Water supply and waste water engineering

Unit-1 Introduction

Water Supply Engineering - The branch of civil engineering which deals with the supply of water for various purpose e.g. domestic,industrial,public is called water supply engineering.

Hydro logical cycle- Is the process of transfer of moisture from atmosphere to the earth in the form of precipitation , and movement of the rainfall water by stream and river to ocean and lake etc and evaporate water back to the atmosphere.

Water supply system

A water supply system or network is a system of engineered hydrologic and hydraulic component which provide water supply. A water supply system includes

a)A drainage basin

b) A raw water collection point above or below ground.

c) Water purification facilities.

d) Additional water pressuring component such as pumping stations

e)A pipe network for distribution of water to the consumer.

f) Connection to the sewer.

The objectives of the community water supply system are

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1. to provide whole some water to the consumers for drinking purpose.

2. to supply adequate quantity to meet at least the minimum needs of the individuals

3. to make adequate provisions for emergencies like fire fighting, festivals, meeting etc

4. to make provision for future demands due to increase in population, increase in standard of living, storage and conveyance

Importance and necessity of water supply system

Next to the air, the other important requirement for human life to exists is water. Water is available in various forms such as rivers, lake, streams etc. Water is required for various purpose:-

a) for drinking and cooking

b) For bathing and washing

c) For watering of lawns

d) For fire fighting

e) For stream power and various industrial processes etc.

Pure and whole some water is to be supplied to the community alone can bring down the morbidity rates.

<u>Unit -2 Quantity of water</u>

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Introduction

It is necessary to determine the total quantity of water required for various purpose by the city or town while designing of water supply scheme of a particular city or town. The quantity of water required depends upon two important factors are:

1. The probable population estimated at the end of the design period.
2. Rate of water consumed per capita per day

Water requirements

The following are the requirements of wholesome water.

1. It should be free from bacteria
2. It should be colourless and sparkling
3. It should be tasty, odour free and cool
4. It should be free from objectionable matter
5. It should not corrode pipes
6. It should have dissolved oxygen and free from carbonic acid so that it may remain fresh

TYPES OF WATER DEMANDS

Following are the various types of water demands of a city or town:

i. Domestic water demand

ii. Industrial demand

iii. Institution and commercial demand

iv. Demand for public use

v. Fire demand

DOMESTIC WATER DEMAND

The quantity of water required in the houses for drinking, bathing, cooking, washing etc is called domestic water demand and mainly depends upon the habits, social status, climatic conditions and customs of the people.under normal conditions, the domestic consumption of water in India is about 135 liters/day/capita. But in developed countries this figure may be 350 liters/day/capita because of use of air coolers, air conditioners, maintenance of lawns, automatic household appliances.

The details of the domestic consumption are

a) Drinking ------ 5 litres

b) Cooking ------ 5 litres

c) Bathing ------ 55 litres

d) Clothes washing ------ 20 litres

e) Utensils washing ------ 10 litres

f) House washing ------ 10 litres

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135 litres/day/capita

INDUSTRIAL DEMAND

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The water required in the industries mainly depends on the type of industries,

which are existing in the city. The water required by factories, paper mills, Cloth mills,Cotton mills, Breweries, Sugar refineries etc. comes under industrial use. The quantity of water demand for industrial purpose is around 20 to 25% of the total demand of the city.

INSTITUTION AND COMMERCIAL DEMAND

Universities, Institution, commercial buildings and commercial centers including office buildings, warehouses, stores, hotels, shopping centers, health centers, schools, temple, cinema houses, railway and bus stations etc comes under this category

Sl.No.	Type of Building	Construction per capita per day (litres)
1.	a) Factories where bathrooms are required to be provided.	45
	b) Factories where no bathrooms are required to be provided	30
2.	Hospitals per bed	340
	a) No. of beds not exceeding 100 No.	

	b) No. of beds exceeding 100 No. Nurses homes and medical quarters.	450
3.	Hostels	135
4.	Offices	135
5.	Restaurants (per seat)	45
6.	Hotel (per bed)	70
7.		180

DEMAND FOR PUBLIC USE

Quantity of water required for public utility purposes such as for washing and sprinkling on roads, cleaning of sewers, watering of public parks, gardens, public fountains etc comes under public demand. To meet the water demand for public use, provision of 5% of the total consumption is made designing the water works for a city.

PurposeWater Requirements

Public parks1.4 litres/m2 /day

Street washing 1.0-1.5 litres/m2 /day

Sewer cleaning4.5 litres/head/day

FIRE DEMAND

Fire may take place due to faulty electric wires by short circuiting, fire catching materials, explosions, bad intension of criminal people or any

other unforeseen mishappenings. If fires are not properly controlled and extinguished in minimum possible time, they lead to serious damage and may burn cities.

he quantity of water required for fire fighting is generally calculated by using different empirical formula.

For Indian conditions kuichings formula gives satisfactory results. _

$$Q=3182\sqrt{p}$$

Where 'Q' is quantity of water required in litres/min

'P' is population of town or city in thousands

PER CAPITA DEMAND

If 'Q' is the total quantity of water required by various purposes by a town per year and 'p' is population of town, then per capita demand will be

Per capita demand = ---------- litres/day

P x 365

For an average Indian town, the requirement of water in various uses is as under

Various use	**Demand in l/h/d**
i.Domestic purpose	135 litres/h/d
ii.Industrial use	40 litres/h/d
iii. Public use	25 litres/h/d
iv. Fire Demand	15 litres/h/d
v. Losses, Wastage	55 litres/h/d

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270 litres/capita/day

FACTORS AFFECTING PER CAPITA DEMAND

a) Climatic conditions

b) Size of community

c) Living standard of the people

d) Industrial and commercial activities

e) System of sanitation

VARIATIONS IN DEMAND

The per capita demand of town is the average consumption of water for a year. In practice it has been seen that this demand doesnot remain uniform throughout the year but it various from season to season, even hour to hour.

SEASONAL VARIATIONS-The water demand varies from season to season. In summer the water demand is maximum, because the people will use more water in bathing, cooling, lawn watering and street sprinkling. This demand will becomes minimum in winter because less water will be used in bathing and there will be no lawn watering. The variations may be upto 15% of the average demand of the year.

DAILY VARIATIONS-This variation depends on the general habits of people, climatic conditions and character of city as industrial, commercial or residential. More water demand will be on Sundays and

holidays due to more comfortable bathing, washing etc as compared to other working days. The maximum daily consumption is usually taken as 180% of the average consumption.

HOURLY VARIATIONS-On Sundays and other holidays the peak hours may be about 8 A.M. due to late awakening where as it may be 6 A.M. to 10 A.M. and 4 P.M. to 8 P.M. and minimum flow may be between 12P.M. to 4P.M. when most of the people are sleeping.The maximum consumption may be rise upto 200% that of average daily demand.

DESIGN PERIOD-The number of years for which the designs of the water works have been done is known as design period. Mostly water works are designed for design period of 22-30 years, which is fairly good period.

POPULATION FORECASTING-

When the design period is fixed the next step is to determine the population of a town or city population of a town depends upon the factors like births, deaths, migration and annexation. The future development of the town mostly depends upon trade expansion, development industries, and surrounding country, discoveries of mines, construction of railway stations etc may produce sharp rises, slow growth, stationary conditions or even decrease the population

The following are the standard methods by which the forecasting population is done.

I.Arithmetical increase method

ii. Geometrical increase method

iii. Incremental increase method

iv. Decrease rate of growth method

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ARITHEMATICAL INCREASE METHOD

This method is based on the assumption that the population is increasing at a constant rate. The rate of change of population with time is constant. The population after ‘n’ decades can be determined by the formula.

Pn = P + n.c where

P → population at present

n → No. of decades

c → Constant determined by the average of increase of ‘n’ decades

GEOMETRICAL INCREASE METHOD

This method is based on the assumption that the percentage increase in population from decade to decade remains constant. In this method the average percentage of growth of last few decades is determined, the population forecasting is done on the basis that percentage increase per decade will be the same.

The population at the end of ‘n’ decades is calculated by

Pn= Po *(1+r)/100

Po= Initial population

Pn= Future population

r= Assumed growth rates (%)

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INCREMENTAL INCREASE METHOD

This method is improvement over the above two methods. The average increase in the population is determined by the arithmetical method and to this is added the average of the net incremental increase once for each future decade.

$$Pn = Po + n\bar{x} + n(n+1)/2.\bar{y}$$

Pn= Population after n decades from present (last known census)

$\bar{x}$= Average increase of population of known decades.

$\bar{y}$ =Average of incremental increase of the known decade

Decrease rate of growth method

In this method, the average decrease in the percentage increase is work out, and is then subtracted from the latest percentage increase for each successive decade. This method is however, applicable only in case , where the rate of growth shows downward trend.

Unit-3 Quality of water

Introduction- Absolutely pure water is never found in nature and contains number of impurities in varying amounts. The rainwater which is originally pure, also absorbs various gases, dust and other impurities while falling. This water when moves on the ground further carries salt,

organic and inorganic impurities. So this water before supplying to the public should be treated and purified for the safety of public health, economy and protection of various industrial process, it is most essential for the water work engineer to thoroughly check analysis and do the treatment of the raw water obtained the sources, before its distribution.

Classification of water

A) **Wholesome water**: Wholesome water is that water which is not chemically pure, but does not contain anything harmful to human health.

B) **Palatable water**: The water which is tasteful for drinking and aesthetically pure, is known as "palatable water".

C) **Potable water**: The water which has both the characteristics I.e., of whole water and palatable water is known as potable water.

D) **Polluted water**: The water which consists of undesirable substance which make it unfit for drinking and domestic use.

E) **Contaminated water** : The Water containing pathogenic organism is called contaminated water.

CHARACTERISTICS OF WATER

PHYSICAL CHARACTERISTICS

The following are the physical characteristics

1. Turbidity: Turbidity is caused due to presence of suspended and colloidal matter in the water. The character and amount of turbidity

depends upon the type of soil over which the water has moved ground waters are less turbid than the surface water.

Turbidity is a measure of resistance of water to the passage of light through it. Turbidity is expressed as NTU (Nephelometric Turbidity Units) or PPM (parts per million) or Milligrams per liter (mg/l). Turbidity is measured by

1) Turbidity rod or Tape 2) Jackson's Turbidimeter 3) Bali’s Turbidimeter

The Sample to be tested is poured into a test tube and placed in the meter and units of turbidity is read directly on the scale by a needle or by digital display. Drinking water should not have turbidity more than 10 N.T.U. This test is useful in determining the detention time in settling for raw water and to dosage of coagulants required to remove turbidity.

2.**Colour and temperature-** Colour in water is usually due to organic matter in colloidal condition but some times it is also due to mineral and dissolved organic impurities. The colour produced by one milligram of platinum in a liter of water has been fixed as the unit of colour. The permissible colour for domestic water is 20ppm on platinum cobalt scale. The colour in water is not harmful but objectionable.

Temperature of water is measured by means of ordinary thermometers. The temperature of surface water is generally at atmospheric temperature, while that of ground water may be more or less than atmospheric temperature. The most desirable temperature for public supply between 4.4° C to 10° C. The temperature above 35° C are unfit for public supply, because it is not palatable.

Taste and odour- Taste and odour in water may be due to presence of dead or live micro-organisms, dissolved gases such as hydrogen sulphide,

methane, carbon dioxide or oxygen combined with organic matter, mineral substances such as sodium chloride, iron compounds and carbonates and sulphates of other substances. The tests of these are done by sense of smell and taste because these are present in such small proportions that it is difficult to detect them by chemical analysis. The water having bad smell and odour is objectionable and should not be supplied to the public.

The intensities of the odours are measured in terms of threshold number. This number is numerically equal to the amount of sample of water in C.C’ s required to be added to one liter of fresh odourless water.

CHEMICAL CHARACTERISTICS

Total Solid And Suspended Solids-Total solids includes the solids in suspension colloidal and in dissolved form. The quantity of suspended solids is determined by filtering the sample of water through fine filter, drying and weighing. The quantity of dissolved and colloidal solids is determined by evaporating the filtered water obtained from the suspended solid test and weighing the residue. The total solids in a water sample can be directly determined by evaporating the filtered water obtained from the suspended solid test and weighing the residue. The total solids in a water sample can be directly determined by evaporating the water and weighing the residue of the residue of total solids is fused in a muffle furnace the organic solids will decompose where as only inorganic solids will remain. By weighing we candetermine the inorganic solids and deducting it from the total solids, we can calculate organic solids.

PH value of water- PH value denotes the concentration of hydrogen ions in the water and it is a measure of acidity or alkanity of a substance

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PH = - log 10[H+] or 1 / log 10[H+]

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1 2 3 4 5 6 7 8 9 10 11 12 13 14

Acidity ← Neutral→ Alkalinity

Depending upon the nature of dissolved salts and minerals, the PH value ranges from 0 to 14. For pure water, PH value is 7 and 0 to 7 acidic and 7 to 14 alkaline range. For public water supply PH value may be 6.5 to 8.5. The lower value may cause tubercolation and corrosion, where as high value may produce incrustation, sediment deposits and other bad effects.

PH value of water is generally determined by PH papers or by using PH meter. PH can read directly on scale or by digital display using PH meter.

HARDNESS OF WATER

It is a property of water, which prevents the lathering of the soap. Hardness is of two types.

1. **Temporary hardness**: It is caused due to the presence of carbonates and sulphates of calcium and magnesium. It is removed by boiling.

2. **Permanent hardness**: It is caused due to the presence of chlorides and nitrates of calcium and magnesium. It is removed by zeolite method.

Hardness is usually expressed in gm/liter or p.p.m. of calcium carbonate in water. Hardness of water is determined by EDTA method. For potable water hardness ranges from 5 to 8 degrees.

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METHODS OF REMOVAL OF HARDNESS

1. Boiling
2. Freezing
3. Lime addition
4. Lime soda process
5. Excess Lime treatment
6. Caustic soda process

CHLORIDE CONTENT-The natural waters near the mines and sea dissolve sodium chloride and also presence of chlorides may be due to mixing of saline water and sewage in the water. Excess of chlorides is dangerous and unfit for use. The chlorides can be reduced by diluting the water. Chlorides above 250p.p.m. are not permissible in water.

DISSOLVED GASES-oxygen and carbon Di-oxide are the gases mostly found in the natural water. The surface water contain large amount of dissolved oxygen because they absorb it from the atmosphere. Algae and other tiny plant life of water also give oxygen to the water. The presence of oxygen in the water in dissolved form keep it fresh and sparkling. But more quantity of oxygen causes corrosion to the pipes material.

Water absorbs carbon-dioxide from the atmosphere. If water comes across calcium and magnesium salts, carbon-dioxide reacts with the salts and converts them into bicarbonates, causes hardness in the water. The presence of carbon-dioxide is easily determined by adding lime solution to water gives milky white colour.

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BIO-CHEMICAL OXYGEN DEMAND -If the water is contaminated with sewage, the demand of oxygen by organic matter in sewage is known as biochemical oxygen demand. The aerobic action continues till the oxygen is present in sewage. As the oxygen exhausts the anaerobic action begins due to which foul smell starts coming. Therefore indirectly the decomposable matters require oxygen, which is used by the organisms. The aerobic decomposition of organic matters is done in two stages. The carbonaceous matters are first oxidized and the oxidation of nitrogenous matters takes place in the latter stage.

BACTERIAL AND MICROSCOPICAL CHARACTERISTICS

The examination of water for the presence of bacteria is important for the water supply engineer from the viewpoint of public health. The bacteria may be harmless to mankind or harmful to mankind. The former category is known as non-pathogenic bacteria and the later category is known as pathogenic bacteria.For bacteriological analysis the following tests are done.

(a) PLANT COUNT TEST

In this method total number of bacteria presents in a ml of water is counted. 1 ml of sample water is diluted in 99ml of sterilized water and 1ml of dilute water is mixed with 10ml of agar of gelatin. This mixture is then kept in incubator at 37° C for 24 hours or 20° C for 48 hours. After the sample will be taken out from the incubator and colonies of bacteria are counted by means of microscope. Drinking water should not have more than 10 coliforms/100ml.

b) Bacteria Coli- (B-coli) or Escherichia Coli (E-Coli) Test

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Test are performed by following tests:

A) Presumtive test : This is performed as:

i. Prepare the diluted sample of water.

ii. Pour this in the standard fermentation tubes containing lactose bile as culture medium.

iii. Now, keep it in incubator at 37°C for 24 hours- 48 hours.

iv. Now, check if some gas (I.e Carbon di-oxide) is evolved , then there are Bacteria -coli in Water otherwise E-Coli are present. E- Coli is harmless bacteria.

B) Confirmative Test:- This is performed as:

I. Firstly, some water sample from above B-coli Test are taken in another fermentation tube containing " brilliant green lactose biles" as culture medium.

II. This tube is again kept at 37°C for 48 hours in incubator.

III. Check the evolution of gas. If gas is evolved, there is presence of B-Coli.

Membrane Filter Technique (MFT)s

i. Filter the sample of water through a sterilized membrane of spacial design, due to which all the bacteria are retained in membrane.

ii. Now, put the membrane in contact of culture medium, named M-Endos' medium in incubator at 37°C for 24 hours.

iii. After 24 hrs, membrane is taken out from incubator and colonies of bacteria are counted by microscope.