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Review of Supervisory Model for Predictive Transformer Protection And Maintenance Using Wireless Sensor Network

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ABSTRACT

New technique are used Power transformers are traditionally protected by differential protection schemes that use voltages and currents to detect abnormalities in the differential zone of protection. A short circuit or high magnitude current must be present to activate a trip. Many transformer protection relays available today have protection functions that operate on insulating oil temperatures, calculated loss-of-life due to high oil temperature,and predicted oil temperatures due to load. These types of functions are not routinely applied, often since protection engineers may lack an understanding of the operating of these functions, and transformer operating conditions, to properly determine a settings me thodology. When looking at these temperature-based functions is the risk of accelerated aging, and transformer failure, is increasing. In utility operating practices try to maximize the utilization of power transformers, which may increase the occurrence of over-temperature conditions, and transformer aging. High-temperature conditions and gives aging are adverse system events that must be identified and protected against the damage. Protection can avoid further transformer damage by using the thermal protection standard. This paper discusses the fundamental thermal principles of power transformers,the of operations and the implementations of thermal protection.

Keywords: Oil-Immersed, thermal protection, etc.

1. Introduction

When transformers are already at their full the rating and extra capacity is needed, especially during summers. Transformer overloads can occur during conditions that are the product of one, two, system elements being isolated from the power the system. Depending on a utility's of, transformers may be allowed to be overloaded, To maintaining transformer integrity, to keep continuity of the load for economical reasons. To make these decisions intelligently, we must comprehend the thermal effects that oil and winding temperatures have on the life of insulation.

The no-load and losses created by the transformer core and windings will have high temperatures that, if not controlled in a timely manner, can damage the properties of the insulation. During normal operating conditions, the temperature thermal process is controlled by the cooling system that keeps the transformer in a thermal equilibrium. Transformer manufacturers guarantee the life of their product as long as it is operated under the temperature specifications. if transformers need to be loaded beyond condition. while Loading of Oil Immerse Transformers aids us in calculating the effect of life of insulation and its exposure to high temperatures. The guide also leads us through the value of the winding hot spot temperature, which is the driving factor for limiting temperature overloads. Knowing how the loss of life and the winding hot spot temperature is the foundation for the development of dynamic ratings for power transformers. Such ratings can be used by system operators during contingency conditions, which will allow them to overload transformers for a define time. Transformer dynamic ratings can also be set to create settings criteria for thermal relays. New numerical relays are capable of replicating the thermal model , and the relay engineer can set thermal limits based on the dynamic ratings established by the loss of life of insulation and winding hot spot calculations. In Thermal relays can predict future temperature condition based on constant present values. Such concepts can alarm system advance of a temperature in the transformer, giving them time to with the problems. In order to properly apply thermal protection for the power transformer, the thermal aspects during overloads is necessary. We must understand the causes for heat, the operation limitations, the insulation's loss of life and the hottest-spot temperature; we must also develop ideas and criteria for transformer dynamics ratings.

2. RELATED WORKS

The process of rebuilding in the field of electricity industry results in a need of innovative techniques for representing a huge quantity of system data. Overbye and Weber [9] have presented a summary on various visualization techniques that might fairly be helpful for the representation of the data. The techniques such as: 1) contouring, 2) animation, 3) data aggregation and, 4) virtual environments must prove to be quite useful. Yet, important challenges remain. The major challenges are: 1) the problem of visualizing not just the state of a existing system but also the potentially huge number of incident states, and, 2) the problem of visualizing not just the impact of a solitary proposed power transfer but of a great number of such transactions.

Johan Driesen et al. have discussed the model of an flexible energy measurement system consisting of a DSP, sensor and communication units. The modern electricity distribution networks utilizes this system, featured by multiple suppliers in a deregulated market, bi-directional energy flows owing to the distributed generation and a diversified demand for the quality of electricity delivery. Different features of the system relating to signal processing, communication and dependability were discussed. Their work also includes the examples of the use of such devices.

Daponte et al. have discussed the design and implementation of Transientmeter, a monitoring system for the detection, classification and measurement of disturbances on electrical power systems. CORBA architecture is utilized as communication interface by the Transientmeter, wavelet-based techniques for automatic signal classification and characterization, and a smart trigger circuit for the detection of disturbances. A measurement algorithm, developed by using the wavelet transform and wavelet networks, had been adopted for the automatic classification and measurement of disturbances.

The results that are obtained after the process of monitoring a distribution transformer during a period of 18 months was described and discussed by Humberto Jimenez et al. The transformer fed several households, each with a grid connected photovoltaic system, and it was identified that the power factor at the transformer attained strange low levels. This was because of the fact that under some circumstances, the systems offers a great portion of the active power that is demanded by the households, whereas the grid supplied all the reactive and distortion powers. The operating temperature was used as an indicator for the pressure on transformer. The temperature level was least when the systems were providing the maximum energy available from the solar cells.

Power quality monitoring systems are capable of detecting disturbances by means of Mathematical Morphology (MM) very quickly. Yet, the signal under examination is frequently corrupted by noises, and the performance of the MM would be greatly degraded. Sen Ouyang and Jianhua Wang [12] have presented a quick process in order to detect the transient disturbances in a noisy atmosphere. In this approach, the suitable morphologic structure element, appropriate mixture of the erosion and the dilation morphologic operators can develop the capability of MM. In addition, the soft-threshold denoising technique based on the Wavelet Transform (WT) was used for purpose of reference. Thus the abilities of the MM can hence be restored. This technique has possessed the following merits: 1) Great speed in calculation, 2) easy implementation of hardware and, 3) better use value. At last, the validity of the proposed technique is demonstrated by the outcome of the simulation and the actual field tests.

The propagation of non-linear and time-variant loads leads to a copious number of disturbances on the electric network, from an extremely significant distortion of both currents and voltages, to transient disturbances on the supply voltage. In this respect the electric network behaves as a “healthy carrier” of disturbances, so that a disturbance generated by single customer can be distributed to other customers, causing possible damages to their equipment. Evaluating the quality of the electric power that is present in a network section is consequently becoming an impelling requirement, mainly in a deregulated electricity market, where every actor can be in charge for the injection of disturbances. Yet, there are several respects of power-quality measurement, from both the methodological and instrumental point of views that are been unsolved yet and needs to be analyzed cautiously. An analysis of these problems and various suggestions about the development of the present research work on this area has been presented by Alessandro Ferrero .

Real-time monitoring of power quality necessitates great abilities of data-handling and data-processing. These requirements limit the possibility of monitoring, in spite of the fact that microprocessor-based monitoring systems have observed vital development in their storage and computational power. Development of compact algorithms will benefit power quality in the following two ways: 1.) they will allow monitoring of more points simultaneously for large systems, and, 2.) they will help in building powerful embeddable monitoring architectures within small power devices, such as a breaker, motors, or power drives. Antonio Ginart et al. 14] have proposed the use of the distance L1 norm as an indicator of power quality. They have shown how their approach has enhanced the computational and storage requirements. Their work has presented: 1.) analyses of the proposed norm, 2.) how it compared with traditional approaches, and, 3.) examples of its applications.

3. PROPOSED MICROCONTROLLER BASED SYSTEM FOR SUBSTATION MONITORING

Distributed transformers are prone to damages due to the raise in oil temperature when there is an overload or huge current flows through the internal winding of the transformer. When the oil temperature rises, it increases the probability of getting damages in the transformers. The transformers are to be monitored very cautiously during these situations. The proposed system consists of a monitoring unit that is connected with the distribution transformer for the purpose of monitoring the same. Hence, we introduce a simulation model which details the operation of the system to rectify the mentioned problem. The monitoring system is constituted by three major units, namely, 1. Data processing and transmitter unit
2. Load and Measurement Systems
3. Receiver and PC display unit

We have designed a system based on microcontroller (AVR) that monitors and controls the voltage, current and oil temperature of a distribution transformer present in a substation. The monitored output will be displayed on a PC at the main station that is at a remote place, through RF communication. The parameters monitored at the distribution transformer are compared with the rated values of the transformer. Additionally the breakdowns caused due to the overload and high voltage are sensed and the signals are transmitted to the main station using RF communication.

The software in the PC compares the received values with the rated measurements of the distribution transformer and shuts down the transformer so that it can be prevented from damages and performances can be enhanced quiet to a remarkable level. The controller consists of a sensing unit which collects the essential parameters such as current, voltage and the oil temperature within the distribution transformer. The digital display connected to the processing unit displays corresponding parameter values at the substation for any technical operations. The controller also senses the overload and high current flow conditions in the internal windings that may lead to breakdown of the corresponding unit. The microcontroller is programmed in such a manner so as to continuously scan the transformer and update the parameters at a particular time interval. The parameter values sensed by the microcontroller are transmitted through the RF transmitter connected to the microcontroller unit.

The transmitted signals are received at the main station using the RF receiver. The received signals are then passed to the PC. The software loaded in the PC is used to monitor the changes in the parameters that are measured from the distribution transformer. When a remarkable change is noticed in the measured values it controls the unit by ending it from any serious damages.

4. CASE STUDY

In order to analyze the efficiency of our microcontroller based monitoring system, we applied three various types of load at the output of the distribution transformer and transformer‟s operating parameters were calculated. Then the received parameters were analyzed with the transformer‟s rated values.

Case (i): The transformer was made to work under usual condition and no additional load is applied to the transformer. During this condition the received parameters were below the rated values of the testing transformer, thus confirming safe operation of entire unit. Under this condition, our monitoring procedures were only executed and the relay was kept in the closed position to allow power distribution. The oil‟s temperature was normal, the current and voltage level were very efficient and maintained normally.

Case (ii): When a small increase in the load was applied to the transformer it was observed that there was a small increase in the oil temperature and, the current and voltage values sensed by the controller was high. This change was due to the gradual increase in the level of oil‟s temperature. Here the measured parameters of current, voltage and temperature were under the safety level. So there was no change in the relay position. This stage also confirmed the safe operation of substation unit with a lower degree of risk.

Case (iii): In this case a heavy load was applied to the transformer and parameters were measured. Since the applied load was higher than the testing transformer‟s rated load the value of current, temperature and voltage also increased to a greater value. The measured parameters exceeded beyond the rated values. Now PC at the main station sends the required control signal indicating that the respective substation transformer is in a dangerous situation. Then the relay is unlocked, so that the substation unit completely shuts down. Thus the distribution transformer was protected from any damage.

The performance of the proposed system has been examined with three various types of loading which has been added to the transformer. From the experimental observations it can be understood that, the proposed system monitors and controls the transformer in an efficient manner. When a sudden rise in temperature was sensed by the system while monitoring the transformer, it directs the main station to shutdown the transformer and thus it guards the unit from any serious damages.

5.Conclusion

As determined in this paper, understanding the fundamental principles of thermal loading for power transformers is a critical factor in comprehending overload limitations for power transformers. The limitation on the loss of life of the insulation and the winding hottest-spot temperature are the driving factors for overload limits. These limitations allow us to create dynamic ratings and philosophies that give us guidelines for loading transformers beyond nameplate ratings. A microprocessor relay capable of protecting transformers for thermal overloads based on thermal principles of the IEEE guide was presented. In addition, an early warning system method was introduced that alerts system operators in advance of possible temperature violations.

This paper should provide relay engineers with the basic principles of thermal loading and protection. The microprocessor relay simplifies calculations and enables easier implementation. Nevertheless, a clear understanding of the thermal limitations of power transformers is necessary to apply the thermal settings. The engineer is encouraged to become very familiar with the IEEE standard if he or she wishes to know more about the loading of power transformers.

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