Study of Magnetic Inrush Current of Power Transformer Using Power Electronic Devices in MATLAB

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Abstract- *In this paper, the effect of Inrush current on power transformer has been studied through the varying magnitudes of inrush current varied by firing a high switching device, in this case a TRIAC, at different angles. When a transformer is energized, it draws a very high current (almost 5-6 times higher than the normal rated current). This current drawn is known as the Inrush current and although this current have a shorter life span it is capable of dealing heavy damages to the transformer as well as the other equipments associated with the transformer.*

Keywords- Magnetic Inrush Current, And Transformer, Switching Devices, Thyristor.

I. INTRODUCTION

In power industry inrush current from transformer reactor energization have always been concerned. Inrush current occurs due to switching of power transformer on no load which leads to resonance. In a power system due to slow damping of inrush current magnitude of inrush current depend on switching angle and switching instance of transformer.

This paper provides effect of magnetizing inrush current on power transformer. The essential component is the transformer and their reliability. When the transformer is energized, the transient current is drawn at the starting period. This current continues to rise up to the tenth cycle, and this current is 5 to 6 times the rated current. The inrush current has various effects on the protective devices; the mechanical structure of the transformer might get damaged as well as power quality of the power system might get reduced.

When an unloaded transformer is switched on to normal voltage on its primary side or when a short circuit occurs on its secondary side then inrush occurs. The idea presented in this paper is by observation and research. In view of the fact that the inrush currents are always unbalanced among three phases, a neutral resistor could provide some damping to the currents. Inrush current in transformer is often gets less importance compared to other effects/faults. Though the magnitude of inrush current may be in some case less than compared to short circuit current, the frequency and duration of inrush current is generally more frequent, thus it will have more adverse effects compared to other faults.

II. INRUSH CURRENT INFORMATION

When a transformer is energized from a standard power source it draws high starting current which can be as high as 10 – 100 times of transformer's rated current. This current will starts to decay at the rate of effective winding resistance and will settle down to steady state condition.

The time to decay can be as long as few seconds. This current is known as magnetizing inrush current. Decay of this transient current is proportional to the series resistance of the transformer winding. If resistance of winding is ignored, the flux offset will never fall back to zero and inrush will r. In a real transformer, winding resistance will damp out the inrush. The decay time can range from a few cycles up to a minute depending on the transformer size and relevant design parameters.

III. EFFECT OF INRUSH CURRENT

A. **Mechanical and Electrical Stresses in windings**: The amplitude of inrush current can be equal to that of the short circuit current and may depends for loner time on system.

This can seriously damage the windings through over mechanical stresses.

B. **Harmonic Resonant Over-Voltages:** Transformer inrush currents are excess in harmonics. A sustain harmonic resonant over voltages may occurs and if this

over voltages found for a longer period of time, they may damage the device.

C. **Mall Operation Of protective Relays:** Due to high magnitude and asymmetrical nature of inrush current a voltage dip is observed by the system. The magnitude, duration and unbalanced of voltages in the respective phases are function of system impedance, source transformer capacities.

III. MODEL DESCRIPTION

The simulation models were developed using MATLAB with SimPower Systems. It is then used to simulate at different firing angles using high switching devices and observe the how much quantity of inrush current are reduced.

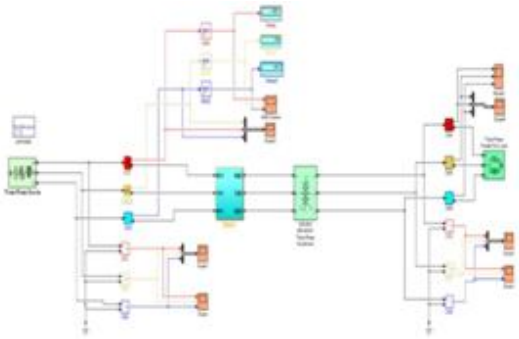

Fig1: Simulation Model

The model were developed with less numbers of blocks according to the model simplicity and reproducibility for the users.

In this stimulation model consist of three separate current measurement connect in series with power transformer in each phase similarly three voltage measurements are connected in parallel with power transformer in each phase for measuring the voltages.

CM 1 is current measurement for phase R
CM 2 is current measurement for phase Y
CM 3 is current measurement for phase B and similarly
VM 1 voltage measurement for phase R
VM 2 voltage measurement for phase Y
VM 3 voltages measurement for phase B.
RMS block is connected for better visualization of sine wave.

As shown in model for transformer 450 MVA, 500/230 KV is used. Current and voltage measurements are used in secondary side of transformer similar to the primary side and three phase RLC load is connected.

As shown in model TRIAC is used as a high switching device for minimizing the effect of inrush. But the TRIAC high switching device is directly not available in MATLAB library. So we have improve the circuit by making the TRIAC in MATLAB with using different components available in MATLAB library. To make the connection of TRIAC by using the parallel connections of two SCR's and taking the gate terminal common for triggering.

IV. SIMULATION AND RESULT

In the simulation result the inrush current of power transformer is decreases at different firing angles as shown in the following table.

In this table the inrush current is given at different firing angle for different phases. From the table consider an inrush current for R phases, the inrush current is maximum at firing angle 0 degree and minimum at 60 degree.

Table1:Inrush current of power transformer at different firing angle

SR No	Angle(degree) α	I(R) Amp	I(Y) Amp	I(B) Amp
1	0	877	1639	332
2	15	854.4	1673	827
3	30	752.8	1716	835.4
4	45	272.3	1746	649.7
5	60	258	1648	531.7
6	75	226.3	1282	278.2
7	90	254.9	874.2	134.8
8	105	321.6	499.1	368.1
9	120	320.1	218	487

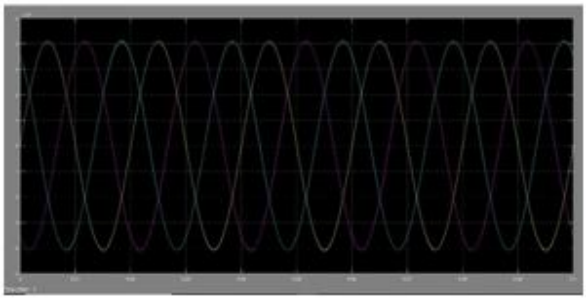

Fig 2: Normal AC sine wave in MATLAB

Fig. 2 shows the wave form of normal current flowing through the transformer without inrush current.

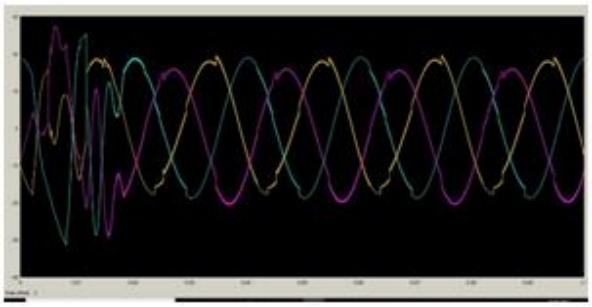

Fig3: AC sine wave with inrush current

During the transformer energization the inrush current is flown through the transformer at some milliseconds this current is represented by transient inrush current is shown in the fig. 3 and fig. 4.

Fig 4: Inrush Current

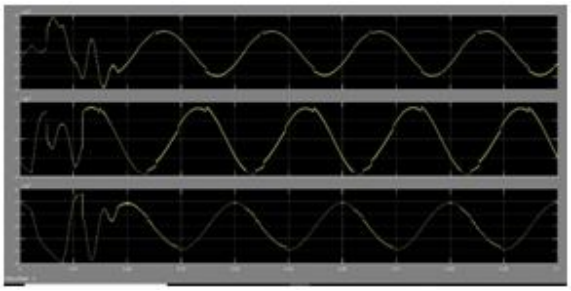

Fig 5.Inrush current at different phases

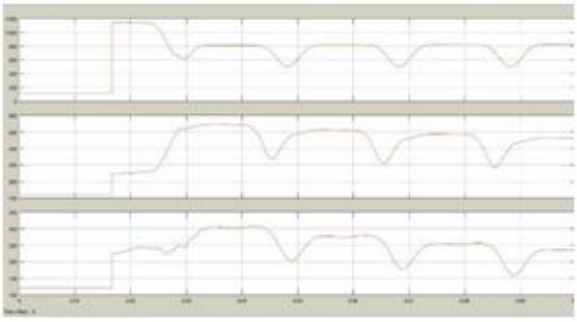

Fig 6. RMS value of inrush current

The inrush current for different phases is R, Y, B is given by in fig. 5 and the RMS value of inrush current is shown in fig. 6.

V. CONCLUSION

The magnetic inrush current is reducing by power transformer by using switching method. TRIAC is used to control the firing angle of transformer, when the firing angle is increase then magnetic inrush current is reduced.

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