

TIPS FOR A FIT ELECTROSTATIC PRECIPITATOR

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Introduction

Electrostatic precipitators are widely used as pollution control equipment. There are mistakes being made during design / construction / maintenance. These end up in poor performance and poor availability of the ESP. We had come across some cases in which the design engineering or installation or maintenance is compromised resulting in poor ESP performance & availability. About 5 years back, we had visited a Cogeneration power plant in a sugar mill. Customer desired the visit to solve the problem of severe back firing in boiler. On inspection, it turned out to be corrosion failure of ESP casing. There was large amount of air ingress through the leaky ESP casing and hence the furnace was back firing. Since then we used to include inspection of ESP in our shut down inspection programs of all boilers. This article is on common mistakes made in ESP installations.

Air ingress at inspection doors

The inspection doors are provided at side casing of the ESP on one side. Some inspection doors provided at the top as well. As we know the ESP inlet gas temperature is close to 130 deg C in most of the installations. Some power plants are operated with a high moisture fuels. In the case of Indonesian coal, the moisture is as much as 25%. It means for every 100 Tons of coal fired, 25 ton of water is being added in to the boiler and is being evaporated. Any fresh air entry in to the ESP would cause a local temperature drop. When the gas temperature drops below 105 deg C, the moisture condenses on the steel surfaces nearby. This begins the corrosion process. This leads to corrosion of ESP casing and at times it leads to failure of collecting electrodes as well. The following are the causes for air ingress.

- Incomplete welding of door frames during erection time.
- Improper placement of sealing rope during maintenance.

Photos 1 to 3 are the proof of the above facts. This can end up in replacement of ESP casing at times. The downtime & repair work cause loss.

Double door system for ESP inspection doors

Inspection doors are needed for each field and for entering inside the penthouse. Door plates have to be warm to avoid condensation of flue gas. Double door system is widely used by reputed quality conscious companies. New entrants and cost conscious companies provide a single door system. In double door system, the outer door frame is seal welded to ESP casing. Insulation mattress is placed in between the inner door and outer door. This provides a good insulation finish around the door. In single door system the insulation work becomes shabby leading to cold spots around the doors. This can also cause localised condensation of flue gases. In fuels that contain high moisture / high sulfur, the casing failures are unavoidable.

See photographs 4 & 5 that explain the arrangement and benefit of double door system. Photograph 6 shows the absence of insulation around the door in the case of single door system. Photograph 7 shows the failure of casing below the doors due to gas side condensation.

Water condensation in ESP penthouse

ESP penthouse is a nice concept practised since long. Of late this is being dropped out by some vendors. This can lead to exposure of ESP roof to gas condensation possibility. A pent house has the following features.

- A leak proof housing called penthouse is set over the ESP roof casing. This penthouse is a clean pressurised house.
- The pressurising fans are provided to ensure no dust comes in to clean chamber. There is no water / moisture. Hence there is no short circuiting between high voltage suspension systems to casing. Imagine the danger of ash & moisture over support insulators.
- The penthouse is to be insulated at sides and as well as at top to prevent condensation of moisture.
- Electrical heaters are provided at the pressurising fans in case of high moisture fuels.

Photographs 8, 9 show a case of no insulation inside the penthouse roof & side casing. The water droplets are seen over the ESP top casing. This ESP had a long complaint of one field tripping. The ash does not come out from the hopper. If ESP top casing is cooled, the gas can condense inside the gas path. Photo 10 shows the condensation of water droplets from penthouse top chequered plate.

Improper insulation without covering the support beams can also cause source of condensation. Without a patch, the penthouse roof plates are to be insulated from inside. Photo 11 shows the poor practice.

Improper seal welding of penthouse

Some ESP suffers from poor workmanship. We can see in photo 12, case where the ESP side casing is corroding due to running water. During the rainy days lots of water must have come inside. In the same plant another ESP was seen to be in dry condition without corrosion of side wall plates of penthouse.

Fit up of access doors in penthouse

Improper sealing of inspection doors on ESP top casing can leave the gas filled inside the ESP during boiler tripping. Under such circumstances, the gas can condense and damage the inside of ESP. maintenance team should remember to seal the doors. Improper fit up of doors without seal welding will allow the pressurizing air to leak in to ESP causing condensation due to air ingress. See photo 13, a case where the access door was left open during maintenance. The ID fan has sucked the insulation mattress from roof.

Improper finishing roof plate against rain water ingress in to insulation

The rain water collected on ESP roof should be properly drained out without allowing it to enter in to the penthouse casing. If it enters, it can create damage to casing by bringing down the temperature. We can see in photo 14, how rain water can spoil insulation of ESP. Also see photo 15, how rain water can be prevented from entering in to insulation.

Improper insulation / no insulation for ESP casing stiffeners

ESP casing stiffeners work as extended surface (like fins of boiler tubes). They dissipate heat to outside. As the heat is taken out, water can condense from flue gas. In one case, we can see that water

running down inside the ESP along the horizontal and vertical stiffeners. See photographs 16 & 17 of an ESP in a cogen plant at a sugar mill. The casing was corroded and severe air ingress took place later causing back firing in furnace. See photo 18, which is a standard feature in many plants. An improper fit up of insulation mattress and cladding can be seen in many plants. ESP being an outdoor equipment, cladding joints should be fitted with sealant tape or sealant paste. See figure 19 for insulation cladding with sealant. Some companies claim this cladding without sealant is their company standard. Consultants have to specify / approve the insulation drawing. Figure 1 shows a typical ESP insulation drawing by a supplier. We may note the insulation over stiffeners and the insulated door double door system at access doors.

Insulator mounting base plate fit up

Alignment of emitting frame with respect to collecting electrode frame is vital for performance of ESP. This can be achieved if only verticality of ESP main frames is maintained at each stage. The emitting / collecting electrode frames are maintained vertical & uniformly spaced if only its supporting base is rigid and levelled. Photo 20 shows the direct mounting of insulator base on a plain casing. We can see the support insulator is already out of verticality. Such defects lead to failure of support insulator. This is a photo taken in a 150 MW plant. Photo 21 shows a nice support system at a 25 MW plant. Ideally, we need to have a jack system to adjust the top surface of insulation support to spirit level. The base of the insulator support plate is supposed to be sealed with ESP top casing. Photo 22 shows the absence of seal welding of the support insulator base.

Hopper heaters functional requirement

Hopper heaters are provided at ESP ash outlet hoppers to keep the wall plates warmer so ash does not form cake due to temperature drop. The moisture condensation can cause troubles in ash flow. See photo 23, where the hopper heaters are not erected properly. We can see hammer marks in ash chutes, where the installation of hopper heaters is incomplete. The hopper heaters are mounted in an outer box surrounding the ash hoppers. The sealing is a must and further insulation is a must to prevent heat lost to ambient.

Temperature control system for ESP

Part load operations / off design fuels can lead to low temperatures at ESP inlet. One has to ensure that the ID fan outlet temperature is not below 120 deg C to ensure that the gas does not lead to failure of expansion joints. Airpreheater by pass / Gas side by pass arrangement are required to achieve this. Some plants do not have this arrangement.

Conclusions

Construction inspection can bring out the defects in ESP. Time and access would be available to rectify the defects. An ESP PG test was offered by an EPC contractor with 5% Oxygen increase across ESP. The emission being quantity of dust per gas flow, mg/Nm³, any air ingress states a better efficiency number. ID fan loading will be more in the case of air infiltration in ESP. The simplest way to identify air infiltration in ESP is to check O₂ in flue gas before and after ESP.

It is for the boiler operating engineers to understand the about possible defects in their ESP and get the best from it.

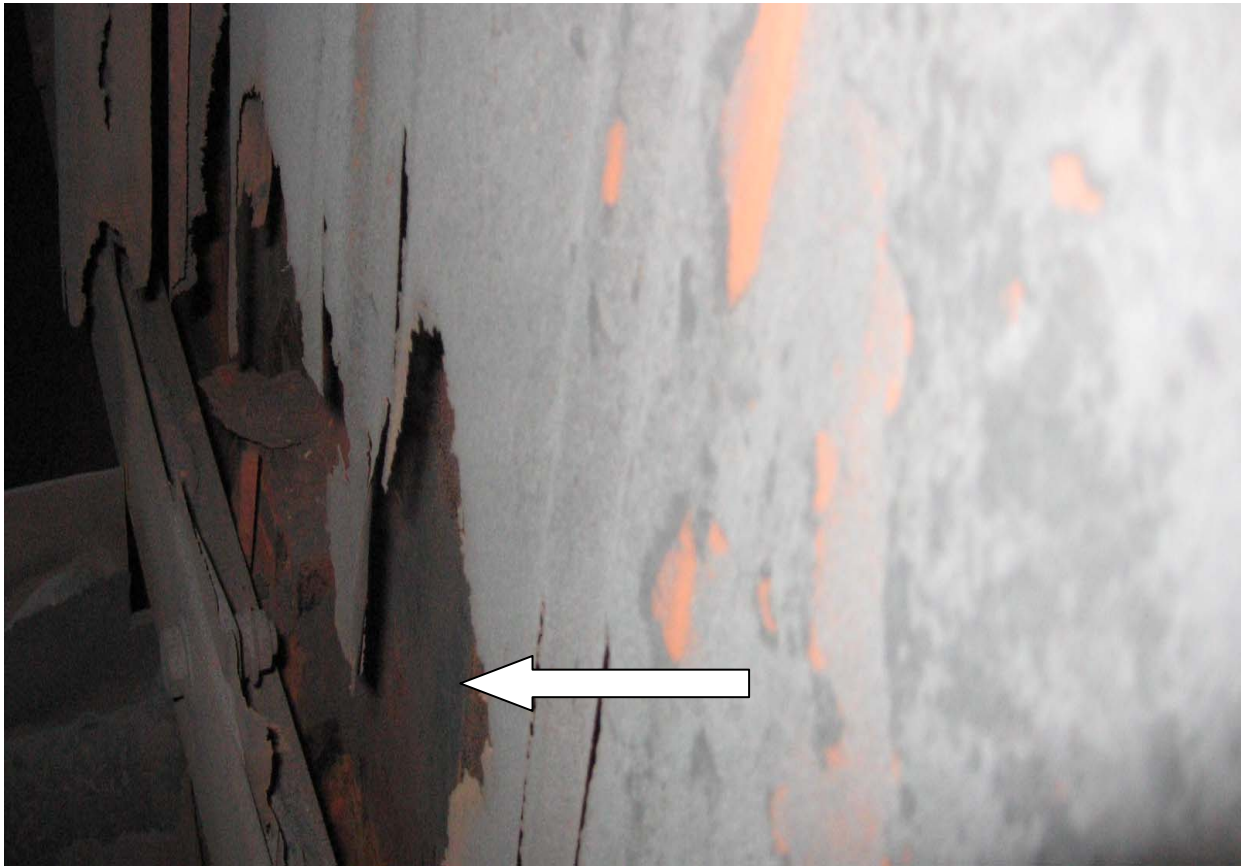


Photo 1: Air ingress from an inspection door of ESP has led to condensation damage of ESP collecting electrodes.



Photo 2: Condensation of flue gas below the inspection door. The door is not a double door system.



Photo 3: Incomplete welding of inspection door frame and absence of double door system is seen causing corrosion of ESP casing.



Photo 4 & 5: ESPs are to be provided with a double door system. This ensures that there is no exposed uninsulated area around the door. In the absence of double door system, the corrosion of casing is more. These problems are addressed by double door system. The photo at right is the arrangement with double door system. In double door system placement of LRB mattress can help to keep the inner door warmer.



Photo 6: This is the area below inspection doors. In most ESP this will be the case. The ESP casing is exposed to ambient. After some time, the casing is seen punctured.



Photo 7: Condensation of flue gas inside ESP casing when the casing is exposed to heat dissipation by improper insulation.



Photo 8: The penthouse is seen uninsulated by an EPC company in to manufacturing ESP.



Photo 9: Condensation of flue gas inside the penthouse. When the boiler frequently stopped for some reason, the condensation of penthouse is unavoidable. If there is any door open at penthouse, the flue gas fills penthouse and starts condensing.



Photo 10: Condensation of gas from ESP penthouse roof plate. No insulation is provided by the manufacturer.



Photo 11: The incomplete penthouse roof insulation is seen here. Patch insulation is not the right way for any hot surface.



Photo 12: Rain water running down inside the penthouse, due to incomplete sealing at top.



Photo 13: In this case, the inspection door was left open in the penthouse. The ID fan has draft has led to falling of mattress from roof.



Photo 14: Improper roof of ESP. The rain water enters inside the ESP insulation. This leads to gas condensation and after some time, the casing starts failing.



Photo 15: This the way the rain water ingress in to insulation is prevented. Yet the skipped welds can cause water running in to insulation.



Photo 16: The ESP casing seen damaged in a plant where the main column & tie beams were not insulated. Hence the ESP collapsed in two years time.



Photo 17: The casing in the above case developed holes and led to more air ingress ultimately affecting the steam generation rate. This is in the case where the columns were not insulated.



Photo 18: The insulation mattresses have to be properly overlapped. In case there is localized cladding disturbance, the cladding needs to be attended on priority.



Photo 19: In outdoor installations, sealant shall be used at the cladding sheet joints. This ensures, the rain water does not go inside the insulation.

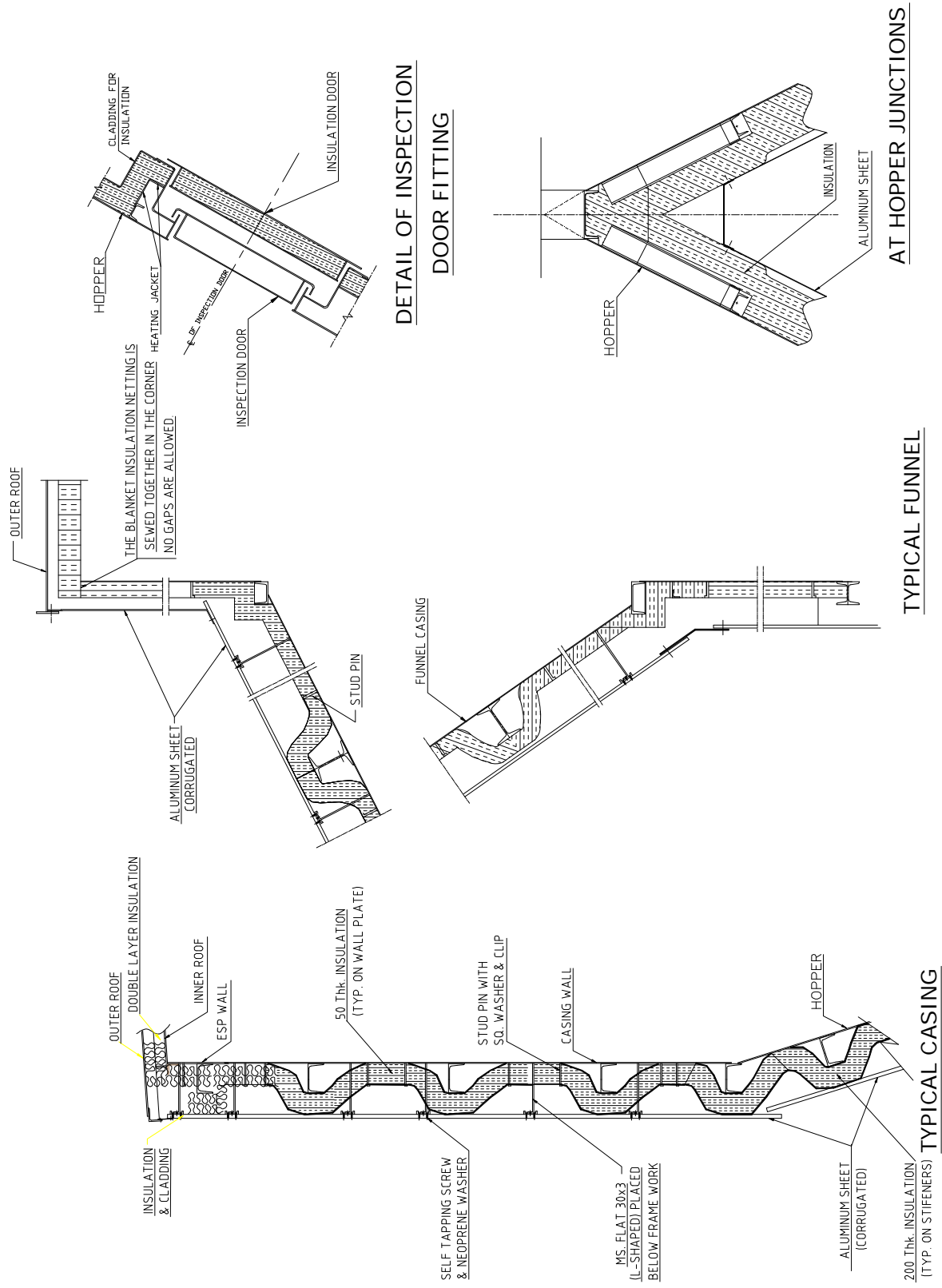


Figure 1: The insulation detailing is very important for ESP. The above is an extract from the insulation arrangement drawing by a good ESP manufacturer.



Photo 20: Improper base for insulator, which supports the emitting frame. Such defects leads to insulator break down.

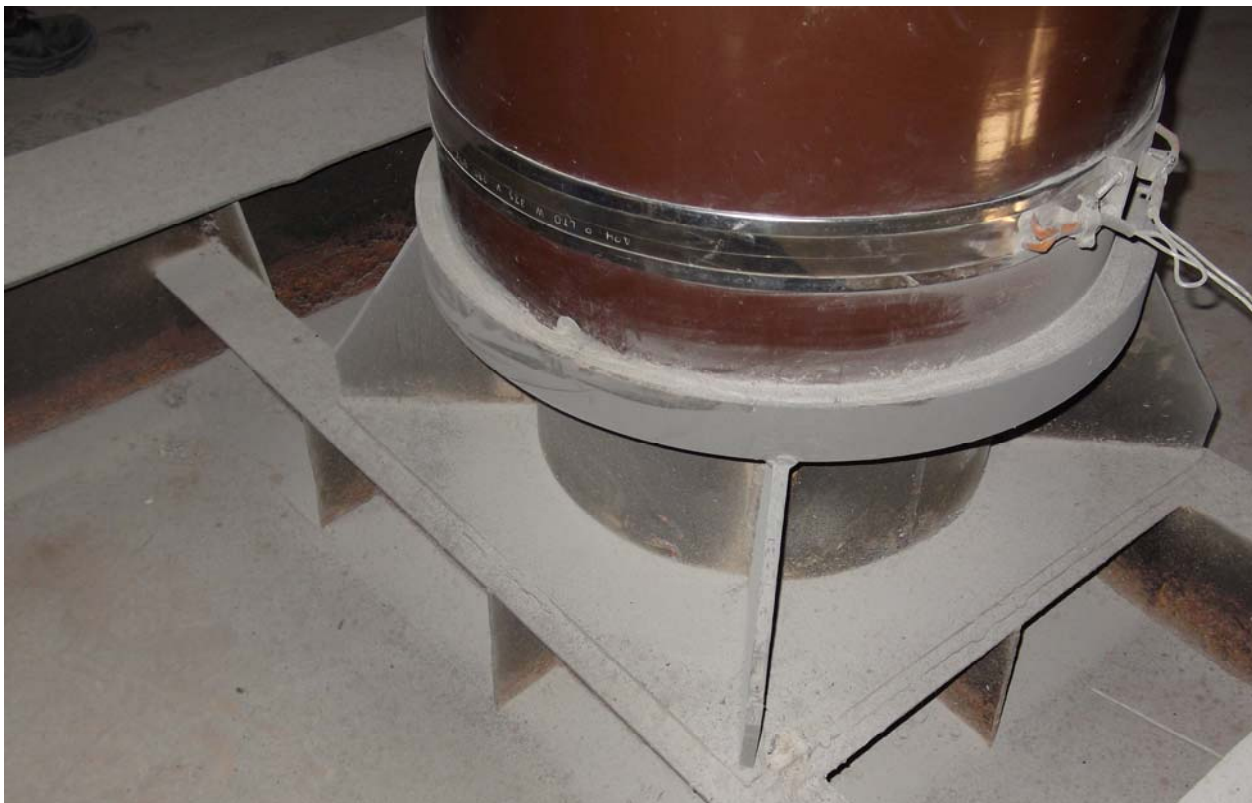


Photo 21: This is a right way to support insulator support. The base is taken from roof beam. Here also leveler jack bolts are required for bring the insulator top to spirit level.



Photo 22: Water pools with ash are seen in ESP penthouse. This space is supposed to be a clean space. It proves there is no perfect sealing between ESP inside and the penthouse. Water around the insulator is unsafe.



Photo 23: The hopper heaters installed by an ESP supplier without the purpose. The box should be completely sealed and insulated outside to help ash flow.