Stage I Foundation of the structure of a smart monitoring system for power transformer cooling system

Stage objectives

Foundation of the structure of a smart monitoring system for power transformer cooling system

Activity I.1 Studies and analyses regarding the transformer monitoring

Activity I.2 Study on specific integrated and smart sensors usable for the cooling system monitoring

Activity I.3 Analysis of the methods used by prestigious companies and development of an own monitoring method for the cooling system

Stage summary

Within this stage, the activities from the achievement plan have been approached by CO-ICMET Craiova and P1-University of Craiova, having in view their compliance with the project objectives.

Activity I.1 Studies and analyses regarding the transformer monitoring

The importance and necessity of on-line monitoring for the safety of power system, supplied consumers and environment have been established.

That is why the problem of maintenance for electrical power equipment has been more and more emphasized lately. If up to present, the time based maintenance (TBM) with periodical revisions was used, in the last years there were attempts to find solutions for passing to condition based maintenance (CBM), which allows cost decrease, extension of equipment life and reduction of the risk of failures in operation, with severe consequences.

There are presented aspects regarding ICMET Craiova (CO) expertise in the field of monitoring by developed equipment variants of MONITRA-type, focused on: tank oil temperature, winding and magnetic core temperatures and partial discharges in bushings. The installation software provides the equipment testing, input quantities acquisition and data processing, data recording in an own nonvolatile memory NVRAM, alarm level assignment, communication with a PC etc.

Activity I.2 Study on specific integrated and intelligent sensors usable for the cooling system monitoring

For cooling the electric and magnetic circuits, each power transformer is fitted out with many cooling batteries, having marked on them their type and power. So, in a cooling battery, by means of the forced circulation of the insulating oil through the fan interstices (circuit closed by electric pump), the heat exchange with the external air with forced circulation (open circuit with electric fans) is carried out.

For being able to monitor on-line these quantities and phenomena, information is collected by means of the transducers with unified voltage signal (0-20 V) or unified current signal (4-20 mA), or of digital type.

The measurement of liquid and gas characteristics imposes the use of industrial automations, such as:

-Temperature transducers like thermal temperature sensitive resistors and thermocouples

-Relative/absolute pressure transducers with electric sensors of resistive, piezoelectric type

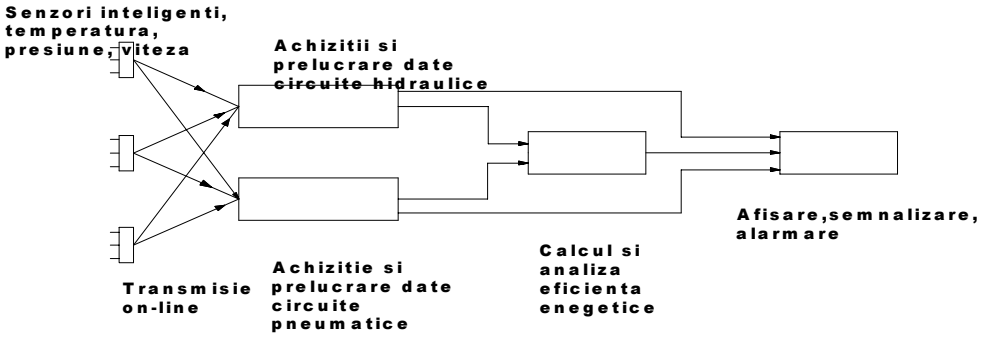
-Transducers for determining the flow velocity. The velocity is indirectly determined by measuring the dynamic pressure using Pitot-Prandtl sensors

Activity I.3 Analysis of the methods used by prestigious companies and development of an own monitoring method for the cooling system

Internationally, both in technical committees and at the meetings of specialists in the field of electric energy generation, processing and distribution and at the meetings of electrical equipment manufacturers (ABB Sweden, Siemens Germany, Alstom France, etc), main directions on equipment operation under safety conditions for power system and environment have been set. So, transformer monitoring is focused on new functions like oil moisture, on load tap changer, insulation system, cooling batteries system etc.

For the transformers manufactured in the country of for the imported ones (ABB, Siemens) which are in operation or in the stage of their mounting in the national power grid, monitoring is not focused on the cooling batteries condition or efficiency. The cooling batteries are only fitted out with local/remote indicators for oil circulation, which offer information like “it flows” or “it does not flow”, without being able to make quantitative or qualitative assessments.

So, an own method for analysis and monitoring was developed:



Together with the partner P1-University of Craiova, we set the mathematic model for assessing the oil and air flow rates, the heat flow released by oil and heat flow taken over by the cooling air and we developed the calculation algorithms and logical diagram. The assessment of the cooling system efficiency consists in comparing the heat flow released by the oil circuit with the heat flow taken over by the air circuit, for which the Simulink block diagram was developed.

By this, I consider that the objectives of this stage are achieved; premises are offered for continuing the activities within stage II of the project.