Sample Output of the Designed Code

Design parameters of a Shell & Tube Heat Exchanger

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Hot Fluid: Heavy Naphtha
Cold Fluid: Water
Enter the mass flow rate of Heavy Naptha in kg/s(if you want to enter in
1.5+0.03*G format enter 'G'): 2.1
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Mass Flow Rate of Heavy Naptha: 2.1 kg/s
Please input the following values in degree Celsius.
Initial Temperature of the Hot Fluid: 85
Desired Final Temperature of the Hot Fluid: 55
Coolant initial temperature: 35
Coolant final temperature: 45

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Caloric Fraction of Hot Fluid: 0.4348
Caloric Temperature Of Hot Fluid: 68.0429 C
Caloric Fraction of Cold Fluid: 0.3774
Caloric Temperature Of Cold Fluid: 38.7737 C

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Properties of the Fluids at Tc

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Hot Fluid: Heavy Naptha
Specific heat Capacity of Hot Fluid: 2036.9947 J/kg·K
Viscosity of Hot Fluid: 0.7333032907813091 cP
Denisty of Hot Fluid: 791.3870 kg/m³
Thermal Conductivity of Hot Fluid: 0.1500 W/m·K

Cold Fluid: Water
Specific Heat Capacity of Water: 4178.5761 J/kg·K
Viscosity of Cold Fluid: 0.6681 cP
Denisty of Cold Fluid: 992.6812 kg/m³
Thermal Conductivity of Cold Fluid: 0.5980 W/m·K

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Enthalpy Heat Balance

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Heat Rate:  128330.6666 J/kg·s
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Mass Flow Rate of Water: 3.0712 kg/s

LMTD and LMTD Correction Factor

LMTD considering counter-current flow: 28.8539 C
R: 3.0 S: 0.2
LMTD correction Factor for 1 shell pass and 2 or more tube passes
Ft = 0.9350
LMTD correction Factor for 2 shell pass and 4 or more tube passes
Ft = 0.9847
1-2 Heat Exchanger is the better option. As Ft>=0.9. The code will proceed calculating parameters for 1-2 HE.

Shell Side and Tube Side Parameters

Iteration 0
U(assumed): 496.8480 W/m²·K
Area: 9.5735 m²
Required number of Tubes: 20
Standard Number of tubes: 32
Ds_sq:0.2540 m

Tube Side Fluid: Heavy Naptha
Tube Side Reynolds Number (Re|tube): 13391.1316
Tube Side Heat Transfer Coefficient (ho):808.7476 W/m²·K

Shell Side Fluid: Water
Shell Side Reynolds Number (Re|shell): 17907.7249
Shell Side Heat Transfer Coefficient (ho): 1062.9282 W/m²·K

Ucal: 230.0459 W/m²·K
Relative error = 53.6989 %
Since the relative error is >5% we proceed to do further iterations

Iteration 1
Required number of Tubes: 43
Standard Number of tubes: 45
Ds_sq:0.3048 m

Tube Side Reynolds Number (Re|tube): 9522.5825
Tube Side Heat Transfer Coefficient (hi):615.6912 W/m²·K
Shell Side Reynolds Number (Re|shell): 12435.9201
Shell Side Heat Transfer Coefficient (ho): 1111.3673 W/m²·K

Ucal: 200.1915 W/m²·K
Relative error = 12.9776 %

Iteration 2
Required number of Tubes: 49
Standard Number of tubes: 56
Ds_sq:0.3365 m

Tube Side Reynolds Number (Re|tube): 7652.0752
Tube Side Heat Transfer Coefficient (hi):516.8715 W/m²·K
Shell Side Reynolds Number (Re|shell): 10200.1993
Shell Side Heat Transfer Coefficient (ho): 999.8507 W/m²·K
Ucal: 177.0657 W/m²·K
Relative error = 11.5518 %

Iteration 3
Required number of Tubes: 56
Standard Number of tubes: 56
Ds_sq:0.3365 m

Tube Side Reynolds Number (Re|tube): 7652.0752
Tube Side Heat Transfer Coefficient (hi):516.8715 W/m²·K
Shell Side Reynolds Number (Re|shell): 10200.1993
Shell Side Heat Transfer Coefficient (ho): 999.8507 W/m²·K
Ucal: 177.0657 W/m²·K
Relative error = 0.0000 %

Pressure Drop and Overdesign

Tube side velocity: 0.4166 m/s
Friction Factor: 0.04244
delta Pf:1044.3083 Pa , delta_Pr: 0.089471 Pa
Tube Side Pressure Drop: 0.1515 psi (1044.3978 Pa)
Required Number of Tubes: 56
Standard Number of Tubes: 56
%Overdesign: 0.0000 %

Design is acceptable and cost-effective