

Model Organic Rankine Cycle Power Plant for Waste Heat Recovery in Olkaria-I Geothermal Power Plant

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Abstract : Energy consumption is an indispensable component for the continued development of the human population. The global energy demand increases with development and population rise. The increase in energy demand, high cost of fossil fuels and the link between energy utilization and environmental impacts have resulted in the need for a sustainable approach to the utilization of the low grade energy resources. The Organic Rankine Cycle (ORC) power plant is an advantageous technology that can be applied in generation of power from low temperature brine of geothermal reservoirs. The power plant utilizes a low boiling organic working fluid such as a refrigerant or a hydrocarbon. Researches indicated that the performance of ORC power plant is highly dependent upon factors such as proper organic working fluid selection, types of heat exchangers (condenser and evaporator) and turbine used. Despite a high pressure drop, shell-tube heat exchangers have satisfactory performance for ORC power plants. This study involved the design, fabrication and performance assessment of the components of a model Organic Rankine Cycle power plant to utilize the low grade geothermal brine. Two shell and tube heat exchangers (evaporator and condenser) and a single stage impulse turbine have been designed, fabricated and the performance assessment of each component has been conducted. Pentane was used as a working fluid and hot water simulating the geothermal brine. The results of the experiment indicated that the increase in mass flow rate of hot water by 0.08 kg/s caused a rise in overall heat transfer coefficient of the evaporator by 17.33% and the heat transferred was increased by 6.74%. In the condenser, the increase of cooling water flow rate from 0.15 kg/s to 0.35 kg/s increased the overall heat transfer coefficient by 1.21% and heat transferred was increased by 4.26%. The shaft speed varied from 1585 to 4590 rpm as inlet pressure was varied from 0.5 to 5.0 bar and power generated was varying from 4.34 to 14.46W. The results of the experiments indicated that the performance of each component of the model Organic Rankine Cycle power plant operating at low temperature heat resources was satisfactory.

Keywords : brine, heat exchanger, ORC, turbine

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