ROLE OF ELECTROSTATIC PRECIPITATOR IN INDUSTRY

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ABSTRACT

Electrostatic Precipitators (ESP) are most important device used to control the pollution by collecting dust particles present on flue gases. In power plants, Coal used in Indian thermal power stations is of inferior grade, at power plant flue gas is often treated with a series of chemical process and scrubbers, having low calorific value (3500-4500)kcal/kg and high ash content due to drift origin. However, Indian power coal ash is specially known by its refractory in nature and low sulphur (below 0.5%) and alkalis (less than 1.5%) contents. The maximum thermal power plants are used for controlling fly ash from ESP. In the present paper various types are attempts to analyze the causes of problems in terms of ash; a special emphasis was given to correlate the different forms of sulphur on E.S.P. performance. In this paper we discuss some methods which are being applied in Thermal Power plant to improve the collection efficiencies of ESP.

Keywords: Electrostatic Precipitator, Pollution, Rapping, Discharge Electrodes.

I.INTRODUCTION

The function of electrostatic precipitator (ESP) is to collect the fly ash particles from the gases by electrostatic principle. Electrostatic precipitators are particulate collection devices that utilize electrical energy directly to assist in the removal of the particulate matter. They have been successfully used for removal of fine dusts from all kinds of waste gases with very high efficiency. The principle on which this equipment operates when a gas containing aerosols is passed between two electrodes that are electrically potential, aerosol particles precipitate on low potential electrode[1]. An ESP is designed for a particular industrial application. Building an ESP is a costly endeavor, so a great deal of time and effort is expended during the design stage. Manufacturers use various methods to design ESPs. They also consider a variety of operating parameters that affect collection efficiency including resistivity, electrical sectionalization, specific collection area, aspect ratio, gas flow distribution, and corona power.

II.TYPES OF ELECTROSTATIC PRECIPITATORS

ESPs can be grouped, or classified, according to a number of distinguishing features in their design. These features include the following:

1) The structural design and operation of the discharge electrodes (rigid-frame, wires or plate) and collection electrodes (tubular or plate)
2) The method of charging (single-stage or two-stage)

3) The temperature of operation (cold-side or hot-side)
4) The method of particle removal from collection surfaces (wet or dry)

In this paper only described the types of Electrostatic precipitator based on structural design and operation of discharge electrodes Tubular and Plate ESPs.

2.1 Tubular

Tubular precipitators consist of cylindrical collection electrodes (tubes) with discharge electrodes (wires) located in the center of the cylinder (Figure 1-10). Dirty gas flows into the tubes, where the particles are charged. The charged particles are then collected on the inside walls of the tubes. Collected dust and/or liquid is removed by washing the tubes with water sprays located directly above the tubes. The tubes may be formed as a circular, square, or hexagonal honeycomb with gas flowing upward or downward. A tubular ESP is tightly sealed to minimize leaks of collected material

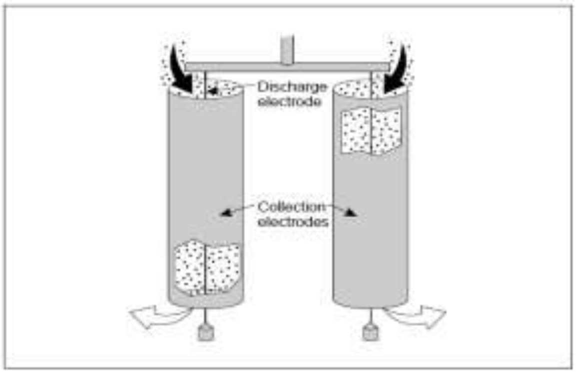

Fig:-1. Gas flow through a tubular precipitator [2]

Tube diameters typically vary from 0.15 to 0.31 m (0.5 to 1 ft), with lengths usually varying from 1.85 to 4.0m (6 to 15 ft). Tubular precipitators are generally used for collecting mists or fogs, and are most commonly used when collecting particles that are wet or sticky [2]. Tubular ESPs have been used to control particulate emissions from sulfuric acid plants, coke oven byproduct gas cleaning (tar removal), and iron and steel sinter plants.

2.2 Plate

Plate electrostatic precipitators primarily collect dry particles and are used more often than tubular precipitators. Plate ESPs can have wire, rigid-frame, or occasionally, plate discharge electrodes. Figure 1-11 shows a plate ESP with wire discharge electrodes. Dirty gas flows into a chamber consisting of a series of discharge electrodes that are equally spaced along the center line between adjacent collection plates. Charged particles are collected on the plates as dust, which is periodically removed by rapping or water sprays. Discharge wire electrodes are approximately 0.13 to 0.38 cm (0.05 to 0.15 in.) in diameter. Collection plates are usually between 6 and 12 m (20 and 40 ft) high. For ESPs with wire discharge electrodes, the plates are usually spaced from 15 to 30 cm (6 to 12 in.) apart. For ESPs with rigid-frame or plate discharge electrodes, plates are typically spaced 30 to 38 cm(12 to 15 in.) apart and 8 to 12 m (30 to 40 ft) in height. Plate ESPs are typically used for collecting fly ash from industrial and utility boilers as well as in many other industries including cement kilns, glass plants and pulp and paper mills.[2]

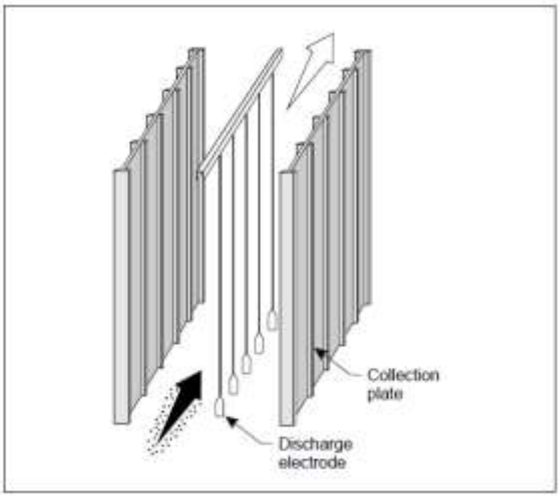

Fig:-2. Gas flow through plate precipitator[2]

III.GENERAL REMARKS

Electrostatic precipitators are mainly used for particles >1 mm, with dust resistivity's between approximately 10^4 and 10^{11} Ω cm. Particles with very high resistivity cause problems due to back corona effects, whereas conductive particles may reverse their charge and thus do not adhere to the collecting electrode (reentrainment) [H.J. White, Entstaubung; Industrieller Gase mit Elektrofiltern, VEB Verlag, 1969.]. When the gas contains condensable components or liquid particles, clogging causes problems in all dry operating separators. As alternative, wet electrostatic precipitators may be employed, which show outstanding collection efficiencies and moderate power consumption. In this study, a wet tubular ESP is investigated. Tubular ESPs have the advantage that scale-up is straightforward once the operational behaviour in one single tube has been investigated. various methods to reduce soot particulate matter developed continually. In this case, negative collection efficiency, where the number of particles of downstream is greater than that of upstream must be studied in an experimental ESP [3], [4].

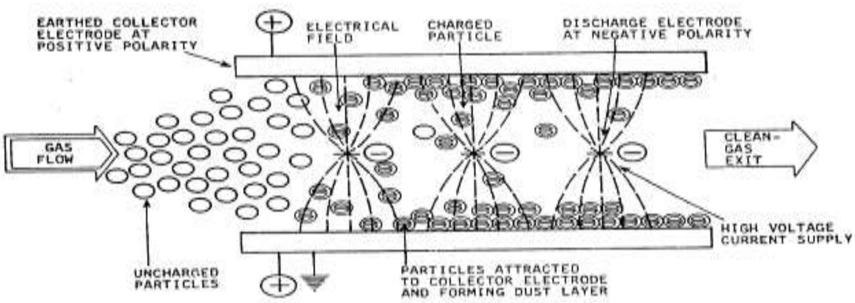

Fig:-3. Process involve in ESP [4]

High-collection-efficiency systems for carbon particles were achieved by using an ESP as an agglomerator [5], [6],and and by mixing water mist with gases [7]. Mitchner and Self [8], Kobashi [9], Kildeso et al. [10], and Laitinen et al. studied the effect of bipolar charging on the AC agglomeration efficiency of a parallel plate agglomerator.

IV.PERFORMANCE OF ELECTROSTATIC PRECIPITATOR

The performance of the electrostatic precipitator is described by a term called overall efficiency(η_o) which is expressed as

$$\eta_o = \frac{\text{Mass of particles retained by collector}}{\text{Mass of all particles entering collectors}}$$

Dentsch has given a simple expression to calculate η_o as given below

$$\eta_o = 1-\exp(-AC_{m0}/Q)$$

where A = area of the plate(m^2),

Q = flue gas volume flow rate for each plate,(m^3/s)

C_{m0}= effective migration velocity of particles,(m/s)

$$= \frac{2.95\times10^{12}K(E/s)^2 d}{\mu}$$

K = 2.0

E = applied voltage(V)

s = distance between charging and collecting electrodes(m),

d = particle diameter(m)

μ_g = gas velocity,(kg/ms)

The performance of electrostatic precipitor is governed by corona characteristics resistivity of the particle, rapping behavior, gas velocity, particle sizes and field strength.

Electrostatic precipitator is the most effective to remove very small particles like smoke, mist, and fly ash. Its range of dust removal is sufficiently large (0.01μ to 1.00μ). The small dust particle below 10μ can not be removed with the help of mechanical separation and wet scrubbers can not be used of sufficient water is not available. Its efficiency is as high as 99.5%. The draught losses are also the least. [11]

V. SPECIFIC POWER ABSORPTION ON ESP EFFICIENCY

An indicator of improved particle collection efficiency in an ESP is an apparent increase in the power that is used. Since the particle migration velocity is proportional to the voltage squared for field charged particles, it follows for a given electrode configuration, which determines the voltage/current relationship, that the efficiency is related to the specific power input (W/m3). It can be shown that the performance, or collection efficiency.

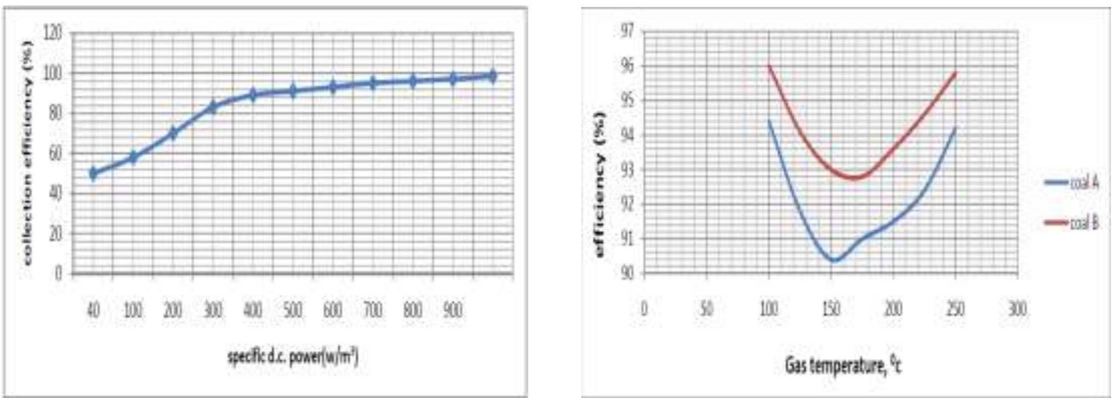

Fig 4 Effect of Specific Power Absorption on ESP Efficiency and Effect of Gas Velocity on ESP Efficiency[12]

VI. ADVANTAGES OF ELECTROSTATIC PRECIPITATORS

- Low maintenance and operating costs.
- High collection efficiency.
- Treatment time is negligible (0.1-10s).
- Low pressure drop (0.25-1.25 cm of water).
- Cleaning is easy by removing units of the precipitator from operation.
- Particles as small as 0.1 µ m can be removed.
- Satisfactory handling of large volume of high temperature gas

VII. APPLICATIONS OF INDUSTRIAL PRECIPITATORS

The important applications of electrostatic precipitators in industries is following

1. Steel plants
   (a) cleaning blast furnace gas to use it as a fuel
   (b) removing tars from coke oven gases
   (c) cleaning open hearth and electric furnace gases
2. Chemical industry
   (a) removing the dust from elemental phosphorus in the vapour state
   (b) collection of sulphuric and phosphoric acid mist
   (c) cleaning various types of gases such as hydrogen, CO_2 and SO_2
3. Cement factories
   (a) cleaning the flue gases from cement kiln
   (b) recovery of cement dust from kilns
4. Petroleum industry
   (a) recovery of catalyst dust
5. Pulp and paper mills
   (a) soda-fume recovery in Kraft pulp mills
6. Electric power industry
   (a) collecting fly ash from coal-fired boilers
7. Non-ferrous metals industry
   (a) recovering valuable material from flue gases.
   (b) collecting acid mist.
8. Carbon black industry
   (a) agglomeration and collection of carbon black.

VIII. CONCLUSION

All types of Electrostatic precipitators use electrostatic attraction to control particulate matter and can handle large volume of gases at low pressure drops. In an ESP, pollutant particles are electrically charged and then collected on collection electrodes. When the discharge and collection electrodes are rapped, the collected particles fall into a hopper and are removed. In this paper we introduce the two types of electrostatic precipitator, but all types of electrostatic precipitator are their own importance in their places. In modern world

world the pollution is a great problem which affect every body indirectly. To reduce the the pollution by dust particles, the ESP is very effective dust collection device.

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