NEUNDORFER

Achieving Long-Term Peak Performance For FCCU Precipitators

Over the past 45 years of helping precipitator owners/operators in North America, we have run across quite a few precipitators. Achieving peak performance and long-term reliability is always a concern of precipitator operators.

Precipitators on Fluidized Catalytic Cracking Units (FCCU) are no different, but can be particularly challenging because they have to operate for 5-6 years, reliably and in emissions compliance, between shutdowns. The challenge is two-fold. First, what can you do to achieve consistent performance between shutdowns? Second, when we get to the shutdown, how do we identify what we need to work on so the precipitator can operate reliably for the next run period?

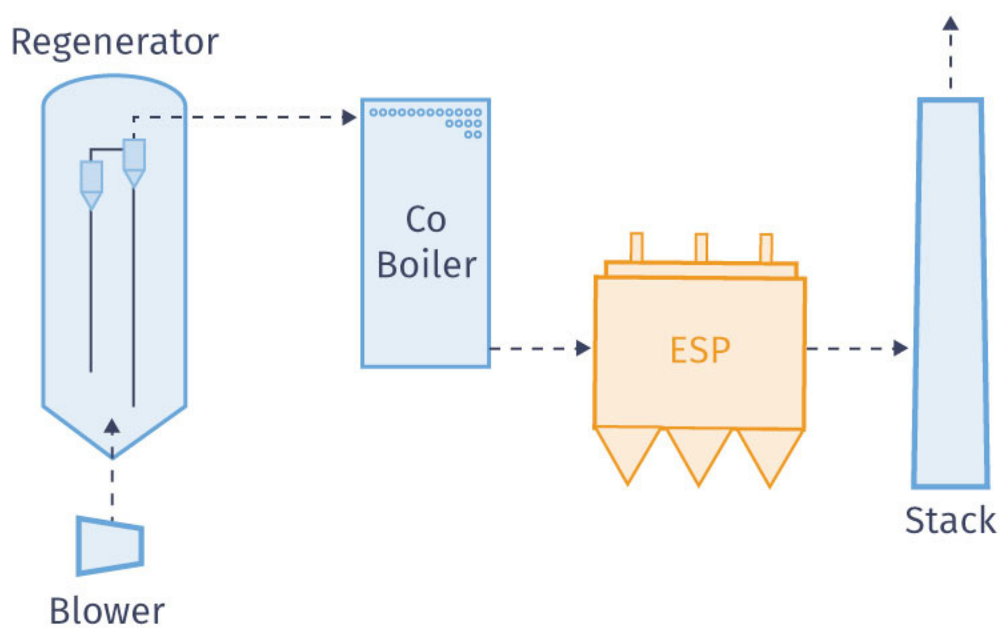
We'll present a 3-part series for FCCU precipitator operators.

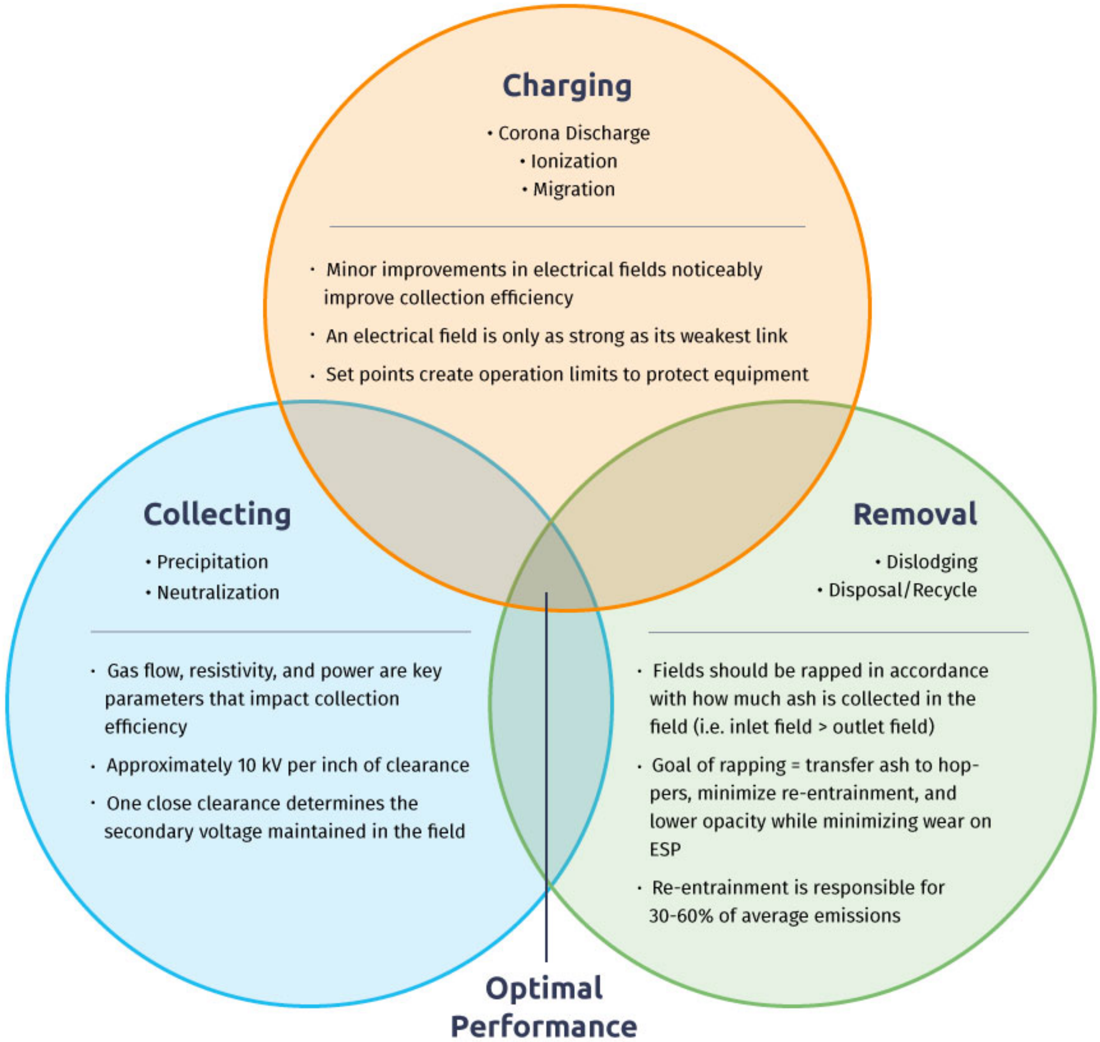
1. Discuss the three key processes of a precipitator, what are common issues and what influences precipitators on FCC units.
2. How to use precipitator data to plan your shutdowns.
3. Long term performance and reliability improvement options.

We'll present helpful tips and ideas to help you achieve long-term peak performance of your FCCU precipitator.

So, let's get started!

TYPICAL FCCU-ESP CONFIGURATION





These three processes are necessary for a properly functioning precipitator:

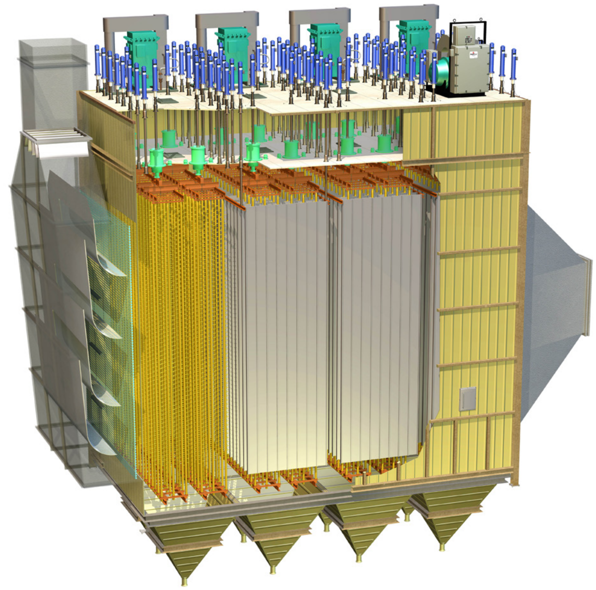
Charging: the process that creates the ions which charge the dust particle

Collecting: the process by which the charged dust particles migrate to the collection surfaces

Removal: the process that involves rapping off the collected dust particles and removing them from the precipitator.

Precipitators are not so forgiving. If one of these steps is not performing optimally, overall precipitator collection performance degrades. You cannot get away with just 2 steps working well.

Diagnosing issues with these steps can be difficult because a symptom may be the result of one or multiple issues within each of the steps that collectively contribute to poor performance.



Below is a discussion on how the three precipitator processes impact FCCU precipitator operation.

1. CHARGING

Maximize secondary voltage (kV) input and you maximize precipitator collection efficiency. Simply put, *kV is King*! Here are the major culprits to not being able to maximize kV input.

YOU'RE ONLY AS GOOD AS YOUR CLOSEST CLEARANCE

Misalignment between collecting electrodes and discharge electrodes (i.e wires, RDEs, etc) results in reducing the point at which the field wants to spark or what is referred to as spark over voltage. This results in lower kV input, along with lower secondary current (mA) input and lower overall power input (kW). Thus, maintaining good clearances is essential for efficient precipitator operation.

Remember, every one (1) inch of clearance between a plate and discharge electrode equates to 10kV. That means that close clearances degrade the available power input into the field by 10kV per inch of clearance lost. Also, depending on your plate spacing and discharge electrode geometry, current does not begin to flow until 18kV-20kV. Why is kV so important? Keep reading.

Alignment of the upper discharge electrode frames and the lower anti sway frames is critical. Removing or repairing bent/warped plates is important, however it may be easier to just remove the wire/discharge electrode(s) that is being affected.

CHECK YOUR CONTROLS

In order to get the best performance out of your precipitator, the voltage controller must be allowed to operate as close to the spark-over voltage as possible. Most controllers used today are modern, microprocessor-based controls. They are not fool proof. They depend on good feedback from the Transformer/Rectifier sets to operate properly. Issues preventing these controls from optimizing performance are:

• Control limit settings programmed lower than the T/R set nameplate

• One or more input signals are out of calibration

• Too low a spark rate set on the controller.

Solutions range from confirming controller set up matches T/R set nameplate rating, periodic checking of feedback signal calibration (yes, even on those “non calibration necessary” controls) and making sure the controls are sparking appropriately to the process.

CORONA QUENCHING

Very fine particles are formed in the catalytic process, and there are a lot of them. This large number of tiny particles have a shielding effect on the power input because; 1) they are lighter than the larger particles, 2) they partially migrate to the collecting plates, and 3) they stay entrained in the gas stream. While they are floating around, they repel other similarly charged particles (same polarity). This condition is prevalent in the inlet fields of a precipitator where the dust loading is the highest.

This condition requires more kV gain for more efficient operation. Solutions range from making sure the controls are not set below nameplate ratings (easy) to better matching T/R set output to the field (harder). Another way to increase kV is to increase the space charge effect. More on this below in the discussion around resistivity.

2. COLLECTING

Collecting is the process of getting the charged dust particle to the collecting plates. The primary influencer here for a FCC unit is gas temperature and its impact on dust resistivity.

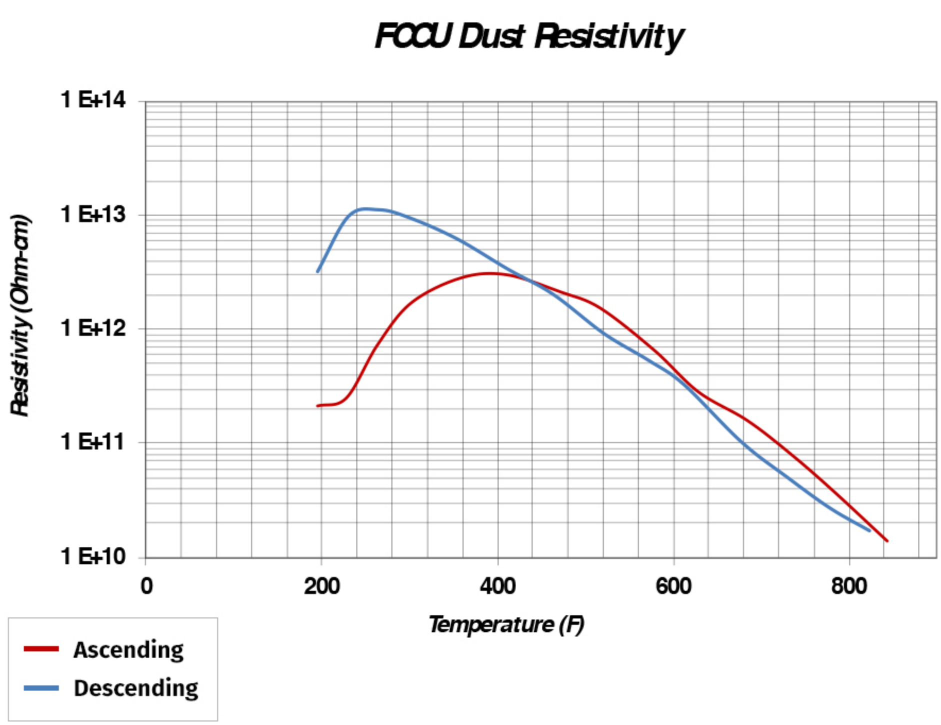
WHAT IS RESISTIVITY?

This term is most critical for the fly ash precipitator because it directly controls the levels of voltage and current observed at most installations. Resistivity, which is a characteristic of particles in an electric field, is a measure of a dust particle's resistance to transferring charge (both accepting and giving up charges). Particles can have high, moderate (normal), or low resistivity.

Resistivity also refers to the electrical resistance of the ash layer after it forms on the positive ground collecting plate. If the resistance level is high, the corona current passing through the ash layer must be generally reduced or reduced performance of the ESP will result.

The range of resistivity is primarily affected by the chemistry of the ash, moisture in the flue gas, levels of sulfur trioxide, and flue gas temperature. Resistivity effects are generally observed by the occurrence of sparking on most ESP fields at some reduced level of voltage and current. Operation in a good zone of resistivity allows the ash layer on the collector plate to bond sufficiently for optimum precipitator performance and helps to reduce the reentrainment of dust.

Dust from a FCCU is typically in the moderate to high resistivity range. An example of a graph of resistivity is below.



INFLUENCES ON RESISTIVITY

In the chart you can see how temperature influences resistivity. Gas temperatures for FCCU precipitators are typically in the 450°F to 650°F range. Most of the temperature comes from the catalytic process in the regenerator.

Metals content in the catalyst will also influence resistivity. As the catalyst ages, more metals are present in the catalyst, thus reducing the resisitivity as the catalyst ages.

MODIFYING RESISTIVITY

A common practice to improve baseline opacity is to reduce resisitivity by injecting Ammonia (NH_3) ahead of the precipitator. Ammonia injected ahead of the precipitator will react with the SO_2 and SO_3 in the gas stream and create ammonia sulfates and ammonia bisulfates.

These compounds have three effects; reduce the resistivity of the dust particle, agglomerate the small particles into larger ones which are easier to collect, and increase the ability of the inter-electrode space to increase kV. These increase the collection efficiency and reduce opacity. This can also help reduce opacity spiking occurrences.

3. REMOVAL

RAPPING

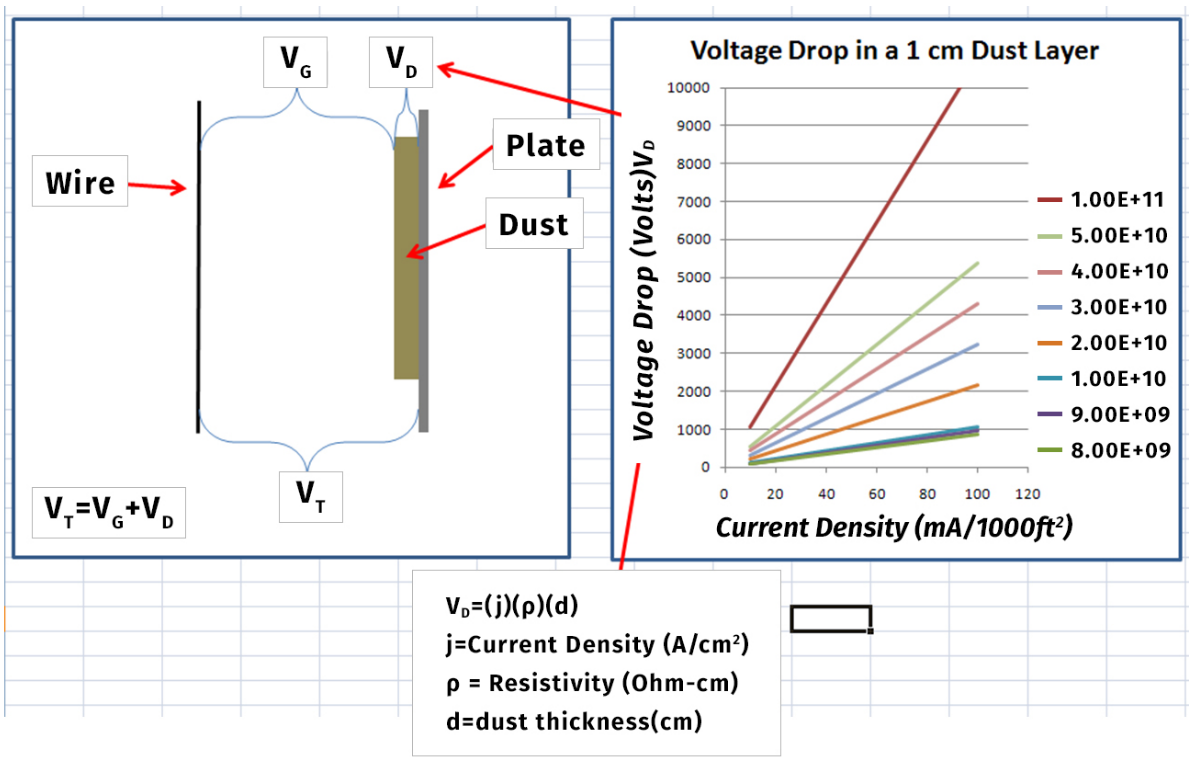
Once the dust is collected on the collecting plates, we have to remove it. Rappers are devices that remove the dust from the collecting plates and drop the dust in the collecting hopper.

Since rapping is more “art” than “science”, the solutions require time and patience. Most of the solutions revolve around assessing the rapping programs (repeat times, impact) and trial and error changes to find the optimal program. For example, Inlet field rapping repeat times may be every 4 minutes while the outlet field may only rap once a day.

Too aggressive rapping (repeat cycles, impact force) can cause the dust to be re-entrained, which leads to high emissions. Rapping too infrequently causes build-up to occur, potentially allowing crusting and a large amount of dust falling off the plates when the rapping event occurs. Both conditions cause the typical “opacity spiking” problem users experience.

RESISTIVITY IMPACTS REMOVAL TOO!

Dusts with high resistivities are a challenge for removal. These dusts are harder to remove from the collecting plate due to the higher "clamping force" associated with high resistivities. Once the charged dust reaches the grounded collecting plate, the charge on the particle is partially discharged and slowly leaked to the grounded collection plate. It is this retained charge ("clamping force") that holds the dust onto the collecting plate. High dust resistivities result in more retained charge across the dust layer. This relationship is shown in the chart below.



Note that the injection of Ammonia (resistivity modifier) can result in "sticky" dust if optimal injection rates are not used. This dust can be very difficult for rappers to remove.

CONCLUSION

Precipitators can perform at high efficiencies over long periods of time if we pay attention to the three processes and understand what is influencing them. The things we should keep in mind all the time are:

- Secondary Voltage (kV) is King
- 10 kV per inch of clearance between discharge electrode and collecting plate
- You are only as good as your closest clearance
- Temperature is a key influencer on performance
- Keeping collecting plates clean is important, but rapping is more an art than a science.

Our next part will discuss how we can use precipitator operating data to diagnose or identify potential problems, things we can do to try to solve problems without shutting down and how to use the data to plan our future shutdowns.

WHO IS NEUNDORFER?

Founded in Cleveland, Ohio in 1975, we have been dedicated to helping owners and operators of air quality control systems reduce emissions and improve pollution control system performance through design, modeling, consulting, product support, installation, and service.

Our highly skilled, technically oriented team is driven by an extremely inquisitive nature and desire to resolve complex issues. We use a proven process that combines in-depth analysis, experiential knowledge, and a focus on both the technical and economic challenges that are unique to each customer.

Neundorfer has extensive experience to help you in these areas:

- On-site and remote troubleshooting
- Precipitator controls tuning and optimization
- Online assessments
- Internal inspections
- Shutdown planning
- Shutdown technical direction
- Customized in-person or virtual training

Questions about your ESP?

We'll help you troubleshoot. Contact the [ESP Help Desk]!