MULTIMODE COOLING SYSTEM FOR POWER TRANSFORMER USING PLC

Ramakrishnan T[1], Ragul R[1], Venkatesh S[1], Venugopal G[1] Ms.T.Dharanika[2]

[1]Department of Electrical and Electronics Engineering,

[1]Sri Krishna College of Technology, Coimbatore, Tamil Nadu, India

Abstract

This Project deals with the monitoring and controlling of cooling system of a transformer using automation.Probability of faults on power transformer is undoubtedly more and hence automatic protection is absolutely necessary.Temperature sensor is used to sense the temperature of the power transformer that indicates the value of the temperature.Output from the sensor is fed to the Programmable Logic Controller (PLC).A PLC is a digitally operating system designed for use in an industrial environment,which uses a programmable memory for its internal operation of user oriented instruction and for implementing specific function such as logic,sequencing,timing,counting and arithmetic.By introducing PLC into action the process becomes more flexible,reliable and PC friendly.HMI activities are availed to have better visualization of the process and control.Trouble shooting experience becomes easier now compared to existing technology .

Keywords: PLC, Power transformer,Monitoring and cooling, automatic operation, Temperature Sensor, Extreme protection, Flexible and reliable, Enhanced operation, .

I. INTRODUCTION

Transformer is a static device which is the integral part of the Power system,and is personified as the heart of the entire system which mainly used to transform power from one circuit to another without changing the frequency.A transformer consists of two insulated windings interlinked by a common or mutual magnetic field established in a core of magnetic material.Primary winding is connected to alternating voltage source which produces mutual flux in the secondary due to electromagnetic induction.EMF induced in the secondary is same as the primary of same frequency with different magnitude.When the number of primary and secondary turns are proportional, almost any desirable voltage ratios can be obtained by tapping the transformer.The construction should ensure sufficient removal of heat from the windings,so that the temperature rise is limited.In the power system the transformer is used for stepping up or stepping down the generated voltage and for distributing generated power .During this operation the winding of the transformer gets heated up,leading to loss of power .In Transformer the air gap provided between the primary and secondary winding is quite large which often leads to production of heat and may

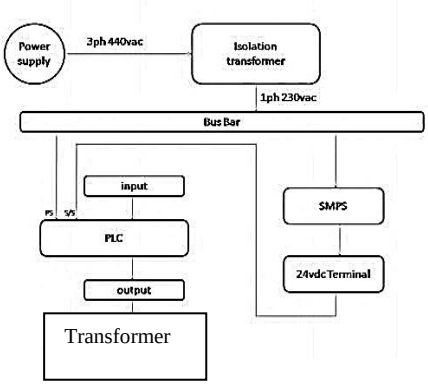
leads to failure in operation of transformer. The primary production of heat in windings of transformer is mainly concerned due to load connected to the transformer is keep on increasing due to increase in demand.In general process of power production,the transformer is placed between the alternator and grid .Incase any failure in transformer may leads to entire collapse in the system and it is quite complicate to mitigate from the effect of transformer failure.Transformer failure is often caused due to failure of the cooling system which is provided to reduce the heat developed in the windings of the transformer.Because of this event leads to development of many components and cooling agents which primarily focuses on the operation of transformer and its protection.There are lot of cooling methods available for transformer cooling but the mostly used cooling methods which use Air,Water,Oil as cooling agents is provided to the transformer based on their capacity. After sustainable development of electronic components and introduction of Relay type protection into the system which enhances the entire operation of the cooling system,but requires human instruction for each step. Incase if the temperature limit exceeds the limit secondary type protection automatically isolates transformer from the entire system,which results in steep down in both resource and economy.Incase of any fault,troubleshooting becomes very tedious as the circuit is complex due to wiring.So the relay based cooling system faces the problem of being reliable.After the introduction of automatic relay based controller known as Programmable Logic Controller(PLC) which automates the entire relay operation where system is provided with knowledge of choosing its own action.Since the load subjected to the transformer is keep on increasing as the demand is steadily rising leads to failure in operation of transformer because temperature developed in transformer can't be handled by single mode cooling system,which requires an alternative optimalsolution.So the approach of providing transformer by providing withmultimode coolants to the same transformer,where the controller can dynamically choose a particular cooling system based on actual temperature.The automated cooling system with controller is provided with different sensing devices can radically reduces the effect of heat developed and it is being controlled by the Programmable Logic Controller.The cooling system is being provided with temperature controller and function of temperature controller is to fed the data gathered by different sensing devices to PLC, where the controller indeed chooses the cooling system and operation is being controlled by PLC.The temperature limits is pre-determined and limit is fetched to the controller which chooses right cooling system for the different working temperature.When the temperature exceeds the limit of one particular cooling system then PLC approaches with alternate cooling system where the temperature is being monitored by the temperature controller.So the possibility of occurring transformer failure which mainly occurs due to effect of heat is reduced drastically.Thus the Multimode PLC based cooling system reduces the complexity of the cooling system in terms of wiring and enhances the operation of the transformer by providing transformer withwide operating range and enhances its protection.

II. LITERATURE SURVEY

The Multimode Cooling System to monitor,control and to reduce the heat developed in the windings of the transformer.The transformer cooling system can be controlled by using temperature comparators[3].The concept of providing automation in single mode cooling system for transformer by means of providing PLC[1].The operation of transformer cooling system can be enhanced by means of providing PLC,where individual cooling system is provided with an automated controller[2].The efficiency of motors which have been employed for oil and water cooling system which provides details for transformer[4].

III. ARCHITECTURE

A. HARDWARE ARCHITECTURE:



A. PROGRAMMABLE LOGIC CONTROLLER:

A Programmable Logic Controller (PLC) is computer based digitizer which is used to control electromechanical action which is being carried out by manual relays.PLC executes the operation and provides command to mechanical relays.There are different types of methods available for programming a PLC which includes Ladder logic,Functional block diagram,Structured text.The instructions to be performed is provided in the form of set of codes or in the form of logical representation where operation is executed in sequential manner..

Fig. Programmable Logic Controller

B. SWITCHED MODE POWER SUPPLY:

Switched Mode Power supply is an electronic switching circuit consisting of switching elements for converting DC or AC to small DC voltage range.SMPS basically carries out necessary switching operations to suppress the supplied voltage range to equivalent working range of the system.SMPS converts input supply voltage to voltage range of 24v which is subjected to all other components.

Fig. Switched Mode Power Supply

C. TEMPERATURE CONTROLLER:

Temperature controller is programmabledevice which is used to monitor the working temperature range and execute cooling operation based on the input data provided.Temperature controller monitors the operating temperature of transformer and compares them with pre-determined data limit.Incase of any mismatch then Temperature controller can dynamically choose a particular cooling systemfor a particular temperature where temperature range for each cooling system is pre-programmed.

Fig. Temperature controller

D. THERMISTOR :

Thermistor is device which continuously monitors the status of the system and indicates whenever the equilibrium of the system is disturbed.Since thermistor can indicate only the status of the system,so the data from the sensor is fed to Temperature controller which performs desired operation.

E. RELAY:

A Relay is an electromechanical switch which performs the switching operations based on the principle of electromagnetic induction.Relay performs all electromechanical operations based on commands provided by PLC.

Fig. Relay

IV. PROPOSED METHODOLOGY

A. PLC AND ITS COMPONENTS:

Since Programmable Logic Controller is digitizer device which is capable of handling any situations dynamically,so instruction to be executed is programmed to controllers. There are lot of methodology available for fetching program in PLC.One among many is ladder diagram in which the operation we want to execute is programmed in the form of ladder diagram which represents logical representation and performs sequential operation,where the data is preloaded into the PLC.Basically PLC is connected to normal AC supply of 230v.Suitable supply to all the necessary componenets such as Sensor,Temperature controller is fed by SMPS. Relay which performs all the manual operation commanded by PLC,where PLC takes the desired actions based on the program data fed.Temperature controller which acts as a cooling system controller is programmed with suitable temperature range.

B TRANSFORMER SETUP:

Transformer is device which needs extreme protection is being provided with different cooling setup and health of system is continuously monitored by temperature controller,so whenever upon exceeding temperature range,the cooling operation is dynamically choosen by the controller.The transformer is provided with many number of thermistor for detecting the temperature and fed the data to the controller.In this way heat detection of the transformer is provided by means of extreme heat detectors.

C COOLING SYSTEM:

The entire control of the cooling system is enhanced by means of providing a separate temperature controller ,which is completely pre-programmed and takes decisions according to the changing temperature.The controller is provided with different temperaturelimit for operation of different cooling system.So whenever reaching a certain temperature the controller dynamically chooses the cooling system according to the pre-programmed command.Whenever limit of one cooling system is reached,the controller chooses another cooling system.The various types of cooling system provided are Air type by means of providing fans,Water which is provided in the form of sprayer,oil which is

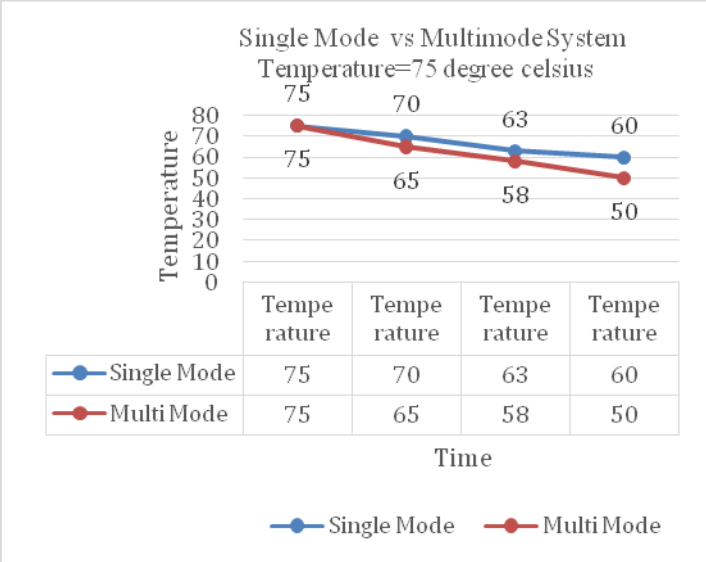
provided by means of solenoid.And also by the prior knowledge about of coolants and their cooling capacity where it is easy to feed the working range of coolants in the temperature controller.

D MONITORING SYSTEM:

The controller which is connected to the PLC which monitors temperature of operating transformer.The system is provided with multimode cooling system which operates under different operating temperatures.The PLC is programmed to operate automatically,when the temperature is reached.When the temperature reaches 65ºC, the fan cooling is operated. Similarly , when the temperature reaches 75ºC, the oil cooling is operated.When the temperature reaches 85ºC, both oil and fan cooling is operated. In this way the cooling is done in the power transformer automatically and temperature is controlled which enhances the operation of transformer and ensures ultimate protection for the transformer.

V. RESULT AND DISCUSSION

The Multimode Cooling for Power Transformer using PLC is tested in a prototype model with different operating temperatures. The enhanced model is comparatively more efficient than other cooling techniques. This technique is tested in different modes of operation and the system is stable in all modes of operation. Thus the multimode cooling system is capable of handling different temperatures of transformer. The operating temperature of transformer is dynamically monitored and the entire enhancement of cooling system is automatically controlled by PLC comparatively. The system can immediately react once the problem occurred.Thus the PLC operated cooling system can handle sudden rise in temperature and the efficiency of enhancing cooling is found to be more efficient.



VI. CONCLUSION

The outcome of this project is to select the suitable cooling method automatically based on temperature using PLC.The main application of cooling system, it can be used in power station for reducing the heat produced by the transformer automatically. peak demand is decreased comparatively. Dealing with issues related to insulation of sensors used along with the transformer operating at high voltages.With continuous development of PLCs, it is expected that larger amount of data storage, faster computing speed and protection of each individual components can be performed and operating range of transformer is enhanced.

REFERENCE

[1] Shreenivas Pai ; Neha Bansal ; Kama Desai ; Archana Doshi ; DevendraMoharkar ; MihirPathare, "Intelligent PLC based transformer cooling control system", 2017 International Conference on Nascent Technologies in Engineering (ICNTE),Details:978-1-5090-1/17,2017.

[2] Guojin Chen ; Ming Xu ; Tingting Liu ; Jing Ni ; DongXie 2013 Fifth International Conference on Measuring Technologyand Mechatronics Automation, "Intelligent Control System of transformer cooling based on DCS and Dual PLC", IEEE Conference,Details:978-0-7695-4932-3/12,2012.

[3] Waheed Khan ; Manzoor Ellahi ; BilalMasood ; Fuad Usman ; Ghulam Abbass, *"*Design of smart cooling system for power transformers*"*,**2018** InternationalConference on Engineering and Emerging Technologies (ICEET**)**

[4] OMICRON'S"Testing and diagonostics of transformers","https://www.omicronenergy.com/