International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 06 Issue: 05 | May - 2022 Impact Factor: 7.185 ISSN: 2582-3930

A REVIEW PAPER ON DESIGN OF COOLING SYSTEM FOR ELECTRICAL TRANSFORMERS, CIRCUIT BREAKERS USED IN TRANSMISSION STATION

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ABSTRACT

Transformer is a device that transfers electric energy from one alternating-current circuit to one or more circuits, either increasing (stepping up) or reducing (stepping down) the voltage. Transformer plays a key role in the power transmission, during this power transmission heat is generated. Cooling of a transformer is the dissipation of heat developed in the transformer to the surroundings. The losses occurring in the transformer are converted into heat which increases the temperature of the windings and the core. In order to dissipate the heat generated cooling should be used. A circuit breaker is an electrical switch that turns off automatically during an overload or short circuit. These switches are important because they protect your electrical components from overheating and breaking. By using different cooling methods we design an cooling system for the transformer and circuit breaker by using Revit software. By using this method, the temperature of transformer and circuit breakers can be reduced in short time. According to generally adopted estimate states that if a transformer's maximum operating temperature is reduced by 6°C-10°C. The main purpose of the experiment is to improve the cooling system of transformer, to increase the life expectancy of transformer.

1. INTRODUCTION

The primary function of the cooling system is to remove excess heat and maintain operating temperature. A transformer is a device that transfers electrical energy from an alternating current circuit to one or more circuits by stepping up or down in voltage. While using a transformer, heat is generated, so to cool the transformer, we use cooling methods to prevent damage to the transformer. There are four methods of cooling a transformer: natural air cooling with natural oil, natural air cooling with forced oil, forced air cooling with forced oil, cooling with forced water to forced oil.

A circuit breaker is an electrical safety device designed to protect an electrical circuit from damage caused by overcurrent or short circuit. Its basic function is to interrupt the flow of current to protect equipment and prevent the risk of fire. There are four cooling methods for circuit breakers: vacuum cooling, partial cooling, static cooling, forced cooling

2. LITERATURE SURVEY

SOHEIL JAFARI [1] Evaporative cooling system concepts proposed over the past century for engine thermal management in automotive applications are critically reviewed and revised. At first, the benefits of evaporative cooling systems reassert themselves in terms of improved engine efficiency, reduced carbon emissions carbon dioxide emissions and improved fuel economy. This is followed by historical coverage of proposed concepts dating back to 1918. Possible evaporative cooling concepts are then classified into four distinct classes and critically examined. Then, through a systematic review of critical areas of evaporative cooling systems for application in automotive engine cooling, remaining research challenges are identified.

AK SHARMA [2] The transformer plays an important role in the power supply system. There are many problems associated with transformer power loss, but this article focuses primarily on an efficient cooling system designed to overcome heating and insulation losses. Cooling efficiency is a crucial factor determining the operational safety and service life of a transformer. In this experimental configuration, it consists of a copper tube, a fan and a water circulation pump. And the best result is found in forced air forced water with refrigerant cooling method. By using this method, the transformer temperature can be reduced in a short time. According to the generally accepted estimate, if the maximum operating temperature of a transformer is reduced by 6°C to 10°C, the thermal life of the insulation system is approximately doubled. The main purpose of the experiment is to improve the cooling system of the transformer, to increase the life expectancy of the transformer.

MOHMADD DJAMALI [3] To get the most out of existing assets, power transformer monitoring provides continuous assessment of transformer overload capability. During periods of overload, the cooling system of a power transformer plays an adhesive role by transferring the heat generated in the windings to the surrounding medium. Cooling system malfunction must be detected by an online monitoring system before the transformer is overloaded. An online algorithm for the detection of cooling system malfunctions based on the calculation of the standardized error in the calculated upper oil temperatures is presented here. For the validation of the algorithm, the data measured during normal operation of three transformers are used, two of which experienced faults in part of their cooling system**.**

TIM GRADNIK [4] In this framework, experimental research is carried out in the field of aging processes that take place in large paper power transformers in oil insulation. Explains the effect of transformer oil and winding temperatures on expected transformer life. These results and the conclusions of two research studies carried out at the Vidmar Electrical Energy Research Institute of Milan (EIMV) in 2004/2005, which evaluated the aging and condition of the cooling system of large transformers of 400 kV and 220 kV transmission, served as the basis. to highlight the occurrence of unexpected premature aging of especially large transformers that were installed in the Slovenian power grid around 1980. It also discusses the effect of optimization of cooling to extend residual life of the transformer and minimize its life cycle cost.

LIVIA MIRON [5] Here we study fluid flow and convective heat transfer in a thermoconvective circuit with multiple cooling channels and different fluid inlet velocities. A steady-state numerical study was carried out for a three-phase step-down power transformer on columns immersed in a mineral oil bath inside a tank. Our main objective is the optimization of the cooling of the power transformer. An obstacle at the bottom of the transformer is used to lead the oil to the hotter surface. To study the influence of the different parameters on both the heat transfer and the fluid flow, we used the highest temperature and the global temperature, as well as the volumetric flow rate. The results obtained show an optimal speed where the temperatures remain below the limits.

ZHIHAHAO ZHANG [6] Cooling management issues face critical challenges with the continued miniaturization and rapidly increasing heat flow of electronic devices. Considerable efforts have been made to develop highly efficient cooling and flexible thermal management solutions and corresponding design tools. This article reviews the latest developments and the state of the art in electronic refrigeration. The methods commonly used in electronic refrigeration, classified into direct and indirect refrigeration. Direct cooling includes air cooling, spray and jet cooling, immersion cooling and droplet electrowetting. With regard to indirect cooling, the most popular and hot topics of the use of microchannels, heat pipes, vapor chambers, thermoelectrics and PCM are described. The effectiveness of thermal management methods for different levels of electronics cooling requirements and ways to improve heat transfer capability.

MUSTAQ ISMAEL HASAN [7] In this, the electrical distribution transformer and the effect of the exterior have been studied numerically. The temperature has been studied in its cooling performance. The studied temperature range covers hot climate regions. A 250 KVA distribution transformer is chosen as the study model. A new coolant is proposed to improve the cooling performance of this transformer, a suspension of microencapsulated phase change materials based on transformer oil is used with a volume concentration of (5 to 25)% as cooling fluid. cooling instead of pure transformer oil. Paraffin wax is used as the phase change material to make the suspension. The results obtained show that the use of MEPCM slurry instead of pure transformer oil lead improves the cooling performance of the transformer by reducing its temperature and, therefore, increasing its protection against failure.

MAZRAN ISMAIL [8] Cooling is one of the primary concerns in building tropical homes. This problem is exacerbated by heat gain from the roof, which accounts for 70% of the total heat gain. Passive cooling technique is one of the innovative practices and technologies that provide buildings with comfortable conditions through natural means. The processes of reflection and radiation are the methods used to decrease heat gain by facilitating the removal of excess heat from inside a building to maintain a comfortable environment. This examination of the physical characteristics of these approaches to guide architects and building designers. The results indicate a significant reduction in operating costs. However, significant differences in color rendering and material properties must be taken into account.

VLADMIR SEGAL [9] Thermal cooling of power transformers with mineral oil based on magnetic fluids. Extensive temperature mapping was performed on a simple laboratory model and two small distribution transformers with disc and foil/wire windings representing two main designs used in practice. It is seen that there is an upper limit to the magnetization of the ferrofluid. With good fluid magnetization, thermal gradients across the windings. In addition, the maximum temperature inside the transformers for active and passive cooling units is significantly reduced. Direct thermocouple measurements show that the improvement in ferrofluid cooling is due to better heat transfer from inside the winding/magnetic core assembly, while Archimedean convection prevails outside the whole. Surprisingly, the DC breakdown strength in a positive needle test configuration was found to be much higher for ferrofluid than for oil.

ANDREA CREMASCO [10] The application of dry-type transformers is growing in the market because the technology is non-flammable, safer and more environmentally friendly. At the design stage, a thermal model of the transformer used to predict the temperature rise is essential and the modeling of the cooling system is particularly important. This introduces a fast computational pressure model and a thermal network model for dry-type transformer cooling systems, previously verified by analytical methods and advanced CFD simulations, and finally validated with experimental results. This document provides an overview of the transformer dry cooling system network model, describing its topology and main variants, including natural or forced ventilation, with or without in-core cooling duct, and floor ventilation openings and air barrier.

JISHEN TEH [11] The dynamic thermal classification system can safely determine the thermal limits of power components based on ambient conditions. the DTR system can provide ratings higher than the traditional static thermal rating 80% to 90% of the time higher than STR. Therefore, the benefits and applications of the DTR system have been widely studied and reported. However, the DTR system focused only on transmission lines and networks, ignoring the thermal limits of the transformer and distribution cable, which could form a thermal bottleneck. Collected articles are categorized according to their purpose and then sorted into small groups according to their research topics. This approach provides potential DTR system researchers with a comprehensive summary of all previous studies.

RAHMATH RAMADON [12] Global energy consumption shows an upward trend. Unfortunately, it is still dominated by the use of fossil fuels. This condition translates into the fear that there is an energy crisis for the depletion of non-renewable energies and an environmental crisis of global warming. One of the technological sectors that consumes a lot of energy are computer servers and data centers. One of the main causes of the inefficiency of this technology is the decrease in performance due to the increase in temperature. Therefore, efficient refrigeration and efficient technology are needed to overcome the increase in operating temperature of computer servers and data centers. One of the most important cooling technologies to solve this problem is immersion cooling. This method has been developed into several types with their respective advantages and disadvantages depending on the needs of the application.

VINAY KARTHIK [13] In the current scenario, with the increasing awareness of environmental degradation due to production, use and disposal of Chlorine-Fluoro-Carbons (CFCs) and Hydro Chlorine-Fluoro-Carbons (HCFCs) as refrigerants in conventional refrigeration. A thermoelectric cooler is a cooler that uses the Peltier effect to create heat flow between junctions of two different types of materials. The TEC, also called a Peltier cooler, is a solid-state heat pump that transfers heat from one side of the device to the other against the temperature gradient (cold to hot), consuming energy electric. The methodology for the design and development of thermoelectric refrigeration was presented. The developed thermoelectric refrigeration system has potential application for the storage and transportation of life-saving drugs.

SIDI THABET [14] The electrical breakdown voltage of transformer oil nanofluids using several nanoparticles (ZnO, MgO, Al2O3, TiO2, SiO2, graphite, LiTaO3 and Fe3O4), found that these nanoparticles act as an electron scavenger in the nanofluids, which slows down the propagation of the current. and leads to an increase in breakdown voltage compared to pure transformer oil. The author further concluded that single and multiparticle nanoparticles in transformer oil increase breakdown voltage. However, multiple nanoparticles have good efficiency compared to single nanoparticles in the base fluid. Among the different combinations of nanoparticles used in transformer oil. The combination of (Fe3O4+MgO) has the best electrical performance because they quickly capture free electrons. Then the other combination is (ZnO + TiO2) followed by (SiO2 + LiTaO3) respectively.

VICTOR A.PRIMO [15] Investigated the impact of different moisture contents on the breakdown voltage of transformer oil using hexane-based Fe3O4 nanoparticles and concluded that the water solubility of mineral oil is higher in the presence of Fe3O4 nanoparticles. It has also been found that the dielectric properties of different samples are better or similar in some cases compared to pure transformer oil. The author further suggested that nanoparticles bind with water molecules to form clusters, which helps improve the breakdown resistance of nanofluids and also suggested that a higher concentration of nanoparticles is needed at low relative humidity, because there are more water molecules present in the oil in this state. While at higher humidity, any concentration of nanoparticles does not improve the resistance to decomposition.

M. ASEFI [16] He studied the stability, electrical and thermal properties of nanofluids. The researcher takes different stabilizers at different concentrations and uses diamond as a nanoparticle in transformer oil. Three general procedures (ultrasonication time, ball milling process, type and concentration) were used for the investigation and it was found that the stability of nanofluids depends on the type of stabilizer used, the amount of nanoparticles used and sonication time. The researcher also found that the surfactant Span80 in a 2:1 ratio is more stable when the sonication time is half an hour. The additional decomposition force of the nanofluid increased by up to 38% and the thermal conductivity index increased by 73%.

AMUTHAN [17] designed a cooling quadrant type transformer, in this environment, the transformer is cooled by the Solar powered outdoor fan. The fans are located in different quadrants with an angle difference of 45 degrees in each quadrant. This method is synonymous with the ONAF method in which air is blown over the cooling fin of the transformer at four angles thus generating rapid cooling. The fans are directly connected to the solar panels in this In this case, a constant cooling occurs each time the UV rays rise.

CHARISMA ALMEDIA [18] Investigated the thermophysical (viscosity, surface tension, density, specific resistance) and electrical properties of grapheme transformer oil at three different concentrations (0.01%, 0.03%, and 0.05%) and at different temperatures ranging from 20°C to 90°C and found that the addition of nanoparticles increases the density and viscosity of nanofluids by 25% and 16.6%, respectively, compared to pure oil. In addition, it has been observed that higher concentration and temperature of nanoparticles lead to a reduction in surface tension. The additional specific resistance of nanofluids decreases at all concentrations, leading to a maximum reduction of 79% at 90°C. They suggested that it would be suitable for the design of electrical equipment.

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