

## CFD ANALYSIS AND OPTIMIZATION OF ELECTROSTATIC PRECIPITATOR -INLET FUNNEL

### Objectives

To modify and optimize the existing ESP's inlet funnel from two funnel system to four funnel system with uniform flow through all four inlet funnels.

To optimize the position and number of deflector plates required on Gas Distribution (GD) screen, to achieve established precipitator gas velocity distribution criteria.

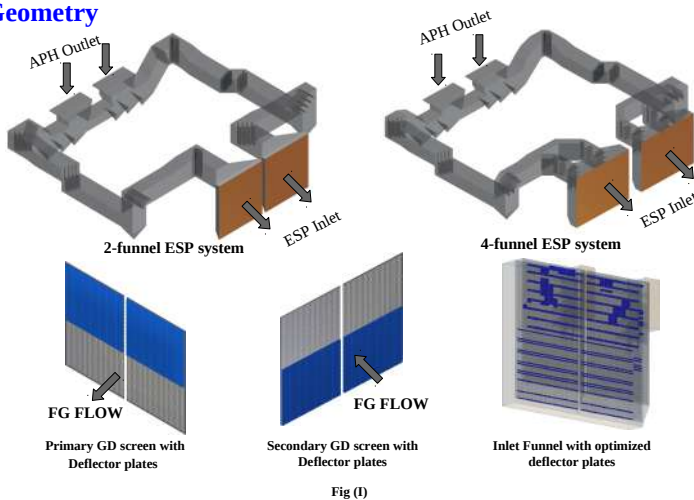
### Challenges

- Meshing of GD-screens, deflector plates and ESP internals.
- Optimizing deflector plate's orientation and position.

### Description

ESP is a static pollution control equipment used in many industrial applications, mostly in thermal power plants for collecting coal ash Suspended Particulate Matter (SPM) present in Flue Gas (FG) and discharge them into hoppers, thereby only clean FG enters atmosphere. Through the principle of ionization with the application of unidirectional high voltage through its components- emitting and collecting electrodes ESP's collects the SPM's. The flow and velocity characteristics of FG plays a major role in overall performance of ESP; both high and low localized FG velocity reduces its collection efficiency. Stringent norms set by air pollution control authorities for dust collection requires ESP systems to **comply with** an established precipitator gas velocity distribution criteria, one such being Standards set by the Institute of Clean Air Companies (ICAC) , **ICAC-EP7 standard**. This requires an optimized design of flow control devices within ESP's, that includes inlet funnel, flow splitters, GD screens and deflector plates.

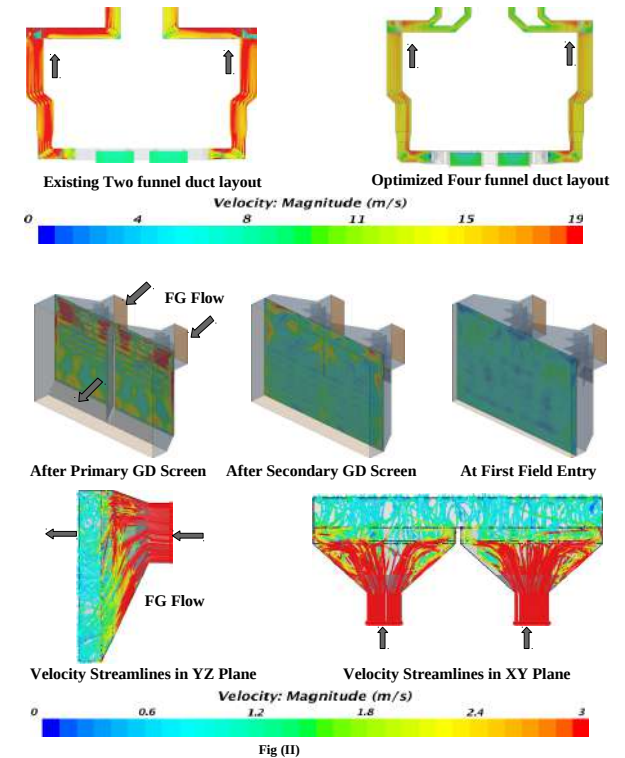
### Geometry



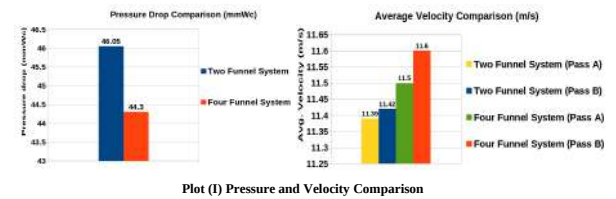
### Approach

A typical 210 MW Coal fired thermal power plant FG duct system from APH outlet to ESP inlet including inlet funnel, flow splitters, GD screens and deflector plates were considered for CFD modeling. Suitable geometrical approximations were made to capture the effect of ESP internals, to reduce the computational time. The full scale 3-D domain of interest was discretized appropriately with structured hexahedral meshing scheme. The 3-D turbulent and highly recirculating flow field of the FG within the duct and ESP inlet funnel section was predicted using Navier stokes code with RANS Std K-ε turbulence model. Flow boundary conditions were set to 80% of TMCR conditions. Trials with suitable modifications were undertaken through CFD to optimize the duct layout, flow splitters and deflector plates on GD screens to achieve the established precipitator gas velocity distribution criteria within the ESP.

### Velocity Contours



### Pressure Drop and Avg. Velocity Plot



### Conclusion

The results obtained through CFD analysis, shown in **plot (I)** indicates uniform gas flow through all the four inlet funnels of the modified ESP FG duct layout design and also the velocity Coefficient of Variance (CoV) predicted at first field entry is in the range of 25%, which in turn is expected to reduce further to < 20% at ESP's first field exit, as required by **ICAC-EP7 standard**. The identified meshing scheme and turbulence model to predict the flow field captures the flow re-circulation within various zones of ESP inlet funnel in particular after the GD screens thereby well capturing the effect of deflector plates placed on GD screen. Flexibility of such offline modifications makes CFD technique as an ideal and cost effective approach for better design of new ESP systems and performance enhancement of existing ESP systems.

### Advantages

1. Significant reduction in In-situ flow testing and correction time.
2. Enhanced dust collection efficiency in ESP.

### Applications

Retrofitting of existing and new ESP design for Power plants & Process industries.

Ref: ICAC Standard: "Electrostatic Precipitator Gas Flow model studies ICAC-EP-7; June 2004".