

# Wet Electrostatic Precipitator

**KC Cottrell Co., Ltd.**

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工作原理  
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## Precipitation and Application

### Type of Precipitation

- Inertia Force
  - Centrifugal Force
  - Scrubbing Force
- 
- Filtering Force
  - Electrostatic Force

### Applied Precipitator

Free Chamber

Cyclone

Scrubber

Packed Tower

Venturi Scrubber

Fabric Filters

Dry Type ESP

Wet Type ESP

## Each Precipitator Characteristic

Type	Size(Dia)	P. Drop	Power Con.	Maintenance
Cyclone	10 um	50~100mmAq	Less	Easiest
Scrubber	5~10 um	300~1000mmAq	High	Easy
Bag House	0.1 um	150~250mmAq	Medium	Difficult
ESP	0.01 um	20mmAq	Least	Easy

## ESP History

- Benjamin Franklin, 1745      Experiments on Corona Discharge
- Hallfield, 1824      Mist Removal Experience by Electric Force
- Fredric Cottrell, 1907      First Commercial ESP for Sulfuric Acid Mist
  
- Researches and Developments on
  - CE & DE Design by Electromagnetic Field Study
  - Wide Spacing ESPs
  - Pulse Power Applications
  - Pre-charged ESPs
  - Model Testing
  - Ash or Dust Characteristic
  - Etc

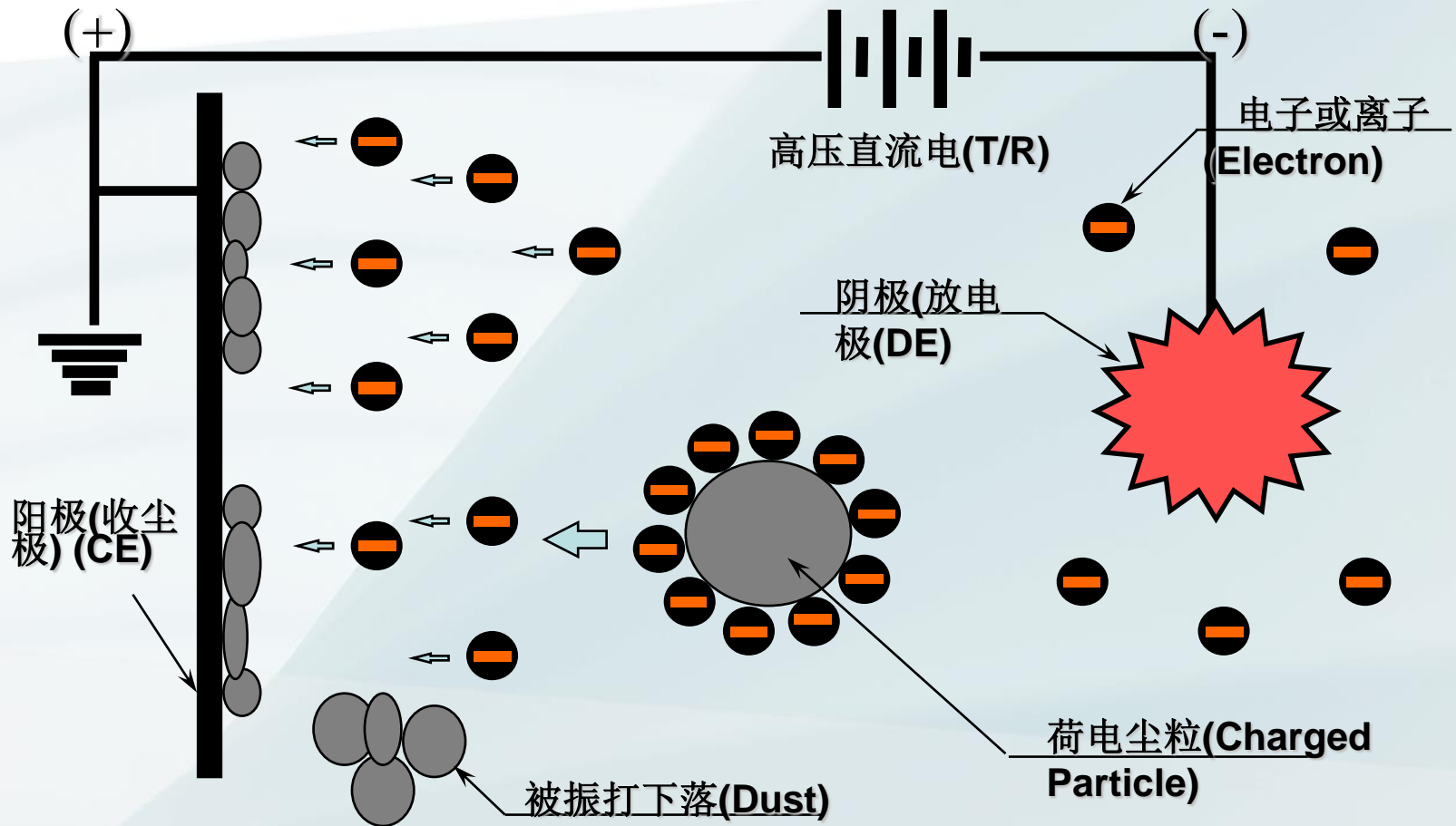
## **ESP Major Benefit**

- **High Efficiency(> 99.9% Achievable)**
- **Fine Particle Collection**
- **Dry & Wet Type Applicable**
- **Least Pressure Loss**
- **Low Operation Cost**
- **Maintenance Easy & Free**
- **High Temperature Applicable**
- **Acid Dust Applicable**
- **Mass Flow Rate Applicable**

## ESP Demerit

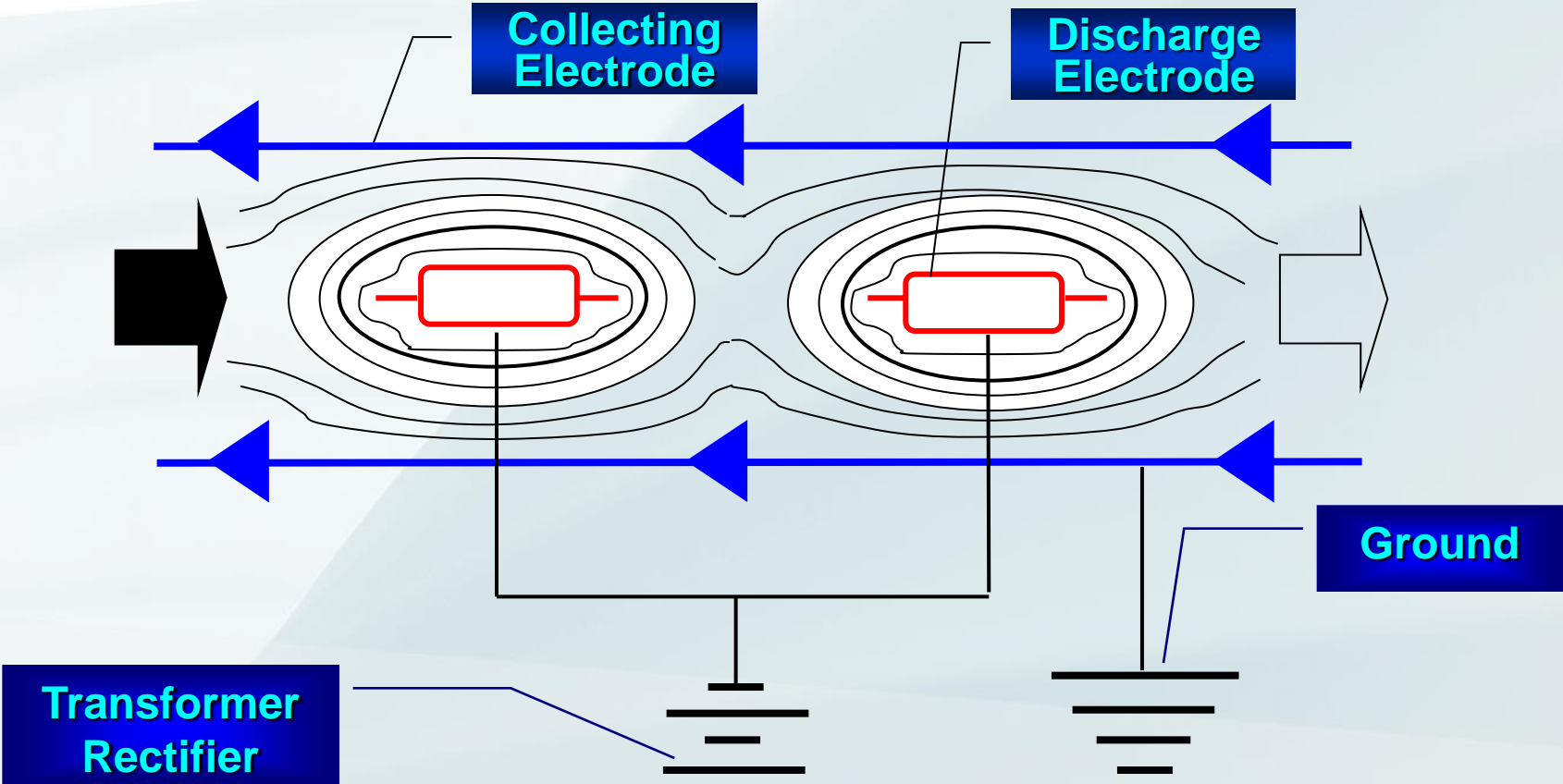
- Initial Investment Cost High
- When applies it to some system, requires subsidiary system
  - $\text{SO}_3$  Injection for Coal Fired Power Plant for high resistivity
  - $\text{NH}_4$  Injection for Oil Fired Power Plant for low resistivity
  - NaOH Spray System for Glass Melting Furnace
  - Water Quenching Sprayer for High Temperature Gas
- Explosion area requires anti-explosion system.

# ESP Operation Principle





# ESP Operation Principle



## ESP Operation Principle

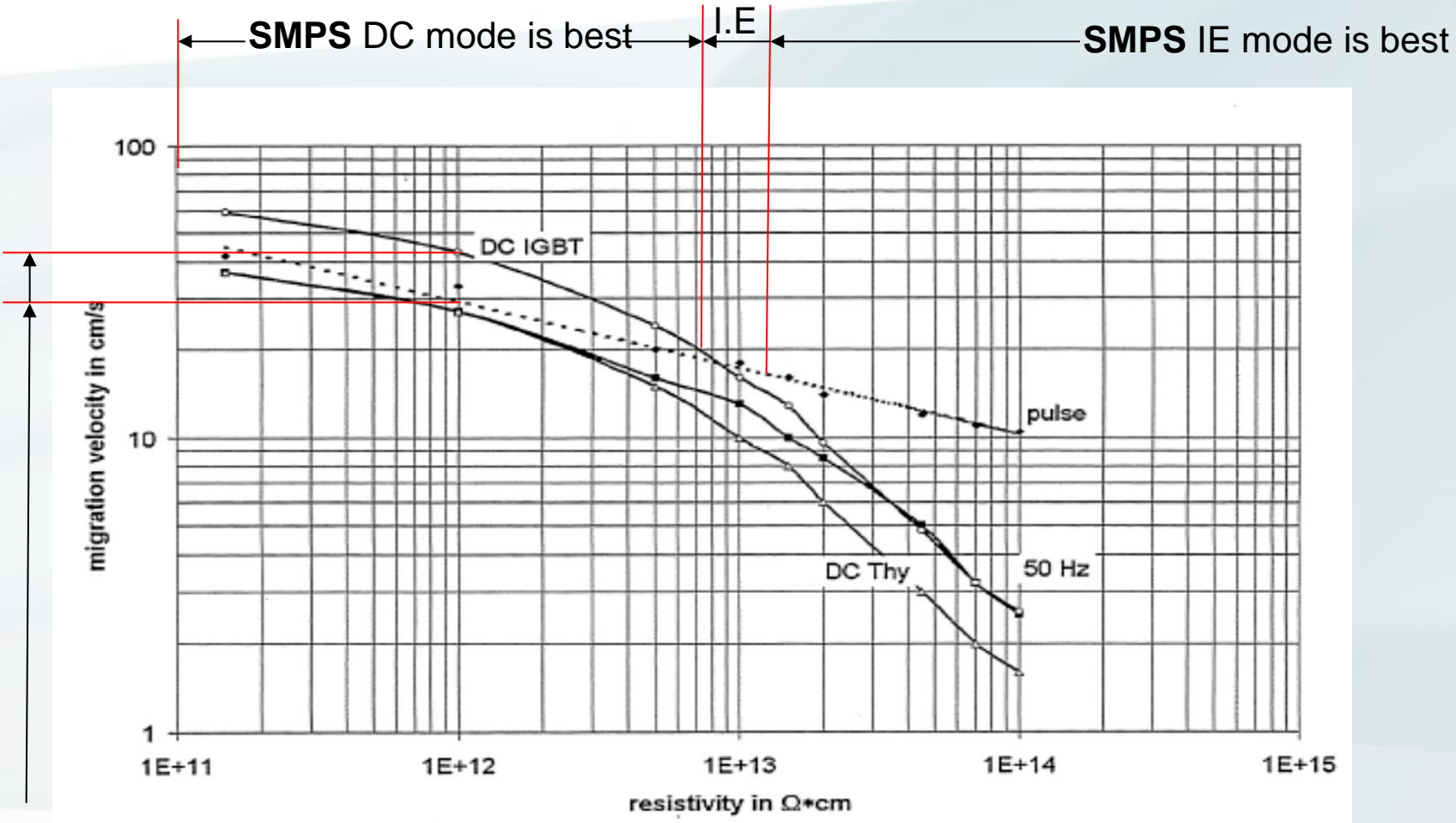
Electrostatic precipitation is a physical process, which collects the particulates suspended and electrically charged under the influence of the electric field which is generated by corona in gas stream. This electric field drives the charged particulates to a collecting surface, separating them from the gas. This process is exceedingly complex. Electrical, mechanical, chemical and aerodynamic phenomena are intimately involved.

Three aspects of the process are :

- Charging the suspended particulate.
- Collecting the particulate under the influence of the electric field.
- Removing the particulate from the collecting surfaces and discharge electrodes and transfer from the system.

An electrostatic precipitator consists of electrically grounded plates with negatively-charged electrode suspended between them. A gas stream with particulate (material to be removed) is introduced between the plates. The electric charge on the electrode creates a corona field which imparts a negative charge to the particulate. The charged plates are repeatedly cleaned with film coating water spray and flushing water spray installed above them, dislodging the particulate which falls into a hopper beneath the plates. Periodically, the particulate is removed from the hoppers to pond.

# Efficiency upon Particle Resistivity in $\Omega\text{cm}$



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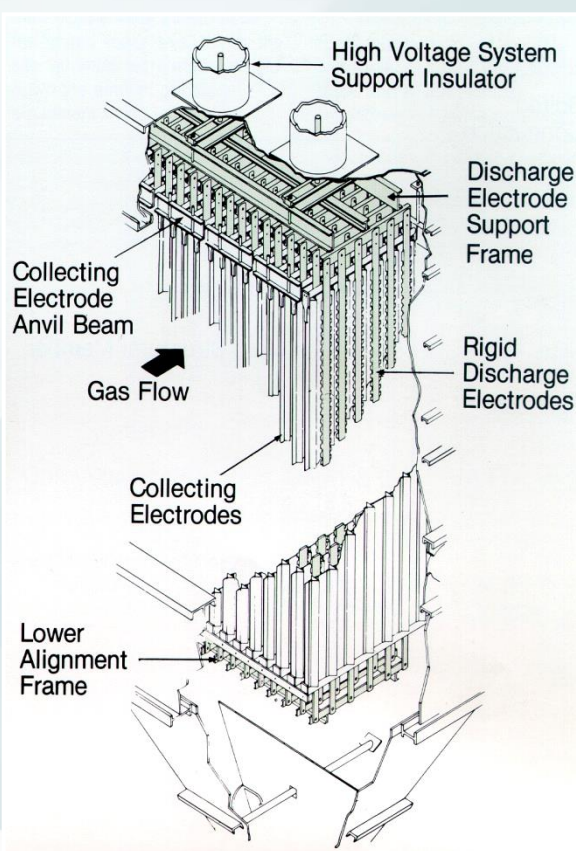
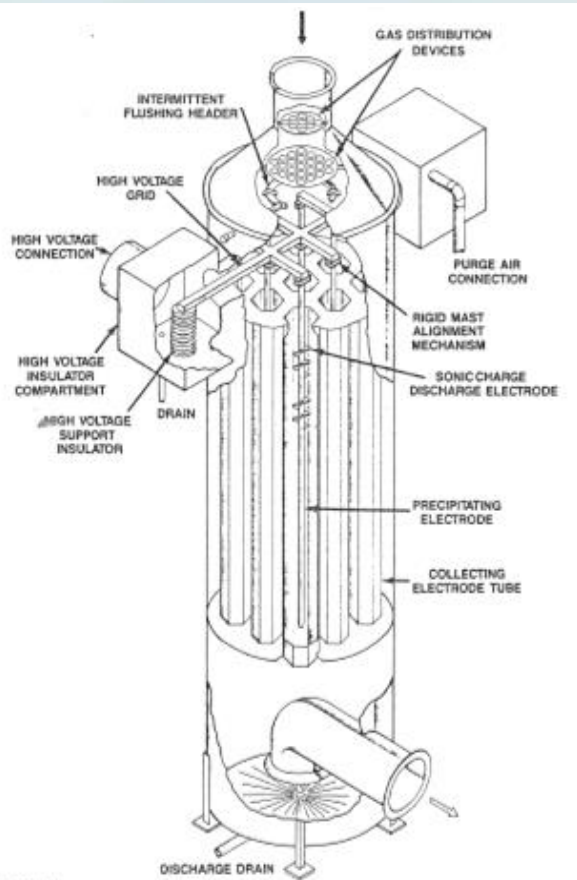
## **WESP Product by KC**

- **WESP Technology with Horizontal and Vertical Flow Design is available.**
- **Various Experiences during more 30 years**
- **Total Solution for various application**
- **Available for every industrial processes**


## WESP Comparison(Plate vs Honey Comb Type)

No.	Items	Plate Type	H/C Type
1	ESP Type		
	De-Dusting Method	Washing or Flushing (Wet Type)	
	Flue Gas Direction	Horizontal Type	Vertical Type
	CE Shape	Plate Type	Honey-Comb

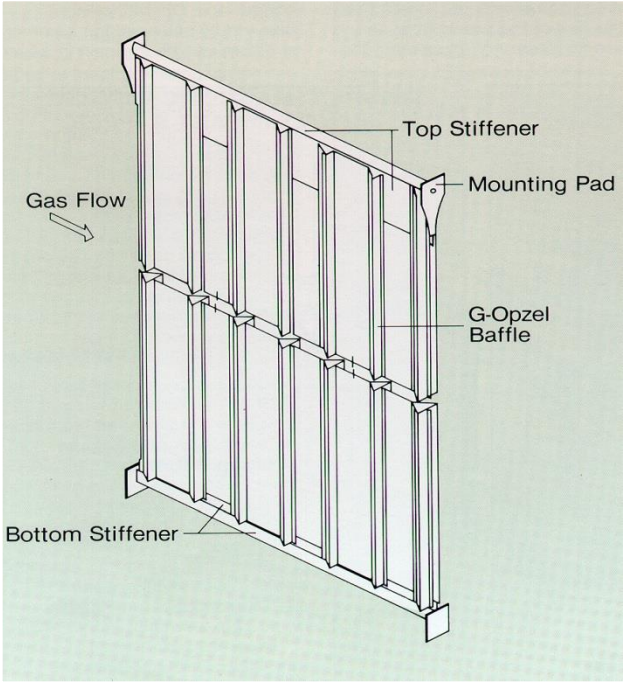
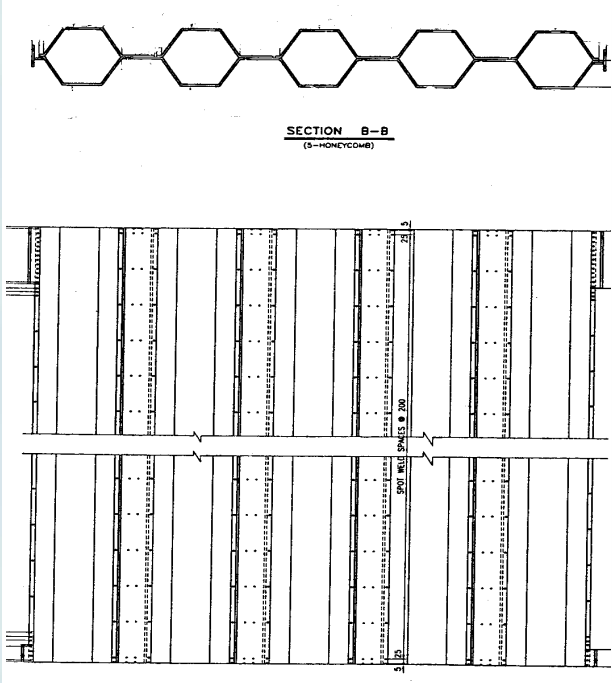
# WESP Comparison(Plate vs Honey Comb Type)

No.	Items	Plate Type	H/C Type
<b>2</b>	<b>ESP Shape I</b>	 <p>The diagram illustrates the internal structure of a Plate Type Electrostatic Precipitator (ESP). It shows a series of parallel plates held together by a 'Discharge Electrode Support Frame' at the top and a 'Lower Alignment Frame' at the bottom. 'Collecting Electrode Anvil Beams' are positioned at the top, and 'Collecting Electrodes' are attached to the lower frame. 'Rigid Discharge Electrodes' are located between the plates. An arrow indicates the direction of 'Gas Flow' from left to right. A 'High Voltage System Support Insulator' is shown at the top, and a 'Drain' is located at the bottom.</p>	 <p>The diagram shows a cross-section of a Honey Comb Type ESP. It features a central 'SONIC CHARGE DISCHARGE ELECTRODE' surrounded by 'PRECIPITATING ELECTRODE' tubes. The entire assembly is housed within a 'COLLECTING ELECTRODE TUBE'. Key components include 'GAS DISTRIBUTION DEVICES' at the top, an 'INTERMITTENT FLUSHING HEADER', a 'HIGH VOLTAGE GRID', and a 'RIGID MAST ALIGNMENT MECHANISM'. Other parts shown are 'HIGH VOLTAGE CONNECTION', 'HIGH VOLTAGE INSULATOR COMPARTMENT', 'DRAIN', 'HIGH VOLTAGE SUPPORT INSULATOR', and 'DISCHARGE DRAIN' at the bottom. A 'PURGE AIR CONNECTION' is also visible on the right side.</p>

## WESP Comparison(Plate vs Honey Comb Type)

No.	Items	Plate Type	H/C 형
2	ESP Shape II	 <p>▷ KYSM)2 CC No2 ▷ 2,500 A m<sup>3</sup>/min ▷ POSCO-1</p>	 <p>▷ KYSM)2TLC ▷ 3,000 A m<sup>3</sup>/min ▷ POSCO-2</p>

# WESP Comparison(Plate vs Honey Comb Type)

No.	Items	Plate Type	H/C Type
<b>3</b>	<b>CE Shape</b>	 <ul style="list-style-type: none"> <li>▷ <b>Plate Type</b></li> <li>▷ <b>Stainless</b></li> <li>▷ <b>1.0 ~ 1.4mmt</b></li> </ul>	 <ul style="list-style-type: none"> <li>▷ <b>Honey-Comb Type</b></li> <li>▷ <b>Stainless</b></li> <li>▷ <b>1.0 ~ 1.4mmt</b></li> </ul>



## WESP Comparison(Plate vs Honey Comb Type)

No.	Description	Plate Type	H/C Type
4	<p><b>Merit &amp; Demerit Comparison</b></p>	<ul style="list-style-type: none"> <li>● Middle, Large ESP</li> <li>● vs. H/C Initial Investment High</li> <li>● Arrangement Easy</li> <li>● More Area Required vs. H/C</li> <li>● ESP Sectional Area is Large &amp; flow velocity is slow, &amp; also due to CE's horizontal arrangement, retention time longer and collecting efficiency is higher vs. H/C. Required CE area is smaller.</li> <li>● Even one T/R down case, collection occurs</li> </ul>	<ul style="list-style-type: none"> <li>● Small ESP</li> <li>● Initial Investment Low</li> <li>● Limitation in Height</li> <li>● Compact Area</li> <li>● Flue gas velocity high in electric field and retention time is short, so required CE area is larger vs. Plate type.</li> <li>● D.E broken and T/R Off case collection not occur</li> </ul>

## WESP Comparison(Plate vs Honey Comb Type)

No.	Items	Plate Type	H/C Type
4	<b>Merit &amp; Demerit Comparison</b>	<ul style="list-style-type: none"> <li>● During T/R on, CE film water spray available</li> <li>● CE space :400mm</li> <li>● High resistivity dust applicable</li> <li>● Maintenance and repair easy</li> <li>● Demister required</li> </ul>	<ul style="list-style-type: none"> <li>● During washing, T/R off, CE continuous cleaning not available</li> <li>● CE space : 300mm</li> <li>● B-C oil fired boiler application</li> <li>● Maintenance and repair area narrow</li> <li>● Demister required</li> </ul>

## WESP Comparison(Plate vs Honey Comb Type)

No.	Items	Plate Type	H/C Type
5	Reference	<ul style="list-style-type: none"> <li>● KYSM)1CCM No2 / 4,000ACMM</li> <li>● KYSM)2CCM No1 / 2,700ACMM</li> <li>● KYSM)2CCM No2 / 4,000ACMM</li> <li>● KYSM)1HSM F.M / 7,100ACMM</li> <li>● KYSM)1Mini Mill / 4,141ACMM</li> <li>● KYSM)2Mini Mill / 4,141ACMM</li> <li>● PHSM)2CCM / 6,000ACMM</li> <li>● PHSM)2HSM R.M / 5,000ACMM</li> <li>● PHSM)3STS TCM / 2,000ACMM</li> <li>● DSC) HSM FM / 3,200ACMM</li> <li>● PHSM)2HSM F.M / 7,100ACFM</li> </ul>	<ul style="list-style-type: none"> <li>● KYSM)1TLC Disposal/3,000ACMM</li> <li>● KYSM)2TLC Disposal/3,000ACMM</li> <li>● KYSM)3TLC Disposal/3,000ACMM</li> <li>● KYSM)4TLC Disposal/6,000ACMM</li> <li>● PHSM)1TLC Disposal/3,000ACMM</li> <li>● PHSM)2TLC Disposal/5,000ACMM</li> <li>● PHSM)3TLC Disposal/3,000ACMM</li> <li>● PHSM)4TLC Disposal/6,000ACMM</li> <li>● PHSM)1HSM F.M/2,000ACMM</li> <li>● PHSM)2HSM F.M / 4,500ACMM</li> <li>● CSS) STS TCM/2,000ACMM</li> </ul>

## WESP Components

### Major Components

- **Spray System**
- **Collecting Electrode**
- **Discharge Electrode**
- **Main Body**
- **Transformer Rectifier**
- **Mist Eliminator**

## WESP Material

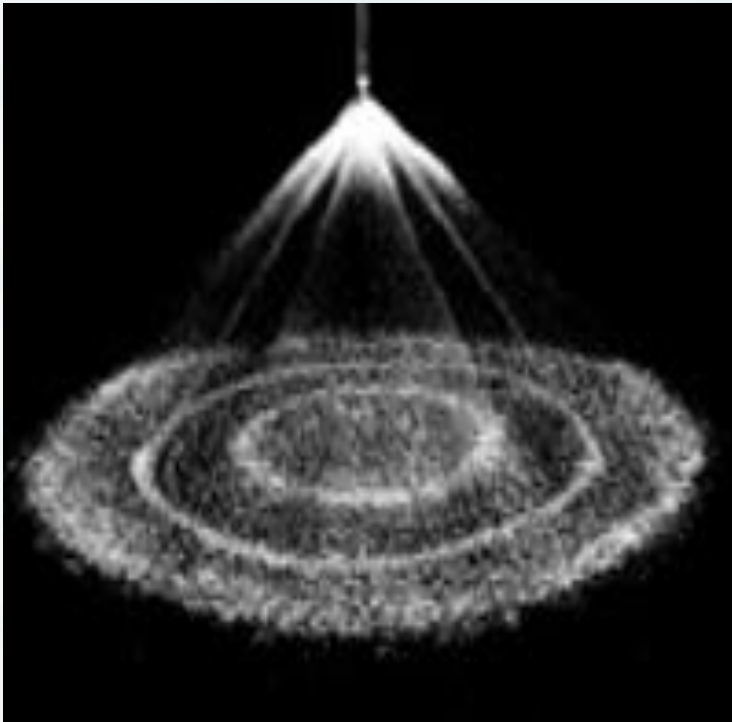
1. WESP Casing Material
  - SS400 + Epoxy Coating
  - Stainless
  - FRP + Carbon Mat Coating
  
2. WESP Collecting Plate Type & Material
  - Honey-Comb & Square Type (Stainless, C-FRP)
  - KC-Opzel Type (Stainless)
  - Plate Type (C-FRP)
  
3. WESP Discharge Electrode Type & Material
  - Dura-Trode Type (Stainless , Rigid Master)
  - Pipe Frame & Square Bar Type (Stainless)
  - R.S Type (Stainless , Pipe + Plate)
  - Cross Need Type (Ti + Pd Alloy)

## Flat Type Film Coating Nozzle



- **Collecting Plate Film Making Nozzle**
- **Flat Type Spray**
- **Cleaning Collected Dust on the Surface of Collecting Plate**

## Full Cone Type Internal Cleaning Nozzle



- **ESP Internal Cleaning Nozzle**
- **Full Cone Type Spray**
- **CE/DE Cleaning Simultaneously**
- **On Line/ Off Line Operation**

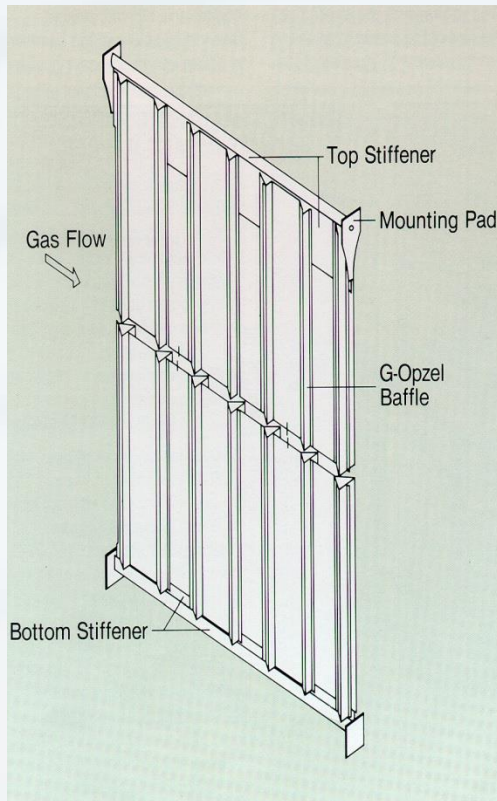
## Full Cone Type Inlet/Outlet Perforated Plate Cleaning & Membrane Nozzle



- Perforated Plate Cleaning Nozzle
- Full Cone Type Spray
- Inlet Membrane Array
- On Line Operation

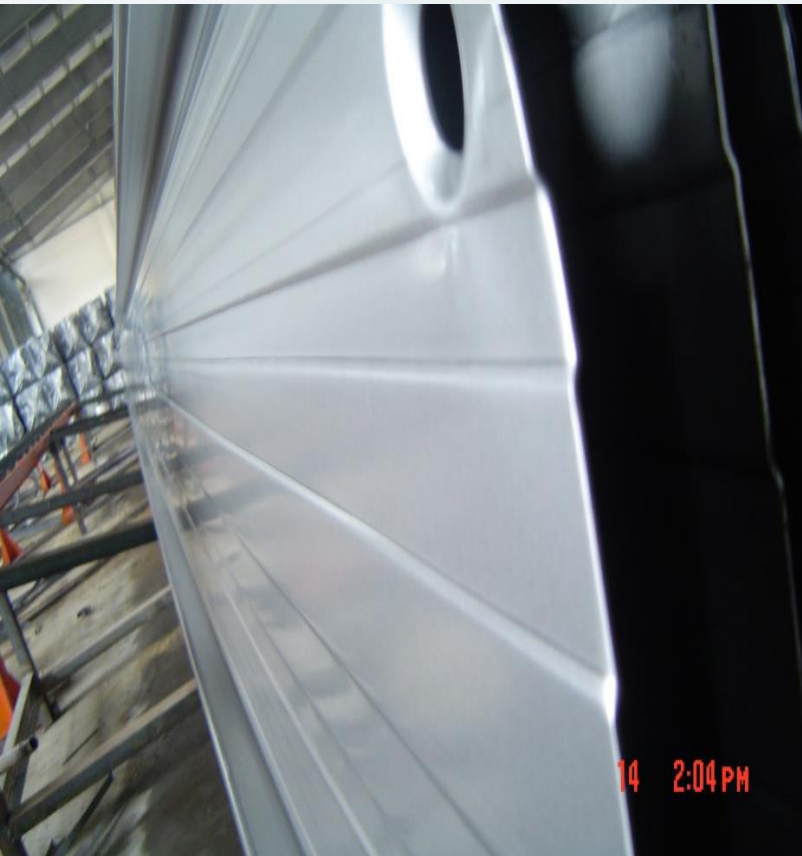


## Collecting Electrode – Traditional Type



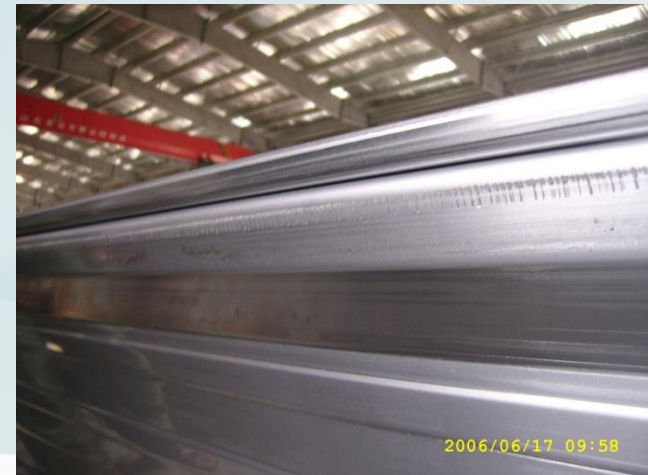
- **KC-Opzel Type**
- **Long Life**
- **No Bending, No cutting**
- **Panel Assembled in Factory**
- **Easy Erection in Site**

## Collecting Plate – Sigma Type

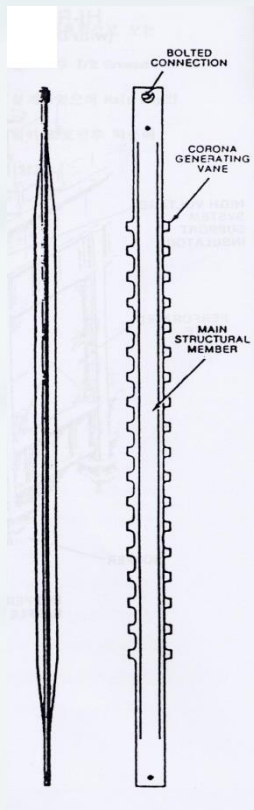


- **KC China - SigmaType**
- **Long Life**
- **No Bending, No cutting**
- **Panel Assembled in Site**
- **Easy Erection in Site**
- **Convenient Spray Condition**

# Collecting Plate – Sigma Type

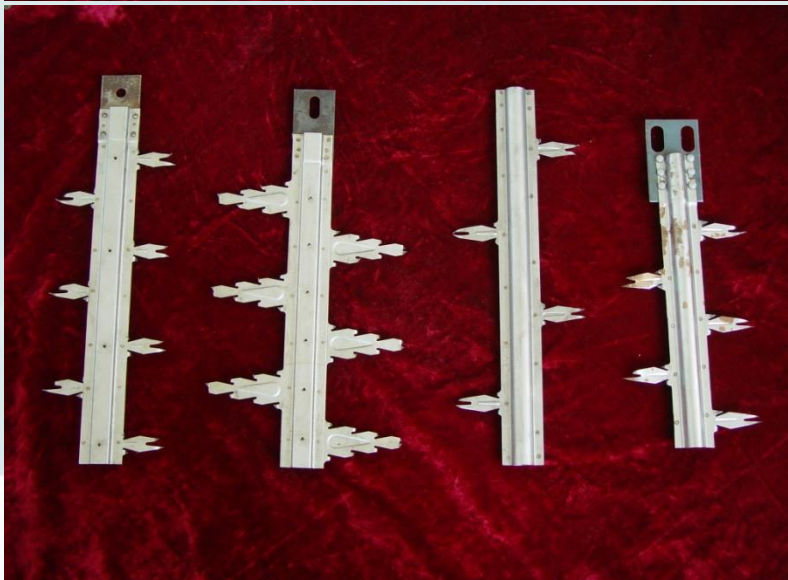
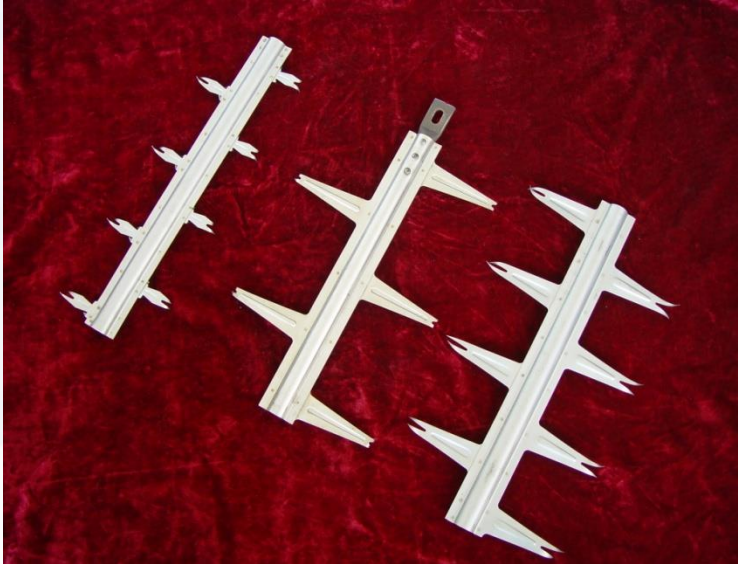
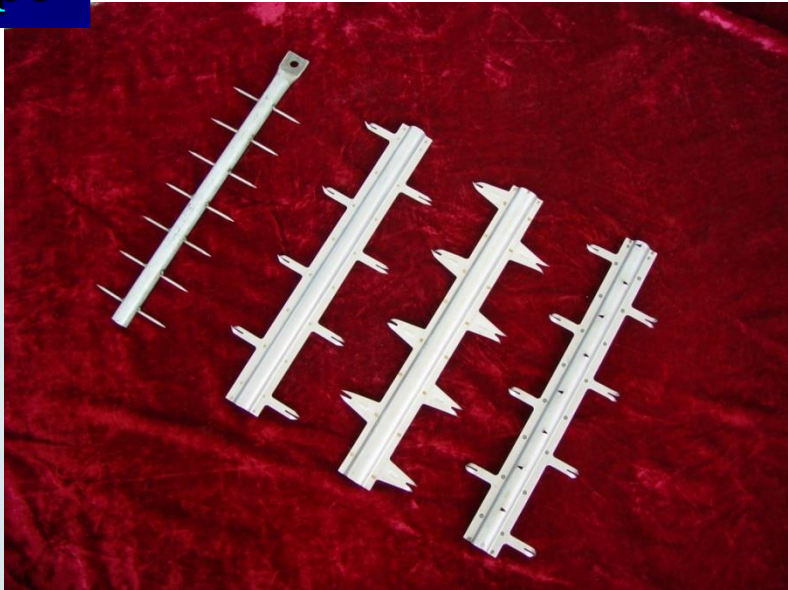
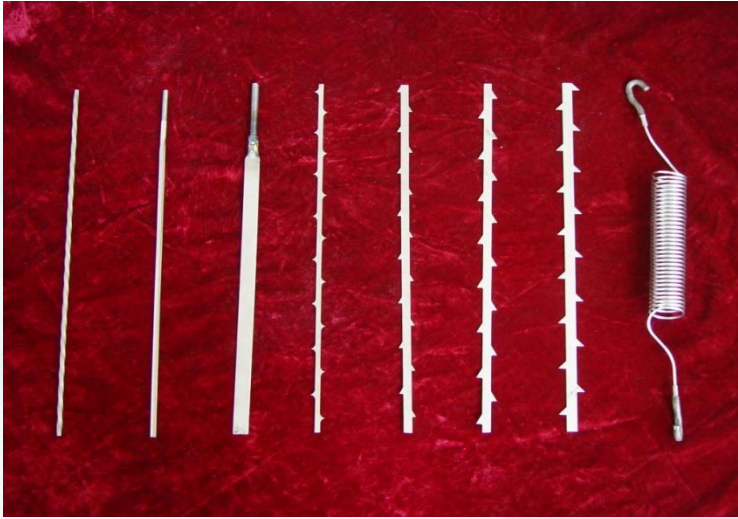


## Discharge Electrode - Traditional Type







- **Rigid Mast Type – Keep Strait**
- **Long Life**
- **No Bending, No cutting**
- **Easy Assemble**

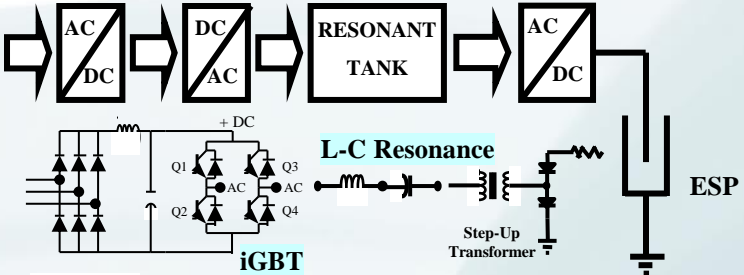
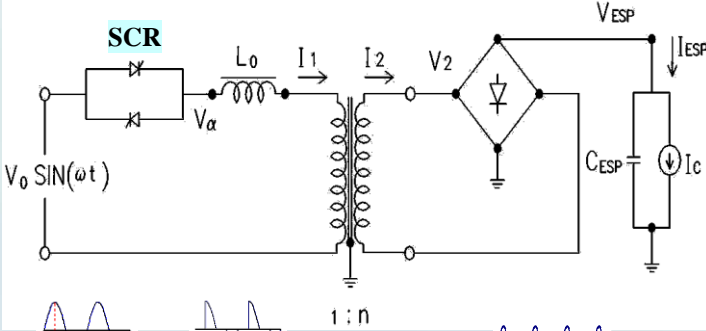
# Discharge Electrode –Other Type



# Power Plus & Conventional T/R Comparison

	Power Plus	Conventional T/R
Outside Form	<p>KEYPAD</p>   <p>Power Plus</p>	 <p>KEYPAD</p> <p>T/R Controller</p>  <p>Si T/R</p>
Component	Power Plus (High Frequency T/R + Controller )	Si T/R , T/R Control Panel
Control Method	SMPS (Switching Mode Power Supply) DSP (Digital Signal Processor)	SCR Angle Control (60Hz) $\mu$ -processor
Control Frequency	iGBT Current Control (High Frequency 25kHz)	SCR Angle Control (60Hz)
Input Power	3Phase 60Hz 480V	1Phase 60Hz 480V
Power Factor	0.94	0.63
Arc Response Time	0.03 ms	8.33 ms

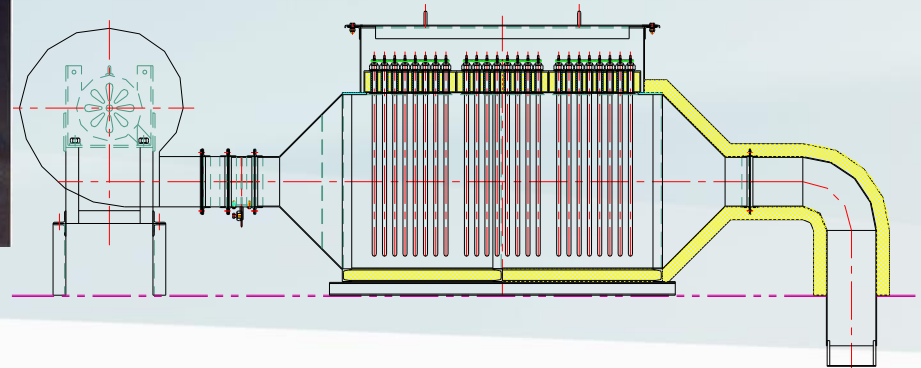
# Power Plus & Conventional T/R

	Power Plus	Conventional T/R
Circuit & Input/Output	 <p>3 Phase 50/60 Hz 480 VAC</p> <p>Single Phase 25 kHz Output</p> <p>mADC</p> <p>KVDC</p>	 <p>1 Phase 50/60 Hz 480 VAC</p> <p>mADC</p> <p>KVDC</p>
Voltage Control Method	<p><b>Duty Ratio</b></p> <p><b>Primary Current</b></p> <p><b>KVDC</b></p> <p>10 %</p> <p>30 %</p> <p>70 %</p> <p>100 %</p> <p>Duty Ratio Voltage Control</p>	<p><b>Conduction Angle</b></p> <p><b>Primary Current</b></p> <p><b>mADC</b></p> <p><b>KVDC</b></p> <p>45 °</p> <p>90 °</p> <p>180 °</p> <p>SCR Angle Voltage Control</p>

## High Voltage Line & Support Bushing



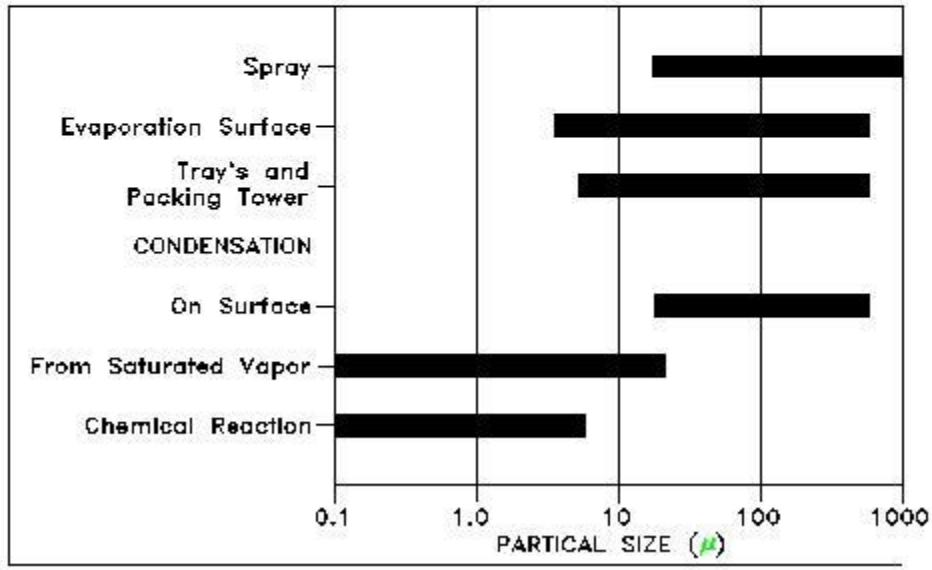
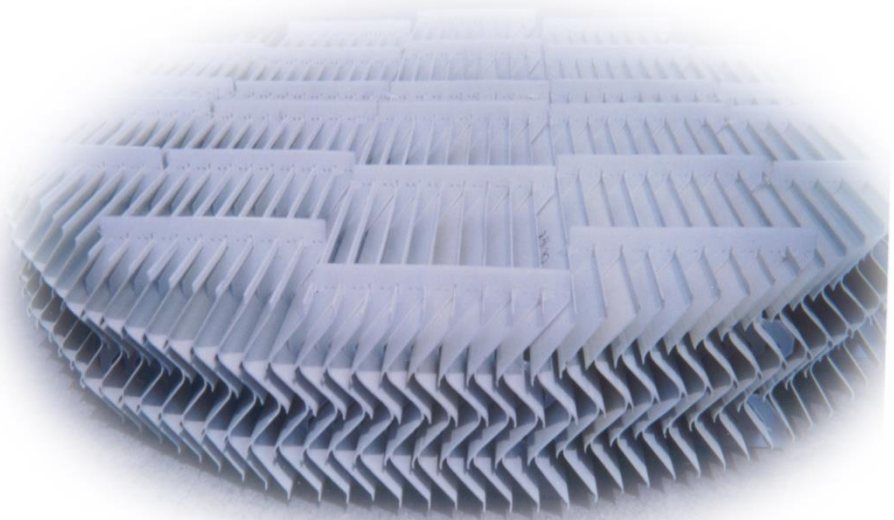
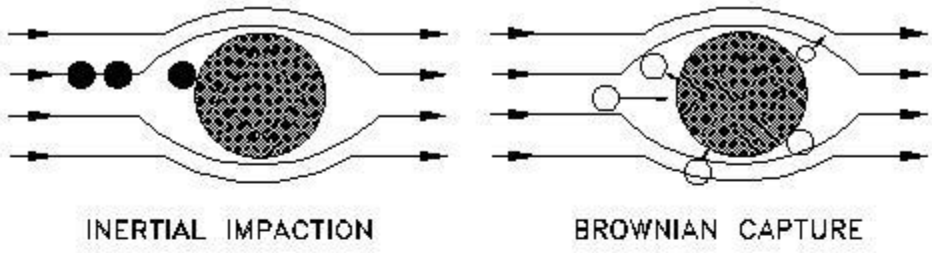
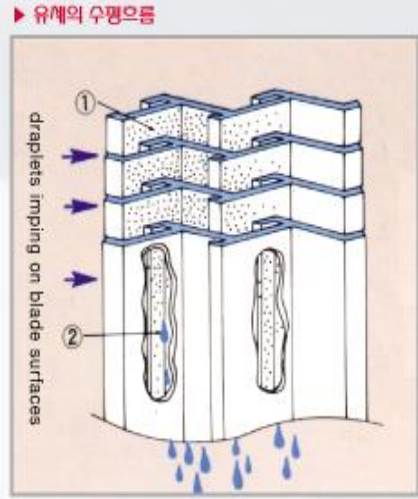
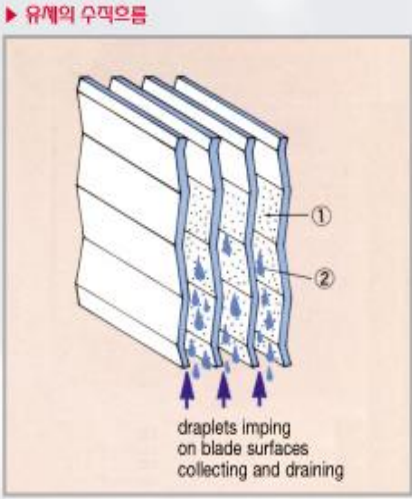
- For High Voltage Supply to ESP – Support and Insulation of Electricity
- To Keep the dry Condition of Insulator – Purge Air Required



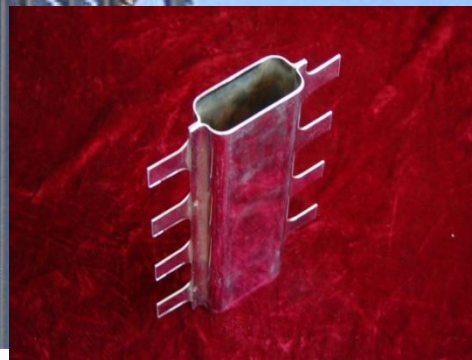


# Mist Eliminator

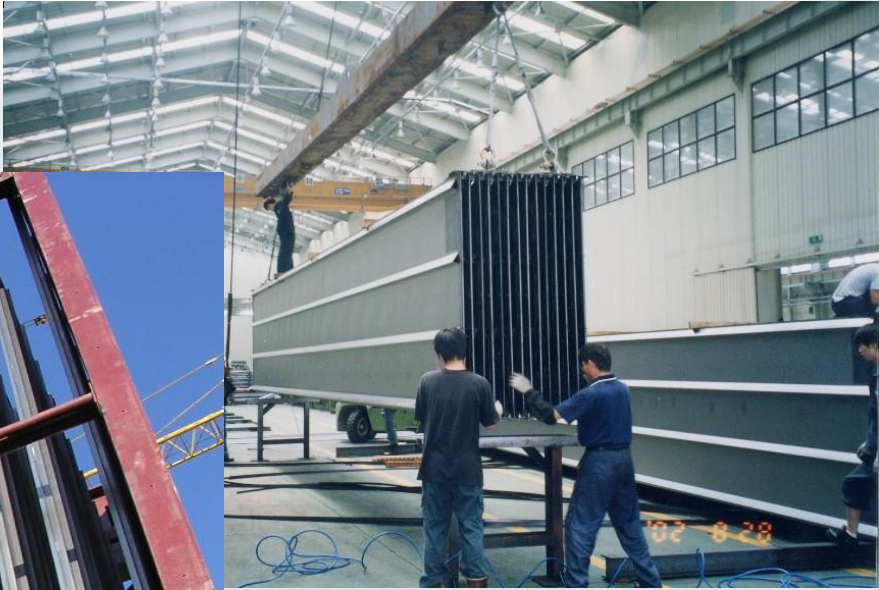
- Mist Elimination For Opacity
- For Protection of I.D. Fan



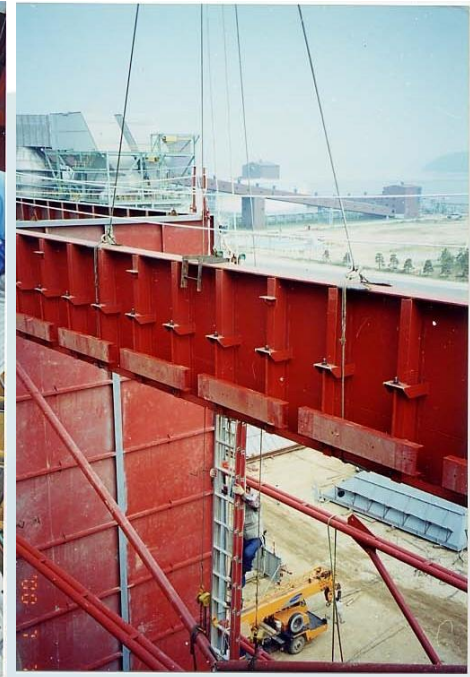
# Discharge Electrode Shape & Erection



# Collecting Plate Fabrication & Erection



# CE/DE Erection



# ESP Main Body Casing



# ESP Body Hopper



# Inlet / Outlet Perforated Plate

● For Flow Balance



# ESP Control System



## ● Control System

- High Voltage Control
- T/R Operation Control
- MCC / Local Panel Control
- PLC Base Control
- HMI Monitoring





# Reference View



**Dragon Steel Side View**

## Reference View



**Dragon Steel Roof Top T/R(High Frequency) & Other Equipment Arrangement**

# Reference View



**Waste Water Treatment View**

## Reference View



**Flushing Nozzle View**

**CE Water Film Nozzle View**

# Reference View



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**Water Control MOV View**

# Hot Air Line for Support Bushing View



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Thank you

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