PHYSICOCHEMICAL BEHAVIOR OF AGED PVC INSULATED CABLE

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Introduction

PVC insulated cables still remain operated in EDF nuclear power plants. Studies have been initiated to characterize the aging state of internal sheath PVC insulated cables and predict their life time.

Electrical tests have shown sometimes a decrease of insulation resistance but a dielectric strength good enough to withstand the voltage. Physicochemical analyses have been done to characterize the insulation material: infrared micro-spectroscopy, differential scanning calorimetry and thermo-mechanical analysis.

Results

Infrared microspectroscopy in the Attenuated Total Reflection (ATR) mode was used to scan the material versus the thickness. Figure 1 shows the 3D plot of the spectra obtained.

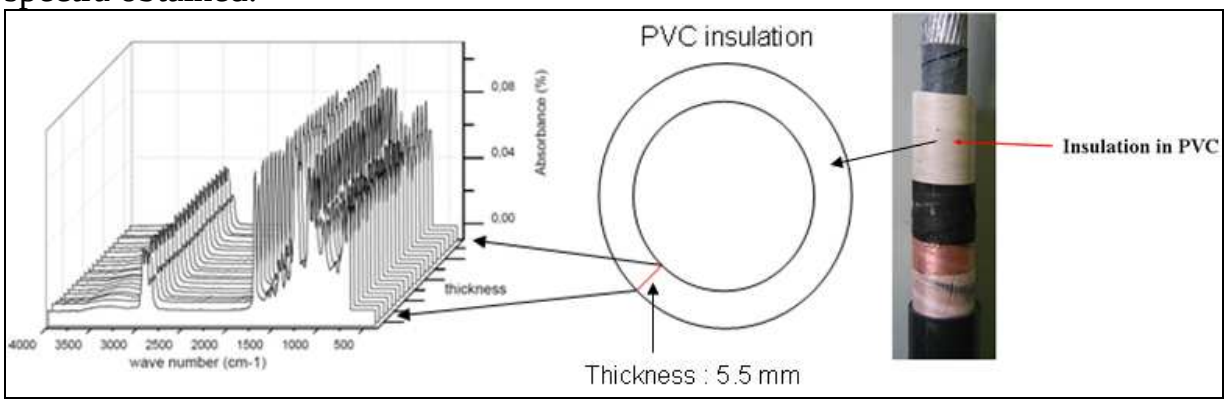

Figure 1 : IR spectra of PVC insulation versus the thickness

The most important vibrationals bands detected are the bands at 1750 cm^{-1}, and 1600 cm^{-1} assigned to the C=O and C–O stretch vibrations of the ester function of the phthalate plasticizer[1]. These bands are present with the same intensity through the thickness of the sample probed. It means that no change in the

composition of the PVC can be detected. Thus migration of the plasticizer does not seem to be an aging phenomenon to consider.
DSC characterizations have allowed us to evidence the working temperature of the cables. Figure 2 shows the thermograms obtained after two identical successive heat treatments:

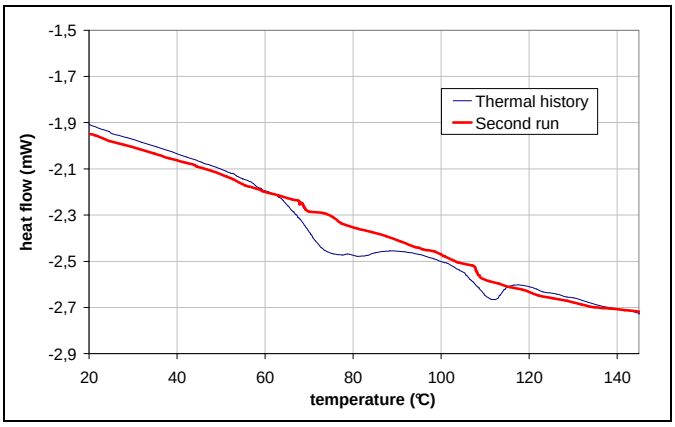

Figure 2: DSC thermograms of PVC sample after two thermal treatments

As they disappear after the second run, the endothermic peaks are a proof of the thermal history of the cable. The first one at about 70°C is in agreement with the theoretical working temperature. The second one at about 110°C is unexpected and we can assume that it may be due to a temporary overheating of the cable.
TMA has shown variations of thermo-mechanical properties along aging with a decrease of the expansion coefficient. Creation of carbon double-bounds by a dehydrochlorination process is suspected to lead to this evolution.

Conclusion

The study of aged PVC coming from cable insulation concerned with a resistivity decrease shows that this decrease is not due to a loss of the plasticizers. As the working temperatures determined by DSC are compatible with the dehydrochlorination aging phenomena[2,3], this hypothesis has to be further investigated. Thermo Mechanical Analysis is a way to link it to the physicochemical behaviour of the PVC insulated cable

Reference

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