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Analysis on Direct Water Cooling System Parameters Monitoring and Control with Distributed I/O Logics

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Abstract : *"Analysis on direct water cooling system parameters monitoring and control with distributed I/O logics" will pay attention on how Stator water cooling system is being carried out using present control logic, its importance, operation, advantages and limitations in existing control. The present IEC standards for Electrical Rotating Machines are referred for testing to establish the performance and quality. However they do not specify limits or trending of various operating parameters of generator Stator Water System, which needs to be continuously monitored. One of the ways of taking away the losses from the windings of any electrical machines is by direct cooling using water. The generator is capable of delivering its rated load only when the stator-water cooling system is functioning properly. Therefore it is necessary that highest attention is paid for proper operation and maintenance. The paper covers a brief on the Generator Stator Water systems, their advantages, and design requirements, monitoring of critical parameters along with permissible associated limits. The direct cooled machine are designed generally, to ensure quick removal of majority of heat by the water flowing in direct contact of the winding conductor, in addition to the removal of heat by hydrogen from the surface of hot winding insulation. We plan to do our project in the above area with Distributed I/O based implementation. To enable software control we introduce Programmable logic controllers. By introducing PLC into SWC System the total control is made possible with software.*

I. INTRODUCTION

Fault diagnosis for technical systems becomes more and more important due to the increased safety and reliability standards. Development in computer techniques and diagnosis methods allow problems of high complexity to be considered and introduction of state-oriented monitoring and maintenance scheduling becomes possible. This paper addresses the fault diagnosis problem concerning the individual stator winding bar water cooling of large turbogenerators. Obstruction of hollow partial conductors in the stator bars could lead to a severe thermal damage of the insulation. Therefore, it is important to detect the tendency leading to such a fault early. To obtain the necessary reference values for a sensitive real-time fault diagnosis, modelling the system behaviour is essential. The components of the physical model which have to be considered for such a sensitive model-based fault diagnosis are described in the paper. The experimental verification shows that the proposed model can be applied successfully.

II. ELECTRICAL ANALYSIS AND LOSS DETERMINATION

The heat losses arising in the stator windings, main terminal bushings and phase connectors are removed by the DM water coming into direct contact with high voltage windings. The DM water must have an electrical conductivity of less than 2.5 micro mho/cm. Fully De-Mineralized water from the Boiler Feed Water Treatment Plant and condensate may only be used if no chemicals, such as Ammonia, Hydrazine, and Phosphate etc. A part of water is bypassed, and is treated in mixed bed ion exchanger, connected in Parallel to the stator winding (Polishing Unit) and returned into suction side of the water pump- thus maintaining the conductivity of closed loop circulating water within permissible level. The DM water pump drives are of single stage type with spiral casing and overhung impeller. The pump is connected to a three phase ac induction motor. Failure of working pump due to fault or power supply failure results in an automatic starting or changeover to standby pump drive. The criterion for such a changeover is the falling of DM water pressure at the downstream-measured or sensed continuously through a Pressure switch.

III. Overview of Stator Water Cooling System

The heat absorbed by the DM water in the generator is dissipated to the secondary coolant in the primary water cooler. The water treatment is (Polishing Unit) provided across the stator winding, essentially comprises an exchanger tank of portable type- filled with anion and cat ion resins in the form of mixed bed ion exchange. The mechanical filter eliminates any foreign particles in the DM water, which may choke, erode the hollow conductors of stator winding. The difference
of pressure at inlet and outlet of stator winding is of the degree of choking. The choked filter may be cleaned after using standby without affecting the system working. The magnetic filter prevents any magnetic particles from entering to the generator. Any accidental leakage of Hydrogen into the DM water stream is detected by Gas Trap device. The DM water from the outlet of stator winding collects in an Overhead Expansion tank, which provides a constant level of water during normal running of the system. The Hot DM water from generator (after cooling) enters the tank through perforated pipe in the form of spray- thus releasing heat and any entrapped gas. A water jet ejector is connected to the expansion tank for creating vacuum for the purpose of removing any traces of Oxygen/Hydrogen- which may be present as a result hydrogen leakage into the DM water stream. Level signaling device in the expansion tank monitors the High and Low level of DM water and initiates a tripping command for running Stator water pump- at low level in expansion tank. Make-up DM water to the system is provided at expansion tank through a float operated level regulator. The quantity of DM water flowing through the windings is measured by a system of orifice plate, flow transducer and flow indicator and recorder. Signaling contacts are available in flow switch/the indicator/recorder, which are set annunciate at low flow through the windings and initiates tripping of machine at emergency flow on the principles of two out of three. Conductivity cell and suitable indicator and recorder, to continuous monitoring of the conductivity of water, which annunciate alarm at conductivity high set value. At very high conductivity is tripped automatically.

A. Formula Used

P=1.732*V*I*0.85
I=P/(1.732*V*0.85)Therefore I2=15.75/400* 9164.29 (Amps)
Therefore
I2=360.8439 Amps.

B. Importance of SWCS

E = 2,10,000 × 1 hr
E = 2,10,000 units
For a day = 5million units
E/hr= 5.40 lakhs
E/hr =5.40 lakhs ×24
=1.30 crores(aprox**)**

The revenue of 1crore 29lakhs for a day (5 million units) is only possible when the stator winding is being cooled effectively with the help of SWCS .Hence SWCS plays a major role for power generation

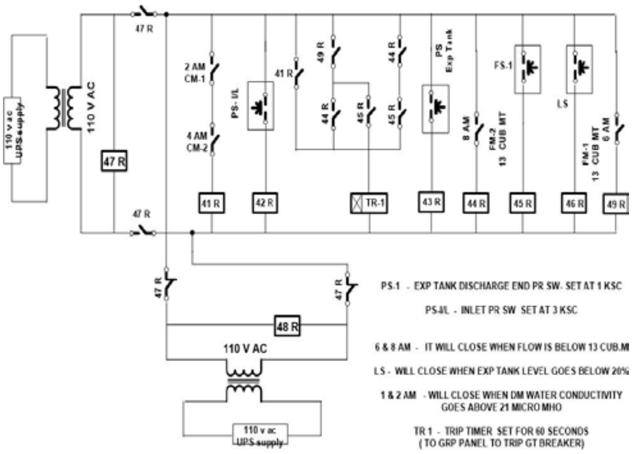

Fig. 1 Instrumentation Diagram of SWCS

C. Equipment and Instrumentation of SWCS

1) *Conductivity Measurement*:

A conductivity meter measures the amount of electrical current are conductance in a solution .Conductivity is useful in determining the overall health of the neutral water body. Within the primary water system the conductivity of the primary water is supervised on ***Downstream of the ion exchange and Upstream of generator inlet.*** The meter is equipped with a probe, usually handheld, for field Measurements, after the probe is placed in the liquid to be measured, the meter applies voltage between two electrodes inside the probe. The measuring point downstream of the ion exchanger serves for checking the ion exchange for proper performance. The measuring point on the primary water inlet to the generator permits the conductivity of the entire cooling circuit. Both measuring devices are equipped for indication and alarm. It will give the trip feedback when it exceeds the high level of 21 micro mho/cm and it will give alarm when 13 micro mho/cm. Generally the DM water used here will have electrical conductivity of less than 2.5 micro mho/cm.

2) *Level Measurement:*

A level-signaling device senses the water level in the expansion tank, with a high or low water level initiating an alarm. A local water level gauge is arranged in parallel to the electrical meter system. Level transmitter detect the level of substance that flow, including liquids, slurries, granular materials and powders. Fluids and fluidized solids flow to become essentially level in their container because of gravity whereas most bulk solids pile at an angle of response to a peak. (e.g. a river or a lake).generally the latter detect levels that are excessively high or low. High level is 90% and low level is 20% if it exceeds the level, then it will give alarm.

3) *Flow Measurement:*

The amount of water flowing through the stator winding is measured by flow measuring system. Flow measuring system are usually basic mechanisms for monitoring air, steam or fluid flows, and can activate alarm signals to pumps or others receptor devices according to the flow meter dictionary. Normally flow monitoring device maintain the low level of 13 meter cube/hr. otherwise it will be tripped and high level 21 meter cube/hr. otherwise it will give alarm.

4) *Pressure Measurement:*

A pressure switch makes electrical contact when a certain set pressure has been reached on its input. The switch program is designed as controllers and Limiters to make contact either on pressure rise or on pressure fall. The inlet pressure must be 1-1.5 kg/cm sq. and the outlet pressure must be 3.0kg/cm sq.

D. CONTROL LOGIC *of SWCS*

The following figures represent the control logic of stator water pump. Based on this relay logic which has been implemented using PLC automation of the system is brought in. The system could be controlled either by remote or manual control by selection option provided at unit control board. The above figure Fig 2 depict the relay logic control circuit of stator water ump A and stator water pump B, The second pump act as standby and is automatically brought into function in case of emergency. The Fig 3 depict the relay control logic of SWCS. The system could be operated either manually or automatically by selecting the required option available at the unit control board. Trip and alarm conditions are generated using the relay logics. For an instance overload rely contact will close when load acts and indicates on or off state based on the availability of supply from 4C.

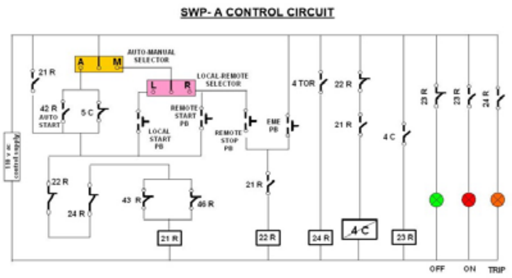

Fig. 2 Stator Water Pump-A Control Circuit

Fig. 3 Relay Control Logic of SWCS

IV. PLC OPERATION

A PLC works by continually scanning a program. We can think of this scan cycle as consisting of 3 important steps. There are typically more than 3 but we can focus on the important parts and not worry about the others. Typically the others are checking the system and updating the current In order to convey information about machine status, the front panel of micro PLC has a series of indicator lights. These are for such things as power, run, faults or I/O status to communicate with the PLC- to enter data or monitor and control machine status-traditional operator interfaces include push buttons, thumb wheel switches, pilot lights and LED display. To improve the interface between the operator and the micro PLC, a new generation of electronic operation interface devices can be connected. These are not programming devices, but graphic or alpha numeric displays and control panels that consolidate all the functions of traditional operator interface devices into a single panel. These interfaces scan output data and display message about machine status display parts count, and track alarms. The products communicate with the PLC through an RS 232 communications port. This opens up I/O point, which can be used for sensors and output devices and enables a micro PLC to control a more complex machine or process.

V. PROPOSED CONTROL SCHEME

The aim of our project is to study SWCS function and its instrument control logic and to upgrade the existing SWCS instrument panel mechanism for control using distributed I/O logics.

If PLC is introduced in the same command will be issued through PLC. Here the software part what we have discussed previously for SWCS (SWP-A, SWP-B & INSTRUMENT) SYSTEMS and discuss something regarding its advantage like non-use of relay and timer and reduction in physical wiring, space will be reduced and the operating time also will be reduced. So we conclude instead of using timer and relay PLC is efficient.

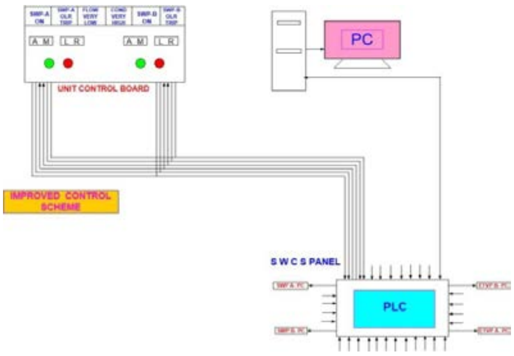

Fig. 3 Proposed Control Scheme

VI. CONCLUSION

We did our project in “Stator Water Cooling system”. We had idea about existing relays and timers based control- for Stator Water Cooling system process requirement. Along the course of project, we had come across discussions with power station executives. We had more clarity on power station operation basics and maintenance activities. Everything that we had planned went smoothly during the project development span. Also we had a limited amount of time for its completion so we were under a certain amount of pressure as well. We do our project to improvise Stator Water Cooling system control activity design using Distributed I/O LOGICS thereby we suggest an enhanced control via software. Due to the superior communication facility with PC, system monitoring via computer is possible.

We did our project related software using Ladder programming and compiled. Simulation found giving good results as we need. We attach herewith the program documents for reference. PLC makes the system control with high reliability, relatively at faster speed of data transfer compared to other available technologies and consumes very less power, for its operation.

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