Experimental model for diagnosing on-load tap changer contact aging with dynamic resistance measurements

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The on-load tap changer

Keeps secondary voltage between limits by adjusting the transformer ratio
Transformer failures

- Transformer failures causes
  - Leakage: 18%
  - Tap-changer: 56%
  - Bushing: 6%
  - Windings: 10%
  - Other: 10%
About this research project:

Most common failure mechanisms of power transformers in the Netherlands are related to the OLTC. In this research the possibilities of Dynamic Resistance Measurements (DRM) on OLTC’s is investigated.

Research goal:
Prevent early breakdown of the OLTC power transformer by performing OLTC diagnosis.

Research result:
A dedicated diagnosis measurement system TDS146 has been developed by Seitz Instruments AG in Switzerland in co-operation with Delft University of Technology and Liandon utility in the Netherlands.
Dynamic resistance measurement (DRM)

Find degradation and defects in the on-load tap changer
1. contact coking,
2. oil film layer deposition,
3. arcing contact wear,
4. longer switch times,
5. contact timing problems,
6. maintenance errors,
7. defect transition resistors,
8. synchronisation problems between phases, etc)
By switchgear / cable

TDS146
Measurement circuit

Directly on transformer
Dynamic resistance measurement (DRM)

TDS 146 Transformer Diagnostic System Seitz Instruments AG, Switzerland

- Apply a DC test voltage to the transformer.
- Switch the tap changer through all its positions and monitor the current.
Recorded current profile

Effect: - winding resistance
- bridging resistors
- (aging and defects)
Laboratory experiments

- Long term aging effect on the change-over selector
  - Oil degradation
  - Mechanical wear
  - Electrical treeing
- Wear of the arcing contacts

Measurements:

- Clean (reference measurements)
- Light aging (oil film layer)
- Moderate aging (thin coking)
- Severe aging (thick coking)
- Light damage (pitting)
- Contact wear
Oil film layer
accelerated aging

40 years at 60°C
tested in 6 hours

40 years at 80°C
tested in 15 hours
Thin semi conductive layer: DRM
Thin semi conductive layer
Thick semi conductive layer: DRM
Contact wear shows as small deviations in the switch time.

Arcing contact 3 is worn.
Field case

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Field case

Before maintenance

After maintenance

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Conclusions

1. A new diagnostic measurement device TDS146 was presented.
2. Modelling and laboratory investigation of the deterioration processes is helpful to gain more systematic knowledge about the applicability of DRM.
3. Laboratory investigation has shown that light aging (the oil film layer as presented above) is not measured with DRM while advanced aging (coking) is measurable.
4. Thick artificial coking is measured at every measurement while a thin layer of artificial coking tends to break due to the contact pressure and is therefore not always measured.
5. Laboratory experiments and a test case showed that DRM is indeed effective for assessing the long term effect on the tap changer contacts.