International Journal of Research in Advent Technology, Vol.2, No.9, September 2014
E-ISSN: 2321-9637

Advantage of Artificial Intelligence Technique in Discriminating Inrush and Fault Condition for Power Transformer Protection

Mr. Navjot singh Randhawa[1], Mr. Sushil Prashar[2]
Department Electrical Engineering, D.A.V.I.E.T., Jalandhar, Punjab, India[1, 2]
Student, Master of Technology, navjot.singhrandhawa28@gmail.com[1]
Assistant Professor, Prashar_sushil@yahoo.com[2]

Abstract— Transformers are key components for electrical energy transfer in power system. Stability and security of transformer protection are important for system operation and we found that many mal-trip cases of transformer protection are caused by inrush current problems. Thus this pseudo tripping of circuit breaker should be prevented for an uninterrupted power supply. Transformer protection is focused on discriminating the internal faults from the magnetizing inrush currents in the power transformer. This paper aims to propose the advantages of artificial intelligent technique on other methods of distinguishing the inrush and fault condition in the transformers.

Index Terms—flux-differential current; fuzzy logic; internal fault; magnetizing inrush; power transformer; protective relay.

1. INTRODUCTION

Transformer is expensive primary plant equipment within a power system network which needs to be isolated quickly and reliably in the event of a fault. Utilities have a responsibility towards the consumer to provide reliable and continuous power in the network without causing a large blackout or cascade power failure. Inrush and fault currents consist of DC component and harmonics and it is a challenging task to estimate and eliminate DC component which occur during transients.

Inrush current happening due to switching of a power transformer on no load may lead to resonance. A resonance is said to have occurred in the power system when there is a slow damping of inrush current. It has been observed that during inrush phenomenon, the magnitude of the inrush current depends on the switching angle and switching instance of the circuit breaker. In a typical normal operating scenario, the primary and secondary current of a power transformer maintains equilibrium but when an internal fault occurs, this balance is disturbed. The magnitude of the fault current depends upon zone of occurrence, the type of the fault (i.e. phase to phase, phase to earth etc), vector group of transformer (i.e. star-star, star-delta, delta-star). The magnitude of an inrush phenomenon is usually 10-15 times the normal[1-6].

2 MAGNETIZING INRUSH CURRENT

This occurrence of transient magnetizing inrush occurs in the primary side of transformer when it is switched on. This current appears as a internal fault and it is sensed as a differential current by the differential relay. The value of the first peak of magnetizing current may be as high as several times of the peak of the full load current. The magnitude and duration of magnetizing inrush current is influenced by many factors as described below[7].

- The input supply of voltage level.
- The instantaneous value of the voltage waveform at the moment of closing Circuit Breaker.
- The value of the residual magnetizing flux.
- Depends on the sign of the residual magnetizing flux.
- Type of iron laminations used in transformer core.
- The saturation of flux density in the core of transformer.
- The final impedance of the supply circuit.
- The size of the transformer.

The effect of the inrush current on the relay is false tripping the transformer without of any existing type of faults. From the principle of operation of the differential relay the relay compares the currents coming from both sides of the power transformer. As the inrush current flows through the primary side of the power transformer and therefore the differential current will have a significant value due to the existence of current in only one side. Thus the planning of relay is to recognize that this current is a normal phenomenon and not to trip due to this current. Hear figure 1 shows the transient period and steady state period of a current that flows through the

power transformer and this transient period is caused due to the inrush current phenomenon.

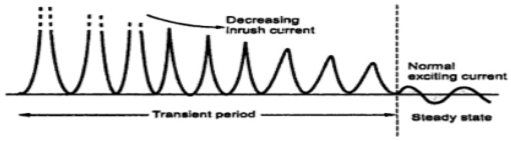

Fig 1 shows an transient period due to inrush current

3 POWER QUALITY PROBLEMS DERIVED FROM MAGNITIZING INRUSH CURRENT

From a power quality point of view the magnetizing inrush current can be considered as a distorted wave with two kind of disturbances.

2.1 Unbalance

2.2 Harmonics

Let us describe these problems caused by inrush current one by one.

2.1 Unbalance

Current unbalance can not be consider as disturbance. Asymmetrical loads produce unbalanced currents. In the same way the magnetizing inrush current produces current unbalance during magnetization. This condition can
be used in parallel with the second harmonic in order to know what it is happen during the connection of the transformer.

2.2 Harmonics

The current demand by the transformer during the magnetization contains all orders of harmonics. However only the second and third harmonics are relevant. The dc component can also be significant during the first cycles depending on the residual flux. The most dominating harmonics are as follows[8].

I. **DC or offset component**: A dc component can be found almost at all times in the inrush current, with different values for each phase of the three-phase system. The dc component is the function of residual flux.

II. **Second harmonic:** The second harmonic is present in all inrush current of all three phases. The value of the second harmonic is a function of the degree of saturation.

III. **Third harmonic:** Third harmonics in the inrush current can be found with the same magnitude that second harmonics. They are produced by saturation.

IV. **Higher harmonics:** Harmonics of high order are present with different values. Actually, they have small values so can be neglected.

4. TECHNIQUES TO DISTINGUISH INRUSH AND FAULT CURRENT

There are several ways of discriminating fault and inrush condition for protection purpose[9-10].

- **Desensitization method** is no longer being practised.
- **Wave shape recognition methods** are still relatively new and not widely practised.
- **Harmonic based methods**

These methods are widely practised. The inrush current has a large harmonic component which is not present in fault currents. Inrush currents generate harmonics with second harmonic amplitudes as high as 65% of the fundamental.

Thus SHR (second harmonic ratio) is used to discriminate inrush current from fault current such that, if SHR is less than threshold value then that condition can be considered as fault and if SHR is more than threshold value then there is inrush current condition

- **Using artificial intelligent technique**

New techniques like artificial intelligent technique (fuzzy logic controller) can help to discriminate between magnetization and fault conditions. Let us elaborate this technique and evaluate its advantages over others.

5. THE FUZZY LOGIC CONTROLLER.

The ideas of fuzzy set and fuzzy control are introduced by Zadeh. Fuzzy logic controllers are applied to many systems with linearity and uncertainty. Here is an figure showing the different parts in the fuzzy logic controller. The structure of fuzzy system can be classified according to the different applications. One of the most popular types is the error feedback fuzzy controller, which is called fuzzy logic controller (FLC). In conventional FLC, there are also PD-type FLC, PI-type FLC and PID-type FLC[12].

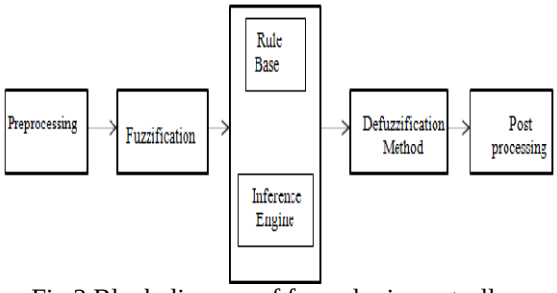

Fig.2 Block diagram of fuzzy logic controller.

The FLC having the following stages:

5.1 Fuzzification:

Fuzzyfication implies the process of the transforming the crisp values of inputs of a controller to the fuzzy domain.

5.2 Knowledge base:

The knowledge base of FLC consists of data base and rule base

- Data base:

It is used to provide necessary information for functioning of fuzzification module, rule base and defuzzification module

.

- Rule base:

The function of rule base is to represent in a structured way the control policy.

5.3 Fuzzy Inference System:

Fuzzy inference system has a simple input -output relationship. Input data from the external world is processed by the fuzzy inference system to produce the data the events having place in this process are referred as the basic fuzzy inference algorithm. Mamdani fuzzy is one of the examples of fuzzy inference system.

5.4 Defuzzification:

It is a process of transforming the fuzzy sets assigned to a control output variable into a crisp value. There are various methods of defuzzification but we used the mean of maximum method (MOM).

6 ADVANTAGES OF USING FUZZY LOGIC CONTROLER.

Fuzzy logic controller has many advantages and these advantages are as shown below[11].

- Inherently robust, not required precise, noise free outputs.
- Flexible
- Not limited to a few feedback inputs.
- Easily designed system.
- Can model non linear functions
- Can store the knowledge of database.
- Can be easily combined with conventional and allied control technologies.
- Conceptually east to understand.

7. CONCLUSION

This paper describes that fuzzy logic-based relaying is best for power transformer protection and includes clear fault discrimination between magnetizing inrush and internal faults i.e to enhance the fault detection sensitivity of traditional percentage differential current relaying algorithm fuzzy logic approaches are used for best output results.

REFERENCES

[1] Shantanu Kumar, Member IEEE and Victor Sreeram, Member IEEE " Elimination of DC Component and Identification of Inrush Current using Harmonic analysis for power transformer protection" IEEE 2013

[2] Okan OZGONENEL, Ondokuz Mayis University,Caner AKUNER, Marmara University "A study on magnetizing inrush current of different core Materials"

[3] Omar A.S. Youssef, A Wavelet-Based Technique for Discrimination Between Faults and Magnetizing Inrush Currents in Transformer, IEEE Transactions on Power Delivery, Vol. 18, No. 1, January, 2003.

[4]http://www.electrical4u.com/magnetizing-inrush-current-in-power-transformer

[5]http://literature.rockwellautomation.com/idc/groups/literature/documents/wp/mvb-wp011_-en-p.pdf

[6] Shantanu Kumar, Victor Sreeram,"Elimination of DC Component and Identification of Inrush Current using Harmonic Analysis for Power Transformer Protection "IEEE 2013 Tenecon – spring

[7] D P Balachandran, R Sreerama ,B Jayanand "Instantaneous Power Based Detection of Inrush Currents in Single Phase Transformers" 2012 IEEE

[8] Dauglas I tayloy, member , IEEE , joseph D law, " Transformer inrush current reduction using prefluxing" Jan 2013

[9] Reena moon "effect of magnitising current on different ratings of transformer" ijareeie April 2014

[10] Abdolmutaleb Abou safe "Modeling and calculations of inrush current in transformer" Damascus Univ. Journal Vol. (21)-No. (1)2005

[11] Matlab and its applications in engineering book by Bansal, Goel and Sharma

[12] Ahmed abdulkader et el " power transformer protection by using fuzzy controller" 2009.