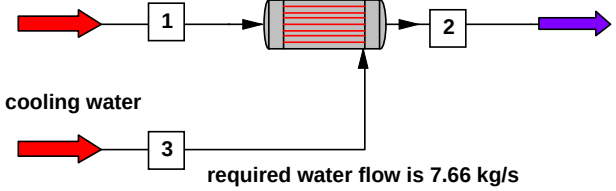
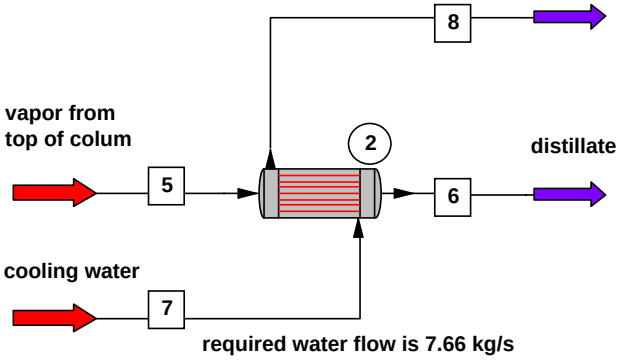


Step 2:
Copy flowsheet to preserve data, and use "Sizing" tool.



Step 3:
Switch heat exchanger 2 to simulation mode to run CCTherm in the rating mode. Then change tube length and number of tubes to optimize annual operating costs. (See Excel sheet).

Design Problem 2

Spreadsheet for evaluating Equation 14-91

Number of tubes	N_t	150	100	72	107
Length of tubes	L	1.250	1.500	2.000	1.830
Tube outer diameter	D_o	0.0254	0.025	0.025	0.0254
Tube inner diameter	D_i	0.0191	0.0191	0.0191	0.0191
Tube wall thickness	x	0.0032	0.0032	0.0032	0.0032
Outside area of tubes	A_o	14.962	11.969	11.491	15.625
Annual fixed charges	K_F	0.2	0.2	0.2	0.2
Installed cost	C	$5,039.13	$4,522.23	$4,453.37	$5,185.68
Installed cost per A_o	C_{Ao}	$336.80	$377.81	$387.56	$331.88
Hours of operation per year	H_y	8000	8000	8000	8000
Tube-side inlet fluid density	ρ_{ti}	1.295	1.295	1.295	1.295
Tube-side oulet fluid density	ρ_{to}	905.847	903.956	910.353	922.522
Tube-side average density	ρ_t	453.571	452.626	455.824	461.908
Tube-side flow rate	m_i	3.234	3.234	3.234	3.234
Tube-side pressure drop	Δp_i	0.000	0.000	0.000	0.000
Tube-side power loss	E_i	0.000	0.000	0.000	0.000
Shell-side inlet fluid density	ρ_{si}	997.844	997.844	997.844	997.844
Shell-side oulet fluid density	ρ_{so}	982.500	982.746	981.908	980.272
Shell-side average density	ρ_s	990.172	990.295	989.876	989.058
Shell-side flow rate	m_o	7.661	7.661	7.661	7.661
Shell-side pressure drop	Δp_o	6.096	8.449	11.911	9.616
Shell-side power loss	E_o	3.152	5.461	8.023	4.767
Cost of pumping power	C_i	$0.12	$0.12	$0.12	$0.12
Fixed charges		$1,007.83	$904.45	$890.67	$1,037.14
Tube-side pumping costs		$0.00	$0.00	$0.00	$0.00
Shell-side pumping costs		$45.28	$62.75	$88.50	$71.50
Total annual cost	C_T	$1,053.10	$967.20	$979.17	$1,108.64

Procedure:
Run ChemCAD in utility mode to determine the necessary flow rate on the cold air.
Run CCTherm in design mode to achieve the optimal dimensions.
Vary the tube length and adjust tube count to keep stream temps on spec.

Conclusion:
Based on this data, the 1.5 m heat exchanger looks like the best choice.

TEMA SHEET

Customer | Ref No.
Address | Prop No.
Plant Loc. | Date Rev
Service of Unit | Item
Size 0.4m x 1.8m Type AEL (Hor/Vert) H Connected in 1 Para 1 Seri
Surf/Unit(G/E) 15.6/14.7 m2; Shell/Unit 1.000000 Surf/Shell 15.6/14.7 m2

PERFORMANCE OF ONE UNIT

Type of Process	Sensible	Horiz Cond	
Fluid Allocation	Shell Side	Tube Side	
Fluid Name			
Flow	7.7	3.2	kg/sec
Liquid	7.7	0.0	kg/sec
Vapor	0.0	3.2	kg/sec
NonCondensable	0.00000	0.00000	kg/sec
Steam	0.0	0.0	kg/sec
Evap/Cond	0.0	3.2	kg/sec
Density	0.00/997.84/ 0.00/982.94	1.30/885.84/ 0.00/902.49	kg/m3
Conductivity	0.00/0.60 / 0.00/0.65	0.02/0.12 / 0.02/0.12	W/m-K
Specific Heat	0.00/4.19 / 0.00/4.18	1.72/2.13 / 1.69/2.06	kJ/kg-K
Viscosity	0.00/0.00 / 0.00/0.00	0.00/0.00 / 0.00/0.00	N-s/m2
Latent Heat	0.00	340.46	kJ/kg
Temperature(In/Out)	20.000/60.000	207.550/180.000	C
Operating Pressure	101.00	33.88	kPa
Fouling Factor	0.000176	0.000176	m2-K/W
Velocity	0.42	6.17	m/sec

Press Drop Allow/Calc 34.474/4.298 34.474/4.163 kPa
Heat Exchanged 1.281e+000 MJ/sec; MTD(Corrected): 162.44 C
Transfer Rate, Service: 536.6 Calc: 708.9 Clean: 997.3 W/m2-K

CONSTRUCTION DATA/SHELL Sketch

	Shell Side	Tube Side
Design/Test Press kPa	0.000000/Code	0.000000/Code
Design Temperature C	0.000	0.000
No. Passes per Shell	1	1
Corrosion Allowance m	0.000	0.000
Connections IN ID m	0.078	0.305
Size & OUT ID m	0.090	0.063
Rating		

Tube No. 107 OD 0.025 m;Thk. 0.0030 m;Length. 1.83 m;Pit. 0.032 m; Ptn. 60
Tube Type Bare Material 1 Carbon Steel
Shell A-285-C 0.39 ID 0.41 OD m Shell Cover
Channel or Bonnet A-285-C Channel Cover
Tubesheet Stationary A-285-C Tubesheet Floating
Floating Head Cover Impingement Protection: Yes
Baffles Cross A-285-C Type SSEG Cut(Diam) 15 Spacing C/C 0.08 m
Baffles Long Seal Type
Supports Tube C.S. U-Bend
Bypass Seal Arrangement Tube-Tubesheet Joint
Expansion Joint No. Type
Rho-V2-Inlet Nozzle 2585.53 Bundle Entrance Bundle Exit
Shell Side Tube Side
Gasket Floating Head
Code Requirements Tema Class R
Weight/Shell
Remarks:

TEMA SHEET
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1 Economic Optimum
2 Customer Ref No.
3 Address Prop No.
4 Plant Loc. Date Rev
5 Service of Unit Item
6 Size 0.4m x 1.5m Type AEL (Hor/Vert) H Connected in 1 Para 1 Seri
7 Surf/Unit(G/E) 12.0/11.2 m2; Shell/Unit 1.000000 Surf/Shell 12.0/11.2 m2
8 PERFORMANCE OF ONE UNIT

9 Type of Process	Sensible	Horiz Cond		
10 Fluid Allocation	Shell Side	Tube Side		
11 Fluid Name				
12 Flow	7.7	3.2	kg/sec	
13 Liquid	7.7	0.0	kg/sec	
14 Vapor	0.0	3.2	kg/sec	
15 NonCondensable	0.00000	0.00000	kg/sec	
16 Steam	0.0	0.0	kg/sec	
17 Evap/Cond	0.0	3.2	kg/sec	
18 Density	0.00/997.84/ 0.00/980.27	1.30/886.17/ 0.00/922.52	kg/m3	
19 Conductivity	0.00/0.60 / 0.00/0.65	0.02/0.12 / 0.02/0.13	W/m-K	
20 Specific Heat	0.00/4.19 / 0.00/4.18	1.72/2.13 / 1.69/1.99	kJ/kg-K	
21 Viscosity	0.00/0.00 / 0.00/0.00	0.00/0.00 / 0.00/0.00	N-s/m2	
22 Latent Heat	0.00	341.80	kJ/kg	
23 Temperature(In/Out)	20.000/64.989	207.550/155.563	C	
24 Operating Pressure	101.00	33.88	kPa	
25 Fouling Factor	0.000176	0.000176	m2-K/W	
26 Velocity	0.44	6.27	m/sec	

27 Press Drop Allow/Calc 34.474/1.518 34.474/4.090 kPa
28 Heat Exchanged 1.441e+000 MJ/sec; MTD(Corrected): 154.87 C
29 Transfer Rate, Service: 831.7 Calc: 649.2 Clean: 883.1 W/m2-K
30 CONSTRUCTION DATA/SHELL Sketch

31	Shell Side	Tube Side	
32 Design/Test Press kPa	0.000000/Code	0.000000/Code	
33 Design Temperature C	0.000	0.000	
34 No. Passes per Shell	1	1	
35 Corrosion Allowance m	0.000	0.000	
36 Connections IN ID m	0.078	0.305	
37 Size & OUT ID m	0.090	0.063	

38 Rating
39 Tube No. 100 OD 0.025 m;Thk. 0.0030 m;Length. 1.50 m;Pit. 0.032 m; Ptn. 60
40 Tube Type Bare Material 1 Carbon Steel
41 Shell A-285-C 0.37 ID 0.40 OD m Shell Cover
42 Channel or Bonnet A-285-C Channel Cover
43 Tubesheet Stationary A-285-C Tubesheet Floating
44 Floating Head Cover Impingement Protection: Yes
45 Baffles Cross A-285-C Type SSEG Cut(Diam) 15 Spacing C/C 0.08 m
46 Baffles Long Seal Type
47 Supports Tube C.S. U-Bend
48 Bypass Seal Arrangement Tube-Tubesheet Joint
49 Expansion Joint No. Type
50 Rho-V2-Inlet Nozzle 2585.53 Bundle Entrance Bundle Exit
51 Shell Side Tube Side
52 Gasket Floating Head
53 Code Requirements Tema Class R
54 Weight/Shell

55 Remarks:
56