Bus Joints: Silver Plating and Corrosion (Tarnish)

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Corrosion of an electrical connection can be a serious concern for equipment users. The reduction in conductivity caused by oxidation of contact surfaces can cause higher operating temperatures. The bus found in indoor switchgear can be aluminum, but is most often copper. Both materials oxidize very quickly when exposed to certain environmental conditions so they are typically plated with silver or tin when used in switchgear. Silver is the harder of the two materials and is better suited for applications where the contact points slide, such as the primary disconnecting devices between the circuit breaker and switchgear or any sliding current transfer point on the circuit breaker. The plating used on bus bars is only required at the connection points and may be silver or tin as required by the environment where the switchgear is applied.

Powell uses copper as the primary conductor for its circuit breakers and switchgear and chooses the plating for components based on the rationale discussed in Technical Brief PTB 41. Technical Brief PTB 135 discusses galvanic corrosion at bus joints with respect to dissimilar hardware material. This Technical Brief will discuss oxidation (tarnish) and discoloration on the exposed surfaces of the silver-plated bus.

Powell utilizes fully plated copper bars rather than applying silver only to the exposed joint surfaces. In our metal-clad switchgear the bus is covered with an epoxy based insulation to meet the dielectric requirements of IEEE C37.20.2. Applying this insulation requires a heating process that tends to turn the silver plating dark. While it often causes questions, this a cosmetic issue only as the process uses temperatures above the level where silver oxidizes in air (bulk silver oxide will recombine with the silver at temperatures above 200°C).

Oxides are not conductive in their pure state. Silver oxide is dark brown to black in color, not unlike the color change that occurs from exposure to high temperatures. However, unlike the color change, the oxidation process leaves a film or tarnished appearance on the surface. Fortunately, the oxidation process for silver is slow and the surface of bus bar is rarely covered at 100% with oxide. The change in conductivity is not so pronounced as to be immediately detrimental. Only the surfaces making up the joint are subject to degradation due to oxidation related loss of conductivity and anecdotally, it does not appear to have a significant effect on switchgear thermal performance. Oxidation on the bus surfaces that are not used for making the joint is essentially a cosmetic concern only.

Where the bus has experienced prolonged exposure to air, it may be necessary to clean the mating surfaces before assembling the joint. Because the silver is a soft material, tightening the joint will displace the material enough to self-clean. Where the oxidation is more substantial, Powell recommends cleaning the silver-plated copper.

Use of cleaning powders is not recommended as these are abrasive and may remove significant amounts of silver if the cleaning process involves too much pressure or an excessive duration. High quality silver cleaners that are creams, pastes or emulsions offer less abrasive compounds and many also contain anti-tarnish inhibitors. These are recommended, but with similar precautions as the abrasive powders as an over-zealous cleaner can do more harm than good, even though the abrasive materials are reduced.

Chemical dips are very effective, but require careful attention as it becomes very easy to remove too much or damage the silver surface with a prolonged exposure to the cleaner (>10 seconds).

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In all cases, product selection should include consideration for a cyanide-free cleaner that does not require additional fluid for clean-up afterward. It should remove the tarnish with little or no abrasives and it should be simple to apply without special protection.

After cleaning, the surfaces should be immediately re-sealed with a light coating of grease. The oxidation process is quite easy to prevent at the joints by the application of a protective grease such as NO-OX-ID. Note that some oxidation inhibitors for copper and aluminum can be detrimental to steel alloy hardware. Once properly assembled, tightened to the correct torque, and sealed with a material that prevents air exposure and moisture ingress, the joint should not oxidize. The external surfaces can be cosmetically preserved by applying a light coating of either grease A or grease B from the standard Powell Powlube-104 kit.

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