Topic 2
Water Supply and Storage

2.1 Introduction

2.1.1 Water sources and supply

2.1.2 Uses of water in building and buildings

- Use of water in Construction
  - As a main ingredient of concrete
  - Production of building materials: bricks, steel, plastics
- Nourishment

2.1 Introduction

- Cleansing and hygiene
- Transportation
- Cooling
- Ornamental
- Recreational
- Protective Uses
  - Fire fighting
  - Control Circulation
- Use of water for power/electricity generation

Use	Desired Quality
A. CONSUMED	
1. Drinking and cooking	Potable
2. Bathing	Potable
3. Laundering	Soft
4. Irrigation and watering of livestock	Unpolluted
5. Industrial processes	As required
6. Vapor to increase the relative humidity of air	
B. CIRCULATED	
1. Hot water for heating 2. Chilled water for cooling 3. Condenser cooling water 4. Swimming pool water 5. Steam for heating, later condensed	*Note:* Make-up water should be soft or neutral and, for swimming, potable
C. GENERALLY STATIC	
1. Water stored for fire protection 2. Water in fire stand pipes 3. Water in sprinkler piping	No special requirement
D. CONTROLLED	
1. Vapor condensed to reduce relative humidity of air	

2.12 Task of the designer

- With water one of the designers main concerns is to ensure:
- Quality of the water supplied
- Appropriate Task performed by the water
- Economy of use
- Matching the quality and quantity of water to the task it performs

- In this country, especially in urban and sub-urban areas, the quality of the water supplied is often dependent on the processes and quality control conducted by the distributing bodies, i.e. once government bodies but now corporatised or privatized, eg. Syarikat Air Johor, SYABAS etc.

After considering the functions of the building, the designer must consider the following:

- The roles that water plays within it
- Determine the quantities of water needed
- Determine the areas in which water will be used
- Determine the areas and equipment associated with water's return to the hydrologic cycle

2.13 Conservation

- The current tasks of estimating water needs is further complicated by the conflict between current practice and conservation. Current practice tends toward the use of large amounts of water for very low grade tasks. Conservation reserves high quality water for high grade tasks and emphasizes recycling as well as reducing overall usage.
- Water supply is estimated in terms of gallons/ liter per capita per day (g/cd or l/cd)

2.3 Major Considerations of Water Supply Systems

- Water Distribution
- Static Pressure
- Upfeed Distribution
- Downfeed Distribution
- Principles of Downfeed Distribution

2.3.1 Water Distribution

- Water needs to be supplied to buildings with sufficient pressures to operate plumbing fixtures.
- Smaller buildings may be served directly by the pressure available in water mains.
- This is called upfeed distribution where the water rises directly from mains to the plumbing fixtures

2.3.1 Water Distribution (con't)

For taller buildings several other options are available:

- Pumped upfeed in which pumps supply the pressure needed
- Hydropneumatic in which pumps force water into sealed tanks, compressing compressing the air within and maintaining the needed water pressure
- Downfeed in which pumps raise water to storage tanks at the top of the building and water then drops down to the plumbing

2.3.1 Water Distribution (con’t)

In cities where water is distributed through a centralized system via street mains at pressures varying from 50 psi (350kpa) to 70psi (480kpa). For low rise buildings of two or three stories, this is sufficient to act against the static pressure of water standing in the vertical piping. Overcome the frictional resistance of water flow in the pipes and still deliver water at the required pressure for operating plumbing fixtures.

2.3.2 **Static Pressure**

- The pressure exerted at the bottom of a stationary “head” of water is related directly to its height. For upfeed and downfeed distribution, the relationship of heights and static pressure is one controlling design factor.

2.3.3 Upfeed Distribution

- In small low buildings that have moderate water demands, it is not difficult to get proper flow pressures at fixtures by the use of an upfeed system. In figure 2.10 the typical upfeed system begins where water supply enters the building. House shutoff controls are usually located at the main, at the curb and within the house. Meters measure the water quantity for which the occupant is to be charged. Since recently, they sometimes also serve a restrictive function.

2.3.3 **Upfeed Distribution (con't)**

- In-house treatment is often performed to reduce water hardness that could clog pipes and equipment and to reduce acidity that causes corrosion. The bypass shutoff valve is opened when treatment tanks are valved off for backwashing or other servicing

2.3.3 Upfeed Distribution (con't)

Water continues under pressure to:

- Supply make-up water to the space heating boiler as required
- Supply water to and pressurize the cold water mains and branches
- Supply water to and pressurize the domestic hot water system through the hot water heater, the hot water storage tank and the mains, branches and circulating lines.

2.3.4 **Downfeed Distribution**

For downfeed distribution, water from the street main is lifted and fed by gravity to a roof storage tank. The advantages of water storage are as follows:

- Provides a reserve against failure of the mains supply

2.3.4 **Downfeed Distribution (con’t)**

- Sudden demands are met from the storage cisterns whichc then fills slowly, making the demand on the main more even. This gives:
  - Economy of water mains and the size of the service pipes
  - Reduced possibility of mains pressure dropping to nothingwhich could lead to backsiphonage of water from sanitary appliances into the main

2.3.4 **Downfeed Distribution (con't)**

- Reduced pressure on the installation which minimizes noise and wastage and enables appliances like hot water cylinders of reasonable gauge to be used.
- Heating and hot water supply apparatus can be vented to the storage cistern thereby minimising safety valve requirements.

2.3.4 Downfeed Distribution (con't)

The disadvantages are:

- Space and support must be provided for the storage cistern. In high buildings a proportion of storage at ground level is usual to save loads on the building and to save space at high level
- Storage cisterns may become dirty especially if not provided with a cover.
- Drinking water is supplied directly from the main.
- The reduced pressure means that the distributing pipes have to be larger.

2.3.4 Downfeed Distribution (con't)

- The traditional material for cold water cisterns has been galvanized sheet steel but plastics (grp) and other materials are more increasingly used.
- Very large storage cisterns are being made from panels of iron or steel about 1m square.
- In some cases cisterns are made of concrete lined with bitumen.

2.3.4 Downfeed Distribution (con't)

- Where it is more practical for installation purposes, several smaller cisterns may be linked together to provide the required storage.
- For large installations it is common to provide at least two cisterns with separately valved ball valves and outgoes (eg Figure 2.12) so that one may be put out of action for cleaning or repairs without disrupting supplies.

2.3.4 Downfeed Distribution (con't)

- For high rise buildings it is probably necessary to pump water up to the top of the building since the head in the main is not likely to be adequate.
- The pumping may be done directly from the main or via a suction tank that is gravity fed from the main.
- For buildings that are very tall it may be necessary to divide the water distribution into zones to keep water pressure within reasonable limits.

2.3.4 Downfeed Distribution (con't)

- Pumps should not be in continuous operation neither should it be switched on and off for every draw-off of water.
- Figure 2.12 shows the use of a pneumatic vessel to overcome this problem:
  - A cushion of air under pressure is maintained in the top of a pressure cylinder;
  - when a tap is opened the air is able to expand by forcing water out of the cylinder and through the pipework.
  - This continues until the water level drops to a predetermined point when the pump is switched on to raise the level again.

2.3.5 Water Distribution for Tall Buildings

- In buildings that rise above 15 stories zoning is necessary to reduce the static pressure at the bottom of the distributing pipes.
- The usual zone height is about 30 m.
- Figure 2.13 shows one method. The main water storage is at ground level avoiding heavy loads at the top of the building. Pumps raise the water in stages of 60 m but with cold water cisterns distributing to stages of 30m.
- Drinking water is distributed using the same system using storage cisterns that are sealed against insects and dust.

2.3.6 **Principles of Downfeed Distribution**

- Water pressure increases with distance below the tank water level as can be seen from figure 2.14.
- Tanks like these add interest to the buildings silhouette.

2.3.6 **Principles of Downfeed Distribution (con't)**

Presently for most high buildings, the rooftop may be crowded with other equipment and technical facilities which include:

- Water storage tanks
- Chimneys
- Numerous Plumbing Vents
- Exhaust fans
- Air conditioning cooling towers
- Cantilevered rolling rig to support a scaffold for exterior window washing
- Perimeter track for a window washing rig
- Photovoltaic cells or solar collectors for DHW

2.3.6 **Principles of Downfeed Distribution (con't)**

- There is also the possibility of wind turbines becoming more in use considering the need for sustainable design.
- Thus since the 1960s. tall buildings commonly have a band or screen two stories or more high above the structured roof.

Type	Main Features	Advantages	Disadvantages
Batch System	Batch tank inside collector box, potable water within collector tank	No external power, few components, collector tank at any location	Seasonal, dependent on freezing locations, heat loss at night from storage
Thermosiphon System	Flat plate liquid collectors, open loop, no pump or external power, storage tank higher than collector	No external power, few components, High performance	Seasonal, dependent on freezing locations (if water is collector fluid), needs structural support for high storage tank
Closed loop freeze resistant system	Flat plate liquid collectors, closed loop piping from collectors to storage tanks, external energy (circulator and differential controller, non freezing collector fluid, pressurised stone lined storage tank	No freezing damage, no mech or elect parts, no liquid service	Temporarily stops operation at sub-zero temp as solution freezes to a slush
Drain back system	Flat plate liquid (water) collectors, open loop, Potable water circulates through heat exchanger in storage tanks (not through collectors)	Can be used in the coldest climates, no antifreeze used, simplest active flat plate system (no valves)	Larger pump, larger consumption of energy, system must drain thoroughly, use of corrosion inhibitor recommended

Type	Main Features	Advantages	Disadvantages
Drain down system	Flat plate liquid collectors, potable water circulated through collectors, line pressure feeds collectors, open loop, automatic drainage valves, pitched headers	No heat exchanger or extra storage tank needed, High performance	In some instances a larger pump, larger consumption of external energy, system must drain throughly, no corrosion inhibitor possible, freeze danger with valve failure
Air to Liquid system	Flat plate air collectors, air to water heat exchanger, ductwork and blower, pipes and circulator, Larger collector area than liquid systems.	Won't freeze, (depemdent on exchange location), air leaks won't cause damage, integrates well with space heating	Hard to detect leaks, more space required fo ducts, blower and circulator required, more carpentry, less effective
Phase change system	Flat plate liquid collectors, storage tanks higher than collectors (passive type), closed looprefrigerent-grade piping from collectors to storage tanks (passive type) or to condenser (subambient type),	No external power (passive type), can be mounted at any position	Very hard to detect leaks, special equipment to install, more equipment required (subambient type)