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Technique of Processing of Thermo grams of Power Transformers

Yuri,V,Vankov and Osamah, M, Al-aomari

Abstract— The conducted researches allowed to reveal shortcomings of the existing techniques of thermo vision control of an assessment of a condition of transformers one of which is low extent of automation of the analysis of thermo grams.

Keywords: Power transformer, thermo grams, Mathcad programs, thermo graphic functions, analysis of pictures.

I. INTRODUCTION

The modern level of development of the industry makes great demands of reliability of the equipment. In power industry of Russia about 50% of transformers developed the resource. In this regard the necessary level of operational reliability can be supported applying methods and means of nondestructive control. Introduction of devices of infrared equipment in power is one of the directions of development of highly effective system of technical diagnostics. Timely carrying out thermo vision inspection allows revealing defects at an early stage, to predict their development. However a problem here that the analysis of results of thermo vision inspection of the equipment is influenced by subjective factors.

Due to the fact that the market has a large number of producers of thermal imagers, each of which is supplied specialized software for researchers is delivered there is a question of processing of thermo grams of the different producers received on the equipment. [3]

At information processing of image formats for the purpose of control of the technical condition of the objects the emphasis is placed not only on visualization of information, but also on definition of numerical characteristics of images. Therefore, in the specified sphere of researches not graphic editors who have the developed tools for work with graphics, and mathematical environments in which tools for graphics are less developed take advantage, but there is an opportunity to express features of graphics numbers and, respectively, to carry out necessary mathematical processing. One of such mathematical environments is MathCAD. [1]

II. THE WORK PURPOSE

Is development of a technique of processing of thermo grams regarding detection of defects of power transformers? Primary information is the thermo grams received from surfaces of the surveyed objects by means of thermal imagers. Figure 1 shows the thermo gram of the transformer, having a defective circulation of oil in the radiator.

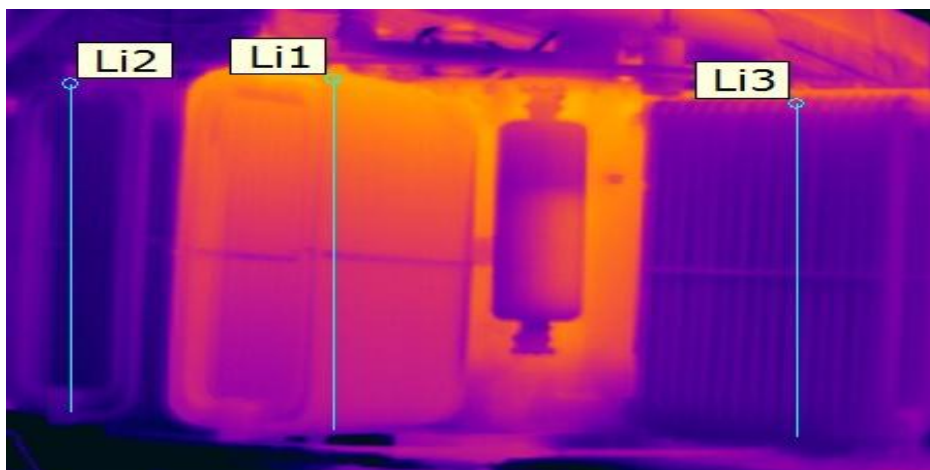


Fig.1 Thermo gram of object

In case of lack of circulation of oil in a transformer tank temperature of oil is approximately same on tank height. Therefore at creation of the schedules reflecting change of temperature of oil in tanks of the transformer (fig. 2), in case of existence of defect the divergence of schedules is observed. The analysis of data on these Δt showed that to bulk of defects there corresponds the area $\Delta t \epsilon$ (5; 23), and $\Delta t \epsilon$ (0; 5) in most cases speaks about lack of defect.

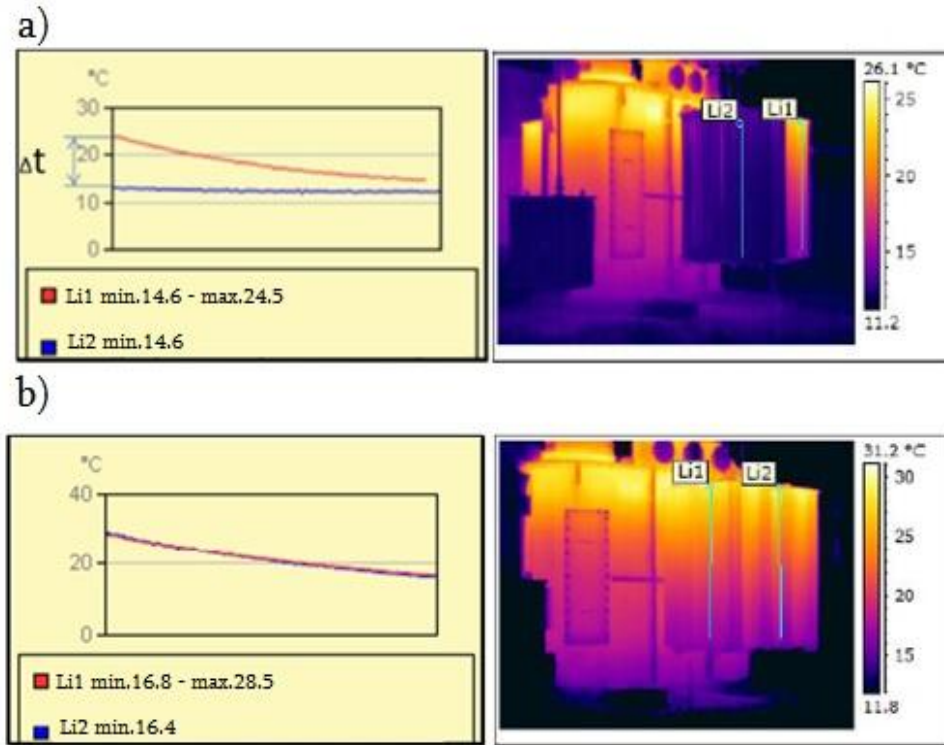


Fig.2 Graph of change of temperature of oil in transformer tanks

(a – lack of circulation of oil in transformer tanks, b – norm)

In the analysis of pictures a lot of things depend on the operator, and there is a possibility of errors. Proceeding from it, there is a requirement of search of opportunities to leave from subjectivity and to develop a technique of the computer analysis.

III. THE METHOD OF ANALYSIS OF THERMO GRAMS

Thermal emission sources in the transformer are:

- A magnetic, massive metal parts of the transformer, including the tank pressing rings, screens, hairpins, consoles in which heat is allocated due to losses from the vortex currents induced by dispersion fields;
- current carrying parts of inputs where heat is allocated due to losses in current carrying part and transitional contact connections of branch of a winding;
- Transitional contact connections of RUL and SWE.

Heat removal from heating sources to oil is carried out by convection in this connection, temperature contrasts on a surface of a tank have insignificant size and are indistinct on rather considerable surface. The accounting of this physical effect also is the basis for a functional method of detection of thermal defects on power transformers, autotransformers and the shunting reactors. [2]

Distribution of temperatures on a transformer T surface (x, y) bears information of the following character:

- About existence of the distributed thermal emission sources in active part;
- About system effectiveness of cooling;
- About existence of the local temperature anomalies caused by the latent defect of thermal character.

Means of MathCAD drawing turns into a matrix which has values of numbers from 0 to 255. The fragment of a matrix is represented in fig. 3. MathCAD allow to receive sub matrixes of three components of flowers: red, blue and green.



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B =

	1	2	3	4	5	6	7	8
1	83	74	57	46	39	35	36	39
2	83	74	57	46	41	37	37	40
3	82	73	56	46	44	40	40	43
4	81	73	56	47	47	44	44	46
5	80	73	58	50	50	49	49	50
6	80	73	58	51	49	49	50	53
7	79	72	58	51	50	50	52	55
8	76	70	57	51	53	53	54	58
9	75	69	57	52	54	53	55	60
10	77	71	58	52	52	51	53	59
11	76	70	57	51	52	51	54	61
12	73	67	54	50	53	54	58	...

Fig.3 Fragment of a Matrix of the Color Image in the .jpg format.

Initial function of two-dimensional distribution of temperature on a surface of the object control of T (x, y) it is represented the thermo gram.

$$F(t^{\circ}) = \sum \sum T(x, y, t^{\circ})$$

The received thermogram is integrated in limits [x1, x2] [by y1, y2] for receiving the ordered massif presented by fig. 4

t°_1	t°_2	t°_3	t°_4	t°_n
F_1	F_2	F_3	F_4	F_n

Fig. 4 Transformation of the thermogram to the ordered row

The Value F (t°C) at this size of temperature characterizes the relative size of a surface of object with this temperature of t °.

IV. ASSESSMENT OF TECHNICAL CONDITION OF THE TRANSFORMER ACCORDING TO THE ANALYSIS OF THERMOGRAPHIC FUNCTIONS

THERMAL INFORMATION FUNCTION OF OBJECT IS FORMED BY STATISTICAL PROCESSING AND AVERAGING OF CURVES ON THE OBJECT IN "NORM".

Power of thermal processes in the range of temperatures [t1; t2], both object, and its fragments is calculated according on a formula:

$$P = \int_{t_1}^{t_2} F(t^{\circ}).tdt \quad (1)$$

The analysis is carried out on comparison of the transformer taken for "standard" to the examinee the transformer. As criterion for a power assessment the dissipation of the phenomena in the transformer is used the deficiency coefficient determined by a criterion correlation [2]:

$$K_{duc} = \frac{P_1 - P_2}{P_1} \quad (2)$$

where: $P_1 = \int_0^{\infty} F_1(t^{\circ}).tdt$, $P_2 = \int_0^{\infty} F_2(t^{\circ}).tdt$

(Calculations of integrals to numerical values are carried out according to the Mathcad programs). [2]

The assessment of technical condition on thermal conditions is made by the level of the coefficient K_{duc} according to tab.1

Table 1 Assessment of Technical Condition of Object

Assessment of technical condition	Norm	Norm with deviations	Norm with considerable deviations	a degraded	The preemergency
K_{duc}	До 1,2	1,2-1,4	1,4-1,6	1,6-2	Более 2

V. REALIZATION OF A TECHNIQUE OF THE ANALYSIS OF THERMOGRAPHIC INFORMATION FUNCTIONS

Examples of realization of the offered analysis technique TIF are presented in (Fig.5-6).

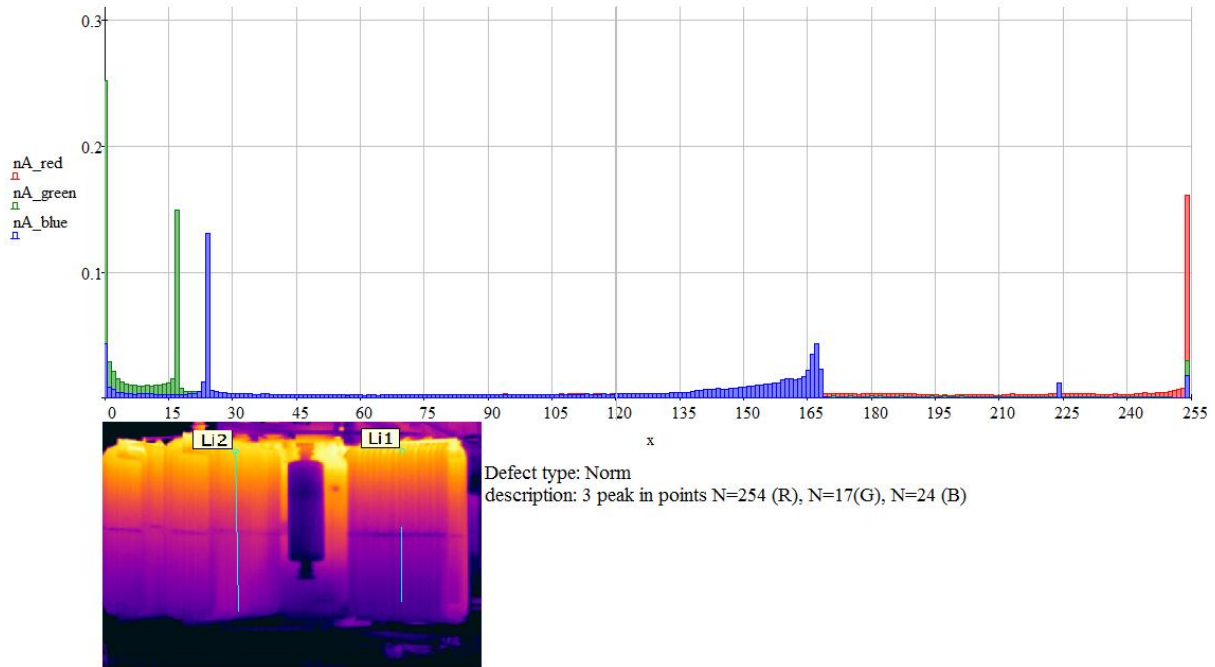


Fig. 5

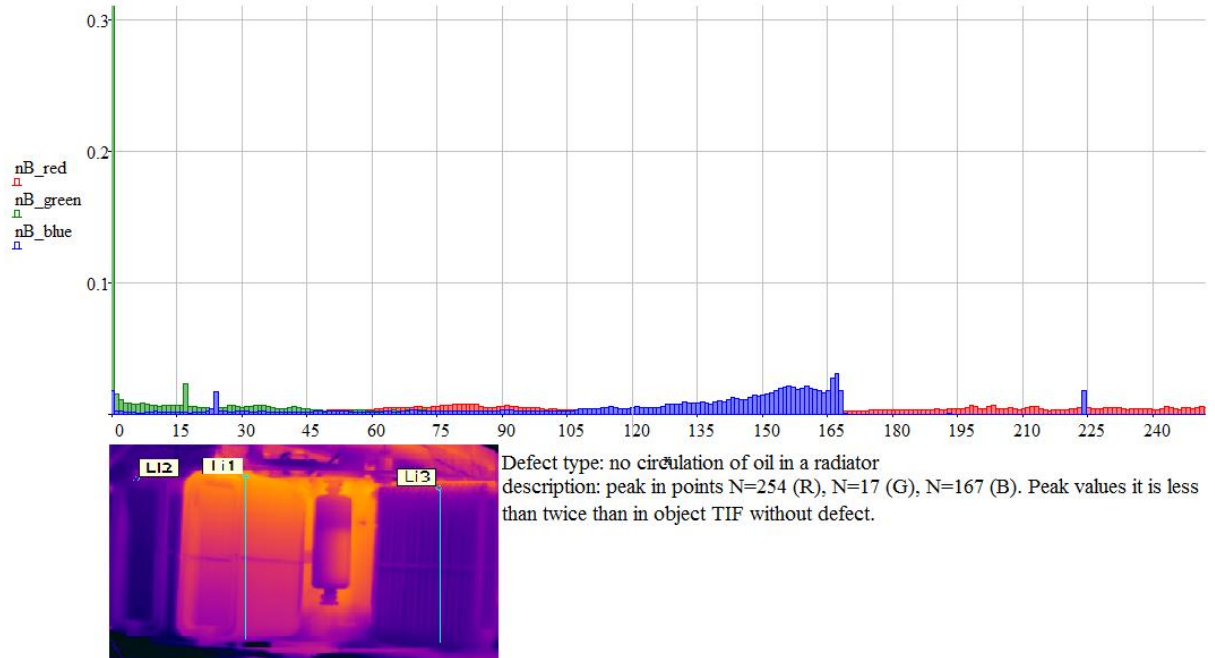


Fig. 6

VI. CONCLUSION

For leaving from subjectivity in the analysis of thermo grams during thermo vision research of transformers it is offered to use thermo graphic information functions. The method of the analysis is realized by means of the mathematical MathCad environment. Approbation of a method is carried out in the analysis of thermo grams of real objects.



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As criterion of an assessment of technical condition of the transformer the deficiency coefficient is used.

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AUTHOR BIOGRAPHY

Yuri, V,Vankov, Doctor of Engineering, professor, Former rector on scientific work of Kazan State Power Engineering University, Head of the department "Industrial power system and systems of heat supply" Kazan state power university- Russia

Osamah, M, Al-aomari, PhD Student of Kazan State Power Engineering University- Russia