Reliability of work of large synchronic turbogenerators

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Absract - **The generators are the one of the most important elements of electrical energetic system EES and of their accuracy depends pogon security of EES. Insulating system of generators performed the weakest point.**

Security of work of large synchronic generators depends on many factors which during the exploatation and annual maintenance are contraled, measured, examined and followed.

In this work are elaborated factors which influence on IS of synchronic generators in feromagnetic material, stators and rotors wires, exposed to influence of external factors (mechanical load, atmospheric influences - humidity, dust, gases etc.) and internal factors (structure of material). During the exploatation of turbogenerators the insulation "grows old" thanks to different exertions as voltage, temperature, mechanical and chemical

Keywords - **generator, reliability, insulating system, rezistance**

I. INTRODUCTION

Insulating system of generators is exposed to friction, oscilations, vibrations, electromagnetic and mechanical forses and also to electrical, mechanical and aerodinamic infuence.

In this paper is analized and mesured insulating system of synchronic turbogenerator on block 3 in REK - Bitola in 1997 till 2003 year. It was mesured temperature performance before and after the repair, condition of magnetic core, impedances, inductances, insulating rezistance, koeficient of apsorpcion and factor of dielectric power loses wich depends by voltage $tg\delta=f(U)$ during the annual repair.

On the base of prophylactic examination of the parametars of insulating system in period of more years are made comparisons and is observed insulation in exploatation conditions. Where a big diference beetwen mesured and factory allowed values is noticed is recomended a detailed examinations of that parametars of insulating system.

A final result is that insulating system of turbogenerator in block 3 in REK Biotola have extremly quolity insulating, but it is not made any particulary documentation about this prophylactical following and there are no special analyses. It is recomended to do special documentation of this examinations.

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II. FACTORS ON WHICH DEPENDS REALIBILITY OF LARGE SYNCHRONIC TURBOGENERATORS

Repairs in block 3 in Rek - Bitola are made every year as regular and every five years as capital. Program for those repairs consist of:

- prepearing work for putting block in repair
- timing plan for repair
- suplies of parts and spare material
- purpose of mechanical thermal operation examination
- organization of examination
- operation of work during the complex examination
- control of mesured instruments
- complex pogon thermal and mechnical examinations
- elaborates, protocols and referats
- pripearing for putting on work of the blok after finishing the repair and turning on the block on the EES of Macedonia.

Preparation work for putting on the block in work consist of the following actions:

- organizations of educated team who will do the repair,
- back up excitation is checked and examined
- turbogenerator is gradually switched off and put in the no-load state
- research of short-circuit and no-load characteristic and influence of protection relay
- examing of rotor impedence of turbogenerator as a function of speed and voltage

Timing plan for the repairing actions consists of:

- exact date and hour of begining and the end of repair
- exact date and hour of begining and the end of repair on: generator plant, protection of worked and back up excitation, mesuring system, controlled system and G.V.Z.

Parts and spare material for carrying out of repair are:

- brushes for the generator, working and back-up excitation
- insulating material, pump material,
- sprays, cleaning materials, alchohol, colors, towels, conducters, bulbs, bateries ect.

III. ACTIVITIES WHICH ARE MADE TO GET RELIABILITY OF WORK FOR ONE YEAR FOR LARGE SYNCHRONIC TURBOGENERATORS

Purpose of pogon thermal- mechanical research is to record the real condition of the main equipment before and after the repair. That will provide blok working till next repair and have reliability for at least one year.

Organization of examination is with complete profesionality and responsibility of all participans in the repair. People who work on the blok are in groups from different profiles and they exactly know the hierarhy and who is responsible for what.

Operations of work during the complex examination are:

- unloading of TG and calling the person in sharge for turning on/off in EES of R. Macedonia
- power and nesesery operation of work: no-load, short circuit, load by 225MW; 200MW; 175MW and 150MW with time of 2 hours till 4h with posibility for some specific situation time increase for 90 min.

Control of mesured instruments mostly consists of:

- voltage and curent measuring transformers
- wattmeter and warmeter
- voltmeters, ammeters
- measurers of primary and secondary vapour, water into turbine and into cotel
- measuring temperature and presure of coolant
- mesured instruments of woking and back-up excitation.

Control of thermal and mechanical condition of main equipment consist of control of: power and producing of electric energy, electrical recording instruments, control of coal,ash, content of CO and O_2, smoke gases, vibration. Also are examinated the atmospheric influences like humidity, pressure, temperature.

Electrical parametars are exzamined with laboratory instrument with accuracy of 0.5 or smaller. Usualy is measured:

- active and reactive power and apparent power is calculated
- currents and voltages on stator and rotor of turbogenerator, main and additional exitater of working and back-up excitation

When all researches and examination are finished, protokols and referats are made. That shows if there is necessity for more researches and how is state of insulating system at this moment.

After finishing of the all repairing work the block is putts on probe and regular wokr on the network. That preparation consist of:

- observation of functionality of worked and back-up excitation
- rotating of the turbine
- observation of rotor impendance of turbogenerator as a function by speed of rotation
- mesuring of short-circuit and no-load characteristis of TG with all following manipulations for grounding and sepparating in substation
- parametars for manual sinchronization during the putting on the network.

In this paper are given the results from last seven years for blok 3 in Rek - Bitola. For active rezistance of stator winding rezults are sistemized according to years and that is the essential for prophylactical following of insulating system.

IV. ANALYSES OF THE RESULTS OF ACTIVE REZISTANCE OF STATOR WINDING ON TURBOGENERATOR ON BLOCK 3 IN REK BITOLA

In experimental part of this paper insulating system on sinchronous turbogenerator in blok 3 in Rek - Bitotla is mesured and special attention is given to the results of measuring of active rezistance of the stator winding. Sistematization is given in table 1.

TABLE I
VALUES FOR ACTIVE REZISTANCE OF STATOR WINDING ON TURBOGENERATOR IN LATELY YEARS

number	**$1C_1$ - C_4**	**$2C_1$ - C_4**	**$1C_2$ - C_5**	**$2C_2$ - C_5**	**$1C_3$ - C_6**	**$2C_3$ - C_6**
factory value R_{15}° mΩ	3.26	3.19	3.23	3.31	3.18	3.27
R_{15}° mΩ 1997	3.272	3.202	3.242	3.307	3.213	3.285
R_{15}° mΩ 1998	3.274	3.205	3.243	3.308	3.215	3.288
R_{15}° mΩ 1999	3.294	3.223	3.226	3.329	3.229	3.291
R_{15}° mΩ 2000	3.312	3.237	3.277	3.343	3.243	3.323
R_{15}° mΩ 2001	3.318	3.240	3.285	3.353	3.209	3.331
R_{15}° mΩ 2002	3.299	3.224	3.260	3.327	3.230	3.306
R_{15}° mΩ 2003	3.289	3.214	3.255	3.322	3.227	3.301

On the basis of the prophylactic followings so far the parametars on the insulating system in period of more years it is made a comparison of insulating values and is evaluated the efficiency of insulation in exploatation condition. For some parametars detal research is recomended.

From analyses and comparisons the mesured and calculated results as the methods of following, it is obvious the recomended acceptable way of prophylactical followings on insulation and continuing the --- of the exploatation wich is the benefit of this research.

The previous table shows that in all years, active rezistance of stator winding is moving to allowed values time. Compared to the factory value never has been bigger then 2% (1.94%) . Also the criteria for differences between max and min measured values do not exceed the value of 5%.

CONCLUSION

The subject of examination in this paper is insulating system on synchronous generators, detailed active rezistance of stator windings, its efficiency in exploatation as its prophylactic following. More characteristics on the insulating system are observed which are given the real state. There are: electrical insulating rezistance R_{iz}, coeficient of apsorpcion K_a, factor of dielectric power loses in function of voltage $tg\delta=(U)$, intensity of partial discharge, current in the insulating system with high d.c. voltage and dielectrical hardness on insulation with test voltage (---, inducated and sparcover voltage).

It is very important to take a special care for accuracy of the generator as the one of the most important components in EES on what depends the pogon security.

The failure on insulating system are the most often in generators and it is performed the weakest point in exploatation.

State of the insulating system on generators depends of external factors such as mechanical load, atmospheric influences: humidity, dust, gases and internal factors: material structure,athesive material etc.

During exploatation insulating system " grows old " and change the characteristic under the influence of those factors. "Growing old" is manifestated by permanent changes of one or more characteristic compared to some previous known state. It is nessesery "growing old" to be under control.

Insulating system must satisfy the following characteristics: big electrical insulating rezistance, small dielectrical losses, low level of partial discarge, positive mechanical, temperatural and chemical characteristic and big stabillity of all characteristic by the time of use.

The basic electrical load are under the influence of the voltage which define a flowing of electric current in the insulating system. Current creates dielectric loses which increase the temperature in insulating system. Thus insulating rezistance fall down and the current, too. That make loses increase their value. This process in insulating systems in god condition ends with making a balance, but the IS with bed state keep going (continued) and a short-circuit will happen.

Following the "growing old" of the insulating system is making with measuring of the curent, insulating rezistance, dieletric loses by a variabile value of voltage.

Criterias for evaluation of efficiency of insulating system in exploatation all over the world as here are based on anylises of prophylactical following of examination of synchronic generators. On the base of that research there are three groups of qulity of the insulating system:

1. Insulating system in god condition, it has pure and dry insulation wich normal geting old and it can work and stay in operation.
2. Insulating system have a little change in insulating characteristics, it is in pogon state, but it is nessesery detale anylises for reasons for variations. It can stay in work one year till next repair when will be elaminated the reasons for changes..
3. Insulating system who work but have big variations in insulating characteristics that can be expected its failureand can not stay in work one year. It require an anylizes for bed insulating state and determinating way for acting for removed the couses of variations. Additional repair had to done for replasing the demage insulation.

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