Water Supply & Sanitary Engineering (DI05006021)

Unit 2: Quantity and Quality of Water

Lecture 3: Types of Water Demand and Computation

GTU Diploma Engineering

Agenda

- Introduction to Water Quantity
- Components of Total Water Demand
- Domestic, Industrial, and Commercial Demand
- Public Use and Fire Demand
- Formulas for Fire Demand
- Per Capita Demand and Computation

Introduction to Water Quantity

- First step in designing a water supply scheme is determining the total quantity of water required.
- Must account for present requirements and future growth over the design period.
- Total quantity depends on population and per capita consumption.

Components of Total Water Demand

- Domestic water demand
- Industrial water demand
- Commercial and institutional water demand
- Water for public uses
- Fire demand
- Losses and wastes

Domestic Water Demand

- Water required for drinking, cooking, bathing, washing, and sanitation.
- Constitutes the largest portion of total demand (about 50-60%).
- According to IS: 1172-1993, normal requirement is 135 to 200 liters per capita per day (lpcd).

Industrial Water Demand

- Water used in manufacturing processes, cooling, and boiler feed.
- Varies greatly depending on the type and size of industries in the area.
- Usually ranges from 50 to 450 lpcd for an industrial city.

Commercial and Institutional Demand

- Requirements for offices, schools, hospitals, hotels, and restaurants.
- Hospitals generally require 340-450 liters per bed per day.
- Schools/Offices typically require 45-50 lpcd.
- Overall average is considered about 20 lpcd.

Demand for Public Uses

- Water used for municipal tasks like street washing, sewer flushing, and public parks.
- Accounts for roughly 5% to 6% of total consumption.
- Typically taken as 10 to 20 lpcd in total calculations.

Fire Demand

- Quantity required for firefighting is relatively small over a year, but the rate of flow required is very high.
- Water pressure must be adequate (usually 1.0 to 1.5 kg/cm2 minimum at hydrants).
- Calculated empirically based on population to ensure pipe sizes are sufficient.

Kuichling's and Freeman's Formulas

Concept 1	Concept 2
Kuichling's Formula: $Q = 3182 * P$	
Freeman's Formula: $Q = 1136 * [(P/5) + 10]$	
Where Q = Quantity in liters/minute, P = Population in thousands	

National Board of Fire Underwriters Formula

- For central congested high-value cities: Q = 4637 * P * (1 - 0.01 * P)
- Where Q = Quantity in liters/minute, P = Population in thousands.
- Considered one of the most reliable and widely used formulas globally.

Losses and Wastes

- Water lost due to defective pipe joints, cracked pipes, and faulty valves.
- Theft or unauthorized illegal connections.
- Generally estimated to be around 15% of the total water demand.

Per Capita Demand (q)

- Defined as the annual average amount of water required by one person per day.
- q = (Total yearly water requirement in liters) / (365 * Total population).
- Typically ranges from 250 to 350 lpcd for a standard Indian city.

Computation of Total Quantity

- Determine the design population (P).
- Determine the per capita demand (q).
- Total daily demand = P * q.
- Design components based on this total daily demand plus peak factors.

Summary

- Total water demand comprises domestic, industrial, commercial, public, and fire demands.
- Losses and theft account for 15% of the total.
- Empirical formulas like Kuichling's determine fire demand flow rates.
- Total daily quantity = Population * Per Capita Demand.