ENGINEERING NEWSLETTER

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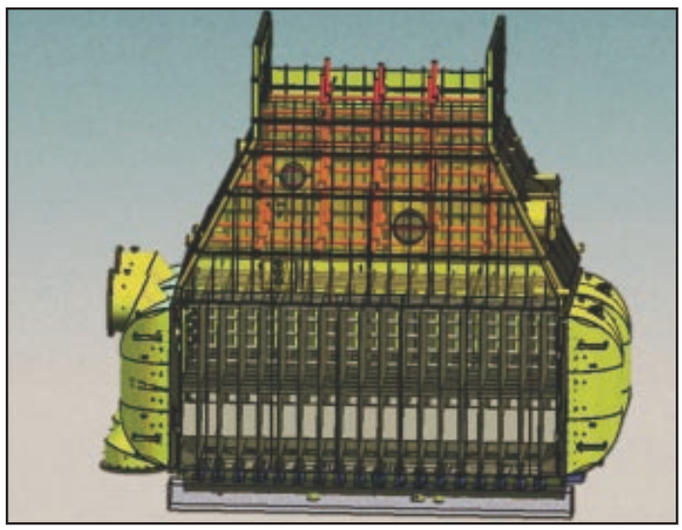
DESIGN AUTOMATION OF 500 MW CONDENSER USING KNOWLEDGE BASED ENGINEERING—AN MOU PROJECT

Knowledge Management has been identified as one of the key corporate strategies to automate total process of product design including release of manufacturing drawings and all engineering documents,with a view to meeting the demand for shorter deliveries and tight commissioning schedules of power projects. In order to meet this objective, an MOU project "Design Automation of 500 MW Condenser Using Knowledge-Based Engineering" was taken up by BHE-HEEP, Haridwar, to begin with. The project has now been successfully completed.

Steam surface condenser is one of the major key equipment in a thermal power plant. The design solely depends on the site conditions vis-à-vis the plant layout, cooling water chemistry and the type of cooling water system.

In this project,the total automation of condenser design has been done capturing design inputs right from the tendering stage up to the contract execution stage. A software tool kit has been developed based on custom-made program logics and Knowledge Fusion tools to help design condenser in an automated manner. A wizard has been developed incorporating developed Graphic User Interfaces (GUIs), integrated legacy software to perform thermo-hydraulic design and for generation of performance curves, detailed design calculations,3-D parametric models of condenser with 30 manufacturing groups comprising nearly 1000 parts, preparation of engineering documents comprising 2-D manufacturing drawings for the 30 manufacturing groups, 14 erection drawings, 3 customer drawings and 1 tender drawing (equivalent to nearly 3000 A4 drawings). All 2-D drawings are in AutoCAD format. Weight calculations, generation of BOM, generation of Datasheets and Cost Estimations have also been covered.

With the completion of this project, the knowledge of design codes, handbooks, knowledge assimilated through collaborators, in-house R&D developments, design improvements, competitors' practices, and the rich experience of work-force in condenser area—all these have been integrated using proper logistics so as to avoid (or to keep at bare minimum) human intervention during total process of design , in order to evolve various design alternatives and select the optimum design.



3-D Model of 500MW Condenser Assembly

The effective use of this project will yield optimized condenser designs with reduction in design cycle-time & cost and improvement in quality & delivery by way of use of modern IT tools.

EVALUATION OF INHIBITORS FOR SS 304 AND ADMIRALTY BRASS CONDENSER TUBE MATERIALS IN CONTACT WITH RIVER WATER

Due to increase in industrialization, there is deterioration in the quality of surface water, but there is no alternative except to use the naturally available water for cooling purposes. Natural water contains dissolved solids, gases and sometimes colloidal or suspended matter. All these impurities affect the scaling / corrosion properties of the water in relation to the metals with which it is in contact. This leads to many operational problems like corrosion, erosion, scaling, fouling etc. Where the available source of cooling water is from a river, either SS 304 or copper alloys is used as tube materials in power plant Condenser. However, due to bad quality of water, these materials, though resistant to corrosion, are also prone to corrosion attack. In order to minimize the corrosion, commercially available inhibitors are dosed into the cooling water. Addition of these inhibitors substantially reduces the corrosion rate of the tube materials, thus increasing the life of the condensers. Performance evaluation of various inhibitors for SS 304 and admiralty brass was recently taken up at Corporate R&D Division of BHEL.

Three commercial inhibitors were evaluated for admiralty brass and cupro-nickel (90/10) in river medium, in static as well as dynamic conditions. Electrochemical experiments were conducted to assess the corrosion rates of these tube materials with and without the addition of inhibitors. The optimum concentration of the inhibitors was found to be 0.1%. In order to carry out the corrosion experiments under dynamic conditions, special probes were used in the dynamic corrosion test rig to evaluate the performance of the inhibitors through linear polarization technique. The corrosion current was continuously measured and recorded in the data acquisition system.

Results :

All the inhibitors performed well under dynamic condition and reduced the corrosion current largely, exhibiting an efficiency of nearly 99% on Copper alloys. In river water medium, SS 304 has high corrosion resistance compared to copper alloys, and hence addition of inhibitors is not required. For copper alloys, any one of the three inhibitors tested can be used, based on the economic considerations.

The studies conducted and the data collected, shall be useful to diagnose, analyse and interpret various cooling water chemistry related problems in condensers. Appropriate inhibitor can also be recommended to minimize the corrosion of condenser tube materials.

Dynamic Corrosion Test Rig

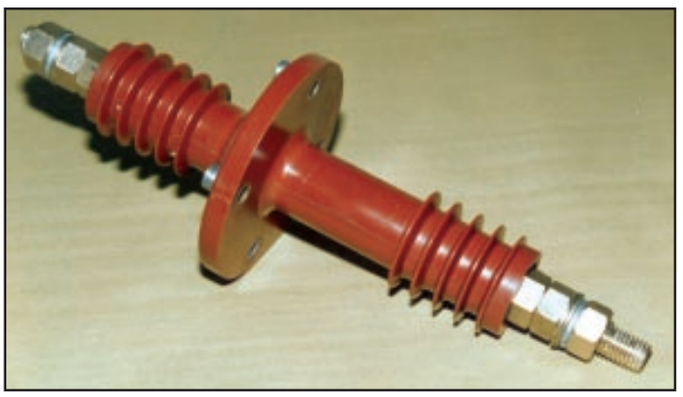
11kV / 750 MVA (0.25 SECOND) WITHSTANDING EPOXY TERMINAL BUSHINGS FOR HIGH-VOLTAGE AC MOTORS DEVELOPED

Epoxy terminal bushings are one of the critical items of a high-voltage ac motor, as they carry high voltage and high current. Current level withstanding requirements of these high-voltage bushings are increasing day by day, from customers. BHEL, a leading supplier of high-voltage ac motors in the country, has been, hitherto, importing these bushings. In order to indigenise these bushings; BHEL has now developed 750 MVA (0.25 second) fault level withstanding epoxy terminal bushings for 11kV high-voltage ac motors, so as to meet the market demands.

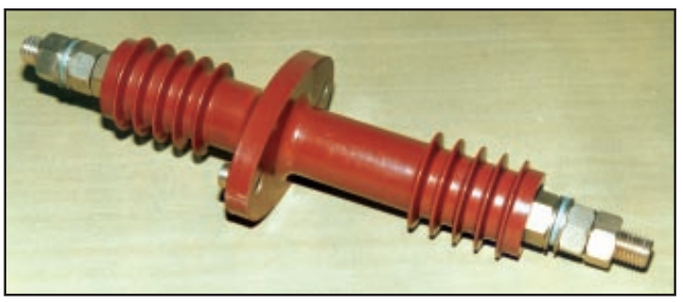
A number of designs were made with different variants, and finally two designs, viz.. (a) circular collar type and

(b) elliptical collar type, were finalized to meet the requirements of existing terminal box manufactured at BHEL. An optimum process cycle was established to process and manufacture sample bushings.

Routine and type tests were conducted on these bushings at ERDA, Vadodara ,and Corporate R&D Division of BHEL. The bushings successfully withstood the following specified tests to meet the requirements of 11 kV insulation system—impulse, partial discharge, power frequency, breakdown voltage, tan delta, capacitance and short-time current rating (at 44 kA for 0.25 second).



Circular Collar Type Bushing



Elliptical Collar Type Bushing

With this indigenous development of expoxy-based terminal bushings, BHEL would be able to use these bushings in all the non-flameproof high-voltage ac motors of 11 kV/1200 A rating, and thereby save in foreign exchange.

250 LPD SOLAR WATER HEATING SYSTEM WITH HEAT PIPE COLLECTORS DEVELOPED

Based on the successful development of 100 LPD Solar Geyers (as already reported in the December 2004 issue), and also from the market study, there was a need to develop higher-capacity Domestic Solar Water Heating System to cater to the different segments of customers. Hence, development of 250 LPD Solar Water Heating System with heat pipe collectors was taken up. As a result, two prototypes have been developed, and installed for long-term testing at the Corporate R&D Division. The system delivers 250 litres of hot water per day at a temperature of 60 to 70^{0}C, depending on the solar intensity.

250 LPD Solar Water Heating System

The 250 LPD system based on heat pipe collector is much more efficient as compared to a standard thermo-syphon system, as there is no heat loss due to reverse circulation during the night, since the heat pipe acts as a thermal diode,. Further, the system developed does not require inter-connecting insulated pipeline between storage tank and the collector array.

The 250 LPD system developed will meet the demand of the higher-end domestic customers as well as Large Solar Water Heating Systems. These systems can be connected in series as well as parallel combination to meet the required capacity of Large Solar Water Heating System, i.e. four systems of 250 LPD can be supplied for a 1000 LPD system. The system can be installed close to the utility point, thereby reducing hot water loss in the pipelines.

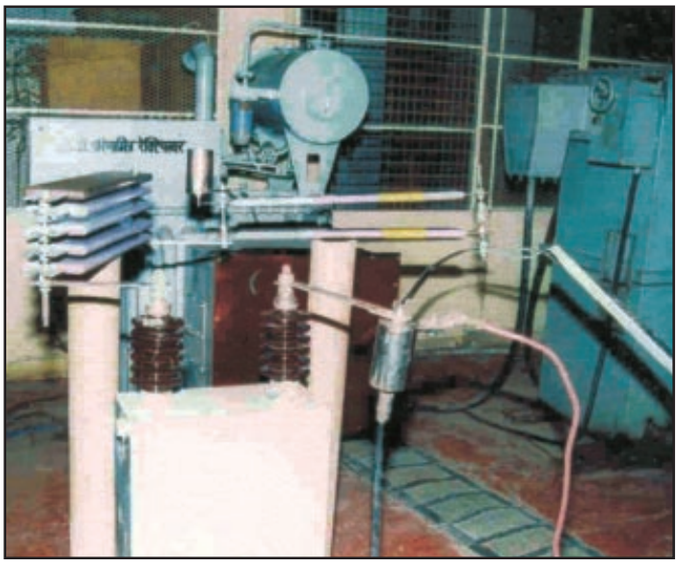
DISCHARGE CURRENT TEST ON HV SERIES CAPACITOR — FACILITY ESTABLISHED IN BHEL

BHEL has developed HV series capacitors for 400 kV series compensation project, for the first time in the country. IEC 60143 standard calls for some special tests like Discharge Current Test for HV series

capacitors used in long transmission lines. This test facility is not available indigenously, and even getting this test conducted at reputed International Testing agencies is beset with problems. In view of this, BHEL undertook and implemented, establishing of this test facility in-house for the first time in the country, to meet Discharge Current Test requirement of our esteemed customer, M/s Power Grid Corporation. This test facility has been established with internal resources mobilized within BHEL-Bhopal.

The testing was completed successfully in the presence of the representative of the Customer.

Thus, BHEL has added one more new test facility to the series of new test facilities it has been developing for conducting special tests in-house, in accordance with International Standards.



Capacitor undergoing Discharge Current Test

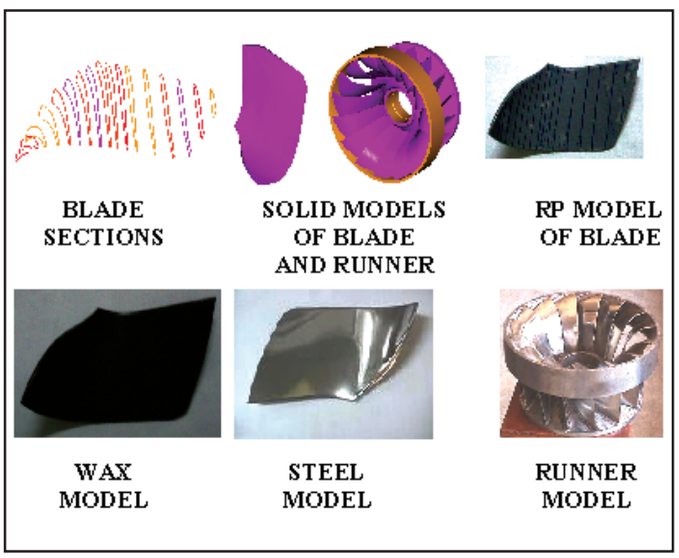
DEVELOPMENT OF HYDRO-TURBINE BLADE/RUNNER MODEL THROUGH RAPID PROTOTYPING TECHNIQUE

BHEL is the largest manufacturer of hydro turbines in the country. At present, scaled models of each and every new machine is made to demonstrate the hydraulic efficiency and related parameters, prior to the manufacturing process. These models are being made through a lengthy and time-consuming process. Rapid Prototyping technique is widely being adopted internationally by major manufacturers for cycle-time reduction in engineering, especially when new products are introduced. In line with this trend, the feasibility of adopting the Rapid Prototyping (RP) technique for making metallic models of Hydro Turbine Blades/Runners was taken up in BHEL.

The Runner blade being the most critical component, was modelled through the RP technique. Crown & lower ring were made by conventional machining. Section profiles and solid model of the hydro turbine blade were generated from the drawings using IDEAS software. Solid models of the matching crown and the lower ring were also generated for assembly checks.

Using the solid model of the Hydro Turbine blade, RP master of the blade was made by the Stereolithography technique. This was inspected by profile checking templates and also by 3D co-ordinate measurement equipment. A silicone rubber mould was made, using the RP master as the pattern, and wax patterns were made using this mould. Stainless steel blades were made using these wax patterns by investment casting.

By adopting Rapid Prototyping technique for making the blades and using conventional method for making crown and lower ring, savings in time and cost were achieved. A common 3D solid model can be used for manufacturing and CFD analysis, thereby minimizing discrepancy in the theoretical and experimental results.



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