

MODIFICATION OF DISCHARGE ELECTRODE IN ELECTROSTATIC PRECIPITATOR

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Abstract

In Fluidized bed boiler the exhaust gas has more ash particles due to the agro fuel. As per the Environmental control board norms the particle level from the exhaust gas should not be exceed 50ppm. But it has 700ppm. Several scientific studies have linked the ash particles with a wide range of health-related disorders resulting in daily mortality, respiratory and cardiovascular hospitalizations, adverse impaired lung function, etc. For control the dust particles the electrostatic precipitator is installed with the boiler. The electrostatic precipitator having rod type discharge electrode and collecting plate to charge and collect the dust particles. The spiked discharge electrode is used instead of rod type discharge electrode and to reduce the material cost of the electrostatic precipitator. The efficiency of the spiked discharge electrode electrostatic precipitator more compare to rod discharge electrode electrostatic precipitator. The electrical field strength of the spiked discharge electrode modeling and analyzing with help of ANSYS (Professional Emag)

Keywords: ESP, Spiked electrode, Rod type electrode

1. INTRODUCTION OF ESP

The electrostatic precipitators (ESP) are one of the more frequently used for particulate collection. They can handle large gas volumes with a wide range of inlet temperatures, pressures, dust volumes, and acid gas conditions. They can collect a wide range of particle sizes, and they can collect particles both in dry and wet states. For many industries, the collection efficiency can go as high as 99%.

2. SPECIFICATION OF THE EXISTING ESP

Type	: Dry type ESP
Size of the ESP	: 2.5 x 2.5 x 4 m
No. of Fields	: 3 Nos.
Collecting plate dimension:	1.8 x 3.6 x 0.002 m
Spacing between CP	: 400 mm
Diameter of the Discharge electrode:	20 mm
Distance between DE	: 200 mm
No. of DE's	: 216 nos.
Radius of the particle	: 0.5 μ m
Efficiency	: 65%

2.1 Arrangement of Existing ESP

The figure 2.1 shows the general arrangement of the existing electrostatic precipitator in sail. This ESP having three field to collect the dust particles. The collected dust particles from the collection plate drained through the bottom drain of ESP.

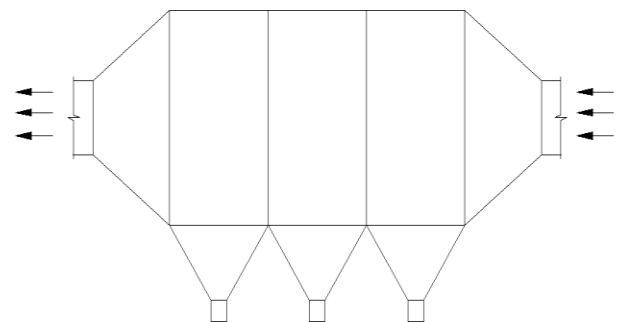


Fig 2.1

2.2 Arrangement of DE & CP in existing ESP

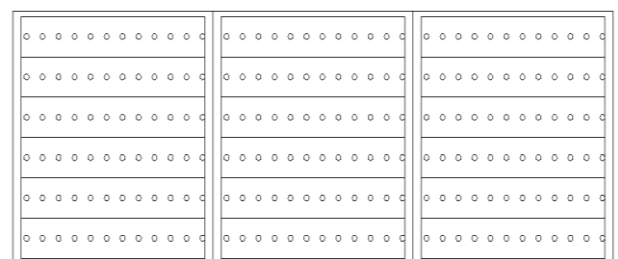


Fig 2.2

The existing electrostatic precipitator details given the above. In this electrostatic precipitator the rod type electrode using as a discharge electrode. The hammering system is used for removing the deposited dust particles from the collection plate. In this project, the spiked discharge electrode is used for charging the dust particles instead of rod type discharge electrode.

3. MODELLING AND ANALYSIS OF SPIKED DISCHARGE ELECTRODE



Fig. 3.1 Arrangement of spiked discharge electrode in electrostatic precipitator (Top view)

4. MODELING AND ANALYSIS OF SPIKED DISCHARGE ELECTRODE

- $W = qEp / (4\pi\mu r)$
- W=Migration velocity
- q= Particle charge (C)
- Ep=Strength of electric field (V/m)
- R = radius of the particles
- $\eta = 1 - \exp(-WA / Q)$
- W=Migration velocity
- Q = gas flow rate
- A = Collection surface area

4.1 Case 1

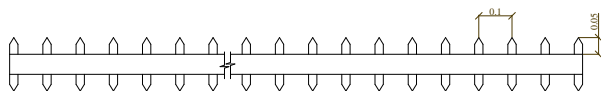


Fig. 4.1 Modelling of spiked discharge electrode with D=0.1m, L=0.05m (D=Distance between spike, L=Length of the spike)

The diameter of the centre rod is 20 mm, the spike length starts from 50mm and the distance between the spike starts from 100mm. The number of spiked discharge electrode per field is 36. So the total number of the electrode in the ESP is 108. This discharge electrode analysed for electric field strength through ANSYS.

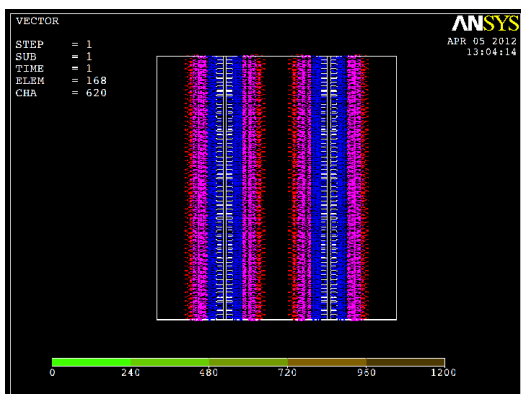


Fig. 4.2 Analysis result of spiked discharge electrode with D=0.1m, L=0.05m

The efficiency of the electrostatic precipitator is 30%.

4.2 Case 2

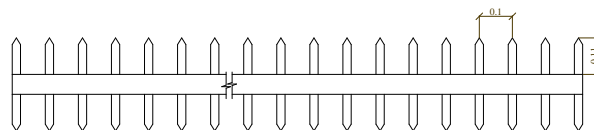


Fig. 4.3 D=0.1m, L=0.11m

The diameter of the centre rod is 20 mm, the spike length 110mm and the distance between the spikes 100mm. The number of spiked discharge electrode per field is 36. So the total number of the electrode in the ESP is 108.

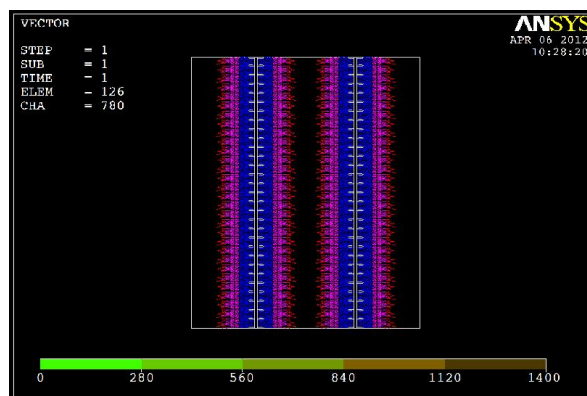


Fig. 4.4 D=0.1m, L=0.11m

4.3 Case 3

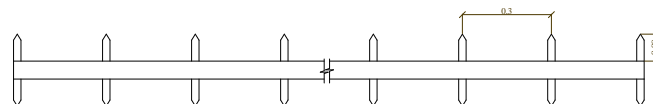


Fig. 4.5 D=0.3m, L=0.09m

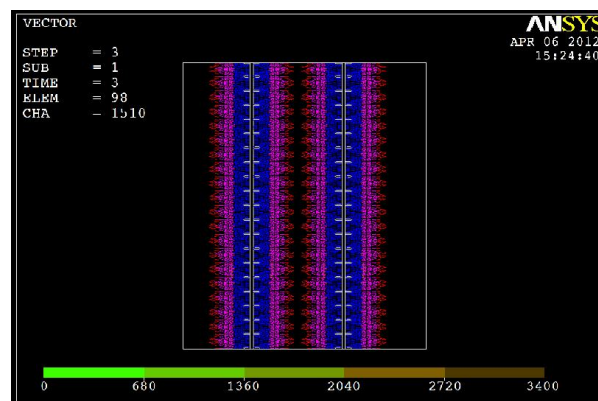


Fig. 4.6 D=0.3m, L=0.09m

4.4 Case 4

The diameter of the centre rod is 20 mm, the spike length 130mm and the distance between the spikes 400mm. The number of spiked discharge electrode per field is 36. So the total number of the electrode in the ESP is 108.

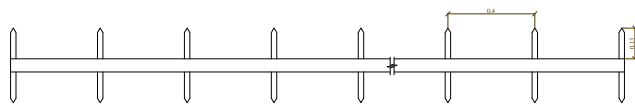


Fig. 4.7 D=0.4m, L=0.13m

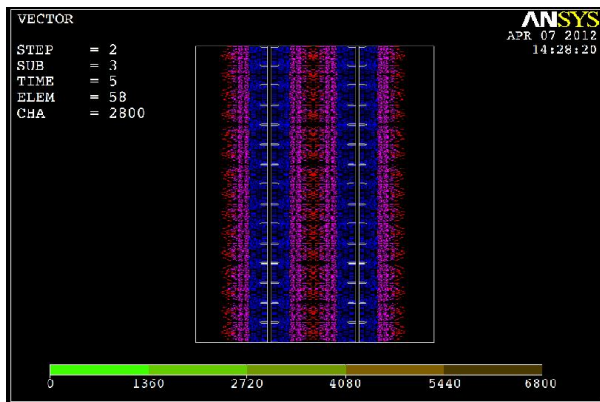


Fig. 4.8 D=0.4m, L=0.13m

5. RESULTS AND DISCUSSION

The summary of the efficiency of electrode calculated with help of analysis in ANSYS is given by the following table,

Table -1: Summary of the analysis with various D and L

D (m)	0.1	0.2	0.3	0.4
L (m)				
0.05	30%	41%	47%	62%
0.07	54%	64%	73%	81%
0.09	82%	88%	91%	91.8%
0.11	-	-	-	95.5%
0.13	-	-	-	99.98

According to this analysis the following distance between the spikes and length of the spike can't use that as a discharge electrode because they will convert as a conductor in that particular charging period.

Table -2: Analysis results for which the electrode convert as a conductor

D (m)	0.1	0.2	0.3	0.4
L (m)				
0.11	1	1	1	-
0.13	1	1	1	-

According to the analysis and calculations D = 400mm & L = 130mm is the optimum dimensions for using the spiked electrode perfectly for this particular electrostatic precipitator.

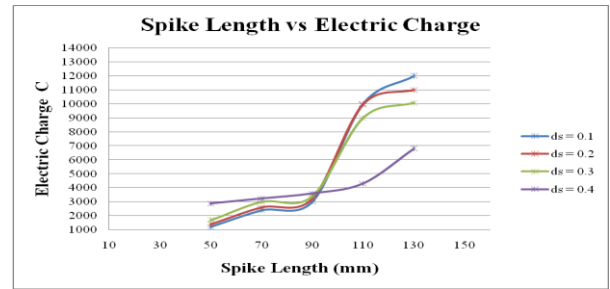


Fig. 5.1 Spike length Vs Electric charge

The figure 5.1 shows, if the length of the spike increases the electric charge density also increases, but the higher electric charge will convert the electrode as a conductor.

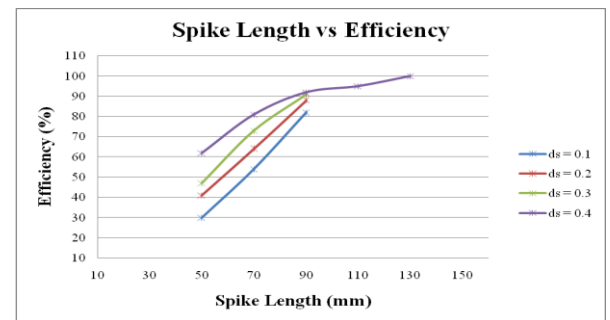


Fig. 5.2 Spike length Vs Efficiency

The figure 5.2 shows, if the spike length increases the efficiency also increases. But the optimum spike length to achieve the maximum efficiency is 130mm.

6. CONCLUSION

In this work the discharge electrode of existing electrostatic precipitator modified as a spiked discharge electrode. The spiked discharge electrode analysed through ANSYS with various dimensions of D and L (D=distance between spike, L=length of the spike). As per the analysis and calculations the 130mm spike length and 400mm of distance between spikes is the optimum spiked discharge electrode to charge and collect the dust particles in electrostatic precipitator. Due to reduction in number of electrodes the spiked discharge electrode can save 40% of electrode material. This will increase the efficiency compare to the existing electrostatic precipitator.

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