SURVEY METHOD IN THE DIRECTION OF THE EXTENSION OF SERVICE OF TURBOGENERATORS

Vjaceslavs Malisevs
Mihails Krilovs
Faculty of Electrical and Power Engineering
Riga Technical University
Kronvalda bulvaris 1, LV-1010, Riga, Latvia
mike.k@inbox.lv

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ABSTRACT

Evaluation of system maintenance and improvements of turbogenerators allow to obtain and to evaluate a complete picture of each plant and the results obtained to build a program of action and develop priority actions, implementation of which will in turn raise the level of operating turbogenerators and increase their reliability. Each local area will allow a more concrete form to make control of the state and operating conditions.

INTRODUCTION

One of the main characteristics of modern power engineering is a big number of turbogenerators with exceeded life span which are still in service. However, our and foreign practice shows, that actual life span of turbogenerators often considerably exceeds life span defined by manufacturer. In such circumstances one of the main goals of diagnostics, formally not defined by normative documents, became evaluation of remanent physical resource of turbogenerators. This isn't a simple task and it couldn't be solved by implementing typical tests.

REVEALING THE PROBLEM

One of the main goals power engineers are facing is the increase of reliability of the power equipment and optimization of the costs for its maintenance. This goal can be achieved by creating a system of service maintenance and wide using of modern methods of equipments technical condition control. Effective control means decrease of repair actions and extension of a life span of power equipment. Technical condition and life resource of turbogenerators straightly depends from the level of repair and maintenance activities. Revelation and timely taken measures to fix generator damages at its initial stage (damages of a frame, rotor, active iron, winding isolation, gas-oil system, brush contacts) can be most effectively achieved by using methods of continuous control (monitoring) with stationary systems of control on a working equipment and with special inspections during repair procedures.

MAIN PRINCIPLES OF DETERMINING OF CONDITION OF TURBOGENERATORS

Resource of a turbogenerator at the moment of inspection can be defined with the unit that has lowest remaining resource. Because estimation of remaining resource has probable nature so for obtaining of more precise estimation estimated defects must be confirmed using different methods.

For taking substantiated decisions about withdrawal of equipment or about amount of repair or about doing nothing and using it as ever besides determination of a unit with the lowest remaining resource information about remaining resource of all other units and parts must be determined.

Main symptom of complexity is maximal (from what available) coverage of properties and characteristics of the object under control and use of tools and methods which completes each other. [1]

Available methods of diagnostics and technologies allow conduct inspections of a whole turbogenerator and its separate parts on a generator under load and on a nonassembled machine. Obtained results supplement each other.

These works can be fulfilled on a different type of turbogenerators:

- control of a turbogenerator using measuring equipment which is placed in air gap (density of stators winding fixation, quality of core separate steel packets compression, condition of core interplate isolation), inspection of difficult-to-access surfaces of a generator parts with endoscope which has big resolution and which can be placed in all parts of the machine;
- control of stators extreme steel packets using ultrasound;
- microspectral analysis of mechanical admixtures in cooling hydrogen or oil;

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- determination of local overheating places in turbogenerators from products of isolation pyrolysis in cooling gas;
- analysis of vibration characteristics on a working turbogenerator using multichannel spectral analyser;
- measurement of level of partial discharges while conducting tests with heightened voltage;
- use of electrooptical defectoscopes for determination of a level of corona while conducting high voltage tests of stator winding isolation;
- use of thermovision for control of heating of steel during tests with circular magnetization method;
- evaluation of a condition of turbogenerators with oil cooling type TBM with method of chromotographical analysis of gases dissolved in oil;
- automatical system of chemical control of a distillate in cooling circuits of generator;
- control of brush contact condition using method of radio interferences measuring;
- ultrasound control of metal of bandage rings of turbogenerators rotor without taking them off from rotors shaft [2];

Monitoring and evaluation of the condition of stator using the vibration method with vibrodiagnostical equipment (such as СД-12М system) is possible both during the repair works and on a working turbogenerator. Vibration method allows identify signs of deterioration of the condition at an early stage of their appearance.

Years of experience and ease of use of this method is based on the identification and analysis of stable trends of controlled vibration parameters for a relatively long period of regular observations. Criteria to evaluate certain aspects of the technical condition are thresholds of individual vibration components as well as the tendency of their changes identified during vibration tests. The technology of vibration measurements, rationale for the choice of controlled vibration parameters and a number of aspects of the analysis of vibration signals were repeatedly reported at conferences of various ranks and media coverage.

As an example results of inspection of stator of turbogenerator ТГВ200 (year of production 1962) can be given. Its rewinding was planed for 1993, but because of a complex of diagnostic procedures where specialists and experts were involved it was said that it is not reasonably to change stator winding in 1993 and recommendations about resource and functionality maintenance were given. Remaining resource was evaluated as not less than 6 years. Planed rewinding was canceled. After inspection stator worked without accidents for 11 years, but prepared for rewinding new winding kit was used for other stator rewinding, which needed rewinding for sure.

The task of extension of a life span and ensuring of turbogenerators reliability can be solved by timely determination and elimination of defects and not allowing them became significant when turbogenerator can crash or accidentally shut down. As well as elimination of founded defects its slowdown or stopping is known as a method of saving of working resource.

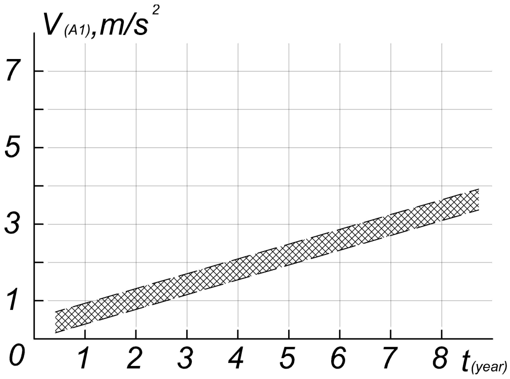
Turbogenerator is item that can be restored. Most parts of turbogenerator can be restored or changed. By that working resource of turbogenerator restores fully (in rare cases) or partly (in most cases). There is only one part which change equals to the change of a whole turbogenerato. This part is stator core.

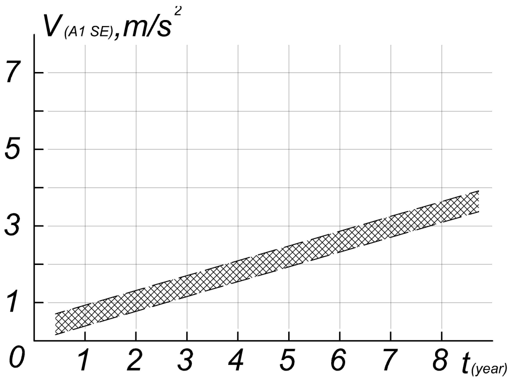
Normative methods of a control of a stator core condition are mostly orientated at a control of a quality of interplate isolation and specific loses in core.

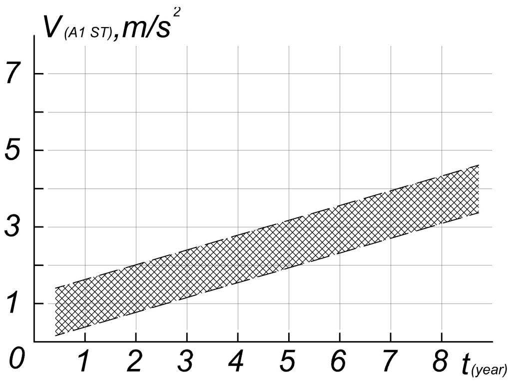
Main mechanical characteristic of a stator core which defines its functionality is resilient pressure condition given to it during production. It is a necessary condition for long-term preservation of the quality of interplate isolation and preventing of the chipping of active steel sheets due to their vibration. The inevitable with the passage of time and under the influence of operational load reduction efforts, compressing of the core, is a potential cause of dangerous accidents and damages to the stator, therefore, the main factor limiting the life of the turbogenerator. Proper evaluation of technical state of the core becomes particularly relevant in cases where it is necessary to decide whether to replace the stator windings. Expensive replacement of windings may be warranted if the stator core has already lost a large extent the mechanical properties [3].

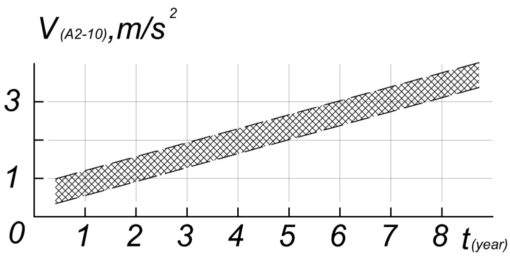
ТВФ1102 and ТВФ1202 types of dependences of controlled vibration parameters A1 and A2-10 (average square values of vibroacceleration at frequencies 100Hz and 200-1000Hz respectively) from time of operation (Figure 1, 2). On each figure respectively for parameters A1 and A2-10 three dependences are shown: separately from the side of the exciter (SE), from the side of the turbine (ST) and averaged (for stator as whole). All dependences represented as dotted line intervals with 95% confidence that experimental values will match these intervals [4].

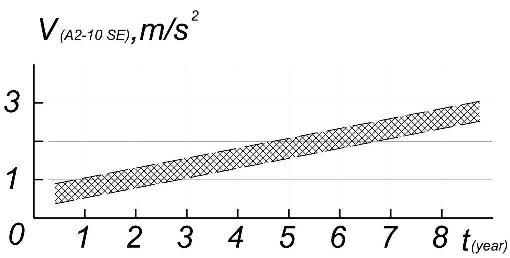
Predominantly growing tendency (except for high-frequency component, the A2-10 with ST) of vibration of the stator, which is evidence of the natural weakening over time of the stiffness properties of the mechanical system of the stator (Figure 1).











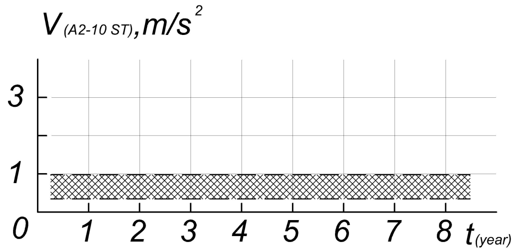
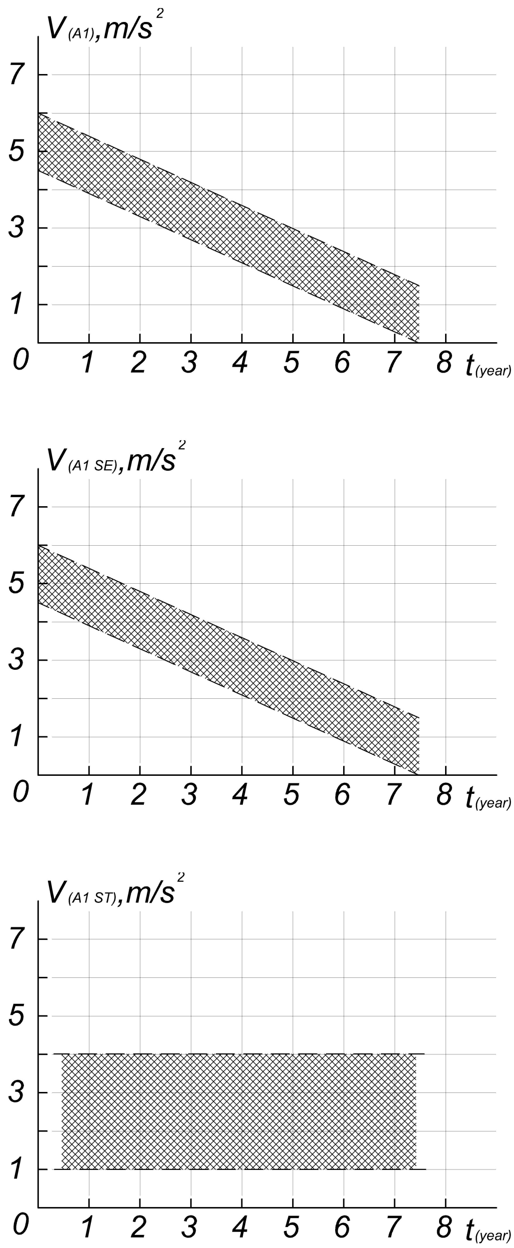


Figure 1: Examples of the change with the trend growth rate of vibration on the stators housing with the passage of time (A1-vibroacc. at 100Hz, A2-10-vibroacc. at 200-1000Hz).

Case where the level of vibration on the housing component of the stator at 100Hz decreases with time, which may indicate a weakening of mechanical connection of the stator core with the stator (Figure 2).



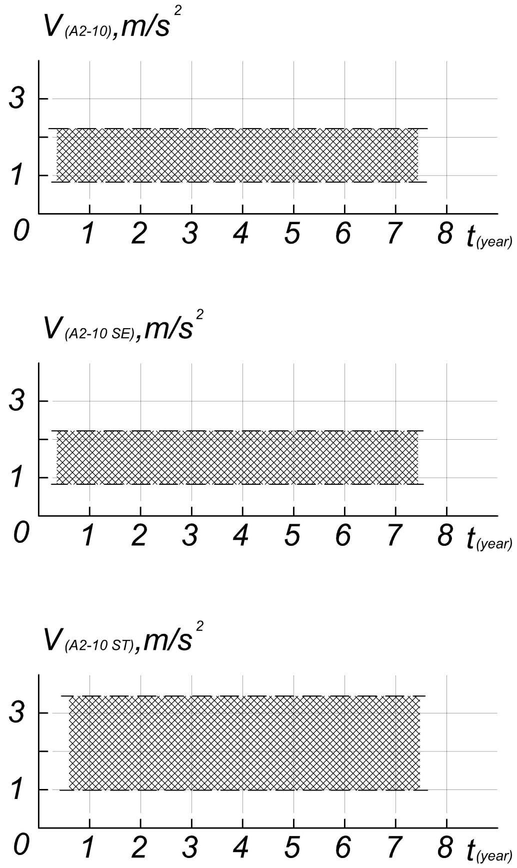


Figure 2: Examples of the change with the trend growth rate of vibration on the stators housing with the passage of time (A1-vibroacc. at 100Hz, A2-10-vibroacc. at 200-1000Hz).

The results of the measurements of decrements of core oscillations with an obviously weakened pressing (Figure 3).

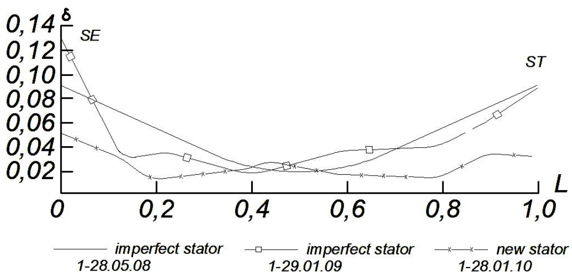


Figure 3. Distribution decrement in length (L) turbogenerator stator core type ТГВ300.

This stator core of turbogenerator ТГВ300 at the period of measurement had restored (after the break of the ends of 9 tie prisms from the exciter side) system of mounting and chronic progressive weakening of tightening of the screws on the ends of the tie prisms on both sides of the stator. Measurements of the decrements of oscillations on this stator were performed twice, the second measurement approximately three years after the first. Both inspections showed high values of the decrements of oscillations in end zones of the core. The second inspection showed a trend growth of decrement of oscillations of the exciter. For comparison, the distributions of the decrements of oscillations in the core of the new stator, which eventually replaced former stator because of the limit condition of the core [5].

CONCLUSION

An integrated approach to inspection of turbogenerators allows with sufficient certainty identify the unit with the smallest resource efficiency.

To improve the reliability of evaluations of turbogenerator unit condition existing control methods must be improved and regular search, developing and enforcing must be done.

Vibration control methods of turbogenerator stator condition allow to track and to evaluate the change in stator mechanical system condition which working recourse defines the life span of a turbogenerator.

For more effective use of the control of the stator condition with the vibration method stator cores must be equipped with stationary fixed vibration sensors.

5. Analysis of the given example of the inspection of turbogenerators stators shows practical and economical effectiveness of the diagnostical works.

6. Graphical visualization of the vibrocharacteristics of the stator allows to visualize the changes in the condition of stator and provide an opportunity to predict the situation in the future.

REFERENCES

Алексеев Б.А. 2001. “Определение состояний (диагностика) крупных турбогенераторов”. М.: ЭНАС.

ЕЭС РОССИИ. 1998. “Объемы и нормы испытаний электрооборудования” РД34.4551.300.97.М: ЭНАС.

А.В. Григорьев, В.Н. Осотов, Д.А. Ямпольский. 2000. ”Патент 2155429 РФ. Способ контроля прессовки сердечника статора электрической машины.” Открытия. Изобретения. № 24.

Григорьев А.В., Осотов В.Н., Ямпольский Д.А. 1998. ”О вибрационном контроле технического состояния статоров турбогенераторов ТГВ-300. ” Электрические станции. № 8. С.27-35.

Семёнов Д.Ю., Григорьев А.В., Осотов В.Н. 2002. ”Разработка и реализация методов вибродиагности-ки статоров турбогенераторов в ОАО Свердловэнерго.” Электрические станции. № 8. С.49-53.

AUTHOR BIOGRAPHIES

VJACESLAVS MALISEVS, born in 1983 in Liepaya, Latvia. In 2009 at the age of 26 graduated the Riga Technical University, the Faculty of Electrical and Power Engineering, obtaining the M.Sc.ing. degree. E-mail: slavi4@inbox.lv

MIHAILS KRILOVS is born in 1984 in Latvia. In 2009, he graduated the Riga Technical University, obtaining the M.Sc.ing. degree.
E-mail: mike.k@inbox.lv