



Environment and health

Definition

- Implies all the external factors
 - living and non-living, material and non-material which surround man
- Three components
 - Physical: water, air, soil, housing, wastes, radiation
 - Biologic: plant and animal life including bacteria, viruses, insects, rodents and animals
 - Social: customs, culture, habits, income, occupation, religion

Sanitation



- Sanitation
 - a way of life
 - expressed in clean home, clean farm, clean business, clean neighborhood and clean community
 - it must come from within the people
 - an obligation and an ideal in human relations
- Environmental sanitation
 - the control of all those factors in man's physical environment which exercise deleterious effect on health

Water



Water

- Safe and wholesome water: defined as
 - free from pathogenic agents
 - free from harmful chemical substances
 - pleasant to the taste
 - free from color and odor
 - usable for domestic purposes
- Polluted or contaminated water - when it does not fulfill the above criteria

Water requirement

- Physiological requirements of drinking water just for survival
 - about 2 liters per capita per day
- 150-200 liters per capita per day - urban areas
- 40 liters per capita per day - rural areas
- Close to the people

Uses of water

- Domestic
- Public
- Industrial
- Agricultural
- Power production
- Carrying away waste

Sources of water supply

- From any one of a number of points in its movement through the hydrological cycle
- Sufficient to serve the population expected at the end of the design period, 10 to 50 years
- Adequate 95 per cent of the year
- Two criteria
 - quantity must be sufficient to meet present and future requirement
 - quality of water must be acceptable

Sources of water supply

- Rain
- Surface water
 - Impounding reservoirs
 - Rivers and streams
 - Tanks, ponds and lakes
- Ground water
 - Dug well - Shallow and deep
 - Tube well - Shallow and deep
 - Artesian well & Springs

Rain



- Water cycle
- Rain water is the purest water in nature
 - clear, bright and sparkling.
 - very soft water containing only traces of dissolved solids, corrosive action on lead pipes
 - free from pathogenic agents
- Impurities
 - acid rain: dilute solution of sulphuric and nitric acid.
 - very few places - Gibraltar depend upon rain

Surface water

- Surface water originates from rain water
- Contamination from human and animal sources, high probability of organic, bacterial and viral contamination
- Majority of Indian cities and towns depend
- Types
 - Impounding Reservoirs
 - Rivers and Streams
 - Tanks, Ponds and Lakes

Impounding reservoirs

- Artificial lakes constructed usually of earthwork or masonry
- Catchment area
- Fairly good quality, clear, palatable and ranks next to rain water in purity.
- Keep the catchment area free from human or animal intrusion



Rivers



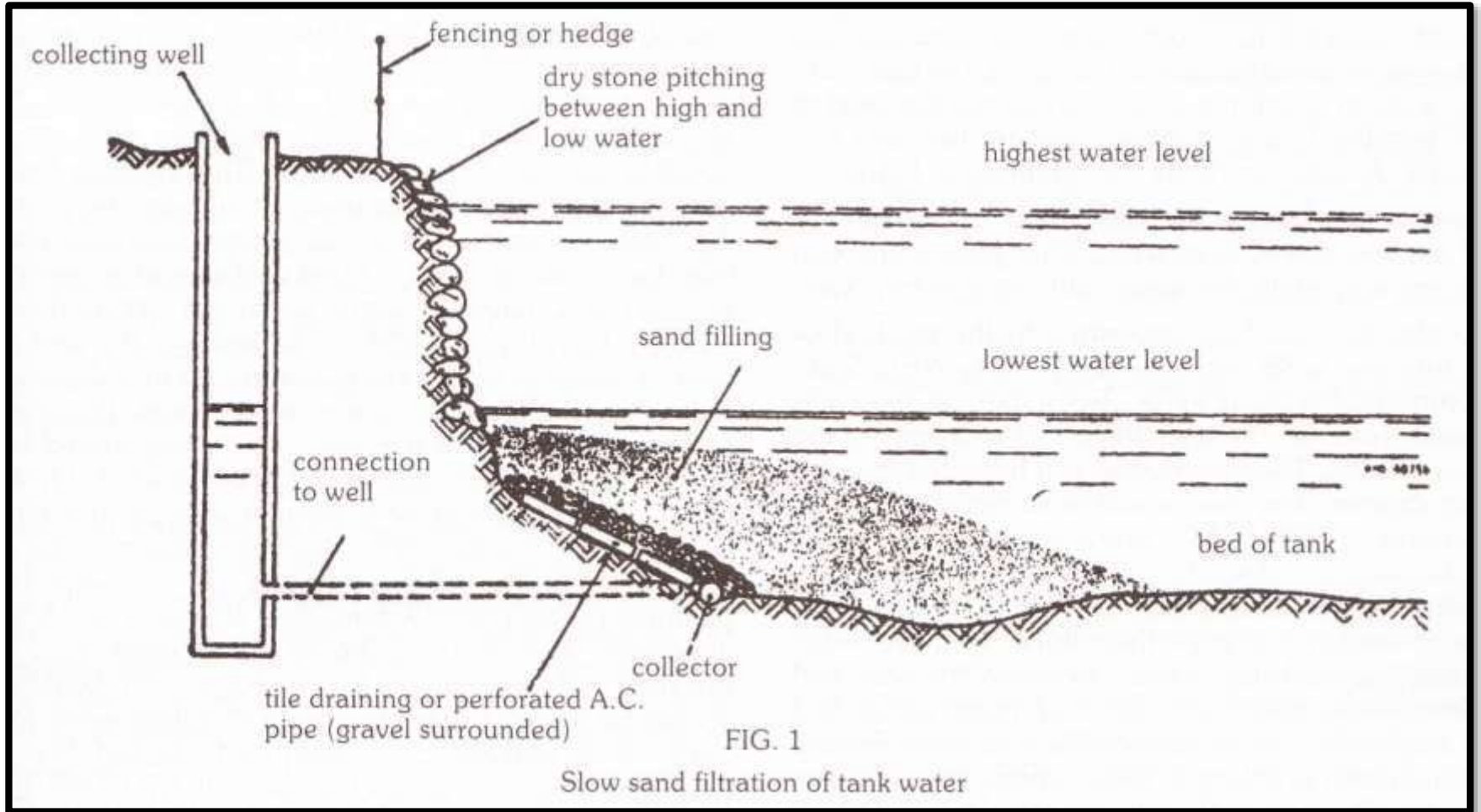
- Delhi, Kolkata and Allahabad rely on river water
- Always grossly polluted and is quite unfit for drinking without treatment
 - direct connection between the alimentary canal of the people living upstream and the mouths of those below
 - washings, sewage and sullage water, industrial and trade wastes, and drainage from agricultural areas
 - bathing, animal washing and disposal of the dead
- Self-purification
 - natural forces, dilution, sedimentation, aeration, oxidation, sunlight, plant and animal life

Tanks



- Large excavations
- Important source of water supply in some Indian villages
- Unlimited possibilities of contamination and are highly dangerous
- Improvement of tanks
 - edges of the tank should be elevated,
 - fence,
 - no one should be permitted to get into the tank directly,
 - elevated platform,
 - cleaned at the end of the dry season
 - simplest solution: sand filtration

Improvement of tanks



Sea water

- Many limitations
- 3.5% of salts in solution
- Desalting and demineralization process involves heavy expenditure
- It is adopted in places where sea water is the only source available

Ground water

- Rain water percolating into ground constitutes ground water
 - Limit to ground water in the world
 - Cheapest and most practical means
 - superior to surface water,
- Advantages
 - free from pathogenic agents
 - requires no treatment
 - available even during dry season
 - less subject to contamination
- Disadvantages
 - High in mineral content, pumping to lift the water
- Types: wells and springs

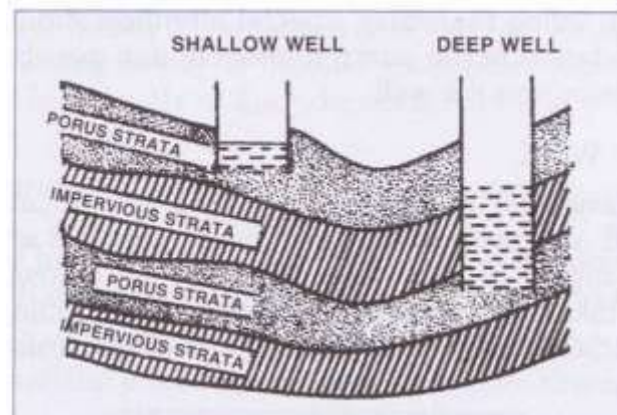
Dug wells

- Two types
 - Unlined katcha well
 - Masonry or pucca well
- Improvement of dug wells
 - Deepening bottom
 - Installing a hand-pump with screen
 - Filling the well with coarse sand up to the water level, and clay above that level
 - Upper 10 feet water-tight lining

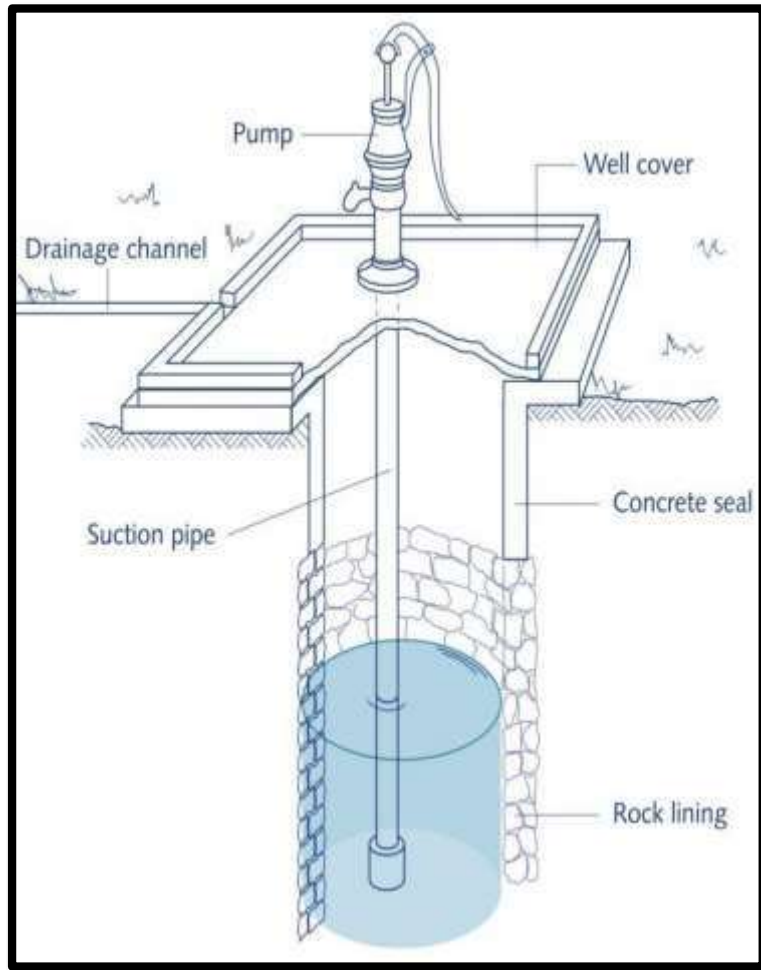


Difference between shallow and deep well

	Shallow well	Deep well
Definition	Above the first impervious layer	Below the first impervious layer
Chemical quality	Moderately hard	Much hard
Bacteriological quality	Often grossly contaminated	Taps purer water
Yield	Dry in summer	Constant supply



Sanitary well



1. Location
2. Lining
3. Parapet wall
4. Platform
5. Drain
6. Covering
7. Hand-pump
8. Consumer responsibility
9. Quality

Tube wells

- Bacteriologically safe, cheap
 - shallow tube wells
 - driven wells
- Consists of a pipe into the water-bearing stratum and fitted with a strainer at the bottom, and a hand pump at the top
- Lasts for a period of 5 to 10 years
- Deep tube well - drilling through successive substrata until water is located
- Chandigarh - entire water supply from tube wells



Artesian wells

- A kind of deep wells, water rises above the ground, held under pressure
- Artesian wells are not common in India



Springs

- Ground water comes to the surface and flows freely under natural pressure
- Shallow springs and deep springs
- Deep springs do not show seasonal fluctuations



Water pollution and purification

Causes and sources of pollution

- Natural
- Man made: Urbanization and industrialization
- Sources of pollution
 - Sewage
 - Industrial and trade waste
 - Agricultural pollutants
 - Physical pollutants, viz heat, radioactive substances
- Indicators of pollution
 - Total suspended solids, biochemical oxygen demand (BOD) at 20 deg. C, concentration of chlorides, nitrogen and phosphorus

Water related diseases

- Biological (Water-borne diseases)
 - Caused by infective agent
 - Viral, Bacterial, Protozoal, Helminthic, Leptospiral
 - Caused by aquatic host
 - Snail, Cyclops
- Chemical
- Dental
- Cyanosis in infants
- Cardiovascular
- Disease due to inadequate use of water
- Insect breeding

Water pollution law

- Water (Prevention and Control of Pollution) Act , 1974
- Central and State Water Boards and Joint Water Boards endowed with wide powers for controlling pollution

Water purification

- **Large scale**
 - **Typical system consists of:**
 - **Storage**
 - **Filtration**
 - **Disinfection**
- **Small scale (domestic)**
 - **Household purification**
 - **Boiling**
 - **Chemical disinfection: Bleaching powder, Chlorine solution , High test hypochlorite (HTH), Chlorine tablets , Iodine, Potassium permanganate**
 - **Household filtration**
 - **Disinfection of well**
 - **By adding bleaching powder**
 - **Double pot method**

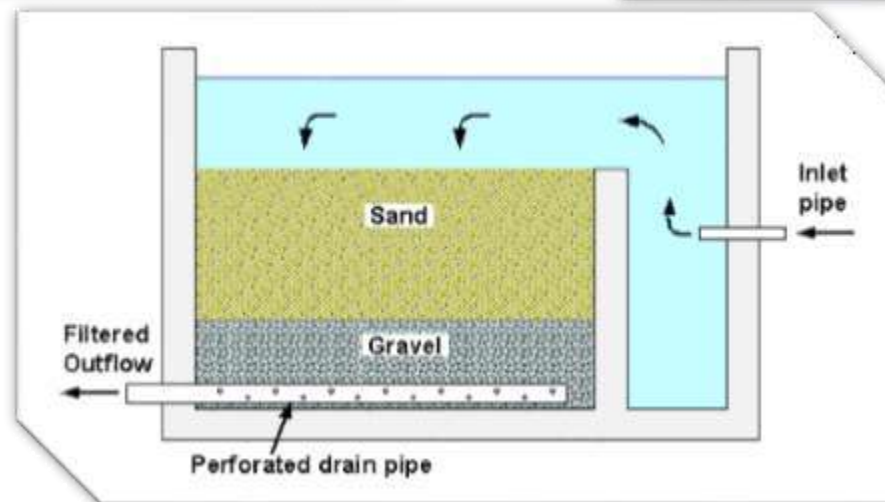
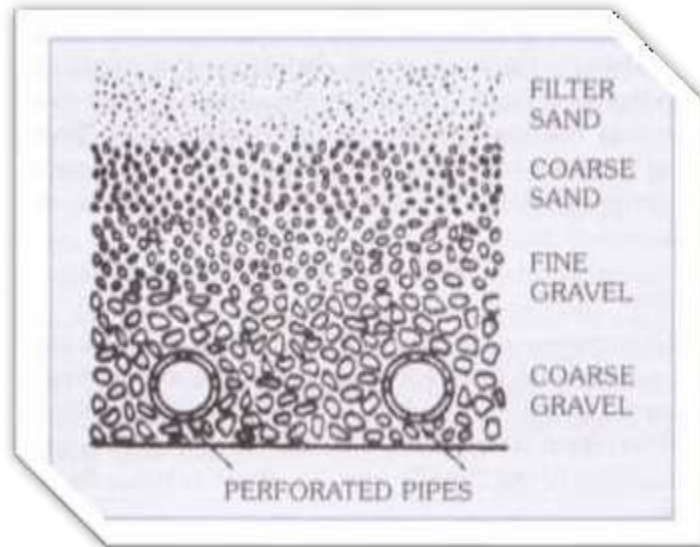
Storage

- In Natural or artificial Reservoirs
- Effects of storage:
 - Physical: Gravity – 90% suspended impurities settle down in one day
 - Chemical: Oxidizing action
 - Biological: Only 10% bacteria remains at the end of 1 week
- Optimum period of storage: 2 weeks

Filtration

- Water pass through porous media
 - Slow sand filter: biological
 - Rapid sand filter: mechanical
- Slow sand or biological filters
 - Used first in 19th century in Scotland
 - Elements of slow sand filter
 - Filter Box
 - Supernatant water
 - Sand bed
 - Under drainage system
 - Filter control valves

Slow sand or biological filters



Parts of the slow sand filter

- Supernatant water
 - Depth: 1 to 1.5 m
 - promotes downward flow of water through the sand bed
 - waiting time of 3-12 hours for raw water to undergo partial purification by sedimentation and oxidation
- Sand bed supported by gravel
 - Depth: 1 m (sand with 0.2-0.3 mm diameter), 0.3m (gravel with 0.2-1 cm diameter)
- Vital/Biological/ Zoogeleal layer/ Schumtzdecke:
 - Slimy, gelatinous layer over sand bed containing threadlike algae, bacteria and diatoms.
 - Heart of the slow sand filter.
- Ripening of filter: Formation of vital layer

Mechanism of action - 1

- Sedimentation
 - The supernatant water acts as a settling reservoir. Settleable particles sink to the sand surface.
- Mechanical straining
 - Particles too big to pass through the interstices between the sand grains are retained.
- Adhesion
 - The suspended particles that come in contact with the surface of the sand grains are retained by adhesion to the biological layer (Schmutzdecke)
- Biochemical processes in the biological layer
 - Removes organic matter, holds back bacteria and oxidizes ammoniacal nitrogen in to nitrates
 - Conversion of soluble iron and manganese compounds into insoluble hydroxides which attach themselves to the sand surfaces

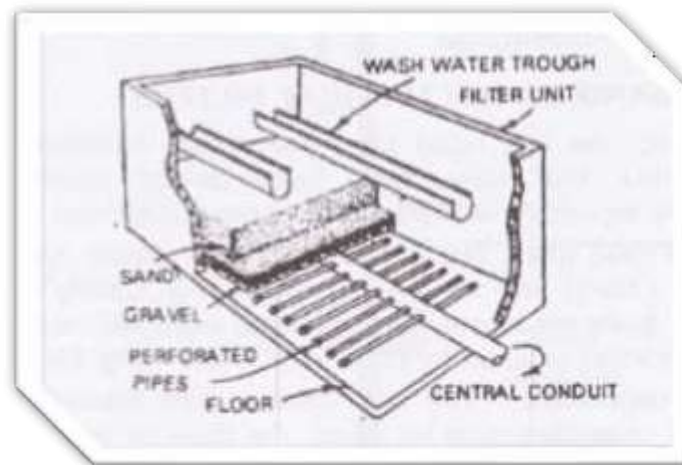
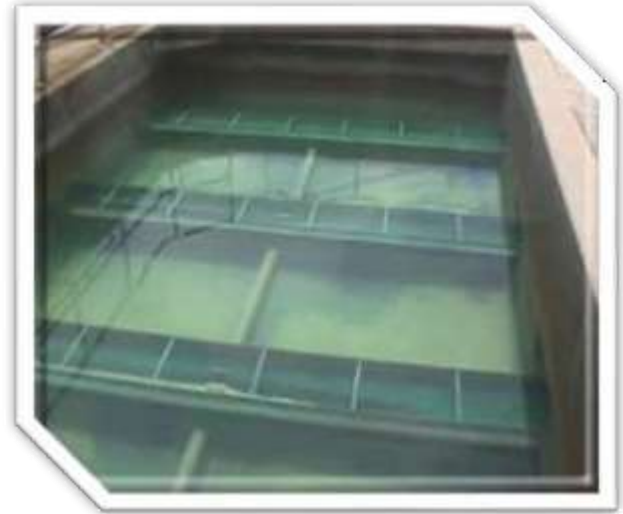
Mechanism of action - 2

- Under drainage system
 - Depth: 0.15 m
 - At the bottom of filter bed
 - Porous pipes: Outlet for filtered water as well as support to the filter media above
- Filter control valves
 - To regulate the flow of water in and out
- Filter cleaning
 - Increased bed resistance -> Necessary to open the regulating valves fully -> Scrapping top portion of sand bed up to 2 cm depth -> Time for cleaning the filter
- After 3-4 years new filter bed is constructed

Rapid sand filtration

- **First in 1885 in USA**
 - Gravity type (Open)/ Paterson's
 - Pressure type (Closed)/ Candy's
- **Mixing Chamber**
 - Coagulation by Alum (5-40 mg/litre)
 - Violent mixing of alum (minutes)
- **Flocculation Chamber**
 - Slow stirring of water by paddles(30 minutes)
 - Flocculent ppt. of Aluminium Hydroxide entangles all particulate, suspended matter along with bacteria
- **Sedimentation Chamber**
 - Flocculent ppt. settle down (removal is done time to time)
 - Clear water above goes for filtration
- **Filtration**
- **Remaining alum floc** - floc layer over sand bed, it holds back bacterias, oxidize organic matter
- **Back washing** - by air bubbles or water when floc layer becomes very thick

Rapid sand filtration



Difference between the two

Properties	Rapid sand filter	Slow sand filter
Area	Small area	Large area
Rate of filtration(L/m ² /hr)	200 mgad	2 mgad
Sand size (diameter)	0.4-0.7 mm	0.2-0.3 mm
Pretreatment	Coagulation & sedimentation	Sedimentation
Filter cleaning	Backwashing	Scraping
Operation	More skilled	Less skilled
Removal of colour	Good	Better
Removal of bacteria	98-99%	99.9%-99.99%

Disinfection

- Criteria for satisfactory disinfectant:
 - Destroy the pathogenic organism without being influenced from properties of water within a time period
 - Should not be toxic and colour imparting or leave the water impotable
 - Available, cheap, easy to use
 - Leave the residual concentration to deal with recontamination
 - Detectable by rapid, simple techniques in small concentration ranges to permit the control of disinfection process

Method of chlorination

- Chlorinating equipment (Paterson's chloronome) for adding gaseous chlorine
- Action:
 - Kills pathogenic bacteria (no effect on spores and viruses)
 - Oxidize iron, manganese and hydrogen sulphide
 - Reduces taste and odours
 - Controls algae
 - Maintains residual disinfection
- Mechanism of action:
 - $\text{H}_2\text{O} + \text{Cl}_2$ (at pH 7) \rightarrow $\text{HCl} + \text{HOCl}$ (main disinfectant)
 - HOCl (at pH > 8.5) \rightarrow $\text{H}^+ + \text{OCl}^-$ (minor action)
 - $\text{NH}_3 + \text{Cl}_2 \rightarrow \text{NH}_2\text{Cl} / \text{NHCl}_2 / \text{NCl}_3 + \text{H}_2\text{O}$ (Mono, Di, Tri Chloramines)

Principles of chlorination

1. Water should be clear, free from turbidity
2. Chlorine demand: Chlorine needed to destroy bacteria, to oxidize organic matter and to neutralize the ammonia in water
3. Free residual chlorine for a contact period of 1 hour is essential
4. Breakpoint: Point when chlorine demand of water is met and free residual chlorine appears
5. Breakpoint chlorination: Chlorination beyond the breakpoint . The principle of break point chlorination is to add sufficient chlorine so that 0.5 mg/L free residual chlorine is present in the water after one hour of contact time
6. Dose of Chlorine = Chlorine demand + Free residual chlorine

Tests to measure Residual Chlorine

- Ortho Tolidine Test, Yellow colour
 - In 10 seconds-free chlorine, In 15 min-both free and combined chlorine
- Ortho Tolidine Arsenite (OTA) Test
 - Yellow colour
 - Tests both free and combined chlorine separately
 - Yellow colour due to nitrites, iron, manganese are overcome by OTA test

Super chlorination

- Method of choice for highly polluted waters
- High dose of chlorine is added
- After 20 minutes of contact, dechlorination is done with sodium sulphate/ sodium thiosulphate to reduce the taste of excess chlorine

Other disinfection methods

- **Ozone**
 - Used in Europe and Canada
 - Strong oxidizing agent
 - Strong Virucidal
 - No residual effect
 - Should be used with chlorination
- **UV Rays**
 - Used in UK
 - Water should be clear
 - No residual effect
 - Expensive

AIR POLLUTION

Air pollution may be defined as the presence of any solid, liquid or gaseous substance including noise and radioactive radiation in the atmosphere in such concentration that may be directly and indirectly injurious to humans or other living organisms, plants, property or interferes with the normal environmental processes.

Causes of air pollution

a. Anthropogenic cause or human activity

1. Industrialization
2. Urbanization
3. Vehicles emission
4. Deforestation
5. Over population

b. Natural sources

1. Methane
2. Radon gas
3. Volcanic Activity

Air pollutants

Air pollutants are of two types

- 1.Primary pollutants
- 2.Secondary pollutants

1. Primary pollutants

Pollutants that are emitted directly from either natural events or from human activities are called primary pollutants. The natural events are dust storms; volcano etc and human activities can be emission from vehicles, industrial wastes.

About 90% of global air pollution is constituted by five primary pollutants. These are

1. Carbon oxides (CO and CO₂)
2. Nitrogen oxides
3. Sulphur oxides
4. Hydrocarbons
5. Particulate matter like Lead
6. Fibres

Pollutant	Source	Harmful effect
Carbon compound(CO and CO ₂)	Automobile exhaust, burning of wood and coal	1.Respiratory problem 2.Green house effect
Sulphur compounds(SO ₂ and H ₂ S)	Power plants and refineries, volcanic eruptions	1.Respiratory problems in humans 2.Loss of chlorophyll in plants (chlorosis) 3.Acid Rain
Nitrogen Compound (NO and N ₂ O)	Motor vehicle exhaust, atmospheric reaction	1. Irritation in eyes and lungs 2.Low productivity in plants 3.Acid rain damages material (metals and stone)
Hydrocarbons (benzene, ethylene)	Automobiles and petroleum industries	1.Respiratory problem 2.Cancer causing properties
SPM (Suspended Particulate Matter) (Any soild and liquid) particles suspended in the air, (flush, dust,lead)	Thermal power plants, Construction activities, metalurgical processes &automobiles	1.Poor visibility, breathing problems 2.Lead interfere with the development of red blood diseases and cancer, 3.Smog (smoke & fog) formation leads to poor visibility and aggravates asthma in patients
Fibres (Cotton, wool)	Textiles and carpet weaving industries.	Lungs disorder

2.Secondary pollutants

Primary pollutants when reacting with each other or from basic components of air; forms a new pollutants called secondary pollutant. For example – sulphuric acid, nitric acid, carbonic acid, etc.

Effects of Air Pollution

1. Acid rain is a rain or any other form of precipitation that is unusually acidic, meaning that it has elevated levels of hydrogen ions (low pH). It can have harmful effects on plants, aquatic animals and infrastructure. Acid rain is caused by emissions of sulphur dioxide and nitrogen oxide, which react with the water molecules in the atmosphere to produce acids.

2. Ozone layer depletion The stratosphere has an ozone layer which protects the earth's surface from excessive ultraviolet (UV) radiation from the Sun. Chlorine from chemicals

such as chlorofluorocarbons (CFCs) used for refrigeration, air conditioning, fire extinguishers, cleaning solvents, aerosols (spray cans of perfumes, medicine, insecticide) cause damage to ozone layer chlorine contained in the CFCs on reaching the ozone (O₃) layer split the ozone molecules to form oxygen (O₂). Amount of ozone, thus gets reduced and cannot prevent the entry of UV radiation. There has been a reduction of ozone umbrella or shield over the Arctic and Antarctic regions. This is known as **ozone hole**. This permits passage of UV radiation on earth's atmosphere which causes sunburn, cataract in eyes leading to blindness, skin cancer, reduced productivity of forests, etc.

3. Green House Effect and Global Warming

Atmospheric gases like carbon dioxide, methane, nitrous oxide, water vapour, and chlorofluorocarbons are capable of trapping the out-going infrared radiation from the earth. Infra-red radiations trapped by the earth's surface cannot pass through these gases and to increase thermal energy or heat in the atmosphere. Thus, the temperature of the global atmosphere is increased. As this phenomenon of increase in temperature is observed in green houses, in the botanical gardens these gases are known as green house gases and the heating effect is known as green house effect. If greenhouse gases are not checked, by the turn of the century the temperature may rise by 5 °C. This will melt the polar ice caps and increase the sea level leading to coastal flooding, loss of coastal areas and ecosystems like swamps and marshes, etc.

Prevention and control of air pollution

A.Prevention and control of indoor air pollution

Use of biogas, kerosene, CNG (Compressed Natural Gas) or electricity

B.Prevention and control of industrial pollution

(a)Use of cleaner fuels such as liquefied natural gas (LNG) in power plants, fertilizer plants etc.

(b)Employing environment friendly industrial processes so that emission of pollutants and hazardous waste is minimized.

c) Installing devices which reduce release of pollutants. Devices like filters, electrostatic precipitators, inertial collectors, scrubbers, gravel bed filters or dry scrubbers increasing the height of chimneys.

d) Closing industries which pollute the environment.

e) Shifting of polluting industries away from cities and heavily populated areas.

C. Control of vehicular pollution

- 1) Changing the type of fuel used to one that produces less pollution.
- 2) Removing inefficient and grossly polluting vehicles.
- 3) Adopting measures to clean the exhaust gases.
- 4) Strategies to reduce the lead in petrol
- 5) Use of motor vehicles working by electric current, battery, gas and encouraging people to use cycles and artificial vehicles working without fuels.

THANK YOU