Taco Training TACO-Ways

Heat Loss:

IDT – ODT = DTD

Infiltration:

Infiltration Factors:

1 outside wall with openings: ..... **.012**
2 outside walls with openings: ..... **.018**
3 outside walls with openings or main entry: ..... **.027**

Infiltration: L × W × H × DTD × Infiltration Factor

Windows/Doors:

L × W (area) × DTD × U-value
U = 1 ÷ R R = 1 ÷ U

Walls:

Net area (subtract window/door area) × DTD × U-value

Ceilings/Floors:

L × W × DTD × U-value

Universal Hydronics Formula:

GPM = BTUH ÷ (ΔT×500)

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Boiler Ratings:

AGA Input: burner input rating
DOE: Federal output rating – jacket, piping losses usable heat
Net IBR: DOE – 15%, jacket, piping losses unusable, "pickup" allowance

Pipe Sizing Guidelines:

2-4 GPM = ¾" 4-9 GPM = 1"
8-14 GPM = 1¼ " 14-22 GPM = 1½"

Head Loss:

Easy Way (estimating):

Measure length of the run
Multiply by 1.5 (fittings, valves, etc)
Multiply by .04 (4' head/100' of straight, properly sized pipe)

Right way (calculating)

Measure run, then count the fittings

Fitting	1/2"	3/4"	1"	1-1/4"	1-1/2"	2"
45˚	1.0	---	---	---	2.2	2.8
90˚	2.5	---	---	---	4.3	5.5
Ball Valve	1.9	2.2	4.3	7.0	6.6	14.0
Globe Vlv Open	17.0	22.0	27.0	36.0	43.0	55.0
Tee	5.0	---	---	---	9.0	12.0
Venturi Tee	X	18.0	14.0	9.5	10.5	X
Flow Check	X	27.0	42.0	60.0	63.0	83.0

Add up Total Developed length

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Find PSI/foot of pipe at correct flow:

Flow, GPM	PRESSURE LOSS OF WATER DUE TO FRICTION IN TYPES K, L, AND M COPPER TUBE (psi per linear foot tube) Nominal or Standard Size, Inches																				
	1/4"			3/8"			1/2"			3/4"			1"			1-1/4"			1-1/2"		
	K	L	M	K	L	M	K	L	M	K	L	M	K	L	M	K	L	M	K	L	M
1	.138	.118	N/A	.036	.023	.021	.010	.008	.007	.002	.001	.001	.000	.000	.000	.000	.000	.000	.000	.000	.000
2	---	---	N/A	.130	.084	.075	.035	.030	.024	.006	.005	.004	.002	.001	.003	.001	.000	.000	.000	.000	.000
3	---	---	N/A	.275	.177	.159	.074	.062	.051	.014	.011	.009	.003	.003	.001	.001	.001	.001	.000	.000	.000
4	---	---	N/A	---	---	---	.125	.106	.086	.023	.018	.015	.006	.005	.004	.002	.002	.002	.001	.001	.001

PSI/foot×Developed length = PSI pressure drop
PSI pressure drop×2.31 = head loss

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Pressure Loss for PEX:

Find PD per foot at correct flow rate, pipe size. Multiply by total length

Flow, GPM	Mr PEX Barrier PEX Pressure Drop per Foot of Pipe				
	3/8″	1/2″	5/8″	3/4″	1″
8.0	11.31	2.48	0.93	0.44	0.12
7.8	10.61	2.32	0.87	0.41	0.12
7.5	9.94	2.18	0.81	0.39	0.11
7.3	9.29	2.03	0.76	0.36	0.10
7.0	8.66	1.90	0.71	0.34	0.09
6.8	8.05	1.76	0.66	0.31	0.09
6.5	7.46	1.63	0.61	0.29	0.08
6.3	6.90	1.51	0.57	0.27	0.08
6.0	6.36	1.39	0.52	0.25	0.07
5.8	5.84	1.28	0.48	0.23	0.06
5.5	5.34	1.17	0.44	0.21	0.06
5.3	4.87	1.07	0.40	0.19	0.05
5.0	4.42	0.97	0.36	0.17	0.05
4.8	3.99	0.87	0.33	0.15	0.04
4.5	3.58	0.78	0.29	0.14	0.04
4.3	3.19	0.70	0.26	0.12	0.03
4.0	2.83	0.62	0.23	0.11	0.03
3.8	2.55	0.56	0.21	0.10	0.03
3.6	2.29	0.50	0.19	0.09	0.03

Flow, GPM	Mr PEX Barrier PEX Pressure Drop per Foot of Pipe				
	3/8″	1/2″	5/8″	3/4″	1″
3.4	2.04	0.45	0.17	0.08	0.02
3.2	1.81	0.40	0.15	0.07	0.02
3.0	1.59	0.35	0.13	0.06	0.02
2.8	1.39	0.30	0.11	0.05	0.02
2.6	1.19	0.26	0.10	0.05	0.01
2.4	1.02	0.22	0.08	0.04	0.01
2.2	0.86	0.19	0.07	0.03	0.01
2.0	0.71	0.15	0.06	0.03	0.01
1.8	0.57	0.13	0.05	0.02	0.01
1.6	0.45	0.10	0.04	0.02	
1.4	0.35	0.08	0.03	0.01	
1.2	0.25	0.06	0.02	0.01	
1.0	0.18	0.04	0.01	0.01	
0.8	0.11	0.02	0.01		
0.6	0.06	0.01	0.01		
0.4	0.03	0.01			
0.2	0.01				
0.0					

Calculating Head Loss using Cv Rating:

$$(\text{Flow} \div \text{Cv})^2 \times 2.31 = \text{Head Loss}$$

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Sizing Buffer Tanks:

Minimum BTUH Firing Rate – BTUH load of smallest zone = BTUH Surplus
BTUH Surplus×Minimum Desire Run Time (10 minutes) = Cycle Factor
Cycle Factor ÷ (Delivery ΔT×500) = Buffer tank size in gallons

Sizing Expansion Tanks:

$$V = V_{system} \times \left[\frac{D_{cold}}{D_{hot}} - 1 \right] \times \left[\frac{P_{relief\ valve} + 9.7}{P_{relief\ valve} - P_{charge} - 5} \right]$$

Water Density (lbs/ft3)	
60˚F	62.34
100˚F	62.00
110˚F	61.84
120˚F	61.73
130˚F	61.54
140˚F	61.39
150˚F	61.20
160˚F	61.01
170˚F	60.79
180˚F	60.57
190˚F	60.39

Piping Water Content:

Copper – Gallons per foot:	
1/2″	0.016
3/4″	0.027
1″	0.046
1-1/4″	0.068
1-1/2″	0.096

PEX – Gallons per 100′:	
3/8″	0.497
1/2″	0.917
5/8″	1.392
3/4″	1.832
1″	3.067

	13″	16″	18″	20″	22″	23″	26″	30″	32″	36″	38″	45″
3 Tubes	---	---	---	1.72	---	2.00	2.33	3.00	---	3.50	3.50	---
4 Tubes	---	---	---	2.25	---	2.50	2.75	---	3.50	4.25	---	---
5 Tubes	---	---	---	2.67	---	3.00	3.50	4.33	4.33	5.00	6.00	---
6 Tubes	---	---	---	3.00	---	3.50	4.00	---	5.00	---	---	---
7 Tubes	2.60	3.50	---	4.20	---	---	4.75	---	---	---	---	---
1 Column	---	---	---	1.50	---	1.67	2.00	---	2.50	---	3.00	---
2 Columns	---	---	---	2.00	---	2.33	2.67	---	3.33	---	4.00	5.00
3 Columns	---	---	2.25	---	3.00	---	3.75	---	4.50	---	5.00	6.00
4 Columns	---	---	3.00	---	4.00	---	5.00	---	6.50	---	8.00	10.0
5 Columns	3.00	3.75	4.50	5.00	---	6.30	7.00	---	8.50	---	10.0	---

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Estimating Fuel Consumption:

$$EFU = \frac{\text{Heating load} \times 24 \times \text{Degree Days} \times \text{Correction Factor}}{\text{AFUE(as decimal)} \times \text{BTUH content of fuel} \times \text{DTD}}$$

Find Degree Days at www.degreedays.net

Correction Factors:

Degree days	Factor
2,500	0.720
3,000	0.700
3,500	0.680
3,750	0.670
4,000	0.660
4,250	0.645

Degree days	Factor
4,500	0.630
4,750	0.620
5,000	0.610
5,250	0.605
5,500	0.600
5,750	0.605

Degree days	Factor
6,000	0.610
6,250	0.615
6,500	0.620
6,750	0.625
7,000	0.630
7,250	0.635

Degree days	Factor
7,500	0.640
7,750	0.645
8,000	0.650
8,500	0.660

Estimating Electrical Consumption:

Watts ÷ 1000 = Kilowatts (kW)

kW × "on" hours = Kilowatt hours (kWh)

kW ×cost/kWh = Estimated operating cost

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Indirect Hot Water Tanks:

Capacity×.75 = Usable Capacity

Recovery/minute = Boiler BTUH output ÷ 45,000 (or 8.33×60×90)

Usable Capacity + (Recovery/minute×60) = First Hour Rating

First Hour Rating ÷ 60 = First Hour GPM available

$(T_{mix} - T_{inc}) \div (T_{stored} - T_{inc})$ = Storage Factor

Usable Capacity ÷ Storage Factor = Tempered Capacity

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