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LECTURE NOTE

WATER SUPPLY & WASTE WATER ENGINEERING, (Th.4)

SEM-5TH

BRANCH- CIVIL ENGINEERING

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SECTION A : WATER SUPPLY

CHAPTER : 01

Introduction to Water Supply, Quantity and Quality of water

1.1 Necessity of treated water supply

1.2 Per capita demand, variation in demand and factors affecting demand

1.3 Methods of forecasting population, Numerical problems using different methods

1.4 Impurities in water – organic and inorganic, Harmful effects of impurities

1.5 Analysis of water –physical, chemical and bacteriological

1.6 Water quality standards for different uses

1. 1 Necessity Of Treated Water Supply

- ★ To supply safe good quality water in adequate quantity to a population
- ★ To prevent the mankind from various water borne diseases due to polluted water
- ★ It is important to protect the health- The harmful chemicals, metal and other contaminants present in water are dangerous for the health of humans and other organisms living on this planet. These harmful substances and toxins lead to various health problems like asthma, cholera, diarrhea, asthma, cancer, skin disorders and even death. Hence, this will reduce the annual death rate of people caused by drinking contaminated water.

1. 2 Per capita demand, variation in demand and factors affecting demand

VARIOUS TYPES OF WATER DEMANDS

While designing the water supply scheme for a town or city, it is necessary to determine the total quantity of a water required for various purposes by the city. As a matter of fact the first duty of the engineer is to determine the water demand of the town and then to find suitable water sourcesfrom where the demand can be met. But as there are so many factors involved in demand of water, it is not possible to accurately determine the actual demand. Certain empirical formulae and thumb rules are employed in determining the water demand, which is very near to the actual demand.

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. Five demand
vi. Loses and wastes

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. As per IS: 1172-1963, under normal conditions, the domestic consumption of water in India is about

135 litres/day/capita. But in developed countries this figure may be 350 litres/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

g) other uses--------------------20 litres

Total 135 litres/day/capita

INDUSTRIAL DEMAND : 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

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 publicdemand. To meet the water demand for public use, provision of 5% of the total consumption is made designing the water works for a city.

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.

Emperical Fomulae for calculating fire demand

(1) National board of Fire underwriters formula :

$$Q = 4640\sqrt{P}\left(1 - 0{\cdot}01\sqrt{P}\right)$$

(2) Freeman's formula

$$Q = 1135{\cdot}5\left(\frac{P}{10} + 10\right)$$

(3) Kuichling's formula

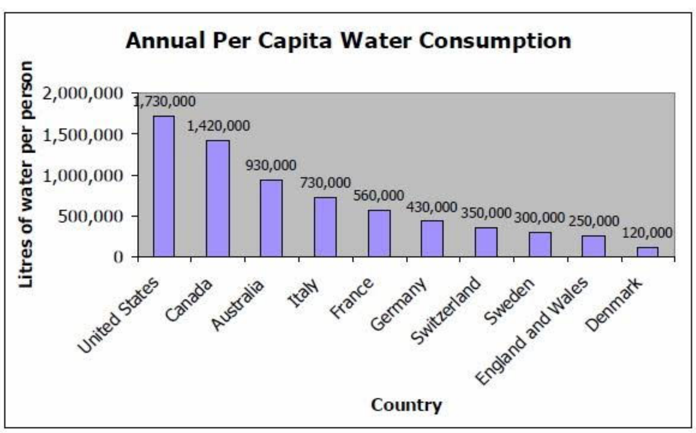
$$Q = 3182\sqrt{P}$$

(4) Buston's formula

$$Q = 5663\sqrt{P}$$

where Q = Quantity of water (in litre/minute)

and P = Population of town (in thousands)



PER CAPITA WATER 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 ,

$$\text{Per capita water demand} = \frac{Q}{P \times 365} \text{ litres/day}$$

Per capita demand of the town depends on various factors like standard of living, no. and type of commercial places in a town etc. For an average Indian town, the requirement of water in various uses is as under

	Low income group	high income group
i. Domestic purpose ------	135 litres/c/d	200 lpcd
ii. Industrial use -------	40 litres/c/d	40 lpcd
iii. Public use -------	25 litres/c/d	25 lpcd
iv. Fire Demand -------	15 litres/c/d	15 lpcd
v. Lossesand thefts -----	55 litres/c/d	55 lpcd
	Total : 270 lpcd	335 lpcd

The total quantity of water required by the town per day shall be 270 multiplied with the total population in litres/day

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. But in highly industrial city where both day and night shifts are working, the consumption in night may be more. The maximum consumption may be rise upto 200% that of average daily demand. The determination of this hourly variations is most necessary, because on its basis the rate of pumping will be adjusted to meet up the demand in all hours.

Average Daily Per Capita Demand

= Quantity Required in 12 Months/ (365 x Population)

Maximum daily demand = 1. 8 x average daily demand

Maximum hourly demand of maximum day i. e. Peak demand

= 1. 5 x average hourly demand

= 1. 5 x Maximum daily demand/24

= 1. 5 x (1. 8 x average daily demand)/24

= 2. 7 x average daily demand/24

= 2. 7 x annual average hourly demand

FACTORS AFFECTING PER CAPITA DEMAND

The following are the main factors affecting for capita demand of the city or town.

a) Climatic conditions : The quantity of water required in hotter and dry places is more than cold countries because of the use of air coolers, air conditioners, sprinkling of water in lawns, gardens, courtyards, washing of rooms, more washing of clothes and bathing etc. But in very cold countries sometimes the quantity of water required may be more due to wastage, because at such places the people often keep their taps open and water continuously flows for fear of freezing of water in the taps and use of hot water for keeping the rooms warm.

b) Size of community : Water demand is more with increase of size fo town because more water is required in street washing, running of sewers, maintenance of parks and gardens.

c) Living standard of the people : The per capita demand of the town increases with the standard of living of the people because of the use of air conditioners, room coolers, maintenance of lawns, use of flush, latrines and automatic home appliancesetc.

d) Industrial and commercial activities : As the quantity of water required in certain industries is much more than domestic demand, their presence in the town will enormously increase per capita demand of the town. As a matter of the fact the water required by the industries has no direct link with the population of the town.

e) Pressure in the distribution system: The rate of water consumption increase in the pressure of the building and even with the required pressure at the farthest point, the consumption of water will automatically increase. This increase in the quantity is firstly due to use of water freely by the people as compared when they get it scarcely and more water loss due to leakage, wastage and thefts etc.

f) System of sanitation: Per capita demand of the towns having water carriage system will be more than the town where this system is not being used.

g) Cost of water: The cost of water directly affects its demand. If the cost of water is more, less quantity of water will be used by the people as compared when the cost is low.

1. 3 Methods of forecasting population

The various methods adopted for estimating future populations are given below. The particular method to be adopted for a particular case or for a particular city depends largely on the factors discussed in the methods, and the selection is left to the discrection and intelligence of the designer.

1. Arithmetic Increase Method
2. Geometric Increase Method
3. Incremental Increase Method
4. Decreasing Rate of Growth Method
5. Simple Graphical Method
6. Comparative Graphical Method
7. Ratio Method
8. Logistic Curve Method

1. 1. Arithmetic Increase Method

This method is applied to areas where it is found that the rate of increase of population with time is constant i. e. dP/dt = Constant;

If P_n = Population of an area after any time 't' or Population after 'n' decades

P_o = Last known Population of that area;

n = number of decades (10 years = 1 decade);

X' = average increase in population. Then

$$P_n = P_o + n x'$$

* This method is suitable for larg ... elopment.

Example 1

Predict the population for the year 2021, 2031, and 2041 from the following population data.

YEAR	1961	1971	1981	1991	2001	2011
POPULATION	8, 58, 545	10, 15, 672	12, 01, 553	16, 91, 538,	20, 77, 820,	25, 85, 862

SOLUTION :

YEAR	POPULATION	INCREMENT IN POPULATION

1961	858545	-
1971	1015672	X1 = 157127
1981	1201553	X2 =185881
1991	1691538	X3 =489985
2001	2077820	X4 =386282
2011	2585862	X5 = 508042

X' = (X1+X2+X3+X4+X5) / 5

= (157127 + 185881 + 489985 + 386282 + 50804) ÷ 5

= 345463

Population in year 2021 is,

P2021 = 2585862 + 345463 x 1 = **2931325**

Similarly P2031 = 2585862 + 345463 x 2 = **3276788**

P2041 = 2585862 + 345463 x 3 = **3622251**

2. Geometric Increase Method

In this method the percentage increase in population from decade to decade is assumed to remain constant. Geometric mean increase is used to find out the future increment in population.

The population at the end of nth decade 'Pn' can be estimated as:

Where, r = geometric mean (%)

Po = last known population

N = no. of decades.

Pn = population after 'n' decades.

$$Pn = Po\left(1 + \frac{r}{100}\right)^n$$

** This method is employed in a ... rapidly increasing or new city*

r =(r1 × r2 × . . . . × r n) ^ 1/n

Example 2 :

Considering data given in example 1 predict the population for the year 2021, 2031, and 2041 using geometrical increase method.

YEAR	1961	1971	1981	1991	2001	2011

POPULATION	8, 58, 545	10, 15, 672	12, 01, 553	16, 91, 538,	20, 77, 820,	25, 85, 862

<u>SOLUTION:</u>

YEAR	POPULATION	INCREMENT IN POPULATION	INCREASE RATE IN GROWTH (r)
1961	858545	-	-
1971	1015672	X1 = 157127	r1 =(157127/858545) = 0. 18
1981	1201553	X2 =185881	r2 =(185881/1015672) = 0. 18
1991	1691538	X3 =489985	r3 =(489985/1201553) = 0. 40
2001	2077820	X4 =386282	r4 =(386282/1691538) = 0. 23
2011	2585862	X5 = 508042	r5 =(508042/2077820) = 0. 24

Geometric mean = (r1 × r2 × r3 × r4 × r5) ^ 1/5

= (0. 18 × 0. 18 × 0. 40 × 0. 23 × 0. 24)^ 1/5

= 0. 235 i. e 23. 5 %

Population in year 2021 is, P2021 = 2585862 x (1+ 0. 235)^1 = **3193540**

Similarly for year 2031 and 2041 can be calculated by,

P2031 = 2585862 x (1+ 0. 235)^2 = **3944021**

P2041 = 2585862 x (1+ 0. 235)^3 = **4870866**

3. Incremental Increase Method

This method is modification of arithmetical increase method and it is suitable for an average size town under normal condition where the growth rate is found to be in increasing order. While adopting this method the increase in increment is considered for calculating future population. The incremental increase is determined for each decade from the past population and the average value is added to the present population along with the average rate of increase. Hence,

population after nth decade is Pn = P+ n. X + {n (n+1)/2}. Y

Where, Pn = Population after nth decade

X = Average increase

Y = Average incremental increase

Example 3 Considering data given in example 1 predict the population for the year 2021, 2031, and 2041 using incremental increase method.

YEAR	1961	1971	1981	1991	2001	2011
POPULATION	8, 58, 545	10, 15, 672	12, 01, 553	16, 91, 538,	20, 77, 820,	25, 85, 862

SOLUTION :

YEAR	POPULATION	INCREASE IN POPULATION (X)	INCREMENTAL INCREASE (Y)
1961	858545	-	-
1971	1015672	X1 = 157127	-
1981	1201553	X2 =185881	+28754
1991	1691538	X3 =489985	+304104
2001	2077820	X4 =386282	-103703
2011	2585862	X5 = 508042	+121760
	TOTAL	1727317	350915
	AVERAGE	345463	87729

Population in year 2021 is, P2021 = 2585862 + (345463 x 1) + {(1 (1+1))/2} x 87729

= 3019054

For year 2031 P2031 = 2585862 + (345463 x 2) + {((2 (2+1)/2)}x 87729

= 3539975

P2041 = 2585862 + (345463 x 3) + {((3 (3+1)/2)}x 87729

= 4148625

1. 4 Impurities in water–organic and inorganic Harmful effects of impurities

Suspended impurities:

They cause turbidity. The concentration of suspended impurities is measured by turbidity. Eg : silt, clay, bacteria, fungi, algae.

Colloidal impurities:

These are finely divided dispersion of solid particles, not voria visible to the naked eye.

These impurities if associated with organic matter having bacteriabecomes the chief source of epidemic.

Dissolved impurities:

It includes organic compounds, inorganic salts and gases.

The following are various dissolved impurities and their effects.

- Salts : $CaCl_2$, $MgCl_2$, CO_3 , HCO_3, They cause hardness and alkalinity in water.
- Metals: Iron causes red colour, Manganese causes brown colour
- Lead and arsenic: It cause poisoning
- Gases: Oxygen causes corrosion of metals Chlorine and Ammonia cause bad taste and odour
- CO_2, and Hydrogen sulphide cause acidity in water

1. 5 Analysis of water

Physical	Chemical	Bacteriological
❖ Turbidity Colour ❖ Tasteand odour ❖ Temperature ❖ Specific Conductivity	❖ pH ❖ Total Solid, Suspended solid, Dissolved solid ❖ Hardness ❖ Chloride content ❖ Nitrogen Content ❖ Metal and Chemical Substances	❖ Standard Plate count test ❖ Most Probable Number ❖ Member Filter Technique Coliform

Physical characteristics

1. Turbidity of water:-

Turbidity is a measure of the degree to which the water loses its transparency due to the presence of suspended particulates. The more total suspended solids in the water, the murkier it seems and the higher the turbidity

Measured on Silica Scale. By Turbidity meter Permissible limit for potable water 5 to 10ppm

Jackson Turbidity meter:- used to measure HIGH TURBIDITY >25 PPM (JTU)

Baylis Turbidity meter:- Precisely records low turbidity value of order 0 to 2 PPM (BTU)

Nephelometer :- Commonly used for turbidity of turbidity 0 to 1 PPM. (NTU)

2. Colour of Water:-

It is caused by dissolved organic matters from decaying vegetation or some inorganic coloured soils, growth of algae, metallic ions (Fe and Mn). Measured by comparing the colour of water sample with other standard glass tubes (Nesslar tubes)Measured by Platinum Cobalt Method. (Measured on Platinum Cobalt Scale)

Permissible limit : 5 to 20 ppm. Measured by Tintometer.

3. Taste & Odour :

Due to dissolved organic matter or inorganic salts, dissolved gases etc. Threshold number is the standard uni t for measuring. Taste is expressed as FTN (Flavor ThresholdNumber)

Odour is expressed as TON (ThresholdOdourNumber)

TON = Dilution ratio. Dilution Ratio= (A+B)/A, A= Vol. of raw water sample, B = Vol. of distilled water used for dilution.

Permissible Limit : 1 to 3. The odour changes with temperature. It is tested normally at20^0C to25^0C.

Odour is measured by an apparatus called Osmoscope.

Osmoscope:

The Osmoscope is 'graduated with PO values from 0 to 5. (pO value of 0 indicates 'no perceptible odour'. pO value of 5 indicates 'extremely strong odour')

Example: If 10 ml water sample diluted with 190 ml distilled water at which odour is just detectable , then TON of the sample is

Sol: TON= (A+B)/A = 10+ 190/10 = 20

4. Temperature : 5^0C to 12^0C. 10^0C is desirable.

5. Specific Conductivity: To know the dissolved salt content. Determined by Dionic water tester

Chemical Characteristic:-

1. Total Solids and Suspended Solids

Total solids (suspended solids + dissolved solids) can be obtained by evaporating a sample of water and weighing the dry residue left and weighing the residue left on the filter paper.

The suspended solid can be found by filtering the water sample. Total permissible amount of solids in water is generally limited to 500 ppm.

2. pH value of Water

If concentration increases, pH decreases and then it will be acidic. If concentration decreases, pH increases and then it will be alkaline.

pH + pOH = 14

if the pH of water is more than 7, it will be alkaline and if it is less than 7, it will be acidic.

The alkalinity is caused by the presence of bicarbonate of calcium and magnesium or by the carbonates of hydroxides of sodium, potassium, calcium and magnesium. Some, but not all of the compounds that cause alkalinity also cause hardness.

3. Hardness of Water

Hard waters are undesirable because they may lead to greater soap consumption, scaling of boilers, causing corrosion and incrustation of pipes, making food tasteless etc.

Temporary Hardness: If bicarbonates and carbonates of calcium and magnesium are present in water, the water is render hard temporarily as this hardness can be removed to some extent by simple boiling or to full extent by adding lime to water. Such a hardness is known as temporary hardness or carbonate hardness.

Permanent Hardness: If sulphates, chlorides and nitrates of calcium or magnesium are present in water, they can not be removed at al by simple boiling and therefore, such water require special treatment for softening. Such a hardness is known as permanent hardness or non-carbonate hardness. It is caused by sulphates, chlorides, nitrates of Ca and Mg.

Carbonate hardness = Total hardness or Alkalinity (which ever is less)

Non-carbonate hardness = Total hardness – Alkalinity

Carbonate hardness is equal to the total hardness or alkalinity which ever is less

Non-carbonate hardness is the total hardness in excess of the alkalinity. If the alkalinity is equal to or greater than the total hardness, there is no non-carbonate hardness.

Water with hardness upto 75 ppm are considered soft and above 200 ppm are considered hard and in between is considered as moderately hard.

The prescribed hardness limit for public supplies range between 75 to 115 ppm.

4. Chloride Content

The chloride content of treated water to be supplied to the public should not exceed a value of about 250 ppm.

The chloride content of water can be measured by titrating the water with standard silver nitrate solution using potassium chromate as indicator.

(5) Nitrogen Content

The presence of nitrogen in water may occur in one or more of the following reasons:

Free ammonia: It indicates very first stage of decomposition of organic matter. It should not exceed 0.15mg/l

Albuminous or Organic Matter: It indicates the quantity of nitrogen present in water before the decomposition of organic molten has started. It should not exceed 0.3mg/l

Nitrites: Not fully oxidized organic matter in water.

Nitrates: It indicates fully oxidized organic matter in water (representing old pollution).

Nitrites is highly dangerous and therefore the permissible amount of nitrites in water should be nil.

Ammonia nitrogen + organic nitrogen = kjeldahl nitrogen

Nitrates in water is not harmful. However the presence of too much of nitrates in water may adversely affect the health of infants causing a disease called methemoglobinemia commonly called blue baby disease.

The nitrate concentration in domestic water supplies is limited to 45 mg/l.

6. Metal and other chemical substances in water:

- Iron – 0.3ppm, excess of these cause discolouration of clothes.
- Manganese – 0.05ppm
- Copper – 1.3ppm
- Sulphate – 250 ppm

- Fluoride – 1. 5 ppm,

excess of this effects human lungs and other respiratory organs.

Fluoride concentration of less than 0. 8 – 1. 0 ppm cause dental cavity (tooth decay). If fluoride concentration is greater than 1. 5ppm, causing spotting and discolouration of teeth (a disease called fluorosis).

7. Dissolved gases:-

Hydrogen Sulfide :- Bad test and odour.

Carbon dioxide:- indicates biological activity and corrosion in pipe lines.

Dissolved Oxygen:- To know the extent of pollution.

Permissible limit for potable water should be between 5 to 10 ppm.

Nitrogen gas :- Indicates presence of organic matter

8. Total Solids and Suspended Solids

Total solids (suspended solids + dissolved solids) can be obtained by evaporating a sample of water and weighing the dry residue left and weighing the residue left on the filter paper.

The suspended solid can be found by filtering the water sample. Total permissible amount of solids in water is generally limited to 500 ppm.

Bacteriological characteristics.

Bacterial examination of water is very important, since it indicates the degree of pollution. Water polluted by sewage contain one or more species of disease producing pathogenic bacteria. Pathogenic organisms cause water borne diseases, and many non pathogenic bacteria such as E. Coli, a member of coliform group, also live in the intestinal tract of human beings. Coliform itself is not a harmful group but it has more resistance to adverse condition than any other group. So, if it is ensured to minimize the number of coliforms, the harmful species will be very less. So, coliform group serves as indicator of contamination of water with sewage and presence of pathogens.

The methods to estimate the bacterial quality of water are:

Standard Plate Count Test

Most Probable Number

Membrane Filter Technique

1. 6 Water quality standards for different uses

Parameter	Desirable-Tolerable.	If no alternative source available, limit extended upto
Turbdity (NTU unit).	< 10	25
Colour (Hazen scale)	< 10	50
Taste and Odour	Un-objectionable.	Un-objectionable
pH.	7. 0-8. 5.	6. 5-9. 2
Total Dissolved Solids mg/l	500-1500	3000
Total Hardness mg/l (as CaCO3)	200-300	600

Chlorides mg/l (as Cl)	200-250	1000
Sulphates mg/l (as SO4).	150-200	400
Fluorides mg/l (as F)	0. 6-1. 2	1. 5
Nitrates mg/l (as NO3)	45	45
Calcium mg/l (as Ca)	75	200
Iron mg/l (as Fe)	0. 1-0. 3.	1. 0

QUESTION BANK

LONG ANSWER TYPE QUESTION

1. What are the various types of water demand ?
2. What do you mean by per capita demand and fluctuation of demand ?
3. State the factors that affect the rate of water demand
4. State the method of population forecasting ?
5. State different type of physical , chemical, biological characteristics of water.

SHORT ANSWER TYPE QUESTION

1. What doyou mean by per capita demand ?
2. What are the emperical formulae used for calculating fire demand ?
3. Differentiate between permanent hardness and temporary hardness
4. What is the difference between suspended particle and colloidal particle ?
5. Name various types of water demand.

MULTIPLE CHOICE TYPE QUESTIONS

1. The nitrate concentration in domestic water supplies, is generally limited to

(A) 10 ppm(B) 15 ppm(C) 30 ppm(D) 45 ppm

Correct Answer

Answer: Option D

2. Carbonates in water produce

(A) Temporary hardness(B) Permanent hardness(C) Acidity(D) Alkanity

Correct Answer

Answer: Option A

3. The ratio of maximum hourly consumption and average hourly consumption of the maximum day, is

(A) 1. 2(B) 1. 5(C) 1. 8(D) 2. 7

Correct Answer

Answer: Option D

4. . Mathamoglobinemia or blue baby disease is caused due to

(A) Chlorides(B) Nitrites(C) Nitrates(D) Sulphides

Correct Answer

Answer: Option C

5. Maximum threshold number permitted for indicating the odour of public water supplies, is

(A) 1(B) 2(C) 3(D) 4

Correct Answer

Answer: Option C

6. As per IS : 1172-1963, water required per head per day for average domestic purposes, is

A. 50 litres B. 65 litres C. 85 litres D. 105 litres

E. 135 litres.

Answer: Option E

7. Increase in population of a rapidly growing city, may be estimated by

A. arithmetical mean method B. geometrical method

C. incremental increase method D. graphical comparison method.

Answer: Option B

8. The prescribed hardness limit of potable water ranges between

A. 50 to 75 P. P. M. B. 75 to 115 P. P. M.

C. 100 to 150 P. P. M. D. 150 to 200 P. P. M.

Answer: Option B

9. For maximum alkalinity of water, pH value should be

A. zero B. ess than 7

C. more than 7 D. 14

Answer: Option D

10. According to Buston's formula, fire demand in litres per minute for a population of P thousands, is

A. 3182 ✓P B. 4637✓ P (1 - 0. 01 ✓P)

C. 5663 ✓P D. none of the qbove

Answer: Option C

11. To detect the turbidity of the order of 0 to 1000 P. P. M. the instrument used is

A. turbidimeter B. Jackson turbidimeter

C. Baylis turbidimeter D. Hallige turbidimeter.

Answer: Option C

12. Color test of water is done with an instrument called

A. Tintometer B. Colorimeter

C. Electro-chemical cell D. Turbidimeter

Answer: Option A

CHAPTER 2

2 Sources and Conveyance of water

2.1 Surface sources – Lake, stream, river and impounded reservoir

2.2 Underground sources – aquifer type & occurrence

Infiltration gallery, infiltration well, springs, well

2.3 Yield from well- method s of determination, Numerical

problems using yield formulae (deduction excluded)

2.4 Intakes – types, description of river intake, reservoir intake, canal intake

2.5 Pumps for conveyance & distribution – types,

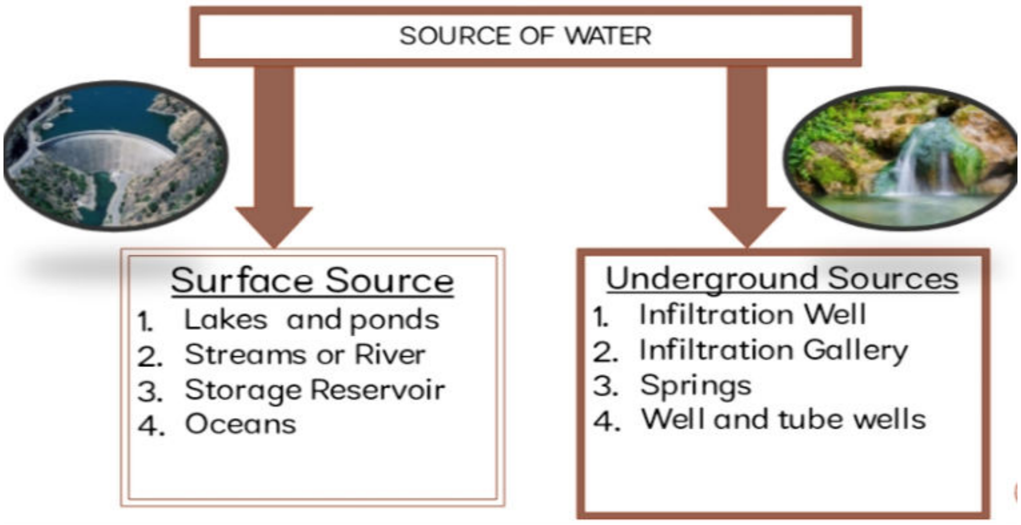
selection, installation.

2.6 Pipe materials – necessity, suitability, merits &

demerits of each type

2.7 Pipe joints – necessity, types of joints, suitability,

methods of jointing ,Laying of pipes – method



2.1 Surface sources – Lake, stream, river and impounded reservoir

Surface sources:-

The sources of water in which the water flows over the earth surface are called surface sources . The surface sources are mainly classified as :- River, Stream & Lakes , Impounding reservoir .

Rivers, Stream & Lakes :- They are formed by rainfall runoff i.e. rain water flowing along the ground into these natural drainage depressions . Quantity varies depending on the catchment.

Rivers:- Rivers are born in the hills , when the discharge of large number of springs and streams combine together. Rivers are the only surface sources of water which have maximum quantity of water which can be easily taken. Streams . In mountainous regions streams are formed by the run off . The discharge in streams is much in rainy season than other seasons. The quality of water in streams is normally good except the water of first run-off.

Lakes :- In mountains at some places natural basins are formed with impervious beds. Water from springs & streams generally flows towards these basins and Lakes are formed . The quantity of water in the lakes depends on its basin capacity , catchment area, annual rainfall & porosity of the ground etc.

Impounded Reservoirs :- It may be defined as an artificial lake created by the construction of a dam across a valley containing a water course . The object is to store a portion of the stream flow so that it may be used for water supply. The reservoir consists of three parts :

(i) A dam to hold back water

(ii) A spillway through which excess stream flow may discharge

(iii) A gate chamber containing the necessary valves for regulating the flow of water from the reservoir

2. 2 UNDER GROUND SOURCE OF WATER

AQUIFER Aquifers in geological terms are referred to as bodies of saturated rocks or geological formations through which volumes of water find their way (permeability) into wells and springs

Aquifers must not only be permeable but must also be porous and are found to include rock types such as sandstones, conglomerates, fractured limestone and unconsolidated sand, gravels and fractured volcanic rocks (columnar basalts).

Aquifers are generally been classed into two main categories namely confined aquifer and unconfined aquifers.

- Confined aquifer
- Unconfined aquifer

CONFINED AQUIFER

Confined Aquifers are those bodies of water found accumulating in a permeable rock and are been enclosed by two impermeable rock layers or rock bodies.

The pressure in this region is higher than atmospheric pressure confined aquifer.

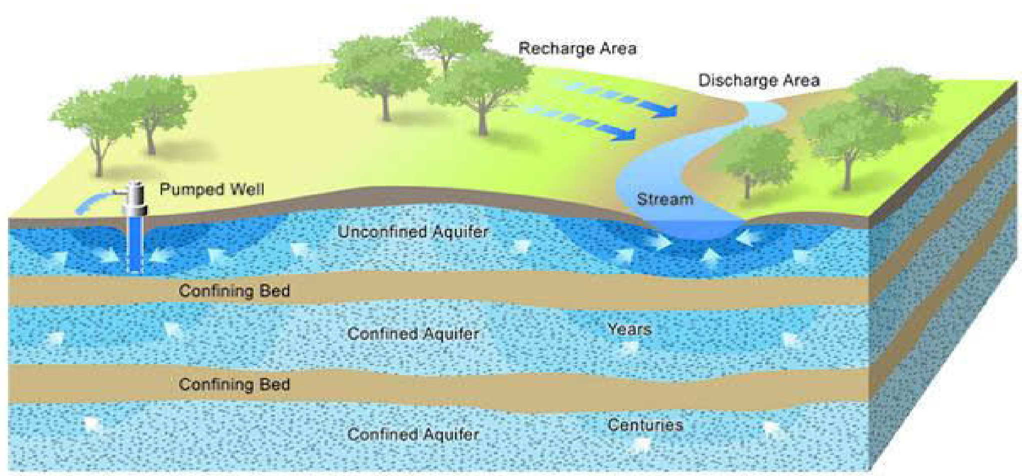
Confined Aquifers are aquifers that are found to be overlain by a confining rock layer or rock bodies, often made up of clay which might offer some form of protection from surface contamination.

UNCONFINED AQUIFER

Where groundwater is in direct contact with the atmosphere through the open pore spaces of the overlying soil or rock, then the aquifer is said to be unconfined. The upper groundwater surface in an unconfined aquifer is called the water table

The depth to the water table varies according to factors such as the topography, geology, season and tidal effects, and the quantities of water being pumped from the aquifer

Unconfined aquifers are usually recharged by rain or streamwater infiltrating directly through the overlying soil.



INFILTRATION GALLERY

Infiltration galleries are horizontal or nearly horizontal tunnels constructed at cello deptt 3-5 m along the banks of the river through the water bearing strata.

This galleries are generally constructed of masonry walls with roof slab and drive their water from the aquifer by various porous drain pipes

These pipes are generally covered with gravel so as to present the entry of the fine sand particles into the pipe. These Tunnel is taken to a song for well from where it is found treated and distributed to the consumers.

INFILTRATION WELL

Infiltration wells are the syllables constructed in a series along the bank of a river, order to collect the seeping water through the bottom of the river.

These soils are closed at the top and open at the bottom manholes are provided at the tops for the inspection purpose.

These are constructed of brick missionary with open joints.

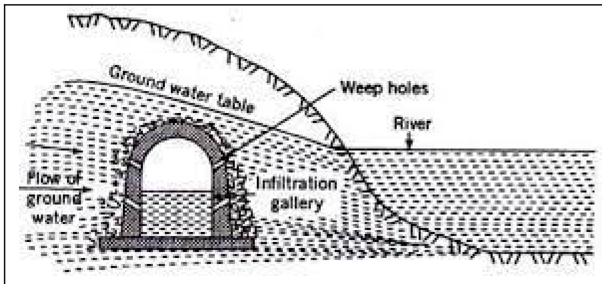
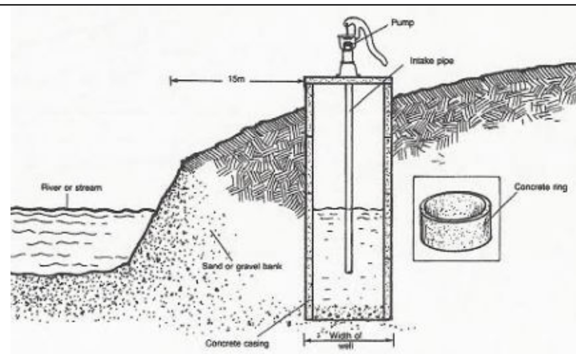


Fig. 4.6. Infiltration galleries.



INFILTRATION WELL

SPRINGS

Spring is the natural outflow of groundwater to the surface of the earth, indicating that the water table has outcropped. Generally, when a pervious layer is crammed between two impervious layers, it eventually gives rise to springs. In certain springs, discharge of hot water is seen due to the presence of sulphur.

Types of springs

- Gravity springs
- Artesian springs
- Surface springs

Wells

A well is a vertically excavated hole on the surface of the earth that facilitates access to groundwater by bringing it up to the surface. Open wells and tube wells are the two types of wells.

* Open well

* Dug well

2. 3 yield of well

Defination it is defined as the rate of pumping of water from the well without causing its failure

Measurement of an open yield :-

The yield can be determined by the following two methods:

(i) Actual Pumping Method

(ii) Theoretical Method

Actual Pumping Method :

The specific yield of a well can be determined by the following formula –

$C'/A = (2.303/T) \log_{10}(S1/S2)$

Where , C'/A = Specific yield.

S1 = Depression head in the well at the time immediately after the pumping was stopped.

S2 = Depression head in the well at time ―t '' after the pumping was stopped.

T = Time after pumping when measurement S2 was taken.

Knowing the value of C'/A , the discharge ―Q ‖of the well can be determined by –:

$Q = (C'/A) * A * S$

Where , A = Cross sectional area of the well

S = Depression head

Theoretical Method :-

The approximate quantity of water entering or percolating in the wall can be calculated as :

Theoretical Method :-

The approximate quantity of water entering or percolating in the wall can be calculated as :

$Q=A\times V\times B$

Where A = cross sectional area of the well opening

V = Velocity of water percolating in the well

B = Permeability constant.

Problem :

The water level in an open well was depressed by pumping up to 3. 0 meter. The water level was raised by 1. 5meter within 50 minutes just after stopping the pumping . Determine Yield from well , if the diameter of the well is 2. 5 meter & the depression head is 3. 3 meter.

Ans.

Given S1 = 3. 0m, S2 = 3 – 1. 5 = 1. 5m , T = 50 minutes = 3000 sec

C '/ A = (2. 3 / T) log10 (S1 /S2)

C '/A = (2. 3/3000) log10 (3/1. 5)

C '/A = 0. 0002307

If d = 2. 5m & S= 3. 3m, then A = 3. 142d^2 = 4. 909 m^2

Then Q = (C '/A) *A *S = 0. 0002307 * 4. 909 * 3. 3 = 3. 737 * 10^-3 litre per second Ans.

2. 4 Intakes – types, description of river intake, reservoir intake, canal intake

INTAKES:- Intake structures are used for collecting water from the surface sources such as river, lake, and reservoir and conveying it further to the water treatment plant.

These structures are masonry or concrete structures and provides relatively clean water, free from pollution, sand and objectionable floating material.

An intake structure consist of two sections-

1) intake conduit with screen at inlet end and valve to control the flow of water and

2) the structure permitting the withdrawal of water from source and housing and supporting intake conduit valves, pumps etc.

Types of Intake Structures

Intakes are classified under three categories:

Category 1:

Submerged intake:- Those intakes that are constructed entirely under water are termed as submerged intakes.

. Submerged intake structures are commonly used to obtain water from lakes.

Exposed intake:- Exposed intakes are in the form of oil or tower constructed near the bank of river, or in some cases even away from the bank of river and are common due to ease in its operation.

Category 2:

Wet intake:- The water level of intake tower is practically the same as that of the water level of sources of supply in wet intake. It is also known as jack well.

Dry intake:- There is no water in the water tower in the case of dry intake. Water enters through the port directly into the conveying pipes. In this type of intake the dry tower is simply used for the operation of valves

Catagory-3

- River intake
- Reservoir intake
- Lake intake
- Canal intake

River Intake Structures

It is a type of intake which may either located sufficiently inside the river so that demands of water are met with in all the seasons of the year, or they may be located near the river bank where a sufficient depth of water is available.

Sometimes, an approach channel is constructed and water is led to the intake tower.

If the water level in the river is low, a weir may be constructed across it to raise the water level and divert it to the intake tower.

Reservoir Intake Structures

When the flow in the river is not guaranteed throughout the year, a dam is constructed across it to store water in the reservoir so formed.

These are similar to river intake, except that these are located near the upstream face of the dam where maximum depth of water is available.

Design of intake may vary based on the type of dam.

Lake Intake Structures

Generally submerged intakes are preferred for lake intakes.

These are constructed as cribs or bell mouths. The cribs are made of heavy timber frame work which is partly or wholly filled with rip-rap to protect the intake conduit against damage by waves etc.

The top of the crib is covered with cast iron or mesh grating.

Canal Intake Structures

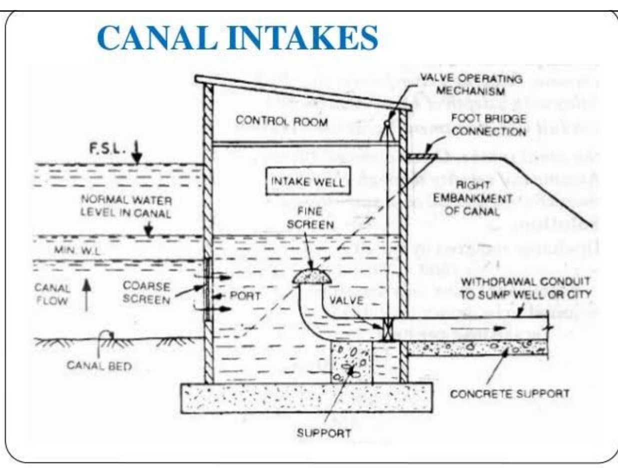
In some cases, source of water supply to a small town may be an irrigation canal passing nearer or through the town. Then it will be constructed.

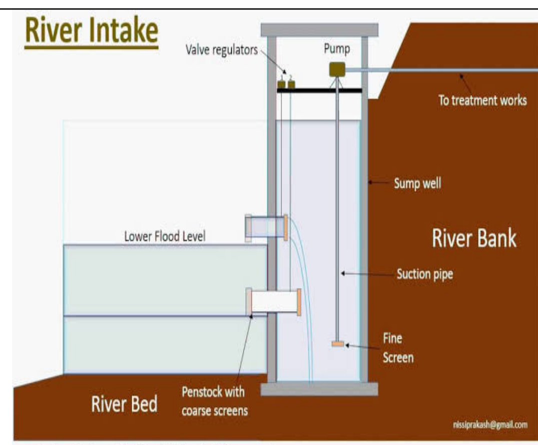
Generally it consists of masonry or concrete intake chamber of rectangular shape, admitting water through a coarse screen.

A fine screen is provided over the bell mouth entry of the outlet pipe.

The intake chamber may be constructed inside the canal bank if it does not offer any appreciable resistance to normal flow in the canal.

It's preferred to provide lining to the canal near the intake chamber.





During Maximum flood level, Valve 1 will be opened

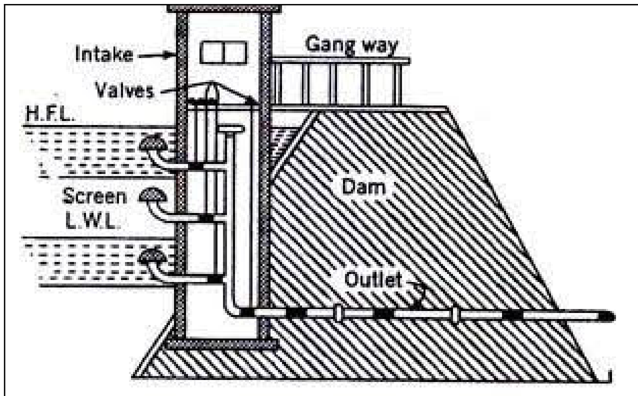


Fig. 7.7. Reservoir Intake.

2. 5 Pumps for conveyance & distribution – types, selection, installation

Pumps

A pump is a device which converts mechanical energy into hydraulic energy. It lifts water from a lower to a higher level and delivers it at high pressure. Pumps are employed in water supply projects at various stages for following purposes:

1)To lift raw water from wells.

2)To deliver treated water to the consumer at desired pressure.

3)To supply pressured water for fire hydrants.

4)To boost up pressure in water mains.

5)To fill elevated overhead water tanks.

6)To back-wash filters.

7)To pump chemical solutions, needed for water treatment.

Classification of Pumps

Based on principle of operation, pumps may be classified as follows:

1)Displacement pumps (reciprocating, rotary)

2(Velocity pumps (centrifugal, turbine and jet pumps)

3)Buoyancy pumps (air lift pumps)

4)Impulse pumps (hydraulic rams)

Capacity of Pumps

Work done by the pump,

$$H.P. = gQH/75$$

where, g= specific weight of water kg/m3, Q= discharge of pump, m3/s; and H= total head against which pump has to work.

H= Hs + Hd + Hf + (losses due to exit, entrance, bends, valves, and so on)

where, Hs=suction head, Hd = delivery head, and Hf = friction loss.

Efficiency of pump (E) = gQH/Brake H. P.

Total brake horse power required = gQH/E

Provide even number of motors say 2, 4, . . . with their total capacity being equal to the total BHP and provide half of the motors required as stand-by.

Conveyance

There are two stages in the transportation of water:

Conveyance of water from the source to the treatment plant.

Conveyance of treated water from treatment plant to the distribution system.

In the first stage water is transported by gravity or by pumping or by the combined action of both, depending upon the relative elevations of the treatment plant and the source of supply.

In the second stage water transmission may be either by pumping into an overhead tank and then supplying by gravity or by pumping directly into the water-main for distribution.

Selection Of type of Pump:-

Following Following consideration govern the choice of particular type of Pump in water supply project:

I) Capacity of Pumps

ii) Importance of water supply scheme

iii) Initial Cost

iv) Location of Pump

v) Maintenance cost

vi) Number of units required

vii) Quality of water to be pumped

viii)Total head of water, variation in pumping head and pumping rate

ix) Type of Supply service:- intermittent or continuous

x) Working or operating conditions such as flexibility in operation, requirement of floor area etc.

PIPE MATERIALS :

The pipes used for plumbing installations in homes and businesses can be manufactured from many different materials. Like in any engineering decisions, the best option changes depending on the application and project conditions.

The most common piping materials used for plumbing are copper, PVC, CPVC and PEX(Cross-Linked Polyethylene Piping) etc.

1)Copper Pipes

Copper is very durable, and it has been the traditional plumbing material since the 1960s. Other materials have been introduced since then, but copper is still one of the best options. The main drawback of copper piping is its high price, and it requires soldering and additional fittings.

Merit	Demerit
*)Resistant to leaks Durable	*)Expensive *)Old installations may contain lead

*)Does not pollute wate *)Heat tolerant *)Old pipes can be recycled *)Corrosion resistant	solder *)Old copper pipes can be recycled, but copper mining and manufacturing cause environmental damage.

2) Polyvinyl Chloride Piping (PVC)

PVC is a plastic material that is commonly used in plumbing, and it comes in two sizes: Schedule 40 and Schedule 80.

Schedule 40 PVC is the most commonly used, having thinner walls and a lower price.

Schedule 80 PVC has thicker walls, making it more durable but also more expensive.

PVC is commonly used for the drain lines of sinks, toilets and bathtubs. Other common applications include indoor plumbing, underground plumbing.

Merit	Demerit
Resistant to rust and corrosion Resistant to high water pressure Low cost Easy installation, no welding or metalwork Versatile: multiple sizes and fittings Strong and durable Non-conductive	Cannot be used for hot water, since heat deforms PVC. PVC degrades with UV light, which means it cannot be exposed to sunlight. Not safe for drinking water. Not recyclable.

3. Galvanized Steel Piping

This materials was popular in the past, but no longer used due to its negative effects:

Internal rusting in small diameter pipes, due to the zinc coating

Can get clogged over time

Lead can be released by corroded pipes

Water discoloration

Galvanized steel is also a heavy material, which limits its applications in plumbing. These pipes were commonly used in greywater and non-potable water drains.

4. Cast Iron Pipes

Cast iron pipes are usually manufactured as a bell and spigot type, and they are the heaviest of all plumbing pipes.

common applications of cast iron pipes are water distribution systems and underground installations, such as the main pipes on drainage and sewer systems.

5. Asbestos Cement Pipe.

The asbestos pipe is made from asbestos, silica, and cement converted under pressure to a dense, homogeneous material possessing considerable strength.

The asbestos fiber is thoroughly mixed with the cement and serves as reinforcement.

They are used to carry water under low pressure. The hydraulic efficiency of an asbestos pipe is high.

These pipes are soft from the inside. That is why their performance is better. They are not rusted and are cheap as well.

6. Concrete Pipe.

#. The Pre-cast Concrete pipe is available in sizes up to 72 inches diameter, and sizes up to 180 inches have been made on special order.

#. The centrifugal force presses the mortar tightly against the forms and results in high-density watertight concrete.

#. Because of the better control in its manufacture, a pre-cast concrete pipe is usually of higher quality and not need to be so thick as a cast-in-place pipe of the same size.

#. Because of the need to move plant and forms over long distances, cast-in-place pipe is relatively expensive and is normally used only for pipe sizes not available in precast form or where transportation difficulties make use of precast pipe impossible.

#. Concrete Pipes are generally used these days. They are used even in low as well as high pressure. Plain concrete pipes are made for low pressure, and R. C. C. (Reinforced Cement Concrete) pipes are made for high pressure.

#. Less expenditure is required for their maintenance. Rust does not affect these pipe. Such pipes are heavy. So, their transportation is difficult. It is also difficult to repair them.

2. 7 Pipe joints – necessity, types of joints, suitability, methods of jointing , Laying of pipes – method

Types of pipe joint

1. Threaded Joint in Pipe

Threaded joint means, pipes are connected by screwing with the help of threads provided for each pipe. One pipe having internal threads and the other one having threads externally. Cast iron pipes, copper pipes, PVC and G. I pipes are available with threads.

They are preferable for low temperature areas and low pressure flows.

2. Brazed Joint in Pipe

Brazing is the process of jointing pipes using molten filler material at above 840oC. Brazing is generally used for joining copper pipes or copper alloy pipes. The filler material majorly consist tin which has great affinity towards copper. But because of its weak property tin is added to other materials like nickel, bismuth, silver and copper.

The melting point of parent metal should be higher than filler metal. Mechanical strength of brazed joint is low compared to other joints. This type of joint is suitable in moderate range of temperature areas.

3. Soldered Joint in Pipe

Soldering is also similar to brazing but the only difference is in case of soldering the filler metal melts at below 840oC. Soldering also used to joint copper and copper alloy pipes. Before proceeding to soldering flux called paste is applied to pipes and fittings to prevent them from oxidation from flame. Here also we require skilled workers for installation.

Soldered joints are suitable for low temperature areas. These are having low mechanical strength as brazed joints.

4. Butt Welded Joint in Pipe

When the pipes are of same diameter butt welding is to done to join the pipes. It is the most common type of welding. Skilled workers are required to install the joint. These joints are generally used for large commercials and industrial piping systems.

Butt weld provides good strength for the joint and it can resist high pressure because of smooth and continuous surface inside the joint.

Butt weld joints are expensive, to make it economical sometimes internal weld backing rings are used, which joins the pipe with less amount of filler material. But these rings may fail under heavy stress and cracks are developed.

5. Socket Welded Joint in Pipe

Socket welded joints are used wherever there is a high chance of leakage in joints. Pipes are connected as putting one into other and welded around the joint. Pipes having different diameters are suitable for this type of joint.

6. Flanged Joint in Pipe

Flanged joints are used for high pressure flows and for large diameter pipes. In general they are used for plain end pipes or threaded pipes. Two flange components are connected by bolts at the pipe joint to prevent leakage.

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