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Sunlight activates vit-D in our body (vit-D in de-activated form is already present in our body). Sunlight itself doesn't have any vit-D.

Natural Gas (CH_4)

- Mixture of various gases (methane, propane, butane).

Non Conventional Energy Program was started in India in 1983-84 by Ministry of Non-Conv. Energy Sources (MNES).

NCES to be discussed in Ch-1:

i) Solar
ii) Wind
iii) Biomass
iv) Geothermal
v) OTEC (Ocean Thermal Energy Conversion)

ATF: ↑ advanced version of Crude Oil
Aviation Turbine Fuel

OP — Octane No. ↓ — for Petrol

CD — Cetane No. ↓ — for Diesel

SOLAR ENERGY

- It is a renewable source of energy.
- Helps to maintain ecosystem as it's the major food source for various organisms including plants.
- Solar Energy is obtained from sun and can be converted into electrical energy using PhotoVoltaic (PV) cells.

- Prime Energy Source
- Essential for plants
- Fertility of soil is maintained by sunlight.

2 Types: i) Direct Solar Energy
ii) Diffused Solar Energy

Diffused Solar Energy

- Varies from place to place
- In polluted regions where some sort of resistance is present in the air.

→ Amount of Solar Energy is expressed in terms of Solar Constant.

Solar Constant: (Heat Flux) — It is the total energy falling on a unit area exposed to the sun

Optimal value: 1.353 kW/m²

Generally, it is around 1 kW/m²

Depends upon:

i) No. of light scattering and ii) absorption in the air.

i) dependent upon presence of dust particles in the air
↳ pollution ↑ --> scattering ↑ → deserts have dirt → more scattering

ii) gases

> The ratio of direct to total energy is varies from place to place depending upon atmospheric conditions like dust particles, smoke, water vapours and other suspended material.

$$\frac{\text{Direct}}{\text{Total}} \Rightarrow 0.64 \text{ to } 0.84$$

Adv: Free of cost
Environment friendly (Pollution free)
No noise pollution (as there's no moving part).

Dis Adv: Poor Efficiency.
Not available continously

Impact on Environment:

i) Solar reflectors may be hazardous for eyes.

ii) Solar Photo Voltaic modules are hazardous to dispose bcz of presence of Arsenic & Cadmium.

iii) Solar Thermal System is hazardous for Nature bcz of Heat Transfer Fluids (Glycol Nitrate)
↳ Highly viscous & High Boiling Point

WIND ENERGY:

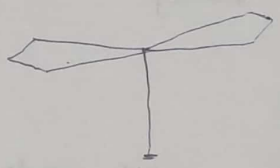
Intro

Formation of Wind

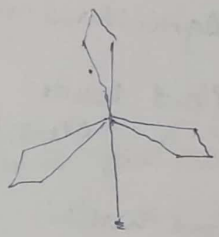
- Speed of wind is higher in coastal areas

Multi-Blade Turbine Wheels:

- Efficiency : 10%.
- High speed propellor.
- Rotor Propellor : used for small scale units, battery charge
  Rotor : Large speed.



2-Blade



3-Blade

Life expectancy: 20 to 25 years.

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Atmosphere:
height: Upto 12 km.

Wind: Advantages:
- No need of maintenance.
- No operators needed
- Repair for large duration
- Non Polluting
- Renewable
- No fuel requirement

Disadvantages:

- Poor efficiency
- Noise Pollution
- Interference with communication signals.
- Not continuously available.

Environmental Impact:

- Hazardous for birds
  ↑ Blades are
- Environment degradation due to noise pollution.
  ↳ affects animals → ecosystem
- Deforestation

Barking dog's 70dB

Biomass (Agriculture ~~Animal~~ Waste)

Biomass refers to the waste excreted by the animals.

→ U.P. (west) Marath

E.g.; i) Agricultural waste such as wheat straw, sugarcane, mustard, Barley

ii) Plant Waste:
Stem, leaves

iii) Food waste:
Coconut, banana, apple waste, pineapple

iv) Industrial Waste:

Formation of Biomass

* Sunlight, Water, Soil, Fertilizers

Biomass is mainly based on Chemical Compounds.

Chemical & energetic value of these materials is based on:
C — C and H — H bond.

- Biomass infacts collects & stores solar energy.
- Biomass is an organic material made from plants & animals.
- Plant absorbs the sunlight in a process called photosynthesis.
- Chemical energy in plants get passed to animals & human beings when consumed.

Why Biomass is a Renewable Energy Source:

Biomass is a renewable energy source bcz: biomass is indirectly made from sunlight and now, as sunlight is a renewable energy source, biomass is a ren. energy source.

Adv. - less cost
- Easily available
- Easy transportation

Geothermal Energy

Geo + Thermal
↓ ↓
Earth Heat

Geothermal fluid is already present under earth's surface (i.e. steam / gaseous)

→ why is it renewable?

→ Geothermal field are identified w/ previous year data, soil quality basis are the places where the geothermal fluid is present under the surface. From geothermal fields, the fluid is extracted & then

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SOLAR ENERGY

Topics to be Covered:

- Basics of Radiation
- Solar Thermal Conversion Systems
- Solar Collectors
- Solar Thermal PP
  - i)
  - ii) Solar PV Systems
    - VI characteristics
    - PV systems types
    - ways to inc. efficiency.

Sun

Diameter : 1.39×10^6 km

D/s b/w sun & Earth : 1.5×10^8 km

Rxn. : Nuclear fusion.

Temperature : 5577 K

Solar Energy

- We obtain solar energy from Sun into 2 forms:
  - i) Direct beam radiation
  - ii) Diffused radiations

→ Diffused energy contributes upto 15 to 20% on a clear day & 100% on a cloudy day.

Conversion Process

Conversion process to convert solar energy into useful energy

- i) Solar Thermodynamic
- ii) Solar PV Systems.

-> In India, favourable conditions for Solar Energy are for only 6 ~~months~~ months of a year - when we have no ~~clouds~~ cloud or rain.

Other possible renewable energy sources which utilize sunlight:

-> Sun is an ultimate source of energy.

- Wind energy
- Ocean thermal
- Biomass
- Geothermal

->Life is not possible w/o Sun:

Without sun → no oxygen (bcz no photosynthesis) → no life.

Also, without photosynthesis → no plants growth → no food for survival.

How pollution is decreasing the age of human beings:

Increase in pollution means that the amount of toxic gases in the environment is high.

Human body requires fats, vitamin, proteins for its growth. Due to increase in pollution, the food that we intake might be polluted too ie, the extent of harmful substances in that food is too more.

Therefore, this leads to many diseases as our bodies start to deteriorate because of consumption of contaminated food.

Additionally, presence of harmful gases in the air might also cause countless respiratory diseases associated with lungs & this intern will aids to kill human beings prematurely.

Solar Energy Conversion Systems & their Applications:

1) Passive Heating Systems (low Temp.) → $T < 150°C$
   - Cooling
   - Residential heating
   - Water Heating
   - Drying of Crops
   - " " Biomass

~~Biomass drying~~

II) Solar Thermal Systems ($T > 150°C$ & $T < 300°$) → Medium

Applications:
- Steam generation
- Hot water
- Heat for chemical indu
- Desalination plants.

III) Solar Thermal Systems (High Temp.) → Greater than 300°C
- Electricity
- High temp steam generation

IV) Solar to electrical energy conversion by PV Systems
- Small voltage
- low voltage applications (mW)

V) Solar Diesel Hybrid Systems (1 kW to 350 kW)
- For remote applications
- villages
- Railways
- Tubewells
- universities

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Solar Thermal Energy Collectors

Collectors: Devices which collect Energy.

Solar Thermal Energy is:

- Clean
- Renewable — but conversion is not economic
- Economic (cheap)

Applications:

i) Solar Water Heating

ii) Solar Pumping

iii) Solar Distillation (To purify Water)

iv) Solar Cooking

v) Generation of Electric Power

Solar Energy is utilized:

i) Collection: Solar energy is collected w/ the help of collectors.

- Absorption :
- Emission :
- Reflection :

} 3 properties of Collectors

- Absorption should be higher.
- Low reflectivity
- low light emission
- low transmitibilty

Collectors : Various Range & Applications

I) Low Temp. (100°C) → Flad (Flat) Plate Collector

App:
- Water Heating
- Drying
- Space Heating

II) Medium Temp. (100 - 200°C) → Cylindrical & Parabolic Collector
- Process Heating
- Cooking
- Vapour engines & Turbine Engines

III) High Temp. (>200°C) → Paraboloid Mirror Arrays.
- Thermoelectric Generators
- Steam Engines

Collection System

I. Solar Energy is collected with the help of Solar Collectors.

II. Storage of Energy (w/ the help of heat transfer fluid such as Glycol Nitrate)

Features / Characteristics of Collectors

1) 2 Types:
   - I. Focusing Collectors (adjust themselves in the d'n of light)
   - II. Non-focusing collectors

2) Temp. working fluid attained:
   - i) Low Temp.
   - ii) Med. Temp.
   - iii) High Temp.

→ Impure semiconductors are called extrinsic semiconductors.

Photo Voltaic Systems

It is a system in which we directly convert solar energy into electricity w/ the help of semiconductors are solar energy.

- A PV system contains solar panels having no. of solar cells to supply solar power.

Metals aren't temp resistant their conductivity changes w/ temperature. That's why conductors are not used in PV cells. Instead, semiconductors are used.

- Power generation from solar PV act as a sustainable energy as ~~long~~ sunlight is being used.

Components of PV System Symbols:

I. Solar Array
II. Cables
III. Mounting System
IV. Solar Trackers
V. Solar inverters.
VI. Batteries
VII. Control System

[Advantages & Disadvantages]

Disadvantages

Properties of Semiconductors

- Temp coeffivient of resistance is -ve.
- Some suitable metallic impurities are added to into the semicond. so that its electrical conductivity increases.
- They metallic in appearance, but are generally hard & brittle.

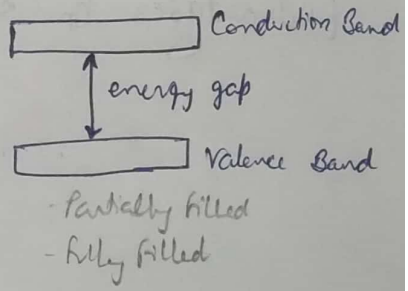
E.g, Silicon, Germanium, Arsenic, Carbon.

- Atoms: less than 4 valence electrons - Good conductor
  - Al ⇒ 3 valency
  - 4 " " - Semiconductor
    - Silicon : 4 valency
  - more than 4 " " - Poor conductor of electricity (insulators).
    - Phosphorus ⇒ 5 valency

i) Intrinsic / Pure Semiconductors

- No free electrons are available bez all covalent bonds are completely filled.

Energy gap ↑ Poor conductors ↓



ii) Extrinsic

Small amount of impurities are added in order to increase the conductivity.

2 type of doping: P-type (Holes are added) ↗ 15

N-type (e^- are added) ↘ 13

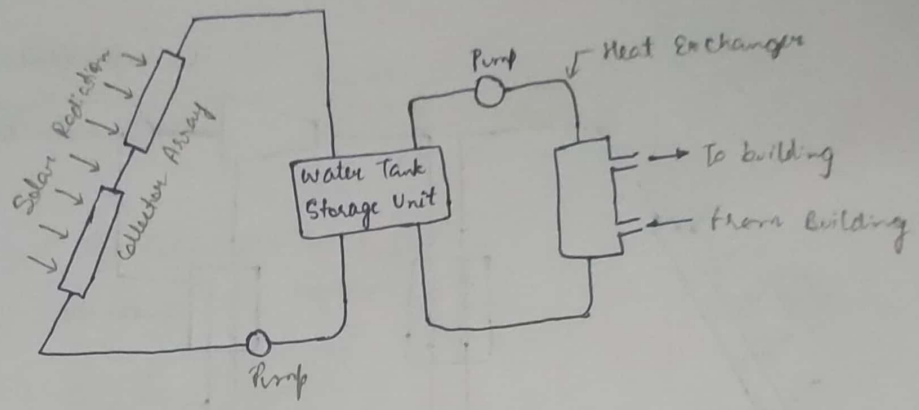


fig: Basic Space Heating System

[Also draw fig 4.6: Forced Circulation Water Heater]

- Solar Pumping
- " Cooking
- " Desalination

Solar Cooking

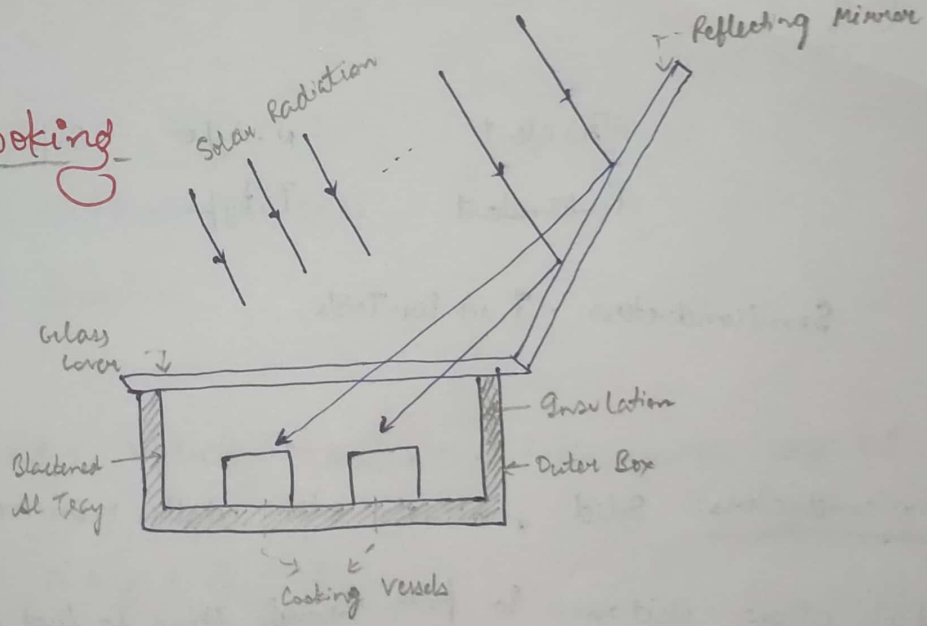
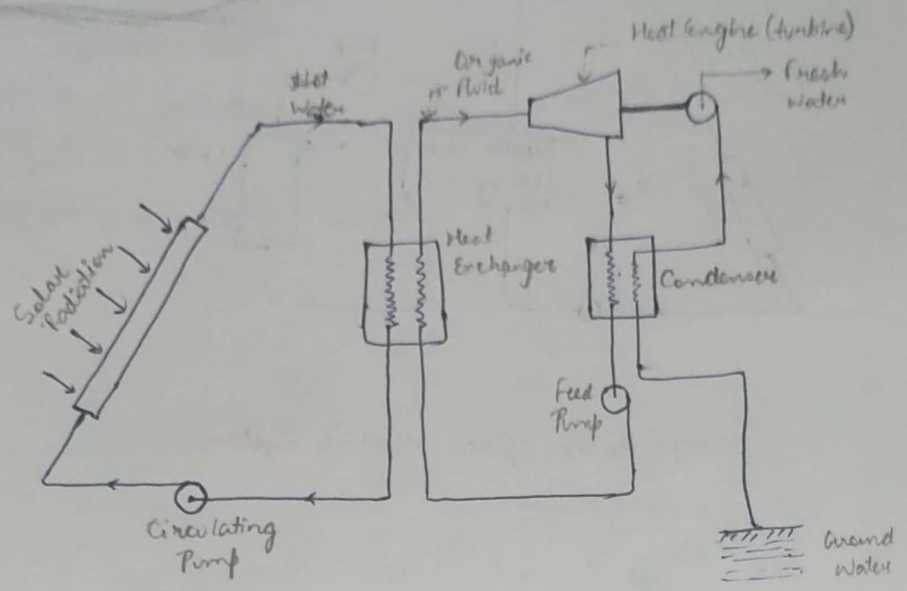


fig: Box-Type Solar Cooker

[Explain construction & working]

Solar Powered Water Pumping System



PV Cell

Trivalent	N-type	Doping	Intrinsic
Pentavalent	P-type		Extrinsic

Semiconductors - 7 in Per. Table

Semiconductors: Solid materials, either metallic, non-metallic or compands, which allow electrons to pass through them so that they conduct electricity in the same sense as metals.

Metallic conductors: Copper, Aluminium, Silver.

Semiconductors: Silicon, Germanium.

3) i) Tracking
   ii) non-Tracking

4) i) Distributor Collectors
   ii) Central Collectors

5) Installation cost of collectors is high.

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1 FLAT PLATE COLLECTOR

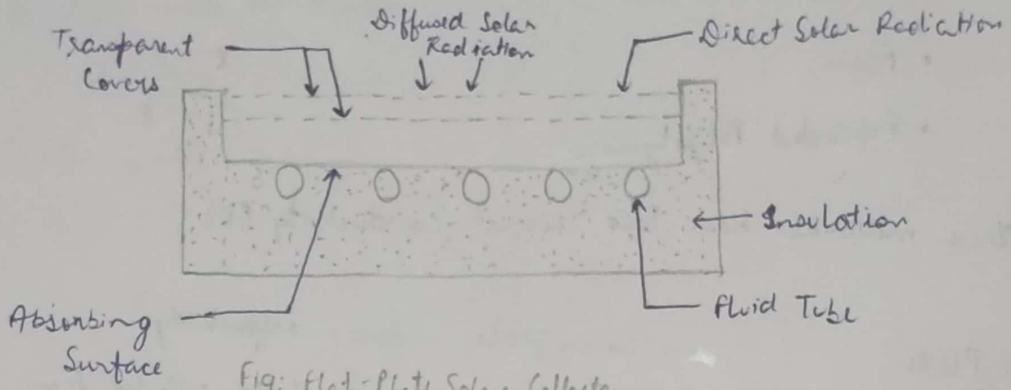

Fig: Flat-Plate Solar Collector

1) Absorber Plate: [Pic]
   > Metallic (Copper, Aluminium, or Steel)
   > It Absorbs solar radiation

[absorption coefficient + reflection coefficient + transmission coefficient = 1

$$\alpha + \rho + \tau = 1.$$]

---

i) Transparent Covers
   Reduces convection, conduction,
   & Re-radiation heat losses.

[Write Construction]
   Explain each part in detail.

iii) Insulation beneath absorber Plate:
   prevents heat losses.

→ Ideally, $\alpha = 1$ & (ρ and τ) is 0.

iv) Outer Metallic Box.

Flat Plate Collector

Absorber Plate

- Cu, Steel, Brass, Silver

→ These materials have high refl absorbitly (α),

Insulation Material

- Glass wool
- Crown white wool
- Foam
- Expanded Polystyrene

→ These materials have low thermal conductivity (K).

α = absorbity
ρ = reflexibility
τ = transmittibility

$\tau + \alpha + \rho = 1$

$\tau + \rho = 0$

$\Rightarrow \boxed{\alpha = 1}$

Cover Plate (Transparent)

- Glass
- Teflon
- Morlex

---> cover plate reduces reflexibility.

» It helps to trapp the light reflected from absorber plate (since it does not have exactly 1 absorbity).

Selection of Coating Surface:

To reduce the heat losses from the absorber plate, we have to use selective absorber coating.

> An ideal coating is a perfect absorber of Solar Radiation.

> Selective coating increases the temp. of absorbing plate.

Properties of Coating Surface:

i. low cost
ii. Easy availability
iii. High absorbitly.
iv. low reflexibility
v. low transmittibility.
vi. Must be able to

Eg of coating Surfaces:

- Black Chrome
- " copper
- " Nickel
- Silver foil
- Nextel

→ Black bitches have high absorbity.
$\alpha \approx 1$.

Advantages of Flat Plate

This can be utilized for hot water heating purposes where the water is boiled at temperature ≥ 100, which converts water from liquid to gaseous state

Disadvantages

Applications:

Factors Affecting performance of FP Collector:

↳ [explain each point]

i) Weather conditions

ii) Cloudy ∝ (cloudiness ↑ efficiency ↓) as above

iii) No. of cover plate

iv) Space b/w absorber plate & glass cover.

v) Selective Surface

vi) Fluid inlet temperature

vii) Deposition of dust particles on cover plate

vii. long life (5-66 years).

ix. Low Corrosion

viii. Properties must not vary according to Temp.

withstand atmospheric conditions. (T and P).