A Technique to Detect Overheated Switchboards with a Gas Density Detector

Masataka AKAGI
Assistant Senior Researcher, Power Supply Systems, Power Supply Technology Division

Overheated wires are cited as one of the most important causes of switchboard failures. When wires or electric instruments, including their insulating materials are overheated the volatile organic compounds (VOCs) of plasticizers are emitted. Thus the damage due to overheating will potentially be mitigated if VOCs can be detected early and before a fire begins.

We have been discussing a technique to detect VOCs with gas chromatograms. One or two categories of characteristic components (such as 1-dodecanol and 2-ethyl-1-hexanol) used as plasticizers are mostly mixed in the base material and, when volatilized, their emissions can be detected from the vinyl sheath, a component element of wire sheathing materials. A comparison of the relative volumes of the component of each category volatilized at different heating temperatures indicates that the peaks of the detected volumes quickly increase at heating temperatures higher than 100ºC. The emitted volume is small at the normal operating temperature and large when they are overheated. Given these special features, VOCs are thought to be an ideal substance to monitor in order to detect abnormalities.

The above-mentioned 1-dodecanol and other substances are a type of VOC that can easily be detected, if a suitable sensor is available. Therefore, we manufactured a prototype gas density monitoring unit using a semi-conductor gas sensor to detect VOCs emitted from deteriorated wire sheath materials. The prototype gas density unit is composed of a sensor head and a data processing device as shown in Fig. 1. The unit detects airborne materials utilizing convection principles and makes measurements on a real time basis to suit the application to routine monitoring.

To verify the performance of the unit, we wound a specimen vinyl sheath material (cross sectional area, 22 mm^2) for a 6,600V CV power cable, rated at AC current 140 A, around a conductor and placed it in a testing case. We then fed a 200 A current to the conductor to heat the specimen.

As a result, we were able to confirm that the detected volume of VOCs gradually increased as the cable surface temperature increased. As shown in Fig. 2, we found that the detected volume of VOCs rapidly increased at cable surface temperatures higher than 145 ºC. Figure 3 shows how the cable sheath softened under test as the temperature increased.

Based on these findings, we confirmed that it is possible to use a gas density monitoring unit to detect the VOCs emitted from the cable surface when it is overheated. The fact that the detected volume of VOCs rapidly skyrockets when the cable surface temperature exceeds a certain threshold value suggests the possibility of its application as an index to trigger the alarming relay mechanism under routine monitoring.

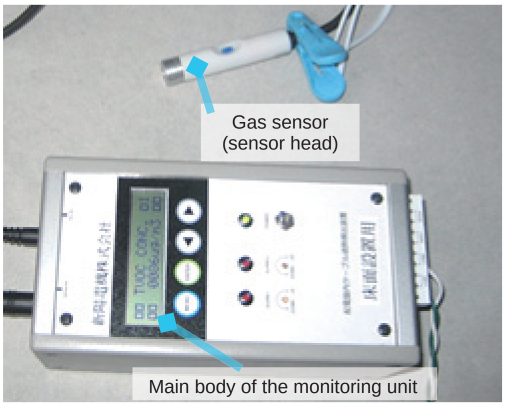


Fig. 1 Gas density monitoring unit

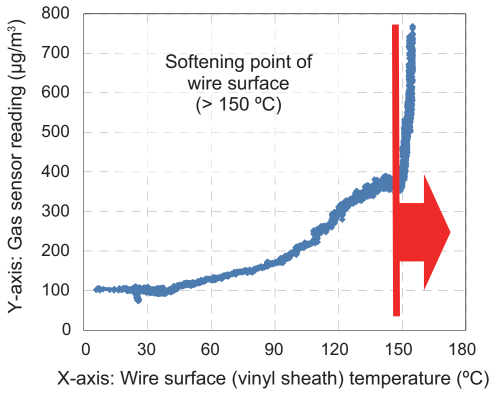
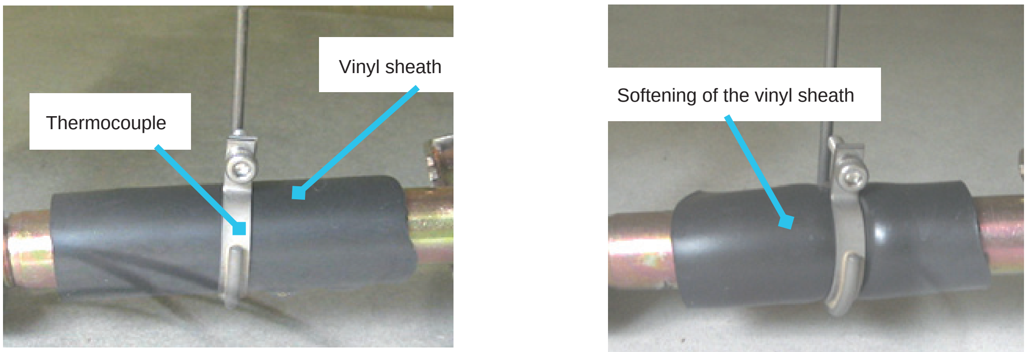


Fig. 2 Volume of VOCs detected with the gas density monitoring unit



Before test

Under test

Fig. 3 Vinyl sheath under test