

## PLATE &amp; FRAME HEAT EXCHANGER SIZING

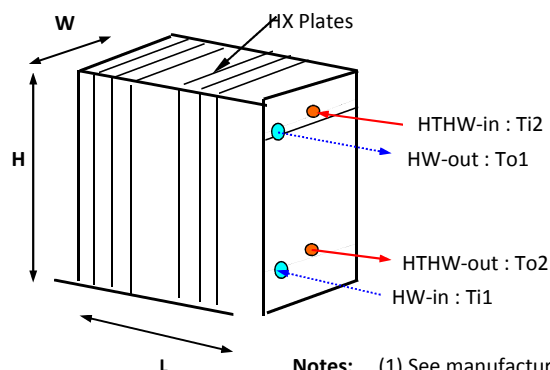
  = User Input      = Calculated by Excel

Project Name	Program Testing				Engr	Varkie Thomas
Project Number	123456-78-910				Date	20 April, 2000

FLUID CONDITIONS	Secondary	Primary
	Desired	Variable
	Output (1)	Input (2)
Fluid Type Circular	HW	HTHW
GPM : Fluid Flow (gallons/min)	1,000	3,304
Ti : Entering Fluid Temp (F)	50	400
To : Leaving Fluid Temp (F)	200	350
Temp Change = ABS ( Ti - To )	150	50
Ta : Average Fluid Temp (F)	125	375
D : Density @ avg Ta (lbs/ft <sup>3</sup> )	61.2	54
SG : Specific Gravity @ avg Ta	0.98	0.87
SH : Specific Heat (btu/lb.F)	1.03	1.06
Q : Heat Gain/Loss (1000 btu/hr)	75,842	75,842
Viscosity (ft <sup>2</sup> /sec) @ avg Ta	7.39	1.75
Pressure Drop (ft H <sub>2</sub> O)	20	15
% SQFT Surface for Fouling	10	5

DT1 =	300	DT2 =	200	LMTD =	247
Heat Transfer Material =	Steel	U-value =	140		
Required Heat Transfer Surface Area (ft <sup>2</sup> ) =	2,709				
Surface Area Adjusted for Fouling (ft <sup>2</sup> ) =	3,128				

FORMULAS					
CFM (ft <sup>3</sup> /min) x 7.48052 = GPM (gals/min)					
GPM / 7.48052 (ft <sup>3</sup> /lb) x D (lbs/ft <sup>3</sup> ) x 60 (min/hr) =					
M ( lbs/hr)					
OR GPM x 8.021 x D = M					
Q (mbh) = M x SH x (Ti - To) / 1000 =					
(GPM x 8.021 x D) x SH x (Ti - To) / 1000 =					
GPM x 0.008021 x D x SH x (Ti - To)					
GPM = Q / [0.008021 x D x SH x (Ti - To)]					
LMTD (Log Mean Temp Diff) =					
[(To2-Ti1) - (Ti2-To1)] / [LN{(To2-Ti1) / (Ti2-To1)}]					
where (To2-Ti1) > (Ti2-To1)					
LMTD = (DT1- DT2) / (LN (DT1/DT2))					
where DT1 > DT2					
Q = A x U x LMTD					
Surface Area (A) = Q / (U x LMTD)					

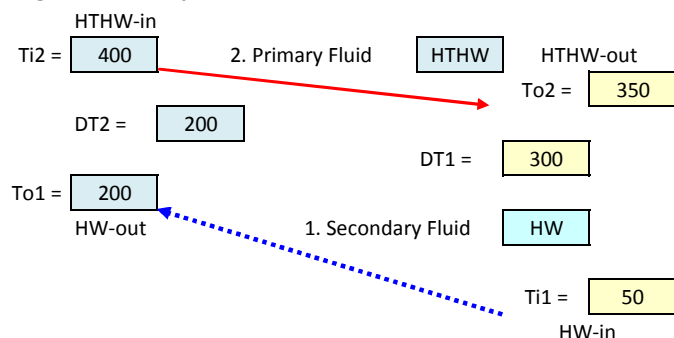


- Notes:**
- (1) See manufacturer's catalogs to get standard heights (H) and widths (W)
  - (2) Length (L) varies with heat transfer surface area required and number of plates
  - (3) Obtain U-value of heat transfer material from HX manufacturer (catalog)

See Next WorkSheet "Properties" for:

- (1) Properties of Fluids
- (2) Properties of Heat Transfer Materials

## Log Mean Temperature Difference (LMTD)



PROPERTIES OF LIQUIDS

Kinematic Viscosity (sq.ft./sec) in Liquid Tables are: (value shown)/1,000,000

Liquid	Properties	Temperature (F)						
		-30	0	30	60	100	150	210
Water	Density (lb/cu ft)			62.42	62.37	62.00	61.20	59.81
	Specific Gravity = Dens/62.4			1.00	1.00	0.99	0.98	0.96
	Kinematic Viscosity (sq ft/sec)			19.31	12.17	7.39	4.76	3.20
	Specific Heat (Btu/lb oF)			1.00	1.00	1.00	1.00	1.01
Glycol	Density (lb/cu ft)	67.98	67.55	67.11	66.55	65.74	64.68	63.12
	Specific Gravity = Dens/62.4	1.09	1.08	1.08	1.07	1.05	1.04	1.01
	Kinematic Viscosity (sq ft/sec)	595.00	190.00	85.40	48.60	22.60	12.50	6.40
	Specific Heat (Btu/lb oF)	0.70	0.73	0.76	0.78	0.81	0.85	0.88
Brine	Density (lb/cu ft)	78.59	78.21	77.71	77.21	76.09		
	Specific Gravity = Dens/62.4	1.26	1.25	1.25	1.24	1.22		
	Kinematic Viscosity (sq ft/sec)	171.70	77.50	34.70	21.80	8.90		
	Specific Heat (Btu/lb oF)	0.66	0.67	0.68	0.69	0.71		

PROPERTIES OF HIGH TEMPERATURE HOT WATER

Temp deg F	Satr Pr psig	Density lb/cu ft	Specific Gravity	Kin Visc sqft/sec	Sp. Heat Btu/lb-F
T	P	D	D/62.4	V	H
212	0.0	59.81	0.96	3.20	1.0055
220	2.5	59.63	0.96	3.00	1.0068
240	10.3	59.10	0.95	2.70	1.0104
260	20.7	58.51	0.94	2.50	1.0148
280	34.5	57.94	0.93	2.30	1.0200
300	52.3	57.31	0.92	2.10	1.2600
350	119.9	55.59	0.89	1.90	1.0440
400	232.6	53.65	0.86	1.70	1.0670
450	407.9	51.55	0.83	1.50	1.0950

PROPERTIES OF STEAM

Press psig	Temp deg F	Sp. Vol. cuft/lb	Density lbs/cuft	Sp. Gr D/62.4	Enthalpy btu/lb			Sp. Ht. Btu/lb-F	Kin Visc sqft/sec
					Liquid	Latent	Total		
0	212.0	26.80	0.03731	0.00060	180.1	970.3	1150.4	0.45300	0.00023
5	227.3	20.34	0.04916	0.00079	195.5	960.5	1156.0	0.36601	0.00017
10	240	16.46	0.06075	0.00097	207.9	952.5	1160.4	0.34646	0.00014
15	250	13.86	0.07215	0.00116	218.3	945.6	1163.9	0.35000	0.00012
20	258.8	11.98	0.08347	0.00134	227.5	939.5	1167.0	0.35227	0.00010
25	266.9	10.56	0.09470	0.00152	235.6	934.0	1169.6	0.32099	0.00009
30	274.1	9.45	0.10582	0.00170	243.0	928.9	1171.9	0.31944	0.00008
35	280.7	8.56	0.11682	0.00187	249.8	924.2	1174.0	0.31818	0.00007
40	286.8	7.83	0.12771	0.00205	256.0	919.8	1175.8	0.29508	0.00007
45	292.4	7.20	0.13889	0.00223	261.8	915.7	1177.5	0.30357	0.00006
50	297.7	6.68	0.14970	0.00240	267.2	911.8	1179.0	0.28302	0.00006
60	307.3	5.83	0.17153	0.00275	277.2	904.6	1181.8	0.29167	0.00005
70	316.4	5.18	0.19305	0.00309	286.2	898.0	1184.2	0.26374	0.00004
80	323.9	4.66	0.21459	0.00344	294.4	891.9	1186.3	0.28000	0.00004
90	331.2	4.24	0.23585	0.00378	301.9	886.1	1188.0	0.23288	0.00004
100	337.9	3.89	0.25707	0.00412	308.9	880.7	1189.6	0.23881	0.00003
110	344.2	3.59	0.27855	0.00446	315.5	875.5	1191.0	0.22222	0.00003
120	350.1	3.34	0.29940	0.00480	321.7	870.7	1192.4	0.23729	0.00003
130	355.6	3.12	0.32051	0.00514	327.6	865.9	1193.5	0.20000	0.00003
140	360.9	2.93	0.34130	0.00547	333.1	861.5	1194.6	0.20755	0.00002
150	365.9	2.76	0.36232	0.00581	338.4	857.2	1195.6	0.20000	0.00002
170	375.2	2.47	0.40486	0.00649	348.3	848.9	1197.2	0.17204	0.00002
200	387.8	2.13	0.46948	0.00752	361.9	837.4	1199.3	0.16667	0.00002
220	395.5	1.95	0.51282	0.00822	370.1	830.3	1200.4	0.14286	0.00002
250	406.1	1.74	0.57471	0.00921	381.6	820.1	1201.7	0.12264	0.00001

Density = 1 / Specific Volume

Density of Water @ 40 F = 62.4

Specific Gravity = Density of Fluid / Density of Water @ 40 F

Specific Heat (btu/lb.F) @ 0 psig & 212 F = 0.453

Sp. Ht. @ 15 psig & 250 F = (TH @ 250F -TH @ 240F) / (250 - 240)

Viscosity (Centipoise) of Steam @ 0 psig & 212 F = 0.0125

Viscosity (Centipoise) of Steam @ ? psig & 932 F = 0.028

Kinematic Viscosity (Centistokes) = Viscosity (Centipoise) / Specific Gravity

Centistokes = 1.0 sq mm / sec = 0.00001076 sq ft / sec

Kin Visc (sqft/sec) = Viscosity (Centipoise) x 0.0000108 / Specific Gravity

PROPERTIES OF HEAT TRANSFER MATERIALS & SURFACES

U : btu/hr.ft2.F      K : btu/hr.ft2.F/in      Film Coeff Ho,Hi : btu/hr.ft2.F

U = 1 / ( 1/Ho + t/K + 1/Hi)      t = Thickness of Material (inches)

Applic	Ht Trans Materl	t	Ho	Hi	K-value	U-value
Heatg	Copper	0.0747	300	1000	2680	229
Water	Aluminum	0.0747	300	1000	1570	228
with	Carbon Steel	0.0747	300	1000	312	219
Steam	Stainless Steel	0.0747	300	1000	113	200
Heatg	Copper	0.0747	300	300	2680	149
Water	Aluminum	0.0747	300	300	1570	149
with	Carbon Steel	0.0747	300	300	312	145
HW	Stainless Steel	0.0747	300	300	113	136
Heatg	Copper	0.0747	5	1000	2680	4.97
Air	Aluminum	0.0747	5	1000	1570	4.97
with	Carbon Steel	0.0747	5	1000	312	4.97
Steam	Stainless Steel	0.0747	5	1000	113	4.96