Thermooxidative stability of a coaxial cable insulation aged by various doses of radiation and temperature using non-isothermal DSC measurements

Anna VYKYDALOVÁ[1], Zuzana CIBULKOVÁ[1], Peter ŠIMON[1], Tibor DUBAJ[1]

[1]Department of Physical Chemistry, Faculty of Chemical and Food Technology, Slovak University of Technology, Radlinského 9, 812 37, Bratislava, Slovakia

Polymer materials are sensitive to changes in chemical structure due to the effect of external conditions. The main factors that usually trigger a chain mechanism of chemical changes in the polymer are heat, light and radiation in the presence of oxygen. The changes in polymer materials caused by these factors are generally known as ageing or degradation of materials. These changes are naturally undesirable. Thermooxidative degradation occurs in two steps. The first one is induction period (IP), where seemingly no chemical reaction takes place [1]. At the end of IP, the second process – oxidation itself begins. The end of IP is characterized by a rapid oxygen uptake and often a sudden change of material characteristics occurs. Therefore, the length of the IP is frequently taken as a measure of a material stability.

The aim of this work was to estimate thermooxidative stability of coaxial cable used in an atomic power plant. The samples contained the original unaged cable and cable aged by various degradation doses. Three types of ageing were used: heat, radiation and combination of heat and radiation. Non-isothermal DSC measurements were employed to study the thermooxidation of the samples. Kinetic parameters describing IP of the thermooxidation were obtained from the dependence of the onset oxidation temperatures on the heating rate by isoconversional method using non-Arrhenian temperature function. Two criteria for the evaluation of the stability of the materials have been chosen: the length of the IP and the residual stability. Based on the obtained results, it has been demonstrated that the radiation and combination of heat and radiation exhibited a negative effect on the lifetime of the cable. In this case, the thermooxidative stability of cable coating decreases with increasing degradation dose. A different situation was observed in the samples aged by the heat. This type of ageing led to initial increase of the thermooxidative stability of materials followed by its exponential decrease. The decrease of residual stability can be described by an exponential equation of first order for all types of ageing. The determination of residual stability allows reliably quantify the extent of the material damage. This method can be regarded as an appropriate technique for the evaluation of a durability of the cable.

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