Boiler vs Water Heater Performance

Table 1 - Possible Flow Rates with Different Delta T's for a given net transfer												
Typical Heating Delta T's					Typical Domestic Water Delta T's							
60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	Net Transfer, Btu/Hr
5	10	15	20	30	40	50	60	70	80	90	100	Difference Between Inlet/Outlet, Deg F
24.0	12.0	8.0	6.0	4.0	3.0	2.4	2.0	1.7	1.5	1.3	1.2	Flow rate, Usgpm

Table 2 - Various Flow Rates for a Fixed Typical Heating Delta T of 20 deg F at Different Net Transfer												
240,000	120,000	80,000	60,000	40,000	30,000	24,000	20,000	17,143	15,000	13,333	12,000	Net Transfer, Btu/Hr
20	20	20	20	20	20	20	20	20	20	20	20	Difference Between Inlet/Outlet, Deg F
24.0	12.0	8.0	6.0	4.0	3.0	2.4	2.0	1.7	1.5	1.3	1.2	Space Heating Flow Rate, Usgpm

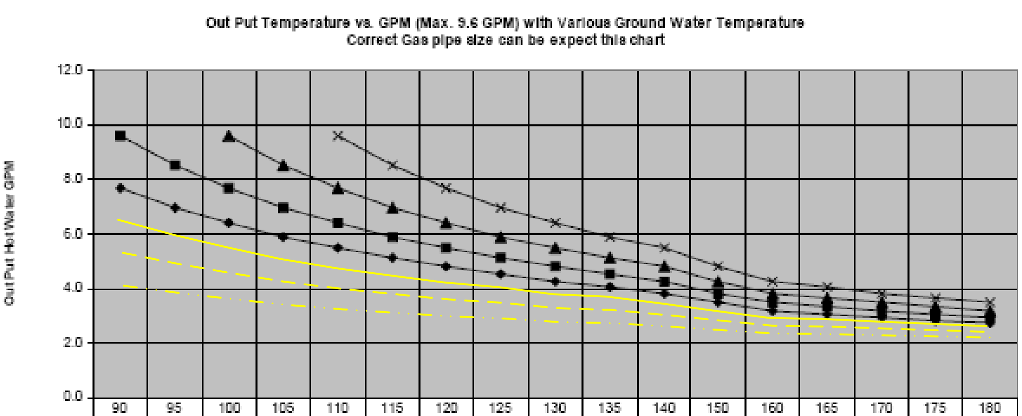
Notes:

The difference in temperature refers to the water temperature entering the heating appliance the leaving temperature and uses the symbol Δ. For example in Table 1, an appliance with a net transfer of 60,000 Btu/hr can heat 4 US gpm with a 30 deg F Δt but only 1.5 US gpm for a 80 deg F Δt...that's why water heaters have storage tanks. Its also why tankless boilers have either limited heat transfer at low Δt or use heat exchangers which have the space heating capacities but also have high head losses. Often you will see the manufacturer limit the flow rate through the heat exchanger to keep velocities within acceptable limits.

The flow rate is a calculation based on the formula, US gpm = Btu/hr / (60 * Cf * Df * ΔT), where Cf = heat capacity of the fluid, and Df is the density.

Btu/hr is the heating load, in the case of space heating it comes from the heat loss calculation. For domestic it's a function of the fixture flow rate, city or well water temperature and desired temperature.

The net transfer rate is not the input rating of the device. The device has to be upsized based on its efficiency and in some case altitude.



	90	95	100	105	110	115	120	125	130	135	140	150	160	165	170	175	180
40 F	7.7	7.0	6.4	5.9	5.5	5.1	4.8	4.5	4.3	4.0	3.8	3.5	3.2	3.1	3.0	2.8	2.7
50 F	9.6	8.5	7.7	7.0	6.4	5.9	5.5	5.1	4.8	4.5	4.3	3.8	3.5	3.3	3.2	3.1	3.0
60 F			9.6	8.5	7.7	7.0	6.4	5.9	5.5	5.1	4.8	4.3	3.8	3.7	3.5	3.3	3.2
70 F					9.6	8.5	7.7	7.0	6.4	5.9	5.5	4.8	4.3	4.0	3.8	3.7	3.5

Out put Hot Water Temperature

40 F 50 F 60 F 70 F

Note the head loss at 9 US gpm is 35 psi...A boiler is around 2 psi.

Water heater applications in radiant heating – an explanation.

The graph to the immediate left is from the Takagi manuals. The tables above are heat transfer references based on flow and Δt and come from our training manuals.

Notice the performances to the left are based on 40, 50, 60 and 70 deg F Δt's but not typical heating Δt's of 5, 10, 15 or 20 deg F. The four black curves (Takagi) represent the performance based on flow (left hand side) and the Δt shown by the different symbols (outlet temp minus inlet temp) for a given outlet temperature….the values shown between 90 deg F and 180 deg F. Notice as you slow the flow the temperature rises. Or conversely if you want higher temperature you have to slow the flow. The curves are function of the heat exchanger design which is why the statement 'heat is heat' is well...open for interpretation. One can interpolate as I have estimated by drawing the 30 deg F Δt (solid yellow) and 20 curve deg F Δt (dashed yellow) and 10 deg F Δt (dashed -dot yellow) on the graph. You can see that as the Δt gets narrower the flow rate performance goes down again as a result of the heat exchanger design. (ask the mfg for exact performance!).
This next statement is very important…***__the curves on this graph all come from one heater with a maximum rating of 235,000 Btu/hr. That's why you can't substitute a boiler and water heater based on their gas ratings. They have completely different designs in heat exchangers…__***