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Design of Controlled Cooling System for Transformer with Support of Renewable Energy

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ABSTRACT: The national electricity supplier in india struggles more and more each year in supplying amount of power. This is practically due to residential consumers that use appliances that require more power. This results in transformer that overheat which decrease the efficiency of the transformer. A possible solution to this problem is to cool the transformer in a controlled manner. This provides the design of a controlled cooling system for a three phase power transformer that is energy efficient and also make use of thermoelectric cooling module (TCEM) which is controlled by an microcontroller 8051.This is sensor which is placed between the windings and core of transformer. A model of actual transformer was used to perform the test to indicate the cooling result where used for the transformer simulation which were then implemented based on the result. In the piping between the tank of a 40 MVA transformer, originally designed for ONAN/ONAF cooling combination, and its bank of radiators, a propeller oil pump was installed. Characteristic temperature rises were measured before and after installation of the pump. The results were applied to the development of a new algorithm for calculation of windings and oil steady-state temperature rises of ONAN/ONAF/ OFAF transformers. The mathematical model is briefly described in the paper, and the basic thermal characteristics of transformers with this combination of cooling types are described. Installation of the oil pump can make transformer cooling more efficient provided that certain condi- tions are satisfied.

I.INTRODUCTION

Pt 100 sensor are the most comman type of platinum resistance thermometer ….100 refers to that at 0C sensors has a resistance of 100 ohms . A resistance thermometer is a type of temperature sensor. It consists of an element that use resistance to measure tempature. An oil-immersed naturally cooled transformer (ONAN) is the most reliable and noiseless form of transformer. The forced-air cooled transformer (ONAF) is more efficient, but has a higher noise level and is less reliable owing to the possibility of fan malfunction. The radiator cooler can be set apart from the trans- former tank. When the distance between them is large, the thermosyphonically induced oil circulation slows down owing to high hydraulic resistance of the piping, and the difference between top and bottom oil tem- peratures in the cooler increases. To improve the oil cir- culation in such cases, it is justified to install an oil pump in the piping of the cooling system (OFAF cooling). The consequence of higher oil 8ow rate is a smaller oil tem- perature drop down the cooler. Cth the top-oil tem- perature rise limit remaining unchanged, the smaller difference between the top and bottom oil temperatures in the cooler makes it possible to increase the average oil temperature rise and, in consequence, to increase the effectiveness of the cooler.Some purchasers demand the installation of an oil pump in ordinary ONAN/ONAF transformers, assuming that the pump installation alone will increase the load- ability of the transformer, and not considering technical and economical consequences. Others usually require maximum rated power for OFAF cooled transformers, 80% of maximum rated power for ONAF cooled, and 60% of maximum rated power for ONAN cooled. This range of demands may be met by combining the efficient, but less reliable, OFAF cooling for rare time occurrences of maximum transform

II.EXISTING SYSTEM

List of symbo1s
cr = specific heat of fluid
g = acceleration due to gravity
h = height from transformer bottom
= mass flow

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= pressure
—— *cooler characteristic heat flux*
D, = difference between top and bottom oil tem-
peratures in cooler
= difference between top and bottom oil tem-
peratures in v'inding
F = surface of cooler
= pump pressure head LV = low voltage
Nu = Nusselt number
p = exchanged heat
= resulting flow resistance
= thermal time constant TC = thermocouple
TR = thermoresistance
U = thermal driving force (thermosyphon)
= volume coefficient of expansion
= temperature
= ambient temperature
= density
= pressure drop
8' = temperature rise
8, = top-oil temperature rise at cooler inlet 8# = hot-spot temperature rise
8p = average oil temperature rise in cooler
8q = average oil temperature rise according to Refer- ence 2
8,, = average oil temperature rise in winding 8, = average winding temperature rise
8, = top oil temperature rise
8p = winding top oil temperature rise 8, — average temperature rise over oil
B,,t = hot-spot temperature rise over oil 8j = hot-spot temperature rise limit
8t = average winding temperature rise limit
8 = top-oil temperature rise limit

III.PROPOSED SYSTEM

On the same two-winding 40 MVA transformer, orig- inally designed for the ONAN/ONAF cooling the same two-winding 40 MVA transformer, orig- inally designed for the ONAN/ONAF cooling com- bination, with one bank of radiators, short-circuit temperature rise tests were performed. The transformer cooling system was adapted for four different types of cooling: (i) ONAF cooling (without oil pump in the
piping) (ii) ONAF cooling with de-energised oil pump in the piping (iii) OFAF cooling (running oil pump) (iv) OFAF cooling with reduced oil flow. The transformer was heated with the same total losses during each temperature rise test. Temperature rise tests were truncated when 98% of the steady-state top-oil tem- perature rise was exceeded (1 j. The ultimate steadystate temperature rises were calculated by
extrapolation, using the least-square method. During the temperature-rise tests, the characteristic oil temperatures (2d were measured with thermocouples (TC); the top oil temperature with oil-immersed TC in the transformer cover's pocket, the oil temperature in thebination, with one bank of radiators, short-circuit
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IV.OPERATING SYSTEM

Details of the piping and the measuring devices are shown in Fig. 2. The oil flow rates were measured with a turbine 8owmeter, and pressure drops were measured with a differential pressure transducer. The diameter of top pipe was 125 mm in all the tests. During the tests on the ONAF cooled transformer, the diameter of the bottom pipe was 250 mm, and it was 100 mm during the tests on the OFAF cooled trans- former (to fit in the diameter of turbine flowmeter). The flow rate was throttled with valve V,. The experiment, as planned, should give a straight comparison of the characteristics of ONAF and OFAF cooling types. The ONAN cooling was not especially studied, because it can be assumed that the deenergised oil pump in the piping will produce similar effects to those in ONAF cooling. pipe leading from the tank to the radiator with TC2 placed on the surface of the pipe, the bottom oil tem- perature with TC placed on the surface of the return pipe, and the ambient air temperature with TC„ TC And TC6 , Each immersed in its own one-litre oil con- tainer. the thermoresistive sensors (TR) were in8ta1led in the transformer to measure oil temperatures directly, as shown in Fig. 1. Details of the piping and the measuring devices are shown in Fig. 2. The oil flow rates were measured with a turbine 8owmeter, and pressure drops were measured with a differential pressure transducer. The diameter of top pipe was 125 mm in all the tests. During the tests on the ONAF cooled transformer, the diameter of the bottom pipe was 250 mm, and it was 100 mm during the tests on the OFAF cooled trans- former (to fit in the diameter of turbine flowmeter). The flow rate was throttled with valve V,. The experiment, as planned, should give a straight comparison of the characteristics of ONAF and OFAF cooling types. The ONAN cooling was not especially studied, because it can be assumed that the deenergised oil pump in the piping will produce similar effects to those in ONAF cooling. pipe leading from the tank to the radiator with TC2 placed on the surface of the pipe, the bottom oil tem- perature with TC placed on the surface of the return pipe,

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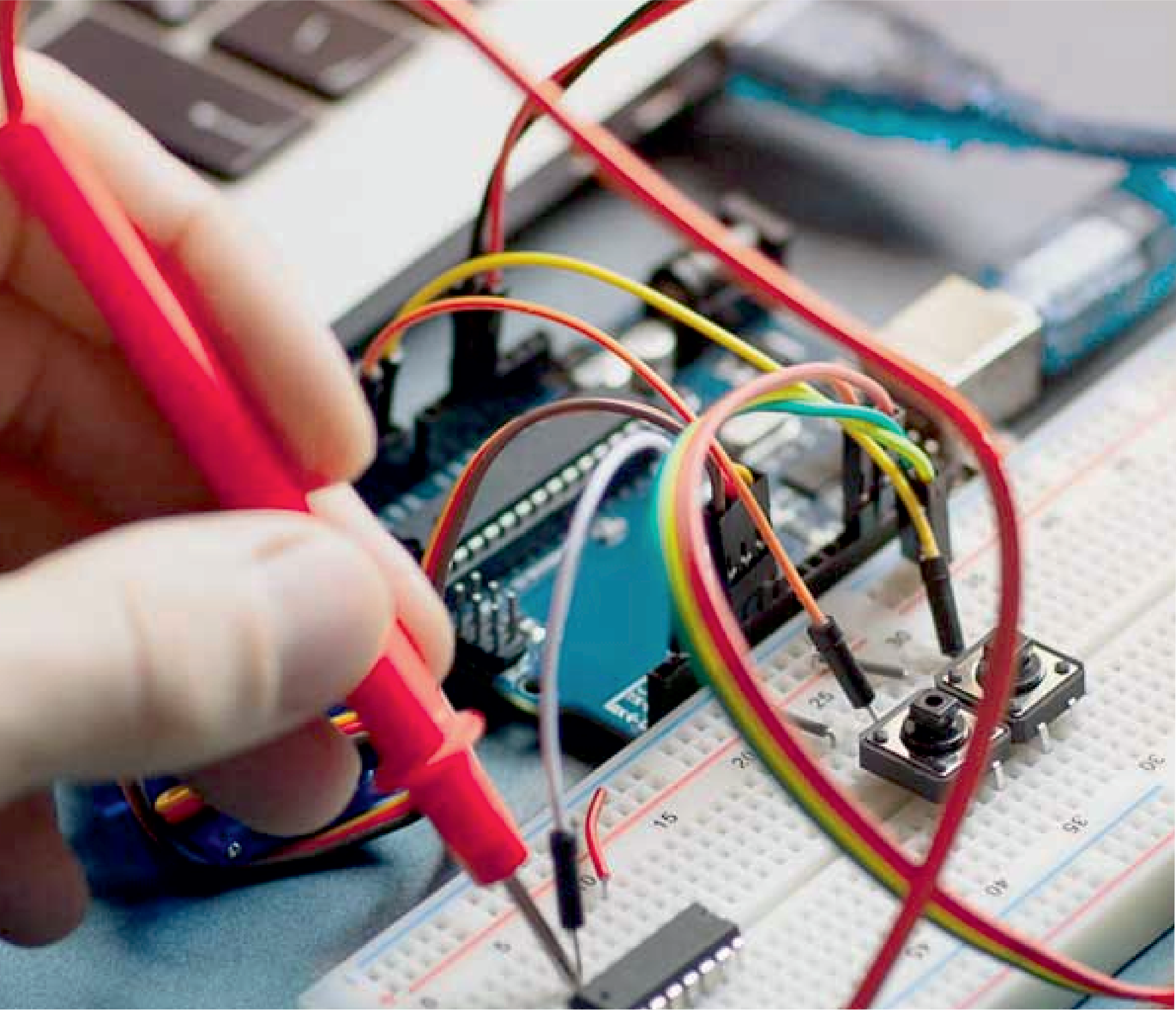

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