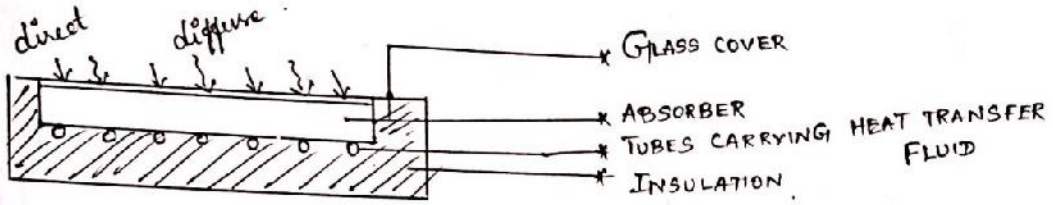
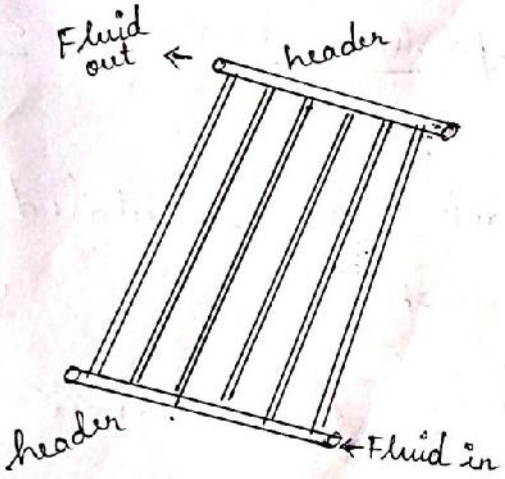
1 a)

Flat - Plate Collector :-



The basic elements are

i) transparent cover of glass / plastic
ii) blackened absorber - cu, aluminium or steel
iii) tubes, channels / passages
iv) insulated container



1b)

Dis - advantages:-

1) High cost
2) use is limited to sunny days.
3) high temp over small area.

2 a)

SOLAR STILL.

(Solar distillation or desalination of water).

→ Fresh water - water with less than 500 ppm salt content

→ Because of rapid industrialization and the population explosion the demand of fresh water has increased enormously.

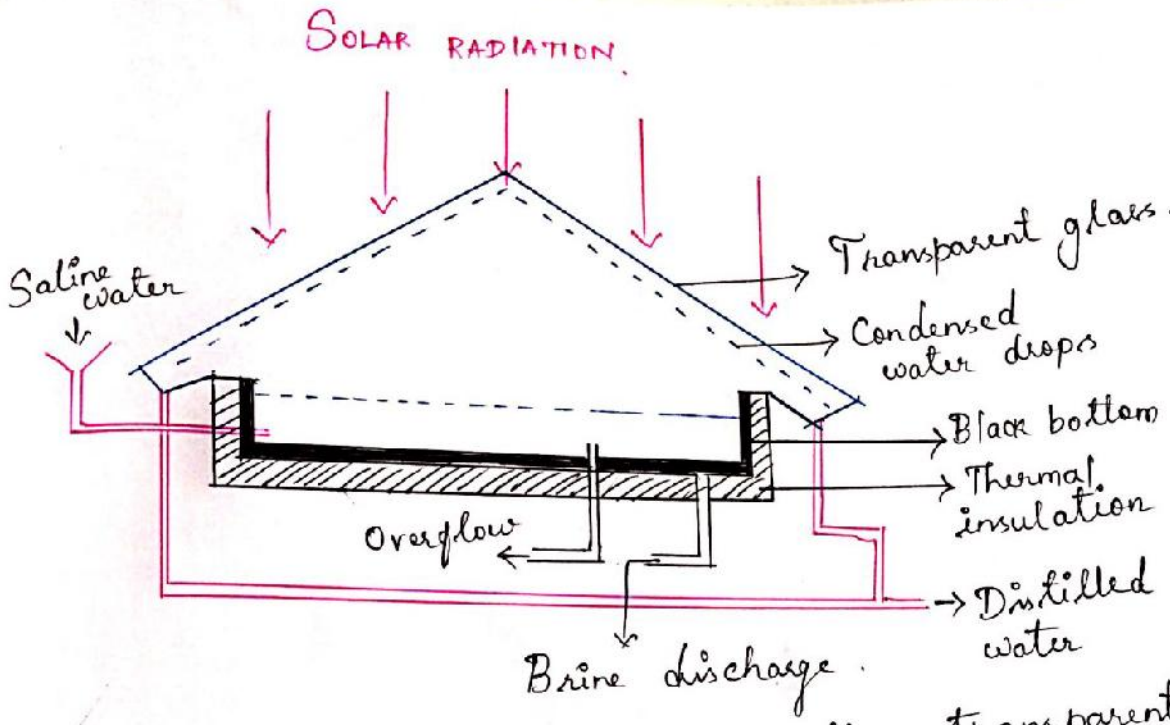
More than 2000 million people have no regular access to adequate safe water.

79% ---> salty
20% ---> brackish (less salty water from wells)
1% ---> fresh

∴ conversion of saline water thro distillation process using solar energy is a good idea.

The idea was first applied in 1872 at Las Salinas, Chile, in a plant supplying drinking water for animals. The conversion device is known as solar still.

Several types have evolved - basin type - commercially on a large scale.

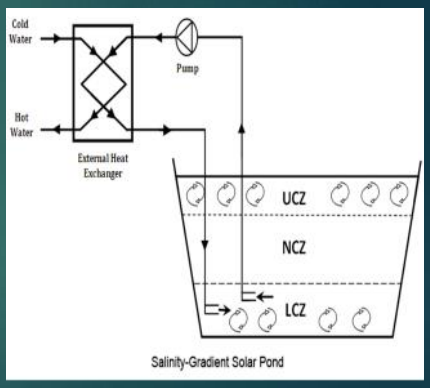


* Solar radiation falls on the transparent roop which gets absorbed by the blackened surface, thus increases the temp of water.
* Water gets evaporated and gets condensed on the cooler underneath the glass.
* The condensed water slips down the slope and is collected thro the condensate channel.

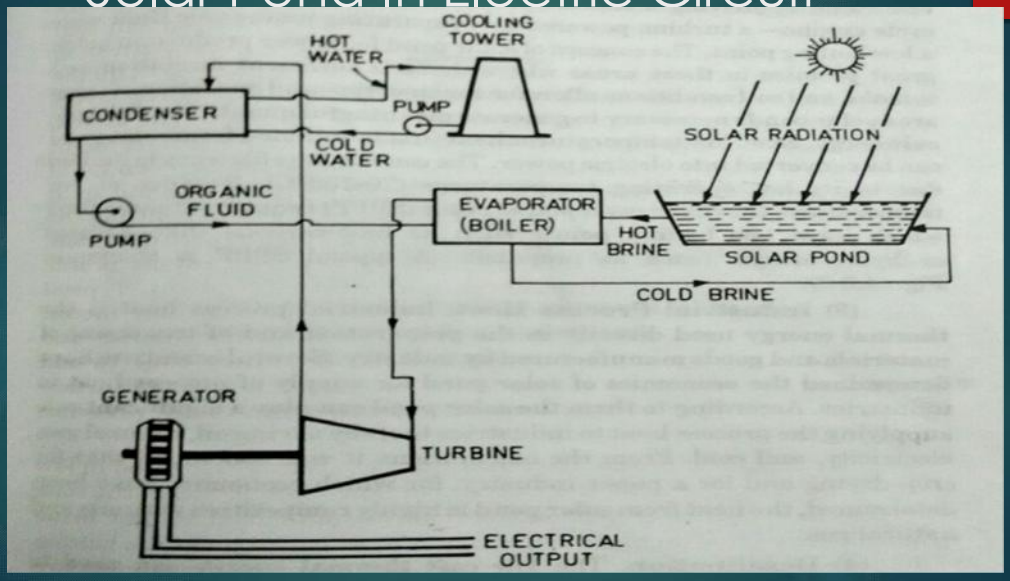
3 a)

Heat Extraction

- For application purpose heat is to be extracted from bottom layer of the pond.
- Pumping the brine i.e. saturated hot salt water through an external heat exchanger or an evaporator removes the heat from the bottom layer.
- In an heat exchanger there is inlet of cold water and outlet for hot water.
- This hot water is then used for various applications, such as thermal power plant, dairy plants,etc.



Solar Pond In Electric Circuit



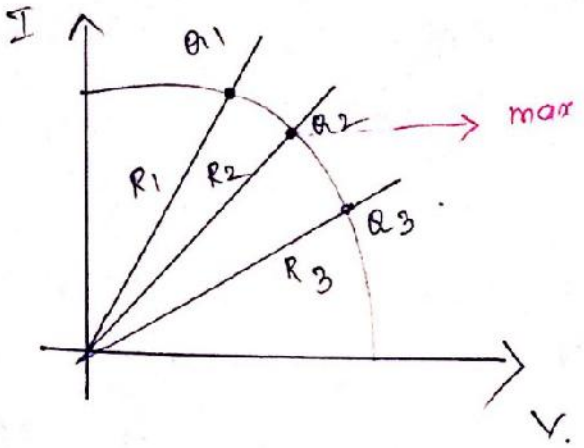
3b)

Maximum Power Point Tracking :- [MPPT]

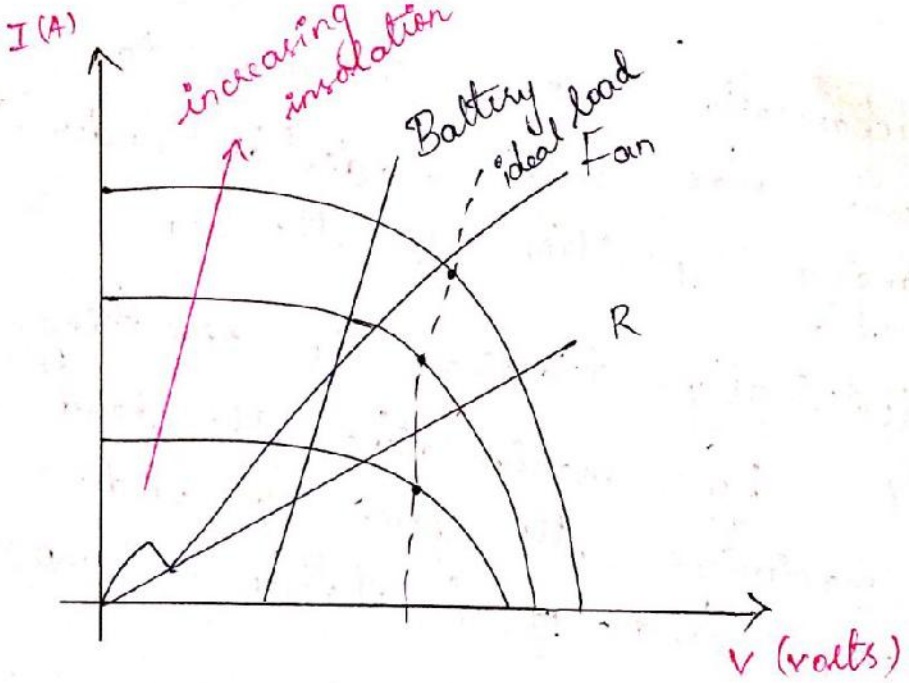
Maximizing o/p power of solar cells - two ways.

① → mechanically tracking the sun to receive max solar radiation under changing position of the sun.

② → electrically tracking the operating point. by manipulating the load to maximize the power o/p under changing conds of insolation & temp.



→ max power point.



→ if operating point deviates from MPP, it is desirable to use electronic max PP tracker. b/w PV system and load.

4 a)

UNIT - 3

SOLAR THERMAL SYSTEMS.

↳ low - grade thermal applications
eg:- cold climate - washing, cleaning, domestic and industrial needs.

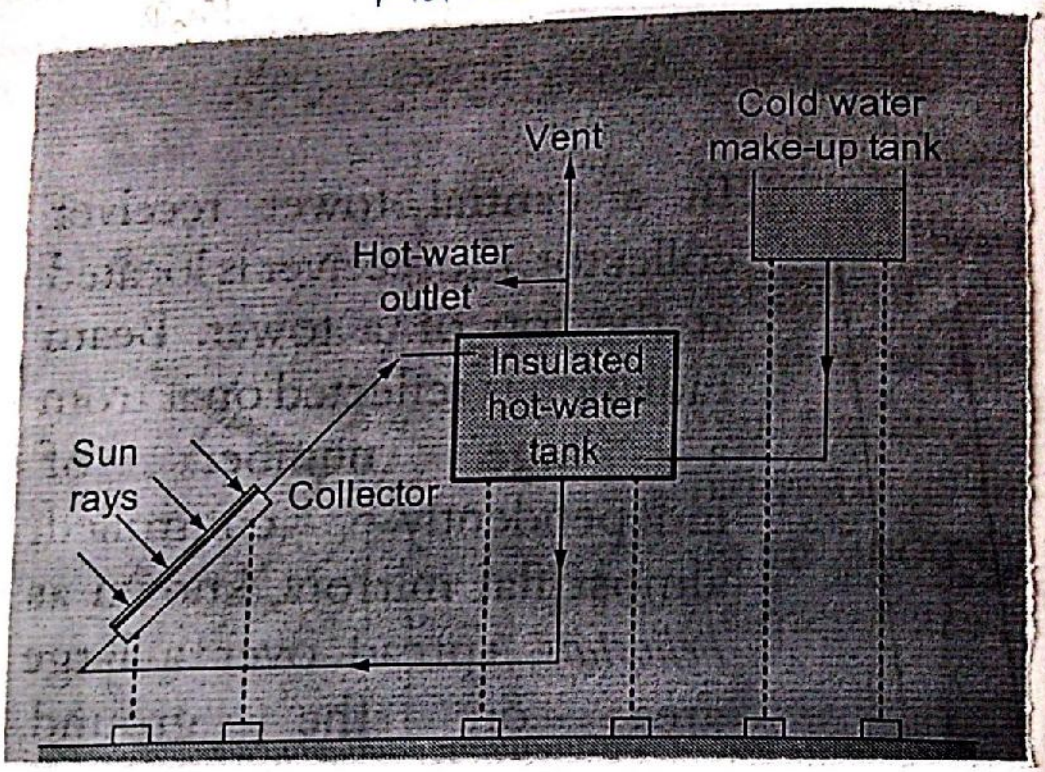
PRINCIPLE OF CONVERSION OF SOLAR RADIATION INTO HEAT :-

* Green house effect - to grow plants in cold climate thro better utilization of available sun-light.

* Radiation (short λ) - strikes a solid or liquid - absorbed - transformed into heat energy - stored as heat energy or re-radiates to other materials of lower temp as long λ rays.

* Glass acts as a "heat trap".
↳ transmits short λ - but poor transmitter of long λ.

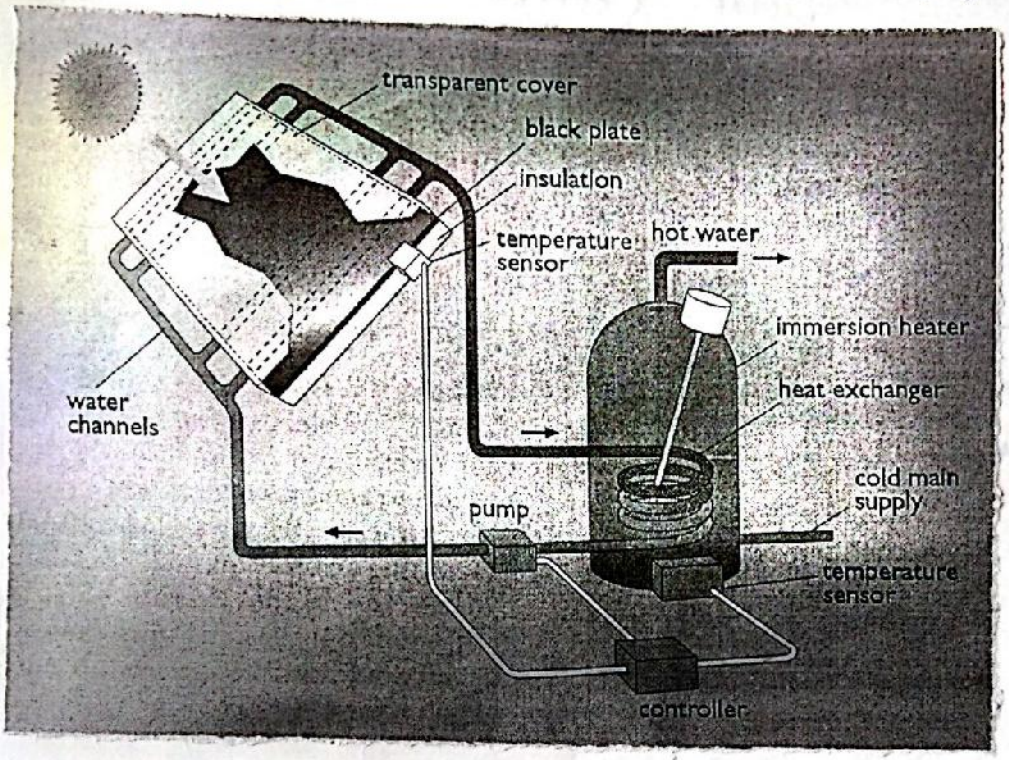
FIG: 1.



* The details of passive heating scheme is shown in fig 1.
* The hot water tank is insulated. The scheme is called passive since water is circulated naturally.
* When the collector is fixed above the level of hot water tank, a pump is required to induce circulation of water which is called ACTIVE OR FORCED THERMAL SYSTEM.

FIG 2.

FORCED THERMAL SYSTEM (SOLAR),



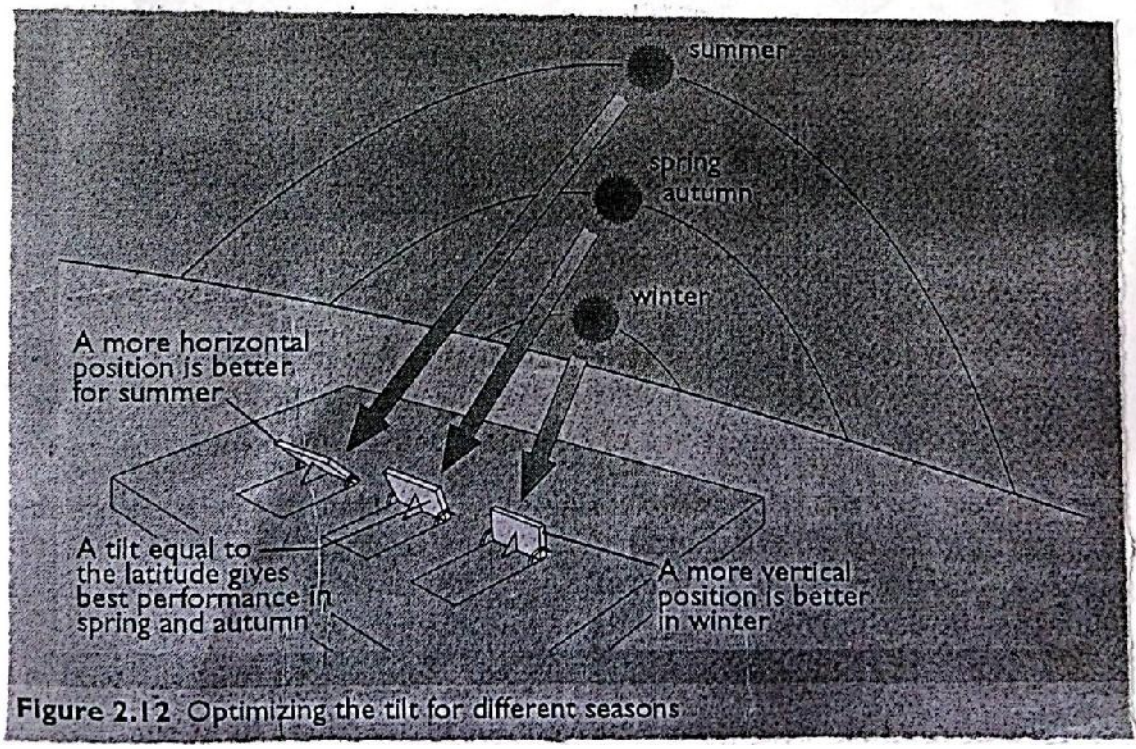
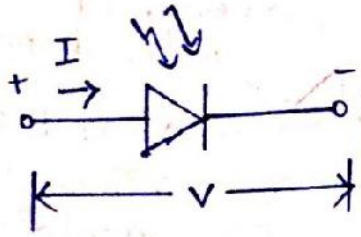


Figure 2.12 Optimizing the tilt for different seasons

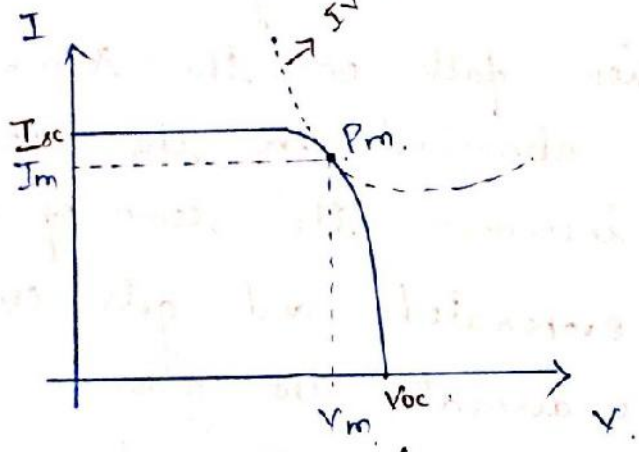
5 a)

Solar cell :-

→ Solar cell - similar to illuminated PN junction.



I-V Characteristics :-



$$I = I_{sc} - I_o \left[e^{(V/V_T)} - 1 \right]$$

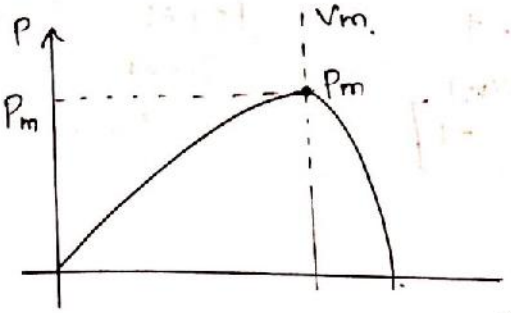
where I_o - reverse saturation current

V_T - voltage equivalent of temp

$$= \frac{KT}{q}$$

K - Boltzman's constant.

It is desirable to operate the cell to produce max power.



P_m - under incident illumination where max electrical power is obtained.

Fill Factor :-

To indicate the quality of the cell.

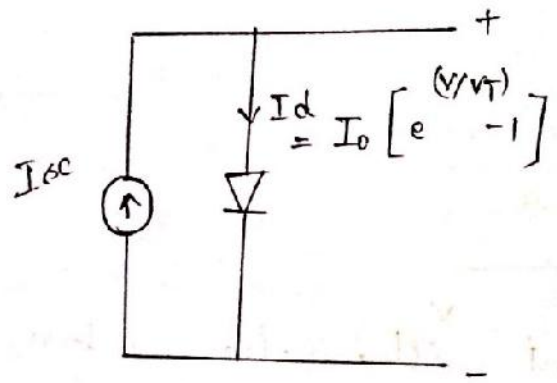
$$FF = \frac{V_m I_m}{V_{oc} I_{sc}}$$

ideal cell should have FF unity.

Conversion efficiency :-

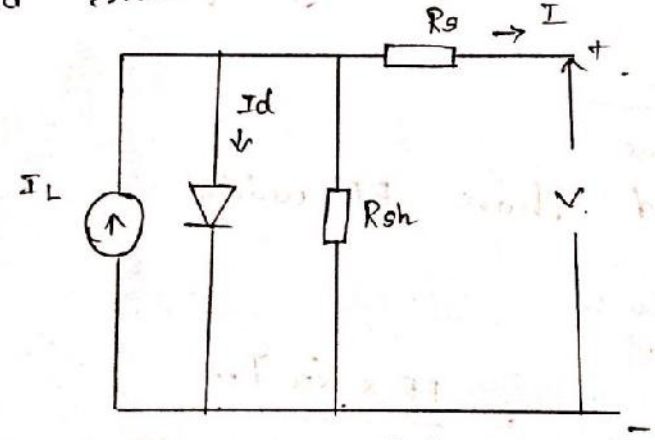
$$\eta = \frac{V_m I_m}{\text{Solar power}} = \frac{FF \times V_{oc} I_{sc}}{\text{solar power}}$$

Equivalent Circuit :-



IDEAL SOLAR CELL.

The above figure shows the ideal solar cell i.e internal series resistance zero and shunt resistance as infinite.



PRACTICAL SOLAR CELL.

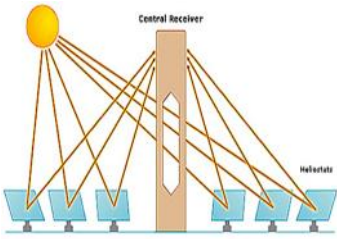
$$I = I_L - I_0 \left[e^{\left(\frac{V+IR_S}{V_T}\right)} - 1 \right] - \left[\frac{V+IR_S}{R_{sh}} \right]$$

For, one square inch silicon cell

$R_S = 0.05$ to $0.1\,\Omega$.

$R_{sh} = 200$ to $300\,\Omega$.

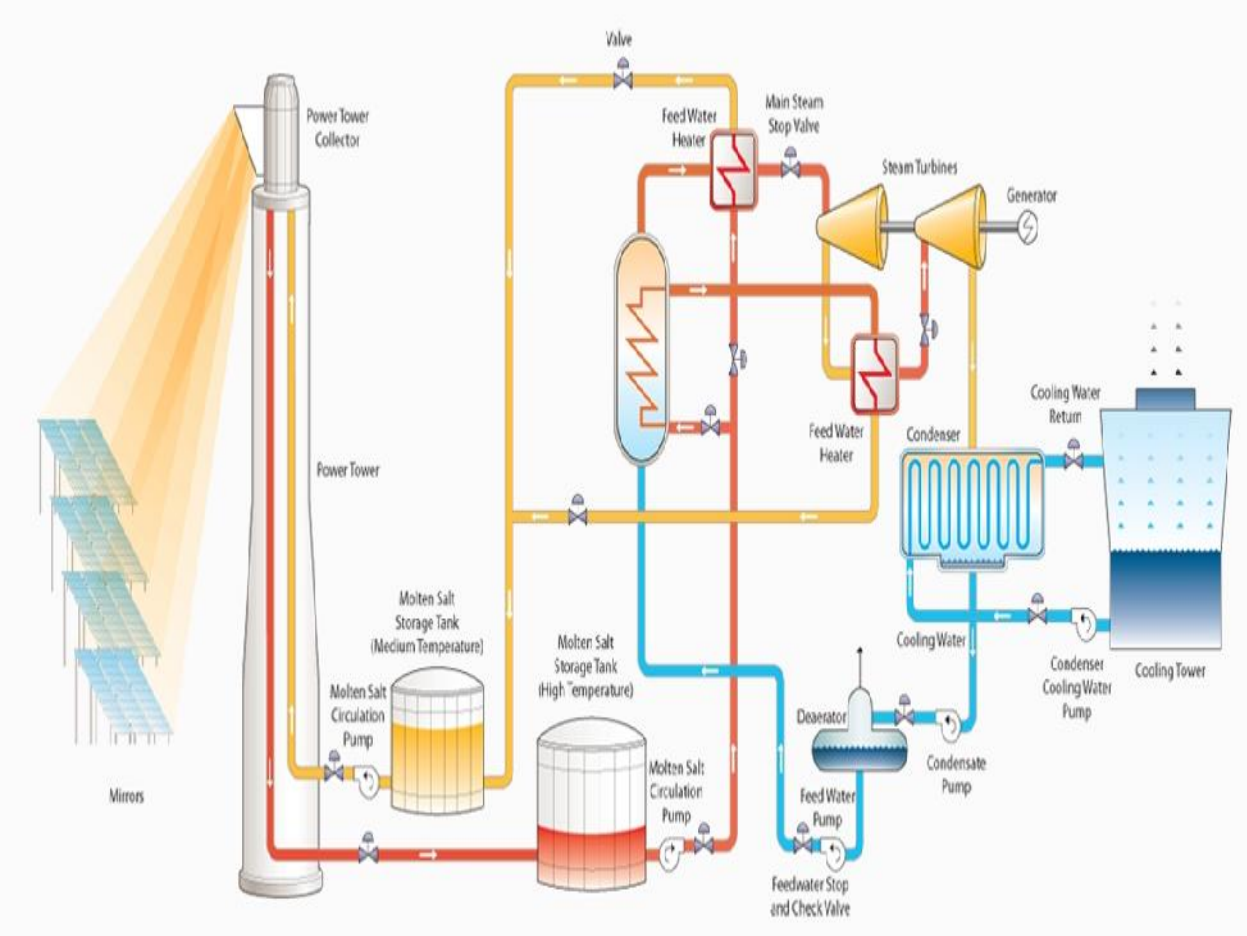
Solar power tower systems



6)

Powertowers (also known as 'central tower' power plants or 'heliostat' power plants).

- These designs capture and focus the sun's thermal energy with thousands of tracking mirrors (called heliostats) in roughly a two square mile field.
- A tower resides in the center of the heliostat field. The heliostats focus concentrated sunlight on a receiver which sits on top of the tower.
- Within the receiver the concentrated sunlight heats molten salt to over 1,000 °F (538 °C).
- The heated molten salt then flows into a thermal storage tank where it is stored, maintaining 98% thermal efficiency, and eventually pumped to a steam generator.
- The steam drives a standard turbine to generate electricity.


Valve
Power Tower Collector
Feed Water Heater
Main Steam Stop Valve
Steam Turbines
Generator
Power Tower
Feed Water Heater
Condenser
Cooling Water Return
Molten Salt Storage Tank (Medium Temperature)
Molten Salt Storage Tank (High Temperature)
Molten Salt Circulation Pump
Molten Salt Circulation Pump
Cooling Water
Condenser Cooling Water Pump
Cooling Tower
Deaerator
Condensate Pump
Feed Water Pump
Feedwater Stop and Check Valve
Mirrors

7)

SOLAR GREENHOUSE

→ Greenhouse - proper environment (enclosure) for growth and production of (crops, veg and flower) plants.

→ Design of green house depends on local climatic conds.

→ Basically all plants require moderate temp and light - adequate CO_2, O_2, minerals, air movement and water.

Refer the table for desired environment for growth of plants.

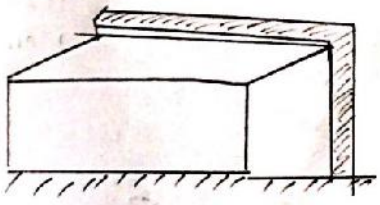
Greenhouse

- active (natural means)
- passive (auxiliary means).

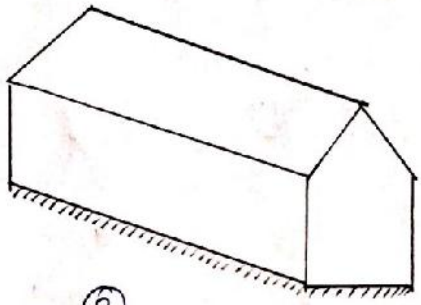
A greenhouse designed to use solar energy to meet these requirements - solar greenhouse.

Types of green house frames.

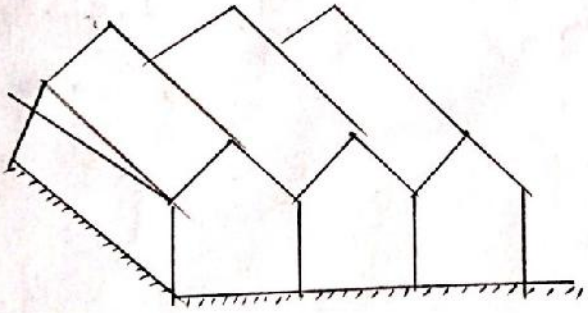
1) Lean to style
2) Single independent style
3) Ridge and furrow style.



① Lean to Style



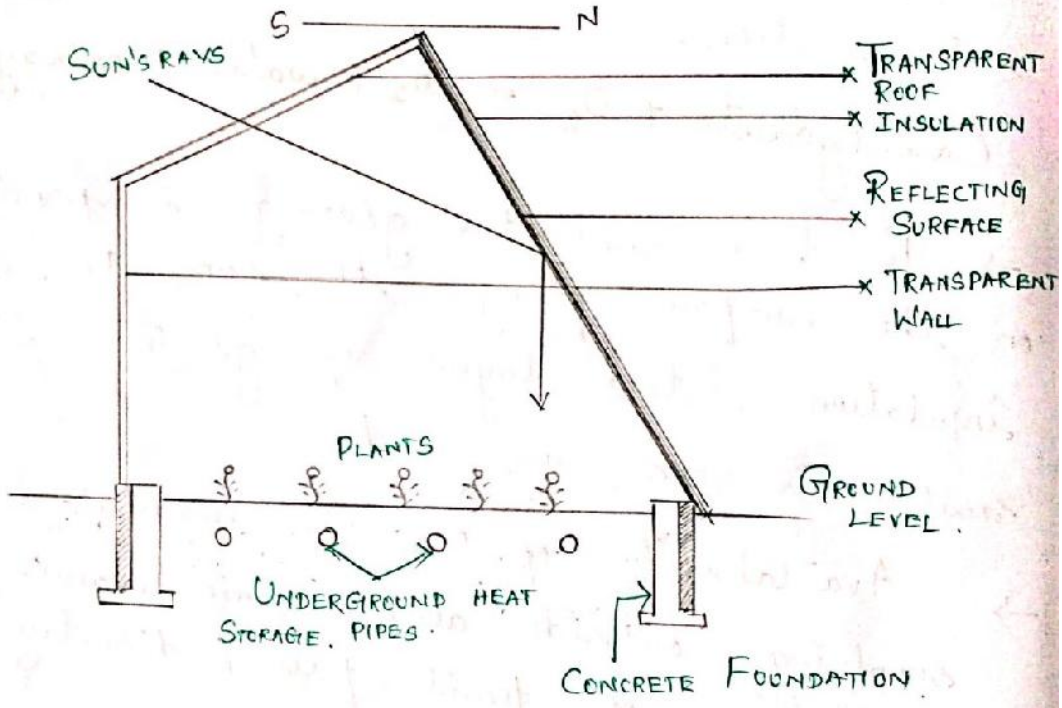
② Single independent style.



③ Ridge and furrow style.

instead of heating is required. To maintain temp - evaporative cooling, fans and wet pads are used. The cooling system is based on - principle that heat is absorbed for evaporation of water.

WINTER GREENHOUSE:



→ The frame of the entire greenhouse is made of wood. The east and west facing walls are provided with a single layer of rigid transparent fiberglass sheets.

→ Underground pipes - to store thermal energy during day time.

→ At the time of surplus heat - air from growing area is blown out thro these pipes to store excess heat

→ At night, heat is recovered by reversing the direction of air-flow thro the pipes.

SUMMER GREEN HOUSE:

→ the important requirements are maintaining moderate temp by reducing cooling loads and provide adequate solar radiation.