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Stationary system for monitoring technical state of power transformer

S.A. Evdokimov, Yu.N. Kondrashova, O.I. Karandaeva*, M.S. Gallyamova

Nosov Magnitogorsk State Technical University, Lenina Av. 38, Magnitogorsk, 455000, Russia

Abstract

Implementation of stationary systems of continuous monitoring technical state of power transformers is considered to be an important and relevant task. The paper provides a summery on the systems implemented at transformers of OJSC Magnitogorsk Iron and Steel Works. It characterizes the transformer of the power generating set of the thermal power plant equipped with the system for monitoring technical state. It lists diagnostic methods and offers an integrated system structure. The monitoring system is based on TDM package developed by OAO Dimrus. As a device for oil condition control, the Hydran M2 analyzer identifying gases dissolved in oil was used. Functions of separate modules, their version and arrangements are under consideration. The system interface is characterized, too. The main screen of controlled parameter of the transformer is provided in Inva-format. There is a challenge to develop methods for fault localization and identification based on the total of diagnostic features. The paper highlights a practical need for investigation of discharge activity with portable devices for control of partial discharges.

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Keywords: power transformer; technical state; monitoring; control methods; stationary system; structure; functional composition; equipment; interface; implementation; recommendations.

The systems of continuous control (monitoring) are designed to prevent failures of power transformers accidents; they use a sensor set for recording various parameters change of which indicates developing defects. Due to the introduction of modern methods and means of effective diagnostics, operational personnel is provided with the following data:

* Corresponding author. Tel.: +7-351-943-1256.
E-mail address: AED174@mail.ru

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- current technical condition of the transformer, sources and defects which have stipulated its deterioration;
- remaining (currently) service life, that is, the possible time period at which their failure-free operation is possible despite the revealed and developing defects;
- optimal terms of the maintenance of this equipment needed to provide its failure-free operation.

These purposes are inseparably associated with each other; the most difficult of them is the issue of effective detection of a current technical state.

It is practically to analyze the state of power transformers in on-line mode without shutdown for maintenance (continuous diagnostic method). Currently, innovative computer-based methods for control of transformers' condition are being intensively developed and implemented; they ensure automatic data collection, processing and analysis. Engineering support of these methods consists of various detectors or sensors directly installed on the equipment.

1. Problem statement

The list of priority areas of OJSC Magnitogorsk Iron and Steel Works includes provision of main facilities with means for technical diagnostics because its transformer stock is largely overaged. Correspondingly, the methods of diagnostics in the real time mode play an increasingly prominent role. Within the framework of the implementation of the adopted strategy, the systems for continuous control of technical state of transformers installed at the arch steel-making and ladle furnaces of the electric steel-making steel works shops have been developed and commissioned [3–7]. A similar system has been mounted and commissioned at NDMS 63000/100000/110U1 transformer at sub-station No. 96 of the network and sub-station shop [8]. These systems are based on the diagnostics equipment of OAO Dimrus (Perm) which is operated at many domestic and foreign power facilities. The main purpose of works performed is reduction of accidents and outages of the essential equipment.

At present, the stationary system for continuous control of technical state of 80 MVA transformer at power generating unit No. 4 of the combined heat and power plant at OJSC Magnitogorsk Iron and Steel Works has been successfully implemented. A number of issues has been solved at its development including the following:

- validation of system functions and diagnostic methods;
- structure development, selection of diagnostic equipment;
- mounting, testing and pilot commissioning.

Therefore, company's proprietary developments were adapted according to specific conditions and requirements of the customer.

2. Main part

TD-80000 power step-down three-phase oil transformers are manufactured at Tolyatti's Transformer plant (OOO Tolyattinsky Transformator). TDN-80000/110-U1 110 kV type two-winding transformer is equipped with high voltage controller operating within the range of 16% with the ONAN, ONAF or OFAF cooling system. These transformers are designed for operation at power plants completed with the generator. See specifications in Table 1.

The following diagnostic methods are validated for the system of monitoring transformer condition:

1. Transformer oil assessment:

- control of oil humidity;
- monitoring content of gases resolved in oil.

2. Thermal analysis:

- monitoring temperatures of the higher and lower oil layers;
- control of environment temperature.
- 3. Electrical analysis:
- measuring operating currents and voltages of the transformer;
- measurement of the dielectric loss angle tgδ, capacity of basic insulation and current imbalance of galvanic currents of inputs.