Space charge distribution in XLPE plates with non-uniform conductivity

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The PEA method has been used to measure the distribution of space charge in XLPE plates having non-uniform as well as uniform distribution of conductivity. Based on the one-dimensional space charge distribution, the electric field distribution and conductivity distribution are evaluated.

XLPE plates have been prepared to have either uniform or non-uniform conductivity. Since the conductivity of these samples is dominated by the concentration of by-products from dicumylperoxide, different conductivity distributions can be prepared by partly degassing the plates. Uniform plates have been kept in diffusion tight wrappings before the PEA measurement, and diffusion has also been minimized during the measurement. Non-uniform plates have been made by degassing from one side of the plates. For 2 mm thick plates, a concentration gradient that spans the entire thickness is obtained after 3 h at 80°C keeping one side of the plate free for the air and the other side blocked by a tight metal foil.

The concentration distributions have been calculated using a numerical model, and experimental verification using a microtome and GC-FID analysis has been made. Simulations of the electric field and space charge distributions as function of time have been compared to the experiments, and good agreement has been obtained.

Depending of the conductivity, the total measurement times are adapted to allow for the transition from capacitive to steady-state resistive distribution of the electric field. When the dielectric time constant is long, it is inevitable that some diffusion of by-products will also influence the measured distribution of space charge. This as well as other challenges related to PEA measurements on XLPE insulation will be discussed.