EMISSION REDUCTION BY OPTIMIZATION OF ELECTRICAL PARAMETERS TO ENHANCE PERFORMANCE IN EXISTING ESP INSTALLATIONS

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Introduction

Plants were designed and built for defined capacities. These capacities have been enhanced over a period of time keeping structural the same. Similarly, the ESP was designed for defined emission limits. Now the ESP faces the challenges from better emission norms and enhanced Plant capacities. The Plants has to face these challenges, else shall need to reduce their outputs. Issues have been further compounded, over a period of time due to changes in fuel composition, etc.
This has created a need for reduction of emission else the plant has to run at reduced load or need to shut down to comply with the existing emission norms.

There are many methods to improve the performance of the ESP, to meet the emission norms. Some of the methods are Extension of the Fields, Installation of additional ESP, changing the internals of the ESP, increasing height of ESP,changing / upgrading the power supplies of the ESP, etc.

This paper describes our experiences in reduction in emission of the existing ESPs by **electrically optimization of the fields keeping other parameters unchanged.**

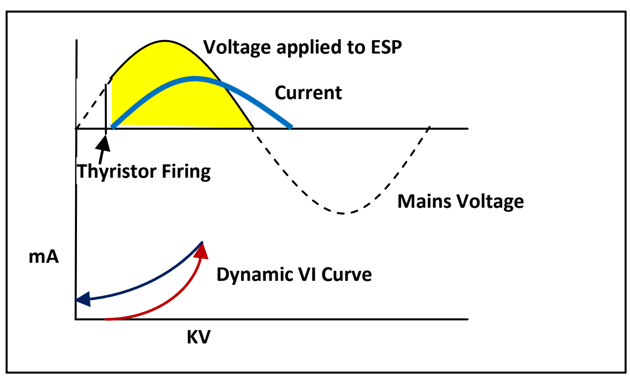
ESP Performance Enhancement by Electrical Optimization of the field

Our control system, through the *Auto optimization fuzzy logic* adapts to the continuously changing process parameters and flashover conditions, to ensure best possible response and operation, thereby enhancing Field performance and thus the ESP performance.

Electrical Field Optimization

The VI Curve of the Electrostatic Precipitator reflects the internal happenings in the ESP field and represents the needed information required for electrical optimization or optimization performance of that Field. This data is used as one of the input parameters for the *Auto optimization* algorithm. The current and voltage feedbacks obtained from the TR set are processed to generate the VI curve in the controller.

Fig 1: Voltage and Current waveform with dynamic VI Curve)



This VI curve is a dynamic curve, changing as per the process, temperature, etc. As this is dynamic in nature, VI curve needs to be generated periodically.
Based on this VI curve data and other optimization inputs, the *Auto Optimization* algorithm defines the best operating point in terms of the operating current / voltage and operating pulse ratios. This operating point is periodically validated and updated.The operating point on the VI curve, whether in continuous mode or pulse mode of operation, provides optimum performance levels. The selection of correct pulse mode and dynamically changing it as per the requirement is a function of this algorithm. This considers a no. of inputs such as Peak / average / trough voltages, average / Peak currents, operating pulse ratio, etc.This operating point is periodically reviewed and updated.

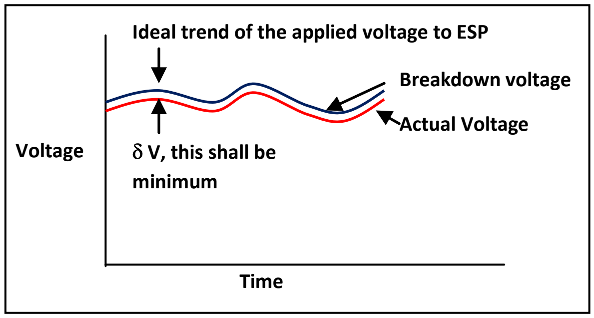
Further, this algorithm also considers Power down rapping. In this case, during rapping event the voltage is reduced or blocked. This reduces the electrostatic force, and by normal rapping this dust can be removed.

In certain cases the capacitance formed by the dust layer retains charge, even though the power is reduced or blocked. In such cases, the power needs to be blocked few seconds before the rapping starts, so that by the time rapping starts the charge held by the dust layer is reduced and the electrostatic forces are negligible.

Response to flashovers

For optimum dust collection the applied voltage shall be always kept as high as possible or just below the breakdown voltage.

Fig 2: Ideal Trend for applied voltage



In view of this, speed of response to flashovers plays a significant role in performance enhancement.
The flashover may be due to electrical breakdown of the dielectric medium or due to higher electric field intensity.
The symptom of the start of the flashover is the increase in rate of rise of current and the start of collapse of the electric field or voltage.

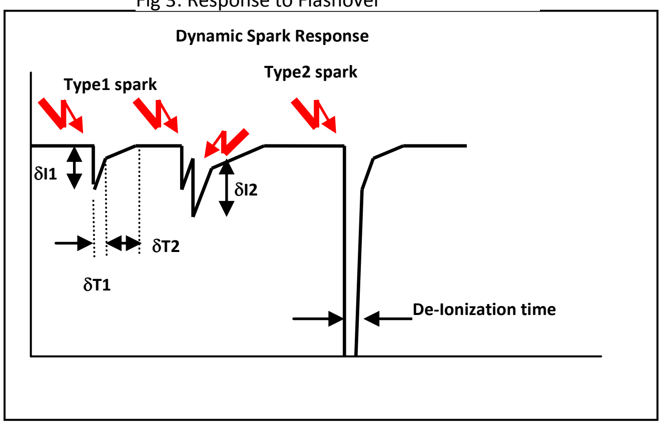
The integral analysis of both these phenomenon results in to categorization of the flashover as spit or Type 1 flashover and arc or Type 2 flashovers. This categorization is based on the intensity of the flashovers. The Type 1 is a relatively low intensity flashover, which needs to be treated appropriately as compared to Type 2, which needs de ionization to quench the flashover. The response needs to be very swift to maximize the 'volt-time' integral, while at the same time ensuring effective quenching of the flashover condition. This also takes into consideration follow up flashovers, flashovers as a result of the reducing levels, due to occurrences of a process related flashover. These need to be avoided / reduced as this progressively reduces the flashover levels.

The detection technique of Type1 or Type 2 plays a significant role and is based on the current and voltage derivatives. The precise and accurate detection and categorization of the flashovers and equally important the speed of response influences the collection efficiency.

Just before the flashover, the voltage has reached to its maximum possible value and the dust charging is also at its optimum level. The flashover response and its dynamics are so designed that the field shall always operate at a higher value and the 'volt – time' integral shall be maximum possible.

In any type of flashover, the drop in voltage and its recovery time is important. The response to the Type 1 and Type 2 flashovers is indicated below.

Fig 3: Response to Flashover



For Type 1 flashover there is no quench or deionization time. The drop in current after spark (δI1) is a function of the pre sparking current (I) and hence it is different for different levels, also the function of drop of current is again dependent on the stability of the pre-sparking current.

If there is flashover detection during rising of current then the drop (δI2)is different as compared to the flashover sensed at steady state current. Thus the drop in current after flashover is moderately optimized and in a self controlled mode

Similarly the fast rise (δT1) and slow recovery time (δT2) and levels are again a function of the dynamic drop and the mean deviation in the running average rate of spark. Thus the complete spark response is dynamically optimized.

Case Studies

The *Auto Optimization* software (ESP Performance enhancement software), embedded in our controller and has been implemented at many plants such as CPP, Cement, Bio mass, Steel, etc. This has provided good results. A few examples are described below.

Plant 1

Plant 1 is located in Indian State of Chhattisgarh. It is a coal fired captive power plant in a steel plant. The capacity of the power plant is 2 x 25 MW. The ESP is having 2 passes with 6 nos. fields per pass. The owner was facing a higher emission problem and planned for a field extension in each passes, however due to space limitation and high cost of field extension, the proposal of field extension was cancelled and the owner retrofitted the existing controls, with our controls *with Auto Optimization software.* Following table gives the results

Table 1 : Results at site

	Emission (mg/Nm^3)
Before retrofitting the controller	55.7
After retrofitting the controls	19

Plant 2

Plant 5 is a biomass operated captive power plant of an Agricultural plant located in Indian State of Haryana. The fuel used is cow dunk. Here there was emission problem. The owner retrofitted the ESP Controls with our controls, with *Auto Optimization software*. The emission was reduced from 225 mg/Nm^3 to 125 mg/Nm^3 and the input power reduced from 16.4 KW to 8 KW.

Plant 3

Plant 3 is a steel plant located in the Indian state of Orissa. Here there are total 3 ESPs having three fields each. There was a high emission problem and the emission was ranging from 170 to 200 mg/Nm^3. Here at one kiln ESP the controls were changed to our controls with *Auto Optimization software*. The emission comes down from 170.7 mg/Nm^3 to 54.8 mg /Nm^{3}this is complemented by the saving in input power from 78.2KW to 22.6 KW. The owner then changed the controllers for other 2 kiln ESP also which gives similar kind of results.

Plant 4

Plant 4 is the cement plant located in the Indian state of Karnataka. Here there are total 4 Fields in cement mill ESP. There was high emission problem. Here the owner had retrofitted the ESP Controls with. Our controls with *Auto Optimization software* This had reduced the emission from 115mg/Nm^{3}to 55mg/Nm^3, complemented by reduction in input power from 51.2 KW to 23.1 KW

Plant 5

Plant 5 is the captive power plant of the cement plant located in the Indian State of Karnataka. Here there are total 2 passes and 5 fields per pass. Thus there are total 10 fields. There was high emission problem. The owner retrofitted the ESP Controls with our controls, with *Auto Optimization software*. The emission was reduced from 165 mg/Nm^3 to 65.4 mg/Nm^3 and the input power reduced from 58 KW to 25.1 KW.

Summery Table

Table 2 : Summery table

	Plant 1 (Captive Power Plant)	Plant 2 (Biomass)	Plant 3 (Steel Plant)	Plant 4 (Cement Plant)	Plant 5 (Cement Plant)
Emission Before (mg/Nm^3)	55.7	225	170.7	115	165
Emission After (mg/Nm^3)	19	125	54.8	55	65.4

Analysis and Conclusions

Keeping the other conditions same and only by electrically optimizing the field by using *Auto Optimization software* had given good results of reduction in emission and at the same time significant reduction in energy consumption in certain cases.

References

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