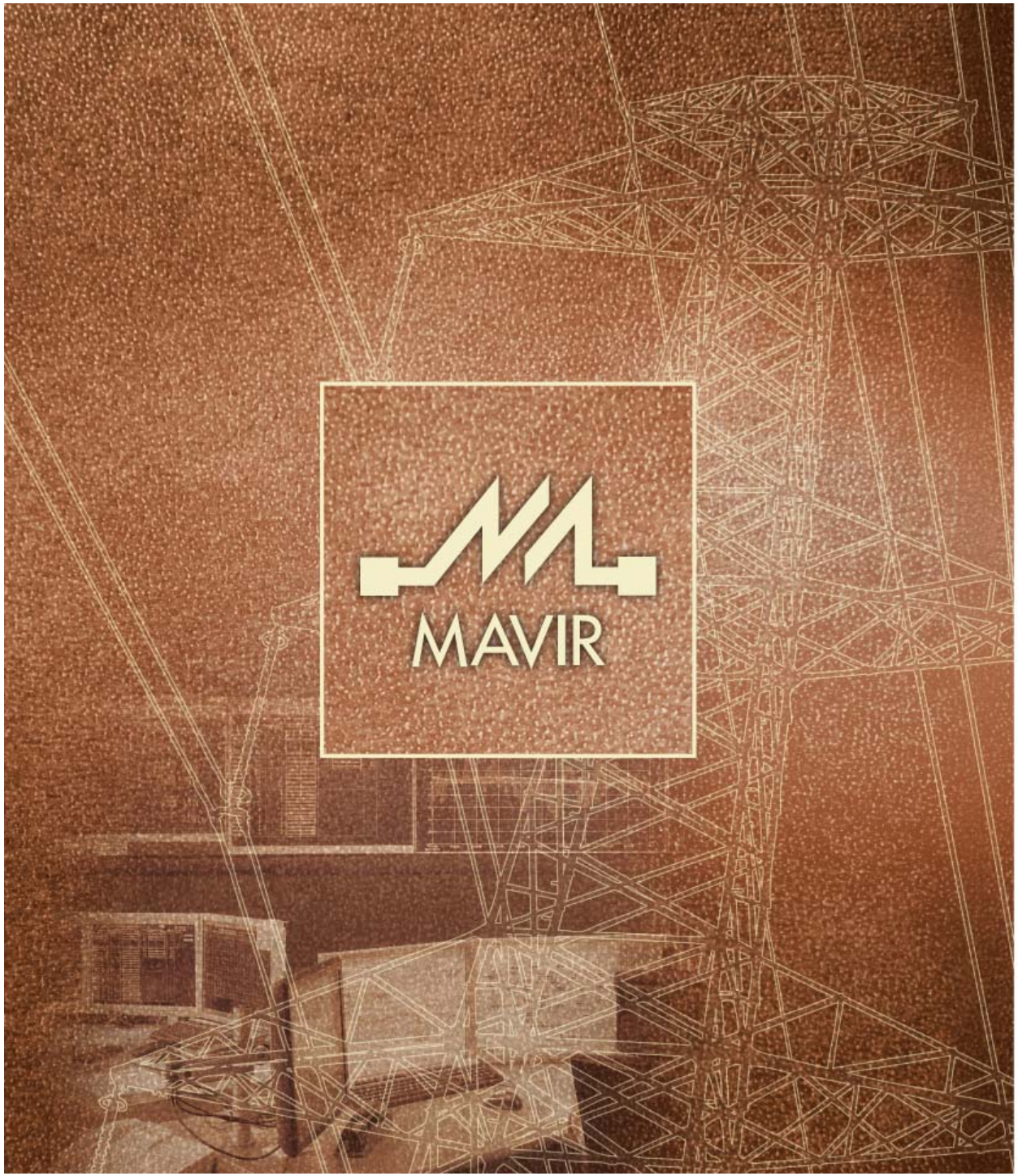


Csépes Gusztáv
MAVIR ZRt.

Polarizációs spektrum módszerek alkalmazása a transzformátor diagnosztikában

MAVIR Magyar Villamosenergia-ipari Átviteli Rendszerirányító Zártkörűen Működő Részvénytársaság
MAVIR Hungarian Transmission System Operator Company Ltd.

Legjobb Munkahely
Világgazdaság - Hewitt Felmérés 2009
Best Employer
Világgazdaság - Hewitt Study 2009

Polarizációs spektrum módszerek

1. Polarizációs spektrummérések időszerűsége
2. Bevezető a polarizációs spektrum mérésekbe
3. FDS módszer
4. RVM módszer
5. PDC módszer
6. Csermátony-Hoffer András „hagyatéka”
7. Polarizációs mérések alkalmazhatósága
8. Összefoglalás

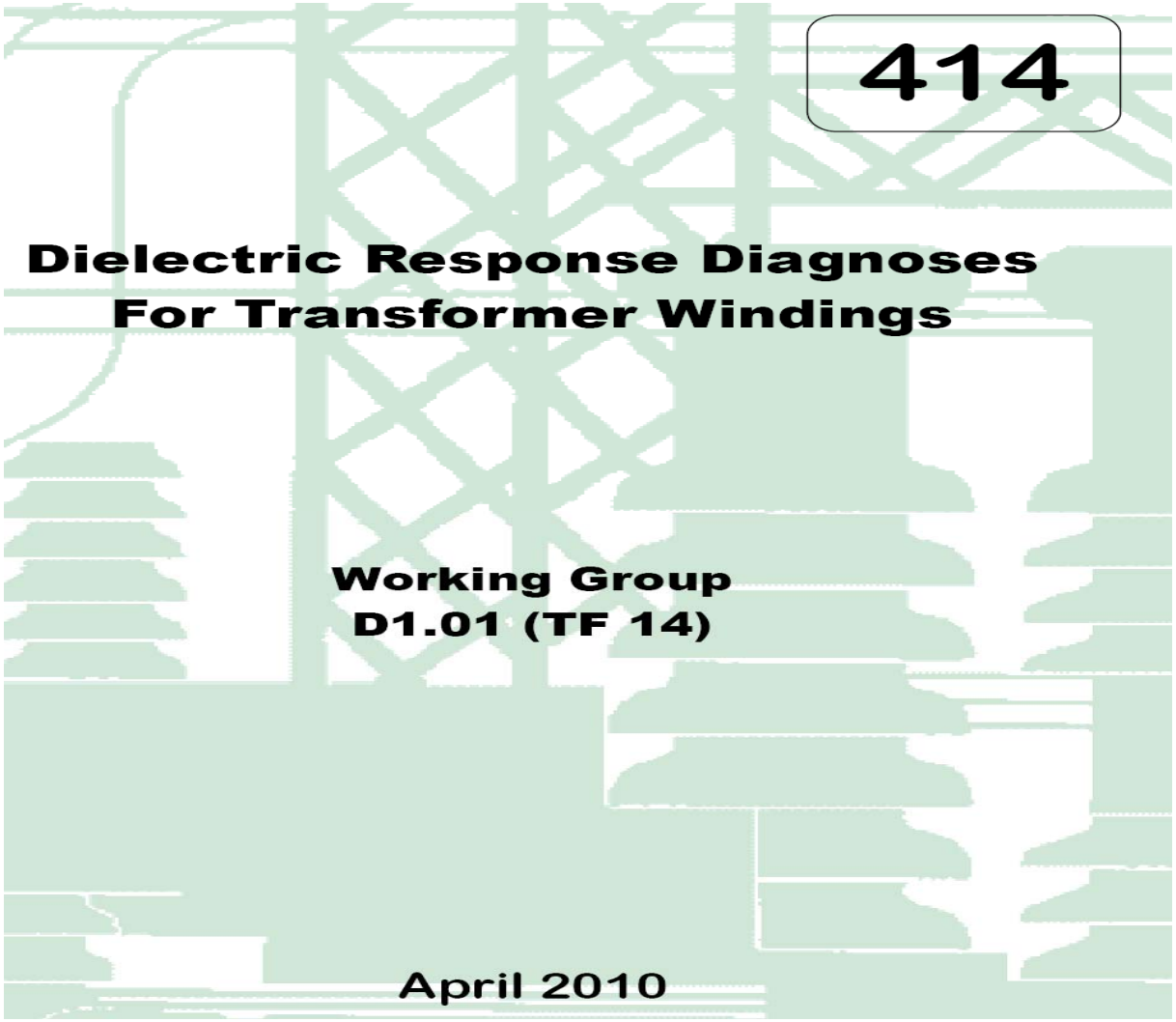
254

Dielectric Response Methods for Diagnostics of Power Transformers

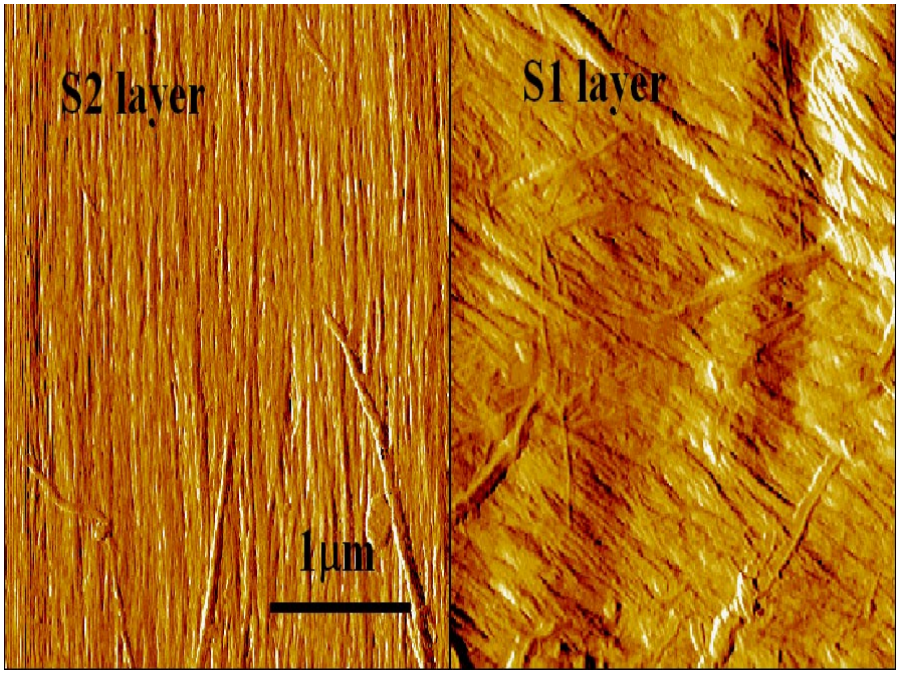
Report of the TF D1.01.09

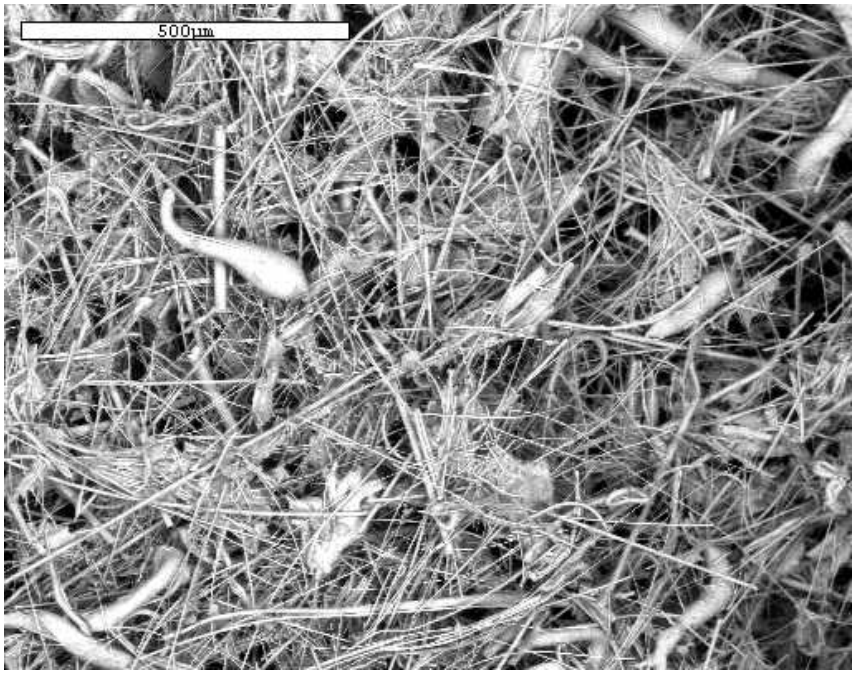
Task Force members:

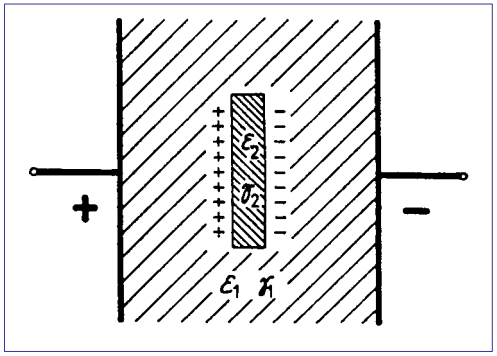
S.M. Gubanski (chair), P. Boss, G. Csépes, V. Der Houhanessian, J. Filippini, P. Guuinic, U. Gäfvert, V. Karius, J. Lapworth, G. Urbani, P. Werelius, W. Zaengl.


414
Dielectric Response Diagnoses
For Transformer Windings
Working Group
D1.01 (TF 14)
April 2010

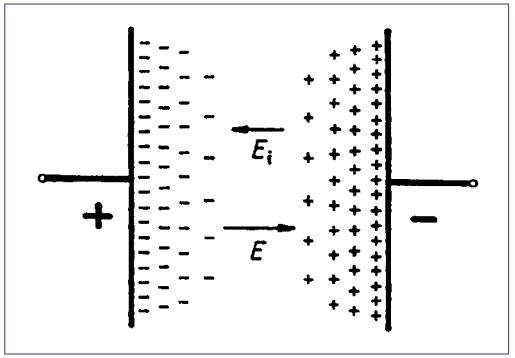
Polarizációs spektrum módszerek



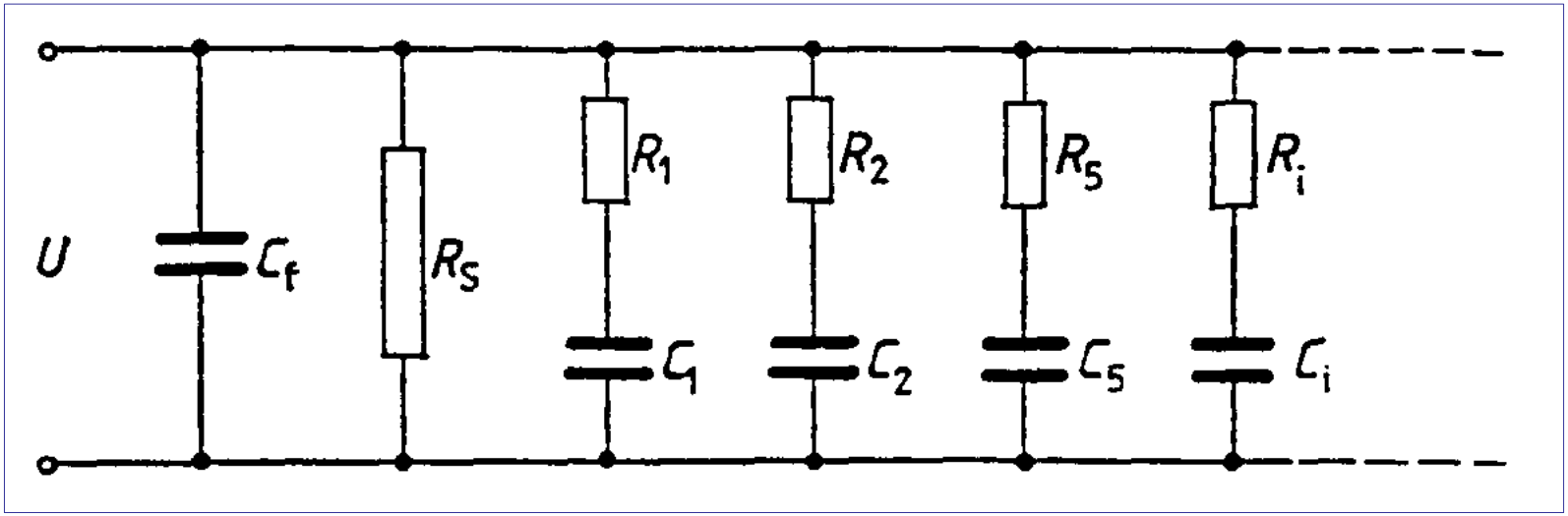




Interfacial polarisation

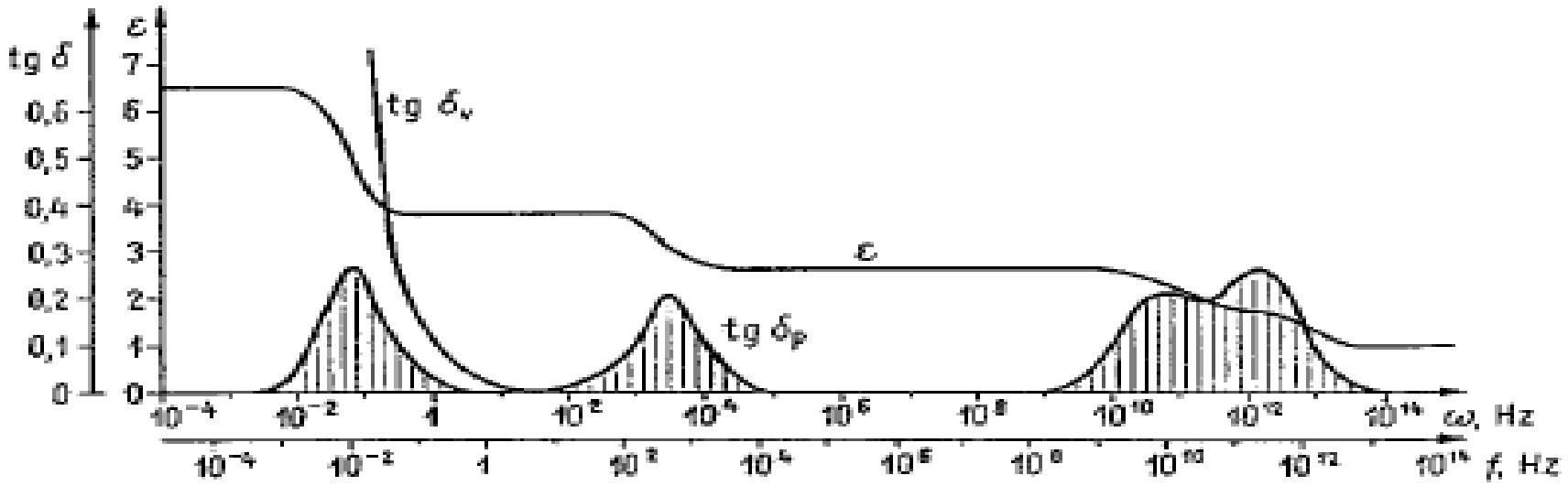


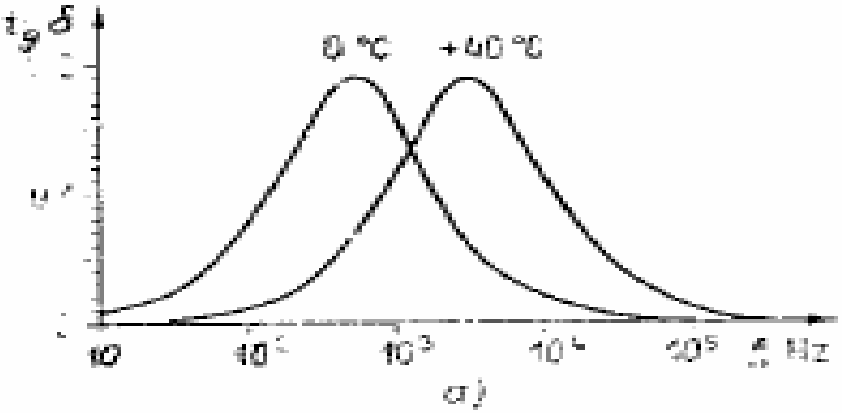
Space-charge polarisation

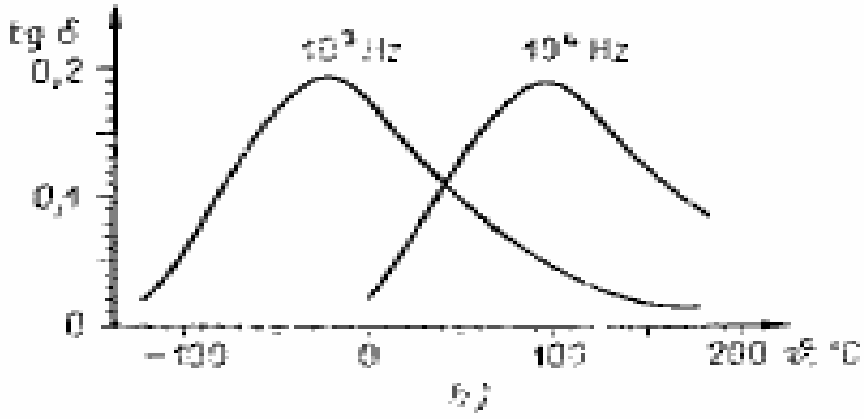


Insulation model with different time constants

Polarizációs spektrum módszerek

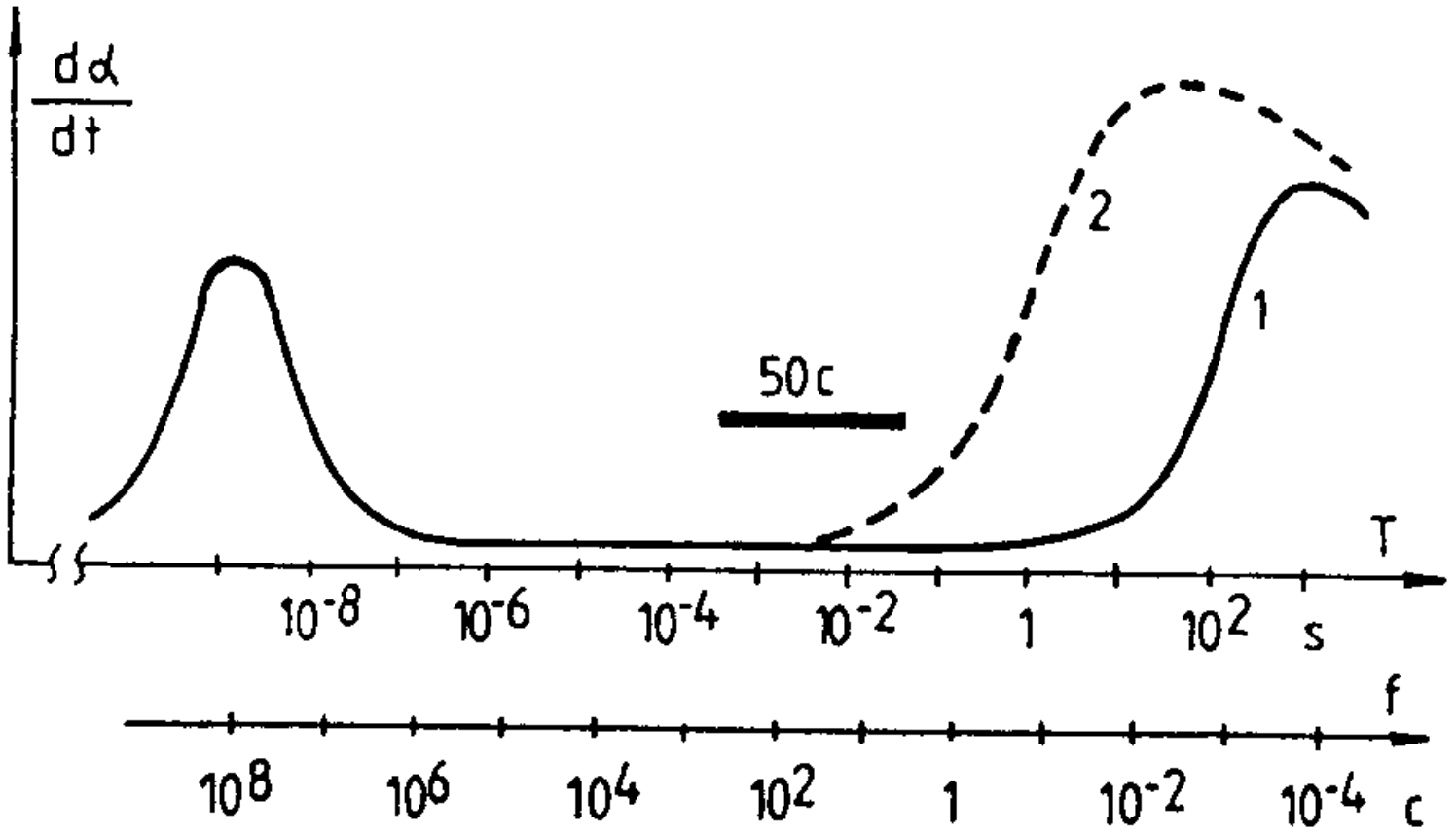






A veszteségi tényező függése a frekvenciától és a hőmérséklettől

Polarizációs spektrum módszerek



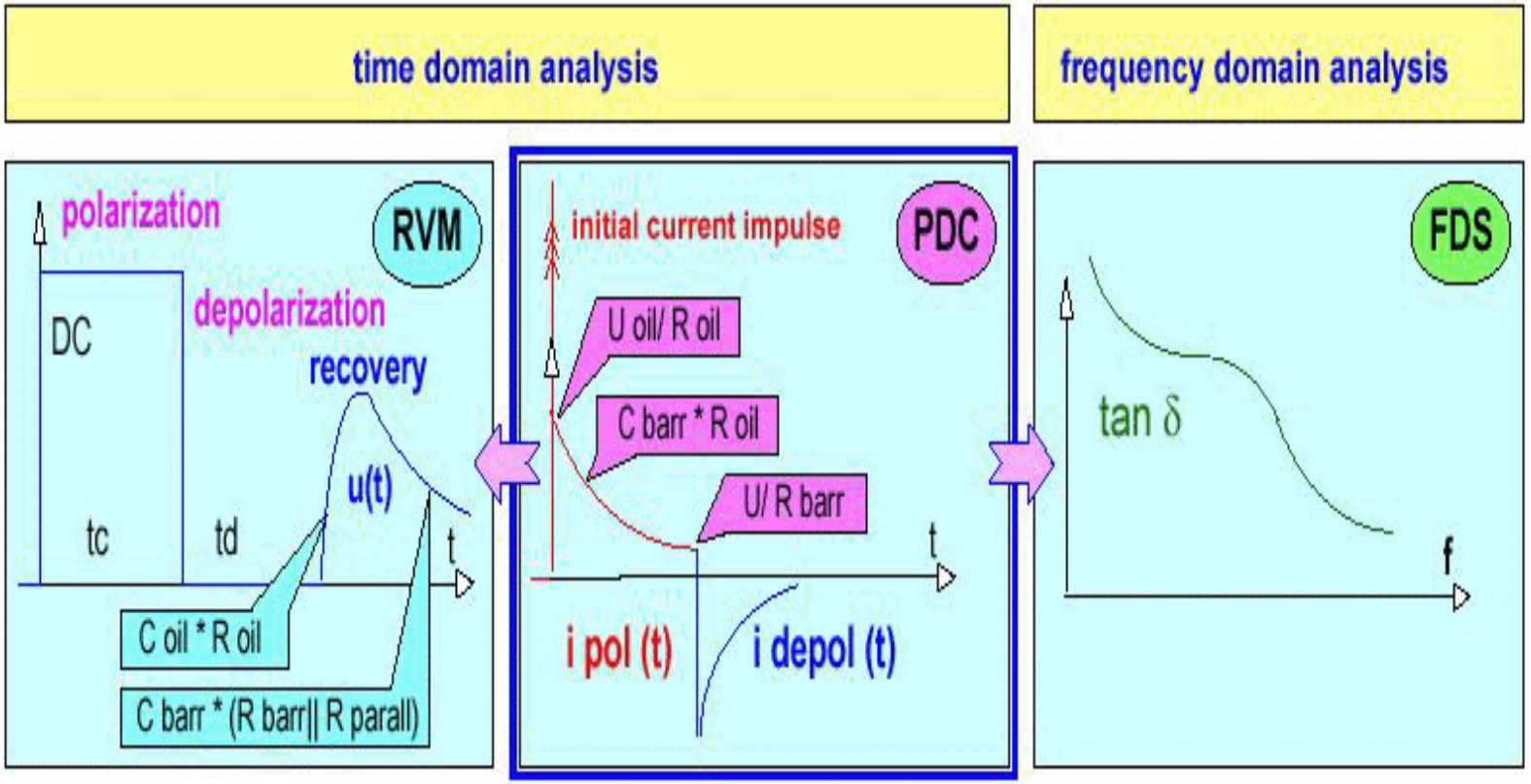
Olaj-papír szigetelés alacsony frekvenciás, vagy nagy időállandós polarizációs spektruma új (1) és öregedett szigetelés esetén.

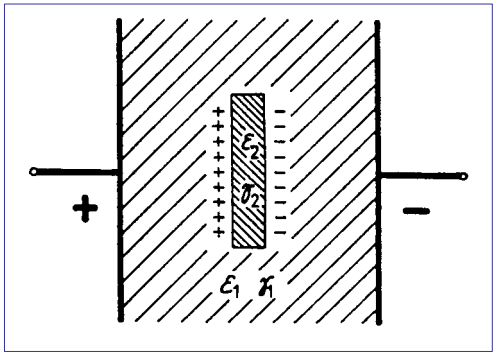
- Return Voltage Measurements (Recovery Voltage Measurements) – RVM (in time domain)

- Dielectric frequency domain spectroscopy (FDS), (Capacitance and dissipation factor variation with Frequency)

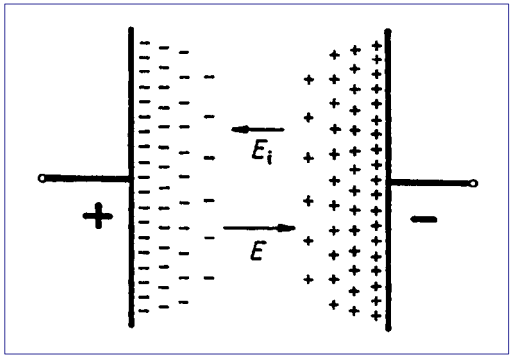
- Polarisation and depolarisation current variation in time domain - (PDC)

Polarizációs spektrum módszerek

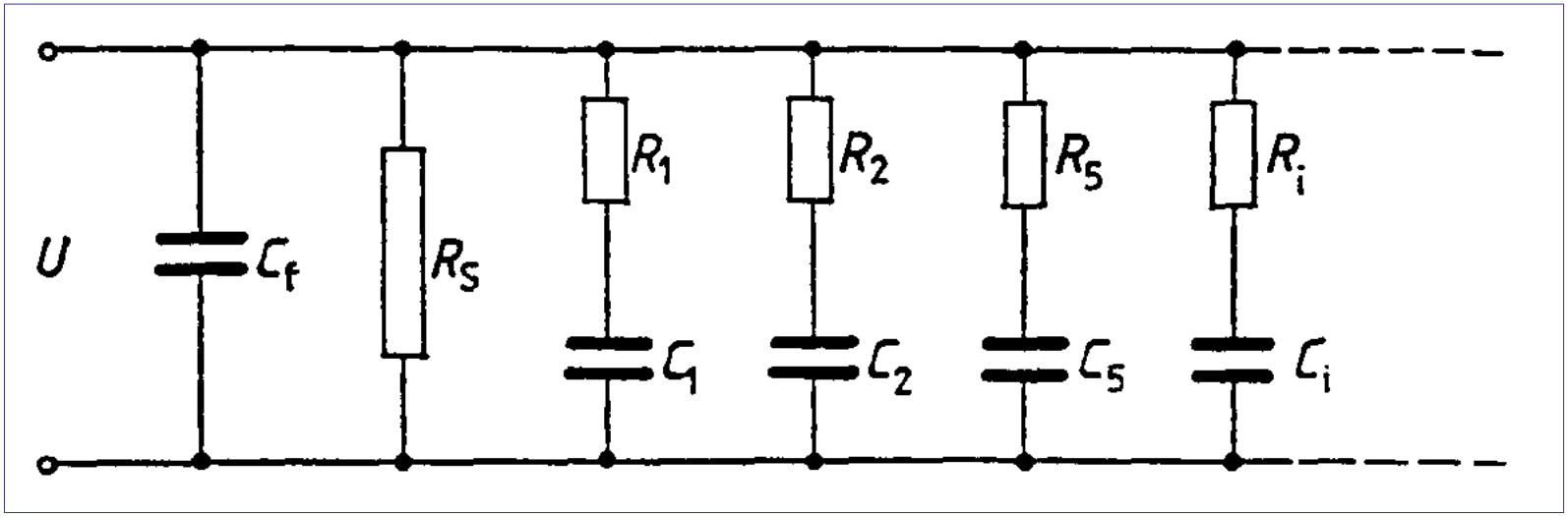




Interfacial polarisation



Space-charge polarisation



Insulation model with different time constants

Polarizációs spektrum módszerek

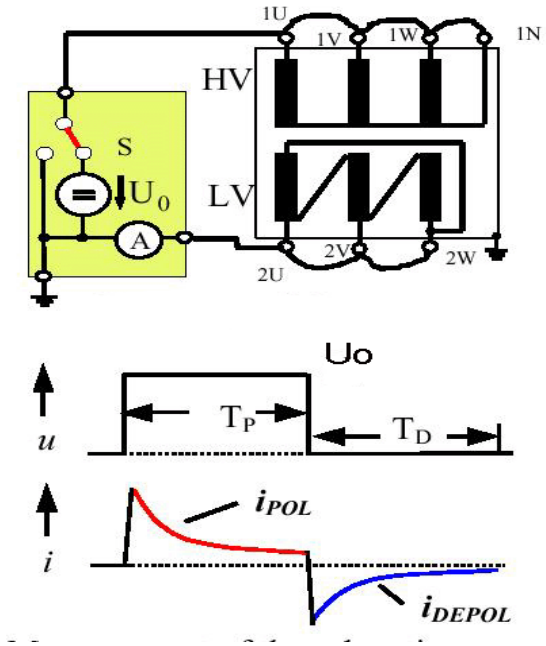
RVM 5461

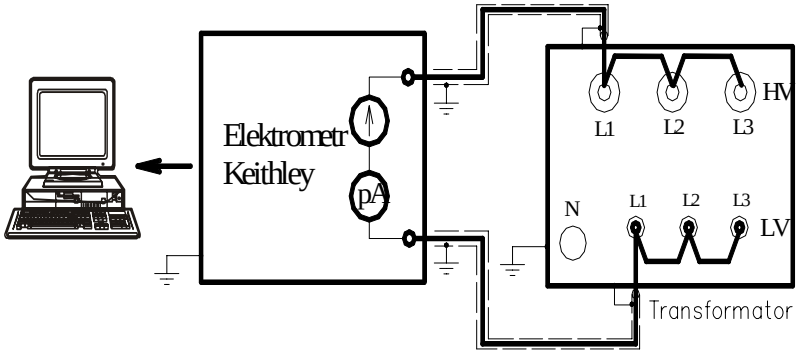
RVM 5462

Polarizációs spektrum módszerek

Dielectric frequency domain spectroscopy (FDS),Capacitance and dissipation factor measurement: IDA 200

PDC Polarisation Depolarisation Current)





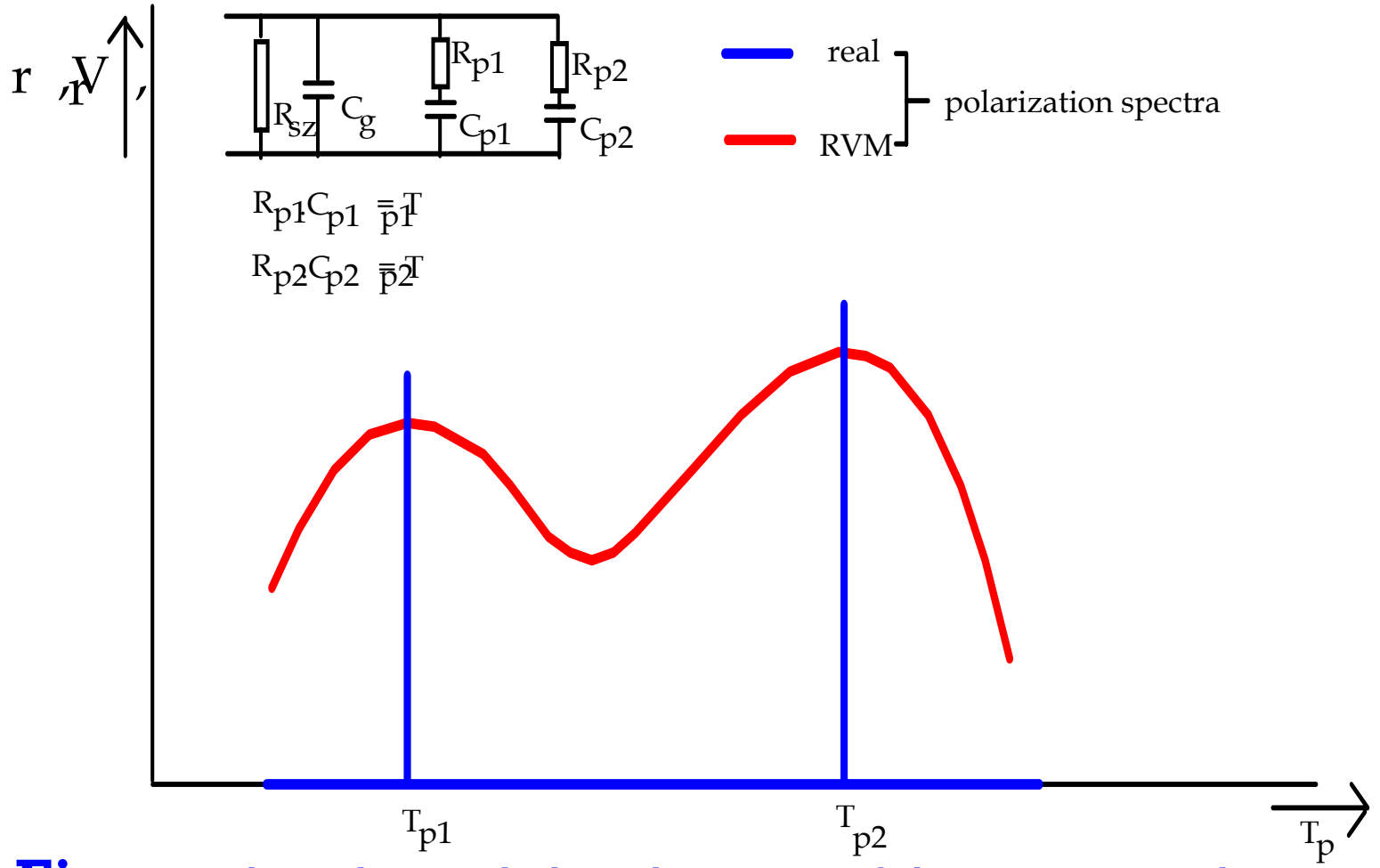
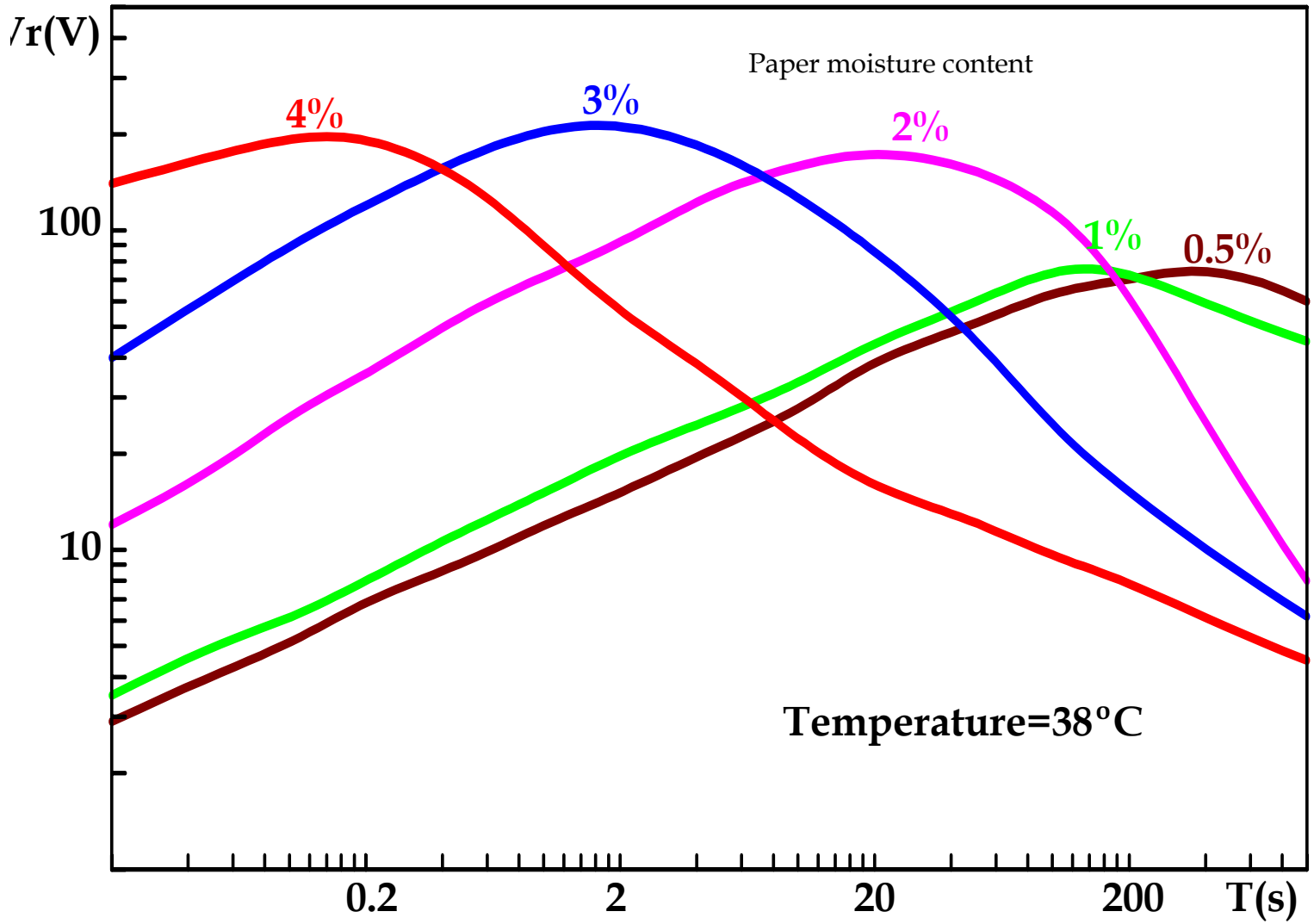


Fig. **"Real" and "quasi" (RVM) spectra of the same "two time constant" model.**

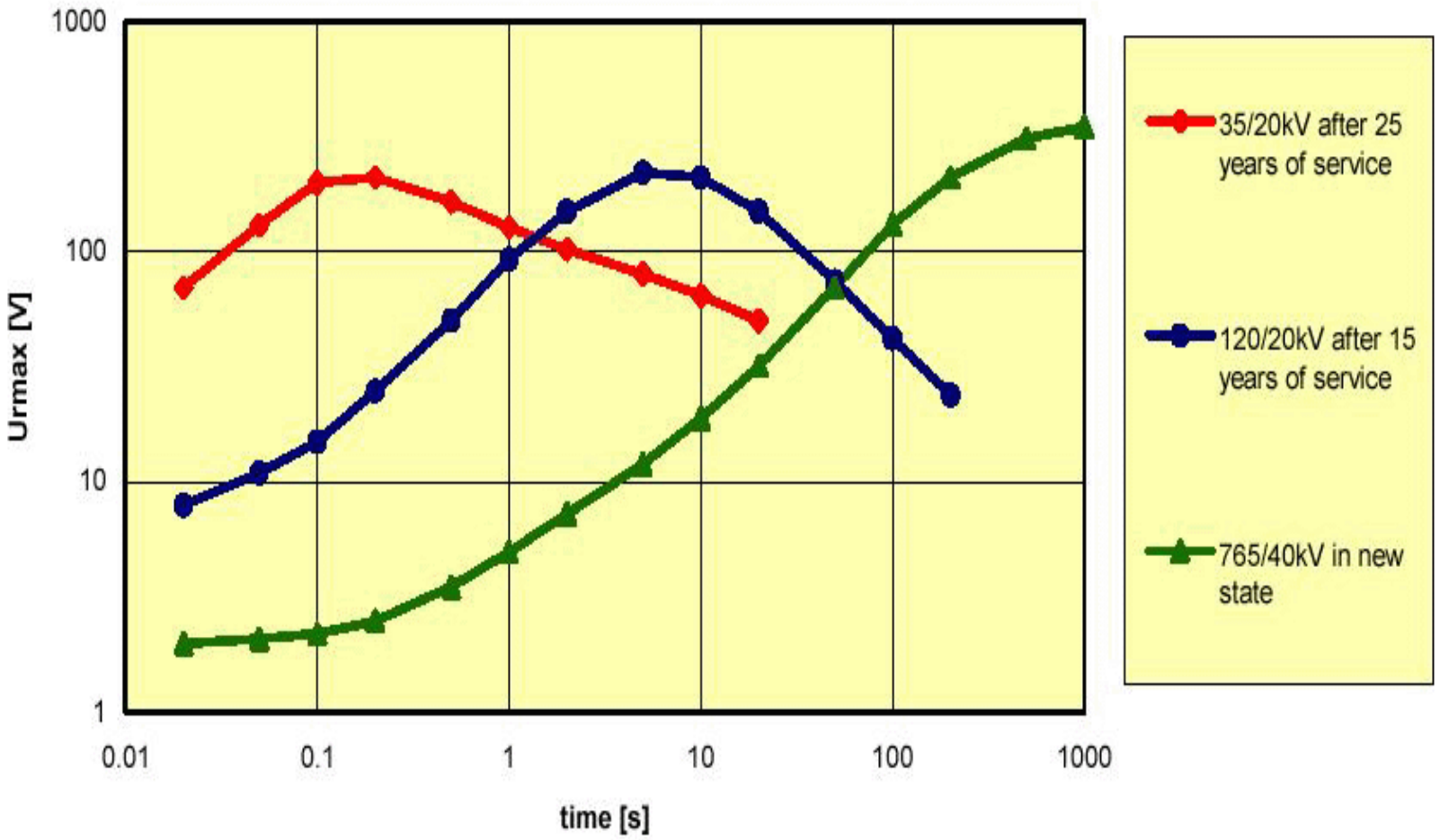
Polarizációs spektrum módszerek

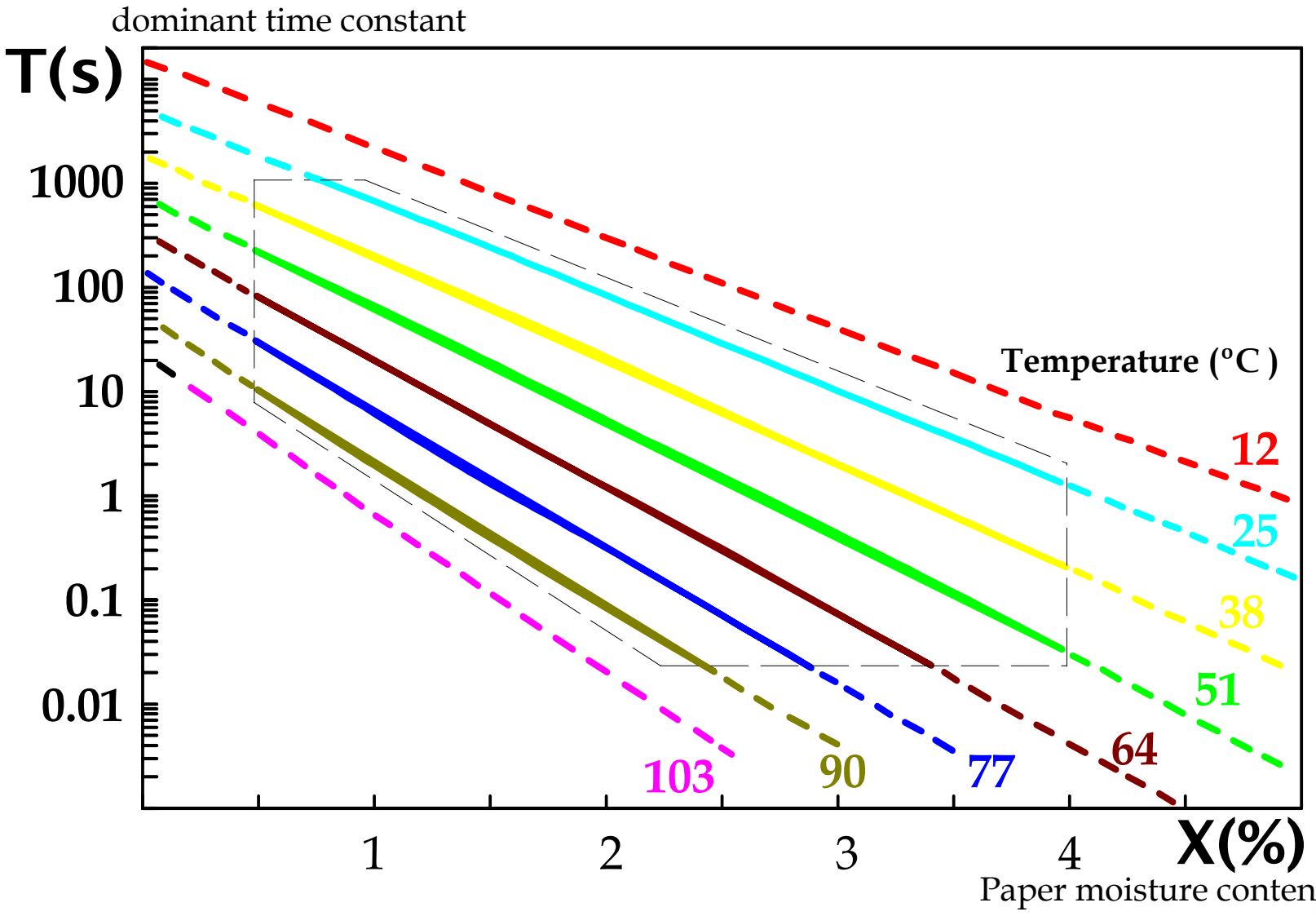
Curves, derived from the maxima of the return voltages



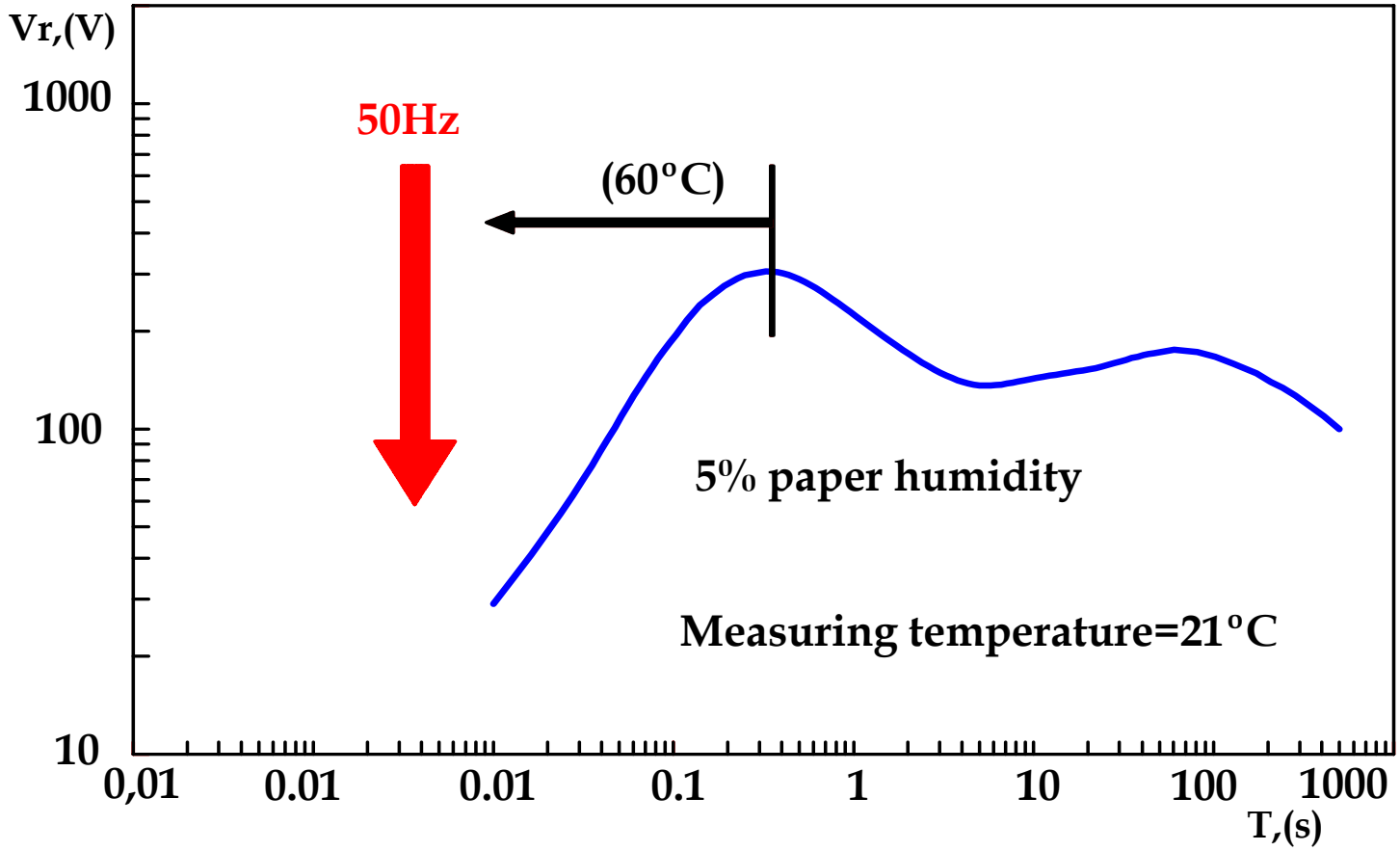
Time constants

Polarizációs spektrum módszerek




dominant time constant
T(s)
1000
100
10
1
0.1
0.01
Temperature (°C)
12
25
38
51
64
77
90
103
1
2
3
4
X(%)
Paper moisture content

Polarizációs spektrum módszerek



Polarizációs spektrum módszerek

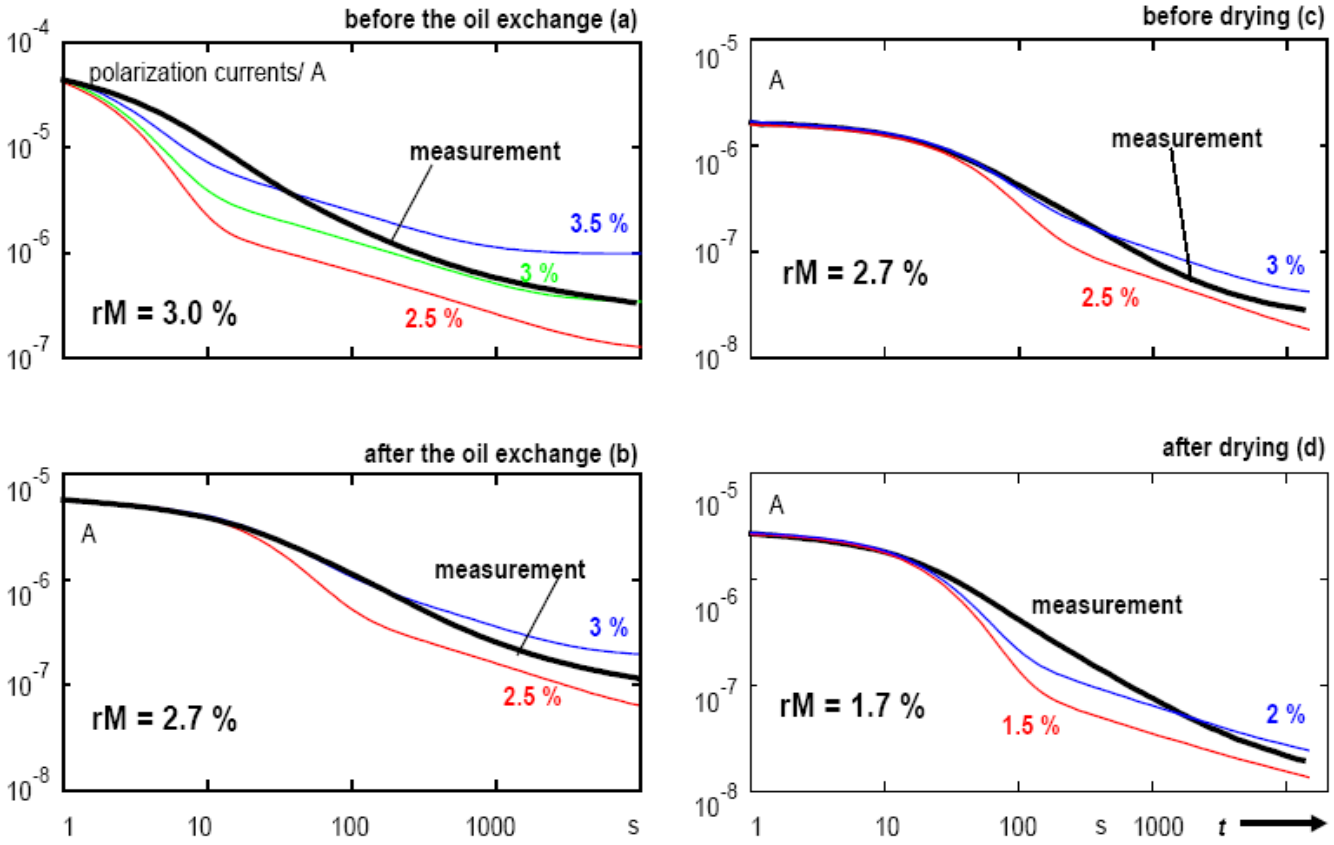
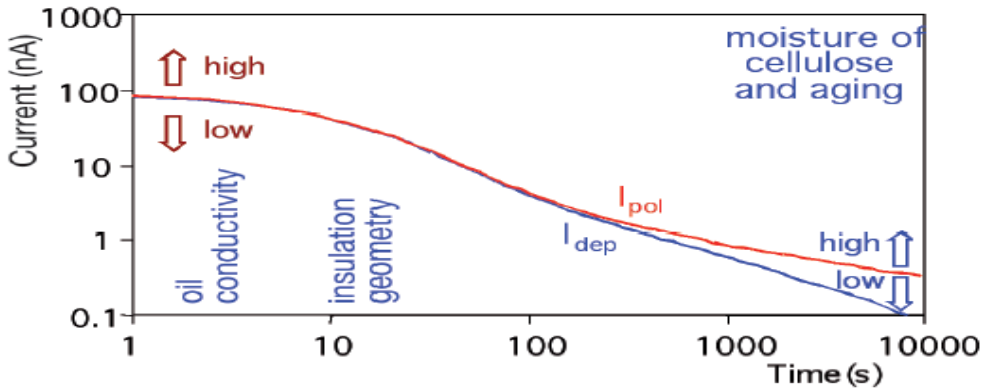
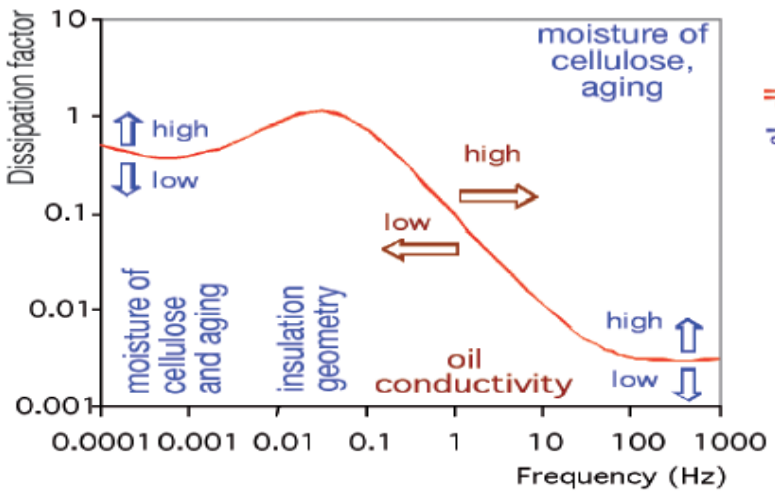


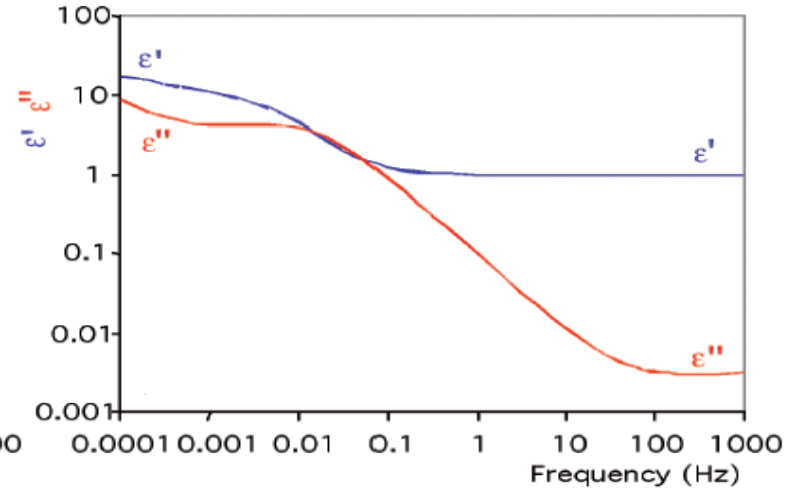
Figure 22: Polarization current measured on 300 MVA power transformer before and after oil exchange (a and b) as well as before and after drying (c and d). Moisture content rM, as marked in the graphs, is determined by curve fitting.

Polarizációs spektrum módszerek



(a)





(b)

Polarizációs spektrum módszerek

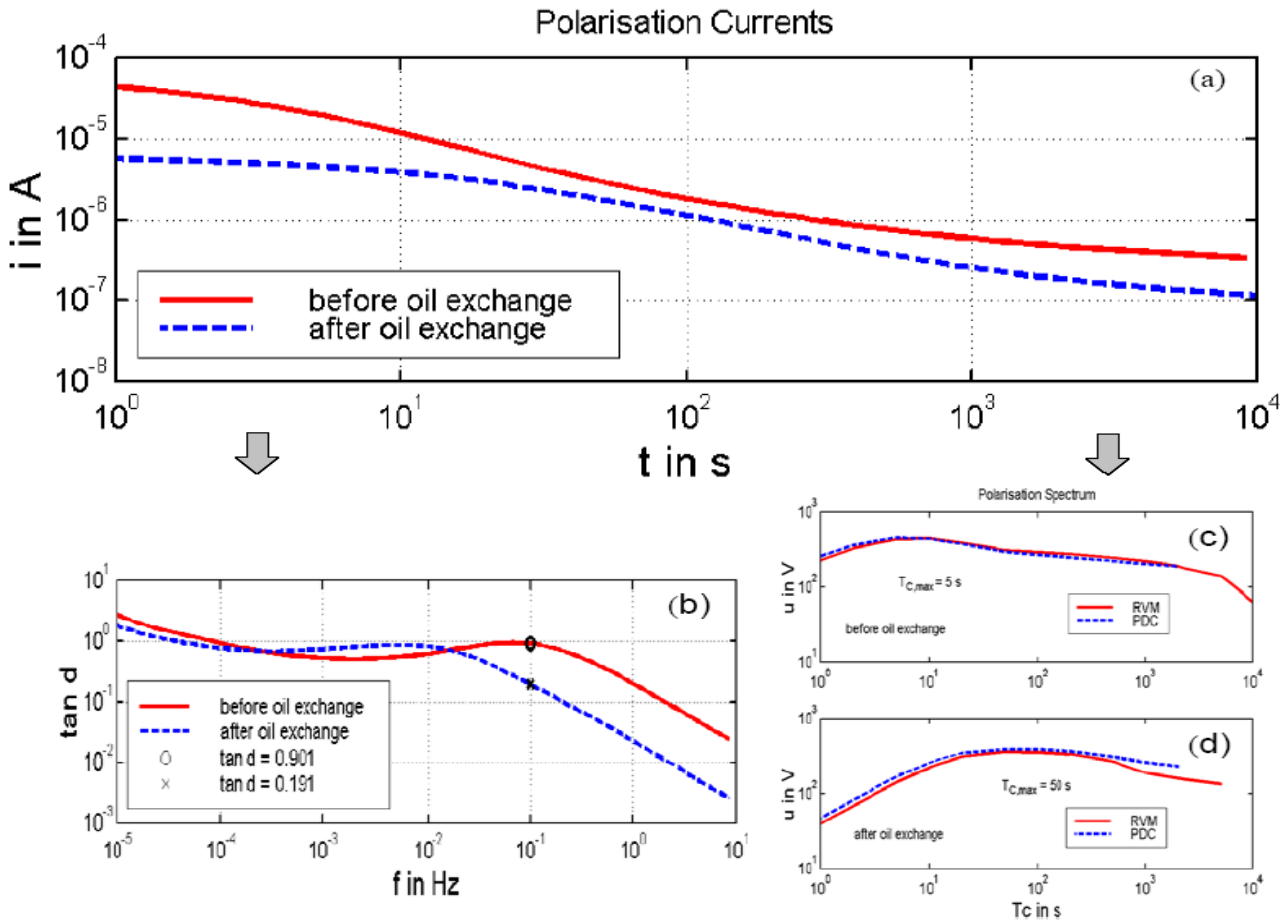
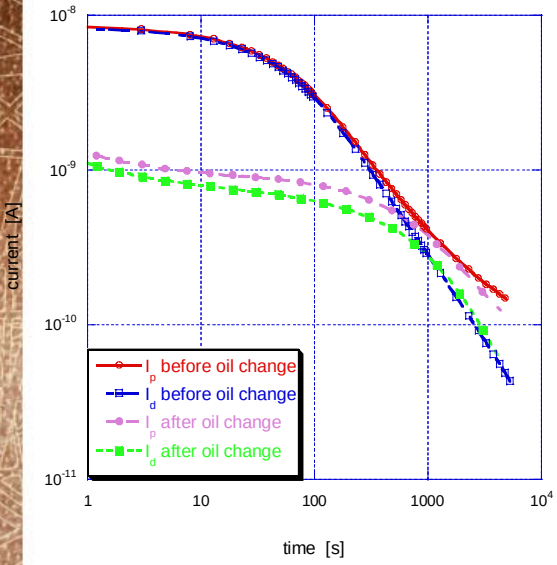
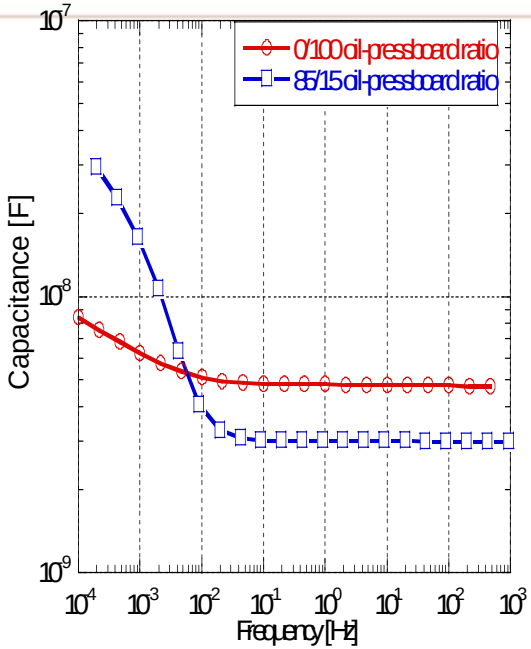
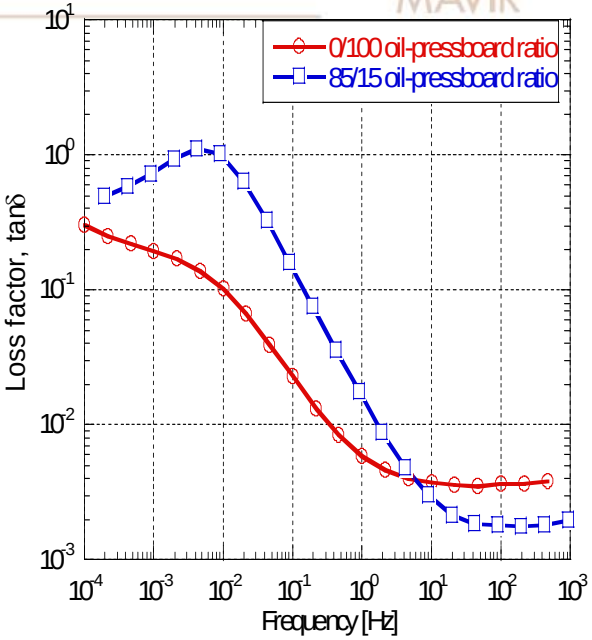


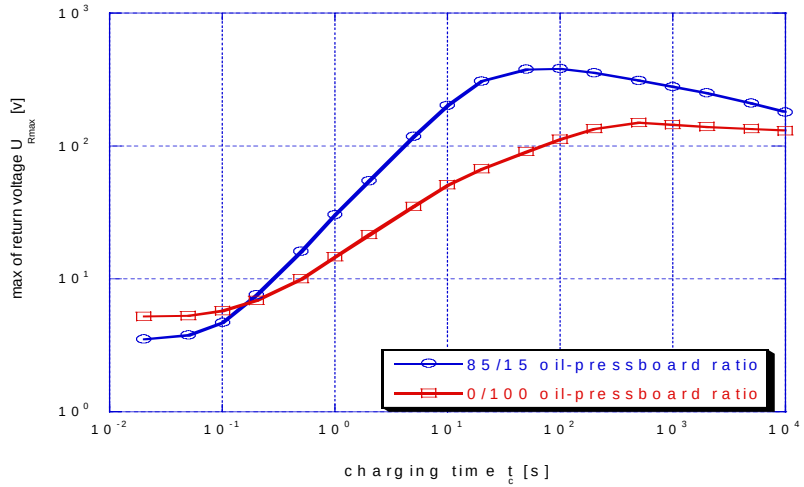
Figure 21: Polarisation currents measured between HV and LV windings in 300 MVA transformer before and after oil exchange (a) with calculated tanδ spectrum in frequency domain (b); RVM polarisation spectra before (c) and after (d) oil exchange compared with spectra calculated from PDC results [27].

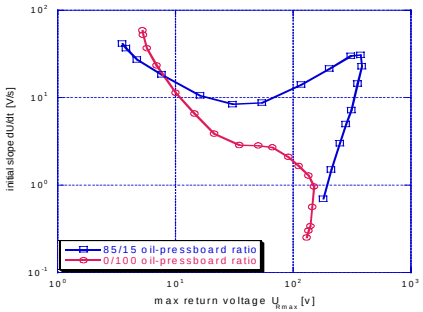
Polarizációs spektrum módszerek



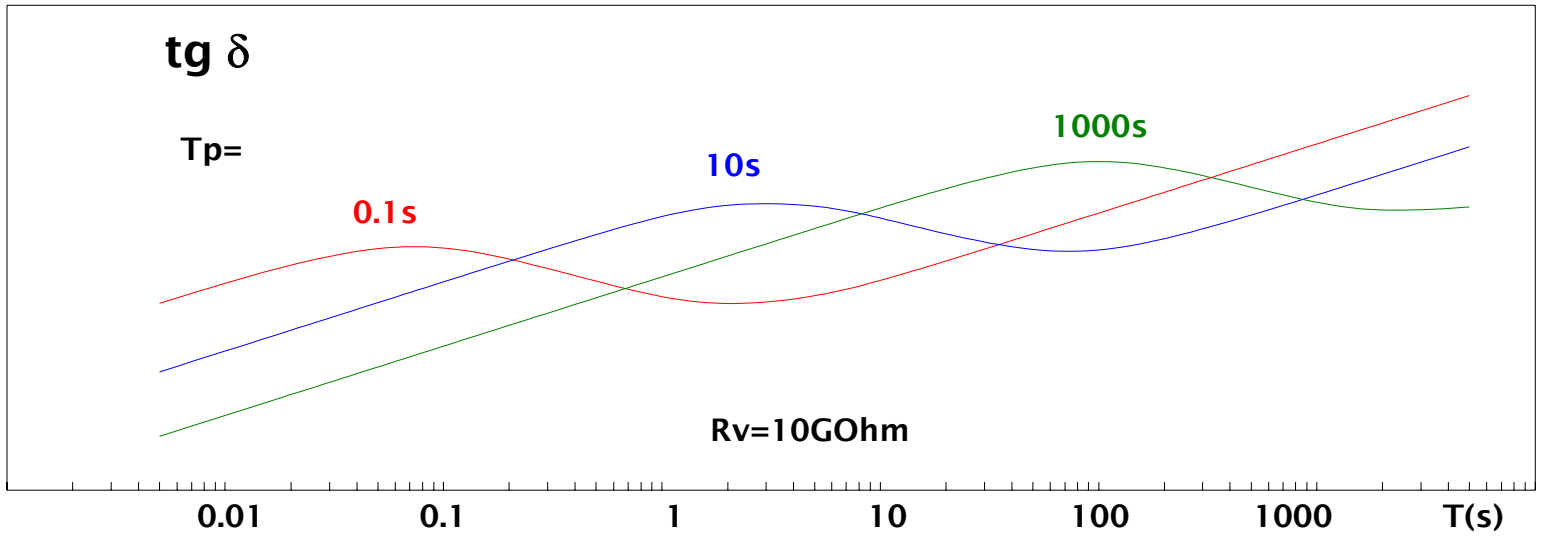


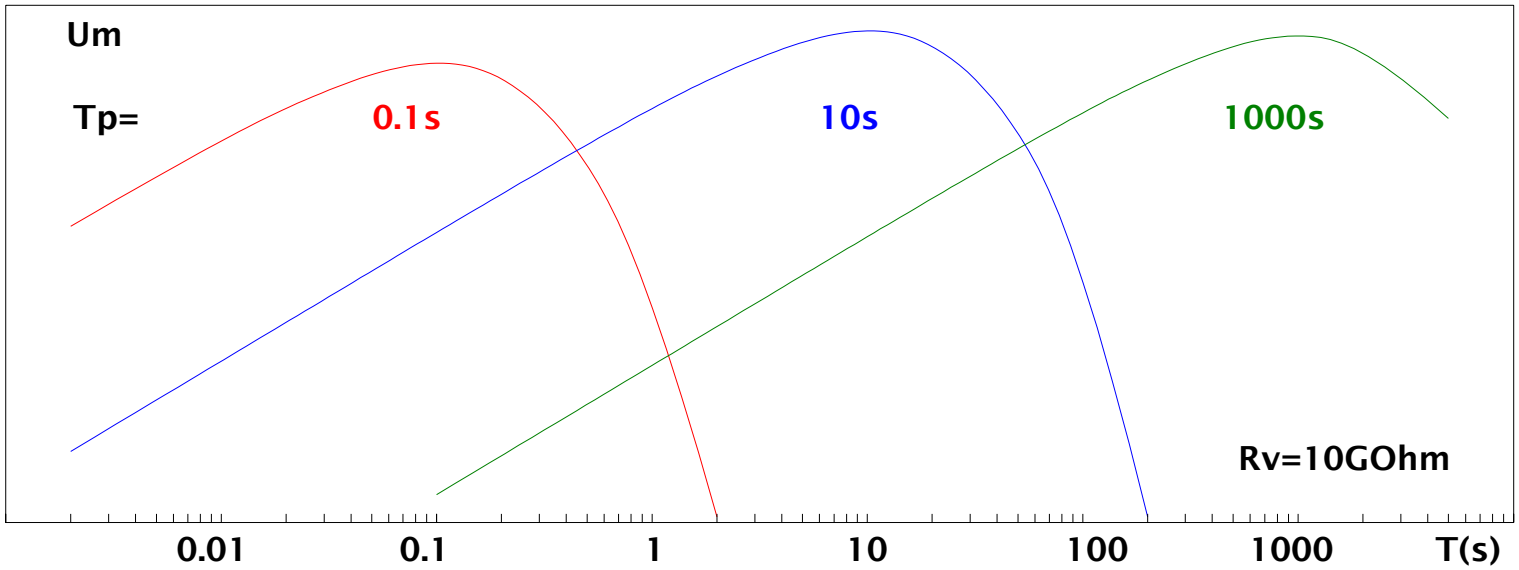






FDS és RVM módszer összehasonlítása





Prof. Csernátony-Hoffer András BME

„Regular Member of CIGRE SC 15”

1979-ig ezen a területen dolgozott

Szponzorok: NIM, OMFB, MVMT.

tgδ: Dielectric dissipation factor measured at constant voltage, tgδ(f;T;X) means "loss factor" , was measured in function of frequency (f), temperature (T) and moisture content in the paper (X).

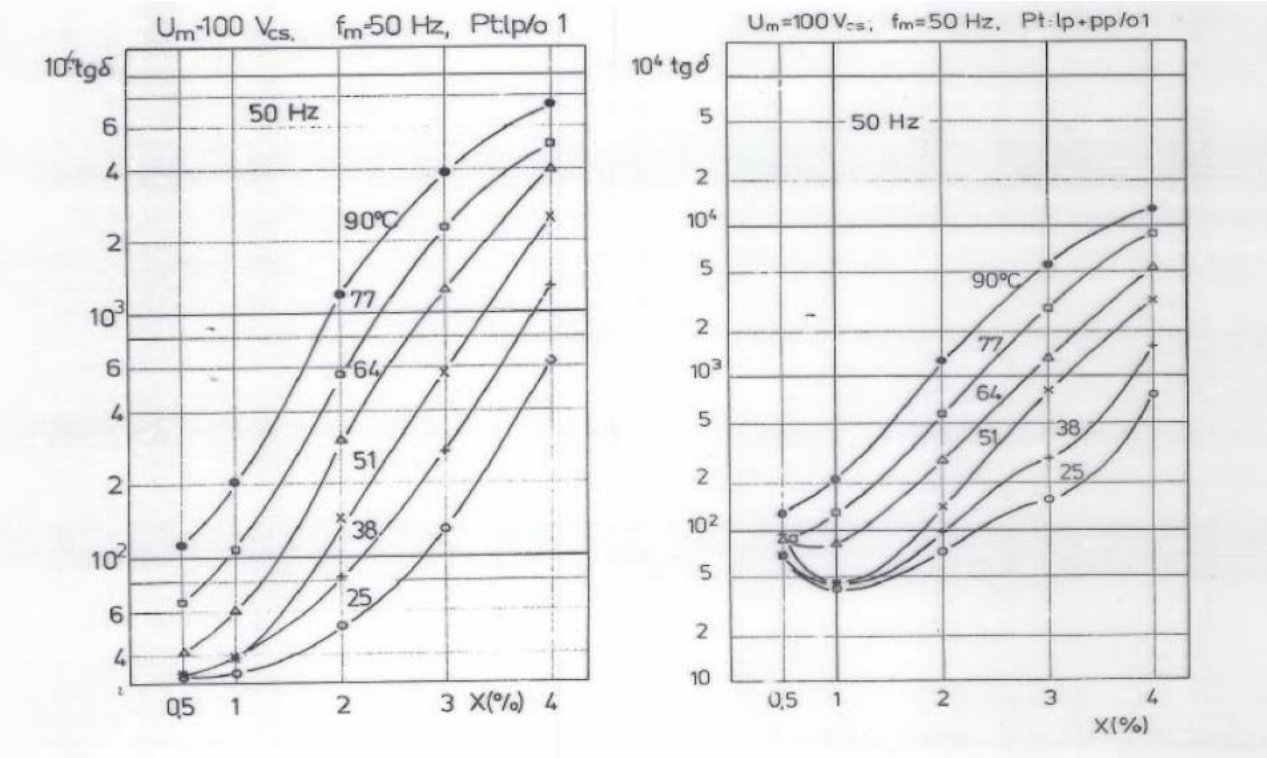
C: Capacitance at constant voltage, C(f;T;X), means the capacitance, was measured in function of frequency (f), temperature (T) and moisture content in the paper (X).
The Initial slope of recovery voltage: $S_R(t_C/t_D;T;X)$
and
The peak of the recovery voltage: $U_R max(t_C/t_D;T;X;T;X)$

The temperature with 6 equally spaced values between 25°C and 90°C (25, 38, 51, 64, 77 and 90°C),
the moisture content of the cellulose with 5 values between 0.5% and 4% (0,5, 1, 2, 3 and 4 %), served as parameters in all of these measurements.
Where frequency was a variable parameter (tg/C or FDS), 8 meas. were taken between 0.05Hz and 50 Hz.
Where voltage was a variable parameter, 8 meas. between 6V and 1400V at 50 Hz were taken for AC tests and
8 measurements at values from 5V to 1000V were taken for DC tests.

RVM were taken at charge and discharge times between 0.02s/0.01s and 1000s/500s (following the series 2; 5; 10).

To investigate the influence of aging of the oil three different aged oils were used for impregnation:
new (Pt:lp/01: tgδ =0,01% or 104tgδ =100 at 90°C),
moderately aged (Pt:lp/02: tgδ=0,1% or 104tgδ =1000 at 90°C), and
heavily aged (Pt:lp/03: 0.5%≤tan(δ)≤0.7% or 104tgδ =5000-7000 at 90°C).
In the figures, the marking of samples with oil ducts was **Pt:lp+pp,** and without oil gap (only layered soft paper, without oil duct), the marking of samples was **Pt:lp.**

The tgδ50Hz curves strongly depend on the temperature and moisture content decreasing sensitivity with decreasing moisture content.



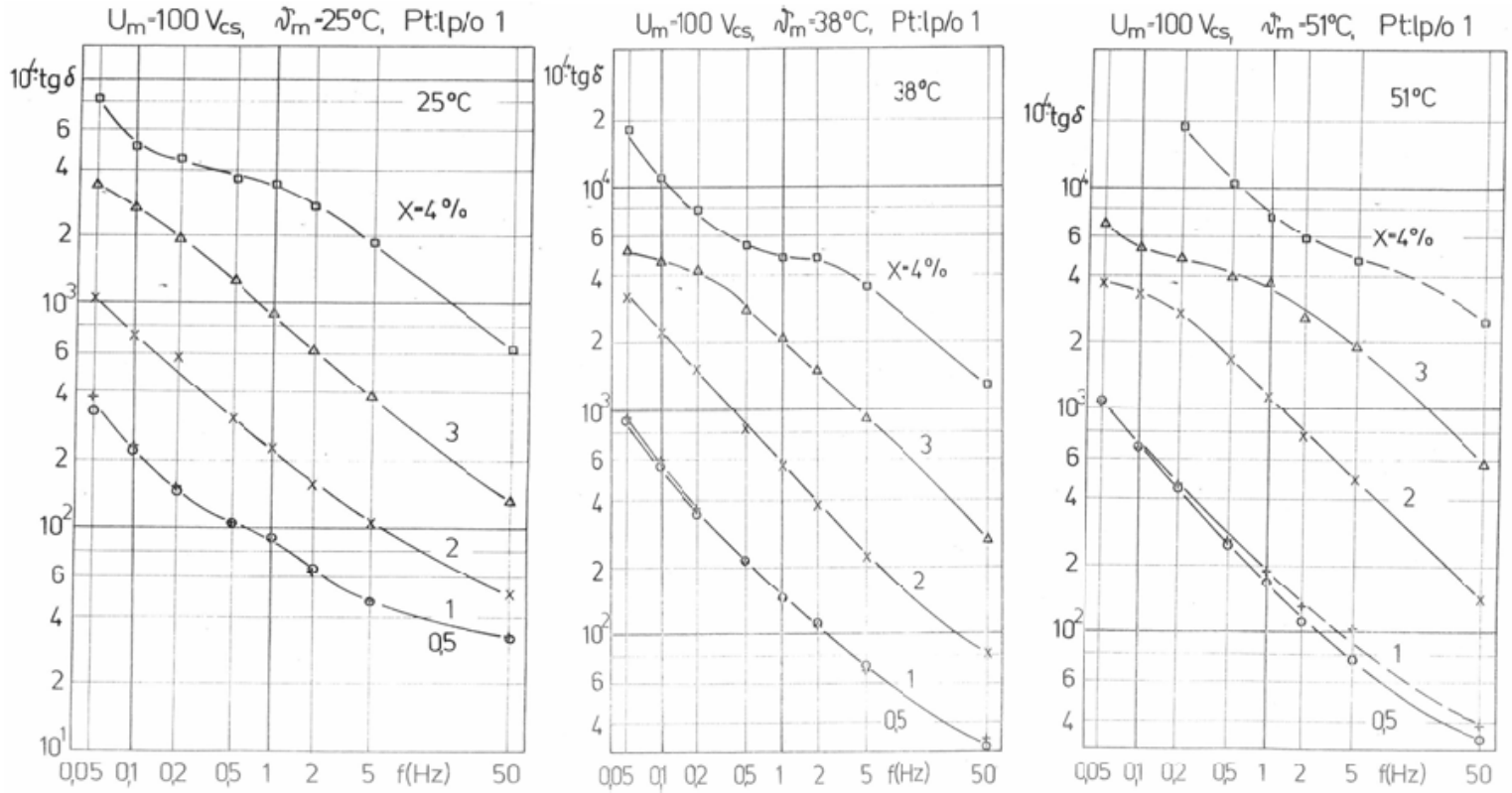
104tg δ50Hz(U;T;X): dielectric dissipation factor at 50 Hz,

Pt:lp/01: new paper, new oil tgδ~0,01% at 90°C without oil duct,

Pt:lp+pp/01 with oil duct.

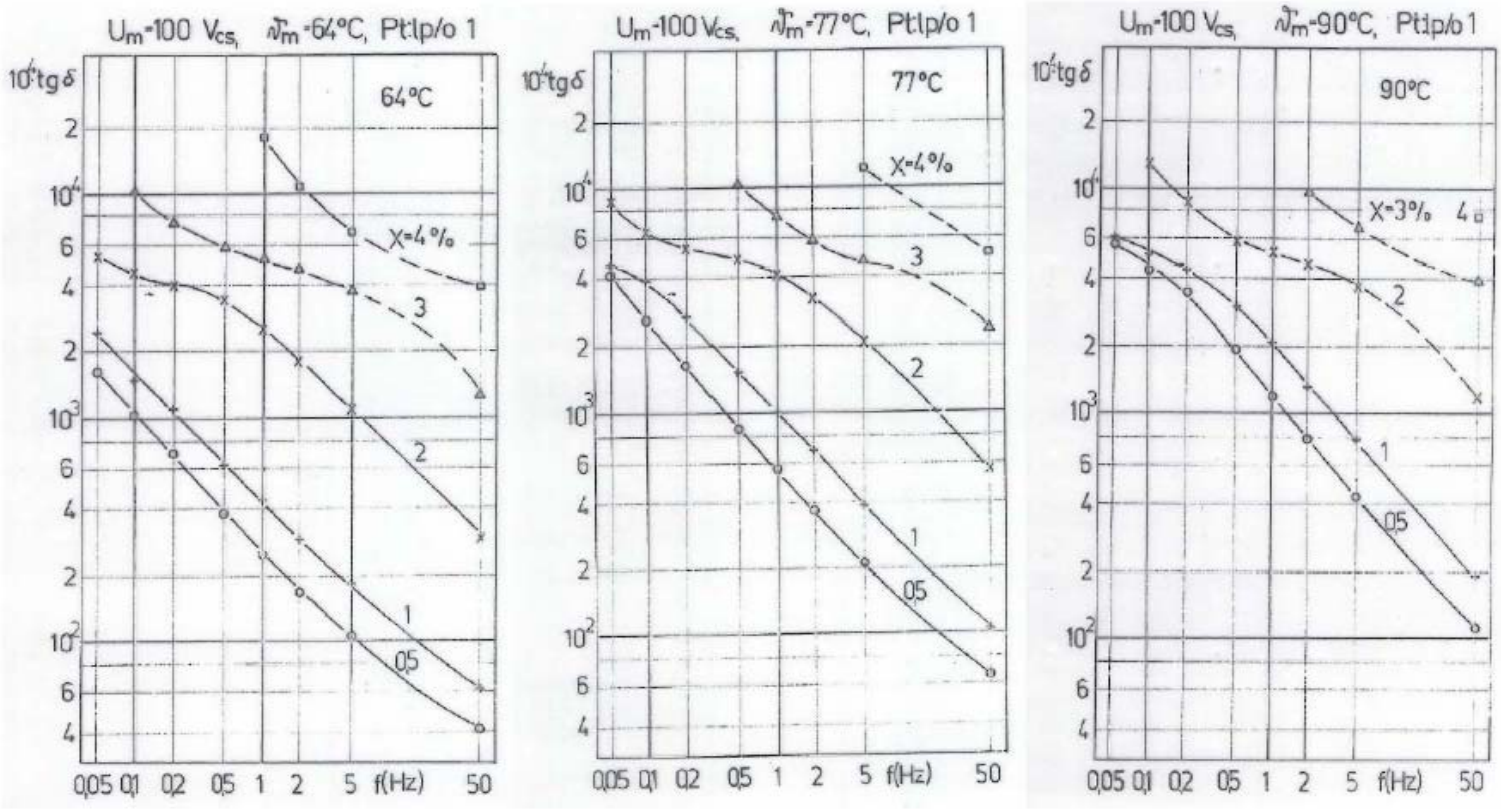
Moisture content in the paper from X=0,5% to 4%, temperature between 25°C -90°C.

tgδ(f) curves show something like a local maximum inflection point, which moves toward higher frequencies with increasing moisture content and temperature.



tg δ(f;T;X): Dielectric dissipation factor measured at constant voltage: It means "loss factor" as a function of frequency (f), moisture content (X) dependence at temperature (T) of 25°C, 38°C and 51°C.

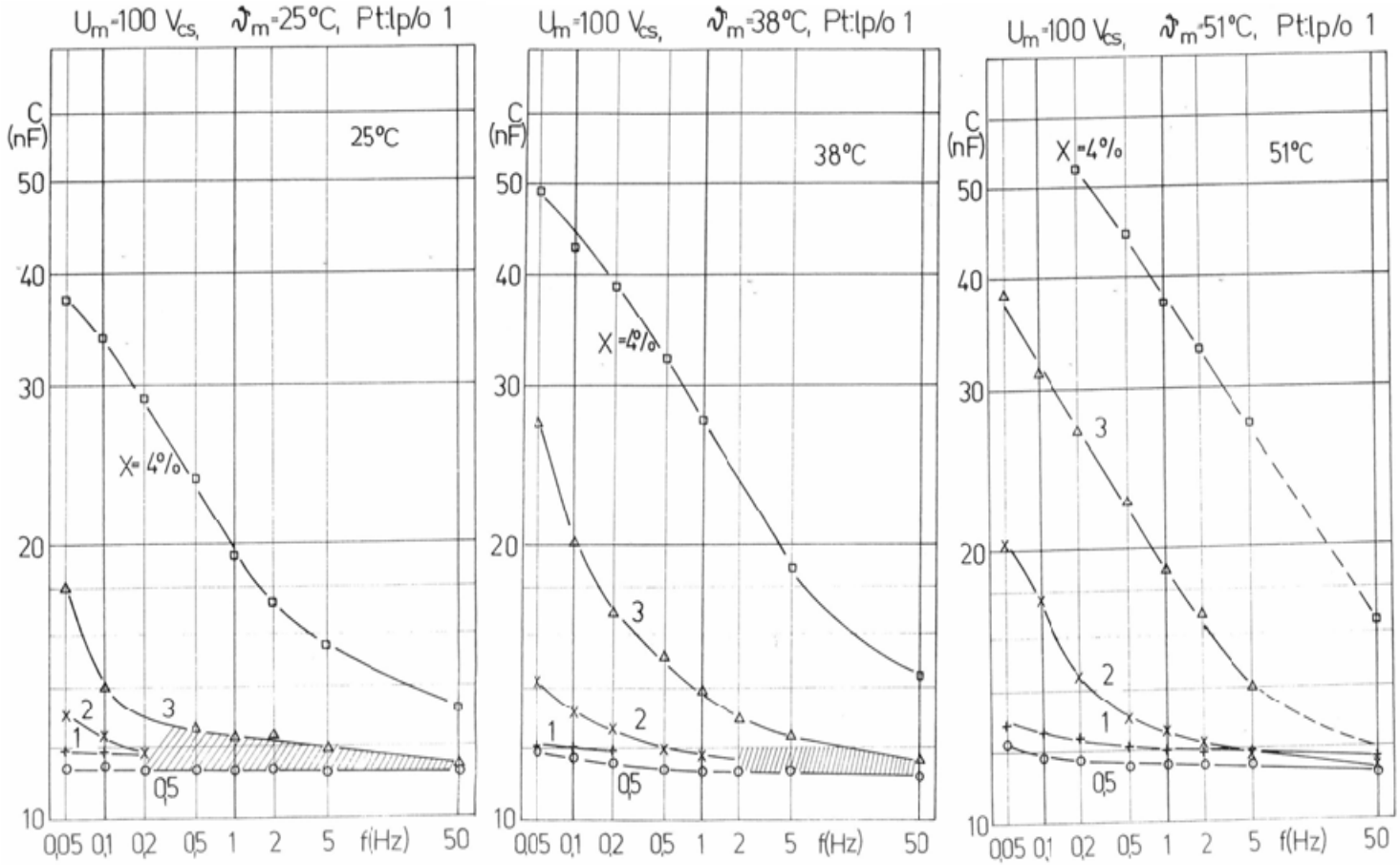
tgδ(f) curves show something like a local maximum iinflection point, which moves toward higher frequencies with increasing moisture content and temperature.



tg δ(f;T;X): Dielectric dissipation factor measured at constant voltage,

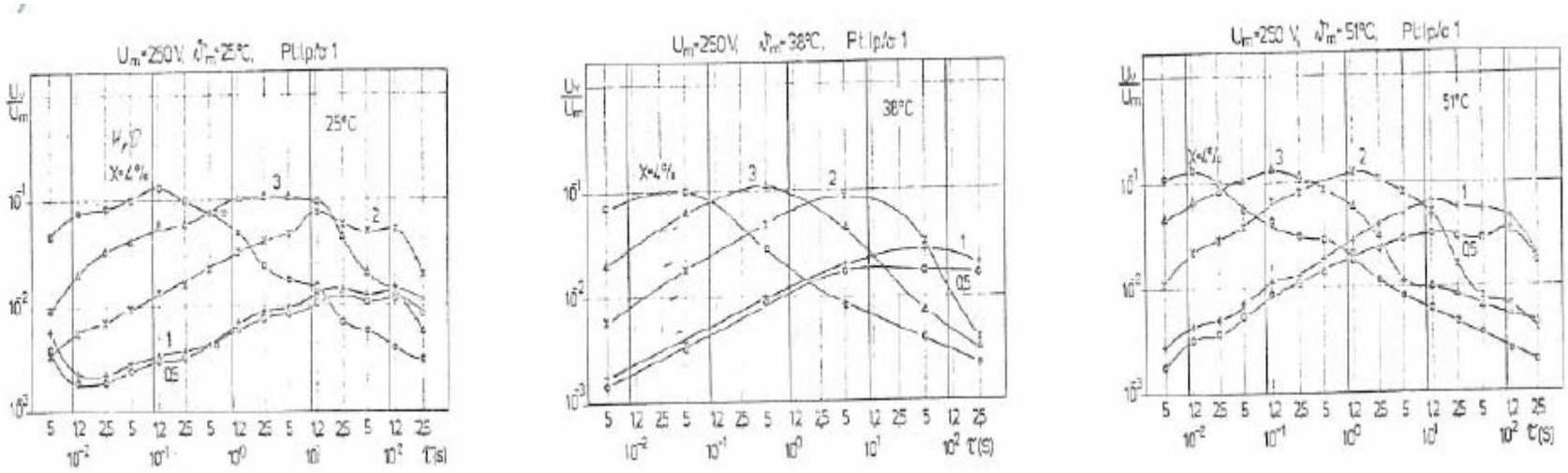
Loss factor as function of frequency (f), moisture content (X) dependence at temperature (T) of 64°C, 77°C and 90°C.

C(f;T;X), capacitance at constant voltage as a function of frequency



C(f;T;X), capacitance at constant voltage as a function of frequency (f): moisture content (X) dependence, at temperature (T) of 25°C, 38°C and 51°C

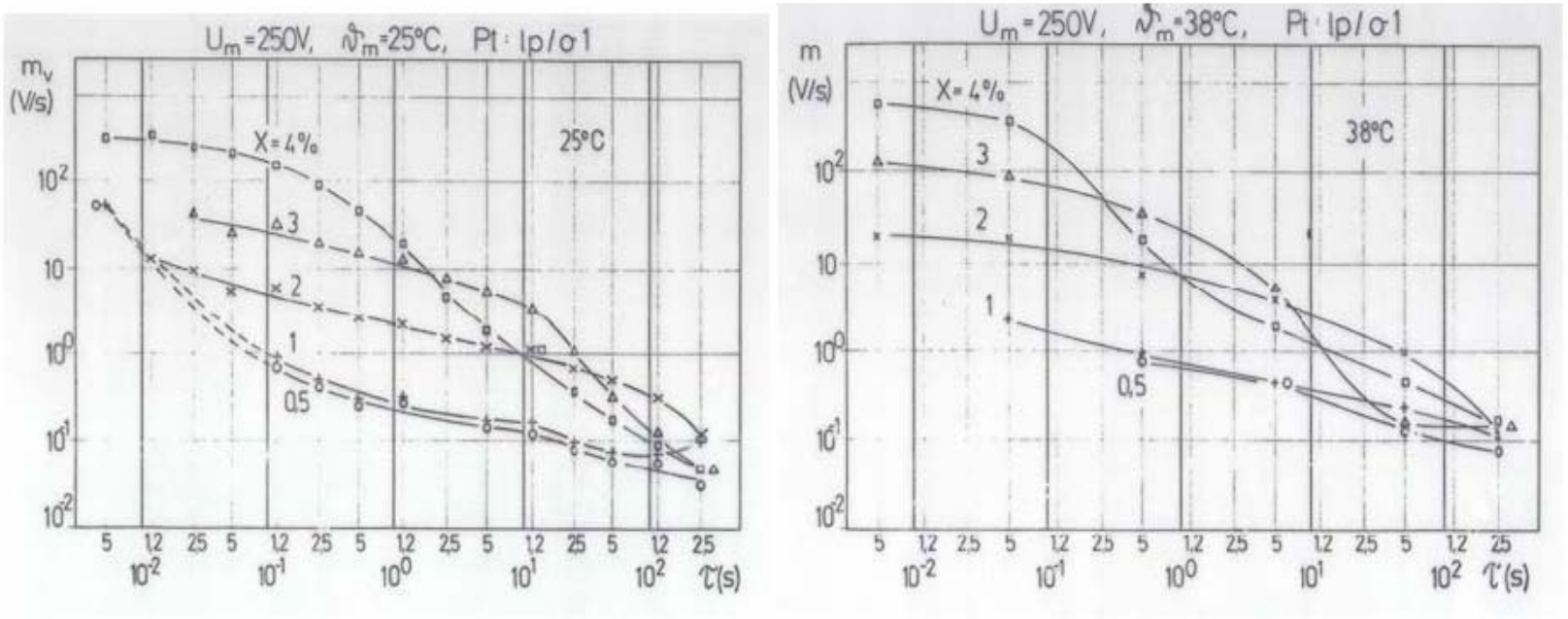
Maximum of the recovery voltage: $U_R max\ (t_C/t_D;T;X)$ as a function of charge/discharge times (t_C/t_D), temperature (T) and moisture content (X).



$U_R max(t_C/t_D;T;X)$, maximum of the recovery voltage, the function of charge//discharge times (t_C/t_D). The curves show the moisture content (X) dependence, the temperature (T) from 25°C to 51°C.

$U_R max\ (t_C/t_D;T;X)$ figures show examples of the recovery voltage maxima expressed as relative values normalized to charge voltage as a function of charge time with moisture content as a parameter. The discharge time is always half of the discharge time. The location of the maximum depend on the temperature, the moisture content and the level of other aging products (model Pt:lp/01 means new paper/now oil).

Polarizációs spektrum módszerek



$S_R(t_C/t_D;T;X)$ the initial slopes of recovery voltage as a function of charge charge/discharge times (t_C/t_D). The curves show the moisture content (X) dependence, at the temperature (T) 25°C and 38°C.

- Összefoglalás
- Polarizációs spektrummérések aktualitása
- Polarizációs spektrummérések fontossága
- Magyar adatok használhatósága
- Szabványosítás jövője

Köszönöm a figyelmet,

Kérdések ?