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ORIGINAL ARTICLE

Model design of condenser for solar assisted geothermal cooling system using software simulation

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Abstract

Condensers are extensively used in refrigeration, air-conditioning and power generation systems. Condenser for the solar assisted geothermal cooling system is designed by using software simulation of condenser's geometrical and flow parameters. The geothermal cooling system is designed to reduce electricity consumption of compressor during peak hours during the summer period in hot weather condition. The subsurface temperature of the earth around 5–6-m depth is fairly constant throughout the year which fulfills the requirement of cooling inside the building or residence by using water as a heat exchanging medium. Water is circulated in closed loop system buried into subsurface which sinks the heat of refrigerant from condenser inside the subsurface soil. The condenser is designed by comparing results obtained from (1) manual calculation (2) simulation by CHEMCAD software. In order to have a good and optimized design, manual and software-based calculations should be carried out simultaneously and verified with each other. It is found that results obtained from both calculations are approximately same with a minor difference. The geometry and flow parameter of the condenser is determined on the basis of surrounding temperature. The solar panel is used for power generation to reduce electricity consumption by the compressor, pump, and evaporator fan coil. This provides the hybrid solar assisted geothermal cooling system.

Keywords Condenser · Geothermal cooling · CHEMCAD

List of symbols

U_L	Condensation heat transfer coefficient (W/m^2 K)
U_S	Sensible heat removal heat transfer coefficient (W/m^2 K)
D_o	Tube outside diameter (mm)
D_i	Tube inside diameter (mm)
L	Tube length (m)
P_t	Tube pitch (mm)
h_t	Fouling coefficient tube side (W/m^{2}K)
h_s	Fouling coefficient shell side (W/m^{2}K)
Q_S	Sensible heat duty (J/s)
Q_L	Latent heat duty (J/s)
$\dot{m}_R$	Refrigerant mass flow rate (kg/s)
$\dot{m}_w$	Water mass flow rate (kg/s)
C_{PR}	Specific heat of refrigerant (kJ/kg K)
C_{PW}	Specific heat of water (kJ/kg K)
λ_R	Latent heat of refrigerant (kJ/kg)
D_b	Tube bundle diameter (mm)
D_s	Shell inside diameter (mm)
A_t	Tube side flow area (m^2)
G_w	Water mass velocity (kg/m^2 s)
K_w	Thermal Conductivity of water (mW/m K)
K_{Cu}	Thermal Conductivity of copper (tube material) (mW/m K)
h_i	Tube side coefficient (W/m^2 K)
h_{oc}	Shell side coefficient (W/m^2 K)
U_{oc}	Overall condensation coefficient (W/m^2 K)
U_{os}	Overall sensible heat removal coefficient (W/m^2 K)

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