**ELECTROSTATIC PRECIPITATOR**

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**Abstract:** It is a common scenario that Air Pollution is increasing nowadays, due to the rapid increase in the no. of Power Plants especially coal based. Hence a process or mechanism is required so that the Air Pollution caused by the ash content in flue gases released by the Power Plant should be reduced. ESP or Electrostatic Static Precipitator is a particulate collection device that removes particles from a flowing gas using the force of an Induced electrostatic charge. As compared to a Wet Scrubbers which apply energy directly to the flowing fluid medium, an ESP applies energy only to the particulate matter being collected and therefore is very efficient in its consumption of energy. Hence ESP can be widely used in Industries for filtration of air, thus reducing Air Pollution.

Keywords: Electro-static precipitator (ESP)

ESP works on the principle of electrostatic precipitation. Precipitator performance is very sensitive due to two particulate properties viz. Resistivity and Particle size distribution. These properties can be determined economically and accurately in the laboratory. A widely taught concept to calculate the collection efficiency is the Deutsch model, which assumes infinite remixing of the perpendicular to the gas stream.

ESP’s continue to be excellent devices for control of many industrial particulate emissions, including smoke from electricity generating utilities, salt cake collection from black liquor boilers in pulp mills, and catalyst collection from fluidized bed catalytic cracker units in oil refineries to name a few. These devices treat gas volumes from several hundred thousand ACFM in the largest coal-fired boiler applications. For a coal-fired boiler the collection is usually performed downstream of the air preheater at about 160 deg.centi. which provides optimal resistivity of the coal ash particles.

**INTRODUCTION**

Nowadays, the environment protection has become a crucial problem and the authorities are requested to set increasingly more stringent limits, one of which is the emissions from the industrial plants of solid particulate and other gaseous pollutants.

Companies have applied for designs to coal-fired boilers, pulp-and-paper recovery boilers bark boilers, catalytic crackers, refuse-to-energy facilities, cement plants, cogeneration facilities and a wide variety of other processes, to minimize the particulate air pollutant.

Air pollution control agency officers who review ESP design plans should consider these factors during the review process. Some of these factors relate to the properties of the dust and flue gas being filtered, while others apply to the specific ESP design:

• Type of discharge electrode

• Type of collection electrode

• Electrical sectionalization (number of fields and individual power supplied used)

• Specific collection area

• Aspect ratio

Construction details, such as shell insulation, inlet location, hopper design,

and dust discharge devices are also important.

This report reviews the ESP design parameters, along with typical ranges for these variables. It also familiarizes you with cost information for various ESP designs so that you can be aware of cost when reviewing design plans and making recommendations

**Electro-Static Precipitator**

**1) What is ESP:-**

Electrostatic precipitator (ESP) is a widely used device in so many different domains to remove the pollutant particulates, especially in industrial plants.

**2) Working Principle of ESP:-**

The working principle of ESP is Electrostatic Discharge.

**3) Main process of ESP :-**

Generally, the processes of electrostatic precipitator are known as three main stages: particle charging, transport and collection.

These are stages interacted that originated from the complexity of the processes of precipitator. To characterize all these stages determines to take a great number of basic phenomena into account from a physical point of view when they occurred.

**4) Process oF Particle charging :-**

Particle charging is the first and foremost beginning in processes. As the voltage applied on precipitator reach threshold value, the space inside divided into ionization region and drift region.

**Components of ESP**

All electrostatic precipitators, regardless of their particular designs, contain the following essential components:

• Discharge electrodes

• Collection electrodes

• High voltage electrical systems

• Rappers

• Hoppers

• Shell

**Discharge electrodes**are either small-diameter metal wires that hang vertically (in the electrostatic precipitator), a number of wires attached together in rigid frames, or a rigid electrode made from a single piece of fabricated metal. Discharge electrodes create a strong electrical field that ionizes flue gas, and this ionization charges particles in the gas.



*Fig:-Rigid Discharge Electrode*

**Discharge Electrode:-**

The discharge electrodes in most U.S. precipitator designs (prior to the 1980s) are thin, round wires varying from 0.13 to 0.38 cm (0.05 to 0.15 in.) in diameter. The most common size diameter for wires is approximately 0.25 cm (0.1 in.).

The discharge electrodes are hung vertically, supported at the top by a frame and held taut and plumb by a weight at the bottom.

The wires are usually made from high-carbon steel, but have also been constructed of stainless steel, copper, titanium alloy, and aluminum. The weights are made of cast iron and are generally 11.4 kg (25 lb) or more.

Discharge wires are supported to help eliminate breakage from mechanical fatigue. The wires move under the influence of aerodynamic and electrical forces and are subject to

mechanical stress.

The weights at the bottom of the wire are attached to guide frames to

help maintain wire alignment and to prevent them from falling into the hopper in the event

that the wire breaks (Figure 2-2).

Weights that are 11.4 kg (25 lb) are used with wires 9.1 m (30 ft) long, and 13.6 kg (30 lb) weights are used with wires from 10.7 to 12.2 m (35 to 40 ft) long.

The bottom and top of each wire are usually covered with a shroud of steel tubing. The shrouds help minimize sparking and consequent metal erosion by sparks at these points on the wire.

**Collection Electrodes**

Most U.S. precipitators use **plate** collection electrodes because these units treat large gas volumes and are designed to achieve high collection efficiency.

The plates are generally made of carbon steel. However, plates are occasionally made of stainless steel or an alloy steel for special flue-gas stream conditions where corrosion of carbon steel plates would occur. The plates range from 0.05 to 0.2 cm (0.02 to 0.08 in.) in thickness.

For ESPs with wire discharge electrodes, plates are spaced from 15 to 30 cm apart (6 to 12 in.). Normal spacing for high-efficiency ESPs (using wires) is 20 to 23 cm (8 to 9 in.). For ESPs using rigid-frame or plate discharge electrodes, collection plates are typically spaced 30 to 38 cm (12 to 15 inches) apart.

Plates are usually between 6 and 12 m (20 to 40 ft) high Collection plates are constructed in various shapes, as shown in Figure 2-7. These plates are solid sheets that are sometimes reinforced with structural stiffeners to increase plate strength. In some cases, the stiffeners act as baffles to help reduce particle reentrainment losses.

This design minimizes the amount of excess rapping energy required to dislodge the dust from the collection plates, because the energy is distributed evenly throughout the plate



**High-Voltage Equipment**

High-voltage equipment determines and controls the strength of the electric field generated between the discharge and collection electrodes. This is accomplished by using power supply sets consisting of three components: a step-up transformer, a high-voltage rectifier, and control metering and protection circuitry (automatic circuitry). The power system maintains voltage at the highest level without causing excess spark over between the discharge electrode and collection plate. These power sets are also commonly called **Transformer-rectifier (T-R) sets**.

In a T-R set, the transformer steps up the voltage from 400 volts to approximately 50,000 volts. This high voltage ionizes gas molecules that charge particles in the flue gas. The rectifier converts alternating current to direct current. Direct (or unidirectional current) is required for electrical precipitation. Most modern precipitators use solid-state silicon rectifiers and oil-filled, high-voltage transformers. The control circuitry in a modern precipitator is usually a Silicon-controlled Rectifier (SCR) automatic voltage controller with a linear reactor in the primary side of the transformer. Meters also included in the control.

**The most commonly used meters are the following:**

**1.Primary voltmeter.**

This meter measures the input voltage, in a.c. volts, coming into the transformer. The input voltage ranges from 220 to 480 volts; however, most modern precipitators use 400 to 480 volts. The meter is located across the primary winding of the transformer.

**2.Primary ammeter.**

This meter measures the current drawn across the transformer in amperes. The primary ammeter is located across the primary winding (wires wound in the coil) of the transformer. The primary voltage and current readings give the power input to a particular section of the ESP.

**Secondary voltmeter.**

This meter measures, in d.c. volts, the operating voltage delivered to the discharge electrodes. The meter is located between the output side of the rectifier and the discharge electrodes.

**Secondary ammeter.**

This meter measures the current supplied to the discharge electrodes in mille-amperes. The secondary ammeter is located between the rectifier output and the automatic control module. The combination of the secondary voltage and current readings gives the power input to the discharge electrodes.

**Spark meter.**

This meter measures the number of sparks per minute in the precipitator section. Sparks are surges of localized electric current between the discharge electrodes and the collection plate.

The transformer-rectifier set ios connected to the discharge electrodes by a **bus line**. A bus line is electric cable that carries high voltage from the transformer-rectifier to the discharge electrodes (Figure 2-10). The bus line is encased in a pipe, or bus duct, to protect the high-voltage line from the environment and to prevent the line from becoming a potential hazard to humans. The high-voltage bus lines are separated, or isolated, from the ESP frame and shells by insulators. The insulators are made of non-conducting plastic or ceramic material.



Fig:- *Automatic Power Control*

**Automatic Power Control**

The WAPC-2000™ is designed to solve many common precipitator problems by reducing electrode failures, lowering power consumption, virtually eliminating control downtime, lowering maintenance costs and reducing opacity spikes

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*Fig:-Central Computer Control*

**Central Computer Control**

The CCC™ is the most efficient way to monitor, operate and maintain your precipitator. It monitors stack emissions and precipitator operating functions and compares them with desired levels, adjusting automatically to save energy and educe emissions.

**Rappers**

Dust that has accumulated on collection and discharge electrodes is removed by rapping. Dust deposits are generally dislodged by mechanical impulses, or vibrations, imparted to the electrodes. A rapping system is designed so that rapping intensity and frequency can be adjusted for varying operational conditions. Once the operating conditions are set, the system must be capable of maintaining uniform rapping for a long time. Collection electrodes are rapped by **hammer/anvil** or **magnetic impulse** systems. Rigid frame discharge electrodes are rapped by **tumbling hammers** and wires are rapped by **vibrators**. As stated previously, liquid sprays are also used (instead of rapping) to remove collected particles form both tubes and plates.

**Hammer/Anvil**

Collection plates are rapped by a number of methods. One rapper system uses hammermounted on a rotating shaft. As the shaft rotates, the hammers drop (by gravity) and strike anvils that are attached to the collection plates. Rappers can be mounted on the top or on the side of collection plates. European precipitator manufacturers use hammer and anvil rappers for removing particles from collection plates. Rapping intensity is controlled by the weight of the hammers and the length of the hammer mounting arm. The frequency of rapping can be changed by adjusting the speed of the rotating shafts

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*Fig:- Rapper*

**Tumbling Hammers for Rigid Frame Discharge Electrodes**

Rigid frame discharge electrodes are rapped by tumbling hammers. The tumbling hammers operate similarly to the hammers used to remove dust from collection electrodes.

The hammers are arranged on a horizontal shaft. As the shaft rotates, the hammers hit an impact beam which transfers the shock, or vibration, to the center tubes on the discharge system, causing the dust to fall.

**Electric Vibrator**

Wire discharge (or corona) electrodes must also be rapped to prevent excessive dust deposit buildup that will interfere with corona generation. This is usually accomplished by the use of air or electric vibrators that gently vibrate the discharge wires. Vibrators are usually mounted externally on precipitator roofs and are connected by rods to the high-tension frames that support the corona electrodes (Figure 2-14). An insulator, located above the rod, electrically insulates the rapper while mechanically transmitting the rapping force.

**Electrostatic Discharge Principle**





**Principle: -**

Electrodes at high voltage create a corona effect (ionized atmosphere) surrounding them. This charges the passing particles. Once charged, particles are subject to a transverse electrostatic force that pulls them toward the collecting plates. Plates are periodically “rapped” (vibrated) to make the collected particles fall down into a receiver basket

Hoppers

When the electrodes are rapped, the dust falls into hoppers and is stored temporarily before it is disposed in a landfill or reused in the process. Dust should be removed as soon as possible to avoid packing, which would make removal very difficult. Hoppers are usually designed with a 50 to 70° (60° is common) slope to allow dust to flow freely from the top of the hopper to the bottom discharge opening.

Some manufacturers add devices to the hopper to promote easy and quick discharge.

These devices include **strike plates, poke holes, vibrators,** and **rappers**. Strike plates are simply pieces of flat steel that are bolted or welded to the center of the hopper wall. If dust becomes stuck in the hopper, rapping the strike plate several times with a mallet will free this material. Hopper designs also usually include access doors, or ports. Access ports allow easier access for cleaning, inspection, and maintenance of the hopper.

Hopper vibrators are occasionally used to help remove dust from the hopper walls. Hopper vibrators are electrically operated devices that cause the side walls of the hopper to vibrate, thereby removing the dust from the hopper walls. These devices must be carefully designed and chosen so that they do not cause dust to be firmly packed against the hopper walls, and thereby plug the hopper. Before installing vibrators to reduce hopper plugging, make sure they have been successfully used in other, similar industrial applications.

**Hopper Discharge Devices**

A **discharge device** is necessary for emptying the hopper and can be manual or automatic.

The simplest manual discharge device is the **slide gate**, a plate held in place by a frame and sealed with gaskets (Figure 2-16). When the hopper needs to be emptied, the plate is removed and the material is discharged. Other manual discharge device include **hinged doors** and **drawers**. The collector must be shut down before openingany manual discharge device. Thus, manual discharge devices are used *only* on very small units that operate on a periodic basis.

Slide-gate Automatic continuous discharge devices are installed on ESPs that operate continuously. Some devices include double-dump valves (also called double flap or trickle valves), and rotary airlock valves. **Double-dump valves** are shown in Figure 2-17. As dust collects in the hopper, the weight of the dust pushes down the counterweight of the top flap and dust discharges downward. The top flap then closes, the bottom flap opens, and the material falls out. This type of valve is available in gravity-operated and motorized versions.

Figure 2-17. Double-dump discharge device

**Rotary airlock valves** are used on medium or large-sized ESPs. The valve is designed with a paddle wheel that is shaft mounted and driven by a motor (Figure 2-18). The rotary valve is similar to a revolving door; the paddles or blades form an airtight seal with the housing, and the motor slowly moves the blades to allow the dust to discharge from the hopper

After the dust leaves the discharge device it is transported to the final disposal destination by screw, drag, or pneumatic conveyers. Screw conveyors can be used as discharge devices when located in the bottom of the hopper as shown in Figure 2-19 or as a separate conveyor to move dust after it is discharged. **Screw conveyers** employ a revolving screw feeder to move the dust through the conveyor. **Drag conveyors** use paddles, or flaps, that are connected to a drag chain to pull the dust through the conveyor trough (Figure 2-20). Drag conveyors are used frequently for conveying sticky or hygroscopic dusts such as calcium chloride dust generated from municipal waste combustors (collected fly ash/acid gas products). **Pneumatic conveyers** use blowers to blow or move the dust through the conveyor (Figure 2-21). Pneumatic conveyors can be positive pressure (dust is moved by a blower) or vacuum type systems (dust is pulled by a vacuum). In large ESPs, dust is usually discharged from hoppers by using a combination of devices. Either rotary airlock or double dump valves empty dust into screw, drag, or pneumatic conveyers that move dust for final disposal into trucks or storage bins.

**Shell**

The **shell** structure encloses the electrodes and supports the precipitator components in a rigid frame to maintain proper electrode alignment and configuration (Figure 2-22). The support structure is especially critical for hot-side precipitators because precipitator components can expand and contract when the temperature differences between the ESP (400°C or 752°F) and the ambient atmosphere (20°C or 68°F) are large. Excessive temperature stresses can literally tear the shell and hopper joints and welds apart. The outer sheet or casing wall is usually made of low-carbon or mild-grade steel that is 0.5 to 0.6 cm (3/16 to 1/4 in.) thick.

ESP shell Collection plates and discharge electrodes are normally attached to the frame at the top so that the elements hang vertically due to gravity. This allows the elements to expand or contract with temperature changes without binding or distorting. Shells, hoppers, and connecting flues should be covered with insulation to conserve heat, and to prevent corrosion resulting from water vapor and acid condensation on internal precipitator components. If the ESP is installed on a coal-fired boiler, the flue gas temperature should be kept above 120°C (250°F) at all times to prevent any acid mists in the flue gas from condensing on ESP internal components. Insulation will also help minimize temperature- differential stresses, especially on hot-side precipitators. Ash hoppers should beinsulated and heated because cold fly ash has a tendency to cake, making it extremely difficult to remove. Insulation material is usually 10 to 15 cm (4 to 6 in.) thick

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**Estimating Collection Efficiency and Collection Area**

The manufacturer designs and sizes the electrostatic precipitator. However, the operator (or reviewer) needs to check or estimate the collection efficiency and the amount of collection area required for a given process flow rate. You can compute these estimates by using the Deutsch-Anderson or Matts-Ohnfeldt equations.

**Impact of Materials of Construction: Metal Thickness and Stainless Steel**

Corrosive or other adverse operating conditions may require specifications of thicker metal sections in the precipitator. Metal thickness can be moderately increased with minimal cost increases. For example, collection plates are typically constructed of 18-gauge mild steel. Most ESP manufacturers can increase the section thickness by 25% without significant design changes or increases in manufacturing costs of more than a few percent. Changes in the type of material can increase the purchase cost of the ESP significantly. Using type 304 stainless steel instead of 18-gauge mild steel for collection plates and precipitator walls can increase costs 30-50%. Using even more expensive materials for all elements of the ESP can increase costs up to several hundred percent.

**Operation in ESP**

**Theory of Precipitation**

Every particle either has or can be given a charge—positive or negative. Let's suppose we impart a negative **charge** to all the particles in a gas stream. Then suppose we set up a grounded plate having a positive charge.What would happen? The negatively charged particle would migrate to the grounded collection plate and be captured. The particles would quickly **collect** on the plate, creating a dust layer. The dust layer would accumulate until we **remove** it, which we could do by rapping the plate or by spraying it with a liquid. *Charging, collecting,**and removing*—that's the basic idea of an ESP, but it gets more complicated. Let's look at atypical scenario using a common ESP construction.

**Particle Charging**

Our typical ESP as shown in Figure 1-1 has thin wires called **discharge electrodes**, which are evenly spaced between large plates called **collection electrodes**, which are grounded. Think of an electrode as something that can conduct or transmit electricity. A negative, high-voltage, pulsating, direct current is applied to the discharge electrode creating a negative electric field. You can mentally divide this field into three regions (Figure 1-2). The field is strongest right next to the discharge electrode, weaker in the areas between the discharge and collection electrodes called the **inter-electrode region**, and weakest near the collection electrode. The region around the discharge electrode is where the particle charging process begins.

**Corona Discharge: Free Electron Generation**

Several things happen very rapidly (in a matter of a millisecond) in the small area around the discharge electrode. The applied voltage is increased until it produces a **corona discharge**, which can be seen as a luminous blue glow around the discharge electrode. The free electrons created by the corona are rapidly fleeing the negative electrode. This acceleration causes them to literally crash into gas molecules, bumping off electrons in the molecules. As a result of losing an electron (which is negative), the gas molecules become positively charged, that is, they become positive ions (Figure 1-3). So, this is the first thing that happens—gas molecules are ionized, and electrons are liberated. All this activity occurs very close to the discharge electrode. This process continues, creating more and more free electrons and more positive ions. The name for all this electron generation activity is **avalanche multiplication.**

**Ionization of Gas Molecules**

As the electrons leave the strong electrical field area around the discharge electrode, they start slowing down. Now they're in the inter-electrode area where they are still repulsed by the discharge electrode but to a lesser extent. There are also gas molecules in the inter-electrode region, but instead of violently colliding with them, the electrons kind of bump up to them and are captured (Figure 1-5). This imparts a negative charge to the gas molecules, creating negative gas ions. This time, because the ions are negative, they too want to move in the direction opposite the strong negative field. Now we have ionization of gas molecules happening near the discharge electrode and in the inter-electrode area, but with a big difference. The ions near the discharge electrode are positive and remain in that area. The ions in the middle area are negative and move away, along the path of invisible electric field lines, toward the collection electrode.

**Particle Charging Mechanisms**

Particles are charged by negative gas ions moving toward the collection plate by one of these two mechanisms: field charging or diffusion charging. In field charging (the mechanism described above), particles capture negatively charged gas ions as the ions move toward the grounded collection plate. Diffusion charging, as its name implies, depends on the random motion of the gas ions to charge particles. **Diffusion charging** is associated with the random Brownian motion of the negative gas ions. The random motion is related to the velocity of the gas ions due to thermal effects: the higher the temperature, the more movement. Negative gas ions collide with the particles because of their random thermal motion and impart a charge on the particles. Because the particles are very small (submicrometer), they do not cause the electric field to be dislocated, as in field charging. Thus, diffusion charging is the only mechanism by which these very small particles become charged. The charged particles then migrate to the collection electrode. Each of these two charging mechanisms occurs to some extent, with one dominating depending on particle size. Field charging dominates for particles with a diameter >1.0 micrometer because particles must be large enough to capture gas ions. Diffusion charging dominates for particles with a diameter less than 0.1 micrometer. A combination of these two charging mechanisms occurs for particles ranging between 0.2 and 1.0 micrometer in diameter. A third type of charging mechanism, which is responsible for very little particle charging is **electron charging**. With this type of charging, fast-moving free electrons that have not combined with gas ions hit the particle and impart a charge.

**Electric Field Strength**

In the inter-electrode region, negative gas ions migrate toward the grounded collection electrode. A **space charge**, which is a stable concentration of negative gas ions, forms in the inter-electrode region because of the high electric field applied to the ESP. Increasing the applied voltage to the discharge electrode will increase the field strength and ion formation until **sparkover** occurs. Sparkover refers to internal sparking between the discharge and collection electrodes. It is a sudden rush of localized electric current through the gas layer between the two electrodes. Sparking causes an immediate short-term collapse of the electric field.

For optimum efficiency, the electric field strength should be as high as possible. More specifically, ESPs should be operated at voltages high enough to cause some sparking, but not so high that sparking and the collapse of the electric field occur too frequently. The average sparkover rate for optimum precipitator operation is between 50 and 100 sparks per minute. At this spark rate, the gain in efficiency associated with increased voltage compensates for decreased gas ionization due to collapse of the electric field.

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**Types of ESP’s**

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

• The structural design and operation of the discharge electrodes (rigid-frame, wires or plate) and collection electrodes (tubular or plate)

• The method of charging (single-stage or two-stage)

• The temperature of operation (cold-side or hot-side)

• The method of particle removal from collection surfaces (wet or dry)

These categories are not mutually exclusive. For example, an ESP can be a rigid-frame, single-stage, cold-side, plate-type ESP.

**ESP Installation**

Depending on the electrostatic precipitator chosen, production, installation and operation startup may take from a few months to one or two years. In any case, proper installation procedures will save time and money, and will also help in future operation and maintenance (O&M) of the ESP. Good coordination between the ESP designer (vendor) and the installation and maintenance crews will help keep the ESP running smoothly for years. Occasionally this coordination is overlooked. Because they are so large, ESPs are usually installed by skilled craftsmen who do not work for the ESP vendor, and, therefore, may not be informed of specific installation instructions. Since all design tolerances are critical (especially those affecting discharge and collection electrode alignment), it is imperative that information about the proper installation procedures be transferred from designers to installers.

**Some key considerations during installation are**:

• Easy access to all potential maintenance areas—fans, motors, hoppers, discharge devices, dampers, flue gas flow rate and temperature monitors, insulators, rappers, T-R sets, and discharge and collection electrodes

• Easy access to all inspection and test areas—stack testing ports and continuous emission monitors (opacity monitors)

• Weather conditions—the ESP must be able to withstand inclement weather such as rain or snow

During installation, the customer purchasing the ESP should be responsible for checking the criteria presented below. The regulatory agency review engineer also should review the process

on which the ESP will be installed and verify that these items are being addressed.

**1. *Proper installation of discharge electrodes and collection plates.***Collection electrodes are

usually installed first, and the discharge wires or rigid frames are positioned relative to them. Check each section of electrodes to ensure that the electrodes are plumb, level, and properly aligned.

**2. *Proper installation of rappers.***Collection-plate rappers and discharge-electrode rappers should be installed and aligned according to vendor specifications. Check magneticimpulse rappers to see if they strike the support frame on the collection plates. Check hammer and anvil rappers to see if the hammers strike the anvils squarely. Check vibrator rappers installed on discharge wires to make sure they operate when activated. Rapper frequency and intensity can be adjusted later when the unit is brought on-line.

**3. *Proper insulation* .**Most ESPs use some type of insulation to keep the flue gas temperature high. This prevents any moisture or acids present in the flue gas from condensing on the hoppers, electrodes, or duct surfaces. Because most ESPs are installed in the field, check that all surfaces and areas of potential heat loss are adequately covered.

**Routine Maintenance and Recordkeeping**

While the overall performance of the ESP is continuously monitored by devices such as voltage meters and transmissometers, the components of the ESP and their operation are periodically inspected by plant personnel as part of a preventive maintenance program. In this way, problems are detected and corrected before they cause a major shutdown of the ESP. Of course, good recordkeeping should be an integral part of any maintenance program. The frequency of inspection of all ESP components should be established by a formal in house maintenance procedure. Vendors' recommendations for an inspection schedule should be followed. A listing of typical periodic maintenance procedures for an ESP used to collect fly ash.

**Summary**

The precipitator should be designed to provide easy access to strategic points of the collector for internal inspection of electrode alignment, for maintenance, and for cleaning electrodes, hoppers, and connecting flues during outages. Vendors typically design the ESPs for a specific particulate emission removal efficiency. The overall design, including the specific components, is based on engineering specifications and/or previous experience with the industrial application. These components have an effect on the overall performance and ease of operation of the ESP. These topics are discussed in more detail in the following lessons.

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