ALFF Engineering, Gomweg 7, CH-8915 Hausen am Albis, Switzerland, phone: +41 44 77 66 77 6, fax: +41 44 77 66 77 7
e-mail: info@alff-engineering.ch web: www.alff-engineering.ch

Quality Assessment of Power Transformer Insulation

The two most important quantities for the quality assessment of the insulation of power transformers, namely the moisture content of pressboard (cellulose) and the conductivity of oil, can be determined by measuring in a first step the polarisation and depolarisation (relaxation) currents of the main insulation of a transformer by means of the **PDC-ANALYSER-1MOD** and by fitting graphically in a second step the simulated currents to the measured ones by making use of the *advanced evaluation software.*

The *advanced evaluation software* of the **PDC-ANALYSER-1MOD** permits the computation of the relaxation currents for different values of moisture content in pressboard and for different values of oil conductivity for a given transformer. This software is based on extended linear models and takes into account the geometrical design of the main insulation.

Figure 1 presents an example of such a graphic fit. The measured polarisation and depolarisation currents of a **used** power transformer are shown together with a set of simulated currents (at 18 °C), the parameter of the curve set being the moisture content in the pressboard (barriers and spacers). For this simulated curve set, the oil parameters (i.e. conductivity and power frequency permittivity) are taken constant and the dielectric properties of pressboard (i.e. dc conductivity, power frequency permittivity and dielectric response function) are all changed according to the moisture content parameter. The dielectric properties of pressboard are taken from well controlled laboratory measurements, this basic pressboard data is an integral part of the *advanced evaluation software.*

It can be seen that the moisture content of pressboard influences mainly the shape of the polarisation and depolarisation currents at long times. In contrast, the value of these currents a few seconds after switching the voltage is very sensitive on oil conductivity. For this used power transformer, the best fit between measured and simulated currents is obtained with a conductivity value of 1.65 pS/m.

Figure 2 displays the high sensitivity of the initial exponential shape of relaxation currents on oil conductivity values. For the simulated curve set, a constant moisture content of 2.5% is taken for the pressboard and the parameter is the value of oil conductivity (1/4, 1 and 4 times 1.65 pS/m). These results show that the predominant influence of oil conductivity on the initial amplitudes of relaxation currents can well be used to quantify the oil conductivity of a transformer even without performing direct conductivity measurements on an oil sample.

The results of Figures 1, 2 and 3 disclose that the moisture content of the pressboard used in this transformer is near 2.5% and the conductivity value of its oil is equal to 1.65 pS/m.

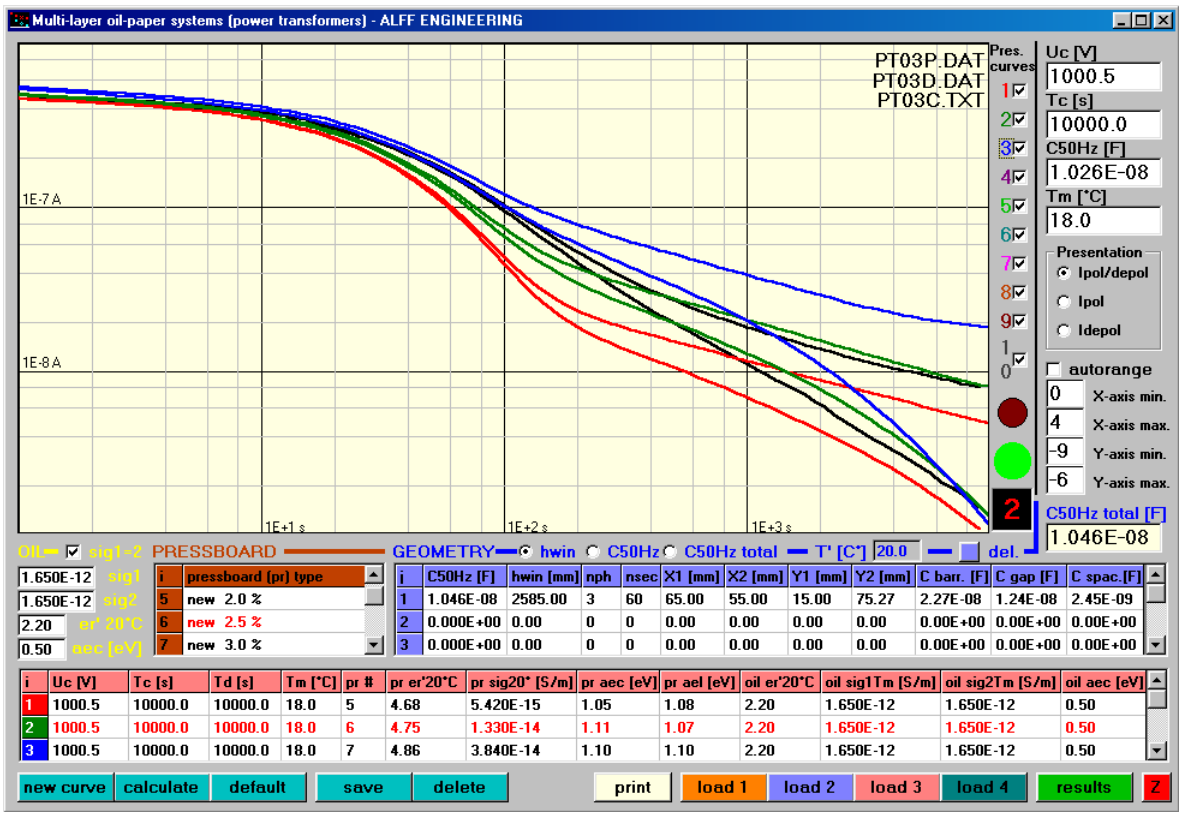

Figure 1: Comparison between measured polarisation and depolarisation currents of a used power transformer (black curves) and a set of simulated currents. The parameter of the simulated polarisation and depolarisation current curves is the moisture content of the pressboard: 2.0%, 2.5% and 3.0% presented respectively in red, green and blue. For this curve set the value of oil conductivity is taken as 1.65 pS/m.

ALFF Engineering, Gomweg 7, CH-8915 Hausen am Albis, Switzerland, phone: +41 44 77 66 77 6, fax: +41 44 77 66 77 7
e-mail: info@alff-engineering.ch web: www.alff-engineering.ch

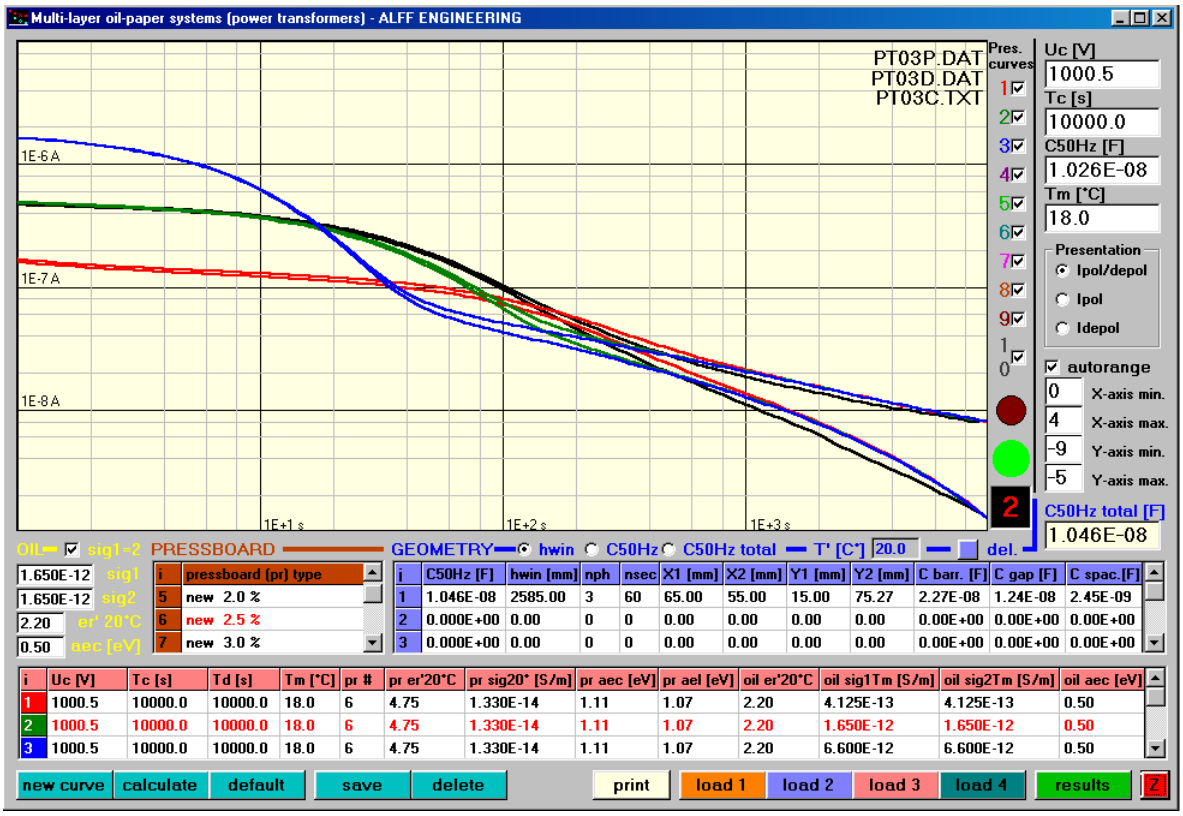

Figure 2: Comparison between measured polarisation and depolarisation currents of a used power transformer (black curves) and a set of simulated currents in function of different values of oil conductivity. The curves are simulated for oil conductivity values of 0.412, 1.65 and 6.6 pS/m, presented respectively in red, green and blue. For these simulations the value of moisture content in pressboard is set to 2.5%.

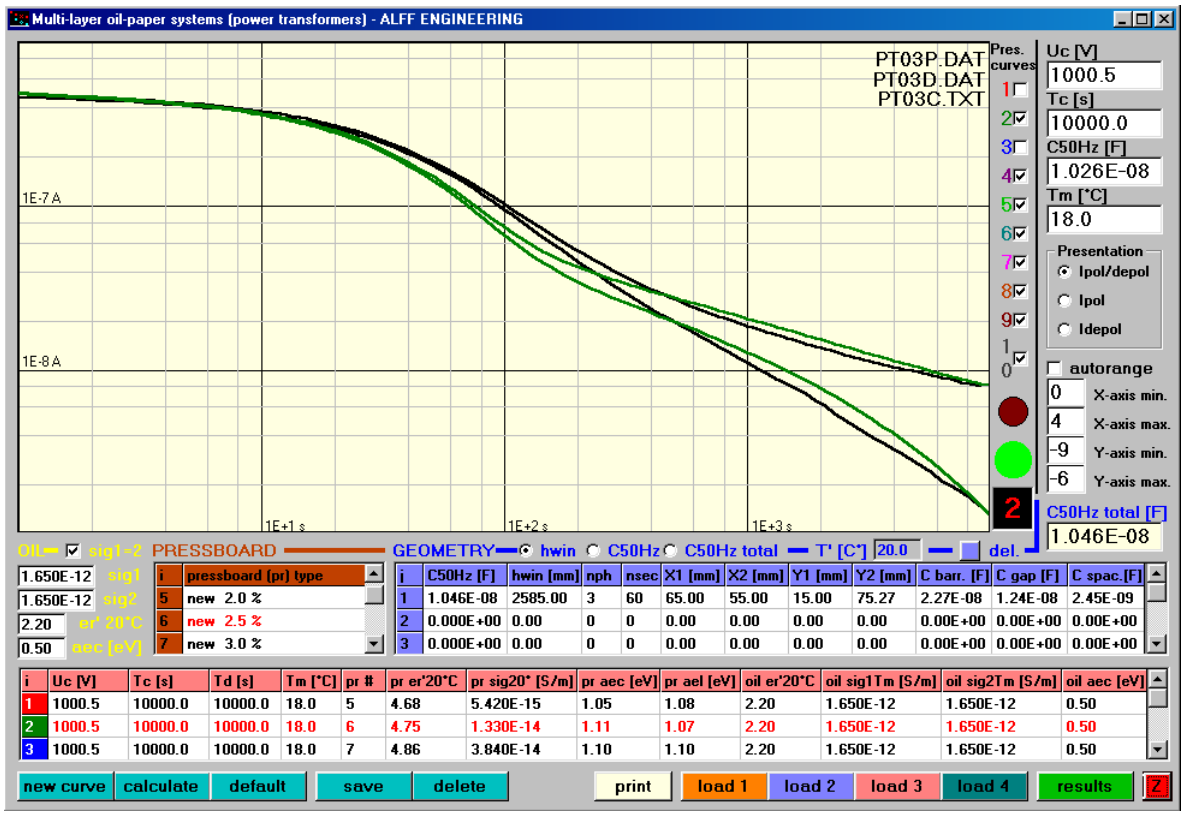

Figure 3: Comparison between measured polarisation and depolarisation currents of a used power transformer (black curves) and simulated currents for a moisture content of 2.5% in pressboard (green curves). For the simulation, the value of oil conductivity is set to 1.65 pS/m.