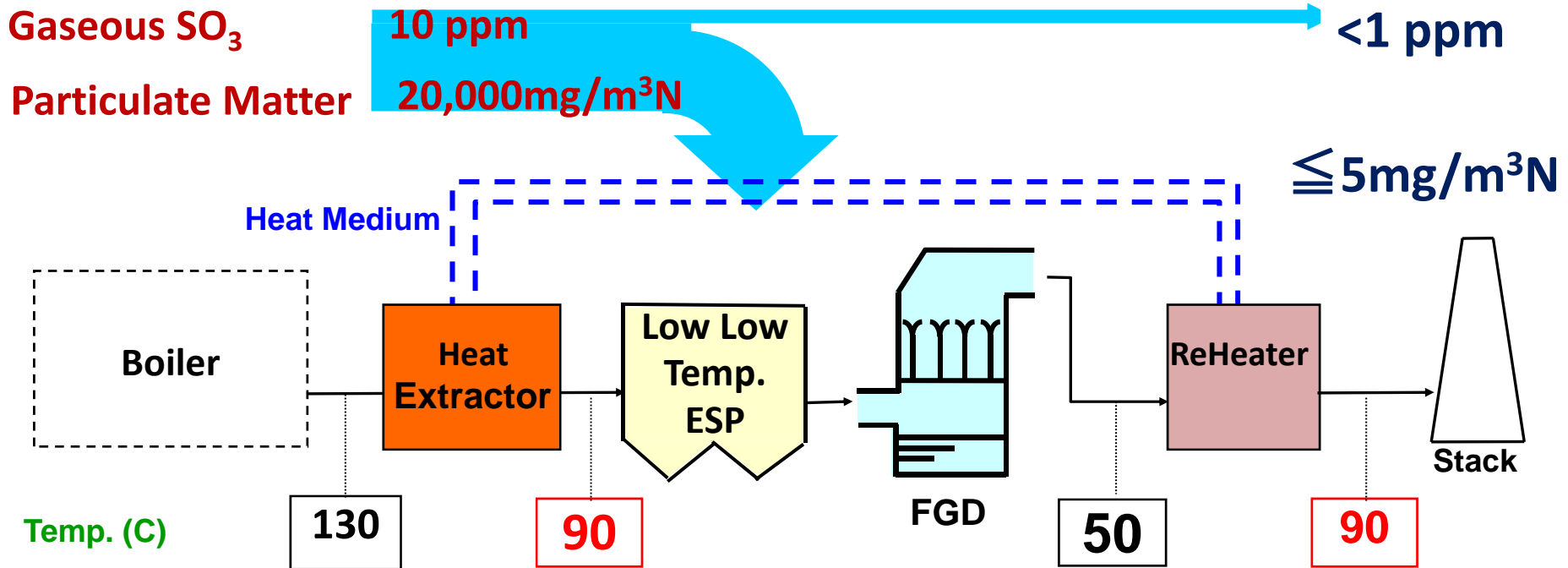


## Low-Low Temp. ESP System (High-Performance System)



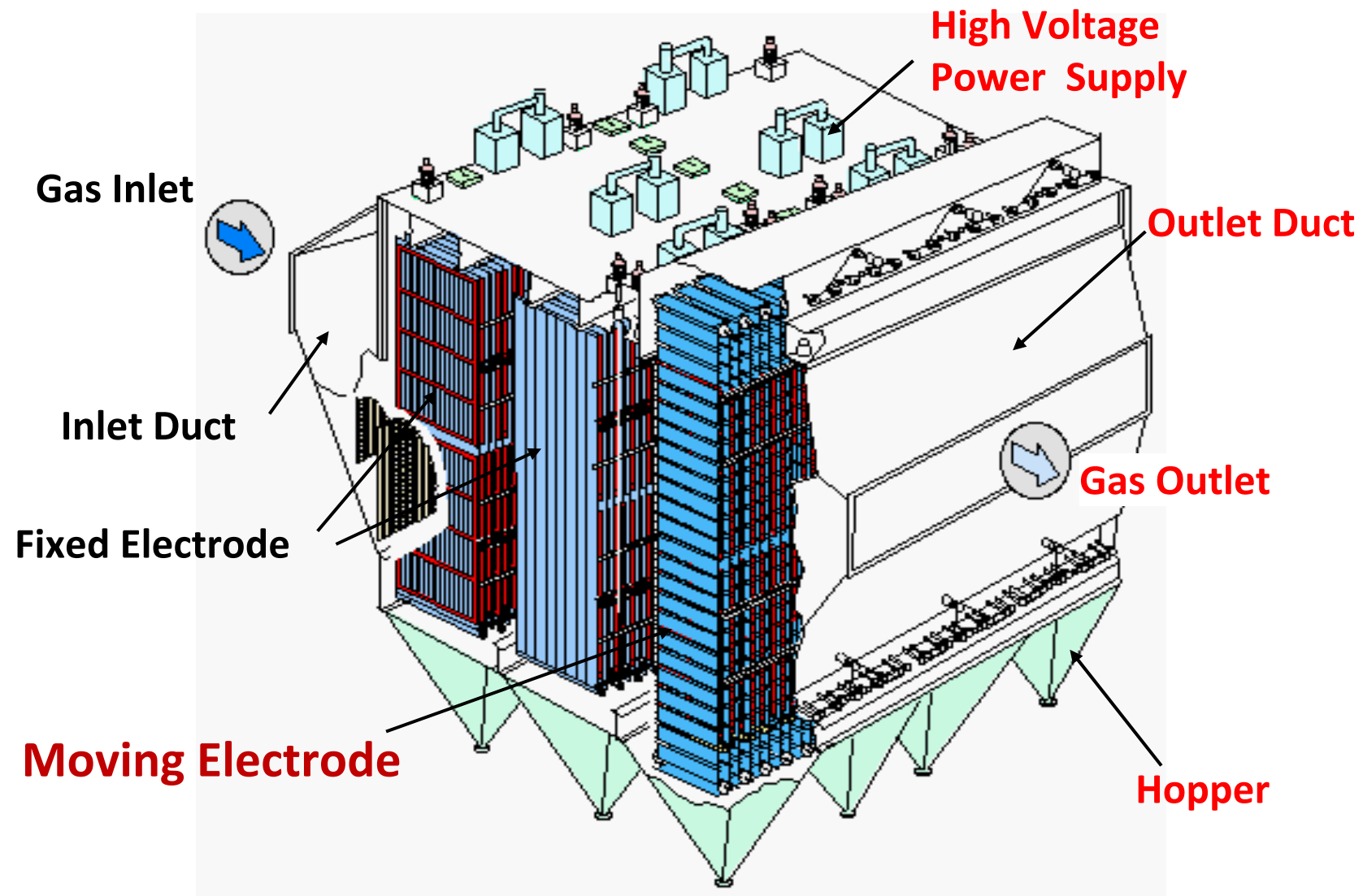
SCR: Selective Catalytic Reduction    A/H: Air Heater    GGH: Gas-Gas Heat Exchanger  
 DESP: Dry Electrostatic Precipitator    FGD: Flue Gas Desulfurization

# Advantage of Low-Low Temperature ESP

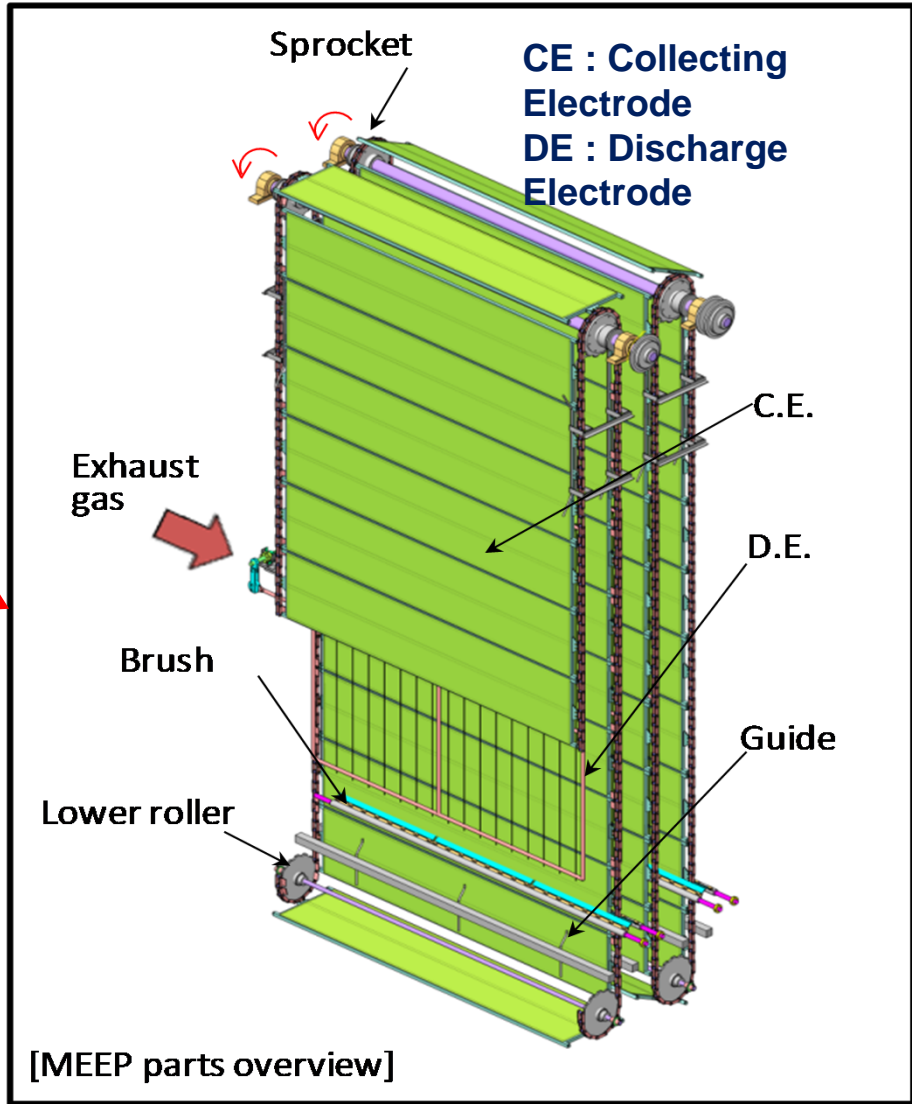
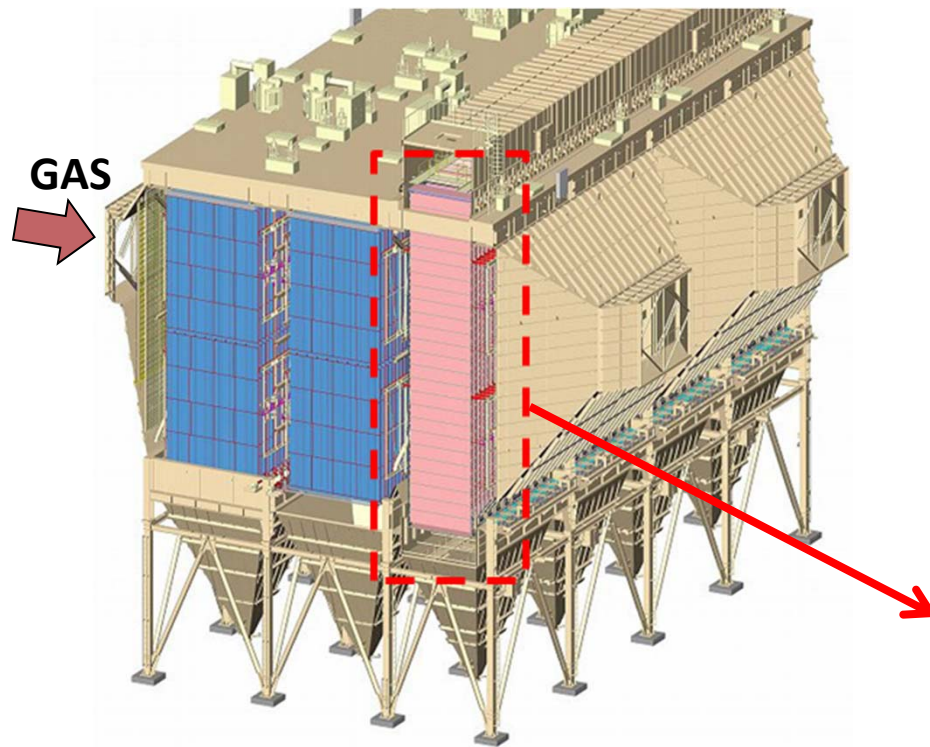


- **SO<sub>3</sub> removal : SO<sub>3</sub> gas is condensed on fly ash**
- **Lower gas flow on account of reduced gas temperature and high performance**
- **Ash resistivity reduced approximately 100 times**
- **Lesser foot print ( 20 – 30%)**
- **Opacity reduction : No plume caused by SO<sub>3</sub> mist at stack**
- **Reduced stack height**
- **With integration of ESP+FGD, emission less than 5 mg/Nm<sup>3</sup> can be achieved**

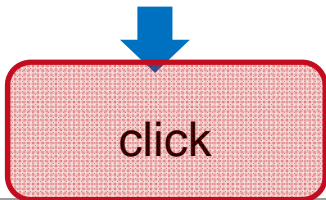
# Moving Electrode Electro Static Precipitator (MEEP)



# Moving Electrode Electrostatic Precipitator (MEEP)



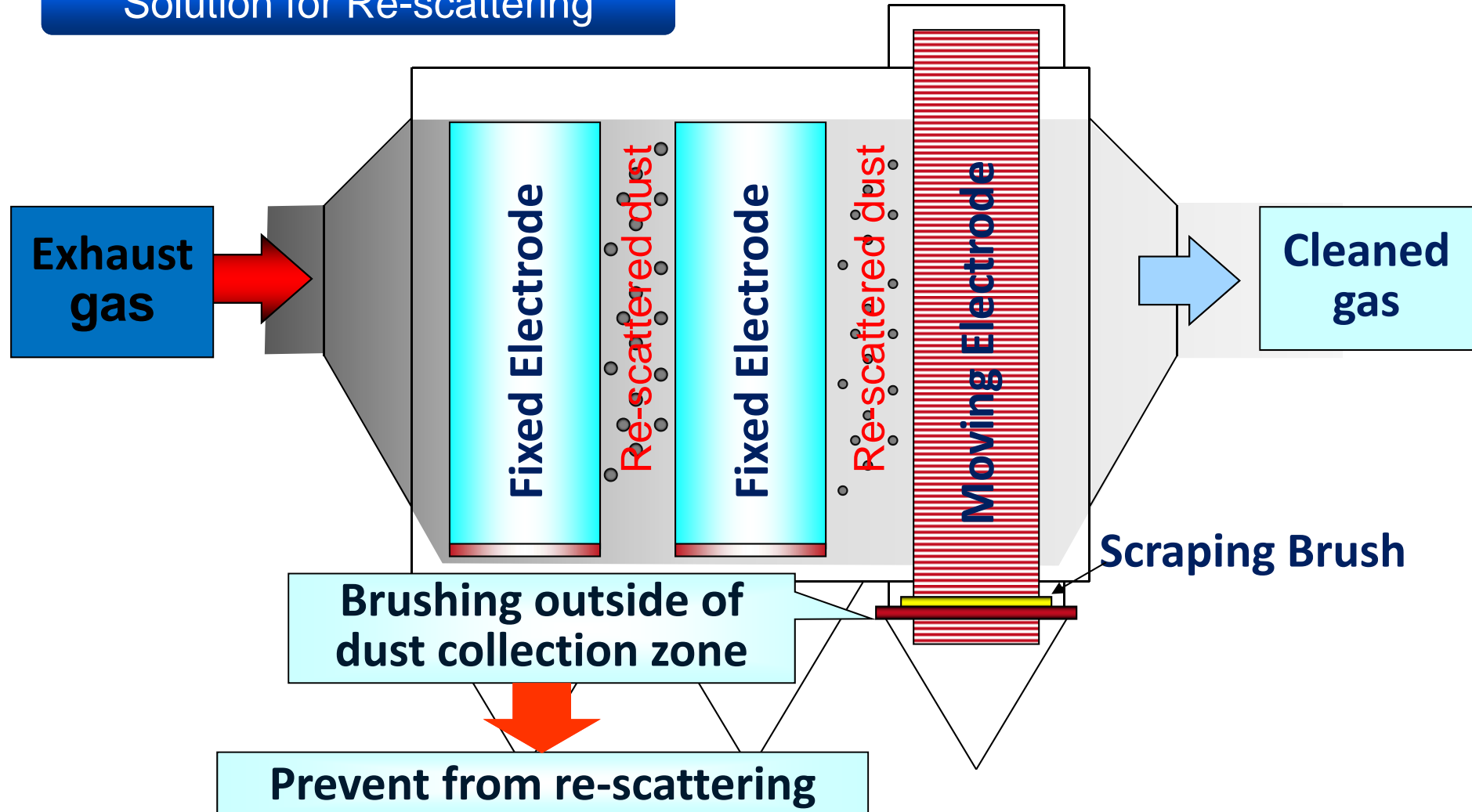
Click here to [play](#) MOVIE



# Application of MEEP Technology



## Solution for Re-scattering









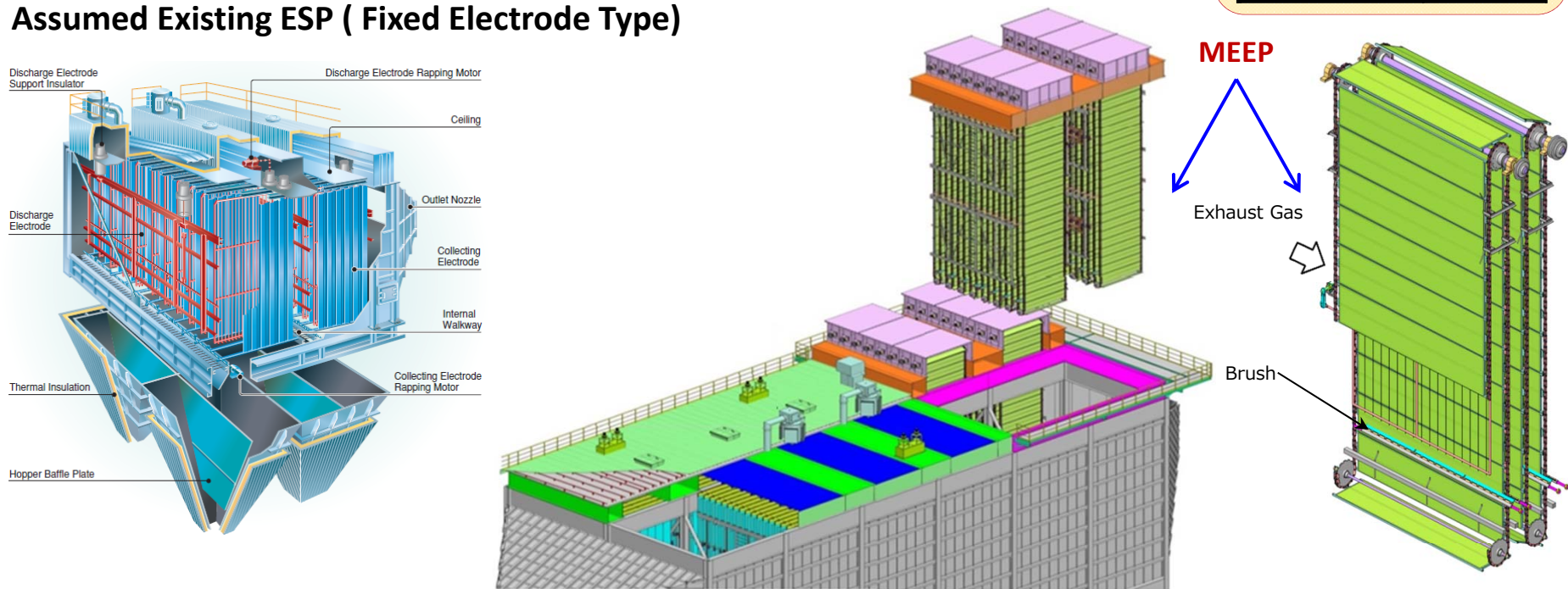
# ESP Performance Upgrading

- **ESP performance upgrade will be achieved by replacing MEEP parts only.**
- **No replacement of fixed electrodes will be needed. It will be benefit for customers.**
- **While, the deep inspection before the work will be indispensable. The conditions of existing fixed electrodes and structure of existing ESP should be inspected.**

MEEP Supply Record

Application	Number
Coal Fired Boiler	45
Sinter	9
Others	13
Total	67

## Assumed Existing ESP ( Fixed Electrode Type)



# MEEP Advantage in Performance



## Applied for Indian high ash coal

### Indian Project 2x500 MW – ESP R&M

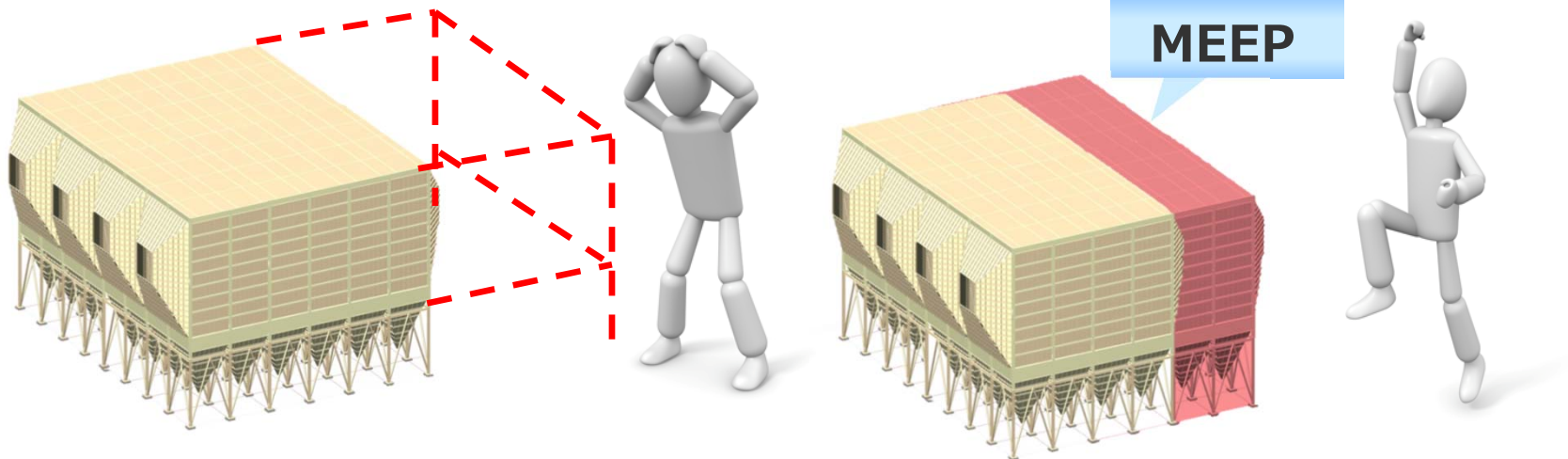
- **Upgrading by Moving Electrode (MEEP)**
- Project commissioned in 2016, and under operation.
- **Reducing dust emission from 500 to 50 mg/Nm<sup>3</sup>**

### Newly Installed MEEP at Indian Project



- By MHPS MEEP technology the collection efficiency increased within the original space!
  - **No Civil works, additional AHS, Control room space and no additional pressure drop**

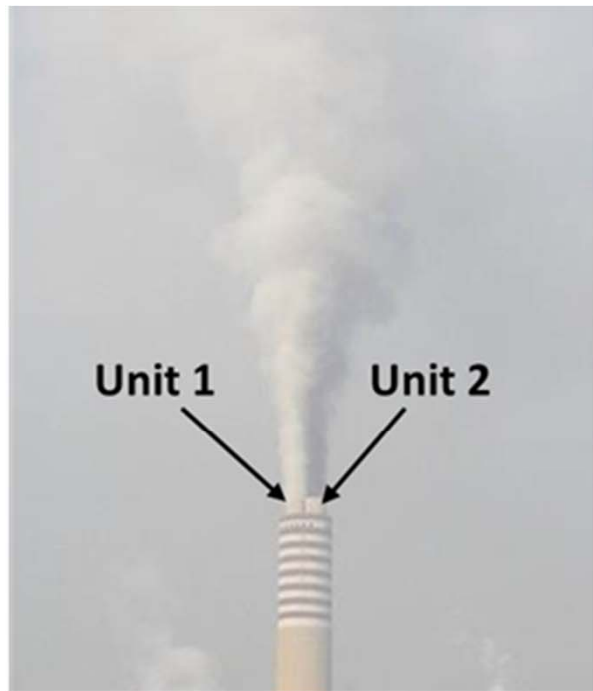
### No Space for existing ESP Expansion!



# Performance of Indian Project

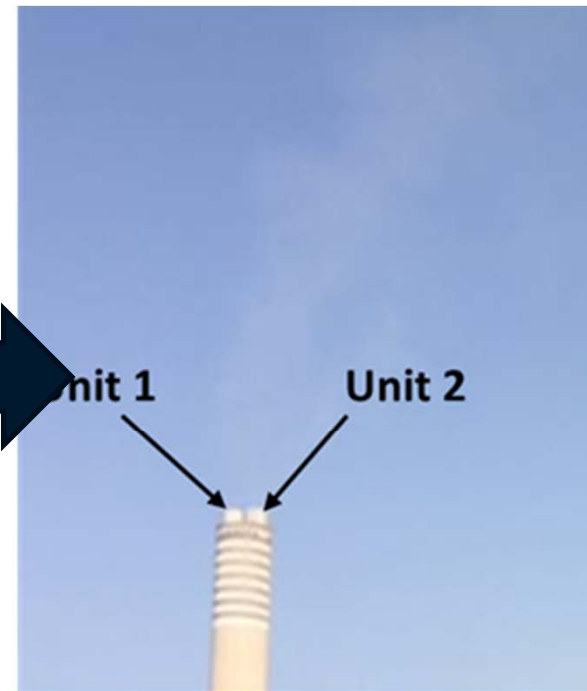


## Appearance of Smoke Emission before and after ESP Modification



Unit 1      Unit 2

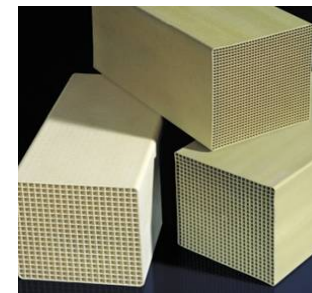
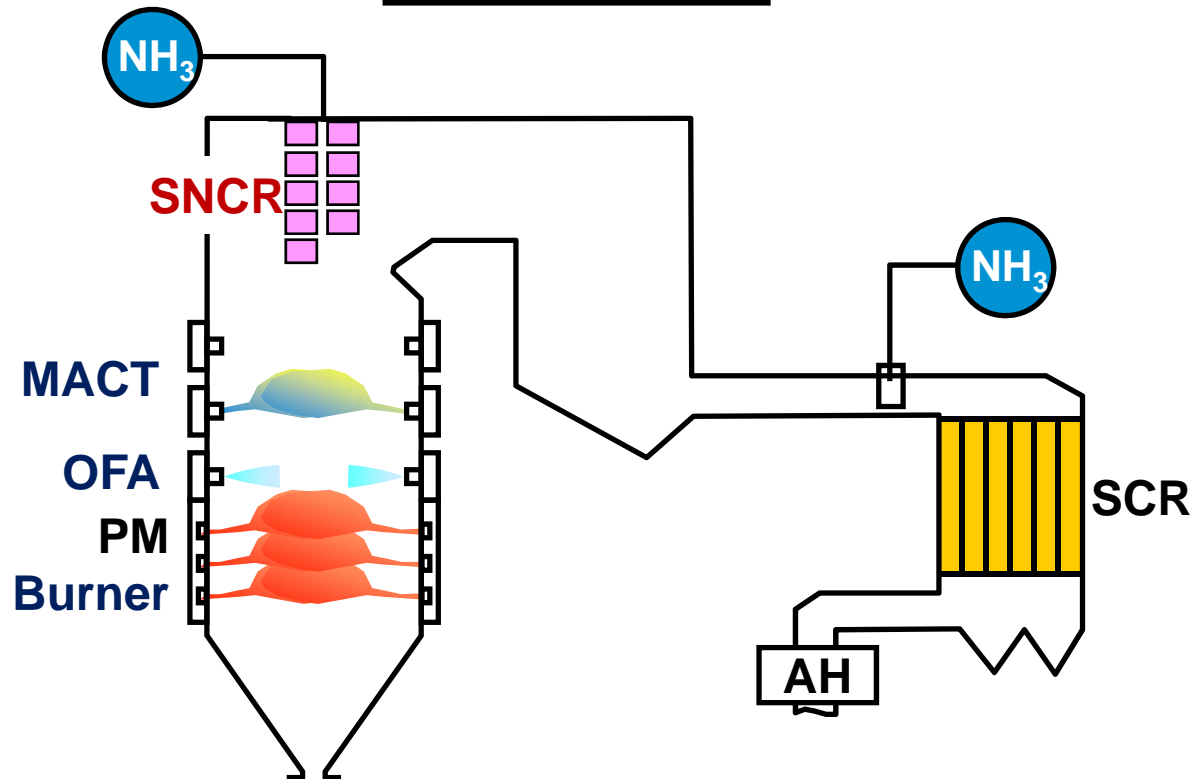
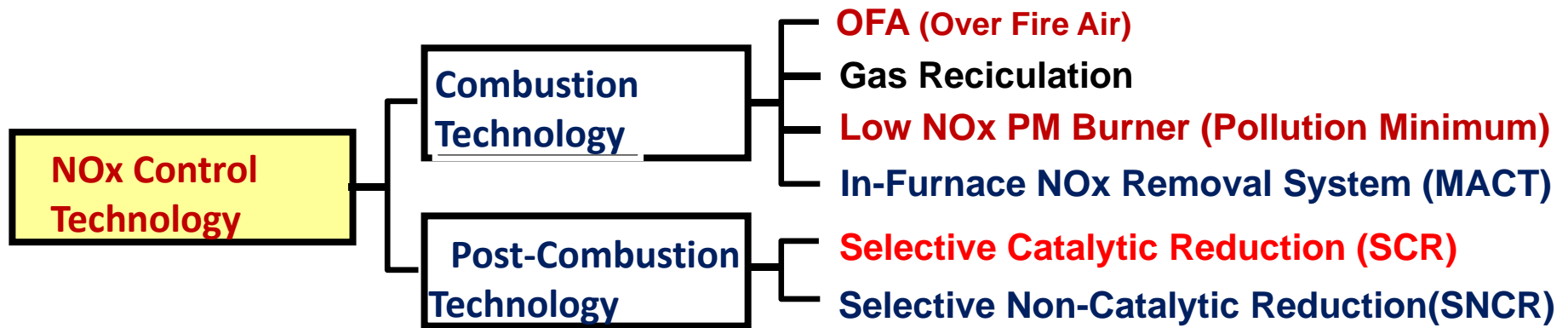
Before modification  
(500-600mg/m<sup>3</sup>N)



Unit 1      Unit 2

After modification  
( $\leq$  50mg/m<sup>3</sup>N)

# NOx Control Technologies



Honeycomb Catalyst

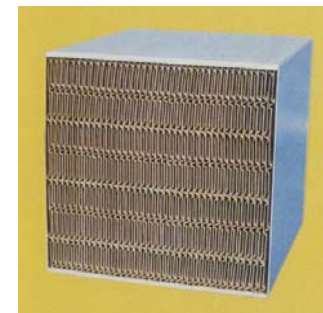
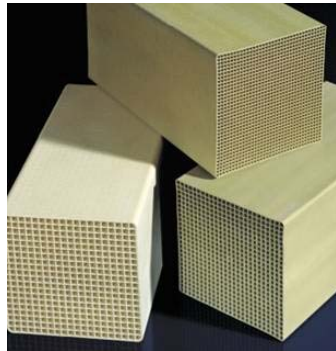


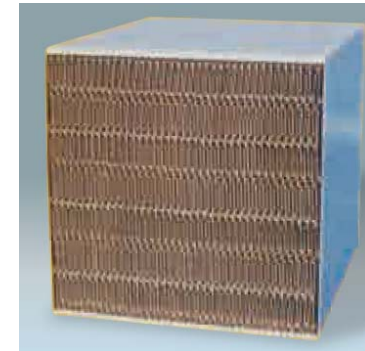
Plate Catalyst



# SCR Catalyst Type



Honeycomb / Plate cover all applications.



**Honeycomb Catalyst**

**Plate Catalyst**

**Coal**

Low Dust

High Dust

**Gas**

High DeNOx

Low DeNOx

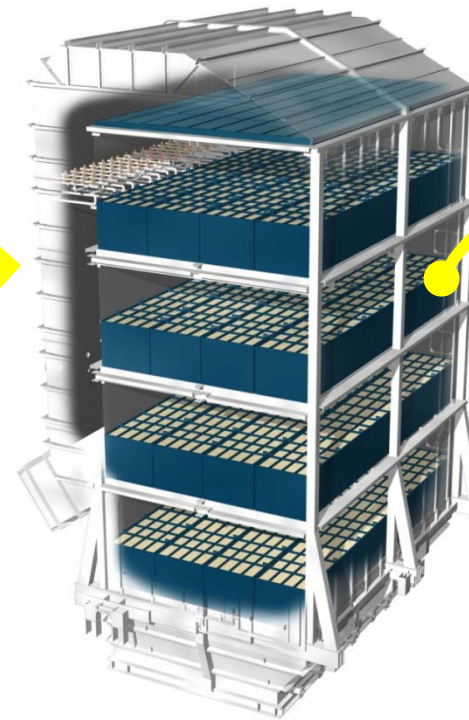
**Oil**

High DeNOx,  
Less SO<sub>2</sub> Oxidation

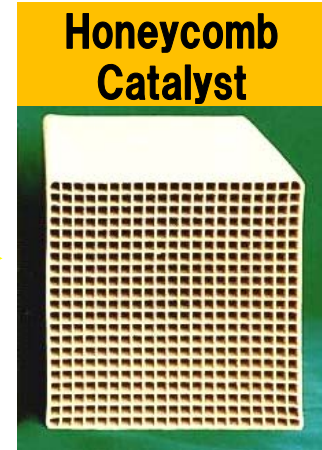
Low DeNOx

**Best Selection of Catalyst provides benefit on Plant Operation and Maintenance Costs.**

# MHPS SCR System ; What MHPS Offers



SCR System



Honeycomb Catalyst

or

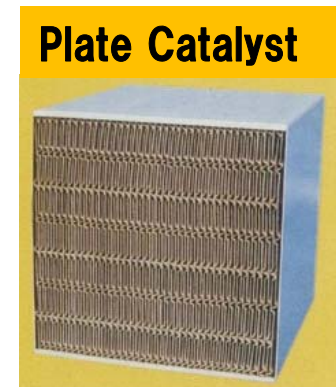


Plate Catalyst

- MHPS is a pioneer of SCR technology, and producing & distributing both honeycomb and plate catalyst type of SCR.
- **Either type of MHPS catalyst has the largest market share in the world and contribute to global environmental conservation.**

## SCR Performance

NOx removal efficiency > 90% can be achieved.

# SCR for High Dust Application



## Plant C

Location	Beijing, China
Boiler Output	200MW x 4
Fuel	Coal
Gas flow rate	773,395 m <sup>3</sup> (Normal)/h
Flue gas temperature	335-390 °C
Removal Eff.	83.3 %
Dust Leading	50 g/m <sup>3</sup> (Normal)
COD	2007~2008
Note	High dust experience

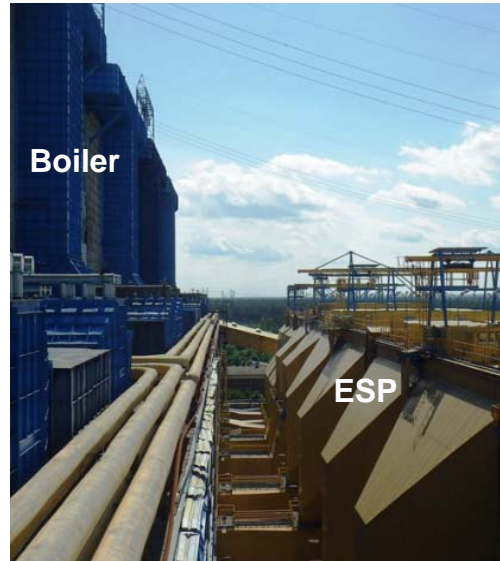


# SCR Retrofit: Reference Project



## Project Outline

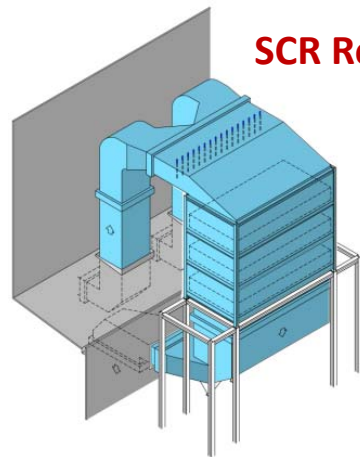
Fuel : Coal  
 Plant Power : 2 x 220 MW  
 DeNOx Efficiency: 80 %  
 Slip NH<sub>3</sub>: 2 ppm  
 Start up: U2 Oct. 2015  
 U1 Mar. 2016



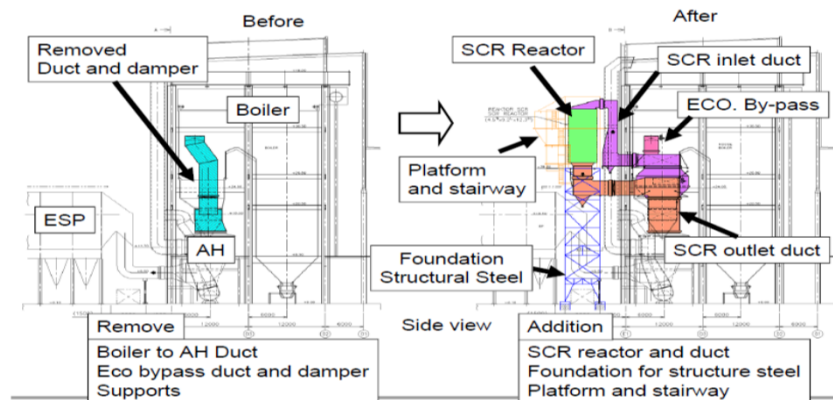
Before installation



After Installation



SCR Reactor



# Summary of MHPS AQCS Technologies



- **Total solution covering ESP, FGD and SCR**
- **Developed novel AQCS technologies to meet stringent emission levels demanded by standards of world Bank, EU, Japan and US.**
- **Extensive experience for retrofitting AQCS to the existing plants within limited space and limited period**
- **Experiences of various type of coal to design optimum catalyst to suit Indian high ash application.**
- **Understanding the importance of cost competitiveness, MHPS would consider local supply chains for further cost reduction**



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In addition, we have applied for and hold numerous patents and other intellectual property rights worldwide in order to legally protect our interest in MHPS Products and their technology.

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