



## Case History Success Story

### Comprehensive Precipitator Performance Improvement

#### Our Customer

Our customer is an investor-owned Midwestern utility with seven electric utility operating companies that serve 4.5 million customers. The company and its generation subsidiaries manage more than 14,000 megawatts capacity.

#### The Issue

The utility was experiencing precipitator performance issues, resulting in restricted output power generation and undesirable opacity levels. Neundorfer worked with the customer to identify inherent issues in the precipitator design, condition, subsystems and operation. Once these issues were identified, Neundorfer identified the greatest performance improvement opportunities as follows:

- Improvements to the internal electrostatic precipitator (ESP)
- Upgrade to flue gas conditioning systems
- Upgrade of hopper evacuation systems

Neundorfer worked with plant personnel to develop a comprehensive, cost-effective plan to optimize overall performance and reliability as well as to ensure compliance with particulate emission and opacity limits. The plan had to be executed within the timeframe of a scheduled overhaul outage.

#### The Solutions...and Results

##### *ESP Enhancement*

The plant's ESP was undersized in comparison to the performance of a modern precipitator in terms of particulate collection efficiencies. The small size of the precipitator also placed heightened focus on section reliability, internal clearances, gas flow distribution and the performance of all precipitator subsystems.

Neundorfer worked with the plant's labor contractor to improve the internal conditions. Items were prioritized and work schedule planned accordingly. The focus of the internal work was on improving electrical clearances.

- Internal clearances were compromised due to sagging upper support girders and warping of collection plates as a result of a severe heat excursion over a short period of time.

*Realigned and improved by 80% in comparison to the start of the outage.*

These clearance improvements enabled each section of the precipitator to achieve increased secondary voltage levels, thus improving the strength of collecting fields and collection efficiency.

Neundorfer also discovered a significant ash buildup in the precipitator inlet nozzle, blocking gas flow from the bottom six to eight feet of the collection plates. The blockage created increased gas velocities in other sections of the ESP and resulted in reduced collection efficiencies.

The ash deposits were removed during the outage, resulting in more uniform gas flow distribution and improved collection efficiencies.

### *Flue Gas Conditioning Improvements*

The utility had previously installed a sulfur trioxide (SO<sub>3</sub>)-based flue gas conditioning system as a means to reduce high ash resistivity levels produced when using low-sulfur, western fuels. For the undersized precipitator, achieving optimal ash resistivity levels was critical to ensuring desired performance.

The feedstock for the plant's SO<sub>3</sub> system was molten sulfur which must be kept in a liquid state through precise temperature control. The molten sulfur was pumped to a sulfur furnace where it oxidizes into SO<sub>2</sub> and then to SO<sub>3</sub> in a catalytic converter. The SO<sub>3</sub> gas is then injected into the flue gas upstream of the ESP. In recent years, the plant's flue gas conditioning system had become unreliable because of aging equipment.

Neundorfer implemented a range of enhancements to the flue gas conditioning system to improve functionality and performance.

- Controls were upgraded to a programmable logic controller (PLC)-based system that improved the functionality of the originally installed system. The upgraded control package included a new Human Machine Interface (HMI) system that enabled quick and simple viewing of system status and adjustments to set-points. In addition, data relating to the operation of the system was stored for future analysis and troubleshooting.
- A unit load rate was incorporated into the control scheme so that the sulfur feedrate would automatically adjust as unit load varied in order to produce the desired concentration of SO<sub>3</sub> to the flue gas. A closed-loop control algorithm on the sulfur feed-rate was added as well by installing a flow meter and control valve in the molten sulfur line.

- Neundorfer replaced injection probes with an updated design that included thermocouples for continuous temperature feedback in order to improve control of the SO<sub>3</sub> nozzle temperature and avoid corrosion and plugging that could reduce effectiveness of the SO<sub>3</sub> system.
- The PLC incorporated a PID loop in conjunction with an existing electric heater to control the temperatures of the burner outlet/converter inlet to maintain optimal conversion of SO<sub>2</sub> to SO<sub>3</sub> and protect the catalyst from temperature excursions. Each of seven heater elements was also retrofitted with an individual SCR controller to allow individual control of each element. Failures of individual heater elements can now be detected and life of each heater is expected to be dramatically extended.
- The new HMI package allows the continuous display and recording of temperature data from the catalyst outlet as compared to the catalyst inlet in order to monitor the SO<sub>2</sub> to SO<sub>3</sub> conversion rate and conversion performance. Since this conversion is exothermic, a specific temperature increase is expected across the catalyst, depending on the inlet gas composition.
- Neundorfer added a mass flow meter to the blower outlet and a variable frequency drive to control the blower speed in order to ensure consistent closed-loop control of the system airflows. Such control of airflow to the sulfur burner is necessary to maintain optimal gas composition and temperature to the converter.

### *Hopper Evacuation Upgrade*

The plant also needed to upgrade their positive-pressure, hopper evacuation system on the ESP. The hopper evacuation system was equipped with vintage controls that utilized cam timers and relays to manage the sequence of the evacuation system's isolation chambers. The system did not allow flexibility for adjusting sequence or timing nor did it provide any warning system for malfunctions until high hopper alarms were reached or precipitator voltage controls displayed poor electrical readings. As a result, hoppers periodically were not always emptied properly, causing ash to accumulate to levels that can ground an ESP bus section or cause permanent damage to internal electrical components.

- Neundorfer minimized these issues by replacing the cam timers and relays with an integrated system comprised of a programmable logic controller (PLC) and a new panel-view Human Machine Interface (HMI) that allows the plant to easily adjust cycle times and sequences based on pressure data that is gathered and stored in the HMI, thereby increasing system capacity. Plant personnel can review captured data and change the hopper sequencing to maximize ash removal. They also have the capability to move cycles from hoppers with little to no ash to those that collect the fastest, reducing the average fill level in the hoppers and thereby reducing potential for bridging or other ash removal problems.
- The customer also installed level and pressure sensors in the NUVA feeders provided by Neundorfer and added SmartAsh optimization software. This software provides plant personnel with a powerful monitoring tool and the potential to immediately detect a problem with

the entire evacuation system or an individual hopper. This allows the plant to cycle or skip any individual hopper at any given time, as well as providing troubleshooting and early detection capabilities (including advanced alarming). The plant is then able to address hopper levels that can cause problems or damage to precipitator electrical components. The plant has since minimized high hopper incidence and has especially valued the predictive capabilities of SmartAsh. Operationally, plant personnel have found that Smart-Ash provides the data needed to identify high hoppers before they become an issue, saving maintenance headaches and avoiding opacity exceedances.

**By taking a full-system view of the functional and compliance issues confronting this utility, Neundorfer was able to apply their experience and expertise to optimize precipitator performance as well as monitoring and reporting capabilities. The utility has benefited with higher efficiencies and lower emissions at less cost.**



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