Analysis on Tangent Measurement Dielectric Loss Diminution Caused by Surface Leakage and Inadequate Shielding

Mineral and negative dielectric value appears occasionally during measurement of electromagnetic PT with end shielding method or measurement of CT or transformer bushing with tangent, this is mainly caused by damped insulation, surface leakage or inadequate shielding, see analysis below:

![Schematic diagram](image1)

![Equivalent circuit diagram](image2)

CX: test object
C1: stray capacitance caused by high voltage end contact with porcelain bushing
C2: stray capacitance caused by low voltage end contact with porcelain bushing
R: resistance caused by porcelain bushing surface leakage against the ground
1: test voltage
2: instrument input

This way, C1, C2 and R form a T shaped network, under the influence of C1 and R differential phase shift, current flows ahead through C2 causing dielectric diminution. Suppose 1 as external voltage U, 2 as ground potential. Current through 2 can be calculated based on the formula:

\[ I = U \left[ -\frac{\omega^2 R C_1 C_2}{1 + [\omega R (C_1 + C_2)]^2} + j \frac{\omega^3 R^2 C_1 C_2 (C_1 + C_2)}{1 + [\omega R (C_1 + C_2)]^2} + j \omega C_X \right] \]
Dielectric loss factor equals the ratio of real current divided by imaginary current, because the first item is a minus value, dielectric loss factor diminishes.

CX=120pF, C1=1pF, C2=0.1pF, R=1000MΩ, CX has no dielectric loss, calculated by formula above, additional dielectric loss caused by the T shaped network equals: -0.025%.

Similarly, tangent dielectric loss caused by maintenance scaffold and packing case diminishes: test object packed in packing case will cause stray capacitance as well as T shaped network interference.

Solution:

1. Wipe clean smudginess on the porcelain bushing surface.
2. Expose test object in direct sunlight or dry the porcelain bushing with heat, blow dry the insulating umbrella of the transformer bushing in the middle.
3. Extend high voltage line horizontally as far as possible, keep away from the porcelain bushing surface.
4. Change to end voltage rise method or regular method in measurement of electromagnetic PT.
5. Make sure to dismantle packing case and scaffold, move away the ladders and untie the noose for testing before hoisting of the new equipment. Ensure to place the transformer bushing on the bushing stand during transformer bushing test, do not lean against the wall or lay on the ground.