UNBALANCED MAGNETIC PULL AND AIR-GAP MONITORING FOR LARGE HYDROGENERATORS

AN INNOVATIVE MEASUREMENT DEVICE FOR THE MONITORING OF STATOR AND ROTOR MAGNETIC CIRCUITS IN HYDROGENERATORS

Patented

MEASUREMENTS

• Deformations of the stator and rotor magnetic circuits
• Relative effective static and dynamic eccentricities
• Magnitude and direction of unbalanced static and dynamic magnetic pulls
• Air-gap magnetic flux

1. OBJECTIVES

Large low speed hydrogenerators have a very small specific air-gap/stator bore diameter ratio making it impossible to have a perfect centering of the elements during the assembly process. This results in that the machines are operated with an eccentricity that though small is not negligible, and is the cause of undesirable effects: considerable unbalanced magnetic pull forces, vibrations, additional losses. It is therefore important to assess the eccentricity and even more to check its trend to guarantee a safe operation and prevent any serious damage. This is the aim of the UMP Monitoring system.

2. PRINCIPLES AND EQUIPMENT

The UMP measurement device consists of 3 parts: sensors, a data acquisition unit and an processor for control and processing.

A. Sensors to measure the magnetic flux

The magnetic flux in the air-gap of the machine is measured using coils distributed on the periphery of the stator, each between two ventilation ducts.

These measurement coils may be put in place by the manufacturer of the machine. For generators already in operation, these sensors are put in place from the back of the stator yoke using a simple and efficient method. It does not requiring an access to the rotor. The installation of 15 to 20 sensors takes only a few hours.

For measurements of limited duration (such as a diagnostic of the machine) the measurement coils are easy to remove.

B. Data acquisition units

A standard device for data acquisition with 12 bit resolution and 5 kHz sampling rate is used with a straight connection to the PC (fig. 3 and 4).

A remote operation through internet is also possible.
3. MEASUREMENT MAIN FEATURES

The measurement is performed in real time over a complete revolution of the rotor. Consequently, the period between two successive measurements depends directly on the rotation speed of the generator.

Analysis of the measurements provides a complete information regarding the condition of the magnetic circuits related to the air-gap:
- deformation of the stator magnetic circuit;
- relative effective static and dynamic eccentricities;
- magnitude and direction of the magnetic pulls;
- air-gap magnetic flux.

The UMP-monitoring equipment provides a numerical and graphical representation of the rotor magnetic circuit defect, stator deformation as well as an harmonic analysis of the deformations.

4. EXAMPLES OF APPLICATION

A. Laboratory prototype machine

The prototype machine (18 kVA) has a rotor and several interchangeable stators to allow for the measurement of different defects. One of the stators allows specific windings (parallel paths, equipotent connections) making possible eccentricity unbalance compensation.

B. Power plant of Verbois 4 x 33 MVA (Geneva)

Generator ABB, 9 kV, 136.4 rpm.

The diagnostic shows that on one hand the rotor doesn’t have any noticeable dynamic eccentricity; but on the other hand, it reveals a slightly deformed stator bore as well as a static eccentricity.

5. UMP DECISIVE ADVANTAGES

- static and dynamic unbalanced magnetic pull measurement;
- real-time assessment of air gap condition;
- very low cost sensors allow high number of measurement points;
- arbitrary number and disposition of sensors;
- easy to install and to remove, no gluing;
- insensitivity to external conditions (humidity and temperature);
- capability to recognize deformation of any shape.