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12 PRACTICAL

1.1 INTRODUCTION

Human beings, plants animals and all other forms of life need water in one or more ways and can't survive without it. Water covers about 2415 parts of earth's total surface area. Although water is perive O earth, but 97% of total water available is too saline to drink and also not useful for agriculture and industrial purposes. The world's total supply offresh water is only 2.5% of the total support and the rest being in the form of oceans. Water is one of the clost wonderful and the rest being in the form of only essentiated plants and animal for support in the total support is not only essentiated plants and animal for support in glife but is also equally important for agricultural, industrial and other purposes. Thus, water available for drinking and other useful purposes is limited in amount. For drinking and industrial purposes, we prefer water that is free from all undesirable dissolved impurities.

1.2 COMMON IMPURITIES IN WATER

Water, when comes into contact with any substances becomes contaminated. Thus, it has been termed as Universal Solvent. Although, the solvency power of water is beneficial to mankind as juices and other drinking beverages, but it posses a major threat to industrial equipment, causing corrosion and scale formation.

Impurities in water can be physical (suspended impurities, colloidal impurities), chemical (dissolved gases, salts) or microscopic (microorganisms). Water impurities include dissolved and suspended solids. For example, a solution of calcium bicarbonate is clear as calcium and bicarbonate ions are atomic sized ions which are not large enough to reflect light (dissolved impurities), whereas, sea water has very high concentration of soluble sodium chloride, suspended sand and silt, collectively makes it slightly cloudy (suspended impurities). Some soluble minerals impart a color to the water when dissolved to prepare solution such as copper salt forms intense blue colored clear solution.

The impurities contained in water can be classified as follows:

Water

Chap 1

1000 mI of the water sample = $\frac{X \times V_3}{V_1 \times Z} \times 1000$ mg of CaCO₃

permanent hardness of the water $=\frac{X \times V_3}{V_4 \times Z} \times 1000$ mg of CaCO₃

For the temporary hardness of the water

Temporary hardness = Total hardness – permanent hardness

1.5 PROBLEMS OF HARD WATER

Hard water posses threats for both demestic and indumial us comestic and industrial purpose is as problems created by hard in Sil

1.5.1 In Domestic Use

Hard water is harmful for domestic use as:

- (a) Hard water is harmful for drinking purposes, due to deposition of calcium in the bone joints and the possibility of forming calcium oxalate crystals in urinary tracts.
- (b) When it is directly fed in boilers for steam generation, causes many problems including scale and sludge formation, corrosion, priming and foaming and caustic embrittlement.
- (c) It does not form lather with soaps or detergents. The soap (sodium stearate) gives lather with water, when all calcium and magnesium salt present in water are precipitated. The reaction of lather formation is:

$$C_{17}H_{35}COONa + H_2O \longrightarrow C_{17}H_{35}COOH + NaOH$$

 $C_{17}H_{35}COOH + C_{17}H_{35}COONa \longrightarrow Lather$

This causes wastage as a lot of soap is being used.

Due to the presence of dissolved hardness producing salts, the (d) boiling point of water is increased. Consequently, more fuel and time are required for cooking.

1.5.2 In Industry

Water has a variety of applications in almost all the industries. Each Dont Purchase any Text Book and Solved Paper for 2nd Semester. Study from Best Jhunjhuwala PDFs

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Page 13	Water	
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Chap 1

industry requires water with a definite specification. The specifications of water required for some important industries are as follows:

- (a) Paper and pulp industries: In paper and pulp industries water should be free from iron and manganese salts and suspended matter. These impurities decrease the brightness, affect colors and interfere with texture and uniformity. Suspended silica particles in water produce cracks in paper.
- (b) Sugar industry: Hard water causes difficulties in the crystallization of sugar from molasses. It also causes the formation of precipitates, which accumulate in the refined sugar.
- (c) Textile and dyeing industries: Hard water precipitations is the and decreases the solubility of acidic dyer, where is information manganese salts produce colored species of theres.
- (d) Starch industry: The water induired for starch industry should be as soft and minoral field spossible. Hard water causes precipitation of salts which occumulate in these accord bon and manganese salts provide yellowish colouration to the starch, which is not desirable.
- (e) Aluminium industry: Water is used for washing the hydrate in aluminium industry. Thus the water should be of high quality. Any impurity introduced in the hydrate wash tends to accumulate in NaOH solution and impair its function.
- (f) Carbonated beverage industries: The industries manufacturing carbonated beverages requires water, which should be free from organic matter, turbidity, color, taste, odour, micro-organisms, iron and manganese salts. It should be of uniformly low alkalinity.
- (g) Laundries: The water used in laundries should be soft. The hard water increase the consumption of soap. Water should also be free from iron and manganese salts, which cause stains on the materials being washed. Water should not contain high bicarbonate alkalinity.

* * * * * * * * * * *

Page 16WaterChap 1EXAMPLE 1.420 ml of
$$0.1 Na_2 CO_3$$
 solution was added to 100 ml of a sample of hard
water. The filtrate from the solution required 30 ml of $0.05 N H_2 SO_4$ for
complete neutralization. Calculate the hardness of the water sample.SOLUTION :The filtrate = 30 ml of $0.05 H_2 SO_4$
 $= \frac{30 \times 0.05}{0.1}$ ml of $0.1 N H_2 SO_4$ The filtrate = 30 ml of $0.05 H_2 SO_4$
 $= \frac{30 \times 0.05}{0.1}$ ml of $0.1 N H_2 SO_4$ The filtrate = 30 ml of $0.05 H_2 SO_4$
 $= \frac{30 \times 0.05}{0.1}$ ml of $0.1 N H_2 SO_4$ To ml of $0.1 N Na_2 CO_3$ solution consumed in precipitating having the fold of hard water = $20 - 15 = 5 ml$. So that
100 ml of water sample = 5 motion (1) $Na_2 CO_3$ solution for
 $On = 100 \times Name = 5 \times 0.1$
 $On = 100 \times Name = 5 \times 0.1$
 $On = 0.05 \times 50 gm per liter $= 0.005 \times 50 gm per liter$
 $= 0.005 \times 50 gm per liter $= 0.005 \times 50 gm per liter$$$

EXAMPLE 1.5

2005

100 ml of tap water was titrated with N/50 HCl with methyl orange as an indicator. If 30 ml of HCl were required, calculate the hardness as parts of CaCO₃ per 100000 parts of water. The hardness is temporary.

SOLUTION :

For the temporary hardness, the chemical reaction is $Ca(HCO_3) + 2HCI \longrightarrow CaCI_2 + 2CO_2 + 2H_2O$ Thus 2 equivalents of HCI = Ca(HCO_3)_2 = CaCO_3 (since 100 parts) $CaCO_3 + H_2O + CO_2 \longrightarrow Ca(HCO_3)_2$ Therefore, 1 equivalent of HCI = 50 gm CaCO_3 Now 100 ml of tap water = 30 ml of N/50 HCI $= \frac{30}{50} ml of N HCI$

$$=\frac{30 \times 0.05}{50} = 0.03 \text{ gm CaCO}_3$$



2.1 INTRODUCTION

The water from the surface sources may have some characteristics which are unsuitable for human consumption, industrial use and commercia Water free from these characteristic is unknown as moving and potable water. The whole process of making water free from impuritie and supply it to the consumer as shown in , is known as mu cipal reviev water supply. de³ Over Head Reservoir Coagulation Pump House Tank Chlorination To Consumers Unit Filtration Plain Sedimentation Unit Water Softening Tank River Unit V = valveIntake Point



2.1.1 Drinking Water or Municipal Water

Water is a vital and essential requirement of all the living creatures. A large amount of water is consumed for drinking, washing and various other purposes. The water with impurities is not suitable for the domestic uses. The water, which is safe for drinking, is called the potable water. The natural water, obtained from rivers, underground wells and canals does not have the characteristic of the potable water. Hence, it is necessary to do some treatment of these types of water to make them potable.

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Municipal Water Supply

Chap 2

2.3 PURIFICATION OF WATER

The type of treatment given to water largely depends upon the quality of raw water and also upon the specified standards. Usually, water treatment for municipal supply or domestic use consists of the following stages:

 Table 2.2 Different Processes Used for Treatment of Municipal Water.



2.3.1 Screening

In screening treatment the raw water obtained from rivers, reservoirs and lakes is passed through steel screens, having large number of holes. Solid floating materials such as dead fish and animals, bits of wood, leaf, weeds and others debris presents in water are simply retained by the screen.

2.3.2 Sedimentation

Removing of suspended clay and other colloidal matter present in water by the process of setting is known as sedimentation. There are two types of sedimentation, plain sedimentation and sedimentation by coagulation.

1. Plain sedimentation

In plain sedimentation, the screened water is lead into a large tank and simply allowed to stand undisturbed for several hours. Heavy and suspended particles settle down at bottom by gravitational force. The time required for plain sedimentation largely depends upon the weight, size and shape of the particles.

The following are the main disadvantages of plain sedimentation process:

- (i) Longer detention period is required.
- (ii) Removal of lower density particles cannot be possible.

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Municipal Water Supply

Chap 2

 Table 2.3. Compares the properties of Slow Sand Filter and Rapid Sand Filter.

No.	Particulars	Slow Sand Filter	Rapid Sand Filter
1.	Area	Requires larger area for installation	Required small area for installation
2.	Base material	Gravel size varies from 3-65 mm.	Gravel size varies from 3-40 mm.
3.	Method of cleaning	Scraping top layer of sand to a thickness of about 25 mm	Back washing by when n complessed air.
4.	Quality of sand	Fine sand, effective size).20-0.35 mm, uniformity peffici () 2 to 2.75	Coarse and effective size 0.35- 0.65 mm, uniformity coefficient 1.20 to 1.80
5.	Supervision	Skilled supervision not required.	Skilled supervision required
6.	Period of cleaning	1 to 3 months	2 to 3 days
7.	Economy	It is not economical.	It is economical.
8.	Rate of filtration	100 to 200 lits per hr per m ² of surface area of filter.	3000 to 6000 lits per hr per m ² of surface area of filter.
9.	Efficiency	Highly efficient in removing bacteria.	Less efficient in removing bacteria.
10.	Suitability	It is suitable for towns.	It is suitable for large cities.

2.3.5 Sterilization and Disinfection

Contaminated water is main cause for the spreading of many diseases like cholera, typhoid, etc. Therefore, to insure water, free from harmful bacteria and viruses, drinking water is treated with certain disinfectants. The chemical which are used to destroy the bacteria and viruses are called the disinfectants and this process of destruction of bacteria and viruses (harmful microorganism) is called the disinfection. Unlike disinfection,

Water Treatment

Chap 3

introduced during the removal of permanent magnesium hardness, Fe^{2+} , AI^{3+} , HCI and H_2SO_4 by lime.

Thus, for the calculation of the amounts of lime and soda required for the treatment of a given sample of water, it would be easy to convert the amounts of all the substances present in the sample in terms of CaCO₃ equivalent. As we have already seen, CaCO₃ equivalent is given by

CaCO₃ equivalent =
$$\frac{W \times 50}{W_{Eqvi}}$$

where,

 $W_{Eqvi.} = equivalent weight of the importing Salar nents can be calculater is follows:$ The lime and soda requirements can be calculate in s follo

Lime Requirement

100 parts by weight of Gallos, are equivalent to 4 parts by weight of Ca(OH),. Hence, if the amounts of input desire expressed in terms of their CaCO₃ equivalents, the amount of lime required to soften a given sample of water is given by Lime required for softening

Temporary calcium hardness

+2 (Temporary magnesium hardness)

imes Volume of Water

 $= \frac{74}{100} \times + \frac{1}{100} +$

All expressed in terms of CaCO₃ equivalents

Soda Requirement

As stated before soda removes both permanent calcium hardness and the permanent calcium hardness introduced during the removal of permanent magnesium hardness, Fe²⁺, Al³⁺, HCl and H₂SO₄ by lime. Hence, the permanent calcium hardness introduced during the removal of the abovementioned impurities by lime must also considered while calculating the soda requirement.

100 parts by weight of CaCO₃ are equivalent to 106 parts by weight of Na₂CO₃.

Thus, if the amounts of impurities are expressed in terms of their CaCO₃ equivalents, the amount of soda required for the removal of permanent calcium hardness already present and the permanent calcium hardness introduced during the removal of permanent magnesium hardness,

Page 53	Water Treat	ment Chap 3
S.No.	Soda-lime process	Permutit/Zeolite process
5.	This process can't operate under pressure.	This process can operate under pressure and can be made automatic.
6.	Treated water does not contain sodium salts.	Treated water contains sodium salts.
7.	The softened water of cold soda-lime process has residual hardness of about 50–60 ppm while hot soda-lime process has 15–30 ppm.	The softened water contains residual hardness of about 10 ppm.
8.	The softened water is free from the hardsess so corr be easily used in the boilers.	The softened water is not ree from the wHCO, so can't be as to the industrial purposes.

3.3.3 Demineralization or Deionization Process

Demineralization is the process of complete removal of all the hardness producing ions present in water. The water produced from this process is also known as deionised water.

The two important demineralization processes are explained as follows:

1. Ion-exchange Process

Ion-exchange process is defined as the complete separation of the dissolved ions present in water by the help of some complex organic compounds (resins). These resins act as ion-exchangers and remove all minerals from the hard water. They remove all cations (negatively charged ions) and anions (positively charged ions), except H⁺ and OH⁻ ions from hard water and make it completely free from ions, so it is called demineralization.

The resins are very complex organic compounds capable of exchanging all the ions present in hard water. They are of following two types:

 (i) Cation exchange resins: Mainly carboxylated or sulphonated styrene-divinylbenzene copolymers are known as cation exchange resigns. These resins possess acidic groups such as -COOH or -SO₃H groups and may be represented as R-H⁺. The structure of a cation exchange resin containing -SO₃H groups can be

Water Treatment

Chap 3

Conversion into $CaCO_3$ equivalents is shown below in table:

S.No.
 Constituent
 Amount
ppm
 Multiplication
factor
 CaCO₃ equivalent
(ppm)

 1.
 Ca⁺²
 40

$$\frac{100}{40}$$
 $40 \times \frac{100}{40} = 100$

 2.
 Mg⁺²
 48
 $\frac{100}{24}$
 $48 \times \frac{100}{24} = 200$

 3.
 CO₂
 22
 $\frac{100}{122}$
 $22 \times \frac{100}{44} = 50$

 4.
 HCO₃⁻¹
 122
 $\frac{100}{122}$
 $R \times \frac{100}{122} = 60$
 $R \times \frac{100}{122} = 100$

 5.
 K⁺
 10
 $R \times \frac{100}{122} = 100$
 $R \times \frac{100}{122} = 100$
 $R \times \frac{100}{122} = 100$

 5.
 K⁺
 10
 $R \times \frac{100}{122} = 100$
 $R \times \frac{100}{122} = 100$
 $R \times \frac{100}{122} = 100$

 5.
 K⁺
 10
 $R \times \frac{100}{122} = 100$
 $R \times \frac{100}{122} = 100$
 $R \times \frac{100}{122} = 100$

 6.
 K⁺
 10
 $R \times \frac{100}{122} = 100$
 $R \times \frac{100}{122} = 100$
 $R \times \frac{100}{122} = 100$

 1.
 Line required $= \frac{74}{100} \times 350 = 259$ ppm or mg/L
 Line (80% pure) required for million litres of water
 $R \times \frac{100}{90} \times 10^6$
 $R \times \frac{100}{90} \times 10^6$
 $R \times \frac{100}{90} = 100$

 259 × $\frac{100}{100} \times \frac{100}{80} \times 10^6$
 $R \times \frac{$

Page 66	Water Treatment	Chap 3

 $= 59.48 \times 100000 = 5948000$ mg or 5.948 kg

EXAMPLE 3.8

1998, 2000

Calculate the quantities of lime and soda needed for softening 2000 litres of hard water which analyzed as follows:

HCI – 7.3 pp Р Г Р	age .	
Dissolved CO ₂ – 44 ppm ieW	. 74 .	
HCO ₃ ⁻ – 732 ppm	from in of	40
Mg ⁺² – 72 ppm	OH ⁻ – 17 ppm OLC	
Ca ⁺² – 160 ppm	$CO_3^{-2} - 30 \text{ ppm}$	216
Analysis of raw water	Analysis of treated water	

SOLUTION :

Conversion to equivalent of CaCO₃ is shown in table:

S. No	Constituent (ppm)	Amount (ppm)	Multiplication (ppm)	CaCO₃ Equivalent (ppm)
1	Ca ⁺²	160	<u>100</u> 40	$160 \times \frac{100}{40} = 400$
2	Mg^{+2}	72	<u>100</u> 24	$72 \times \frac{100}{24} = 300$
3	HCO ₃ ⁻	732	<u>100</u> 122	$732 \times \frac{100}{122} = 600$
4	CO ₂	44	<u>100</u> 44	$44 \times \frac{100}{44} = 100$
5	HCI	7.3	<u>100</u> 73	$7.3 imes rac{100}{73} = 10$
6	OH-	17	<u>100</u> 17	$17 \times \frac{100}{17} = 100$
7	CO ₃ ⁻²	30	<u>100</u> 60	$30 imes rac{100}{60} = 50$

Amount of lime required for softening raw water is

 $= \frac{74}{100} [Mg^{+2} + HCO_3^- + CO_2 + HCI] \text{ as } CaCO_3 \text{ eq.}$

Water Treatment

Chap 3

$$= 169.6 \times \left(\frac{100}{90}\right) \times 20000 \text{ mg}$$

= 3.77 × 10⁶ mg = 3.77 kg
Hence, cost of softening is
= 4.05 × $\left(\frac{75}{100}\right)$ Rs. + 3.77 × $\left(\frac{2480}{100}\right)$ Rs.
= 3.04 + 93.50 = Rs. 96.54

EXAMPLE 3.13

tesale Calculate the amount of lime and soda required for litres of hard water containing: MgCO $CaCO_3 = 25 p$ $MgCl_2 = 95 \text{ ppm}$, $CaCl_2 = 111 \text{ ppm}$, Fl_2O 25 ppm, Na SC = (5)

SOLUTION :

Conversion into CaCO₃ equivalents are tho

S. No.	Constituent	Amount (ppm)	Multiplication factor	CaCO ₃ Equivalent (ppm or mg/L)
1	MgCO ₃	144	<u>100</u> 84	$144 \times \frac{100}{84} = 171.4$
2	CaCO ₃	25	<u>100</u> 100	$25 \times \frac{100}{100} = 25.0$
3	MgCl ₂	95	<u>100</u> 95	$95 imes rac{100}{95} = 100.0$
4	CaCl ₂	111	<u>100</u> 111	$111 \times \frac{100}{111} = 100.0$

Substances Fe₂O₃ and Na₂SO₄ do not impart any hardness and therefore, these do not consume any lime or soda.

Lime requirement

 $= \frac{74}{100} [2MgCO_3 + CaCO_3 + MgCI_2] \text{ as } CaCO_3 \text{ eq.} \times \text{Vol. of water}$ $=\frac{74}{100}[2 \times 171.4 + 25.0 + 100.0] \text{ mg/L} \times 50000 \text{ L}$ $=\frac{74}{100}(467.8)\times 50000$ mg = 17308600 mg = 17.31 kg

Page 75		Water Treatment		Chap 3	
3	MgSO ₄	30.0	<u>100</u> 120	$30.0 imes rac{100}{120} = 25$	
4	CaSO ₄	34.0	<u>100</u> 136	$34.0 imes rac{100}{136} = 25$	
5	CaCl ₂	27.75	<u>100</u> 111	$27.75 \times \frac{100}{111} = 25$	

NaCI do not contribute any hardness.



Page 81	Boiler Feed Water	Chap 4

concentration of solute or suspended matter between the surface film and the bulk of the liquid. Foaming is due to the presence of oil or grease which generally reduces the surface tension of water in boiler.

The substances which increase the viscosity of the surface film also increase foam forming tendency.

Causes of Priming and Foaming

- (i) The presence of large quantities of alkali sulphate and chloride in rom Notesale age 89 of 140 water.
- (ii) Sudden boiling.
- (iii) Sudden increase in steam production rate.
- (iv) Improper boiler design.
- (v) The high steam velocities.
- (vi) Very high water level in the viller

d Foamina Disadvantages of Prim

Priming and forming are often used synonymeasly. These are highly objectionable because the droplets of water carry away with them some suspended and dissolved impurities present in the boiler water. These droplets and impurities lead to the following disadvantages :

- A part of the dried salts may be carried along with the steam (i) farther and deposit on the engine valves thereby decreasing their life.
- (ii) These deposite reduce their efficiency by hindering the flow of steam.
- (iii) Presence of water droplets in the steam may lead to corrosion in the steam-inlet ends of super-heaters.
- (iv) Height of the water column cannot be judged properly due to foaming thereby making the maintenance of the boiler pressure difficult.

Prevention of Priming

Priming can be avoided by:

- Keeping the water level lower. (i)
- (ii) Reducing steam velocities also decreases the moisture content of steam because of greater chances of condensing available for the drop.
- (iii) Efficient softening and filtration of boiler feed waters so as to minimize the dissolved and suspended impurities.
- (iv) Good boiler design fitted with mechanical steam purifiers.
- (v) Avoiding rapid change in steaming rate.

Basics of Environment

Chap 5

4. Biosphere

This is the region of the earth where life exists and includes a global region extending from about 10,000 m below sea-level to 6,000 m above sealevel. Thus the biosphere covers the entire kingdom of living organism and their interactions with the other segments of the environment, namely the lithosphere, the hydrosphere and the atmosphere.

5.3 **ENVIRONMENT AS SCIENCE AND EDUCATION**

Environmental science may be defined as the systematic study of the Solution of humans on the environment. Using the term "systematic study of the Solution of the systematic study of the sys it is a science.

The use of the term Environmen Stadies may simply a single subject, but its essence is is a Nisciplinary nature atively new field, it has evaluating the integrated use of n a verscipilities and includes some of the most important topics of modern of ilization as well as some of the oldest Philosophical concerns of the human beings. Environmental studies encompasses many other fields such as given in table 5.1.

Table	5.1.	Different	Fields	of	Environmental	Study.
-------	------	-----------	--------	----	---------------	--------

Biology	Physics	Sociology
Chemistry	Geology	Political Science
Ecology	Economics	Philosophy
Paleontology	History	Arts
Religion	• Law	Literature

It is therefore a complex topic. As with any of the sciences, Environmental Scientists don't know about all of these, areas, but specialize. For example, it may be someone who studies the effects of pollution on groundwater, which would include chemistry, geology, and biology. One may instead be interested in the effects of environmental regulations on a segment of the economy, in this case be might be called and Environmental Economist.

Environmental education is an integral process, which deals with man's interrelationship with his natural and man made surroundings, including the relation of population growth, pollution, resource allocation and depletion, conservation, technology and urban rural planning to the total human environment. Environmental education is a study of the factors influencing ecosystems, mental and physical health, living and

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Basics of Environment

Chap 5

- (vi) Relationship of the proposed activity to the existing land use plans i.e. conformity or conflict with other land use plans and policies (when in conflict-extent of recommendation and reasons for proceeding with action).
- (vii) Relationship between the local short term uses and long term productivity of the resources involved.
- (viii) Identifying the measures to minimise the adverse effects.
- (ix) Incorporating the modification in the proposed project.

After it has been written, the EIS is presented to the public to make the role of public participation more effective in developmental planning approximation process. NO

4. Review of the EIS

Finally the EIS, written in a clear and comprehensive manner is presented to the public compating to the public, competent la torives and independent experts. It is reviewed carefu who for eany decision is taken in the ur or against passing the proposes project.

In order to maintain a safe and healthy environment and to upgrade the standard of living by taking advantages of new technological developments without exploiting the environment, responsible and concerned public participation is important.

The proposed project is then made available for public inspection by publicity through the press for a period of at least one month in addition with discussion sessions of the government agency, the proponent and the public. This provides the further information and submission of comments from the public and competent authorities.

After the final review of beneficial and adverse environmental impacts and cost benefit analysis, ultimately a decision is made to either approve or reject the project or approve the most acceptable alternative in actual or modified form. Cost effectiveness of EIA can be improved by:

- (i) Reducing unnecessary assessment and monitoring by better screening.
- (ii) Making use of available data and experience.
- (iii) Assigning responsibilities to the members of the analysis team, thereby avoiding duplication or overlapping of duties and activities.
- (iv) Simplifying administrative procedures.

5.12.3 Role of EIA in Sustainable Development

Sustainable development is closely linked to the carrying capacity of an ecosystem as the latter determines the limits to economic development.

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purposes because sunlight falling on any black surface is readily absorbed and converted to heat in the desired temperature range. Temperature of about $20^{\circ}-22^{\circ}$ C are used for space heating and $50^{\circ}-60^{\circ}$ C are used for hot water. Therefore, complex collection or conversion equipment is not required when solar energy is to be used for obtaining low-temperature heat. A simple flat-plate collector is sufficient.

Flat-plate collectors basically consists of a black surface covered by a clear plastic or glass "window" as shown in Fig. 5.3. The black surface absorbs sunlight converts it to heat and the window prevents the heat from escaping out. Air can be heated by passing it between the window and the black surface whereas water heating can be done by plasting it through tubes embedded in the surface. Thus, minimum cust is involved in collecting and converting solar energy term a

Storage tank



Thermosyphon Flow

Hot water from collector

Collector

Toughened Glass

Figure 5.3

Hot Water to Use

Solar heating system may be "Active" or "passive". An active solar heating system uses either pumps or blowers to circulate the air or water Dont Purchase any Text Book and Solved Paper for 2nd Semester. Study from Best Jhunjhuwala PDFs

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oduction

Solar Furnaces

In solar furnace, high temperature is obtained by concentrating the solar radiations onto a specimen using a number of heliostats (turnable mirrors) arranged on a stopping surface. The solar furnace is used for studying the properties of ceramics at extremely high temperatures above the range measurable in laboratories with flames and electric currents. Heating can be accomplished without any contamination and temperature can be easily controlled by changing the position of the material in focus. This is especially useful for metallurgical and chemical operations. Various property measurements are possible on an open specimen.

An important future application of solar furnaces of nitric acid and fertilizers from air.

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Solar Cooking

A simple solar proker the flat plate box types are cooker. It consists of a well insulated metal or wooden box VD crait V skened from the inner side. The solar radiations entering the box are of short wavelength. As higher wavelength radiations are unable to pass through the glass covers, the re-radiation from the blackened interior to outside the box through the two glass covers is minimized, thereby minimizing the heat loss.

The heat loss due to convection is minimized by making the box air tight. This is achieved by providing a rubber strip between the upper lid and the box for minimizing the heat loss due to conduction, the space between the blackened tray and outer cover of the box is filled with an insulating material like glasswool, saw-dust, paddy husk etc.

When placed in sunlight, the solar rays penetrate the glass covers and are absorbed by the blackened surface thereby resulting in an increase in temperature inside the box. Cooking pots blackened from outside are placed in the solar box. The uncooked food gets cooked with the heat energy produced due to increased temperature of the solar box. Collector area of such a solar cooker can be increased by providing a plane reflector mirror. When this reflector is adjusted to reflect the sun rays into the box, then a 15° C to 25° C rise in temperature is achieved inside the cooker box.

Solar Green Houses

A green house is a structure covered with transparent material (glass or plastic) that acts as a solar collector and utilizes solar radiant energy to grow plants. It has heating, cooling and ventilating devices for controlling the temperature inside the greenhouse.

Solar radiations can pass through the green house glazing but the thermal radiations emitted by the objects within the green house cannot Dont Purchase any Text Book and Solved Paper for 2nd Semester. Study from Best Jhunjhuwala PDFs

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that out flowing water continues to generate power. At present, tidal power plants are in operation in Russia, France and Nova Scotia.

For any tidal power project to be of practical use, a fluctuation of at least 6 meters is needed between the high tide and low tide. Such a situation exists only at about 15 locations in the world. The Bay of Fundy in North America is one of such locations and a large tidal power plants is being developed.

Tidal plants are accompanied by the adverse environmental effects because of the dams which may trap sediments, impede the migration of marine organisms, change water circulation and cause mixing of the set water with salt water.

Ocean Thermal Energy Conversion (OTE)

In oceans, a thermal gradient standard difference of a start exists between surface make heated by the sun are cold r deep water. In tropical regions the temperature of the sector sector is as high at 26°C, whereas at a depth of 1,000 meters, the temperature is 5 to 6°C. This temperature difference can be harnessed to produce power. This concept is known as Ocean Thermal Energy Conversions (OTEC). An OTEC power plant can be built on a brage (i.e. sailing vessel) that could travel anywhere in the ocean. It uses the warm surface water to heat and vaporize a low boiling liquid such as ammonia. The increased pressure of the vaporized liquid would drive turbo generators. The ammonia vapour leaving the turbines would then be condensed by cold deep water which is about 100 m below the surface and is returned back to start the cycle again. The electrical power so generated could be used to produce hydrogen and shipped to the shore. Alternatively, an energy intensive industry can be located on factory ships that would anchor alongside the OTEC Plant. A few OTEC Plants have been tested.

In addition to electricity, an OTEC plant delivers cold sea water to the surface, which can be used to air-condition nearby buildings. The water from the deep ocean, which is rich in nutrients, can support agriculture and mariculture enterprises. An experimental station in Hawaii is exploring the possibilities for integrated power, water, air-conditioning and farming activities on the shore.

Further, the difference in salt concentration between the oceans and fresh water represents a large osmotic pressure which is equivalent to a 240 meter water head. A practical application of using this mixing energy is worth exploring.

Owing to the small temperature difference between the surface water and deep water. The conversion efficiency is as low as 2-3%. This Dont Purchase any Text Book and Solved Paper for 2nd Semester. Study from Best Jhunjhuwala PDFs

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 Table 5.3. Estimates of Potential Capacities from Renewable Energy
 Sources (in MWs)

Source	Approximate Potential		
Biomass Energy	19500		
Solar Energy	20000		
Wind Energy	47000		
Small Hydropower	15000		
Ocean Energy	50000 Note		
Energy Production and Reserves			

Energy Production and Reserves

frO India is the third most coal preducing unity of the world. Car production has grown considerably from 1.0 MT (million topped) in 1175-6 to 306 MT in 1998-1999. Op 15% of the place has coking properties and is used in the iron and steel industry. The bulk of the coal produced in inferior grade non-coking coal used to meet the demands of the power sector. This coal is of poor quality with a high ash contents (40-50%) and low calorific value (1300-4200 Kcal/kg).

India is one of the least explored regions with a oil well density of 20 per 10000 sq. km against a worlds average of 100. Inspite of a significant growth, domestic production has not matched demand which tends to a constant growth in net imports as estimated at 39.81 MT of crude oil and 17.4 MT of petroleum products in 1998-99. The country's self reliance in petroleum products has declined from 56% in 1990-91 to about 34% in 1998-99.

The share of hydro in the hydro-thermal capacity mix has changed significantly since the early 1970s. It was 43% in 1970-71 which has now come down to about 24%. India also has substantial reservoir of nuclear fuels with the world's largest deposits of thorium, about 363 thousand tonnes and about 34 thousands tonnes of the Uranium ore.

Traditionally India has been deficient in power generation with compare to its demand. The following table 5.4, shows deficit and capacity additions during various plan periods.

In India with the high rate of growth in population and increasing development needs, the growth in the demand of primary energy has been accompanied by a shift to an increase in the share of commercial energy in the total energy demand. The domestic sources of commercial energy supply have not kept pace with growing requirements as may be seen from the following table 5.5.