Study of nanofluids application in electrical transformers

Victor T. Hayashi, Marcelo S. Rocha, Otávio L. Oliveira

Instituto de Pesquisas Energéticas e Nucleares

victor.hayashi@usp.br

Objective

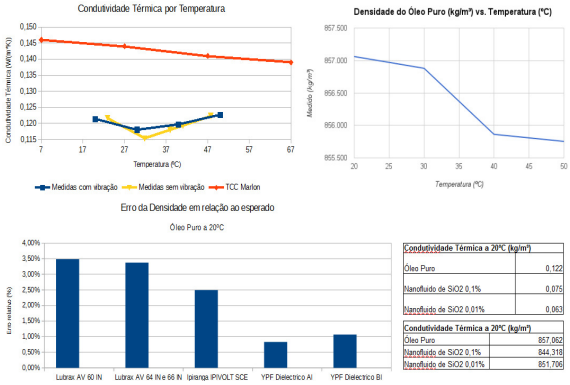
Investigate how the change of electrical and thermal properties of nanofluids based on mineral oil and SiO2 nanoparticles can contribute to improve the efficiency of electrical transformers.

Materials and Methods

The theoretical study included the basic theory of transformers (heat source), insulating mineral oils (conventional cooling) and nanofluids (proposed cooling) as well as related standards and resolutions. Nanofluids samples concentrations of 0.1% and 0.01% were prepared from ultrasonic treatment, and the density and thermal conductivity properties (transient hot wire method) are taken at temperatures between 20 ° C and 40 ° C (3 min measures for each configuration). Dielectric strength tests and viscosity are also provided. Comparation with the values found with in the literature will be preformed, and a simulation using the finite element method will be performed. It is expected that a conclusion regarding the application that allows the entry of a greater amount of power in the transformer with the same active part, without reducing the electrical insulation provided by the insulating oil. It is considered a 50 kVA transformer reference with natural oil circulation and cooling system.

Results

The following graphs and tables related to the thermal conductivity and density measurements are presented:



Condutividade Térmica a 20°C (kg/m³)	
Óleo Puro	0,122
Nanofluido de SiO2 0,1%	0,075
Nanofluido de SiO2 0,01%	0,063

Condutividade Térmica a 20°C (kg/m³)	
Óleo Puro	857,062
Nanofluido de SiO2 0,1%	844,318
Nanofluido de SiO2 0,01%	851,706

Picture 1: Results for the pure oil (graphics) and comparison to 20º C (tables)

Conclusions

Given the degradation of thermal conductivity, it is expected that the simulation confirm that the use of SiO2 nanoparticles is not ideal. However, the proposed method allows extension of the work to study other nanoparticles (such as TiO 2), constituting an innovation initiative.

References

JIN, Hufei et al. Properties of Mineral Oil based Silica Nanofluids. IEEE, 2014.

PRASS, Marlon. Estudo das trocas térmicas nas aletas de um transformador a óleo. RS: UNIJUÍ, 2013. TCC.

KOSOW, Irving L. Transformadores. Máquinas Elétricas e Transformadores. Porto Alegre: Globo, 1982. Cap. 13, p. 511-530.

AGÊNCIA NACIONAL DO PETRÓLEO GÁS NATURAL E BIOCOMBUSTÍVEIS ANP. Resolução nº 36/2008.

ASSOCIAÇÃO BRASILEIRA DE NORMAS TÉCNICAS. NBR 5356-2: Transformadores de potência Parte 2: Aquecimento. Rio de Janeiro, 2012.