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Research Article

Distribution Transformer Monitor of Food Refrigerated Transport Based on the Analysis of the Characteristic Quantity

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Abstract: With the increase of purchasing power, allowing consumers to pay more attention to food quality, including protein, vitamins, trace elements, rather than just buying the food. Power transformer is one of the key equipment in power system, it undertakes the voltage conversion, power distribution and transmission and provide the service of power, reliable transmission of electrical energy, has the extremely vital significance of flexible distribution and safe use. The safe operation or not, will directly relate to the whole power system could continuously. Therefore, the normal operation of power transformer is the power system safe, reliable, high quality, an important guarantee of economic operation, we must maximize to prevent and reduce the occurrence of accidents of transformer, but because of the long-term operation of transformer, fault and general accident could not be avoided completely.

Keywords: Electrical features, food refrigerated transport, loss ratio of negative, negative loss, power transformer

INTRODUCTION

With the increase of purchasing power, allowing consumers to pay more attention to food quality, including protein, vitamins, trace elements, rather than just buying the food. Only good storage capacity in order to ensure the quality of food will not decline over time, rather than only a "shell." Several studies have demonstrated the refrigeration equipment Air inhomogeneity, including non-uniformity of temperature and humidity, which will lead to food quality and safety deteriorated. In the cold chain, the type of equipment of different, difficult to control and maintain a stable temperature (Angel, 2009). Transformer fault diagnosis and online monitoring technology must be accurate and timely internal fault of transformer, transformer maintenance timely and reasonable arrangements, to ensure reliable power supply (Qi *et al*., 2005). At present, the transformer fault diagnosis on the original preventive test combined with gradually transit to the transformers online monitoring dissolved gas chromatography analysis supplemented by off-line diagnosis (Luder, 1974). Each part of the windings of the transformer failure are the most and internal fault of transformer is in the inter turn short circuit and development (Cai *et al*., 2005).

As the transformer fault involves a broader, more specific types of classification methods, such as the loop is divided from the main circuit fault, fault and magnetic circuit fault. If the main structure from the division, can be divided into winding fault, core failure, failure and accessories oil failure (Lian and Mark, 2005). At the same time the customary for the type of transformer failure is generally according to the common fault prone location division, such as insulation failure, core failure and changer fault (Man *et al*., 2010; Chia-Hung *et al*., 2008). The most serious impact on the transformer itself, at present incidence and is the highest transformer outlet short circuit fault, there is also leakage of transformer fault, the fault current of charged oil, protection misoperation fault. all these different faults. Types and some may reflect the thermal fault and some may reflect the power failure, some may only reflect the overheating fault and the existence of discharge fault and the variation characteristics of transformer leakage may not exist thermal fault or an electrical fault in the general case (Xu *et al*., 2007).

As the country began to focus on the construction of power distribution network power supply reliability and power quality, distribution transformers importance of safe and reliable operation safe and stable operation of the distribution network in more prominent, so the need to strengthen the operation of distribution transformer maintenance and improve distribution power system operation and economic benefits. Maintenance of electrical equipment maintenance afterwards be divided into regularly scheduled maintenance and condition-based maintenance three phases. Since the distribution system characteristics and development status of planning and construction, maintenance of distribution transformers mainly after

the overhaul and regular scheduled maintenance based. With the rapid development of the distribution system for distribution transformer diagnosis timeliness, timeliness and effectiveness of the increasingly high demand. This study expounds the parameters of transformer winding fault diagnosis model and current research situation, determine the fault diagnosis method for transformer winding, investigation and the causes of fault type distribution transformer winding.

RELATED THEORY

Research status of transformer parameter model: Research and many experts and scholars to the transformer primary winding fault involves building and transformer design optimization numerical model, winding insulation analytical techniques, research transient short-circuit winding, winding fault diagnosis technology, the winding state assessment methods. But research interests lie in large power transformers, distribution transformers for less research and ripe winding transformer fault diagnosis method is difficult to apply in the distribution system. Transformer is one of the most difficult to establish the accurate mathematics model of equipment in power system, can be based on the electromagnetic characteristics of transformer to provide data to build reasonable transformer model to predict the electrical performance of transformer for different operation conditions (Majid and Gamcel, 2010). Since the actual transformer parasitic components exist to store or use a small amount of energy, so the actual transformer model, the need to increase the four important parameters: the winding resistance produces copper consumption, eddy current and hysteresis loss of iron loss, leakage magnetic field winding around, the excitation characteristics of iron core, wherein the excitation characteristic curve of the iron core is the main reason of transformer nonlinear (Aleksandar and Vladimir, 2010).

Accurate transformer model need to consider the resistance and coil winding each turn of the coil mutual inductance and capacitance between the transformer model, yet so complex is unrealistic. Usually set up transformer model criterion is not affecting precision condition, ignore unnecessary parameters, parameter extraction key to establish the model of the transformer. So far, researchers put forward different types of transformer model, used to study the transformer transient fault and the steady-state failure, in which the transformer model is divided into two main categories: linear model and nonlinear model (Seungh *et al*., 2010).

The existing problem of power transformer fault detection: Since the implementation after the practice and experience of long-term accumulation based on periodic preventive test and repair technology to run time, before the formation of technical specification for continuous improvement. Obviously, from the regular repair transition to state repair, namely from the blackout the health state of equipment diagnosis to uninterrupted real-time or timing monitoring the health state of equipment, assessment and remaining life prediction and give the repair strategies, it is technological change, practice and operation experience needs a long time of accumulation, it may summarize the online monitoring and diagnosis technology of similar preventive test technical specification is to realize the real foundation of state repair system, therefore must pay attention to the operation of on-line monitoring device of some technical problems.

Sequence component of transformer: For the voltage current transformer side one or two phasor, after 120 after transformation, you can get the symmetrical component correspondence, which is stipulated as follows: Fl, F2 is divided into a primary side, secondary side two components, F1a, F1b, F1c three-phase component to a side, symmetrical voltage component the availability of a primary side of a transformer is U1a, U1b, U1c, U2a, U2b, U2c is expressed as:

$$\begin{bmatrix}\dot{U}_{1o(t)}\\ \dot{U}_{1o(2)}\\ \dot{U}_{1o(0)}\end{bmatrix}=\frac{1}{3}\begin{bmatrix}1 & a & a^2\\ 1 & a^2 & a\\ 1 & 1 & 1\end{bmatrix}\begin{bmatrix}\dot{U}_{1a}\\ \dot{U}_{1b}\\ \dot{U}_{1c}\end{bmatrix}\quad\begin{bmatrix}\dot{U}_{2o(t)}\\ \dot{U}_{2o(2)}\\ \dot{U}_{2o(0)}\end{bmatrix}=\frac{1}{3}\begin{bmatrix}1 & a & a^2\\ 1 & a^2 & a\\ 1 & 1 & 1\end{bmatrix}\begin{bmatrix}\dot{U}_{2a}\\ \dot{U}_{2b}\\ \dot{U}_{2c}\end{bmatrix} \quad (1)$$

Load loss, namely iron loss, referring to the port when a voltage is applied to the transformer primary flux electric power consumed in the core. With the same load loss, load loss also includes two parts, one is the basic loss, in addition part of the additional loss caused by the leakage magnetic field. The basic loss includes hysteresis loss and eddy current loss.

Fault diagnosis method for power transformer:
The structural characteristics of insulation of oil immersed power transformer: According to the capacity of oil immersed transformer can be divided, generally considered as belonging to a small capacity transformer below 630 kVA, a 6300 kVA transformer for medium sized transformer, transformer 63000 kVA for large transformers, 90000 kVA and above are collectively referred to as the oversize transformer insulation oil filled transformer. The main production at home and abroad mostly adopts the oil barrier insulation structure the insulation system, the structure of classification is shown in Fig. 1:

Distribution transformers are electrical distribution systems necessary equipment, distribution transformer winding faults of power supply reliability to the distribution system bring great challenges. About 70-80% of the distribution transformer failures are caused by the transformer winding faults between winding turns of winding insulation damage caused by short-circuit and short circuit winding on the ground is the main cause winding failure. When the distribution transformer winding short-circuit, the entire winding can be divided into several sub-winding short circuit, due to the resistance and inductance matrix after short circuit winding changes, resulting in a short circuit

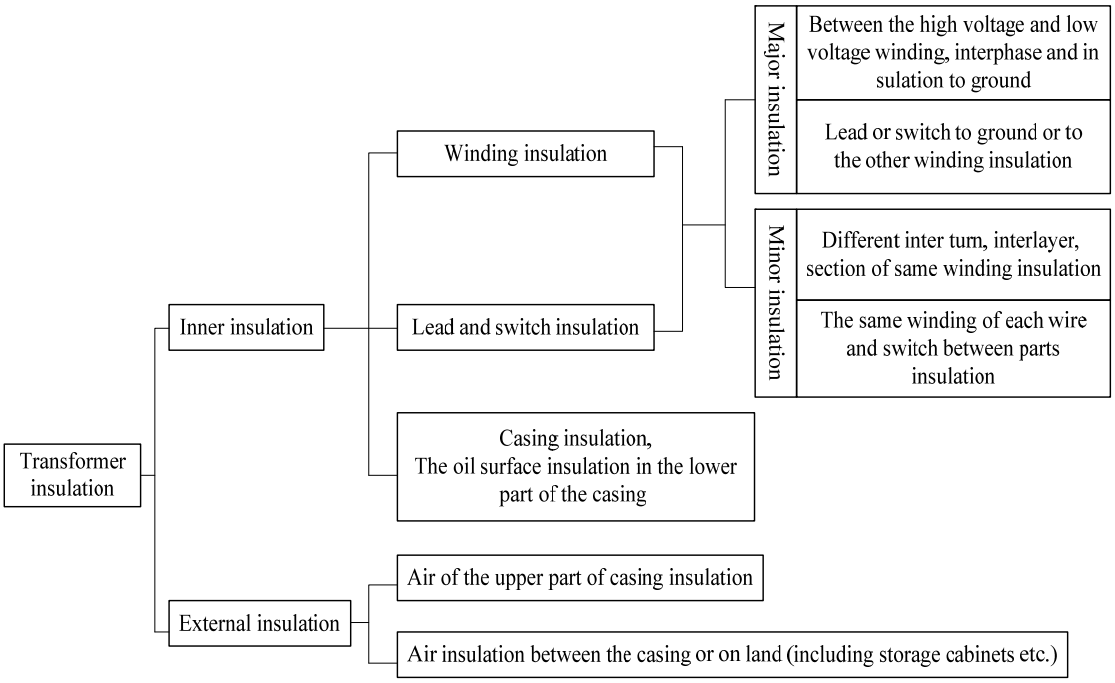


Fig. 1: Classification of insulation of oil immersed power transformer

Table 1: The criterion of three ratio method with no code

Property of fault	C_2H_2/C_2H_4	C_2H_4/C_2H_6	CH_4/H_2
Low-temperature superheated<300°C	<0.1	<1	Irrelevant
Middle-temperature superheated 300-700°C	<0.1	1<ratio<3	Irrelevant
High-temperature superheated >700°C	<0.1	>3	Irrelevant
High energy discharge	0.1<ratio<3	Irrelevant	<1
High energy discharge and overheating	0.1<ratio<3	Irrelevant	>1
Low energy discharge	>3	Irrelevant	<1
Low energy discharge and overheating	>3	Irrelevant	>1

stator windings have different current distribution, resulting in the leakage magnetic field distribution transformer occurred change, electrical power each segment winding around winding leakage due to changes in the magnetic field and current change, while energy leakage magnetic field of the whole winding as the winding axial magnetic field component and a radial component of the magnetic field variation and change, thereby causing a short circuit reactance of the windings and the end of the current changes.

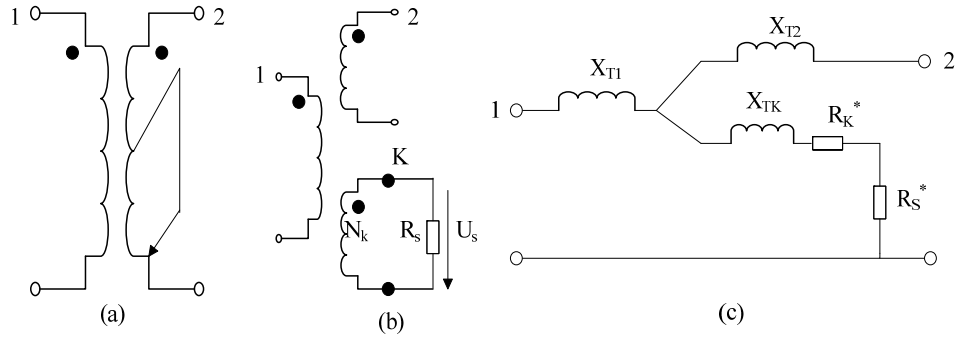
Method for judging the nature and type of transformer faults: Three ratio methods have played an important role in the fault diagnosis of power transformer, it is a kind of method recommended by IEC, it is actually a modified Rodgers ratio method. The method is by calculating the ratio of C_2H_2/C_2H_4, CH_4/H_2, C_2H_4/C_2H_6 three, based on the known coding rules and classification method, look-up table to determine the nature of the fault, as shown in Table 1:

Analysis of short circuit fault inside transformer: Figure 2a showing the occurrence of the interturn short circuit conditions of single-phase two winding transformer, regardless of inter turn short circuit occurs in 1 or 2 winding winding, Nk can be shorted turn as the third winding and third winding short circuit occurs (Fig. 2b), which is fully equivalent, FIG. where is the fault point and arc resistance, short circuit current, inter turn insulation arc path, oil pressure, temperature and other factors concerned, test results show, the arc voltage in insulating oil Ub is about 5-150V, the general desirability for rated voltage of 75v. Third winding can be expressed as:

$$U_{3N} = \frac{N_K}{N} U_N = \alpha U_N \tag{2}$$

To make the Fig. 2b of the equivalent circuit, wherein R is winding resistance, when a small number of short circuited turns, can be compared with the equivalent reactance of Nk quasi, regardless of Rk will cause the interturn short circuit current large error, Rg, Rk can be expressed as (Fig. 2c):

$$R_{g^*} = \frac{R_g}{\frac{U_{3N}}{I_{3N}}} = R_g \frac{1}{\alpha^2} \frac{S_N}{U_N^2} \quad R_{K^*} = R_K \frac{1}{\alpha^2} \frac{S_N}{U_N^2} \tag{3}$$



Single-phase two winding transformer interturn short circuit and its equivalent circuit

Fig. 2: The occurrence of the interturn short circuit conditions; (a): Interturn short circuit; (b): Equivalcent of three window transformer; (c): Equivalent circuit

Set field circuit coupled physical model, it is necessary to set in different parts of the winding is shorted to ground control switches, by controlling the switch occurred in different parts of the control winding is shorted to ground fault. According to the field winding is shorted to ground circuit Coupled Model of the design requirements, the need to distribution transformer primary winding and the secondary winding is divided into n series of coils.

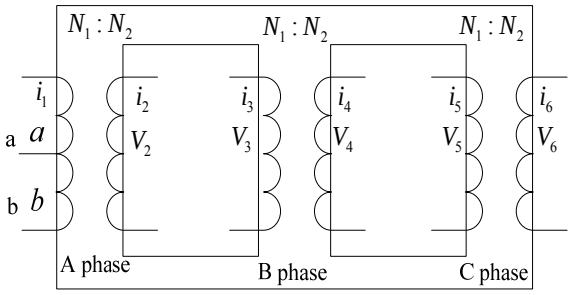


Fig. 3: Three-phase transformer winding turn to ground fault

EXPERIMENTAL RESULTS

Mathematic model of winding short circuit fault: To the internal fault of transformer is calculated, the physical model must first establish transformer winding fault. Based on the transformer inductance and mutual inductance matrix model of winding ground fault occurs, the differential equation of port voltage and current is expressed as:

$$[V]=[R]_D[I]+[L]_D\frac{d}{dt}[I] \tag{4}$$

In it:

$$[V]=[V_a \quad V_b \quad V_2 \quad V_3 \quad V_4 \quad V_5 \quad V_6]^T$$
$$[I]=[I_a \quad I_b \quad I_2 \quad I_3 \quad I_4 \quad I_5 \quad I_6]^T$$

Short circuit resistance and inductance matrix differential equations by the 6 order matrix under normal circumstances becomes 7 order matrix. The establishment of transformer winding to ground fault model, need the fault winding is divided into 2 sub windings a, B, to calculate the winding of distribution transformer grounding fault. For example in the transformer high voltage winding a phase to ground fault occurs, the winding is connected with the site is divided into two sub windings (Fig. 3).

Distribution transformer windings to ground short circuit occurs, it causes the winding ground upper and lower portions of the coil current distribution changes. Change the current distribution of windings can cause a secondary winding turns axially An uneven distribution so that the leakage magnetic field winding between the transverse component of the increase, but a decrease and short partial winding ampere-turns of the winding of the change in the current direction and the size of the leak will affect the distribution of the axial magnetic field distribution transformers and thus calculate the different transformer windings to-ground short circuit transformer leakage magnetic field distribution is necessary.

The dynamic simulating test: Based on the fault diagnosis of power transformer online monitoring, flow chart of electrical characteristics was shown in Fig. 4. The first step to start the online monitoring program of power transformer, for the initial value of the examination; the second step is the transformer on-line electric quantities of data collection, the wiring of transformer on both sides of the concrete as shown in Fig. 4.

Transformer shorted to ground one at a time point, calculate different short to ground fault transformer leakage distribution of the field winding 145 every turn coil set. Figure 5 is a normal winding and winding turns of the coil 725 is shorted to ground occurs when the leakage magnetic field of the transformer comparison chart.

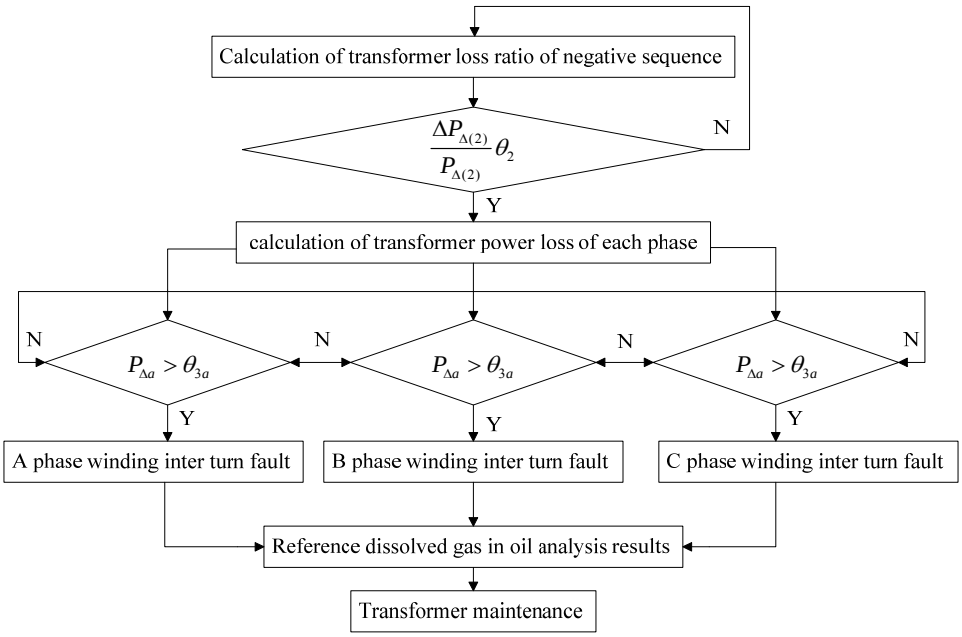


Fig. 4: The wiring of transformer on both sides of the concrete

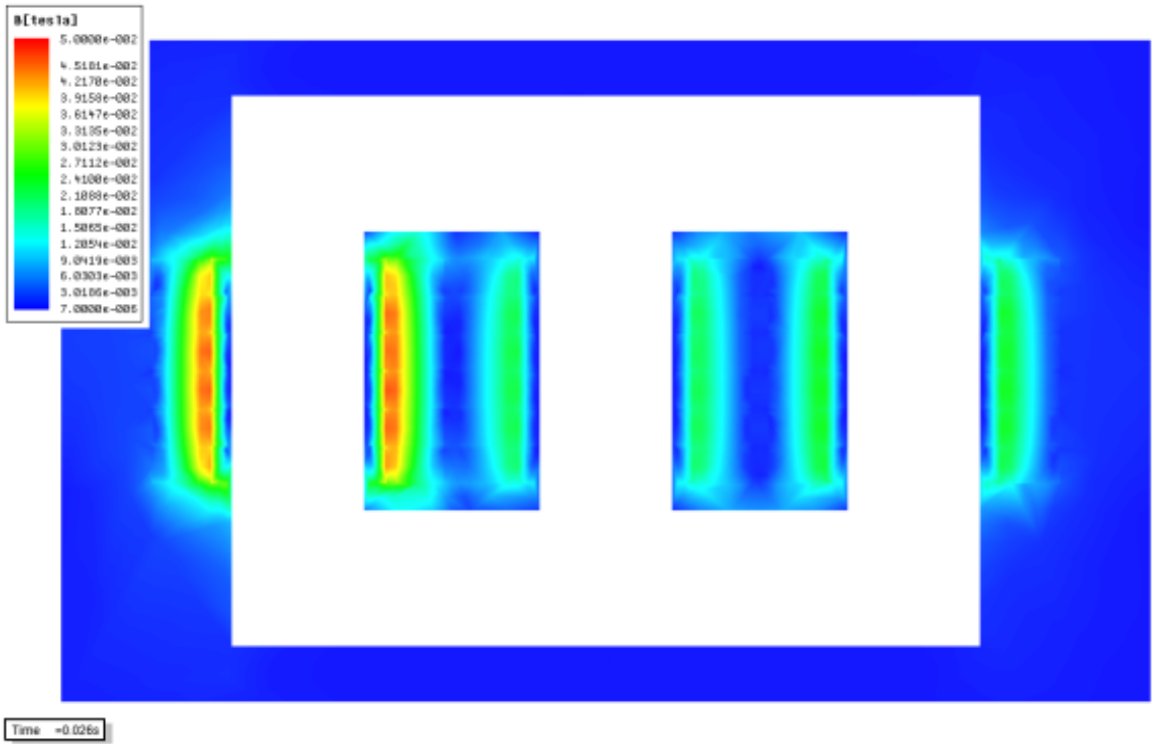


Fig. 5: The normal winding and winding turns of the coil

CONCLUSION

This study introduces the structure characteristics of power transformer, summarizes the form and characteristics of transformer fault, this study summarizes the status of transformer fault diagnosis and its commonly used methods and the hot and difficult to fault diagnosis of transformer) online monitoring technology status and characteristics of different principle of online monitoring technology and the problems of a more comprehensive exposition, also made a brief introduction of transformer state maintenance and online monitoring technology. Then this study in detail analysis of the physical phenomena

of the internal fault occurs when the transformer principle and equivalent circuit and transformer winding interturn fault occurrence, mechanism of changes of internal magnetic field of transformer interturn short-circuit and the power loss of transformer and the changes of transformer loss ratio of negative sequence are discussed.

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