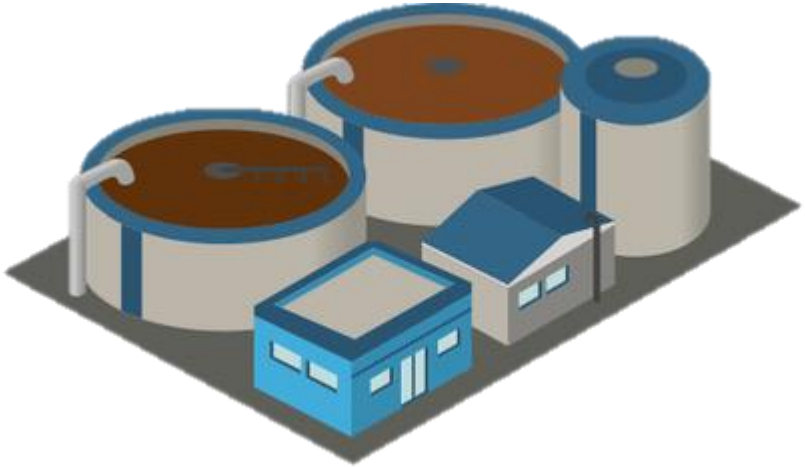
ENVIRONMENTAL SCIENCE

स्वच्छ भारत
एक कदम स्वच्छता की ओर

Tackling water pollution



Brajesh Kr Dubey, PhD

Professor -Environmental Engineering & Management
Department of Civil Engineering
Chairperson – School of Water Resources

Indian Institute of Technology Kharagpur

Topics covered

- Sources of water pollution
- Classification of water pollutants
- Typical flow schemes for sewage treatment plant
- Potable water quality requirements (IS 10500)
- Water quality index
- Overview of wastewater treatment plant

Definition

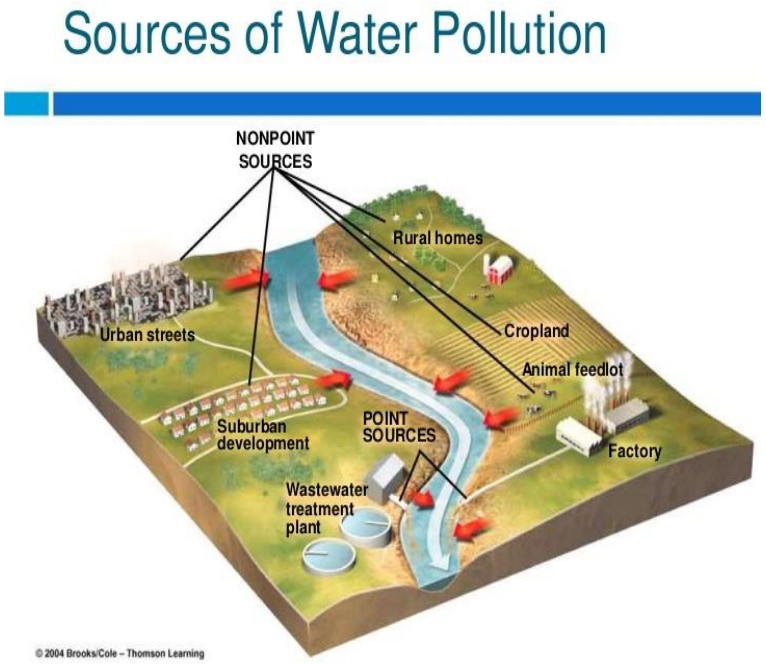
- Water pollution is any ***chemical, biological, or physical change in water quality*** that has a ***harmful effect*** on living organism or makes water unsuitable for desired uses.
- It has been suggested that it is the leading worldwide cause of deaths and diseases, and that it accounts for the ***deaths of more than 14,000 people daily***.

Source: https://www.google.co.in/url?sa=i&url=https%3A%2F%2Fblog.ipleaders.in%2Faspects-of-water-pollution%2F&psig=AOvVaw3Xs3vaW4RavlCPPgr_qRAw&ust=1610438806265000&source=images&cd=vfe&ved=0CAIQjRxqFwoTCOiUuqq2k-4CFQAAAAAdAAAAABAD

Sources of Water Pollution

Two chief sources of water pollution can be seen as ***POINT*** and ***NON-POINT***.

- POINT refer to the pollutants that ***belong to a single source***. An example of this would be emissions from factories into the water.
- NON-POINT on the other hand means ***pollutants emitted from multiple sources.*** Contaminated water after rains that has traveled through several regions may also be considered as a Non point source of pollution



https://www.slideshare.net/Gowthambe/water-pollutionandtreatment

Sources of Water Pollution

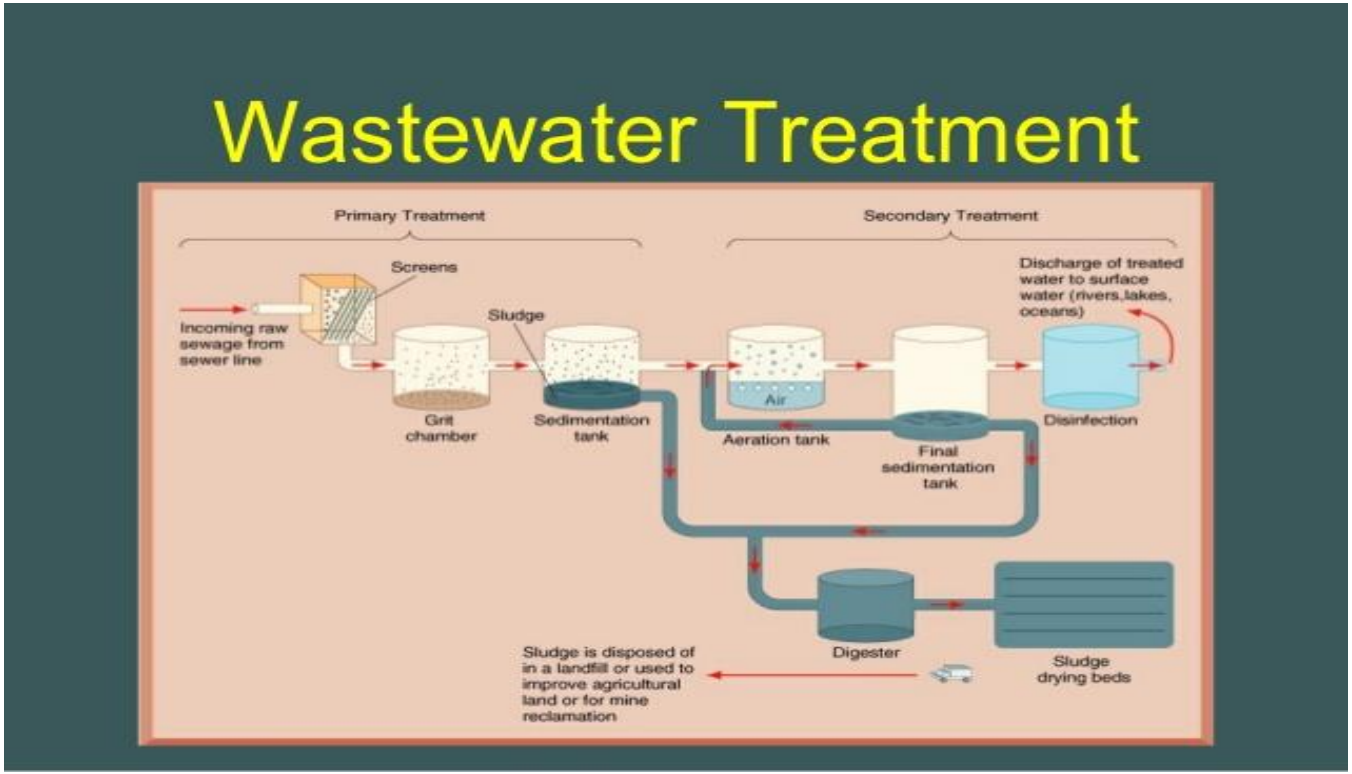
Source: https://www.google.co.in/url?sa=i&url=https%3A%2F%2Fwww.filterwater.com%2Ft-articles.waterpollution.aspx&psig=AOvVaw0WjjOoAWQb5oLNv5aqrSSL&ust=1608017756872000&source=images&cd=vfe&ved=0CAIQjRxqFwoTCKi8kZL7zO0CFQAAAAAdAAAAABAD

Classification of water pollutants

The various types of water pollutants can be classified in to following major categories:

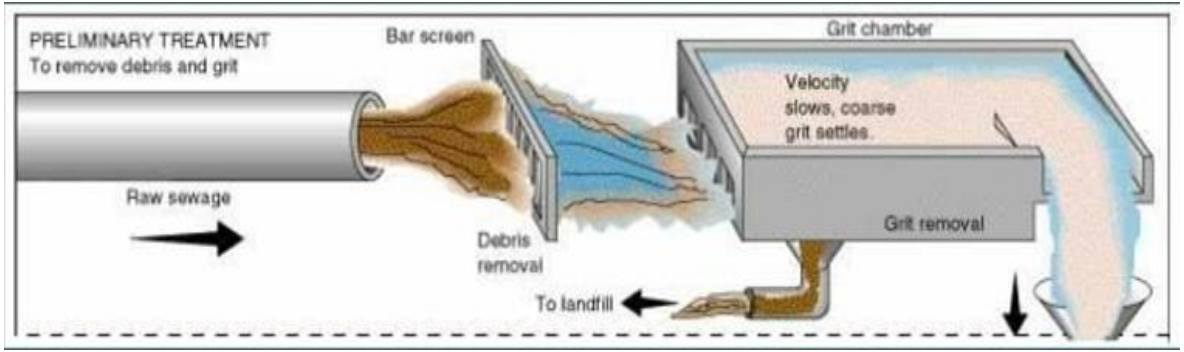
1) Organic pollutants
2) Pathogens
3) Nutrients and agriculture runoff
4) Suspended solids and sediments
5) Inorganic pollutants (salts and metals)
6) Thermal Pollution
7) Radioactive pollutants

Typical flow scheme for sewage treatment



Source: https://www.slideshare.net/GhassanHadi/waste-water-treatment-120127260

Preliminary Treatment



-Removes large objects and non-degradable materials

-Protects ***pumps and equipment from damage***

-Screening, grit chamber, Detritus tank, skimming tank and grit chamber.

Source: https://www.slideshare.net/GhassanHadi/waste-water-treatment-120127260

Preliminary Treatment

- **Screening** - removes ***floating materials***
- **Aerated grit chamber** - removes the ***grit particle***
- **Detritus tank** - removes the ***heavy suspended particle matter***
- **Skimming tank** - removes ***oil and grease***
- **Comminutors** - grinds the solid particles into ***small pieces***
- **Flotation units** - make to ***float the impurities*** to remove easily
- **Pre-aeration units** - to freshen the wastewater, remove gases, ***add oxygen***, promote flotation of grease, and aid coagulation

Screening

-very ***first operation*** carried out at a sewage treatment plant

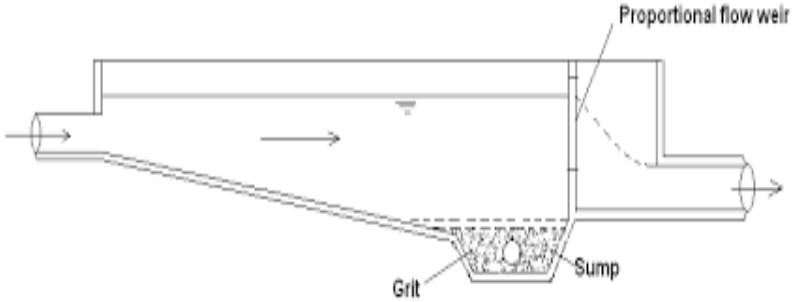
- to trap and ***remove the floating matter*** such as pieces of wood, cork, hair, fiber present in sewage.

Types of screen

- ❑Coarse screen - ***50mm or more***
- ❑Medium screen - ***6 to 40 mm***
- ❑Fine screen - ***1.5mm to 3mm***

Source: http://www.edwardsaquifer.net/waterrecycling.html

Grit chamber



-sedimentation basins placed in front of the wastewater treatment plant

- to ***remove the inorganic particle***(specific gravity about 2.65) such as sand, gravel, grit and other nonputresible materials

-may ***clog channels or damage pumps*** due to abrasion and to prevent their accumulation in sludge digesters.

Source: https://www.google.co.in/url?sa=i&url=http%3A%2F%2Feacharya.inflibnet.ac.in%2Fdata-server%2Feacharya-documents%2F55da9cb2e41301e54e2caeb7_INFIEP_206%2F4033%2FET%2F206-4033-ET-V1-S1__m15l19.pdf&psig=AOvVaw2KwVoS1ViT2MOXNoRp6uuo&ust=1607865914752000&source=images&cd=vfe&ved=0CAIQjRxqFwoTCJDCwr3FyO0CFQAAAAAdAAAAABAD

Discharge measuring device

- ***Parshall flume-*** a horizontally constricted vertical throat provided in a rectangular section.
- ***Proportional flow weir-*** a special shaped weir in which the flow through the weir is directly proportional to the head.
- ***Sutro weir-*** A dam with at least one curved side and horizontal crest, so formed that the head above the crest is directly proportional to the discharge.

https://instrumentationtools.com/weirs-and-flumes/

Primary Treatment

-It is a ***physical process***

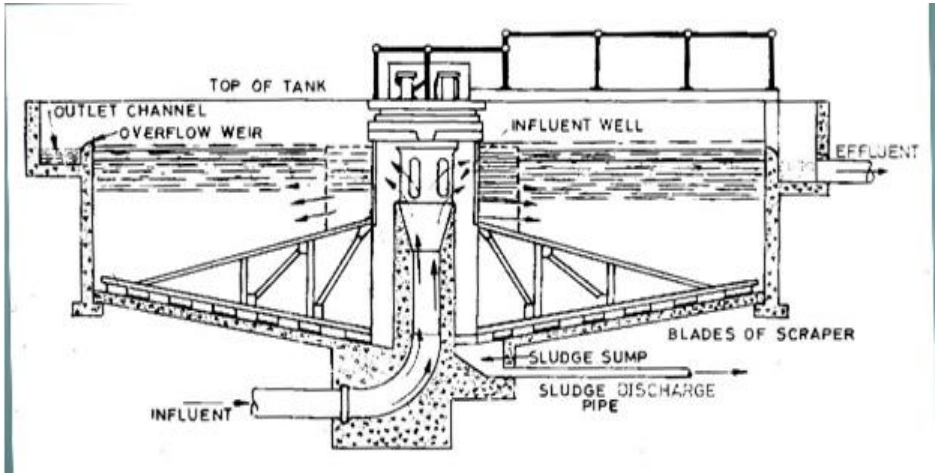
-It includes of rectangular or circular ***primary sedimentation tank*** / clarifier tank.

-to remove a ***part of the organic matter*** from the sewage effluent coming out from the grit chambers.

-Wastewater flow is slowed down and ***suspended solids settle to the bottom by gravity.***

-This sedimentation is carried out ***twice*** in the treatment process; once ***before*** the biological process and once ***after*** the biological process

Primary Treatment



Source: https://www.aboutcivil.org/sedimentation-tank-types

Secondary treatment

-It is a ***biological process***

-It is carried out by changing the ***character of the organic matter*** and thus converting it into ***stable forms like nitrates and sulphates*** by oxidation or nitrification.

-The ***colloidal organic matter***, which passes the primary treatment without settling there has to be removed further by this treatment

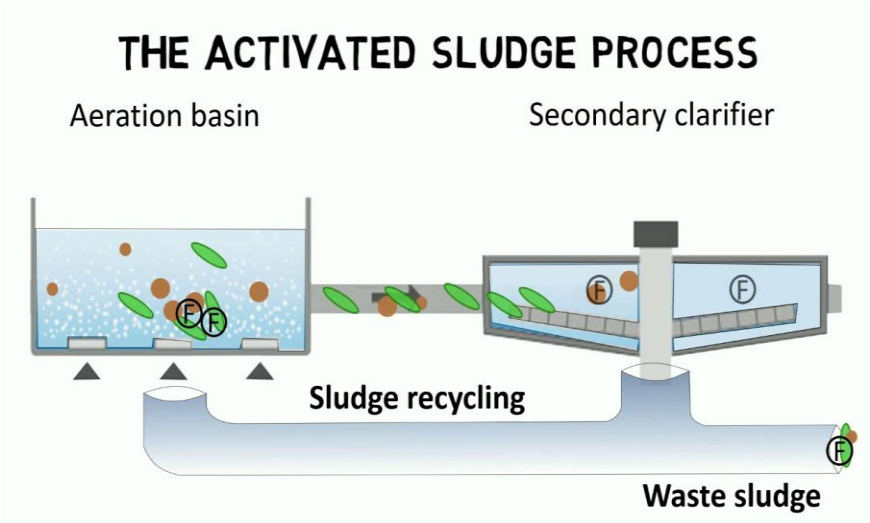
-It utilizes bacteria and algae to ***metabolize organic matter.***

-It involves ***aerobic and anaerobic*** process

Example: activated sludge process, trickling filter

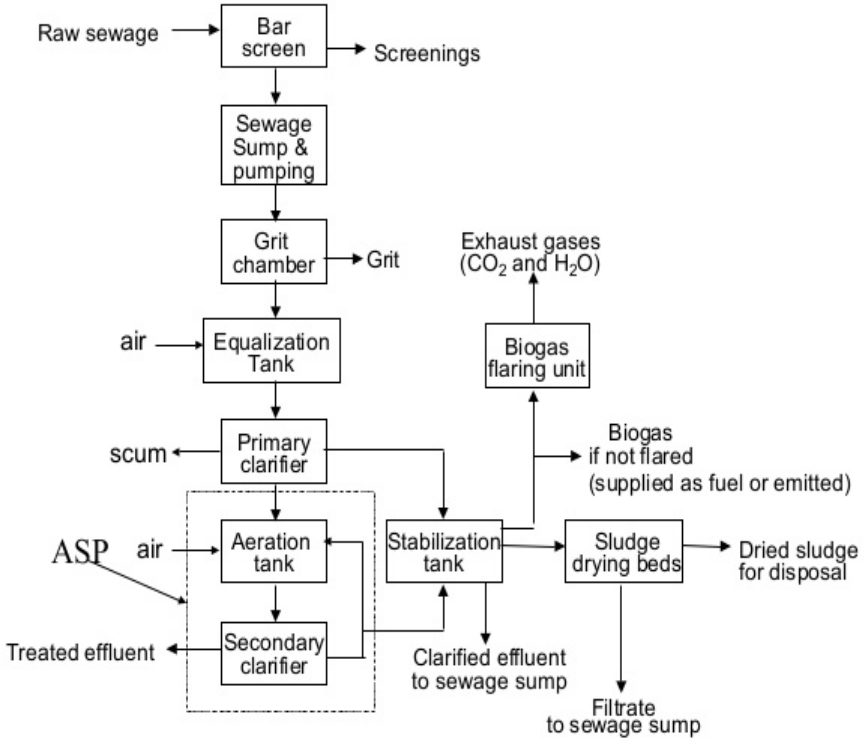
Activated Sludge Process

- It is an ***aerobic process, suspended growth*** and also a ***biological process***
- The ***mechanism*** involved for this process are substrate ***adsorption and utilization***
- The formed solids due to oxidation will be removed and the ***solids/liquid separation*** is taken place in the ***secondary clarifier***



Source:
https://www.google.co.in/url?sa=i&url=https%3A%2F%2Fwww.youtube.com%2Fwatch%3Fv%3DciPFC3Y2rkg&psig=AOvVaw1E1pGruzkgOTE8nYQL0uMh&ust=1608021116233000&source=images&cd=vfe&ved=0CAIQjRxqFwoTCPD5nNCHze0CFQAAAAAdAAAAABAJ

Activated Sludge Process



STP Incorporating ASP

Source: https://www2.slideshare.net/reddyas/activated-sludge-process-58957250?qid=5a57d3b9-8241-4d2c-8341-0b299cf8bb81&v=&b=&from_search=1

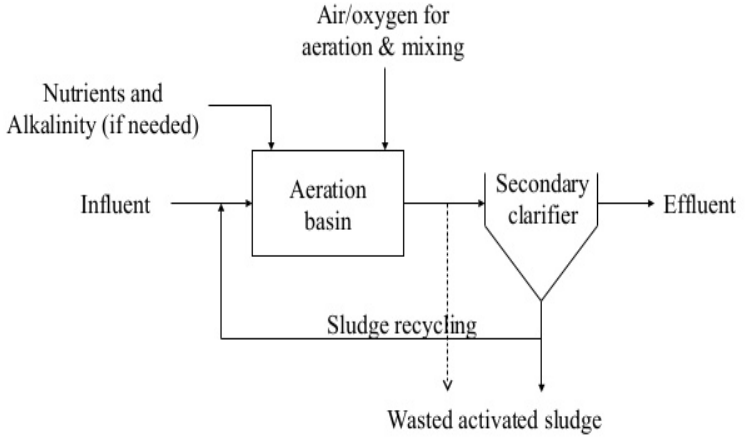
Activated Sludge Process

-The settled sludge containing micro-organism called ***activated sludge***, is recycled to the head of the aeration tank

-The effluent from the primary treatment which is mixed with ***20 to 30 %*** of ***own volume of activated sludge.***

-The mixture enters an ***aeration tank***, where the micro-organisms coated around the sludge solids and it is ***mixed with*** a large quantity of ***air*** for about ***4 to 8 hours.***

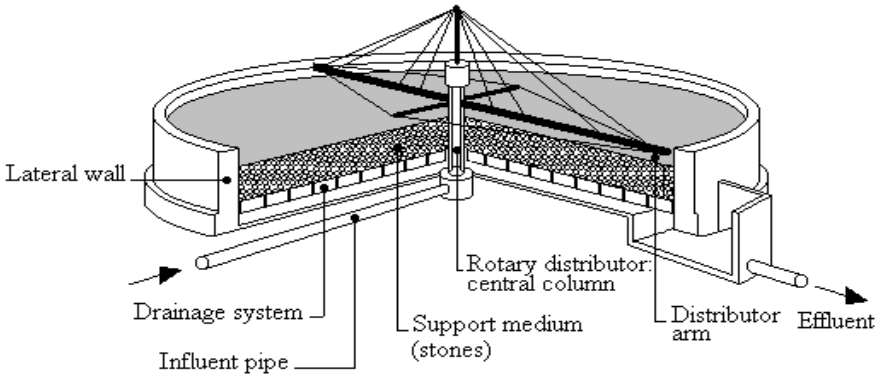
-The ***sludge gets settle*** in the secondary clarifier



Activated Sludge Process

Source: https://www2.slideshare.net/reddyas/activated-sludge-process-58957250?qid=5a57d3b9-8241-4d2c-8341-0b299cf8bb81&v=&b=&from_search=1

Trickling Filter



- It is a ***attached growth*** process and also ***aerobic process.***

-Alternate secondary wastewater treatment

-**Media:** Rock, slag, Plastic

-Biomass growing on the media uses organic matter along with a portion of the nitrogen and phosphorus to grow new microorganisms.

Source: https://www.researchgate.net/figure/Typical-configuration-and-main-parts-of-a-classic-trickling-filter-Figure-adapted-from_fig9_266736009

Oxidation ponds and aeration lagoons

-It is a ***suspended culture.***

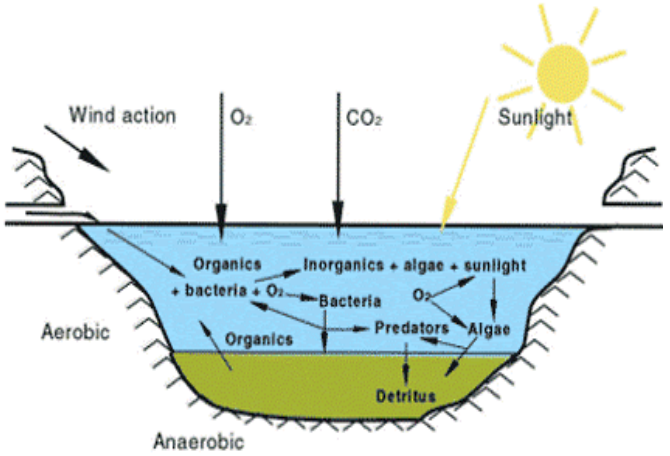
-It is a open flow-through ***earthen basins*** which has a ***longer detention period*** when compared with other treatment units.

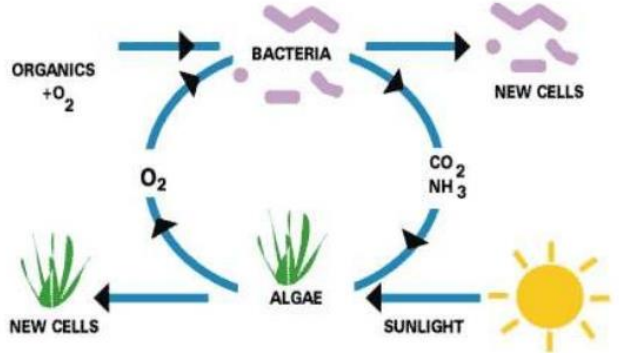
-I may be of ***aerobic, facultative or anaerobic*** process based on the climatic condition and the depth of the earthen basin

-It is most ***suitable*** for hot countries like ***India***

-This method very ***cheap and economical***

-Also has ***disadvantage of nuisance*** due to mosquito breeding and open flow





Source: https://www.slideshare.net/9021050570/oxidation-pond

Anaerobic Stabilization units

Anaerobic and facultative stabilization ponds- the ***deeper stabilization*** ponds, usually operating under the action of anaerobic bacteria.

Imhoff tank- ***improvement over septic tank*** in which the incoming sewage is not allowed to get mixed up with the sludge produced and the outgoing effluent is not allowed to carry with it large amount of organic load

Anaerobic contact process- contains a closed stirred tank reactor the biomass leaving with the reactor effluent is settled in a sedimentation tank and is recycled to the stirred tank, the ***sludge is entrapped in the void space*** between the packing material

Anaerobic Stabilization units

Anaerobic filter- wastewater is entered ***from the bottom to move up packing media***

UASB reactor – maintains a ***high concentration of biomass*** through the formation of highly settleable microbial sludge aggregates

Septic tank- generally called primary sedimentation tank for longer detention period of about ***12 to 36 hours***

Secondary Clarification

-It separates the ***suspended and biological solids*** from the liquid wastewater

-It removes the ***settable suspended solids*** created in biological treatment process

-The ***concentrated impurities*** discharged from the bottom of the tank are known as ***sludge***

-The two end product from this stage that are ***effluent and sludge***

Source: http://industrialgames247.blogspot.com/2016/04/secondary-clarifier.html

Sludge

-Sludge contains ***highly putrescible substances*** and ***pathogenic organism***

-It should be ***treated*** further for ***safe disposal***

-There are two types of sludge like raw sludge and secondary sludge

-**RAW SLUDGE** which are ***deposited in a primary sedimentation*** tank

-contains highly putrescible matter

-moisture content ***95%***

-**SECONDARY SLUDGE** which are ***deposited in a secondary clarifier***

-contains putrescible matter, but less objectionable compared to raw sludge

-moisture content ***96% - 98%***

Sludge Treatment

-Preliminary operation

-Sludge thickening

-Stabilization

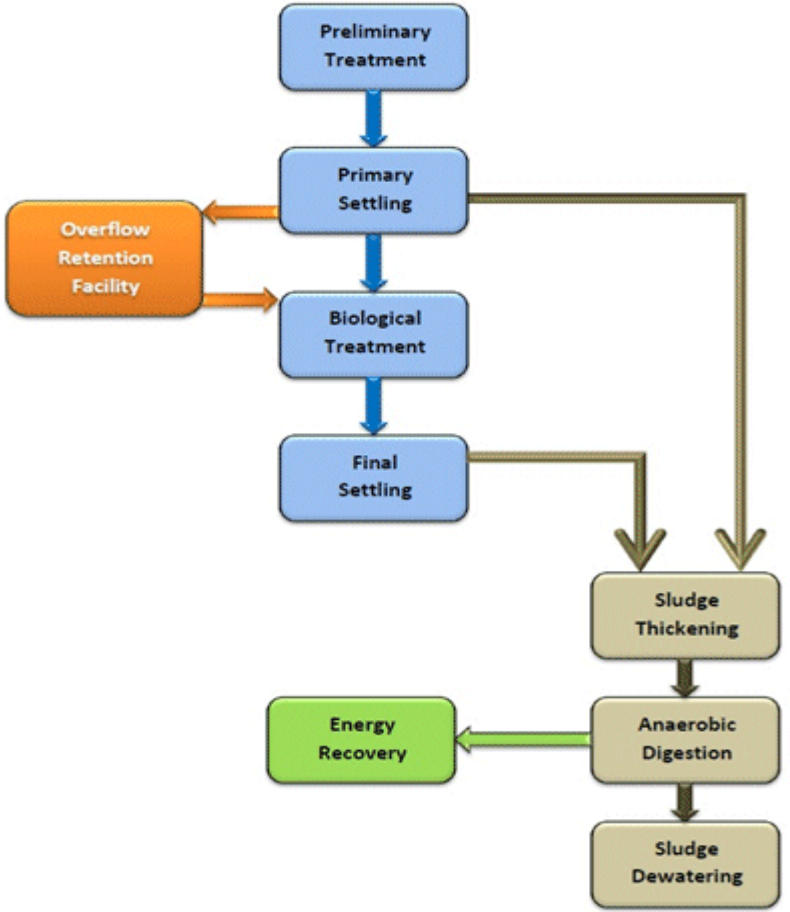
-conditioning

-Dewatering

-Heat drying

-Incineration

-Conveyance and storage



Sludge treatment

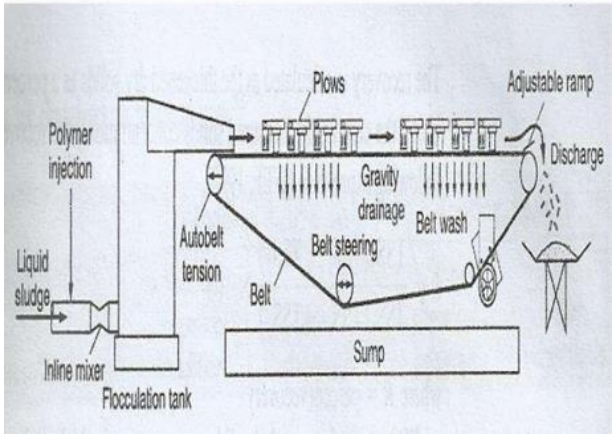
PRELIMINARY OPERATION

- ✓Grinding-Particle size reduction
- ✓Screening-Removal of fibrous material
- ✓De-gritting-Grit removal
- ✓Blending-Homogenization of solids streams
- ✓Storage- Flow equalization

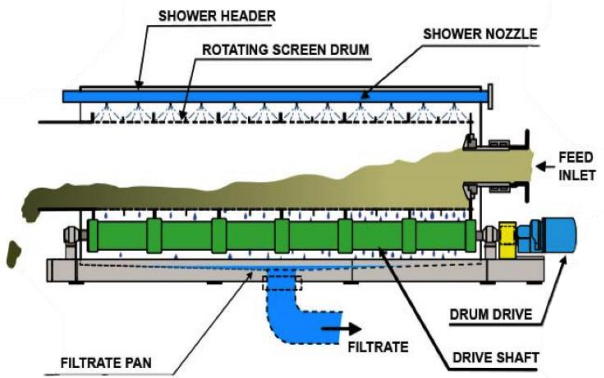
SLUDGE THICKENING -Volume reduction

- ✓Gravity thickening
- ✓Flotation thickening
- ✓Centrifugation
- ✓Gravity-belt thickening
- ✓Rotary-drum thickening

GRAVITY BELT THICKNING



ROTARY DRUM THICKENING



Source: https://viridis-engineering.com/solutions/water-treatment/rotary-drum-thickener/

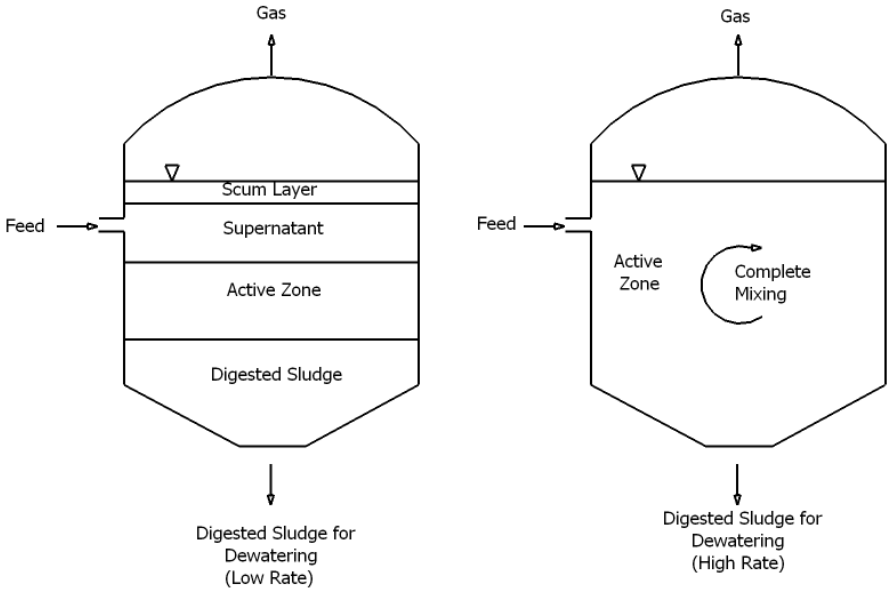
Sludge Treatment

STABILIZATION

- Alkaline stabilization - stabilization
- Anaerobic digestion - stabilization, mass reduction
- Aerobic digestion – stabilization, mass reduction
- Autothermal aerobic digestion – stabilization, mass reduction
- Composting – stabilization, product recovery

CONDITIONING

- Chemical conditioning - Improve de-waterability
- Other conditioning methods – Improve de-waterability



Sludge anaerobic Digestion

Source: https://sswm.info/step-nawatech/module-1-nawatech-basics/appropriate-technologies-0/anaerobic-digestion-of-sewage-sludge

Sludge Treatment

DEWATERING - ***Volume reduction***

- ❑Centrifuge
- ❑Belt-filter press
- ❑Filter press
- ❑Sludge drying beds
- ❑Reed beds
- ❑Lagoon

HEAT DRYING – ***weight and volume reduction***

- ❑Direct dryers
- ❑Indirect dryers

Sludge Treatment

INCINERATION -*volume reduction*

- Multiple-hearth incineration
- Fluidized-bed incineration
- Co-incineration with solid waste

CONVEYANCE AND STORAGE - *solid transport and storage*

Water Quality Index

It is defined as the ***rating, reflecting the composite influence*** of different water quality parameters on the overall quality of water.

OBJECTIVE: WQI is to ***turn the complex water quality data*** into information which is easily ***understandable and usable***.

-Can be used for specific (industrial, municipal, irrigational,ecological)

-Transforms the vast and complicated water quality data into a simple number that is easily understood by all

Water Quality Index (WQI)

-Water quality - measured by ***multitude of parameters***

- Organoleptic and physical parameters - 6
- General parameters - 25
- Toxic parameters - 10 categories: heavy metals (Hg, As, Cd and Ni), pesticide residues, PAH, PCBs, trihalomethanes, cyanides, & chromium-VI
- Radioactive parameters (Alpha emitters and Beta emitters)
- Bacteriological, virological and biological water quality parameters

-All parameters are not equally important, Units of measurement can be different, Ranges of values are different

-Too many parameters to monitor - prove costly, time and resource consuming, and require sophisticated labs

Calculation

-Select finite number of ***parameters*** and monitor ***water quality against the parameters***

-***Develop transformation functions/curves*** and use them to transform the monitored values into Environmental common scale units

-Assign relative importance values to the parameters and ***obtain weighted values*** to the parameters

-Aggregate the parameter values

- Take a) ***sum*** or b) ***average*** or c) ***geometric mean or combination*** of these

-Or use maximum operator or minimum operator

- Obtain sub-indices and aggregate the sub-indices into WQI

Transformation function or curves

Parameters	Concentration Range	Transformation Equation
pH	2.7 – 5.0	$y = 6.889x^2 - 40.00x + 57.79$
	5.0 – 7.5	$y = -10.66x^2 + 161.9x - 513.8$
	7.5 – 9.5	$y = -22.33x^2 + 346.3x - 1242.8$
	9.5 – 12.0	$y = 2.666x^2 - 69.33x + 448$
Conductivity	0 – 4500 (µS/cm)	$y = 8E\text{-}07x^2 - 0.025x + 104.1$
Turbidity	0-5 (NTU)	$y = 99.42e^{0.07x}$
	5-80 (NTU)	$y = -22.3\ln(x) + 102.9$
TDS	50 – 3000 (mg/L)	$y = 6E\text{-}06x^2 - 0.046x + 96.90$
Total Alkalinity	0-1000 (mg/L)	$y = 7E\text{-}05x^2 - 0.158x + 100.7$
Total Hardness	0-600 (mg/L)	$y = -35.1\ln(x) + 234.4$
Ammonical-N	0 – 2 (mg/L)	$y = -7x^2 - 1x + 100$
	2 – 40 (mg/L)	$y = -20.5\ln(x) + 84.61$
Nitrate-N	0 – 23 (mg/L)	$y = 0.161x^2 - 7.953x + 104.5$
Fluoride	0 – 1.5 (mg/L)	$y = -24x^2+16x+100$
	1.5 – 8.0 (mg/L)	$y = 105.61e^{-0.327x}$
Iron	0 – 30 (mg/L)	$y = -18.0\ln(x) + 70.32$
Chloride	0-1200 (mg/L)	$y = 7E\text{-}05x^2 - 0.157x + 99.60$
Sulfate	0-1000 (mg/L)	$y = 7E\text{-}05x^2 - 0.158x + 100.7$
Fecal Coliform	0 – 1000 (mpn/100ml)	$y = 80.702e^{-0.001x}$
	1000-100000 (mpn/100ml)	$y = -4.7772\ln(x) + 63$
Heavy metal conc. ratio	0 – 16	$y = 101.9e^{-0.15x}$
Pesticides and toxic organics conc. ratio	0 – 16	$y = 101.9e^{-0.15x}$

Source: https://www.slideshare.net/reddyas/01-water-quality

Relative Importance Values

S. No.	Parameters	Final weights
1	Fecal Coliform	0.134
2	Chloride	0.090
3	Fluoride	0.088
4	Turbidity	0.087
5	Nitrate-N	0.085
6	pH	0.083
7	TDS	0.079
8	Hardness	0.072
9	Iron	0.067
10	Ammonical-N	0.060
11	Alkalinity	0.054
12	Conductivity	0.051
13	Sulfate	0.050

Source: https://www.slideshare.net/reddyas/01-water-quality

Sample WQI Calculation scheme

Water quality parameter (i)	Monitored value of the parameter ($P_{i.Mon.}$)	Parameter value in CESU (P_{CESU}) at the scale of 0-1	Relative weight assigned to the parameter (W)	$P_{CESU} \times W$
1.	$P_{1.Mon.}$	$P_{1.CESU}$	W_1	$P_{1.CESU} \times W_1$
2.	$P_{2.Mon.}$	$P_{2.CESU}$	W_2	$P_{2.CESU} \times W_2$
...	...	...		...
I	$P_{i.Mon.}$	$P_{i.CESU}$	W_i	$P_{i.CESU} \times W_i$
...	...	...		...
N	$P_{n.Mon.}$	$P_{n.CESU}$	W_n	$P_{n.CESU} \times W_n$

$$SI_{cp} = \sqrt{\sum P_{CESU} \times W}$$

Source: https://www.slideshare.net/reddyas/01-water-quality

Water Quality Parameters

- Bacteriological, Virological and Biological requirements
- ***Bacteriological requirements*** (table-6 of IS 10500:2012)
  - MPN test for E. coli (or thermotolerant coliform bacteria)
- ***Virological requirements***
  - Enterovirus, Reovirus and Adinovirus PCR (Polymerase Chain Reaction) test method - Annex-B of IS 10500: 2012)
- ***Biological requirements***
  - Algae, Zoo plankton, Flagellates, Parasites and Toxin producing organisms.

Total Suspended Solids(TSS)

- Measured by ***gravimetry (mg/L)***
- Water is filtered through a filter paper - ***dry weight*** of the filtered out material is found (hot air oven at 100-105°C)
- Water sample and filtered water sample are ***hot air oven dried at 100-105°C*** and weight difference is taken as TSS
- ***Removed*** by gravity settling, ***filtration and flotation***
- Grit channels/chambers, aerated grit chambers, vortex type degritters and cyclone degritters
- Primary and secondary sedimentation tanks (and plate settlers and tube settlers)
- Filtration and membrane filtration
  - Slow sand filters/rapid gravity filters/pressure filters and/or roughing filters
  - Micro-filtration and ultra-filtration
- Flotation - microscopic air bubbles make the suspended flocs light and float - ***floating material*** is ***skimmed out***

Colloidal Solids

-Imparts ***turbidity*** and contributes to taste & odour

-***Measured*** by turbidimetry as ***NTU and JTU***

- NTU - light passing through the ***sample is scattered*** and the scattered light is measured - calibrated by turbidity standards
- JTU - a white disc is dipped in water ***uptill that depth*** at which it disappears - scattering results in attenuation of light

-***Removed*** by coagulation-flocculation-settling

- Using ***coagulating agents*** (alum, ferrous sulfate, etc .) the colloids are destabilized
- ***Destabilized colloidal particles*** are transformed into suspended floes - flocculating agents (polyelectrolites) are used
- Zeta meter is used to measure the level of stability of the colloidal particles

-***Removal*** by ***electrocoagulation/electro flocculation***

-***Slow sand filters*** also reduce the ***turbidity***

Total Dissolved Solids(TDS)

- ***Measured*** directly by ***gravimetry*** and indirectly through conductivity measurement
- Gravimetric measurement involves hot air oven drying of t he filtered water sample
- ***Drying*** at ***100-105° C*** for dissolved solids and at ***180°C*** for dissolved salts
- Estimation through conductivity measurement involves use of a multiplying factor
- TDS ***removal*** or reduction can be by
- ***Ion exchange process***
  - Demineralization, dealkalization and water softening
- ***Membrane process***
  - RO process and Nanofiltration
- ***Distillation process*** (vacuum evaporation and condensation)
  - Solar water stills

Biological Water Quality Requirements

-Water samples should ***test negative for E.coli*** or thermo tolerant coliform bacteria in 100 ml sample

-Over 12 months ***95% of the samples*** from a distribution system must ***test negative***

-Rest ***5%*** of the samples should have the ***MPN <10/100*** ml

-In case of positive test results

- Resample to confirm the results
- Immediately investigate and discover the source of contamination and recommend removal of the source of contamination

-MPN testing - ***IS 162 2: 1981***- Methods of sampling and microbial examination of water

-All samples of a water distribution system should be free from enterovirus, reovirus and adinovirus

-Water should be ***free from algae, zooplankton, flagellates***, parasites and toxin producing organisms.

Treatment for Biological Water Quality

-Treatment for ***bacteriological*** requirements

- Disinfection by ***chlorination***, ***ozonation***, and ***UV radiation***

-Treatment for ***virological*** requirements

- Enterovirus is resistant to chlorine - however ***virus inactivation rate*** and redox potential are ***exponentially related***
  - Redox potential of 650 mV can instantaneously inactivate

-Treatment for ***biological*** requirements

- ***Chlorination*** at typical doses may be ***ineffective*** but ***conventional flocculation and filtration can prove effective***

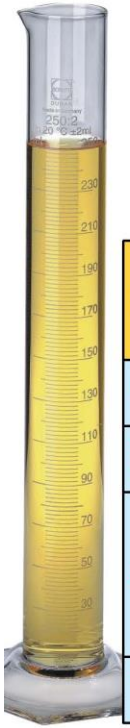
-Membrane filtration (ultrafiltration), slow sand filtration,and coagulation-flocculation and settling can also ***prove effective*** for bacteriological and biological water quality

Heavy Metals

- ***Sources***- industrial processes, mining and mineral processing, contaminated ground water
- Metals having toxicity, and metals with SG > ***4 to 5***
  - Aluminium, arsenic, cadmium, chromium, lead, mercury, nickel, selenium, strontium, zinc, etc.
  - Bioaccumulation and toxicity - ***affecting nervous system*** and kidneys, carcinogenic & mutagenic
- Sample preparation ***and analysis by flame photometer***, AAS and ICP (mg/L as the metal)
- Neutralization and precipitation (as hydroxide and/or sulfides}, and settling/filtration
  - ***Ion exchange process*** and ***membrane processes (RO)*** can also ***remove*** the heavy metals

Water Quality Standard

Water Quality Standard



Colour, Hazen Units	
IS 10500-2012	Desirable : 5 Hz. , Permissible : 25 Hz.
Risks or effects	Visible tint, acceptance decreases
Sources	Tannins, Iron, Copper, Manganese Natural deposits
Treatment	Filtration, Distillation, Reverse osmosis, Ozonisation

Source: https://www.slideshare.net/indiawaterportal/water-quality-standard-indian-standard-drinking-water-specification-is-10500-1991

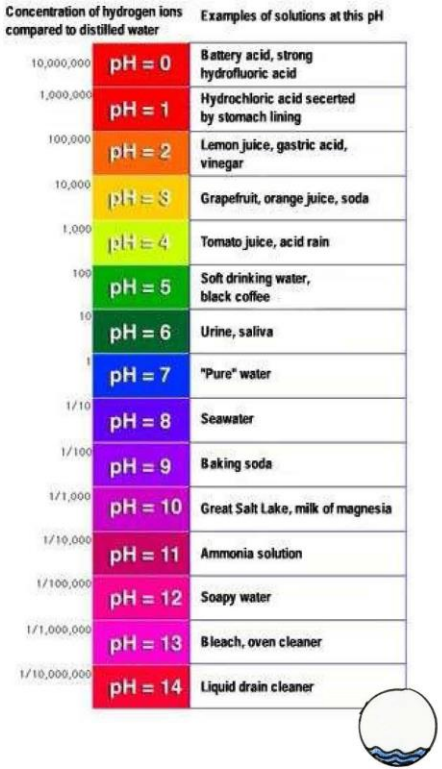
Water Quality Standard

ODOUR	
IS 10500-2012	Unobjectionable
Risks or effects	Rotten egg, Musty, Chemical
Sources	Chlorine, Hydrogen sulphide, Organic matter, Septic contamination, Methane gas
Treatment	Activated carbon, Air stripping, oxidation, Filtration

Source: https://www.slideshare.net/indiawaterportal/water-quality-standard-indian-standard-drinking-water-specification-is-10500-1991

Water Quality Standard

pH	
IS 10500-2012	Desirable :6.5 – 8.5, Permissible :No relaxation
Risks or effects	Low pH - corrosion, metallic taste High pH – bitter/soda taste, deposits
Sources	Natural
Treatment	Increase pH by soda ash Decrease pH with white vinegar / citric acid



Source: https://www.slideshare.net/indiawaterportal/water-quality-standard-indian-standard-drinking-water-specification-is-10500-199

Water Quality Standard

Total Dissolved Solids (TDS)	
IS 10500-2012	Desirable : 500 mg/l , Permissible : 2000 mg/l
Risks or effects	Hardness, scaly deposits, sediment, cloudy colored water, staining, salty or bitter taste, corrosion of pipes and fittings
Sources	Livestock waste, septic system Landfills, nature of soil Hazardous waste landfills Dissolved minerals, iron and manganese
Treatment	Reverse Osmosis, Distillation, deionization by ion exchange

Source: https://www.slideshare.net/indiawaterportal/water-quality-standard-indian-standard-drinking-water-specification-is-10500-1991

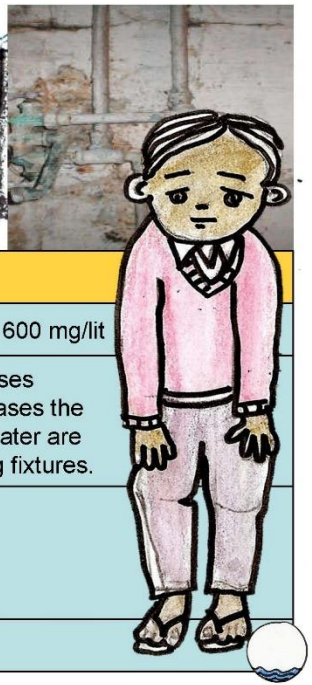
Water Quality Standard

Hardness	
IS 10500-2012	Desirable :300 mg/l , Permissible : 600 mg/l
Risks or effects	Scale in utensils and hot water system, soap scums
Sources	Dissolved calcium and magnesium from soil and aquifer minerals containing limestone or dolomite
Treatment	Water Softener Ion Exchanger , Reverse Osmosis

http://www.portatreatment.com/yours.htm

Source: https://www.slideshare.net/indiawaterportal/water-quality-standard-indian-standard-drinking-water-specification-is-10500-1991

Water Quality Standard



Alkalinity	
IS 10500- 2012	Desirable : 200 mg/l , Permissible : 600 mg/lit
Risks or effects	Low Alkalinity (i.e. high acidity) causes deterioration of plumbing and increases the chance for many heavy metals in water are present in pipes, solder or plumbing fixtures.
Sources	Pipes, landfills Hazardous waste landfills
Treatment	Neutralizing agent

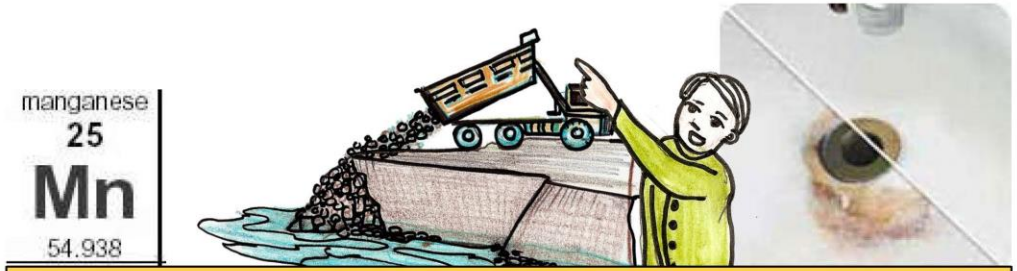
Source: https://www.slideshare.net/indiawaterportal/water-quality-standard-indian-standard-drinking-water-specification-is-10500-1991

Water Quality Standard

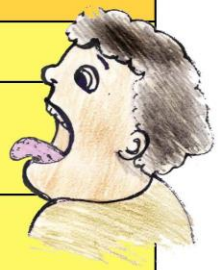
Iron	
IS 10500-2012	Desirable : 0.3 mg/l , Permissible : 1.0 mg/l
Risks or effects	Brackish color, rusty sediment, bitter or metallic taste, brown-green stains, iron bacteria, discolored beverages
Sources	Leaching of cast iron pipes in water distribution systems Natural
Treatment	Oxidizing Filter , Green-sand Mechanical Filter

Source: https://www.slideshare.net/indiawaterportal/water-quality-standard-indian-standard-drinking-water-specification-is-10500-1991

Water Quality Standard



Manganese	
IS 10500-2012	Desirable : 0.1 mg/l , Permissible : 0.3 mg/l
Risks or effects	Brownish color, black stains on laundry and fixtures at .2 mg/l, bitter taste, altered taste of water-mixed beverages
Sources	Landfills Deposits in rock and soil
Treatment	Ion Exchange , Chlorination, Oxidizing Filter , Green-sand Mechanical Filter



Source: https://www.slideshare.net/indiawaterportal/water-quality-standard-indian-standard-drinking-water-specification-is-10500-1991

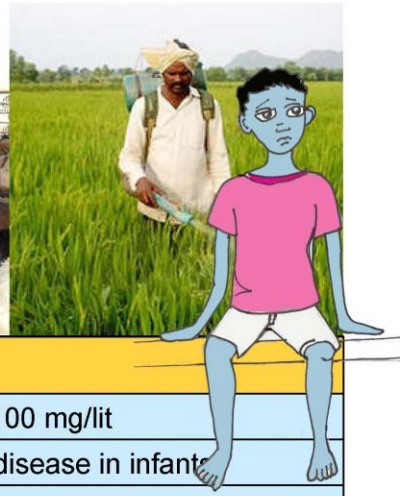
Water Quality Standard

Sul phat e	
IS 10500-2012	Desirable : 200 mg/l, Permissible : 400 mg/l
Risks or effects	Bitter, medicinal taste, scaly deposits, corrosion, laxative effects, "rotten-egg" odour from hydrogen sulphide gas formation
Sources	Animal sewage, septic system, sewage By-product of coal mining, industrial waste Natural deposits or salt
Sulphate Treatment	Ion Exchange , Distillation , Reverse Osmosis

Source: https://www.slideshare.net/indiawaterportal/water-quality-standard-indian-standard-drinking-water-specification-is-10500-1991

Water Quality Standard

NO_{3-}



Nitrate	
IS 10500-2012	Desirable : 45 mg/l, Permissible : 100 mg/lit
Risks or effects	Methemoglobinemia or blue baby disease in infants
Sources	Livestock facilities, septic systems, manure lagoons, Household waste water, Fertilizers, Natural Deposits,
Treatment	Ion Exchange, Distillation, Reverse Osmosis

Source: https://www.slideshare.net/indiawaterportal/water-quality-standard-indian-standard-drinking-water-specification-is-10500-1991

Water Quality Standard

Cl	
Chl or i de	
IS 10500-2012	Desirable : 250 mg/l , Permissible : 1000 mg/l
Risks or effects	High blood pressure, salty taste, corroded pipes, fixtures and appliances, blackening and pitting of stainless steel
Sources	Fertilizers Industrial wastes Minerals, seawater
Treatment	Reverse Osmosis , Distillation, Activated Carbon

Source: https://www.slideshare.net/indiawaterportal/water-quality-standard-indian-standard-drinking-water-specification-is-10500-1991

Water Quality Standard

Fluoride	
IS 10500-2012	Desirable : 1.0 mg/l, Permissible : 1.5 mg/l
Risks or effects	Brownish discoloration of teeth, bone damage
Sources	Industrial waste Geological
Treatment	Activated Alumina, Distillation, Reverse Osmosis, Ion Exchange

Source: https://www.slideshare.net/indiawaterportal/water-quality-standard-indian-standard-drinking-water-specification-is-10500-1991

Water Quality Standard

Arsenic	
IS:10500-2012	Desirable: 0.05 mg/l Permissible: No relaxation
Risks or effects	Weight loss; Depression; Lack of energy; Skin and nervous system toxicity
Sources	Previously used in pesticides (orchards) Improper waste disposal or product storage of glass or electronics, Mining Rocks
Treatment	Activated Alumina Filtration, Reverse Osmosis, Distillation, Chemical Precipitation, Ion exchange, lime softening

Source: https://www.slideshare.net/indiawaterportal/water-quality-standard-indian-standard-drinking-water-specification-is-10500-1991

Water Quality Standard

Chromium	
IS 10500-2012	Desirable : 0.05 mg/l, Permissible : No relaxation
Risks or effects	Skin irritation, skin and nasal ulcers, lung tumors, gastrointestinal effects, damage to the nervous system and circulatory system, accumulates in the spleen, bones, kidney and liver
Sources	Septic systems Industrial discharge, mining sites Geological
Treatment	Ion Exchange, Reverse Osmosis, Distillation

Source: https://www.slideshare.net/indiawaterportal/water-quality-standard-indian-standard-drinking-water-specification-is-10500-1991

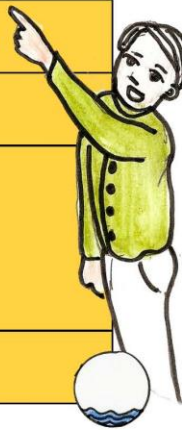
Water Quality Standard

Copper	
IS 10500-2012	Desirable : 0.05 mg/l, Permissible : 1.5 mg/l
Risks or effects	Anemia, digestive disturbances, liver and kidney damage, gastrointestinal irritations, bitter or metallic taste; Blue-green stains on plumbing fixtures
Sources	Leaching from copper water pipes and tubing, algae treatment Industrial and mining waste, wood preservatives Natural deposits
Treatment	Ion Exchange, Reverse Osmosis, Distillation

Source: https://www.slideshare.net/indiawaterportal/water-quality-standard-indian-standard-drinking-water-specification-is-10500-1991

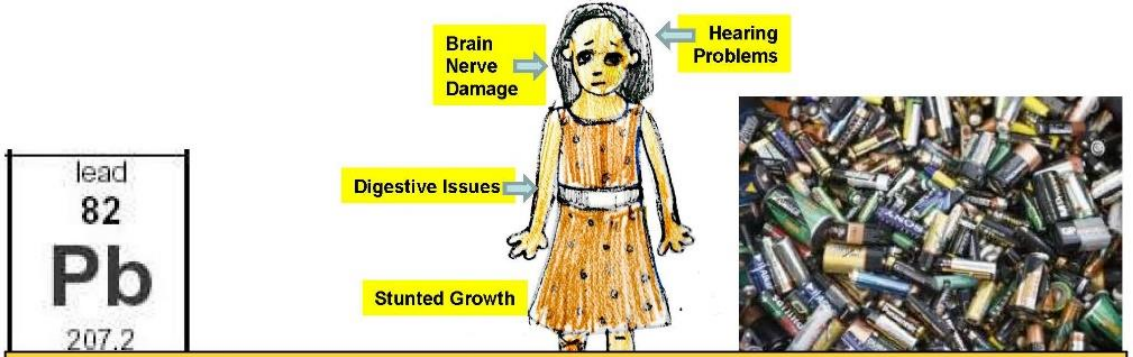
Water Quality Standard

Cyani de	
IS 10500-2012	Desirable : 0.05 mg/l, Permissible : No relaxation
Risks or effects	Thyroid, nervous system damage
Sources	Fertilizer Electronics, steel, plastics mining
Treatment	Ion Exchange, Reverse Osmosis, Chlorination



Source: https://www.slideshare.net/indiawaterportal/water-quality-standard-indian-standard-drinking-water-specification-is-10500-1991

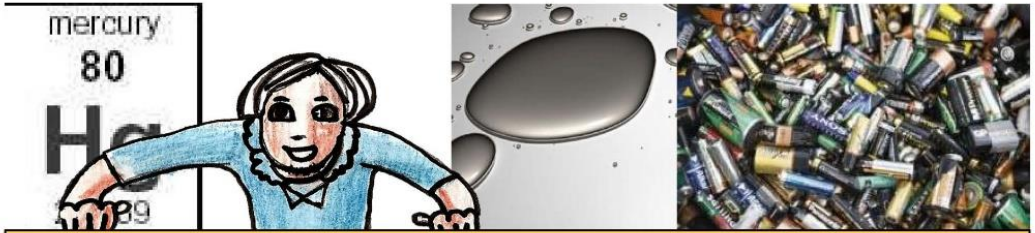
Water Quality Standard



Lead	
IS 10500-2012	Desirable : 0.05 mg/l, Permissible : No relaxation
Risks or effects	Reduces mental capacity (mental retardation), interference with kidney and neurological functions, hearing loss, blood disorders, hypertension, death at high levels
Sources	Paint, diesel fuel combustion Pipes and solder, discarded batteries, paint, leaded gasoline Natural deposits
Treatment	Ion Exchange, Activated Carbon , Reverse Osmosis, Distillation

Source: https://www.slideshare.net/indiawaterportal/water-quality-standard-indian-standard-drinking-water-specification-is-10500-1991

Water Quality Standard



Mercury	
IS 10500-2012	Desirable : 0.001 mg/l, Permissible : No relaxation
Risks or effects	Loss of vision and hearing, intellectual deterioration, kidney and nervous system disorders, death at high levels
Sources	Fungicides Batteries, fungicides Mining, electrical equipment, plant, paper and vinyl chloride Natural deposits
Treatment	Reverse Osmosis, Distillation

Source: https://www.slideshare.net/indiawaterportal/water-quality-standard-indian-standard-drinking-water-specification-is-10500-1991

Water Quality Standard

zinc
30
Zn
65.39

Zi nc	
IS 10500-2012	Desirable :5 mg/l, Permissible : 15 mg/l
Risks or effects	Metallic taste
Sources	Leaching of galvanized pipes and fittings, paints, dyes Natural deposits
Treatment	Ion Exchange Water Softeners, Reverse Osmosis, Distillation

Source: https://www.slideshare.net/indiawaterportal/water-quality-standard-indian-standard-drinking-water-specification-is-10500-1991

Water Quality Standard



Total Coliform Bacteria	
IS 10500-2012	95% of samples should not contain coliform in 100 ml 10 coliform / 100ml
Risks or effects	Gastrointestinal illness
Sources	Livestock facilities, septic systems, manure lagoons Household waste water Naturally occurring
Treatment	Chlorination , Ultraviolet, Distillation, Iodination

Source: https://www.slideshare.net/indiawaterportal/water-quality-standard-indian-standard-drinking-water-specification-is-10500-1991

Water Quality Standard

E. coli form Bacteria	
IS 10500-2012	Nil / 100ml
Risks or effects	Gastrointestinal illness
Sources	Livestock facilities, septic systems, manure lagoons Household waste water Naturally occurring
Treatment	Chlorination , Ultraviolet, Distillation, Iodination

Source: https://www.slideshare.net/indiawaterportal/water-quality-standard-indian-standard-drinking-water-specification-is-10500-1991

Health Effects of Chemical Parameters

Parameter	BIS Guideline value (maximum allowable)	General & Health effect
Total dissolved solids	2000 mg/L	Undesirable taste; gastro intestinal irritations; corrosion or incrustation
PH	6.5-8.5	Affects mucous membrane; bitter taste; corrosion; affects aquatic life
Alkalinity	600 mg/L	Boiled rice turns yellowish
Hardness	600 mg/L	Poor lathering with soap; deterioration of the quality of clothes; scale forming; skin irritation; boiled meat and food become poor in quality
Calcium	200	Poor lathering and deterioration of the quality of clothes; incrustation in pipes; scale formation
Magnesium	100	Poor lathering and deterioration of clothes; with sulfate laxative
Iron	1.0	Poor or sometimes bitter taste, color and turbidity; staining of clothes materials; iron bacteria causing slime
Manganese	0.3	Poor taste, color and turbidity; staining; black slime

Source: https://www.slideshare.net/indiawaterportal/water-quality-standard-indian-standard-drinking-water-specification-is-10500-1991

Health Effects of Chemical parameters

Parameter	BIS Guideline value (maximum allowable)	General & Health effect
Aluminum	0.2	Neurological disorders; Alzheimer's disease
Copper	1.5	Liver damage; mucosal irritation, renal damage and depression; restricts growth of aquatic plants
Zinc	15	Astringent taste; opalescence in water; gastro intestinal irritation; vomiting, dehydration, abdominal pain, nausea and dizziness
Ammonia	-	Indicates pollution; growth of algae
Nitrite	-	Forms nitrosoamines which are carcinogenic
Nitrate	100	Blue baby disease (methemoglobineamia); algal growth
Sulfate	400	Taste affected; laxative effect; gastro intestinal irritation
Chloride	1000	Taste affected; corrosive
Fluoride	1.5	Dental and skeletal fluorosis; non-skeletal

Source: https://www.slideshare.net/indiawaterportal/water-quality-standard-indian-standard-drinking-water-specification-is-10500-1991

Health Effects of Chemical Parameters

Parameter	BIS Guideline value (maximum allowable)	General & Health effect
Phosphate	-	Algal growth
Arsenic	0.05	Toxic; bio-accumulation; central nervous system affected; carcinogenic
Mercury	0.001	Highly toxic; causes 'minamata' disease-neurological impairment and renal disturbances; mutagenic
Cadmium	0.01	Highly toxic; causes 'itai-itai' disease-painful rheumatic condition; cardio vascular system affected; gastro intestinal upsets and hyper tension
Lead	0.05	Causes plumbism-tiredness, lassitudes, abdominal discomfort, irritability, anaemia; bio-accumulation; impaired neurological and motor development, and damage to kidneys
Chromium	0.05	Carcinogenic; ulcerations, respiratory problems and skin complaints
Pesticide	0.001	Affects central nervous system
Detergent	-	Undesirable foaming

Source: https://www.slideshare.net/indiawaterportal/water-quality-standard-indian-standard-drinking-water-specification-is-10500-1991

IS 10500:2012

Table 1 Organoleptic and Physical Parameters

(*Foreword* and *Clause* 4)

Sl No.	Characteristic	Requirement (Acceptable Limit)	Permissible Limit in the Absence of Alternate Source	Method of Test, Ref to Part of IS 3025	Remarks
(1)	(2)	(3)	(4)	(5)	(6)
i)	Colour, Hazen units, *Max*	5	15	Part 4	Extended to 15 only, if toxic substances are not suspected in absence of alternate sources
ii)	Odour	Agreeable	Agreeable	Part 5	a) Test cold and when heated b) Test at several dilutions
iii)	*p*H value	6.5-8.5	No relaxation	Part 11	—
iv)	Taste	Agreeable	Agreeable	Parts 7 and 8	Test to be conducted only after safety has been established
v)	Turbidity, NTU, *Max*	1	5	Part 10	—
vi)	Total dissolved solids, mg/l, *Max*	500	2 000	Part 16	—

NOTE — It is recommended that the acceptable limit is to be implemented. Values in excess of those mentioned under 'acceptable' render the water not suitable, but still may be tolerated in the absence of an alternative source but up to the limits indicated under 'permissible limit in the absence of alternate source' in col 4, above which the sources will have to be rejected.

Source: https://law.resource.org/pub/in/bis/S06/is.10500.2012.pdf

IS 10500:2012

Table 2 General Parameters Concerning Substances Undesirable in Excessive Amounts

(*Foreword* and *Clause* 4)

Sl No.	Characteristic	Requirement (Acceptable Limit)	Permissible Limit in the Absence of Alternate Source	Method of Test, Ref to	Remarks
(1)	(2)	(3)	(4)	(5)	(6)
i)	Aluminium (as Al), mg/l, *Max*	0.03	0.2	IS 3025 (Part 55)	—
ii)	Ammonia (as total ammonia-N), mg/l, *Max*	0.5	No relaxation	IS 3025 (Part 34)	—
iii)	Anionic detergents (as MBAS) mg/l, *Max*	0.2	1.0	Annex K of IS 13428	—
iv)	Barium (as Ba), mg/l, *Max*	0.7	No relaxation	Annex F of IS 13428* or IS 15302	—
v)	Boron (as B), mg/l, *Max*	0.5	1.0	IS 3025 (Part 57)	—
vi)	Calcium (as Ca), mg/l, *Max*	75	200	IS 3025 (Part 40)	—
vii)	Chloramines (as Cl_2), mg/l, *Max*	4.0	No relaxation	IS 3025 (Part 26)* or APHA 4500-Cl G	—
viii)	Chloride (as Cl), mg/l, *Max*	250	1 000	IS 3025 (Part 32)	—
ix)	Copper (as Cu), mg/l, *Max*	0.05	1.5	IS 3025 (Part 42)	—
x)	Fluoride (as F) mg/l, *Max*	1.0	1.5	IS 3025 (Part 60)	—
xi)	Free residual chlorine, mg/l, *Min*	0.2	1	IS 3025 (Part 26)	To be applicable only when water is chlorinated. Tested at consumer end. When protection against viral infection is required, it should be minimum 0.5 mg/l
xii)	Iron (as Fe), mg/l, *Max*	0.3	No relaxation	IS 3025 (Part 53)	Total concentration of manganese (as Mn) and iron (as Fe) shall not exceed 0.3 mg/l
xiii)	Magnesium (as Mg), mg/l, *Max*	30	100	IS 3025 (Part 46)	—

Source: https://law.resource.org/pub/in/bis/S06/is.10500.2012.pdf

IS 10500:2012

xiv)	Manganese (as Mn), mg/l, *Max*	0.1	0.3	IS 3025 (Part 59)	Total concentration of manganese (as Mn) and iron (as Fe) shall not exceed 0.3 mg/l
xv)	Mineral oil, mg/l, *Max*	0.5	No relaxation	Clause **6** of IS 3025 (Part 39) Infrared partition method	—
xvi)	Nitrate (as NO_3), mg/l, *Max*	45	No relaxation	IS 3025 (Part 34)	—
xvii)	Phenolic compounds (as C_6H_5OH), mg/l, *Max*	0.001	0.002	IS 3025 (Part 43)	—
xviii)	Selenium (as Se), mg/l, *Max*	0.01	No relaxation	IS 3025 (Part 56) or IS 15303*	—
xix)	Silver (as Ag), mg/l, *Max*	0.1	No relaxation	Annex J of IS 13428	—
xx)	Sulphate (as SO_4) mg/l, *Max*	200	400	IS 3025 (Part 24)	May be extended to 400 provided that Magnesium does not exceed 30
xxi)	Sulphide (as H_2S), mg/l, *Max*	0.05	No relaxation	IS 3025 (Part 29)	—
xxii)	Total alkalinity as calcium carbonate, mg/l, *Max*	200	600	IS 3025 (Part 23)	—
xxiii)	Total hardness (as $CaCO_3$), mg/l, *Max*	200	600	IS 3025 (Part 21)	—
xxiv)	Zinc (as Zn), mg/l, *Max*	5	15	IS 3025 (Part 49)	—

NOTES

1 In case of dispute, the method indicated by '*' shall be the referee method.

2 It is recommended that the acceptable limit is to be implemented. Values in excess of those mentioned under 'acceptable' render the water not suitable, but still may be tolerated in the absence of an alternative source but up to the limits indicated under 'permissible limit in the absence of alternate source' in col 4, above which the sources will have to be rejected.

Source: https://law.resource.org/pub/in/bis/S06/is.10500.2012.pdf

THANK YOU