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Ph.D. thesis (2020-2023)

LGP2 (G. Mortha; N. Marlin)

Thèse Confidentielle

Study of paper ageing behavior : How to assess the lifespan of distribution transformers?

Lois de vieillissement des papiers :

Comment appréhender la durée de vie des isolants dans un transformateur ?

Context

Lifespan of distribution transformers :

The lifespan of the HTA/BT distribution transformers depends on the ageing of the oil-impregnated insulating papers (cellulosic materials).



- Experimentally, paper degradation could be assessed by the chemical tracer detected in the oil.
- The new insulation system contains new papers such as the thermally upgraded paper 'TUP' and the diamond paper.
- Unlike Kraft paper, the ageing behavior of these new papers in transformers is not yet established.



TUP



Diamond paper

Funded by  **EDF**  **Enedis**

Objectives

Thermomechanical ageing behavior

Study of thermomechanical ageing behavior adapted to new papers :

- Study of the accelerated ageing of the insulating paper with an innovative experimental approach.
- Validation of the experimental model considering the results found with studies carried on real transformers.
- Using experimental results to implement the "Dynamic Fault Tree" modeling algorithm.
- Evaluation of the residual lifetime margins, based on the predefined exploitation scenarios.

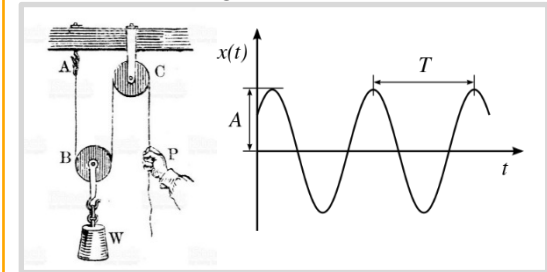
Industrial application:

Studying several operating scenarios involving different papers, and the possibility of standardizing the model.

Methods

Experimental approach

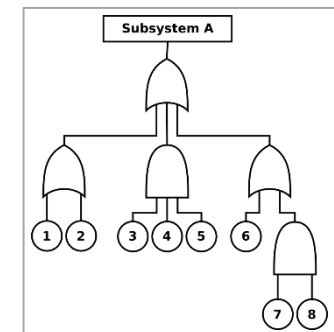
Reproducing the oscillating sinusoidal load of Laplace forces, created by the magnetic field within the transformer, on the insulating paper .



Main principle

Modeling approach

Settling a relevant model using the principle of "dynamic fault tree".



Example of a dynamic fault tree