ESP CONTROLS FOR PLASTIC TUBE WET ESP

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Introduction

This paper describes our experience in implementation of the control system, especially for surface discharges, for plastic tube Wet ESP's. There are WESP that traditionally have used metal Tubes, whereas this paper focuses on plastic tubes, where there are some differing requirements.

Plastic Tube Wet ESP

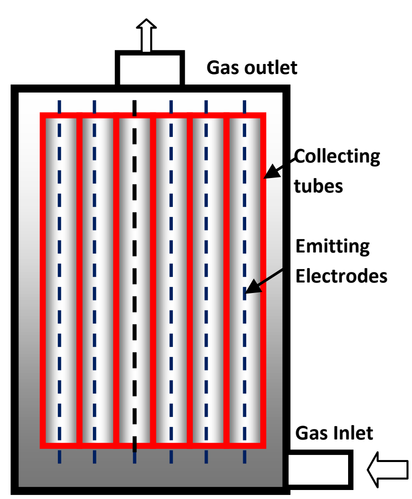
Wet electrostatic precipitators have been used for many years to remove particulates, acid mist, organic emissions and other particulates from water-saturated air and other gases by electrostatic means. In a WESP, particulate and/or mist laden water saturated air Flows in a region of the precipitator between discharge and collecting electrodes, where the particulates and/or mist is electrically charged by corona emitted from the high voltage discharge electrodes. As the water-saturated gas flows further within the WESP, the charged particulate matter and/or mist is electrostatically attracted to a grounded collecting plates or electrodes where it is collected. The accumulated materials are continuously washed off through the film of water.

Wet ESPs are used for industrial applications where the potential for explosion is high, or where dust is very sticky, corrosive, has very high resistivity or contains higher moisture content. WESPs are used to remove pollutants from the gas streams discharged from various industrial sources, such as incinerators, wood products manufacturing, coke ovens, glass furnaces, non-ferrous metallurgical plants, coal-fired power generation plants, forest product facilities, food drying plants and petrochemical plants.

Traditionally, the collecting surfaces and other parts of electrostatic precipitators exposed to the process gas stream have been fabricated from carbon steel, stainless steel, corrosion and temperature resistant alloys and lead.

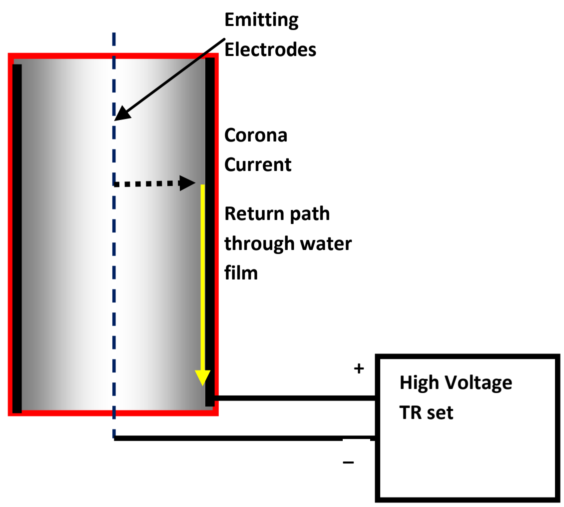
However, such materials tend to corrode and/or degrade (creep) over time, especially when the precipitators are operating in severe environments. Other materials such as PVC, polypropylene, carbon powder impregnated glass reinforced plastic (GRP), Fiberglass reinforced Polyester (FRP), etc. have been used to fabricate collecting surfaces involving the use of plastic materials; **these materials rely on a continuous water film to ensure electrical grounding of the equipment. In such types, there could be issues of significant holes from arcing and flashover-induced fires, impacting performance, in case of improper sensing and control action from the control system**.

As the liquid film on the collecting tube is acting as a current carrier, it is imperative to pay special attention to the control system to take care of this operational requirement.

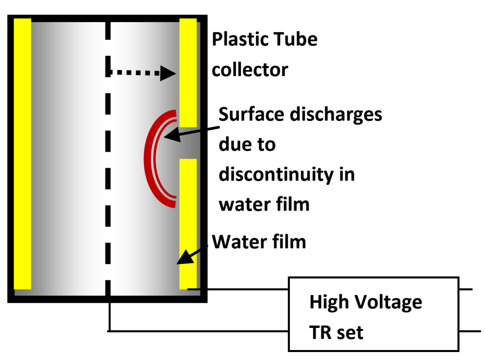


Control System - Flashovers

The corona current passes through the liquid film on the collecting tube. In some types of wet ESP, the formation of the liquid film is a function of the relative humidity of the gas, and in other types, use a liquid film, (generally water) on the collecting tube internals.This water or moisture film acts as a return path for the corona current.

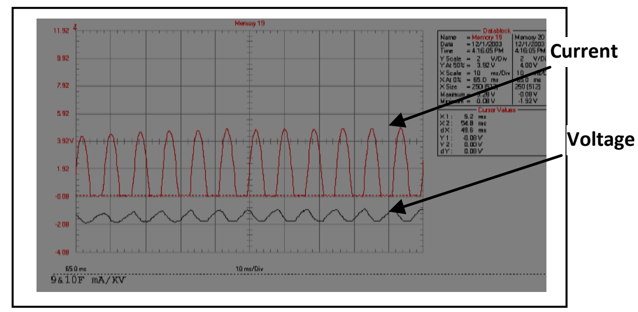


However, there are issues, due to disruptions, due to spraying (misting) of water, formation of dry spots due to the effects of water surface tension (channeling), etc.



If the plastic tube part is not sufficiently wetted then there is discontinuity in the corona current path, creating surface discharges on the plastic tube collector. This reduces the effective voltage for collection and more dangerously, can seriously damage the plastic tube, because of the localized high temperature. If remain undetected / Unchecked, these could cause holes and deteriorate the collecting surfaces as well as possibly lead to fire hazards, etc.

These discharges are not due to any breakup of the dielectric medium, and hence the effect of these, on the output current and voltage waveform is not significant, as indicated below.

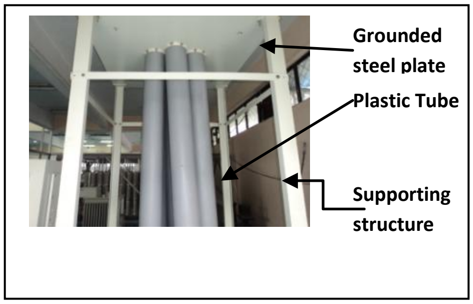


Generally In a control system, the flashover / disruptive discharges are detected through analysis of variations in the waveform of output voltage, output current, input current, etc. These, of course are digital sampling intensity based and hence highly sensitive to be able to detect and take control action for a very low intensity discharge such as spits, etc. Due to the typical waveform, where the effect was negligible, in terms of intensity, the control system was unavailable to detect this.

These discharges are not desirable but are a part of the system and difficult to avoid.

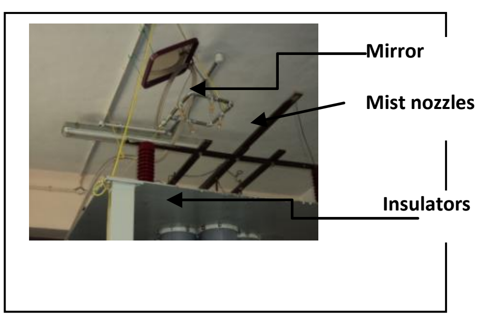
To simulate these conditions, an experimental set up was manufactured and installed, as described below. The idea of this set up was jointly worked out with M/s GEA Bischoff, Frankfurt laboratory.

A Plastic Tube ESP Model was constructed using is 6 numbers of PVC tubes, with diameter of 200 mm and length of 2 meters. These tubes were suspended from a steel plate at the top. The bottom of these tubes, were rigidly coupled to each other. Grounding was provided at the top steel plate. The discharge electrodes were formed by a 6 mm steel rod having spikes, of 1 inch in length and spaced at 2 inches from each other. These discharge electrodes were connected with each other through the steel frame and the steel frame was isolated / suspended through high voltage insulators. Water nozzles were provided through which water mist was generated and sprayed in the collecting electrodes tubes.



The discharge electrodes was powered with a negative high voltage through a High Voltage Transformer Rectifier set, rated as 70 KV (P), 300 mA. The HV transformer rectifier set was powered through a Thyristorized control system with our control system.

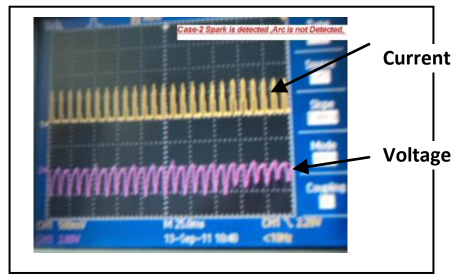
The water through the nozzle was sprayed inside the plastic tubes to simulate the wet ESP conditions. A control valve was provided to vary the water flow rate. A mirror was strategically placed to view discharges in the inside portion of the collecting tubes.



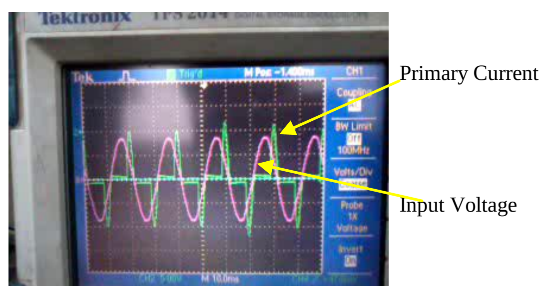
With moderate mist generation, the water film inside the plastic tube was adequate and continuous. In this condition, a voltage of approx. 35 KV with a current of about 50 mA was attained without any flashovers / discharges. After further increasing the voltage, normal flashovers occurred inside the tubes, quite similar to flashovers in a dry ESP and were detected and controlled very well.

After this, the control valve was operated to reduce the flow rate, to create an un-continuous water film, in the plastic tube. Surface discharges were observed through the mirror.

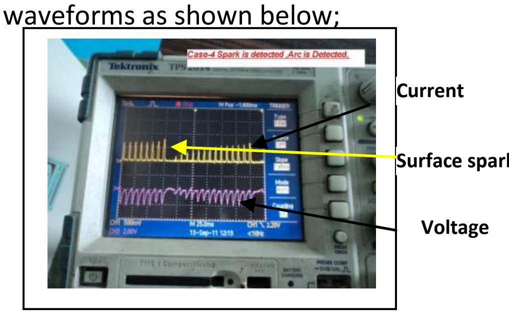
The output current and voltage did not exhibit any significant changes in their waveforms.



After carrying out various experiments with various conditions, a special algorithm was developed to sense such discharges. **This utilized the phase relation between primary current and input voltage. During surface discharges, the phase relation between primary current and input voltage changes and this change was additionally incorporated into the control system. This was an additional input to detect the surface discharges.**

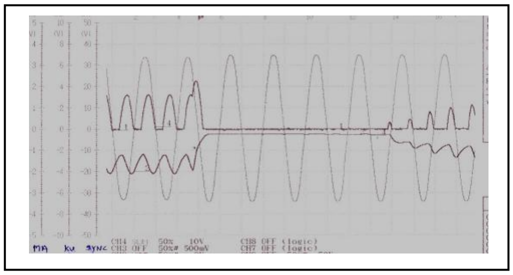


Various confirmatory tests were carried out to validate the algorithm, under various conditions. The surface discharges were detected and controlled. Typical output voltage and current waveforms as shown below;



Field Results

This control algorithm is implemented at one of the Zinc Smelter Plant in India and the results have been validated. The special algorithm detected the surface discharges. Typical Oscillograph;



This has eliminated the potential of deterioration / damages to the collecting tubes and possibility of any fire hazard.

Additionally, timers were incorporated in the control system, to periodically spray the water (as required) and during this spraying process, the voltage could be dropped to a lower level, including at a zero level. This forms a total integrated control system for a plastic tube Wet ESP.

Acknowledgements

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