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Performance enhancement of a laboratory steam power plant condenser

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The steam power plant located at the Thermo-fluid laboratory of the Mechanical Engineering Department of the Open university Sri Lanka, gives an opportunity for undergraduate students as well as those engaged in research work to conduct tests and observe the workings of a steam power plant. The plant, which operates on a simple Rankin cycle, mainly consists of an electrical boiler, steam engine, condenser and other auxiliary components. It has been observed that continuous bleeding of steam occurs with the condensate into the condenser tank and the plant does not operate as intended. Initial tests conducted on the plant revealed that the condenser performance was not in compliance with the manufacturer's recommended values. A high degree of deviation was observed in the cooling water flow-rate and the delta temperature of the cooling water in-out from the condenser which could not be rectified with the present laboratory conditions. Therefore, this study was carried out with the aim of enhancing the performance of the condenser, especially to reduce the specific steam consumption (SSC) and to increase the overall efficiency of the plant, taking into consideration the limitations of the laboratory environment. Experimental analysis showed that an 18.5 kW heat rejection is to be maintained at the condenser if the plant is to comply with the manufacturer standards. Therefore, three different water circulation designs, Inclined plate, sprinkling water pouring system and cross flow evaporative heat exchanger were selected and evaluated. An optimum design was selected based on sprinkler water pouring system, which utilizes a cooling tower principle to reject heat from the cooling loop. The design, fabricated out of plastic and aluminum, consists of a vessel with 1.14 meter active cooling height which directly contacts water and air in counter flow arrangement aided by an axial flow exhaust fan. Four layers of square mesh were introduced in order to increase contact area of air and water and a centrifugal pump to maintain the required flow rate. Tests carried out after implementing the design shows an increase in overall plant efficiency by 135% and a reduction in the SSC to the desired manufacturer standards.

Key Words: Steam power plant, Condenser performance, Cooling tower, Overall plant efficiency.

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