Sizing Hydronic Heating and Cooling Piping

Theory

ASHRAE Fundamentals Chapter 33:

Flow is limited due to noise in the pipes and a potential for erosion through control valves.

Flow is limited to 4 FPS for 2" and under piping and 4 ft/100 ft for piping from 2" to 8". The piping above 8" is limited to 10 FPS. When the annual time the system is operated at the maximum design flow rate is low, and/or the application is industrial, the 10 FPS limitation may be relaxed to 15 FPS.

This information is based on the Hazen-Williams equation:

$$h=3.022L(V/C)^{1.852}(1/D^{1.167})$$

h= head (ft)
L=length of pipe (ft)
V=average velocity (ft/sec)
D=diameter of pipe (ft)
C=roughness factor
(150 for plastic or copper pipe, 140 new steel pipe, 100 rough or badly corroded piping)

A reverse return system is used to give the hydronic system a tendency to be self-balancing. If all of the pipe runs can be made the same length, and the piping is all sized for the same pressure drop per 100 foot, the piping losses of all the pipe runs will be equal. In practice the piping is run such that the load with the shortest supply feed will have the longest return feed, the load with the second shortest supply feed will have the second longest return feed and so on. This also makes the calculation of the pump head required much easier. The piping run to the load with the greatest individual pressure drop is the run used to size the pump head.

Application

You will need:

A. Floor plans marked up with the locations of all of the hydronic equipment (ie. radiation, cabinet and unit heaters, coils).

B. Loads in GPM for each piece of equipment shown on the plans.

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C. Connect piping to the loads in a reverse return fashion. Some judgement will have to be used concerning how far to take the reverse return system. Sometimes it is better to put flow measuring/throttling points in for the takeoffs for each floor rather than running a 4" main around to pick up some unit heaters.

D. Make sure that each space that will need heating has a source of heat. Compare the heating loads of the spaces. Does a small space have a bigger heating load than a larger space? Is there a reason for this (skylight, door to the outside, etc.) ?

E. When your piping scheme is nailed down as firmly as you can, the actual sizing of the piping can begin. Even though it is not that hard to do, its not much fun to have to do it more than once.

F. Total up the GPM on the return line starting with the first load served on the supply pipe. Write this GPM in pencil on the plan. Now go back on the return piping doing the same thing. If you do not end up with exactly the same amount of flow in the supply and return piping redo the totaling because you have an error in your calculations.

G. Use the tables below to size the piping based on the amount of flow in each piece of pipe and mark these up on the plan. If you feel that some changes could still take place in the piping system, save your markup after the piping is drafted. Changing these GPM's are easier than starting over from scratch.

H. The size of a pipe may need to be increased if it is feeding the load with the worst pressure drop. Increasing the pipe size on a long run can sometimes result in substantially lower pump head and considerable energy savings.

Pipe Size	GPM	Pressure Drop ft/100	Velocity FPS	TONS @2.4 GPM/TON 10 Deg DT	MBH @20 Deg DT
1/2	1.5	4.5	1.5	0.6	15
3/4	3.5	4	2.4	1.5	35
1	7.5	4	2.7	3.1	75
1-1/4	13	4	3.4	5.5	130
1-1/2	20	4	3.5	8.3	200
2	40	3	3.8	16.7	400
2-1/2	70	4	4.5	29.2	700
3	140	4	5.7	58.3	1400
4	260	4	6.1	108.3	2600
5	500	4	8.0	208.3	5000
6	800	4	9.0	333.3	8000
8	1500	3.9	10.0	625	15000
10	2500	2.9	10.0	1040	25000
12	3500	2.5	10.0	1460	35000
14	4000	2	10.0	1660	40000
16	5500	1.75	10.0	2290	55000
18	7000	1.5	10.0	2915	70000
20	9000	1.3	10.0	3750	90000
24	13000	1	10.0	5415	130000

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