WATER SUPPLY & TREATMENT ENGINEERING (15CV64)

Internal Assessment Test 1 Solution – Mar. 2018

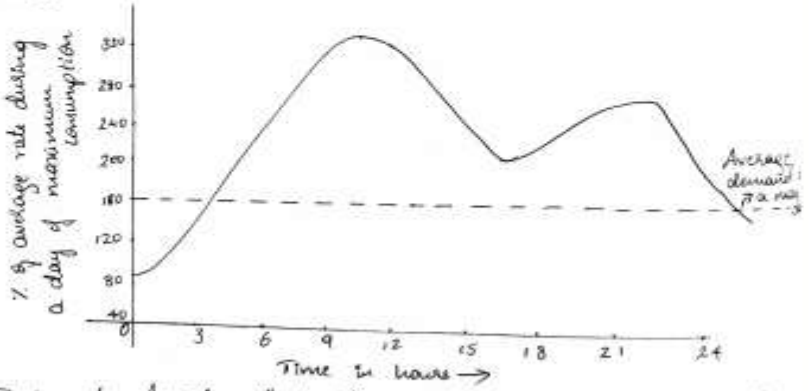
1. **What is peak-hour demand and how does it affect the design of water supply system? Sketch the fluctuations in demand for typical Indian conditions.**

Variations in Demand

There are wide variations in the use of water in different seasons in different months of the years, in different days of month & in different hours of the day.

Seasonal & monthly variations are prominent in tropical countries like India. Rate of consumption reaches maximum in summer season due to greater use of water for street & lawn sprinkling etc., it goes down in winter months. The fluctuation in the rate of consumption may be as much as 150% of the average annual consumption.

Hourly variations



Daily & hourly fluctuations depends on the general habits of people, climatic conditions etc, more water demand will be on Sundays & holidays due to more comfortable working, bathing etc., as compared to other working days & hour maximum flow &

peak hours may be 6.00 am to 10.00 am & 10.00 am to 4.00 pm minimum flow is between 10 pm to 4 am it is very less. The above graph shows the hourly variation in demand of water or rate of consumption The maximum hourly consumption may rise upto 200% of average hourly demand.

The term absolute max. hourly demand is used to indicate the consumption of max. hour or max. day of max. month of max. season. Let the annual average consumption in a city be 150 lpcd. The rate of consumption on maximum day will be $150 \times 1.8 = 270$ litres.

Max hourly consumption will be = $\frac{150}{24} \cdot 1.8 \times 1.5 = 16.9$ lit/hour

2. Mention the permissible limits as per Indian standards for the following parameters and explain the significance of each: Hardness, Chloride, Fluoride, turbidity and nitrates.

Sl No	Parameter	Limits
1	Hardness	200-600 mg/L
2	Chloride	250-1000 mg/L
3	Turbidity	1-5 NTU
4	Fluoride	1.0-1.5 mg/L
5	Nitrates	45 mg/L

3. Describe briefly the method of collecting samples of water from different sources for its physical and chemical examination.

Sampling methods

If an environmental domain was completely homogenous, a single sample would adequately represent it. However, we seldom come across such a situation as the environment is highly heterogenous.

Different methods of sampling are

1) Systematic sampling

Systematic sampling where points are selected at regular & even intervals providing the co-ordinates of the first sampling point are determined by random numbers. Systematic sampling does not generate clusters of sampling point and is easier to use to survey sampling locations than random sampling. For example, area to be analyzed may be divided into grid and sample is taken at each point of the grid.

2) Random sampling

With random sampling, sampling points are selected randomly - but not arbitrarily. A legitimate random number generator should be used to determine sampling point co-ordinates. Most scientific calculators can generate numbers that are sufficiently random for the intended purpose. The randomising

process ensures any location within the sampling area has an equal chance of being selected as a sampling point. While random sampling is statistically unbiased, sampling points by chance can cluster together.

For example area to be sampled is divided into triangular or rectangular areas with a grid. Three dimensional grids are used if the variation of depth also needs to be studied. The grid blocks are given numbers. A random number generator or a random number table is then used to select the grid points at which samples should be collected.

Judgemental sampling

Sampling points are selected on the basis of the investigator's knowledge of the probable distribution of contaminants at the site. It is an efficient sampling method which makes use of the site history & field observations but has the disadvantage of being potentially biased. The quality of the sampling results depends on the experience of the investigator & the available site history information.

For example lake sampler might be collected just around the outfall point. this type of judgemental sampling introduces a certain degree of bias into the measurement. It would be wrong to conclude that the average concentration at these clustered sampling points is a measure of the concentration of entire lake.

4) Stratified sampling

Divide the site into sub-areas according to geological and geographical features, nature of the contamination, former usage pattern of the site, intended future use of the sub-area & other relevant factors. Each sub-area can then be treated as an individual site and different sampling patterns and sampling densities applied. A stratified sampling pattern approach is best suited to investigations of large sites with complex contaminant distributions. This sampling pattern may require a more complex statistical analysis.

5) Haphazard sampling

A sampling location or sampling time is chosen arbitrarily. This type of sampling is reasonable for a homogeneous system. Since most environmental systems have significant spatial & temporal variability, haphazard sampling often leads to biased results. However, this approach may be used as a preliminary screening technique to identify a possible problem before a full scale sampling is done.

4. With the help of flowchart explain the different treatment processes adopted for domestic water supply

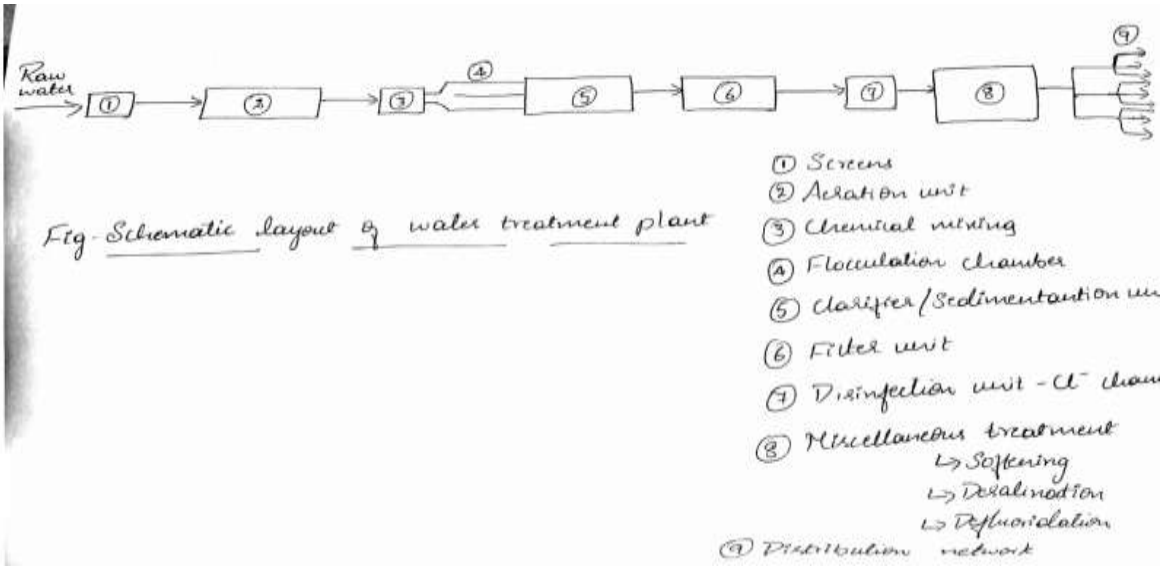
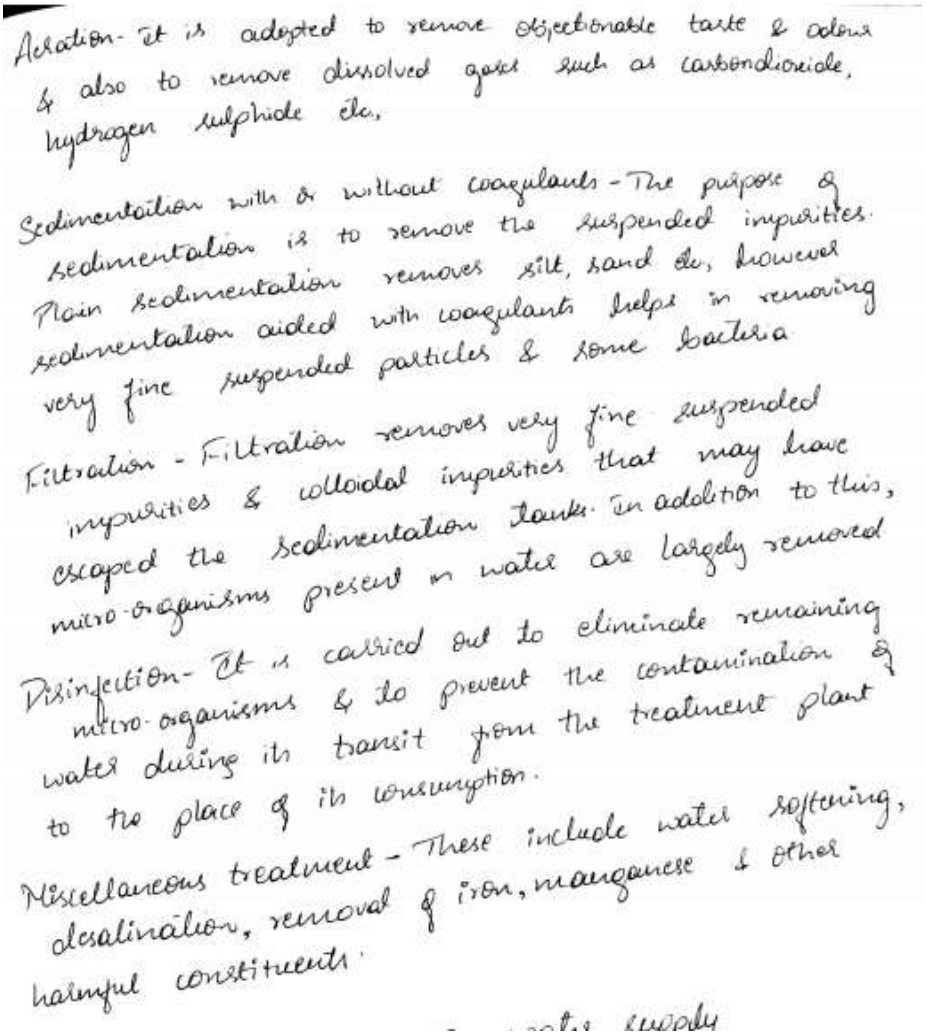


Fig. Schematic layout of water treatment plant

① Screens
② Aeration unit
③ Chemical mixing
④ Flocculation chamber
⑤ Clarifier / Sedimentation unit
⑥ Filter unit
⑦ Disinfection unit - Cl^- chamber
⑧ Miscellaneous treatment
↳ Softening
↳ Desalination
↳ Defluoridation
⑨ Distribution network


Aeration - It is adopted to remove objectionable taste & odour & also to remove dissolved gases such as carbondioxide, hydrogen sulphide etc.

Sedimentation with or without coagulants - The purpose of sedimentation is to remove the suspended impurities. Plain sedimentation removes silt, sand etc, however sedimentation aided with coagulants helps in removing very fine suspended particles & some bacteria

Filtration - Filtration removes very fine suspended impurities & colloidal impurities that may have escaped the sedimentation tanks. In addition to this, micro-organisms present in water are largely removed

Disinfection - It is carried out to eliminate remaining micro-organisms & to prevent the contamination of water during its transit from the treatment plant to the place of its consumption.

Miscellaneous treatment - These include water softening, desalination, removal of iron, manganese & other harmful constituents.

5. List out the chemical characteristics of water and explain in detail how to determine hardness and residual chlorine of them.

The chemical characteristics of water are

- pH
- Solids
- Hardness
- Residual chlorine
- Chlorides
- Fluoride
- Nitrates
- Iron and manganese

2) Hardness - Hardness is the property of water which prevents the formation of lather & foam & needs large quantities of soap. It forms scales in hot water pipes, heaters, boilers where the temperature of water is increased

Causes - The principal hardness causing cations are calcium & magnesium. There are two types of hardness- temporary & permanent hardness

Temporary hardness caused due to presence of carbonates and bicarbonates of calcium & magnesium. This can be removed by boiling & by adding lime solution in water. Temporary hardness is also called carbonate hardness.

Permanent hardness of water is due to the presence of sulphates, chlorides & nitrates of calcium and magnesium & requires special treatment of water softening. It is also called as non-carbonate hardness.

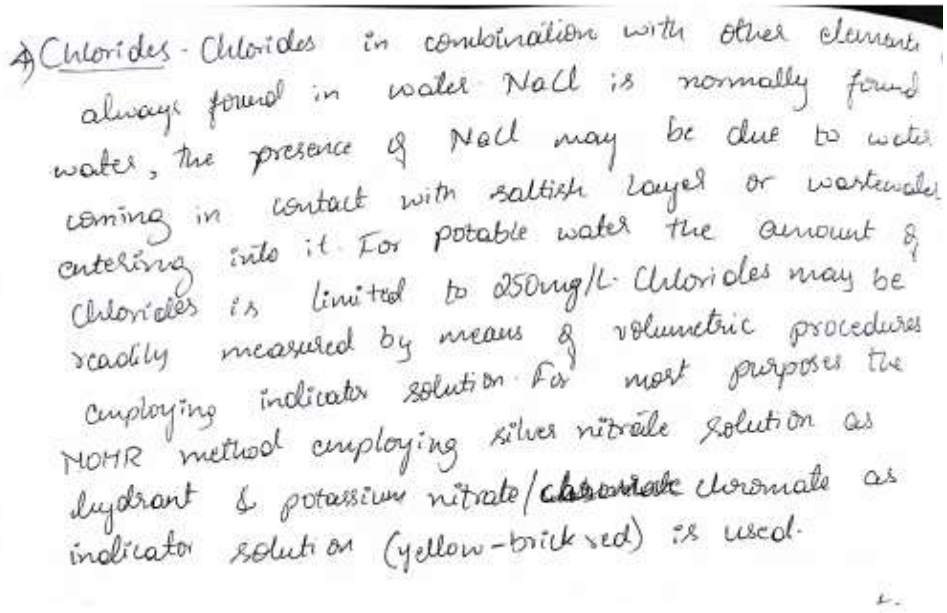
Determination of hardness

Hardness can be determined by EDTA titrandum method [Ethylene Diamine Tetra Acetic acid] Eriochrome Black-T is used as indicator.

EBT + Water ——→ less stable ions
(Blue color) (Ca^{++}, Mg^{++}) (wine red color)

EDTA + less stable ion ——→ EBT + more stable ion
(Titrant) (blue color)

Colorchange - Wine red to blue



4) Chlorides - Chlorides in combination with other elements always found in water NaCl is normally found water, the presence of NaCl may be due to water coming in contact with saltish layer or waste entering into it. For potable water the amount of Chlorides is limited to 250mg/L. Chlorides may be readily measured by means of volumetric procedures employing indicator solution. For most purposes the MOHR method employing silver nitrate solution as hydrant & potassium nitrate/~~chromate~~ chromate as indicator solution (yellow-brick red) is used.

6. **The census record of a town is as follows:**

Year	**1940**	**1950**	**1960**	**1970**	**1980**
Population	**81,420**	**1,25,000**	**1,70,000**	**2,20,000**	**2,30,000**

Workout the population after two decades using AIM, GIM and IIM.

Solution

Year	Population	Increase/decade	% increase/decade	Incremental increase
1940	81,420			
		43580	53.52	
1950	1,25,000		36	+420
		45000		+5000
1960	1,70,000		29.41	
		50,000		-40,000
1970	2,20,000		4.55	
		10000		
1980	2,30,000			
		$I_a = 37145$	$I_5 = 30.87$	$I_i = -11194$

(1) By Arithmetical increase method

$$P_{2010} = P_{1980} + n\ I_a$$
$$= 230000 + 3(37145)$$
$$P_{2010} = 341435$$

(2) By Geometrical increase method

$$P_{2010} = P_{1980}\left(1 + \frac{I_q}{100}\right)^n$$
$$= 230000\left(1 + \frac{30.87}{100}\right)^3$$
$$P_{2010} = 315529$$

(3) By incremental increase method

$$P_{1990} = P_{1980} + I_a + I_i$$
$$= 230000 + 37145 - 11194$$
$$P_{1990} = 255951$$

$$P_{2000} = P_{1990} + I_a + I_i$$
$$= 255951 + 37145 - 11194$$
$$P_{2000} = 281902$$

$$P_{2010} = P_{2000} + I_a + I_i$$
$$= 281902 + 37145 - 11194$$
$$P_{2010} = 307853$$

hour are as