14th International Research/Expert Conference
"Trends in the Development of Machinery and Associated Technology"
TMT 2010, Mediterranean Cruise, 11-18 September 2010

INVESTIGATION OF STEAM TURBINE LOW PRESSURE ROTOR AXIAL CHANNEL BY METAL MAGNETIC MEMORY METHOD

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ABSTRACT
Investigation of axial opening is performed during regular generator overhaul. We have implemented metal magnetic memory method (MMM), which does not require cleaning or preparation of investigated surface. Work technique consists of ferro probe mechanism connected by cables to IKN defectoscope. On the basis of performed measurements of magnet field Hp, automatically defines the value of filed gradient Kin. Detailed data processing is done through specially prepared software. The paper presents investigation results in thermal power plant "Nikola Tesla" – Obrenovac.
Keywords: metal magnetic memory method, magnet field, gradient

1. INTRODUCTION

The method of metal magnetic memory, MMM, is fast and elegant, requires neither cleaning of an axial channel nor other preparations (artificial magnetisation).
The MMM is, in principle, a new diagnostic method based on the magnet field analysis of an object which is tested. The goal is to determine tension concentration zones (TCZ) which can be a source of potential failures. Assessment of the condition of a metal is integral, since at the same time, it reflects the properties of structural condition, distribution of tensions, and defects.
Tension-deformation condition reflects through measured values of an object magnetic field and an appropriate gradient. The basic parameters measured by an instrument are:

$H_p\left[A/m\right]$, normal magnetic field of dispersion;

$K_{in} = \frac{dH}{dx}\left[A/m/mm\right]$, gradient, intensity coefficient or the speed of change of the magnetic field of dispersion, shows the level of remained tensions;

m, magnetic indicator of deformation capability of a material or an indicator of deformation strengthening of a material and it is measured from the correlation:

$$m = \frac{K_{max}}{K_{sr}} = \left[\frac{\sigma_m}{\sigma_{0.,2}}\right]^2$$

The measured magnetic field Hp and its gradient are the integral properties of tension-deformation condition, which take into account the changes of the metal structure in the tension concentration zone. This is one of the most important practical advantages of the MMM over the other known methods of tension and deformation control (ultrasound, Barkhausen effect, tensometrics, roentgen and other methods) /1/.

2. INVESTIGATION

The investigation of the axial opening was performed during the regular maintenance of a generator. We applied the MMM which requires neither cleaning nor other preparations. Work technique consists using a ferro-probe attached with the cable to the defectoscope IKN series. On the basis of the performed measurements of the magnetic field Hp, the field gradient value (Kin) is automatically determined. Detailed data processing was done on a computer.

It is well-known the investigation of the axial channel of a rotor of a steam turbine by traditional methods is time-consuming, unreliable and substantially difficult when particular facts are taken into account: opening diameter is about 90mm, the length of the axis 5, 6, 7 m, area of the axial opening is dirty and covered with charred elements. The investigation is performed with coloured penetrants and visually - endoscopy. These investigations are preceded by cleaning which is very difficult and often insufficiently good. Finally, cleaning of the panetrants is very problematic, and, consequently the data reading is biased since it is not clear whether it is a defect or deposits.

Control of the axial channel was performed by the device IKN 3M-12 (*Figure 1*) /2/, which is composed of a ferro-probe for measuring the magnetic field Hp. In the housing there is an electronic block which measures covered distance and value of the magnetic field. The casing is attached to connexion cable with the defectoscope IKN 3M-12 and telescopic stick. This device enables control to be performed up to 10 metres in length.

Figure 1. Device IKN 3M-12

Figure 2. Investigation of the axial opening

Measured values are stored in the device, and then transferred into the computer where the analysis and processing of obtained data are performed. On the basis of magnetogram properties and its gradients we can draw a conclusion on the condition of the investigated object. Special software enables automatic data processing /3/.

On the shown magnetograms (*Fifure 3-5*) /4/ we can clearly see the changes in magnetic field and increased gradients which indicate presence of a defect. Visual investigation showed the defect is related to surface damages caused by erosion.

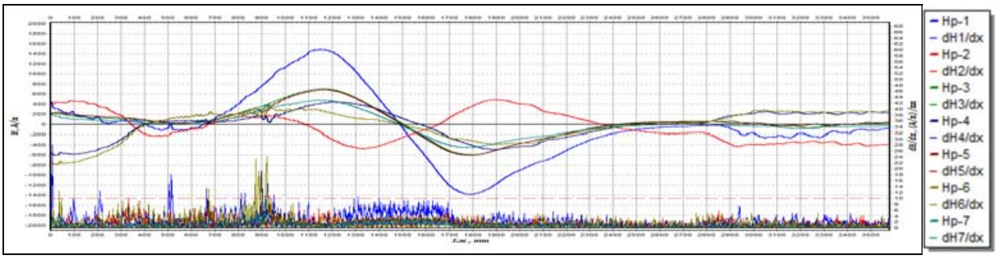

Figure 3. Figure of normal and tangential components with appropriate gradients

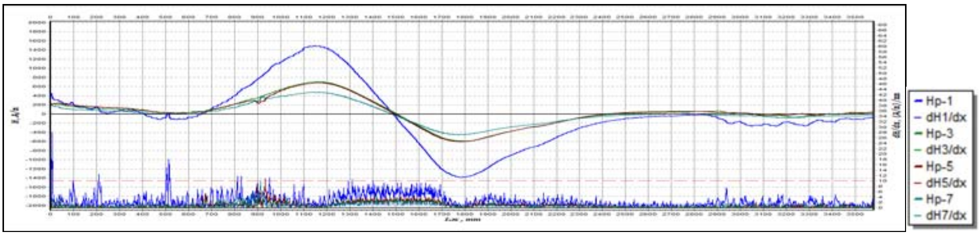

Figure 4. Tangential components

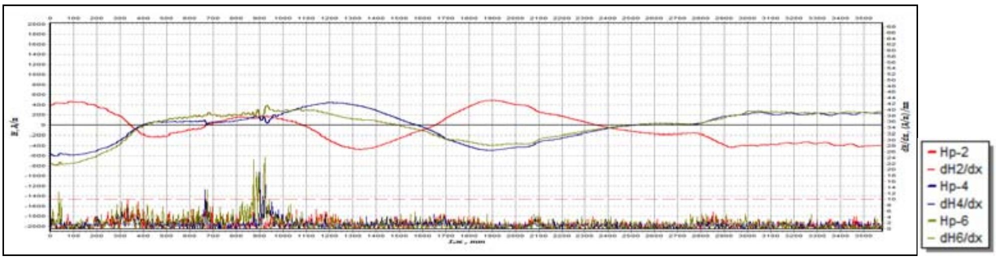

Figure 5. Normal components

Magnetogram analysis shows that in the tension concentration zone (TCZ), the curves, both with tangential and normal components change their character. What is characteristic, are the gradients for surface damages like corrosion, erosion and cavitation. The first and the last gradients are higher (entrance, exit), and the middle part is with a lower gradient. On the bottom of a diagram we can read the length of the damage since the beginning of scanning and, for example, with TCZ 1, the length of the damage is 20 mm (500 mm-520 mm), with TCZ 2the length of the damage is 55 mm (875 mm – 930 mm).

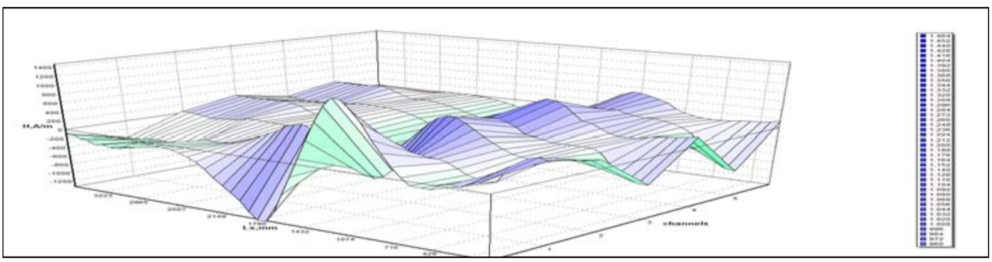

Figure 6. Spatial display of distribution of tension of the magnetic field Hp

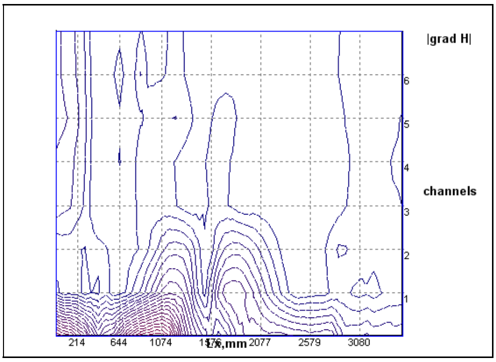

Figure 7. Distribution of isolines of gradients of a resulting magnet filed

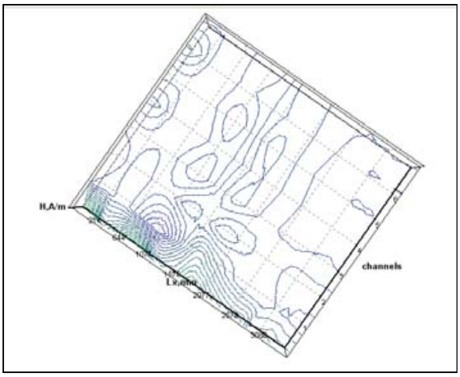

Figure 8. Distribution of isolines of a resulting magnetic field Hp

Concentrated isolines mark places with an increased tension concentration (*Figure 7*).

Compressed isolines show the place is loaded with pressure, and spread isolines show areas loaded with extension force (*Figure 8*).

3. CONCLUSION

On the basis of magnetogram properties and gradients values, we can conclude the rotor in question is in a good condition. It is recommended during the next overhaul the MMM control is once again performed in order to compare the obtained results.

Taking into consideration the manner of performance of the control, reliability of the measured values, speed and price, the MMM method should be applied not only to the control of axial channels of camshaft of turbines, but also for all the elements and objects which are controlled, and it should be done in such a manner the MMM method is used as a pre method for rapid detection of zones with increased tension concentration of, followed by the control with more traditional methods.

4. REFERENCES

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