



Powell Technical Brief #80

Switchgear in a Sulfur Rich Environment

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Sulfur rich environments such as those found in paper and refinery processes have a special problem with the silver plating in Switchgear and Motor Control Centers. Silver plating is used throughout switchgear because of the superior conductivity and longevity. The silver is found on the bus, in the circuit breaker, in protective relays, auxiliary relays, control switches, and test switches. In and around process units with sulfur present it is very common to open up the switchgear and see fine black hairs commonly referred to as whiskers growing from any and every silver plated surface, - be it a relay contact or a breaker stab.

These whiskers and the black tarnish forming under them are silver sulfide. The whiskers are semi conducting and the tarnish is highly resistive. The silver sulfide tarnish grows in areas of the switchgear where the highest concentrations of sulfur is exposed to heat and since the hottest areas are bus joints and sliding contacts, such as the bus stabs, this is not good. The tarnish at the splices and sliding contacts result in a high resistance connection, which produces more heat, and in turn accelerates the tarnishing and the growth of the semi conducting whiskers. This death spiral continues on until you clean the surfaces or the whiskers get long enough to reach a ground plane.

How does the sulfur get in?

The sulfur from the process combines with air to form Hydrogen Sulfide (H_2S) with some Sulfur Dioxide (SO_2) and Sulfur Trioxide (SO_3) by-products. ISA Standard 70.01 defines a **harsh environment** as a concentration of 50 ppb (parts per billion) of H_2S or 300 ppb of SO_2 and SO_3 . Your nose can give you some idea whether sulfur is present. The odor threshold is down around 8 ppb for the H_2S . But the best way to detect sulfur is by surveying the existing gear for the problems described above and in the case of grass roots facilities discussing with your environmental people the types of fugitive emissions expected from the new units.

To combat the effects of sulfur on switchgear there are a couple of steps that can be taken. These include:

Chemical Filtration

One of the most effective ways of combating the whiskers is to filter the H_2S , SO_2 and SO_3 out of the air in the switchgear room. If the Switchgear and MCC's are going into a separate Power Control Room the air conditioning can be fitted with activated carbon filters. These filters are housed in a separate box about the size of one of the air conditioning units and reduce the ISA harsh environment levels such as the 50 ppb of H_2S to an H_2S concentration of 3 ppb and SO_2 and SO_3 to 10 ppb. The unit does require some maintenance and the filters have to be changed approximately once a year.



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The next level of protection is to fit individual active carbon filters over all switchgear louvers. These individual filters are disposable and can do a good job of filtering whatever portion of the air that goes through the louvers. While the individual filters do have a significant impact on how often the switchgear has to be maintained it will not protect the equipment in the instrument compartment or cubicles where there is not a definite air entry, so their overall effectiveness is limited.

Exposure Avoidance

The other strategy commonly used is to minimize the amount of silver exposed to the sulfur by specifying tin plated bus in place of the silver and gold plated contacts or hermetically sealed relays where available. Conducting grease applied at any sliding contact points can help to seal out the sulfur and stiffer springs to improve the wipe can also assist in fighting the problem. In the areas where we replaced the silver with either tin or gold we have eliminated the chance for the whiskers to grow. But there are difficulties with this strategy, many control switches, test switches and protective relay contacts are not available with gold plated contacts. And tin has a couple of problems such as galling and softness that make it less than ideal for sliding contact applications. **See PTB 41 "Plating of Contact Surfaces in Switchgear and Circuit Breakers".**

It is well worth while to evaluate the cost of these different options on any job where H₂S or SO₂ and SO₃ may be present. For those, who have experienced these problems first hand you know that this is more than just a shorter maintenance interval. The whiskers are not only a threat to the power circuit they can be rather insidious in affecting the functionality of the protective scheme.

If we can help with this in any way please give us a call.



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