Chapter 1

Introduction to Water Services

Chapter 1 discusses four aspects of water services:

1. Quality of water
2. Water pressure and flow rates
3. Water pressure and static head
4. Design pressures

Quality of Water

The quality of potable water will not have an effect on the pipe sizing calculations. All countries and local authorities provide potable water to designated water quality guidelines and there is an assumption that the water has been purified to comply with these guidelines (pH 7). The composition of water can affect the long-term performance of the water service within a building, thus reducing flow and pressure.

It is important to be aware of the minerals in water that have an effect on the efficiency and life expectancy of pipes, hot water systems and pumps, as well as kitchen and laundry equipment. For example, if calcium deposits form in the pipe, this will reduce the diameter and restrict the flow. Figure 1-1 is a photo of a 40mm copper pipe whose capacity has been reduced to 15mm due to calcium build-up.

Figure 1-1 Photo of a 40mm Copper Pipe with Calcium Build-Up

Minerals found in water that can have adverse effects on pipes and equipment, are:

Magnesium (Mg)

If high levels of magnesium are present, scale will form on the internal surface of the pipe. It will also build up on the internal surface of expensive equipment and reduce its efficiency.

Sodium (Na)

Sodium is a salt mineral that causes a 'salty taste' in water and is very reactive chemically. When found in high levels it will leave scale build-up in the pipes and will also corrode metallic surfaces.

Iron (Fe)

Iron is a metallic element that causes copper pipe to corrode and to a lesser degree can affect stainless steel pipe. Should the water be acidic (low pH), the rate of corrosion will accelerate considerably.

Chloride (Cl)

Chloride is a chemical found in all water supplies. Many local authorities add it to the water, as chlorine, which destroys bacteria. High levels of chloride when combined with heated water, particularly at temperatures above 50°C, will cause corrosion.

Calcium (Ca)

Calcium forms a thick scale on the internal surface of pipes and equipment. At high levels it has been known to block the flow of water in circulating hot water pipes.

Aluminium Sulphate

Aluminium sulphate is added to the water during the purification process. This attracts particles and floc (collections of particles), which become heavy and settle to the bottom of the pond. If excessive aluminium sulphate is added to the water it will cause the pipes to corrode.

Hard and Soft Water

Water is classified as 'hard' or 'soft' depending on its composition. The degree of hardness reflects the level of minerals in the water. The type of ground surface the water runs over in the catchment area when rain first falls to earth will contribute to the degree of hardness, as minerals from the soil will dissolve in the water. Water flowing over land is more likely to be harder than rain falling directly into a dam or storage area, as there are no minerals in rainwater.

Local authorities are more concerned about purification of water for human consumption than the degree of hardness. Therefore, it may be necessary to install water softeners for the end user's comfort and to protect the equipment installed in commercial and residential buildings from scale and corrosion.

Soap and detergent do not easily lather in hard water and the dissolved minerals will cause scum to form in baths, leading the occupant to believe the dirt was from his/her body, when in fact it was in the water. Hard water will turn white clothing to a light grey colour, considerably reducing the life of the garment, as well as that of the washing machine. Hot water systems, dishwashers and commercial equipment for laundries, kitchens and plant rooms will also be adversely affected.

Water Pressure and Flow Rates

For design purposes, water pressure is expressed in 'metres head' (m/h). However, pressure gauges are calibrated in kilopascals (kPa), therefore pressure can also be expressed in kPa, as well as bar.

1 m/h = 9.81 kPa = 0.0981 bar

Engineering practices in different countries give preference to one of the three terms as shown, when measuring water pressure. It will be found that calculations are easier using 'metres head' (m/h).

In this text, water flows are expressed in litres per second (L/s).

The terms litres per minute (L/m) and litres per hour (L/h) are used by some equipment manufacturers. Calculations involving water pumps, shower outlets and fire sprinkler heads are three examples where litres per minute (L/m) are used by the manufacturer. Design engineers mostly use litres per second (L/s).

1 L/s = 60 L/m = 3,600 L/h

When reading a pressure gauge on an existing water service, the engineer should be familiar with the two different forms of pressure readings that can be obtained:

'Flow Pressure' is the reading on the gauge while an outlet is discharging the required flow.

'Static Pressure' is the reading on the gauge at a time when all outlets are closed and there is no movement of water within the system.

Water Pressure and Static Head

The easiest principle to understand in pipe sizing is that 'the higher a column of water, the higher the pressure at the base of that column'.

For every one metre rise in a column of water, the pressure will increase 1 m/h or 9.81 kPa or 0.0981 bar.

A water storage tank positioned on the top floor of a building 100 metres high to the highest water level, with a pipe feeding to the ground floor, will have a pressure of '100 m/h'. The pressure gauge will read 981 kPa or 9.81 bar.

Using Figure 1-2 the calculation is:

RL 125.00 – RL 25.00 = 100 m/h

100 m/h x 9.81 kPa = 981 kPa or 9.81 bar

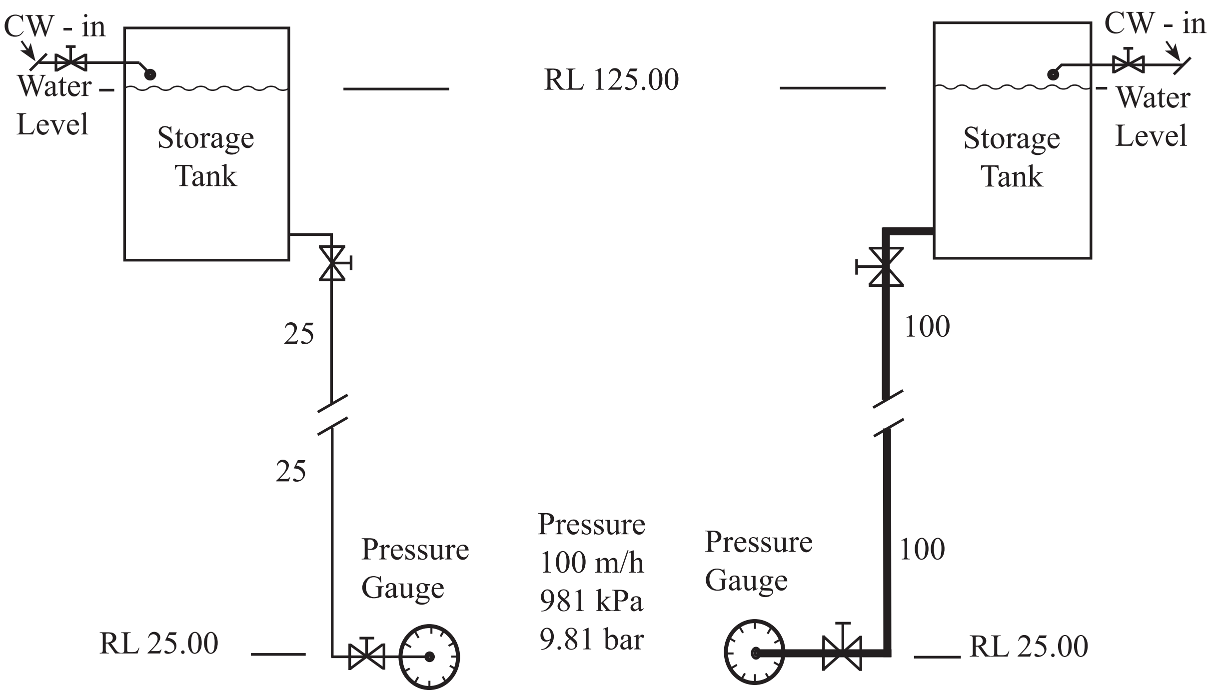

Figure 1-2 Pressure Created by Head of Water

The static head remains the same regardless of the pipe diameter.

A property at the top of a hill, or the penthouse in an apartment building, is the most sought after and expensive real estate and yet the natural water pressure will be the lowest in all cases. The designer must take into consideration that the pressure may need to be boosted.

Exercise 1-1

A local authority's water reservoir is located at the top of a 50 metre hill with a water level of 10 metres.

A house at the bottom of the hill will enjoy a pressure of 60 m/h, 588.6 kPa or 5.88 bar, when the reservoir is full. (50m + 10m) x 9.81 = 588.6 kPa or 5.88 bar.

A house at the top of the hill at the same level as the reservoir will only have the pressure created by the level of water in the reservoir at any given time.

The result will be a maximum of 10 m/h, 98.1 kPa or 0.981 bar.

Design Pressures

Government standards set pressures for fixtures as low as 5 m/h, which are too low for good engineering practices. The minimum pressure has been set this low to protect local authorities in cases where the available pressure in their main is very low. There are few, if any, local authorities whose water mains would not achieve a 5 m/h. In fact most are between 22 m/h and 80 m/h.

Designers' opinions will vary regarding minimum pressure, depending on the local situation. A reasonable minimum design pressure recommended in this text is 21 m/h or 206 kPa (2 bar). Where the project cannot achieve this target, the guideline may be lowered, in order to avoid the use of pressure pumps. The designer must then decide what he or she considers is acceptable for the project after taking into account the type of building and its function.

A design range of 21 m/h (206 kPa or 2.0 bar) to 50 m/h (490 kPa or 4.90 bar) provides the best results for the end user. Where manufacturers' equipment requires the pressure to be limited to 350 kPa, pressure-limiting valves will be required. This is the case in nursing homes, public housing and similar institutions. Where water pressure exceeds 50 m/h (490 kPa or 4.90 bar), it can present a risk to people with arthritis or similar medical conditions. Cups and glasses tend to be forced out of their hands with the sudden surge in pressure when the tap is turned on. To reduce pressure in the water lines, a pressure-limiting valve is fitted.