

Advancements in ESP

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First Installations of Precipitators

1907 Chemical Industry
1910 Copper Lead & Zinc Smelters
1911 Cement Industry
1915 De-tarring of Fuel Gases
1916 Paper Mills
1919 Steel Industry
1923 Electric Power Industry
1926 Carbon Black
1949 Aluminum Smelters

Since invention, over last more than 100 years, lots of improvements / advancements did take place in ESP components & operating practices. Some of these advancements are covered here.

Advancements in ESP

- Computational Fluid Dynamics (CFD) study : For ensuring uniform gas & dust flow distribution within ESP fields
- Pipe-& Spike emitting electrodes : For ensuring effective corona generation even with dust coating on pipes, Have capability of operating without snapping
- Side-to-Top Rapping conversion : For increasing coll. plate area by 25 to 33% within the same ESP casing
- TR Controllers : For handling high resistive dust with better control over 'Back corona'
- Dust Load Distribution Technology (DLDT) : For reduced ESP outlet emission
- Hybrid ESP + Bag filter : For ESPs which are giving too high a emission due to plant capacity enhancement/ tighter emission norm/ changes in design parameters/ inadequate ESP sizing etc.

Computational Fluid Dynamics (CFD)

Computational Fluid Dynamics (CFD)

ESP Performance :

Many a time, though ESP Design Conditions are well evaluated while sizing ESP, inlet/outlet duct routing along with nozzle design & orientation may play a major role in spoiling performance of otherwise correctly sized ESP, through uneven gas & dust flow distribution.

Regrettably, this performance killer, on many occasions, is overlooked even by Designer / Consultant initially or by Customer during capacity enhancement stage.

Computational Fluid Dynamics (CFD)

ESP Performance :

In short, even correctly sized ESP or ESP with plant capacity enhancement, has Performance dependence on Uniform distribution of gas & dust throughout its cross section.

That is where

" Computational Fluid Dynamics (CFD) study "
plays a Vital role in improving
Gas distribution in Electrostatic Precipitator

Computational Fluid Dynamics (CFD)

CFD Advantages :

- Avoids extensive, repetitive Trial-&Error (T&E) method on field erected ESP, for ensuring uniform gas velocity inside ESP
- For a new ESP, CFD ensures proper orientation of inlet / outlet nozzles, GD screens
- For a field erected ESP, CFD eliminates costlier site modifications / alterations of nozzles, GD screens & vanes after every T&E test.

Computational Fluid Dynamics (CFD)

CFD Advantages :

- Minimises loss of time associated with repetitive T&E tests, site modifications etc. which proves crucial in an ESP upgradation job.
- Facilitates better planning of Plant Shut-downs for ESP upgradations with No last minute surprises, No shut-down extensions, No additional loss of production
- Has lower cost (~ one-fourth of Model study)
- Better speed of results (2 to 3 months)

Computational Fluid Dynamics (CFD)

CFD Advantages :

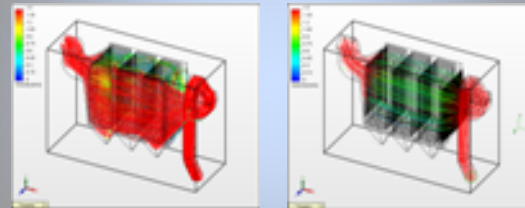
- No Model study set-up
 - Flexi-glass model
 - No elaborate floor space requirement for lab set-up
- (CFD requires only a Workstation & Software)
- No Field GD test at site
 - No ESP shut down (~ 10-12 days) for GD tests
 - No likely extension of shut down period resulting in extended loss of production & revenue



Case Study : Electrostatic Precipitator

Prior to CFD study

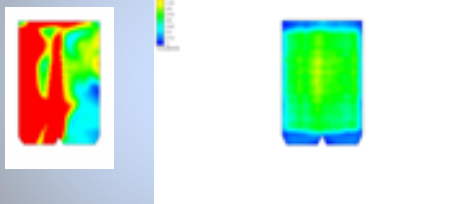
After CFD study



Case Study : Electrostatic Precipitator

Prior to CFD study

After CFD study



ESP Cross-sectional view

Emitting Electrodes

Types of Emitting Electrodes

1. Spiral
2. Twisted square
3. Twisted pair
4. Saw-tooth ribbon
5. Twist barbed
6. Smooth round
7. Open hook
8. Loop ring
9. S-hook loop ring

Types of Emitting Electrodes

10. Pipe-&Pin Emitting Electrodes 11. Pipe-&Spike Emitting Electrode

Emitting Electrode Corona Glow - Typical

Problems associated with EE : Heavy Dust Coating

∅ Heavy Dust Coating :

- Badly affects emissivity
- Suppresses Secondary Current
- Field operates at much lower efficiency

Problems associated with EE : Snapping

∅ Every spark & arc results in etching of metal from surface of emitting electrodes

∅ Etching results in :

- Reduction in radius of curvature
- More corona generation
- Possible next spark/arc at same location

∅ And the Outcome – Snapping of emitting electrode

Solution to Dust coating, Snapping of EE

∅ That is where Pipe-&Spike design of emitting electrodes offer a solution.

- ü Annealed copper coated nails ensure sharp corona points over a long time.
- ü Zero probability of Snapping
- ü Lower 'corona onset voltage'
- ü Higher efficiency of ESP for same process parameter
- ü Simplicity of installation
- ü Adaptability to all designs
- ü Lower downtime for retrofits

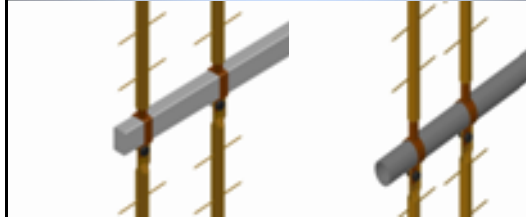
Pipe-&-Spike design emitting electrodes

- Ø Reduces possibility of 'back corona'
- ü Lower corona onset voltage ensures beginning of process of ionization well in advance of back corona region
- ü During back corona, emitting electrodes get coated with dust
- ü Pipe provides surface for such coating
- ü Nails still remain free from dust to generate corona
- ü ESP continues to receive power with dust-coated electrodes



Pipe-&-Spike design emitting electrodes

- Ø Simplicity of ESP Retrofit/Upgradation
- ü Can easily be retrofitted on any existing Emitting electrode frame/ mast design

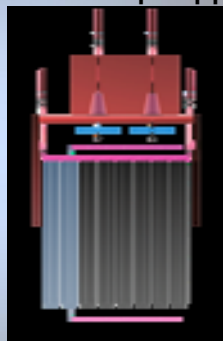
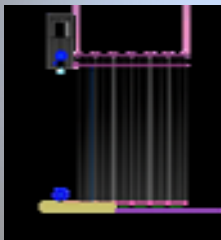


Mechanical Upgrade Side-to-Top Rapping

Mechanical Upgrade - Side-to-Top Rapping

- Ø An innovative way to increase collecting plate area as well as improve rapper impact
- Ø The space between two consecutive fields can be utilised for installing additional collecting plates.
- Ø This design modification is applicable only to certain types of ESPs.
- Ø However the increase in collection area that this modification can fetch is up to 33%

Mechanical Upgrade - Side-to-Top Rapping



Mechanical Upgrade - Side-to-Top Rapping

- Ø Advantages
 - ü No change in footprint
 - ü Inlet, outlet duct work & nozzles remain same
 - ü Fan and stack location kept unchanged
 - ü No moving parts within precipitator casing
 - ü Virtual elimination of maintenance
 - ü Moving parts being outside gas stream, they can be maintained online

Mechanical Upgrade - Side-to-Top Rapping

Advantages

- Improved reliability in rapping mechanisms
- Rapping sequence, frequency & intensity can readily be changed through micro-controller. This minimises possibility of puffing.
- Higher treatment length reduce re-entrainment of dust
- Support insulators pertaining to an individual field are housed in separate compartments.

TR Controller

TR Controller

Control System Adaptable for handling high resistive dust such as :

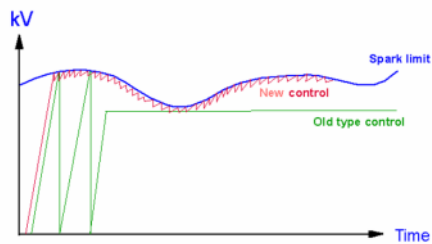
- Clinker cooler dust (Cement industry)
- Indian Coal fired boiler fly-ash (Power Industry)
- Sinter strand dust (Metallurgical industry)

TR Controller

Control System Requirements

- Optimise effective power into ESP field
- Prevent back corona
- Prevent/ minimise sparking
- Automatically track process changes
- Provide meaningful fault diagnostics
- Prevent ESP damage under severe faults

TR Controller



Dust Load Distribution Technology (DLDT)

DLDT : Revolutionary Technology

- Lowers outlet emission by 25 to 50 % at about one tenth cost of conventional methods
- Saves electrical power by 10 to 15 %
- Lowest down time required for implementation
- No recurring costs

What is DLDT ?

- Modify gas flow pattern inside ESP - deflect it from inlet bottom to outlet top - to achieve uniform dust load from top to bottom of ESP
 - with turning vanes
 - with blocking of perforated plates
 - with additional gas distribution devices at outlet of ESP

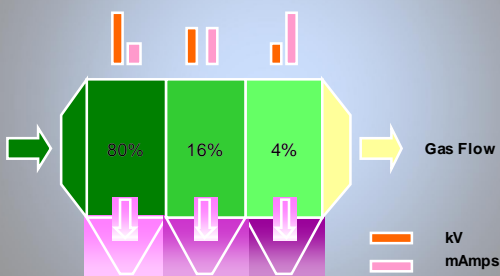
What is Important ?

Gas Distribution
or
Dust Load Distribution ?

Theory Book Says

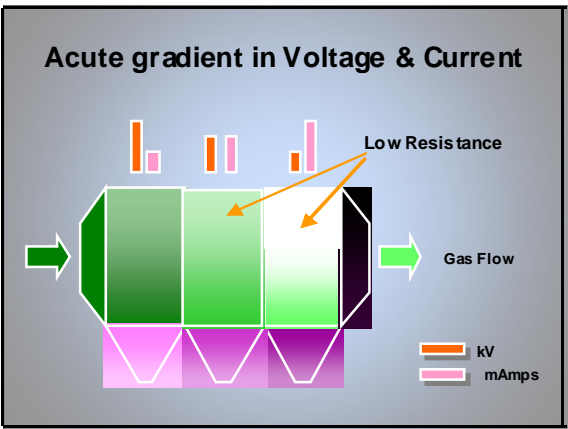
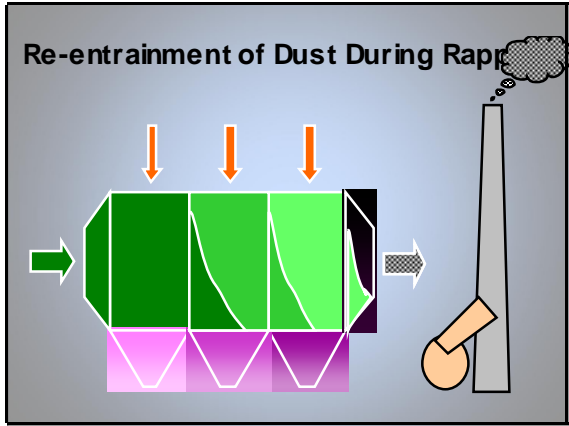
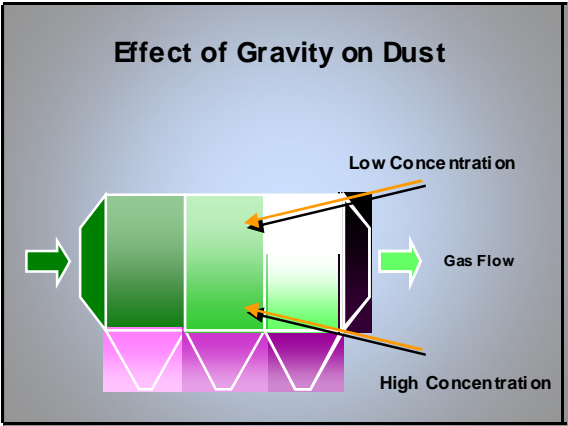
- Gas distribution has to be as per Institute of Clean Air Companies (ICAC) standards
- First field collects 80% of dust
- Second field collects 16% of dust
- Third field collects 4% of dust
- Current increases from first to last field
- Voltage decreases from first to last field

Theory Book Shows

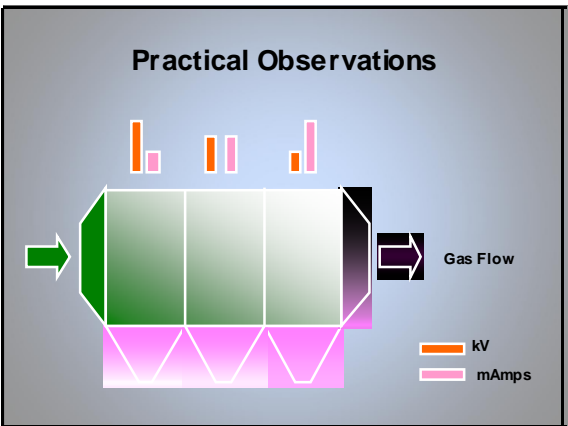


Aspects Overlooked

- At low gas velocity dust settles down due to gravity
- Re-entrainment of dust during rapping of plates
- Acute gradient in voltage & current levels affect migration velocity



- ### Practical Observations
- ∅ Upper portion is under-utilized
 - ∅ Lower portion is over-loaded
 - ∅ High current drain in low resistance area
 - ∅ Voltage drops due to loading of T/R set
 - ∅ No corona in lower portion



- ### Practical Problems
- ∅ Drop in voltage reduces migration velocity
 - ∅ Increased gas volume increases re-entrainment of dust
 - ∅ Fine & light dust that is more susceptible, increases emission
 - ∅ Puffing is more visible & adds to average emission

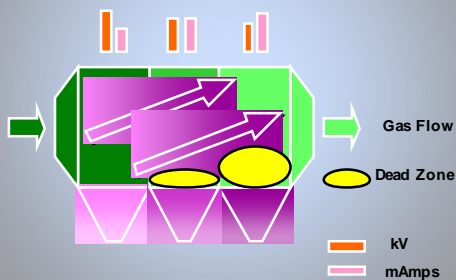
Underlining Theory

Dust Load Distribution
is
More Important
than
Gas Distribution

DLDT Methodology

- ∅ Identify ideal angle for gas flow to overcome gravitational effect
- ∅ Create a DEAD POCKET at outlet bottom of ESP
- ∅ Computer flow modeling to arrive at new gas distribution devices
- ∅ Verification of computer modeling in field after implementation

Methodology



Advantages - Electrical

- ∅ Entire ESP from top to bottom is uniformly loaded
- ∅ Reduction of current drain saves electrical energy
- ∅ Higher kV results in higher migration velocity - crucial for collection of fine particles

Reduced Emission

- ∅ Dust falls in dead pockets at lower end of outlet field during rapping
- ∅ Reduced re-entrainment of dust during ESP operation
- ∅ Puffing is eliminated

Technological Advantages

- ∅ All ESPs are sized as per Deutsch Anderson Equation
- ∅ DLDT is based on parameters over & above those in Deutsch Anderson Equation
- ∅ As a result, with DLDT, Performance improvement is assured in all ESPs

Conclusion

Dust Load Distribution

is

More Important

Than

Gas Distribution !

Hybrid ESP + Bag filter

Hybrid ESP + Bag filter

Customer : JRP Cement Plant, Rewa, MP

Problem : Higher emission from Fly-ash Dryer ESP

Background : Fly-ash Dryer ESP installed along with pre-collector Cyclone

Input : Ash from NTPC Power plants of 2 types

- Ø Ash with 20-25% w/w moisture (pond ash)
- Ø Ash with 8-10% w/w moisture

Emission from ESP for :

- Ø Ash with 20-25% w/w moisture, ~ 100 mg/ Nm³
- Ø Ash with 8-10% w/w moisture, > 1000 mg/ Nm³

Hybrid ESP + Bag filter

Customer : JRP Cement Plant, Rewa, MP

Problem : Higher emission from Fly-ash Dryer ESP

Viable Solutions :

Option 1 : ESP be made bigger in size by 60-65% by adding 2 more fields to present 3 fields in operation

Option 2 : Install a new ESP in parallel to existing ESP with a split-flow of 40% & 60% respectively.

Option 3 : Install Hybrid Bag filter within existing ESP by dismantling last field & adding a new Fan if reqd

Customer confirmed Option 3 (Hybrid ESP + Bag filter)

Hybrid ESP + Bag filter

Customer : JRP Cement Plant, Rewa, MP

Problem : Higher emission from Fly-ash Dryer ESP

Installation : Hybrid ESP + Bag filter

ESP last field emptied, installed "Precip Filter"

Precip Filter Design Parameters :

- Ø Gas Flow Rate : 250,000 m³/ hr at 120 Deg C
- Ø Bag Material : PolyAcrylonitrile with PTFE treatment
- Ø No of Bags : 640
- Ø Bag Dia x Length (mm x mm) : 150 x 6000
- Ø Air-to-Cloth Ratio : 2.30 m³/mi n-m²

Result : All time Clean Stack

ESP in Operation
Prior to Precip Filter



ESP housing 3 Fields (Prior to Retrofit)
(Hazy environment due to dusty stack)

ESP with Precip Filter
in Operation



Precip Filter installed in last ESP field
(field emptied of its internals)
ESP now housing 2 Fields Plus "Precip Filter"
(Clean Environment)

Fly-ash Dryer ESP at JRP Cement Plant, Rewa, MP
running over last 3 years with Zero maintenance

Ionisation Filtration Ind. Pvt Ltd (IFI), Pune, India
(Formerly known as Baltec Systems Pvt Ltd)

- ◊A project engineering company.
- ◊Handles complete APC jobs starting from concept to commissioning.
- ◊The services cover Application Engg, Design, CFD, Supply, and Supervision of E&C & Maintenance contracts for Air Pollution Control (APC) equipment.
- ◊Conducts Inspection/Comprehensive Audits of old ESP/Baghouses & proposes Short /Long term Corrective measures with a special focus on minimum cost, least downtime & least loss of production
- ◊IFI also offers quality replacement parts of air pollution control equipment.
- ◊Now an established name as original eqpt manufacturer (OEM) & project engineering company for ESPs, Bag Filters, Emission monitors, amongst others.

Thanks.