PIPE SIZING FOR HOT AND COLD WATER

PART ONE - BASIC PRINCIPLES

When deciding the tube diameters required for plumbing systems a number of factors have to be taken into account if an adequate flow rate is to be achieved without using oversized tube. The volume flow rate required and the pressure available are very important, other factors to consider include the length of the tube and the number of fittings used.

In this first half of a two part article we shall look at the basic principles and procedures to determine copper tube diameters which will satisfy the demand required and give an economical installation.

Assessment of likely demand

As the number of discharge points fitted to an installation increases the proportion that will be in use at any one time reduces. Research has provided a system to estimate probable demand based on Loading Units. These take into account the flow rate, frequency and length of use of common sanitary appliances. See Table 1 for values, it also gives BS 6700 recommended design flow rates. To use it the number of each type of appliance fed by a pipe is multiplied by the loading unit. These can then be totalled for a group of appliances and then converted into a flow rate in litres per second using Figure 1.

Table 1 Loading units and flow rates, hot or cold water supplies

Sanitary fitting	Loading unit value	Flow rate (l/s)
WC Cistern	2	0.1
1/2" Washbasin tap	1.5	0.15
Spray mixer tap	-	0.04
3/4" Bath tap	10	0.3
Shower mixer	3	0.1
1/2" Sink or Washing machine tap	3	0.2

If necessary, any other water fittings requiring high or continuous flow rates can then be added to give a total flow rate.

An example: consider a mains water service with a minimum pressure of 3 bar serving a dwelling with a kitchen, bathroom, en-suite shower and cloaks WC.

This might comprise the following discharge points:

	Loading units
<u>Bathroom</u>	
3/4" bath taps	2 @ 10 = 20
1/2" basin taps	2 @ 1.5 = 3
WC cistern	1 @ 2 = 2
<u>En-suite</u>	
Shower	2 @ 3 = 6
<u>Kitchen</u>	
1/2" sink taps	2 @ 3 = 6
15mm w/machine taps	2 @ 3 = 6
<u>Cloaks</u>	
Basin spray tap	1 @ 0 = 0
WC cistern	1 @ 2 = 2
Total loading units	45

Figure 1 gives us a probable flow rate of 0.72 l/s.

Available head

On mains pressure systems the minimum pressure at peak demand periods can be obtained from the water supplier or measured on site. On cistern fed systems the head available should be measured vertically from the cistern outlet to the discharge point. Where the supply is sufficient half the cistern height or 0.5m can be added.

One bar pressure is approximately equal to ten metres head. So, multiply by 10 to convert bars to metres head, in this case 3 bar is 30m.

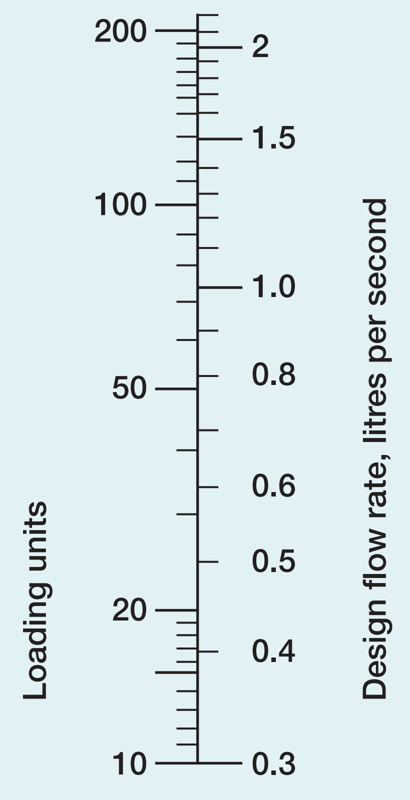
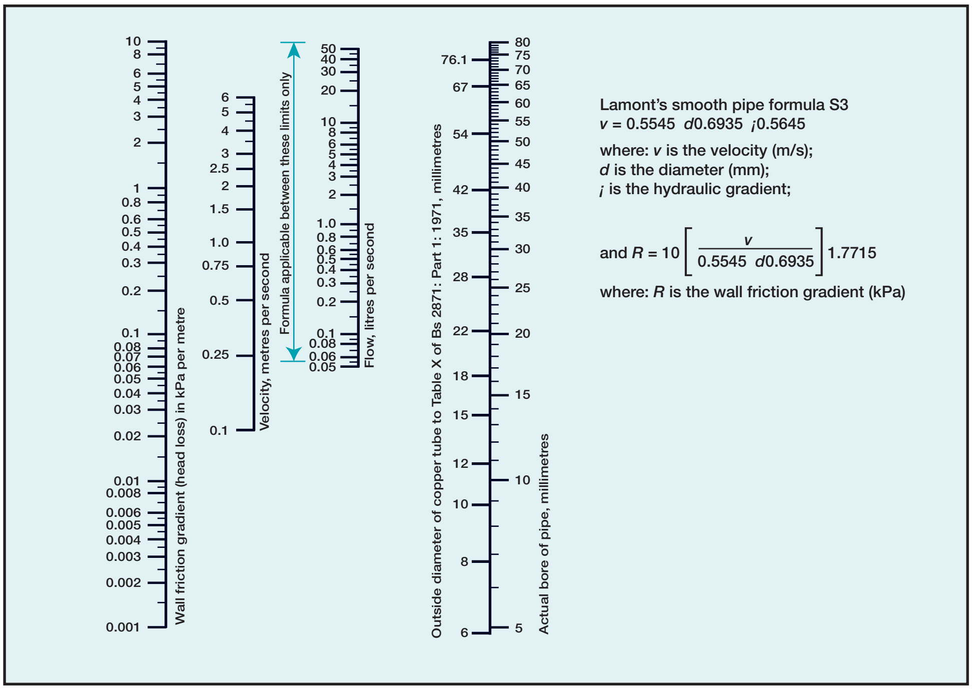


Figure 1

Head loss through tube, fittings and valves

Copper tube has a smooth bore and this means that relatively little head is lost as the water flows. The relationship between tube diameter, length, flow rate and head loss are illustrated in Figure 2. The head loss and water velocity can be found by aligning a ruler with the particular tube diameter and flow rate required. Using the previously determined flow rate, a 22mm service passing 0.72 l/s would use about 0.33 metres head for each metre run of tube. The water velocity would be about 2.5m/s, this is below the BS 6700 recommended maximum of 3m/s for cold water and so not likely to create flow noises.



Fittings

The loss of head due to bends, elbows and tees can best be given as an equivalent length of tube. A bend has about half the resistance of an elbow, so, where pressure is low it is better to use bends where possible. Losses for tees are added on a change of direction only. Where the numbers of fittings to be used can be estimated they can be multiplied to give an equivalent length. This can then be added to the actual length of the tube. An alternative, where the numbers of fittings cannot be forecast, is to add a percentage to the length of tube. This can vary between about 10% and 40% depending on the complexity of the layout.

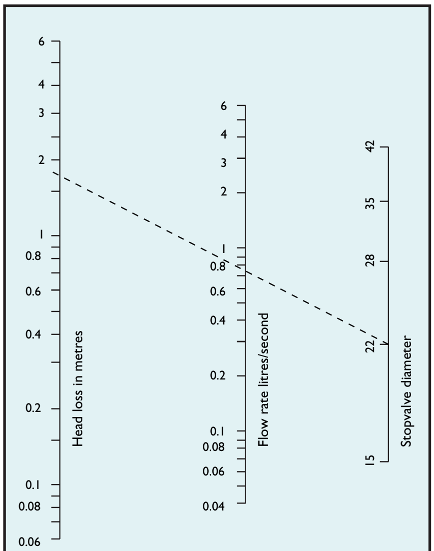


Figure 3 Loss of head through stop valves

Taps and valves

Head loss through stop valves is relatively large, see Table 2 for equivalent lengths. These equivalent lengths can also be added to the length of tube. Losses through gate valves and quarter turn ball valves can be ignored.

If the actual length of the 22mm service mentioned previously was 10 metres and 4 bends and a stop valve were fitted the total equivalent length would be:

actual length of tube 10.0m
equivalent length of bends 4 at 0.4 = 1.6m
equivalent length of valve 1 at 7.0 = 7.0m
giving a total equivalent length of 18.6m

Alternatively, the actual head loss for valves can be established using Figure 3 and then subtracted from the head available.

For example the 22mm stop valve flowing at 0.72 l/s has a resistance of about 1.75 metres head.

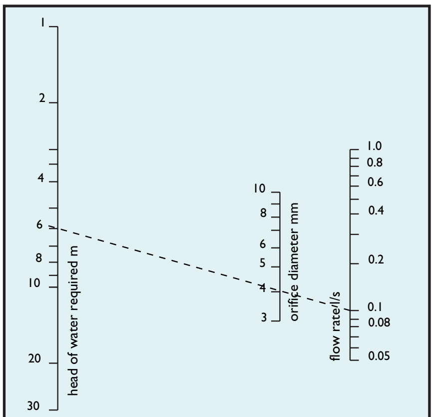


Figure 4 Head loss through float valve orifices

Figure 4 gives the head required for a given float valve orifice and flow rate.

For example a float operated valve with a 4mm orifice passing 0.1 l/s requires a head pressure of about 6m.

Water meters

Where a water meter is to be fitted the loss of head at the required flow rate should be subtracted from the head available. The manufacturers data sheet can be consulted to find the head loss.

Permissible head loss

Once the head pressure available and the effective length of tube has been found the permissible loss of head per metre run can be determined. This is done by dividing the head available by the total effective length of tube.

In the case of our service pipe example with a head of water of 30m and an effective length of 18.6m, this would be: 30 / 18.6 = 1.6m/m.

Residual head

Referring back to Figure 2 our 22mm service pipe with a flow of 0.72 l/s only uses about 0.33m/m of head. So, in total 18.6 x 0.33 = 6.1m, say 6m, head would be used up leaving 30 - 6 = 24m residual head remaining for the internal installation.

Final tube diameter

If insufficient residual head remains select a larger tube diameter to reduce the head used. If only a small percentage of the head available has been used consider a smaller tube diameter. In any case, however, check that the flow velocity is not greater than the BS 6700 recommendation of 3m/s for cold and 2.5m/s for hot water. Also, to prevent sluggish flow and the settlement of detritus in long runs of horizontal tube, keep the velocity above 0.5m/s by avoiding use of oversized tube.

The above procedures can be used to determine tube diameters for a complete installation. Keep this article handy and next month we will put them into practice with a straightforward systematic method based on a tabulation chart.