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Technical Bulletin

Can Switch Mode Power Supplies Cause Damage to Weighted Wires?

While we consider the likelihood to be very small, we will take a look at the potential and provide some points of consideration:

- **Plate to electrode clearance**: Bowed collector plates or kinked electrodes can cause premature failure due to penciling down during arcing or sparking.
- **Age of the discharge electrodes:** Over the years, exposure to the elevated temperatures and heating and cooling can cause elongation. This causes slack or loss of tension in the electrode, which can lead to close clearances.
- **Proper Tensioning/Anti-sways:** The rule of thumb is 1 pound of weight per linear foot of discharge electrode. Also, the anti-sway devices must hold the lower discharge electrode frame in a way that it can thermally expand and retract without reducing the collecting plate to weighted wire electrode clearances.
- **Spark Response:** Since most SPMS units control both the gating on and off of the IGBTs, they can shut off the power to the field much faster than a 60 hertz power supply. The following calculations show that a switchmode unit only adds 1/1000th of the energy that a conventional SCR-CLR-TR system would add to the weighted wire during an arc.

Faster Arc Response

Energy from the Power Supply dumped into a weighted wire during an arc:

$$J = Isc^2 * R_{arc} * T$$

J : Power Supply Energy in Joules added into the portion of weighted wire carrying arc current
Isc: Short circuit current during the arc (Amps)
R_arc: effective resistance of the length of weighted wire that carries arc current (Ohms)
T: time that the Isc is present (seconds)

Conventional TR and Controller	PowerPlus
Rating: 55 kVdc, 1000mAdc, 40%X	Rating: 70 kVdc, 1000 mAdc
Isc: 2500 mA	Isc: 1300 mA
R_arc: .1 ohm	R_arc: .1 ohm
T: .00833 sec (1/2 cycle shutdown)	T: .000030 sec
J: 5.21 mJ (milli-J)	J: 5.1 uJ (micro-J)

The energy dumped into the weighted wire by a PowerPlus unit is less than 1/1000th of the energy added into the weighted wire by the conventional TR-SCR-CLR system.

- **Size/Capacitance of the field:** Studies have shown that in a field that is controlled well, the energy that contributes to internal precipitator wire damage actually comes from the capacitance of the field discharging all of its stored energy when the arc occurs.

  The reason for this is that all of the electrodes and collecting plates of a precipitator form a large parallel plate capacitor. For a field that is powered by a properly sized 1000 mAdc SMPS or TR, the capacitance of the field is typically 100 nF. The energy stored in the field is ½ x C x v^2. For this typical 100 nF field arcing at a level of 65 kV peak, the stored energy is 211 Joules. It is easy to see that this amount of stored energy in the field is many orders of magnitude greater than the energy that any type of power supply adds into a weighted wire during an arc. **For a precipitator field that arcs at the same kV peak level (before and after changing power supply type), the stored energy added into a section of weighted wire during an arc is independent of the type of the power supply.**

  This discharge of the precipitator field stored energy is particularly tough on weighted wires. The arc occurs when the kV flashes from a single point along the weighted wire to a ground point. At that instant, all of the stored energy in the field is discharged in just several microseconds through the closest clearance that arced to ground. If that arcing point happens to be at a wire, the .100-.250" diameter wire must dissipate all of the stored energy in the field. The total resistance of this discharge path to ground is certainly less than 1 ohm. At one ohm, the peak discharge current for an arc that occurs at 65 kV is 65 kilo-amperes! If the field has a problem and this one wire is subjected to repeated high arcing rates at a single point, then the thermal and mechanical stresses on the wire can lead to failure.

  Not only does sectionalizing the field provide better collection since two sections rarely arc at the same instant, but the smaller fields also have less stored energy to dump into the weighted wires during an arc event.

- **Increased Voltage/Increased Magnetism-** There are definitely pros and cons of increasing the voltage to an operating precipitator field. The pro of course is it does its job better and collects more dust. The con is that the large magnetic field created may cause undesirable movement of the weighted wires if they are not properly tensioned.

  Increased Collection Can Create a Need for Increased Cleaning-Typically this will affect the collector plate cleaning more than the discharge electrode cleaning cycle. Since SMPS units result in greater amounts of dust being collected, both rapping periods and the emptying of hoppers have to occur more frequently than when less dust was collected.

The conclusion of this brief review of weighted wire precipitator fields is that the type of the power supply does not influence the life of the weighted wires. The amount of stored energy in the field, the location of repeated arcs within the field, the age, the precipitator condition and the material properties of the weighted wire are the primary factors in determining weighted wire life.