IMPACT OF QUALITY OF INSULATION ON THE PERFORMANCE OF TRANSFORMERS

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IMPACT OF QUALITY OF INSULATION

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WEIDMANN is worldwide’s largest manufacturer of (solid) transformer insulation, operating 7 (5+2) Transformerboard machines and several component and paper manufacturing sites.

2. Transformerboard, the electric insulation material made from pure, unbleached Kraft pulp, was invented almost 75 years ago, by WEIDMANN (Hans Tschudi, 1937).

3. WEIDMANN facts and figures:
   - Turnover: 605 / 390 Mio CHF
   - Employees: 3630 / 2626
     (Group / Electrical BA)
One of WEIDMANN’s core competence is the development and production of tailor-made insulation solutions from cellulose based materials and other, eg high-temperature insulation materials.

A modular design of lead exits, as invented by WEIDMANN, allows to decrease throughput time and cost of this vital transformer component significantly.

In addition to transformer insulation components WEIDMANN produces a wide range of specialized insulation papers, eg. diamond dotted paper (DDP) for Distribution transformers.
WEIDMANN offers its customers, transformer OEMs as well as transformer operators and users unique engineering services (electric, magnetic, thermal field calculations, design reviews, static and dynamic analysis of networks and other Power system services, up to services related to Power electronics) to make their transformers and their operation more efficient and reliable.

2. WEIDMANN provides diagnostic services (e.g., oil analysis) and newly engineers and manufactures also transformer monitoring devices.

-> to learn more, please visit our booth
ELECTRICAL INSULATION OF TRANSFORMERS

OIL – CELLULOSE SYSTEM

1. The most appropriate insulation system for a transformer consists of cellulose based solid insulation (Transformerboard, papers etc.) and mineral oil or other insulation fluids. (These fluids are used for cooling the transformer too.)

2. Transformerboard and insulating papers as used in transformers consist of pure cellulose fibres (no additives, glue etc). The poreous structures of the insulation materials allow for a complete impregnation with oil.

Model of a Power transformer
QUALITY ASPECTS OF TRANSFORMER INSULATION (I)

PRIMARY ASPECT: TO FULFIL AN INSULATION FUNCTION

1. Cleanliness (I): -> selection and test of raw material, eg conductivity, ash content, DP (Degree of Polymerisation), etc.

2. Cleanliness (II) -> screening of manufactured insulation:
   - in-line particle/hole detection
   - x-ray (voids)
   - geometrical stability

3. Avoid other foreign substances:
   - as little glue as needed (voids etc.)
   - avoid sources of metal during manufacturing
   - avoid ingress of moisture

X-ray of WEIDMANN Transformerboard
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1. To provide mechanical strength:
   - achieve mechanical stability and strength with as little glue as needed.
   - avoid voids, when substantial glue is needed (laminated Transformerboard)

2. To endure thermal stress:
   - adequate design (as little solid insulation as needed – avoid thick insulation) to allow for smallest electrical gaps with optimal cooling.
1. To age in a controlled way:
   - achieve a lifetime of the Transformerboard – oil insulation system that equals or exceeds that of the entire transformer.
   - the entire system, oil-Transformerboard / paper needs to be examined and understood in aging tests.
1. Mechanical stability:
   - withstand occasional short-circuit without physical change
   - withstand any transportation shocks without permanent movement / displacement
   - withstand an earthquake with no damage

2. Overloadability:
   - allow for a controlled overload without premature aging
   - insulation system may be designed specially (hybrid system) for overload capability
INSULATION QUALITY - PERFORMANCE OF TRANSFORMERS (II)

QUALITY IMPROVES TOTAL COST OF APPARATUS

1. Uptime:
   An acceptance test failure of a transformer due to a quality defect of its insulation leads to costly repair. A failure due to inadequate insulation quality during the operation of the transformer leads usually to expenses or losses exceeding the cost of the unit by far.

2. Long life:
   If the insulation system is not properly designed or if the quality of the materials used is otherwise insufficient (e.g., low DP due to excessive drying, no thermal uprating, etc.), local thermal hotspots, heat pockets, or even regular service temperatures may lead to an accelerated end of life of the transformer.
QUALITY OF INSULATION DURING TRANSFORMER LIFE (I)

WHAT DOES WEIDMANN DO: FROM DESIGN......

1. Proper design:
The design of an insulation system is the foundation on which quality can be realized. Optimization of quality usually means optimization of design first.

2. Proper manufacturing, handling, assembly:
The transformer insulation has to be adequately protected - from moisture, foreign particles etc - during the manufacturing process until the insulation is finally assembled in the transformer. The remedies - plastic covers, a cleanliness discipline in the workshop etc - sound simple, but need to be observed and continuously trained.

Design of a Faltenbalg protecting the transformer interior from dust and moisture
WHAT DOES WEIDMANN DO: TO DEMISE.....

1. Diagnostic and monitoring of transformers:
   Condition assessment (of insulation) through diagnostics and selective (smart) monitoring assures a trouble-free operation of a transformer and helps predict and also prolong the end of its useful life.

2. Tear down analysis:
   A laboratory analysis of insulation samples taken during a tear down (decommissioning) of a transformer is used to optimize future insulation systems.

Insulogix H®, WEIDMANN's new hydrogen monitor detects this key fault gas
CONCLUSION

IT’S ABOUT VALUE

1. Properly selected and controlled quality of insulation material and an adequate design of the insulation system are prime factors to improve the performance and to extend the lifetime of a transformer.

2. The value of a transformer, expressed through its total cost of ownership – measured during the lifetime from design to demise of the unit - can be maximized by using quality insulation.

MATELEC transformers and Swiss gold coin
THANK YOU FOR YOUR ATTENTION!