Automatic Load Sharing of Distribution Transformers to Reduce Over all Losses in Distribution network.

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Abstract. An increase in the development of Industries and rapid growth in the population has led to an increase in the power demand in the distribution network. With these increased needs, the existing distribution transformer have become overloaded conditions. Due to overload on the transformer, the efficiency and power factor drops and also it led to increase in the transformer voltage regulation and windings get overheated. This paper presents a novel topology called transformer auto stop-start that will automatically energise and de-energise, one pair of transformers at a kV/V Distribution network. In this way, the proposed technique reduces overall electric losses. Performance of transformer under different load conditions are illustrated by simulation.

Keywords: Transformer overload, Distribution network, MATLAB/Simulink

1 Introduction

Transformer is a static device, that transfers alternating voltage from one electrical network to another electrical network by the principal of mutual induction. Distribution transformers are also called as heart of the power system and they place an important role in power system [1].

Now a days an increase in the development of industries and rapid growth in the population have led to an increase the demand on electrical power generation system. The increase in the needs of the consumers, the existing distribution network have become overloaded [2]. Due to overload on the transformer, the voltage regulation of transformer increases, the windings get over heated and also the efficiency drops [3]. These problems can be overcome by connecting the transformers in parallel [4-6]. The parallel operation reduces the burden on single transformer; thus, it increases the efficiency and reduces winding failure [7]. The main draw back of parallel operation was to operate with same rating of transformer [8-9]. This paper describes the operation of two different kVA transformers under different load conditions.

This paper is categorised into six parts: I Introduction, II proposed methodology, III Simulation of proposed technique, IV Simulation Results, V Comparison of parallel operation and proposed technique, VI Presents the conclusion of the proposed technique.

2 Proposed Methodology

Fig.1. Load sharing of two different rating transformers

The working of two different kVA transformer operating under Load is as shown in Fig.1. In this methodology, the transformer will automatically energise and de-energise one of a pair of transformer at a kV/V Distribution network. The open circuit and short circuit results of (150kVA+63kVA), 11kV/430V, Transformers are tabulated in the Table 1.

Table 1. OC and SC results of (150kVA+63kVA), 11kV/430V, transformers

Transformer (kVA)	Load (%)	Primary current	No- load loss (W)	Load loss	Total losses
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		(A)		(W)	(W)
63	0	0	165	0	165
63	10	1.122	165	18	283
63	20	2.224	165	464	629
150	30	3.336	270	372	642
150	40	4.448	270	662	932
150	50	5.56	270	1034	1304
150+63	60	6.672	435	1097	1532
150+63	70	7.784	435	1493	1928
150+63	80	8.896	435	1950	2385

3 Simulation of Proposed Technique

Fig.2. Simulation circuit diagram of 150kVA and 63 kVA system

The circuit diagram of a 3- ϕ , (150kVA+63kVA), 11kV/430V distribution system is as shown in Fig.2. Both the transformer primary are connected to 11kV bus through Circuit breaker. Circuit breaker are used to make or break the transformer in the circuit. The current and voltage sensors are used to measures the designed parameters. Based on the load condition, the Logic circuit will monitor the opération of Transformers.

4 Simulation results of proposed technique.

4.1 Results of (150kVA+63 kVA) transformer system for a load of 20kW.

Fig.3. (a). Secondary voltage of transformer 1 (T₁)

Fig.3 (b). Secondary Current of transformer 1 (T₁)

Fig.3. (c). Secondary voltage of Transformer 2 (T₂)

Fig.3. (d). Secondary Current of Transformer 2 (T₂)

Fig.3. Output waveform of (150kVA+63 kVA) system for a load of 20kW

The results of (150kVA+63kVA) distribution transformer system for a load of 20kW are shown in Fig.3. The secondary voltage of transformer T₁ and transformer T₂ are shown in Fig.3.(a) and Fig.3.(c)

The secondary current of transformer T₁ and T₂ are shown in Fig.3.(b) and Fig.3.(d). In this case, a load of 20kW is applied to the circuit. A applied load current is less than the rated current of transformer T₂. The logic circuit given a signal to turn-off 150 kVA transformer T₁. Now the transformer T₁ is isolated and transformer T₂ alone supplies the load until any control signal changes from the logic circuit. The output of 20kW load is shown in the Fig.4.

Fig.4. Output of 20kW load

4.2 Results of (150kVA+63 kVA) transformer system for a load of 80kW.

Fig.5.(a) Secondary voltage of Transformer (T₁) for a load of 80kW

Fig.5.(b) Secondary current of Transformer (T₁) for a load of 80kW

Fig.5.(c) Secondary voltage of Transformer (T₂) for a load of 80kW

Fig.5.(d) Secondary Current of Transformer (T₂) for a load of 80kW

Fig.5. Output waveform of (150kVA+63 kVA) system for load of 80kW

The results of (150kVA+63kVA) distribution transformer system for a load of 80kW are shown in Fig.5. The secondary voltage of transformer T₁ and transformer T₂ are shown in Fig.5.(a) and Fig.5.(c). The secondary current of transformer T₁ and T₂ are shown in Fig.5.(b) and Fig.5.(d). In this case, a load of 80kW is applied to the circuit. A applied load current is less than the rated current of transformer T₁ and greater than the rated current of transformer T₂. The logic circuit given a signal to turn-off 63 kVA transformer T₂. Now the transformer T₂ is isolated and transformer T₁ alone supplies the load until any control signal changes from the logic circuit.

The output of 80kW load is shown in the Fig.6

Fig.6. Output of 80kW load

4.3 Results of (150kVA+63 kVA) transformer system for a load of 170kW.

Fig.7 (a) Secondary voltage of Transformer (T₁) for a load of 170kW

Fig.7 (b) Secondary Current of Transformer (T_1) for a load of 170kW

Fig.7 (c) Secondary voltage of Transformer (T_2) for a load of 170kW

Fig.7. (d) Secondary Current of Transformer (T_2) for a load of 170kW

Fig.7. Output waveform of (150kVA+63 kVA) system for a load of 170kW

The results of (150kVA+63kVA) distribution transformer system for a load of 170kW are shown in Fig.7. The secondary voltage of transformer T_1 and transformer T_2 are shown in Fig.7.(a) and Fig.7.(c). The secondary current of transformer T_1 and T_2 are shown in Fig.7.(b) and Fig.7.(d). In this case, a load of 170kW is applied to the circuit. A applied load current is grater than individual rated current of transformer T_1 and transformer T_2 . Both the Transformers are operated.

5. comparison of proposed technique with parallel operation

The transformer losses under diffèrent conditions are as shown in Fig.8. The maximum loading of transformer is limited to 80%. If the load exceed, results in more heat dissipation in the transformer winding and also it reduces over all life of the transformer. In the proposed technique, at any instant of time transformer will automatically energise and de-energise, one of a pair of transformer at a kV/V Distribution network.

Fig.8. Graphical representation of transformer losses

It improve the system efficiency and reduces over all losses. From the graph it is clear that, the combination of two different transformer (150kVA+63kVA) system will results in less losses comparing with the two 100kVA transformer system.

6.Conclusion

Transformers the most generic and expensive equipment of the transmission and distribution network. Losses of the transformer mainly depends on rating and size of the transformer. Most of the villages and cities were suffering with electric instructions and it was due to transformer failure. In this paper, the system automatically couples and decouples the switch to share transformer loads and it was successfully achieving the load sharing of two different (150kVA+63kVA) transformer under load conditions.

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