

Use of vibro-acoustic measurement (VAM) for On-Load Tap-Changer (OLTC) diagnostics

The average age of transformer fleets increases worldwide and the knowledge about the asset condition is getting more and more important. To secure a reliable transformer operation, an increasing demand of monitoring and diagnosis methods and equipment is recognizable. By using vibro-acoustic measurement (VAM) it is possible to close a gap in diagnosis and monitoring to assess the OLTC diverter switch. Mechanical movements and the arcing activity during an OLTC switching process produce vibrations along a wide frequency range. VAM allows to measure and analyse these vibration patterns.

The measurement of VAM signals is facilitated by using acceleration sensors. In case the VAM is performed on an energized power transformer, the sensor can be placed at the transformer tank wall, at a position which is nearby the OLTC. In case VAM is performed on a de-energized power transformer, a sensor placement is also possible at the OLTC head cover, where the signal-to-noise ratio (SNR) is better, compared to a placement of the sensor at the tank wall.

The sensor measures an oscillating raw signal which covers the entire tap switch operation from motor start to finish. This raw signal can already be used for a first comparison with reference data (compare “fingerprint”). However, the raw signal form is not suitable for detailed analysis because different frequency ranges are not distinguishable (Fig. 1, a). By using several mathematical operations and filter functions, the measured VAM raw data can be transferred in proper signal forms like frequency-time spectra and signal envelopes.

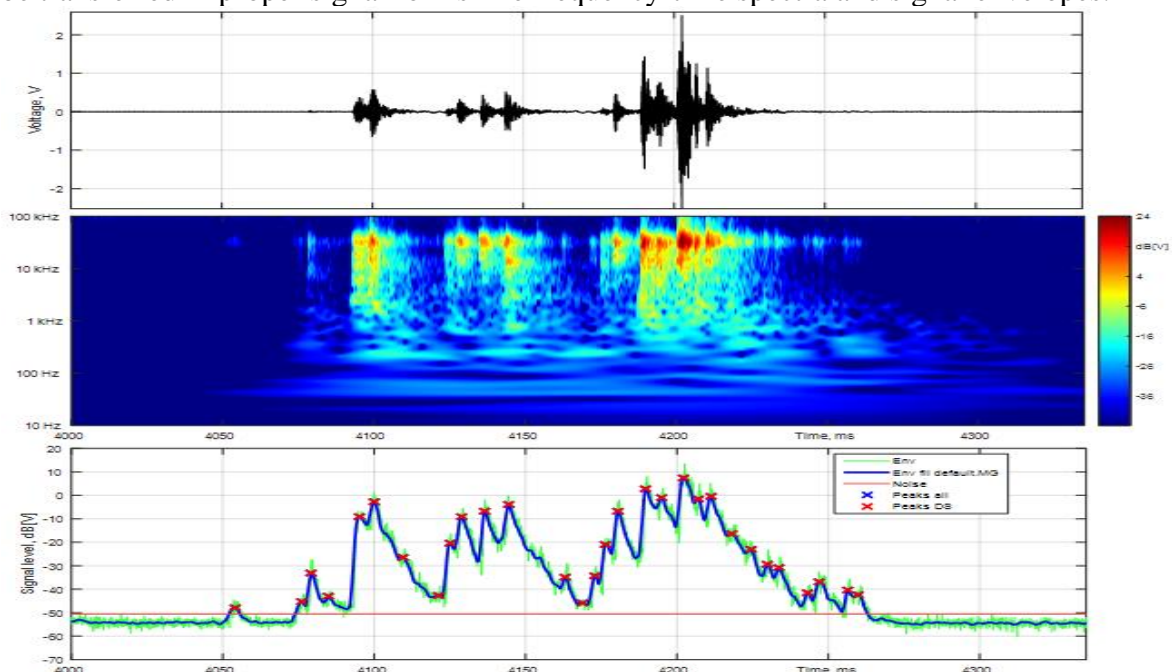


Figure 1 a) Raw signal (top), b) data processing (middle). c) VAM-envelope (bottom)

With help of the frequency-time spectrum all measured frequencies (up to 250 kHz) and their intensity can be visualized, which helps to identify the main events of the switching operation (Fig. 1, b).

The envelope curve represents the energy of the measured raw signal in the selected frequency range of 10 kHz to 100 kHz and reflects also the main OLTC switching events, especially the diverter switch operation which is not observable by monitoring and diagnosis methods (Fig. 1, c).

To secure that the measured VAM data have sufficient signal quality VAM data should be verified with an automated quality check already in the field. Therefore, time related criteria and signal related criteria can be used for quality assessment of the measurement. In case that the data quality check shows a not sufficient data quality an automated notice can be generated which helps the service technician to improve the measurement setup.

A comparison of measured envelopes at two different instants of time, is the most common application of VAM. E.g. VAM measurements on the same OLTC at factory acceptance test and site acceptance test show very good conformity in the curves. The time deviation between the peaks is around 1 ms, which is sufficient for a qualified interpretation. The comparison of envelopes enables to observe changes and anomalies during the operational life of the OLTC, e.g. incorrect installation and transport damages.

A further use case is the combination VAM and dynamic resistance measurement (DRM) which complement each other and helps to improve the ability of interpretation with help of additional information regarding OLTC timings, contact wear and unusual arcing. The recorded acoustic events can be assigned to mechanical and electrical events happening in the OLTC. With the deep knowledge of the tap-changer design, it is possible to detect anomalies in the switching operation.

As a conclusion, the VAM method offers the possibility to provide valuable information and is a useful as well as stable method for OLTC condition assessment. In the same time, sophisticated data processing is necessary to generate useful information from the available data.