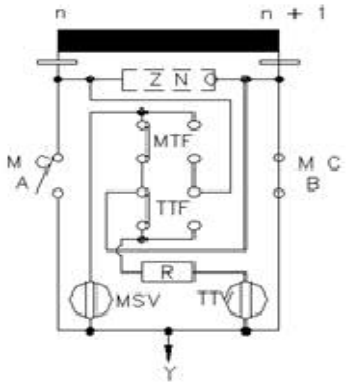
What are the factors to determine the need of varistor in the regulating windings or in the tap changer? Is it possible to avoid it? Are there feedbacks on the long-term reliability of such components? Is there a way to evaluate varistor condition during the transformer lifetime?

Varistors are used in the regulating windings when

1. Their step voltage or voltage across the winding exceeds the voltage limit of the tap changer.
2. There is a retrofit requirement with identical or higher capacity transformer with site dimensional and shipping limitations (As per the agreement between manufacture and the user)

Varistors made of ZnO elements are used in vacuum type tap changers because no switching resistors may be included in the protective circuit due to its switching principle. ZnO elements of the varistor realize a short circuit for specific overvoltage in order to protect the tap changer for damages.

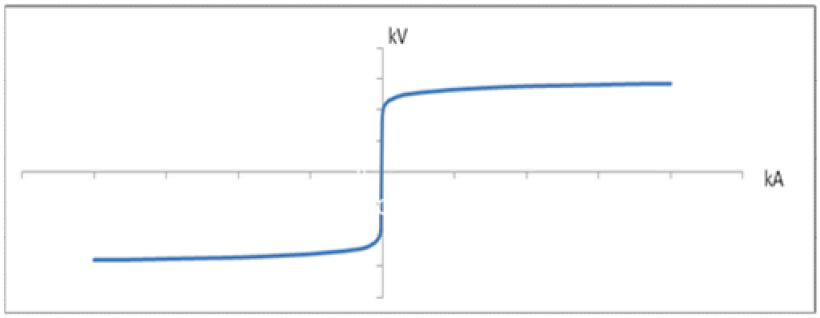


Sometimes use of varistors can be avoided by changing the transformer design to change the RLC network
(i.e. different winding arrangements or winding designs to change the series and ground capacitances of the windings) .However ,this may be unavoidable due to the size of the transformer and/or other specification requirements which may dictate particular winding arrangements due to impedance or other performance parameters .

For tap changers, this is a part of protective circuit and may be unavoidable for a given tap changer design / technology

ZnO varistor is a resistor, whose resistance reduces very quickly above a certain voltage with following characteristics.

- At normal operating voltage, the resistance is very high
- In overvoltage conditions the resistance instantaneously reduces to a very small value
- It is made from a zinc oxide alloy
- It does not matter if the voltage is positive or negative



An important point for the lifetime of the ZnO elements is the load current magnitude occurring in transient overvoltage of the varistors. This depends on the expected voltage level and the surge impedance of the transformer.

With the induction of ZnO technology, most of the operating / maintenance issues reported earlier with SiC have been largely eliminated .

There is no existing practice known to evaluate varistor condition during the transformer lifetime. However, online condition monitoring of ZnO varistors in transformers may use the same principles as those used for electronic circuits.

1. Measuring resistive component of leakage current
2. Measuring harmonic content of leakage current
3. Thermal measurements
4. Electromagnetic field method
5. Sweep Frequency Response Analysis (SFRA)

Conventional inspection /maintenance schedule as followed for the transformers is found to be sufficient for the successful operation of these varistors as well .