Solar Radiation :-

* The power of the sun intercepted by earth is 1.8×10^{11} MW. and if we harness. this energy with the 0.01 % efficiency it is sufficient for world power consumption.

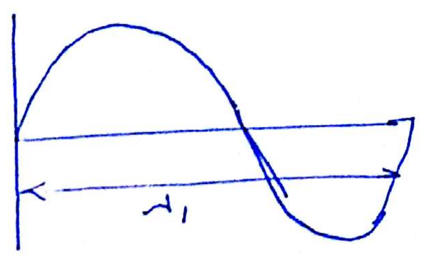
* The solar radiation flux having a maximum value of 1 kW/m^2 and over a day it is maximum of 7 kWh/m^2.

Solar energy Quantification :-

D_s = 1.39×10^6 km Diameter of sun

D_e = 1.27×10^4 km Diameter of earth

L_m = 1.5×10^8 km mean distance between sun & earth



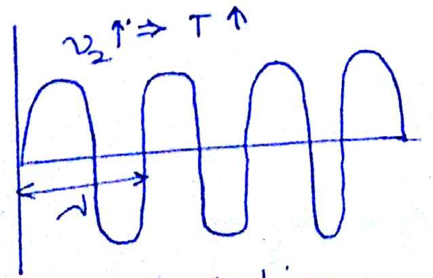
Frequency ∝ temp

$\nu \propto T$

$\lambda \propto \frac{1}{\nu}$

$\lambda . \nu = \vec{c}$

$\Rightarrow \nu \propto T \propto \frac{1}{\lambda}$

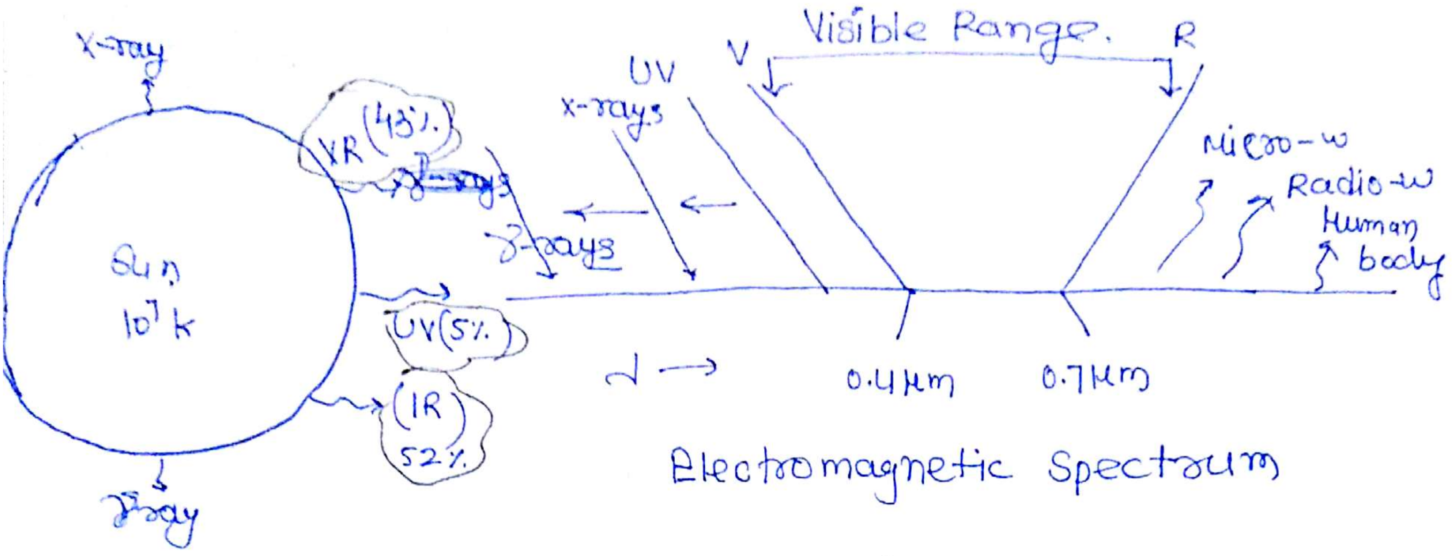


More penetration

$\Rightarrow \lambda . \nu = c \; (3 \times 10^8 \, m/s)$

$\lambda . T$ = Const. (2898 μm-K)

$\frac{\nu}{T} = \frac{c}{2898}$



Electromagnetic Spectrum

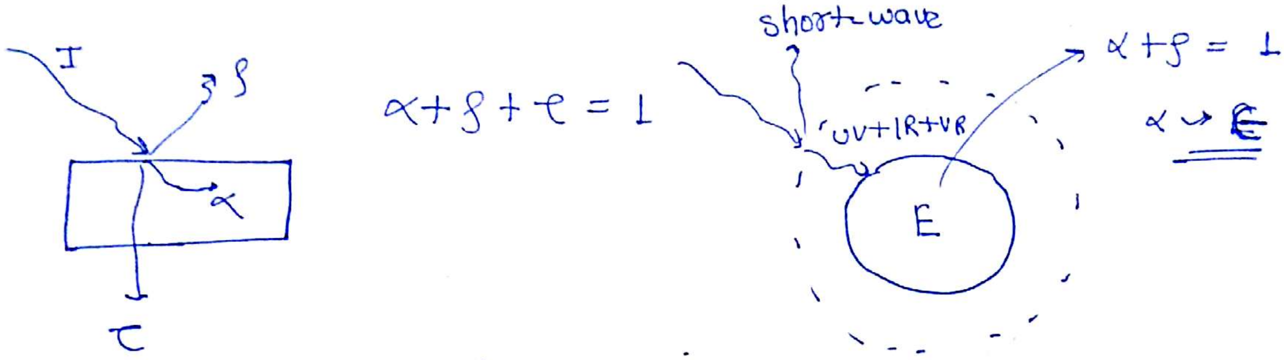
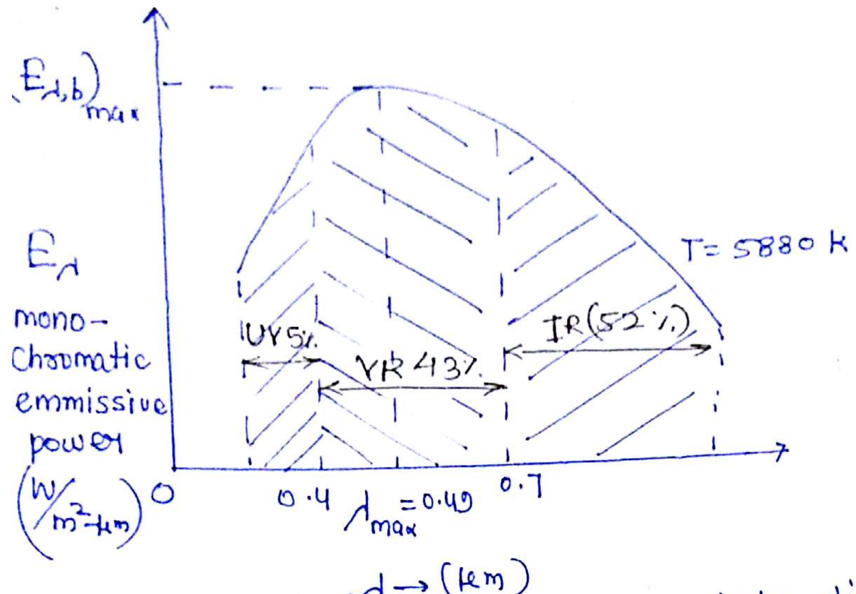


Fig:- Basic surface property

UV - Ultra Violet. (5%)
VR - Visible range (43%)
IR - Infrared (52%)

Electromagnetic spectrum of solar Radiation :-

* Solar radiation covers the entire range of visible region and some part of UV & IR waves.
* The maximum emmissive power reaching the earth surface (extraterrestrial solar flux) is in the Infra red region but the maximum monochromatic or spectral emmissive power is in the visible region ($\lambda_{max} = 0.49\ \mu m$)



Plank's law

$$E_{\lambda,b} \propto \frac{1}{e^{\frac{C_2}{\lambda T}}}$$

wein's displacement law

$$E_{\lambda,b} \propto \frac{1}{e^{C_2/\lambda T}} \rightarrow \lambda_{max} \cdot T = 2898 \ \mu m - k$$

(for black & Gray body not valid for real surface)

Stefan-Boltzman law

$$E_b = \int_0^\infty E_{\lambda,b} \cdot d\lambda = \sigma T^4$$

~~kelvin law~~ Kirchaf's law

At thermal eq^m

$$\boxed{\alpha = \epsilon}$$

Question Determine the range of wavelength for which earth surface is emmiting max. spectral emisive power if the earth temp range from 250 to 300 K

sol^n

$$\lambda_{m_1} \, 250 = 2898 \Rightarrow \lambda_{m_1} = 11.592 \ \mu m$$

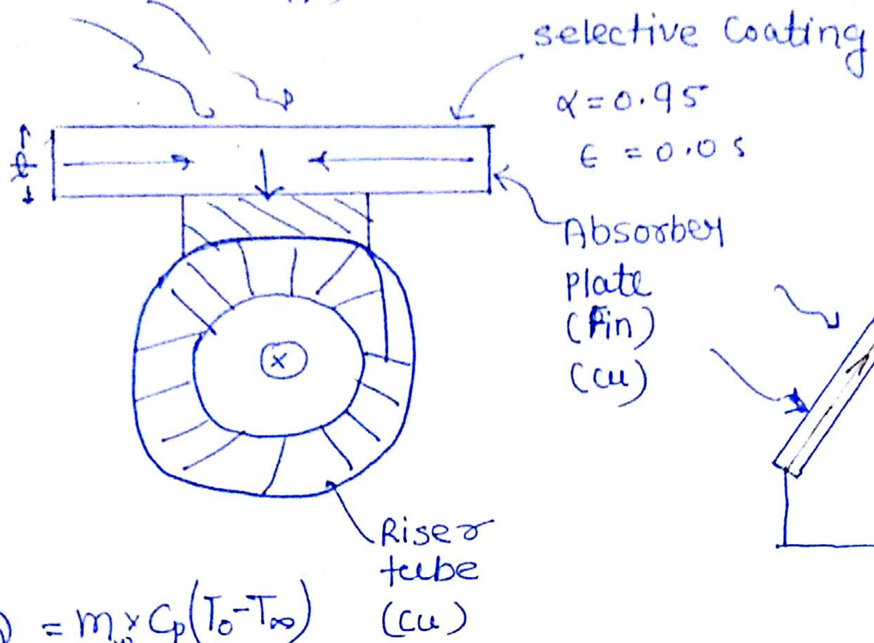
$$\lambda_{m_2} \cdot 300 = 2898 \Rightarrow \lambda_{m_2} = 9.66 \ \mu m$$

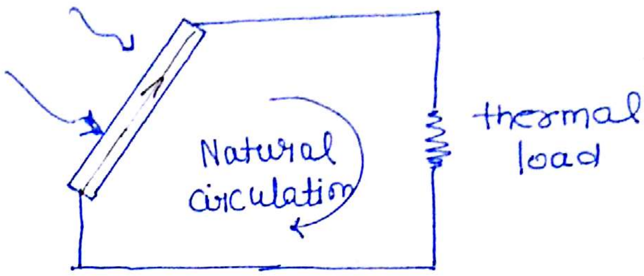
So the range of wave length in which earth emit max. spec. emmisive power is

$$\lambda_m \in (11.59, 966) \ \mu m$$

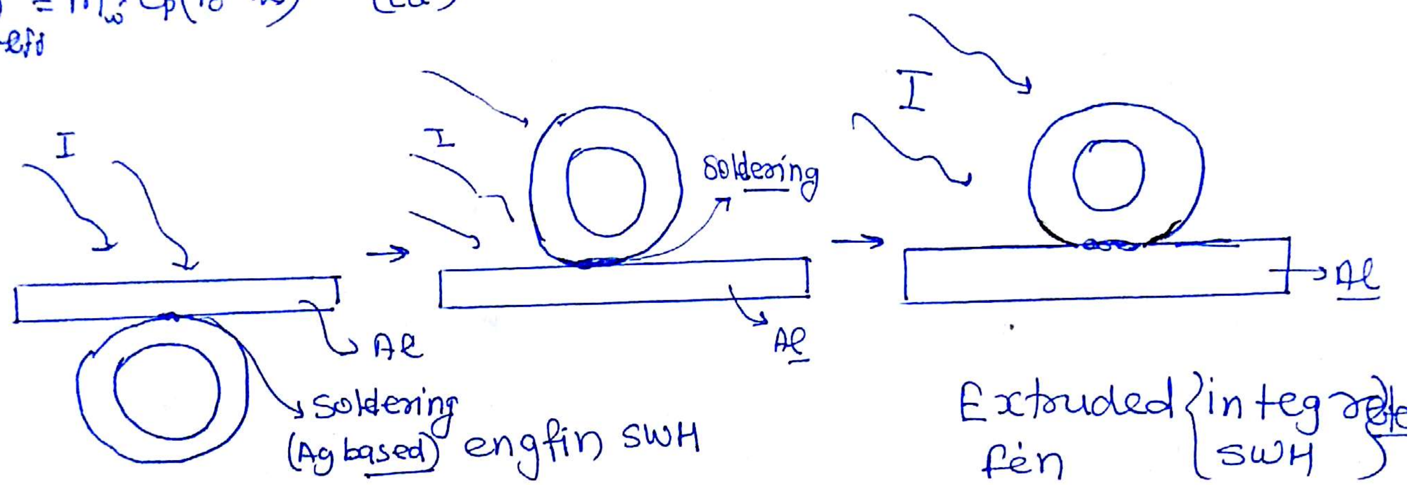
Solar water Heater Analysis:—

$I \simeq (1\,kW/m^2) \times A_C$





$Q_{eff} = m_w \times C_p (T_o - T_\infty)$



Top fin solar water heater (SWH)

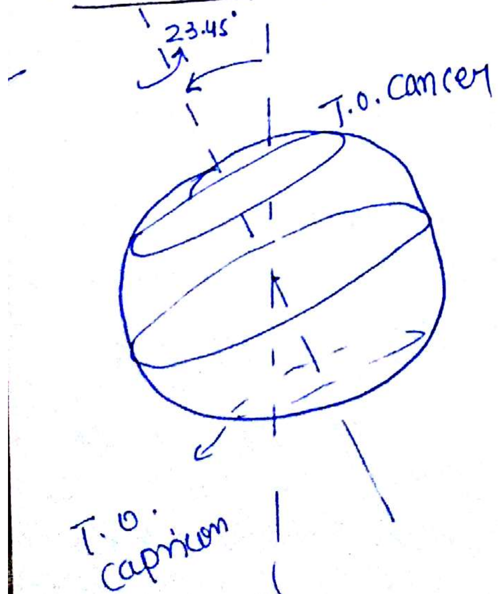
engfin SWH

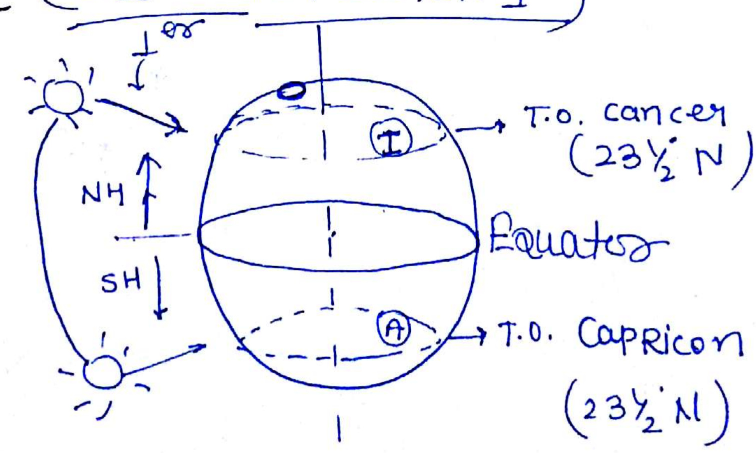
$\Delta T = 2^\circ$

Extruded fin {integrate SWH}

$\frac{\dot{Q}_u}{I \times A_C} = \eta$ (efficiency)

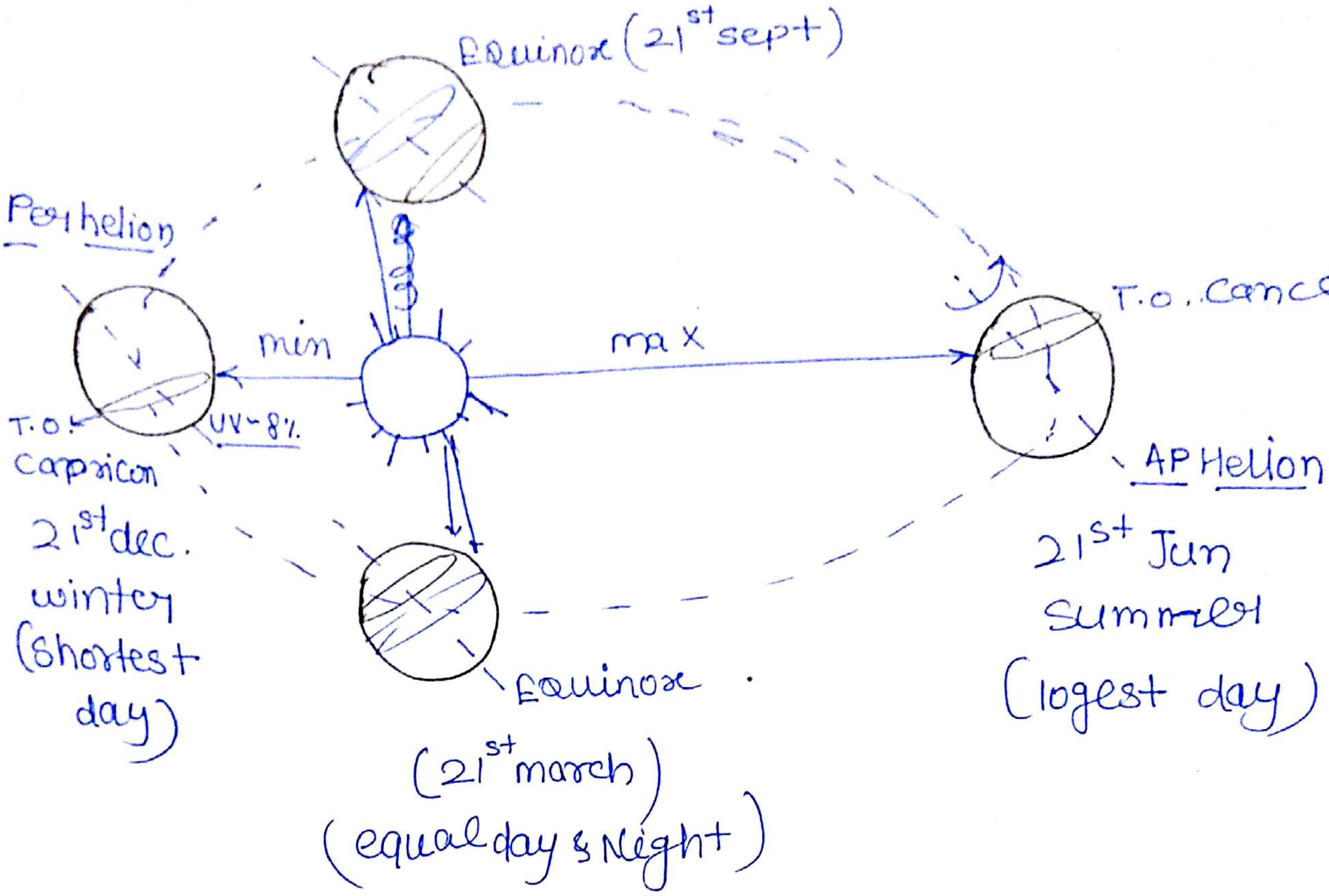
Solar flux Variation (I_{sc} = Solar Const. $\perp^r$)





NH - Northern Hemisphere

SH - Southern Hemisphere

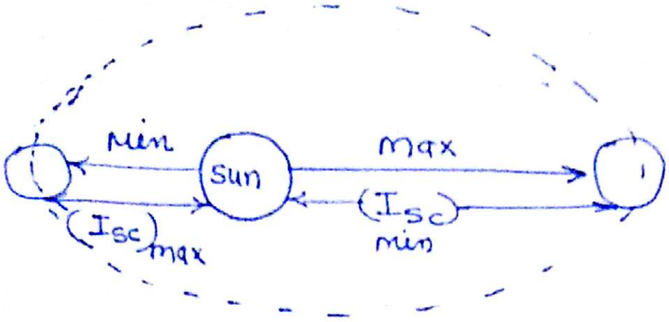


The orbit on which earth revolves around the sun is eliptical hence the distance between the earth and sun varies w.r.t. day.
The maxn solar flux strike the earth surface is on 21st Dec. in Southern hemisphare whereas the min on 21st Jun in Northern hemisphare (NH) in ⊥er direction.

Solar Constant :- The energy flux receive from the flux to the outside surface of earth.

$$I_{sc} = 1367 \; W/m^2 \rightarrow \text{Solar Constant.}$$

* The orbit of the earth on which earth revolves around the sun is eliplipticalhence the mean distant b/w sun and earth varies and so thus the solar constant also changes.



$I_{sc} = 1367\ W/m^2$

total variation of $I_{sc} = \pm 3.3\%$

for n^{th} day

$$I'_{sc} = I_{sc}\left\{1 + 0.033\cos\left(360^\circ \times \frac{n}{365}\right)\right\}$$

$\cos\theta$ — Max = +1, min = −1

$n \rightarrow n^{th}$ day

$n = 1 \Rightarrow$ 1 Jan.

For Jun 21, $n = 31+28+31+30+31+21 = 172$

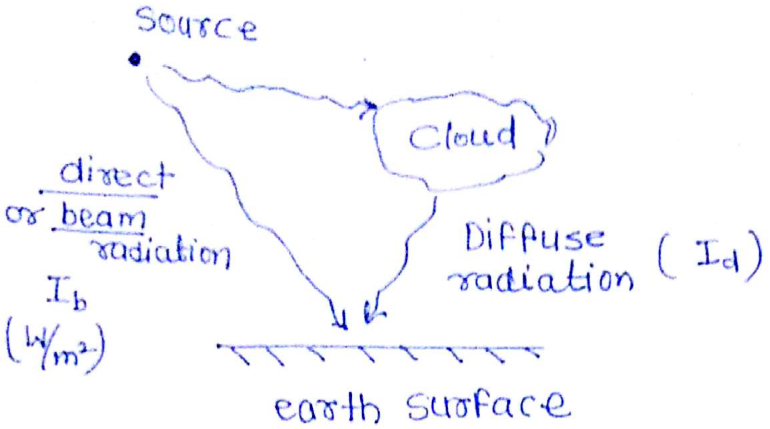
$I'_{sc} = 1320.6\ W/m^2$

For Dec 21, $n = 355$

$I'_{sc} = 1411.4\ W/m^2$

Effect of Enviroment on Solar radiation:—

Solar radiation recipive on the earth surface are under gone Absorption, scattering or reflection from the ozone layer and water vapour.



Total Radiation I_g = Global radiation = $I_b + I_d$

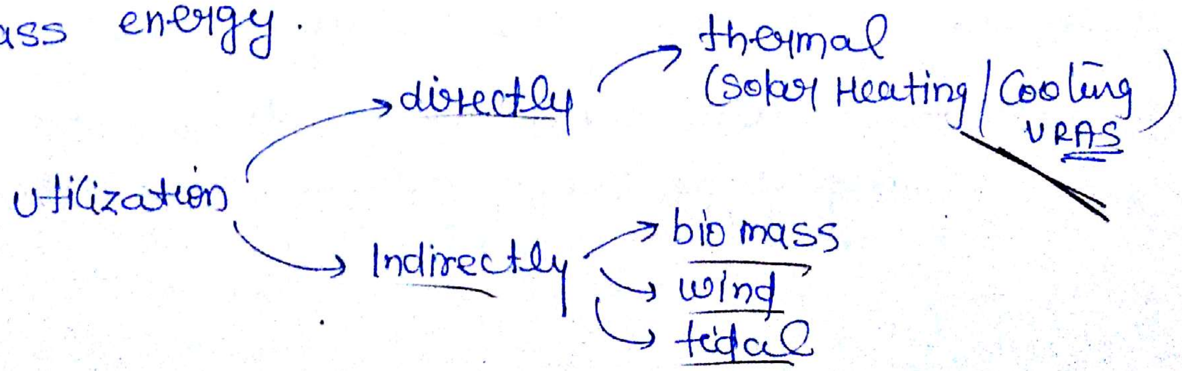
Direct/Beam Radiation:- Solar radiation receive at the surface of earth in line with the sun is know as direct radiation

Diffuse Radiation:- Solar radiation receive on the earth after getting scatter because of the atmosphere of earth.

Utilization Method for solar Energy:-

Solar energy can be utilise directly or indirectly in which directly heat of water or air or Conversation of solar into electricity.

Indirect method of solar energy drives the ecology System. some of the examples are. wind energy and Bio-mass energy.



Directly :-

(A) Thermal – solar heating or Cooling

Solar Power Plant :-

→ any fluid which have energy called turbo

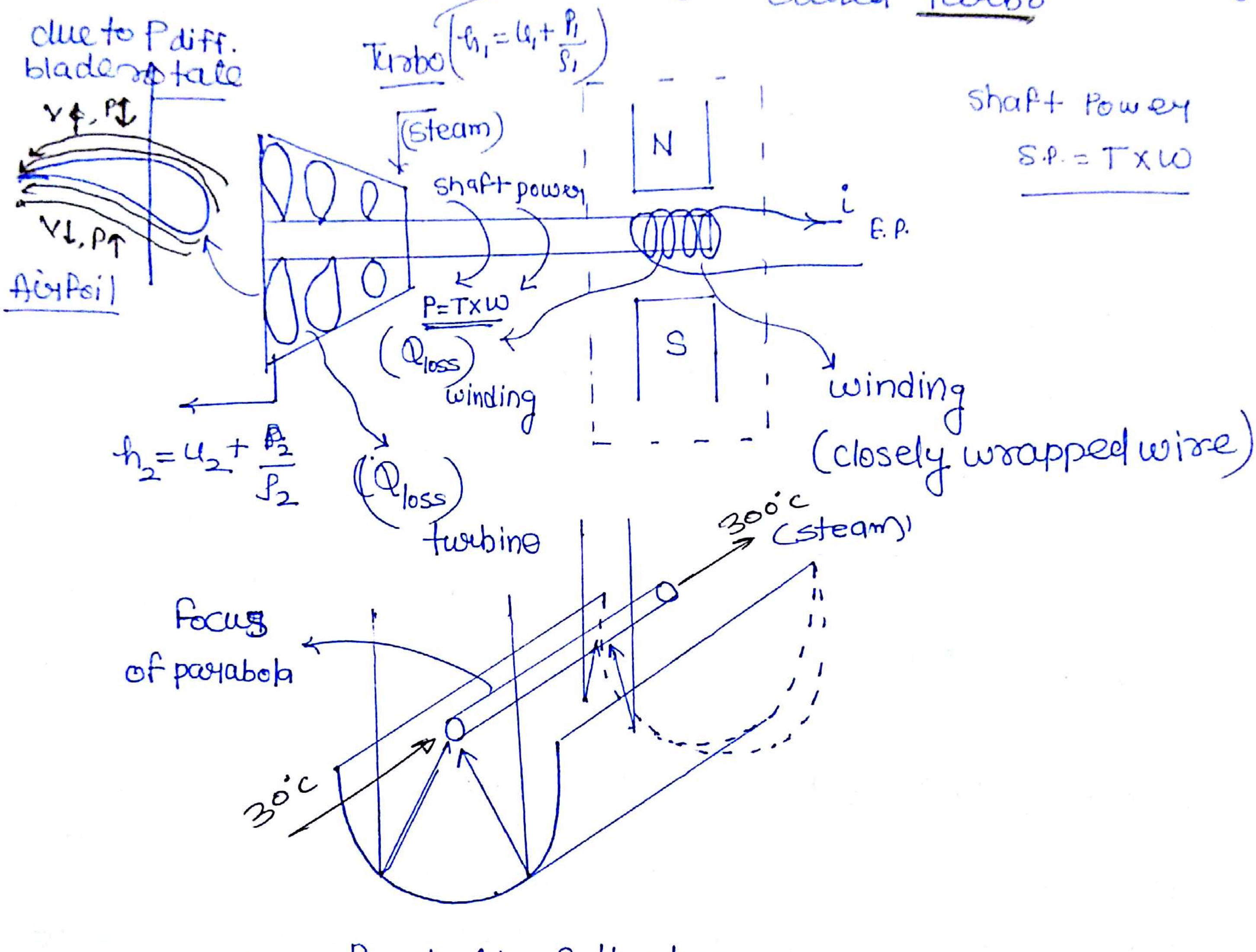


Fig:- Parabolic Collecter

* A high energy containtent fluid (turbo) is entered into the turbine and losses its energy and that energy is given the turbine shaft power
* In order to create high energy fluid like steam concentrating type soler collertor are used.

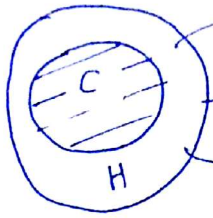
*

(B) Photo-Volatic

{ Solar energy $\xrightarrow{\text{Directly}}$ Electrical energy }

Indirectly

Bio mass :-



'H' Comb. first
'H' Comb. Rapidly
$\Delta_H >> \Delta_C$

* $CH_4 + 2O_2 \longrightarrow 2 \cdot H_2O + CO_2$

stiochimetry reaction / perfect Combustion

* $C_3H_8 + 5O_2 \longrightarrow 4H_2O + 3CO_2$

C – O – O → CO_2
C – O – O → CO_2
C – O → CO

let 10% less O_2

$C_3H_8 + 4.5O_2 \longrightarrow 4H_2O + CO + 2CO_2$

$$\% CO = \frac{1}{4+1+2} = 14.28\%$$

Gate-2016

$C \xrightarrow{O} CO \xrightarrow{O} CO_2$

* First rapidly 'H' Comb. happens and H_2O becomes then rest O_2 make CO and then CO_2

* $C_8H_{18} + 12.5 O_2 \longrightarrow 9H_2O + 8 CO_2$ Complate combustion

* ~~Stub~~ let $10 O_2$

$$C_8H_{18} + 10 O_2 \longrightarrow 9H_2O + 5 CO_2 + 3 CO_2$$

$$\% CO = \frac{5}{9+5+3} = 29.4\%$$

पहले H_2O बनेगा   11→0 left

fhir CO ⇒ एक एक O से और फिर CO_2

C–O–O ⇒ CO_2 C–O ⇒ CO

C–O–O ⇒ CO_2 C–O ⇒ CO

C–O–O ⇒ CO_2 C–O ⇒ CO

C–O ⇒ CO   C–O ⇒ CO

⇒ $5CO + 3CO_2$

* $$C_{10}H_{22} + 15.5\left\{O_2 + \frac{79}{21}N_2\right\} \longrightarrow 11 H_2O + 10 CO_2 + 15.5 \times \frac{79}{21} N_2$$

11 + 20 = 31 O require

So $15.5 O_2$

Air

- 21% → O_2
- 79% → N_2
- for 1 O_2: $\frac{79}{21} N_2$

let $10.5 O_2$ then

$$C_{10}H_{22} + 10.5\left\{O_2 + \frac{79}{21}N_2\right\} \longrightarrow 11 H_2O + 10 CO + 10 \times \frac{79}{21} \times N_2$$

10→0 left

$$\text{So. } \% CO = \frac{10}{10 + 11 + 10 \times \frac{79}{21}} = 17.05\%$$

* $C_{10}H_{22} + 20\{O_2 + \frac{79}{21}N_2\} \longrightarrow 11\,H_2O + 10.CO_2 + 20 \times \frac{79}{21} N_2 + 4.5\,O_2$

let $20\,O_2$

$$N_2 \xrightarrow[\text{High temp.}]{\text{oxidation}} NO_x$$

Lattitude and longgitute :- Definition of Angle

Lattitude Angle(ϕ) :- The lattitude of a location P is the Angle made by the redial line Joining the location to the center of earth with the projection ~~on~~ of line on equitorial plane.

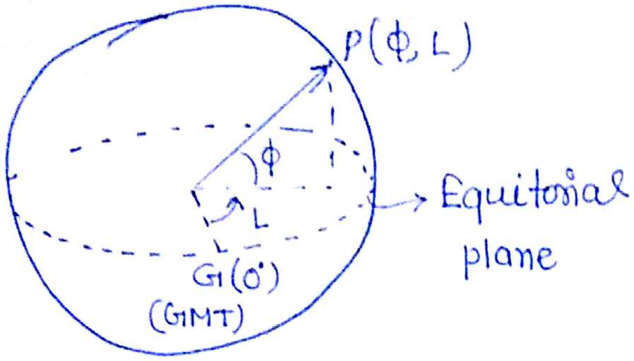
Sign Convention :-

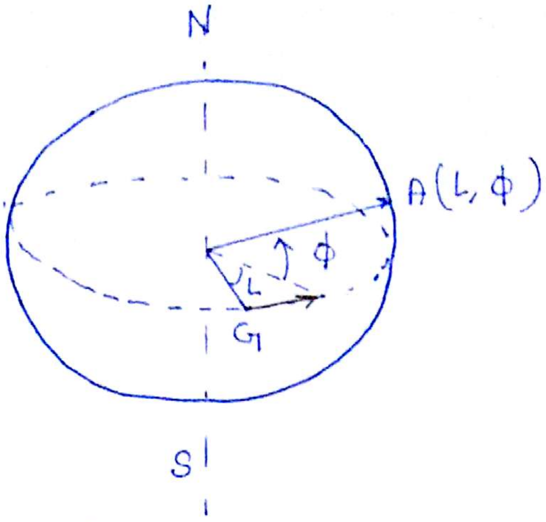
$\phi \rightarrow$ Lattitude → $\phi°$ N, → $\phi°$ S

Longitude (L) :- longitude is measured from the refrance point Greenwhich, England and it is the angle between the projection of line of any point P on equitorial plane the projection of line having lattitude of Greenwhich.

sign convention

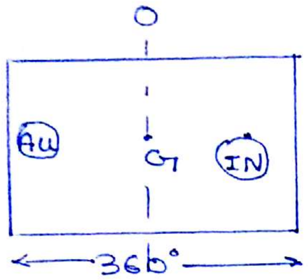
$L \rightarrow \theta°$ E / W } from Greenwhich england





G - Greenwhich

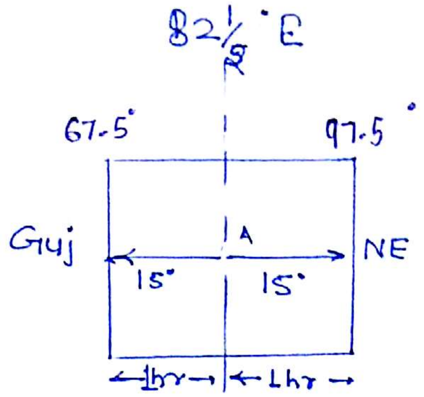
GMT - Global Meridian time (Greenwhich)



one day = 360°

1 hr = $\frac{360}{24} = 15°/hr$

Solar Noon = 12:00



A - Allahbad Mirzapur

Diff b/w Allahabad & Green which

$= \frac{82\frac{1}{2}°}{15°} = 5.5$ hrs

(depand only one longitute)

$$\text{Solar time} = \text{Watch time} - 4(L_{ST} - L_{lo})$$

$$ST = WT - 4(L_{st} - L_{lo})$$

L_{st} = longitude of standard Maridian (Country)

L_{lo} = local longitude

$(ST)_{NE} = 12 - 4(-15) = 1300$ hr

$(ST)_{Guj} = 12 - 4(15) = 1100$ hrs