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THERMAL HYDRAULIC MANAGEMENT PLATFORM FOR CORE-TYPE POWER TRANSFORMERS

A.V.Minaeva
FSBEE HE "KSPEU", Kazan, Republic of Tatarstan
alin.minaeva2000@gmail.com
Scientific leader PhD, Associate Professor Aytuganova Jh.I.

The theses is devoted to how such problems as the inability to predict the integral behavior of a power transformer using the basic boundary conditions available at the design and operation stages can be solved with the help of Thermal Hydraulic Management Platform. This platform is based on already existing thermal modeling principles such as Computational Fluid Dynamics and Thermal Hydraulic Networks Models.

Keywords: power transformer, CFD, THNM, THMP, thermal modelling, digital twin.

Power transformers are extremely efficient devices in power grids, increasing the service life of which is a major challenge for manufacturers and for utilities. So temperature is the main parameter that leads to the aging of the transformer and limits the output power. Therefore, methods such as Computational Fluid Dynamics (CFD) and Thermal Hydraulic Networks Models (THNM) are used to determine the temperature distribution inside the transformer.

In CFD, when describing the principles governing fluid flow and heat transfer in the liquid and solid regions, differential equations are used, which are replaced by algebraic equations and solved at discrete points. THNM uses simpler algebraic equations that rely on analytical and / or empirical coefficients.

However, these methods have their advantages and disadvantages. For example, THNM models are fairly accurate compared to CFD models. But this model cannot capture singular and local phenomena. And CFD in terms of computing and human resources is considered a more demanding method.

However, these methods are highly dependent on boundary conditions. Therefore, when geometric or operational conditions need to be estimated, namely when these boundary conditions are unknown, accurate prediction of average winding temperatures is not possible.

Научный руководитель Айтуганова Ж. И. К. Анв

Therefore, to solve these problems have developed a global model based on the knowledge gained from the methods of THNM and CFD. This model is called Thermal Hydraulic Management Platform THMP.

The THMP has been developed for core-type power transformers, but it is expected to extend the concept to other types and subtypes of not only power, but also distribution transformers. No boundary conditions are required for the calculation of this method, since the parameters are mainly geometric conditions. Therefore, THMP is relevant at the design stage, when many quantities are still unknown and when the influence of each component must be analyzed integrated into the whole system. Another advantage of THMP is that the principles governing heat transfer and fluid flow are described using algebraic equations based on analytical and / or empirical coefficients. These equations are then converted to their equivalents. Therefore, the analogy of an electrical circuit can be applied to solve flow, temperature, and pressure.

THMP allows for the most informed design decisions and also represents a significant step towards the development of a thermal Digital Twin for power transformers.

BIBLIOGRAPHY

1. Campelo H.M.R., Quintela M.A., Torriano F., Labbe P. and Picher P. Numerical thermofluid analysis of a power transformer disc-type winding // Electrical Insulation Conference. Montreal, Canada, 2016. P. 362-365.

2. Campelo H.M.R., Brana L.F. and Lopez-Fernandez X. Thermal Hydraulic Network Modelling Performance in Real Core Type Transformers // International Conference on Electrical Machines (ICEM). Berlin, Germany, 2014. P. 2275–2281.