

The background features abstract, flowing lines in shades of purple, green, and blue, interspersed with small yellow triangles, creating a dynamic and artistic feel.

Theme 5

Renewable Energy Technologies

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MAIN RENEWABLE ENERGIES IN VIETNAM

- Solar energy
- Wind energy
- Bio-fuels, biomass and biogas
- Small hydropower
- Rubbish and industrial waste
- Geothermal energy
- Tidal energy



IMPORTANT RENEWABLE ENERGIES IN VIETNAM

- Solar energy
- Wind energy
- Bio-fuels, biomass and biogas
- Small hydropower

A decorative graphic on the left side of the slide featuring three balloons: a green one at the top, a light blue one in the middle, and a purple one at the bottom. Each balloon is attached to a streamer and has several small yellow triangular flags hanging from it.

5.1. SOLAR ENREGY

A decorative graphic on the left side of the slide features three balloons: a green one at the top, a light blue one in the middle, and a purple one at the bottom. Each balloon is attached to a streamer and has several small yellow triangular flags hanging from it.

5.1.1. FUDAMENTAL



• SOLAR PROPERTIES

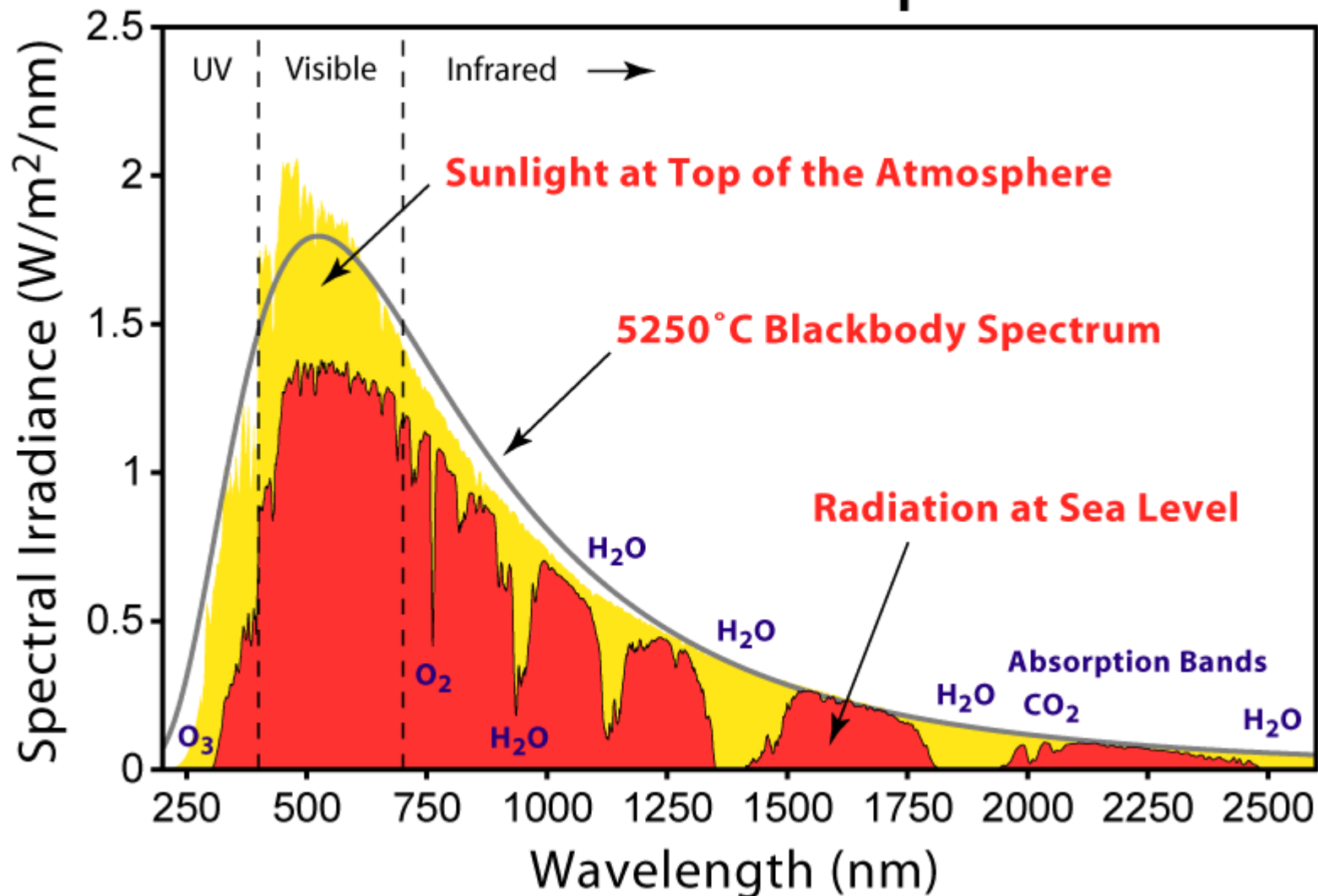
- Diameter: $1,39 \cdot 10^6 km$
- Distance to the earth: $150 \cdot 10^6 km (\pm 1,7\%)$.
- Surface temperature: $6000 K$
- Core temperature: $8 \cdot 10^6 K - 40 \cdot 10^6 K$



Solar radiation

- **Similar to the radiation generated from absolute black object at around 6000K**
- **Solar radiation consist of 8% Ultraviolet, 44% visible and 48% infra-red.**

Solar Radiation Spectrum



EARTH SURFACE REFLECTION

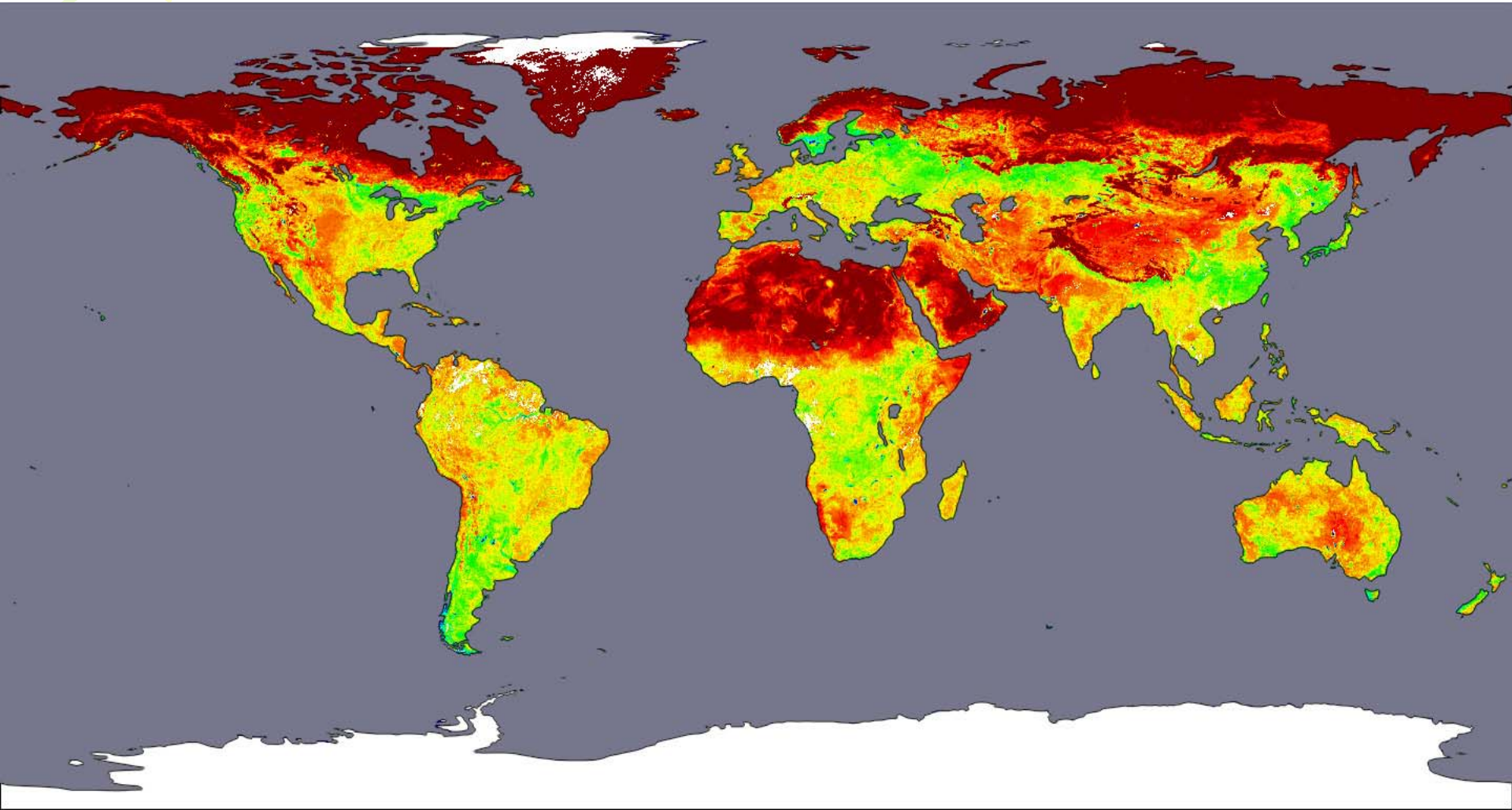
@ The reflection of solar radiation depends on the characteristics of the surface

@ ALBEDO of one surface is percentage of solar radiation reflected by that surface

@ ALBEDO:

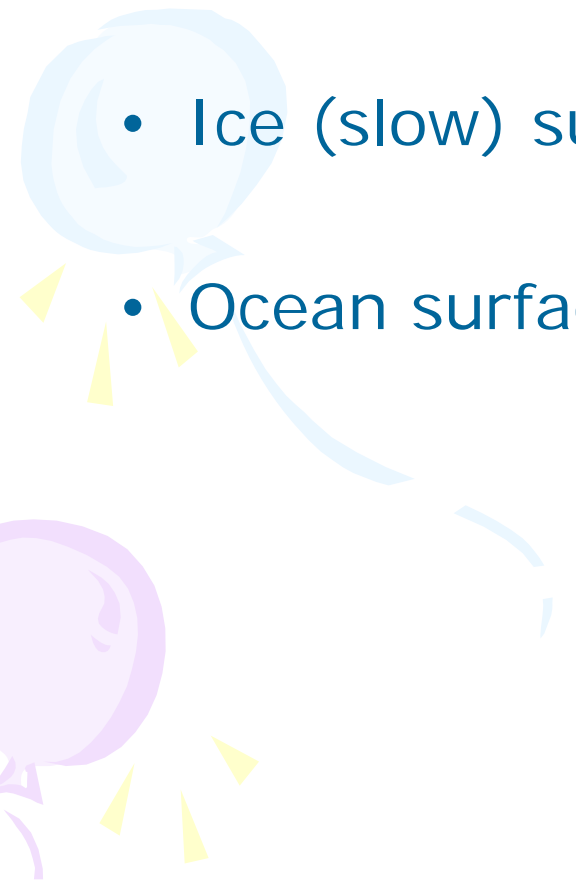
Type of surface	Vegetational cover	Dark-color soil	Light-color soil	Water	Cloud
<i>Albedo</i>	0,2	0,1	0,3	0,1	0,5-0,9

Note: ALBEDO varies in the range of 0.4-0 (red-good reflection, yellow and green: medium, blue and violet: weak, white: unknown)





The globally annual average ALBEDO: 30%

- Albedo depends on the season and position
 - Ice (snow) surface has a very high Albedo
 - Ocean surface has a very low Albedo
- 



5.1.2. Parameters determines the solar position

5.1.2.1. Solar Altitude Angle

- is the angle between a line that points from the site towards the centre of the sun, and the horizon
- Depends on survey time and position

5.1.2.2. Declination δ :

- is the angle between the rays of the Sun and the plane of the Earth's equator.

$$\delta = 23,45 \cdot \sin \left[\frac{360 (284 + n)}{365} \right]$$



5.1.2.3. Solar Hour Angle: ω

- is the angle through which the earth would turn to bring the meridian of the point directly under the sun



5.1.2.4. Solar Time

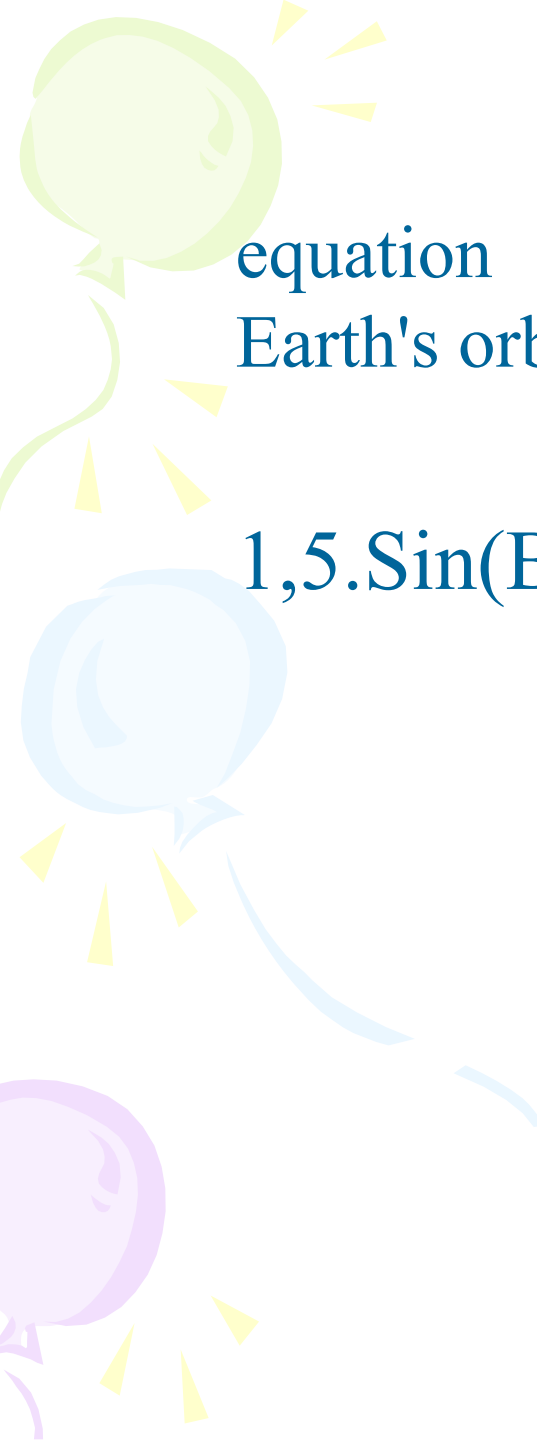
- is a reckoning of the passage of time based on the Sun's position in the sky . We have:

- Local Solar time = Local time $\pm 4(L_{st} - L_{loc})$
+ E

- Where

L_{st} : Local Standard Time Meridian

L_{loc} : Longitude



- E: the equation of time is an empirical equation that corrects for the eccentricity of the Earth's orbit and the Earth's axial tilt

$$E = 9,87.\text{Sin}(2B) - 7,53.\text{Cos}(B) - 1,5.\text{Sin}(B)$$

where

$$B = 360 \left(\frac{n - 81}{364} \right)$$

5.1.2.5. Zenith Angle: θ_Z

- the angle made between the surface of the Earth and a line between the observer and the observed.
We have:

$$a + \theta_Z = 90^\circ$$

$$\cos \theta_Z = \cos \delta \cdot \cos \phi \cdot \cos \omega + \sin \delta \cdot \sin \phi$$

δ - the declination of the sun

ϕ - the latitude

ω - hour angle

Three stylized balloons in green, light blue, and purple are positioned on the left side of the slide. Each balloon has a string and several small yellow triangular flags attached to it.

5.1.2.6. γ_S (Solar Azimuth Angle):

- is the azimuth angle of the sun. It is most often defined as the angle from due north in a clockwise direction.

A decorative graphic on the left side of the slide features a green balloon at the top, a blue balloon in the middle, and a purple balloon at the bottom. Each balloon is attached to a streamer with yellow triangular flags.

5.1.3. Parameters Determining Geometry Relationship between the Sun and Investigated Surface

A decorative graphic in the top-left corner of the slide features three balloons: a green one at the top, a light blue one in the middle, and a purple one at the bottom. Each balloon has a string and several yellow triangular flags attached to it.


5.1.3.1. γ (Surface Azimuth Angle):

- angle between the projection of the normal to the surface into the horizontal plane and the local meridian. Zero azimuth is facing the equator, west positive east



5.1.3.2. θ (Angle of Incidence):

- the angle that a line makes with a line perpendicular to the surface at the point of incidence. We have:


$$\begin{aligned}\cos\theta &= \sin\delta.\sin\phi.\cos\beta - \sin\delta.\cos\phi.\sin\beta.\cos\gamma \\ &+ \cos\delta.\cos\phi.\cos\beta.\cos\omega \\ &+ \cos\delta.\sin\phi.\sin\beta.\cos\gamma.\cos\omega \\ &+ \cos\delta.\sin\beta.\sin\gamma.\sin\omega\end{aligned}$$



β is the declination between investigated surface and horizontal plane

5.1.4. SOLAR COLLECTOR

- FLAT-PLATE COLLECTOR**
- EVACUATED-TUBE COLLECTOR**
- CONCENTRATING COLLECTOR**

5.1.4.1. Solar Collector

1. FLAT-PLATE COLLECTOR

Flat-plate collectors facing south at fixed tilt

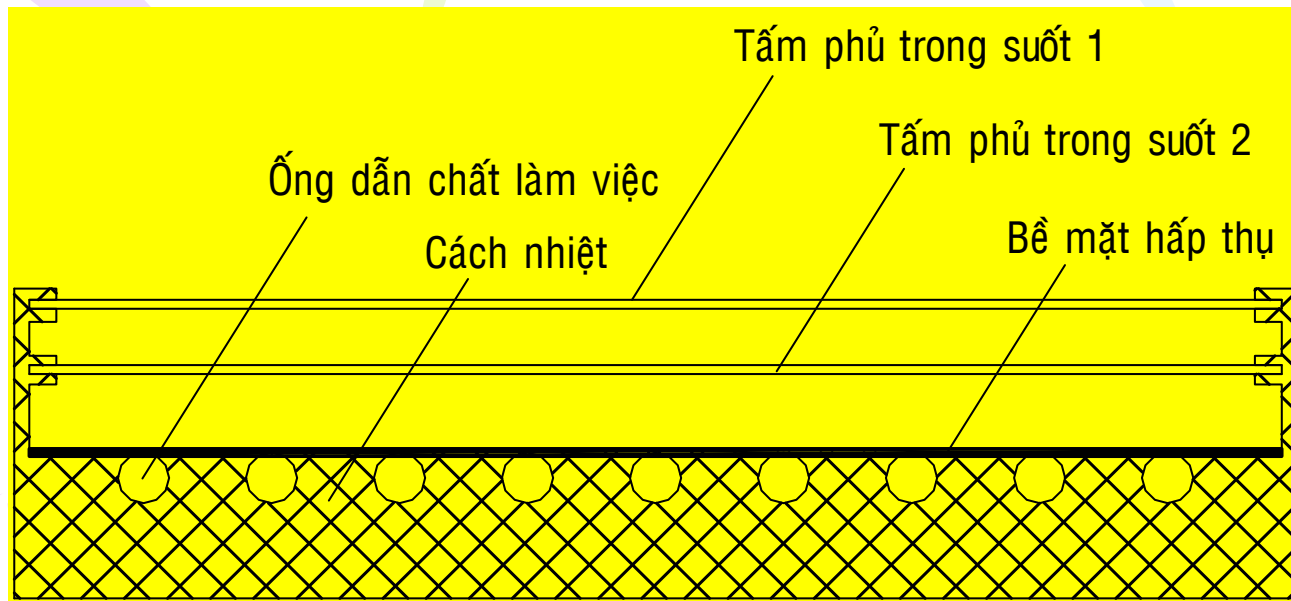
In general, one-axis tracking flat-plate collectors with axis oriented north-south.

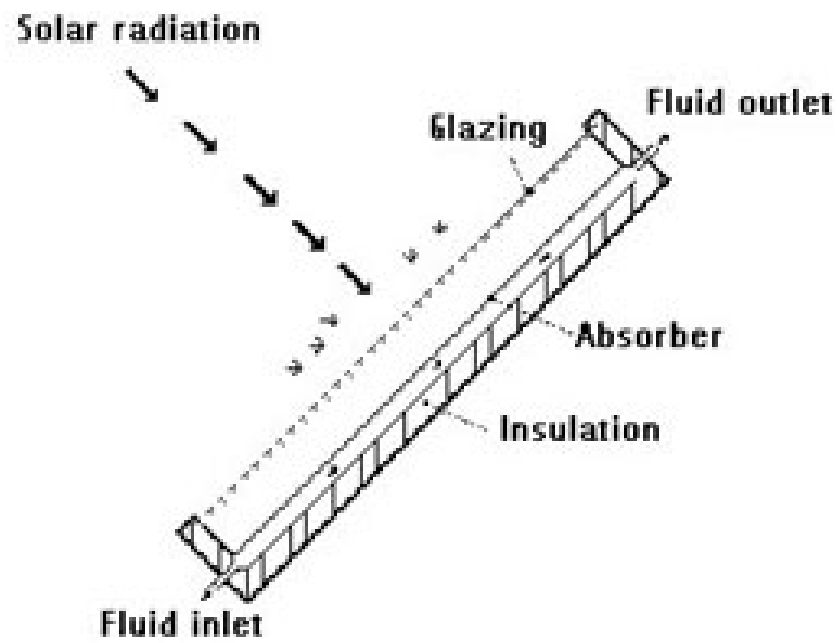
Usually work with water or air

Easy to process and manufacture

Design

+ Flat plate Collector







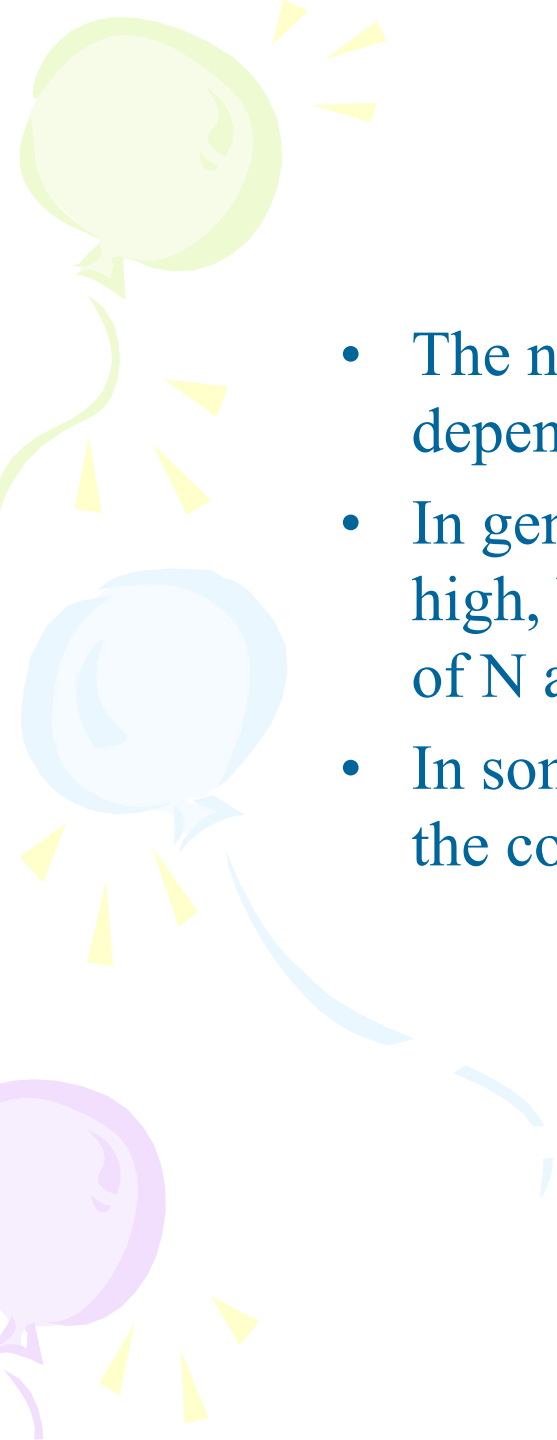
Basis components

- Transparent or translucent cover sheets
- Absorber plate
- Working fluid drain
- Insulated box




a. Transparent cover sheets

- Are made from glass or other transparent materials
- Fundamental task of the sheets is making Greenhouse Effect in order to minimize radiant emission and reduce convective heat loss
- The sheets should be as transparent as possible for maximum radiant energy absorption.

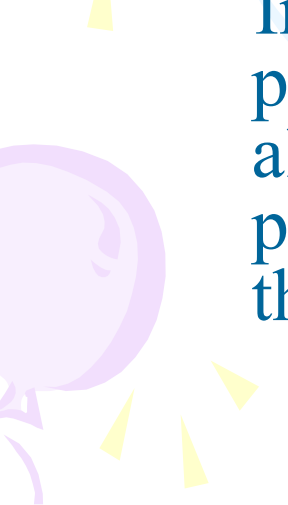
- 
- Three balloons (green, light blue, and purple) are positioned vertically on the left side of the slide. Each balloon has a string and several small yellow triangular flags attached to it.
- The number of the cover sheets (N) varies depending on working temperature.
 - In general, when the working temperature is high, N should be larger. The common values of N are from 1 to 2.
 - In some cases, it could be unnecessary to use the cover sheets




The cover sheets have to be solid, durable and transparent enough

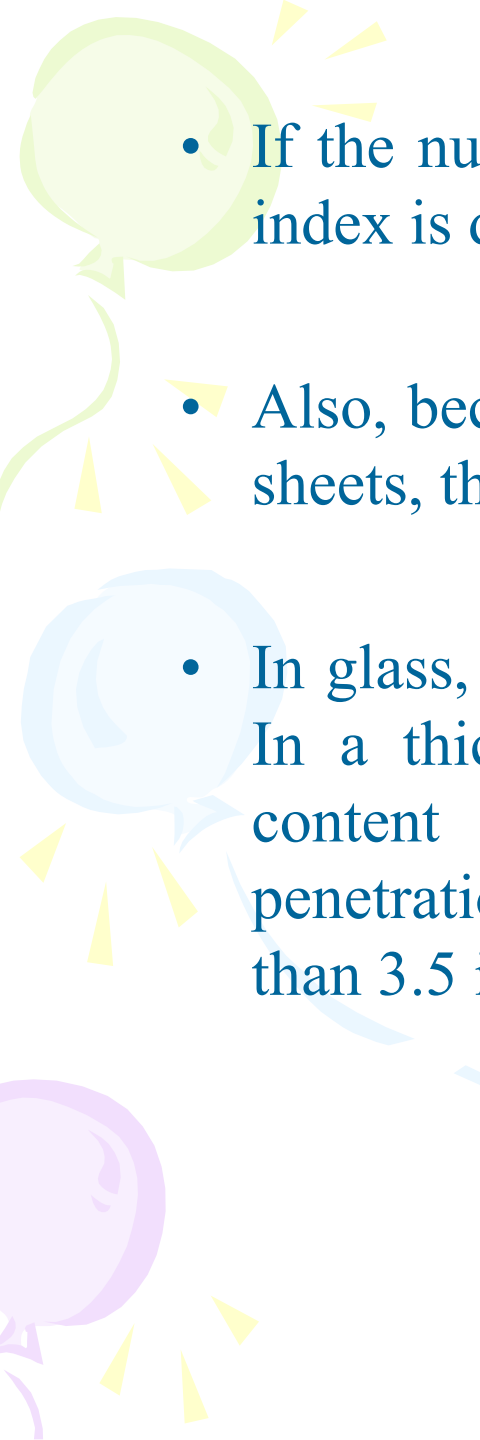


Plastic cover sheets are sometimes used for the second cover sheet when two sheets are required, in which the material is usually used is Acrylic Polycarbonate Plastics.



Installation of the plastic sheet beneath the glass protects the plastic from the environment. Glass also does not transmit UV radiation and thus protects the plastic, which is usually sensitive to this portion of the solar spectrum.


- 
- Three stylized balloons in green, blue, and purple are positioned on the left side of the slide. Each balloon has a string and several small yellow triangular flags attached to it. The balloons are partially cut off by the left edge of the frame.
- The refractive index of Glass and Plastic that are used for the cover sheets is about 1,5.
 - In general, the surface of cover sheets is processed to reduce the reflection phenomenon. However, the reflection index of the cover sheets is rather high for radiation with a small Angle of Incidence, which is about 0.08
 - So, the maximum penetration index of almost cover sheets is 0,92.

- 
- If the number of cover sheets is increased, the penetration index is decreased
 - Also, because of the absorbability of the materials of cover sheets, the penetration index is decreased
 - In glass, the penetration index depends on the iron content
In a thickness sight, if the green is observed, the iron content in the glass is large, which implies that the penetration index is small. Glass with thickness smaller than 3.5 is chosen to do sheet covers



b. Absorber plate

- Is the surface that absorbs solar radiation, and then transfers this absorbed energy into a working fluid. In general, the surface is painted in black
- In order to increase the absorbability of the solar radiation and decrease the reflection, selective surface can be created by using specialized paints

- 
- Three stylized balloons in green, light blue, and purple are positioned on the left side of the slide. Each balloon has a string and several small yellow triangular flags attached to it.
- Formerly, the absorber plate and the working fluid drain are disjointed parts, and in order to connect these parts, people can use compression technique, with and without welding
 - However, the basis disadvantage of this solution is increasing the thermal resistant
 - Now a day, because of progress of process techniques and materials, people can use the surface material itself to create the drain. This method is very propitious for mass production and help decreasing the thermal resistant remarkably

A decorative graphic on the left side of the slide featuring three balloons in green, blue, and purple, each with yellow triangular rays emanating from it.

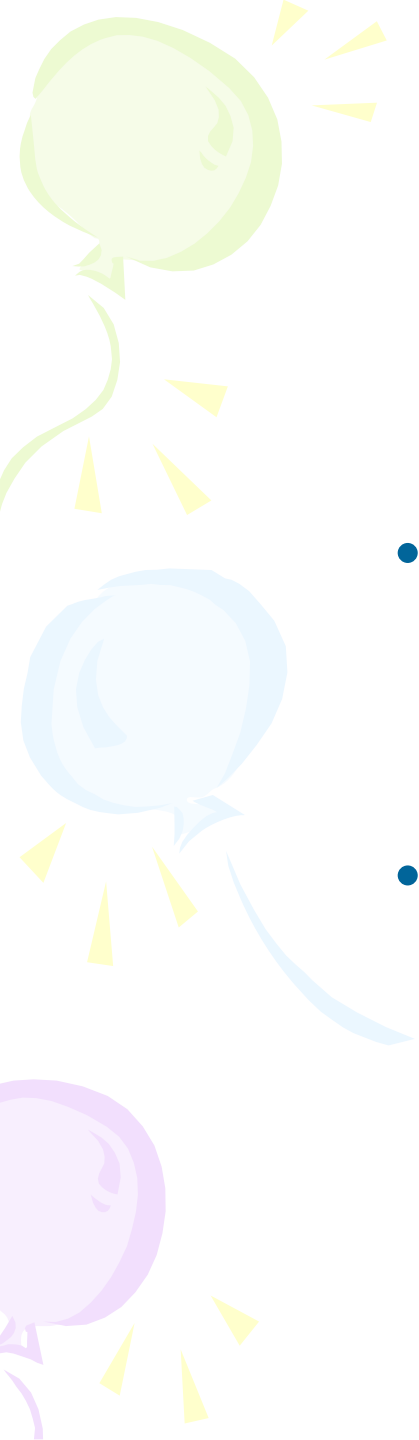
Surface Material of absorber plate

- Having basis properties such as: high heat conducting coefficient, compressible, difficult to be eroded, difficult to be covered with dirt
- In many cases, copper is often selected because of high heat conducting coefficient
- Besides, people can use aluminum, zinc, steel and other kinds of plastic such as propylene, Polyvinyl Chloride and Polybutelene

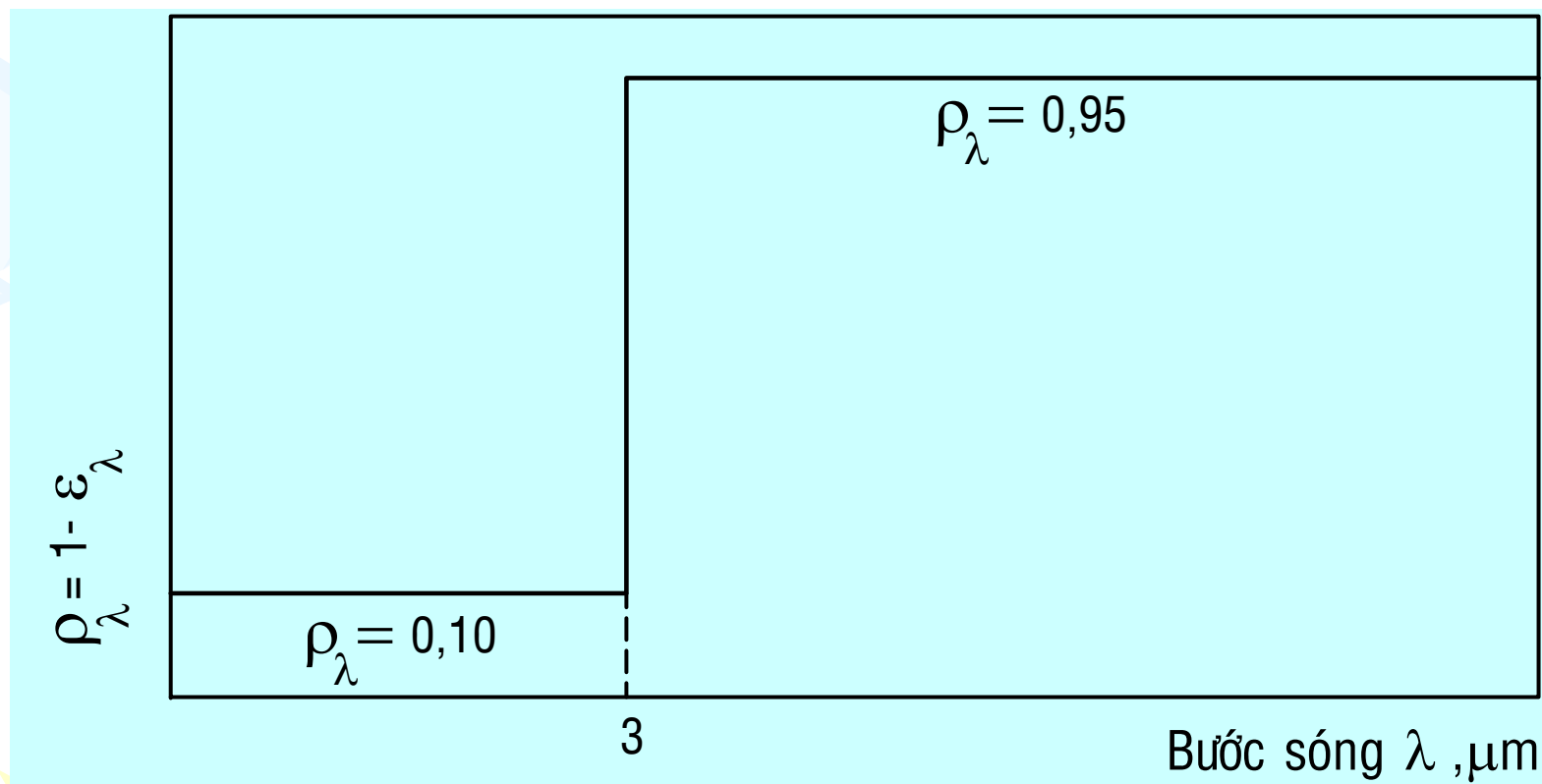


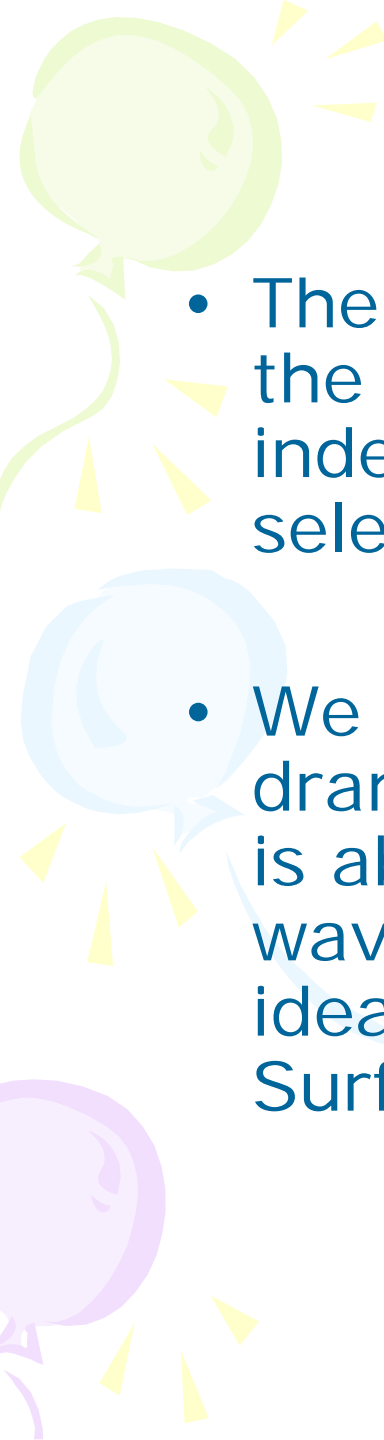
Selective Surface

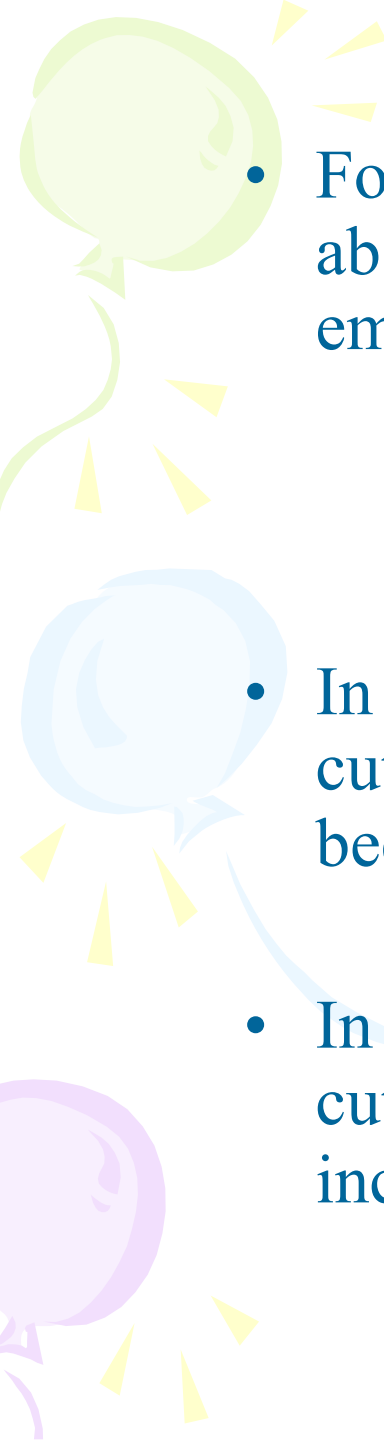
- Planck and Wien's law: the wavelength of radiation rays emitted from a surface is inverse proportional to the working temperature of that surface
- So, radiation rays from the sun to the collector surface will be in the range of short-wavelength with $\lambda < 3 \mu\text{m}$, and radiation emitted from the absorber plate of the collector will be in the range of long-wavelength



- Selective surface: has different responses depending on the wavelength of the radiation ray
- The cover of such surface can absorb well the incoming radiation rays with short-wavelength, and minimize the long-wavelength radiation emitting

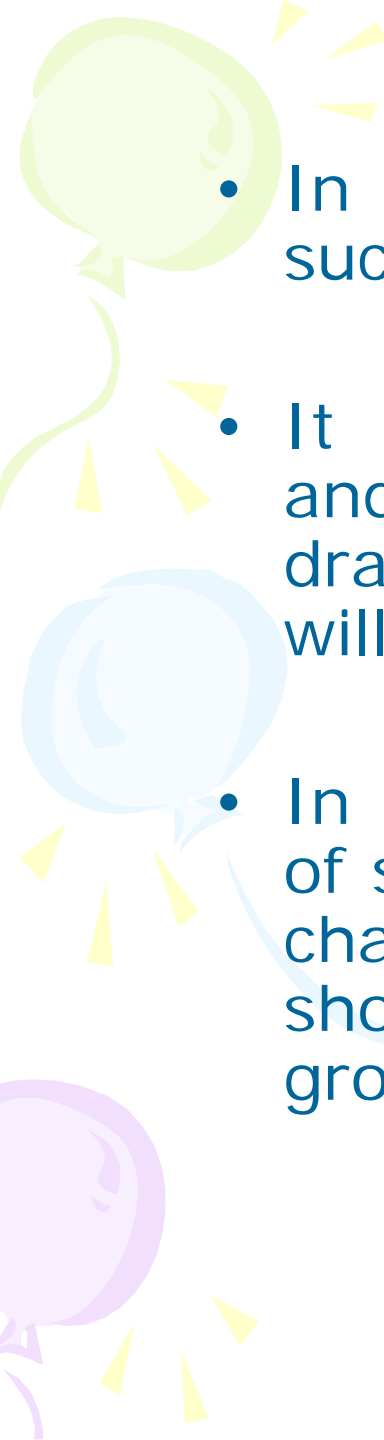


- 
- The figure in the previous slide describes the ideal relationship between the reflection index ρ and the wavelength λ of the selective surface
 - We can see that the absorbability dramatically changes when the wavelength is about $3\text{ }\mu\text{m}$, which is called cut-off wavelength λ_c . The surface in the above ideal working condition is called Semi-Gray Surface)

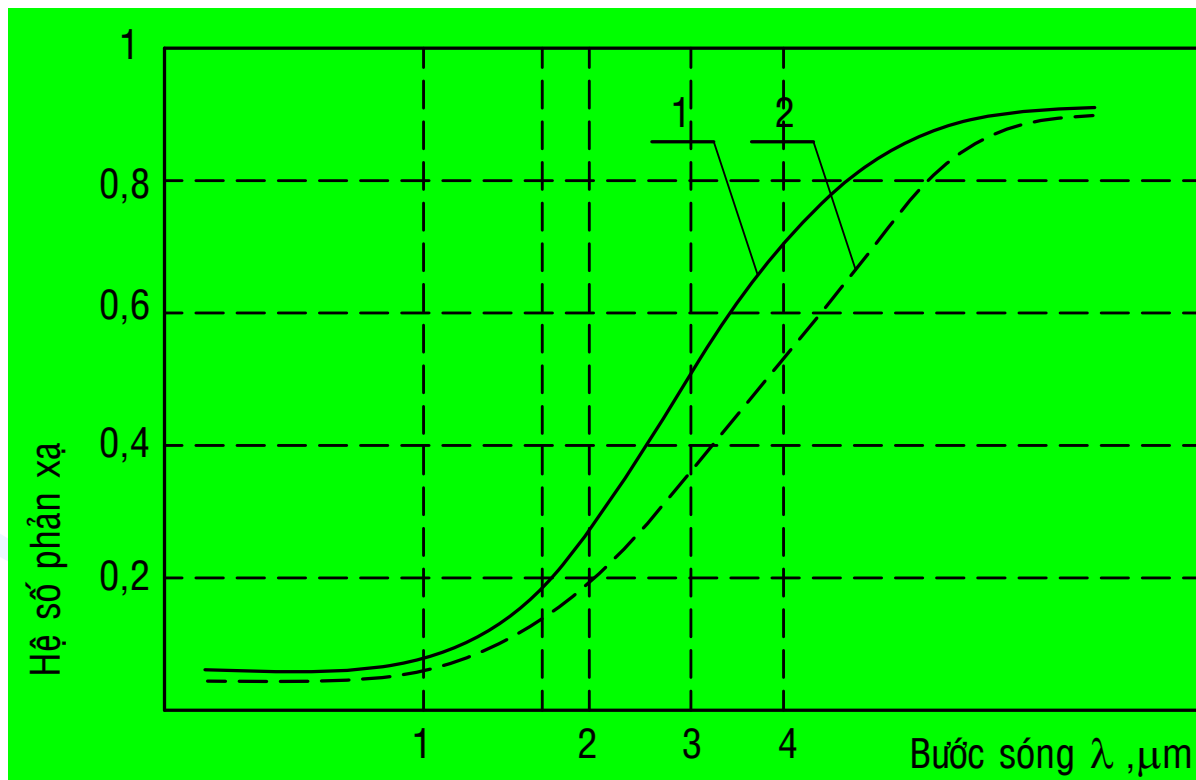
- 
- For opaque surfaces, the relationship among the absorption index α_λ , reflection index ρ_λ and emission index ε_λ is:

$$\alpha_\lambda = \varepsilon_\lambda = 1 - \rho_\lambda$$

- In a range, where the wavelength is smaller than the cut-off wavelength, the absorption index is high because the value of ρ_λ is quite small
- In a range, where the wavelength is larger than the cut-off wavelength, since the value of ρ_λ is increased, the emission index is decreased.

- 
- In practice, it is difficult to have exactly such above properties for selective surface
 - It means that, depending on techniques and surface materials, the properties of dramatic change with cut-off wavelength will be different
 - In practice, the absorbability and emission of selective surface can not be dramatically changed. Therefore, the cut-off wavelength should be understood as not a value but a group of contiguous values

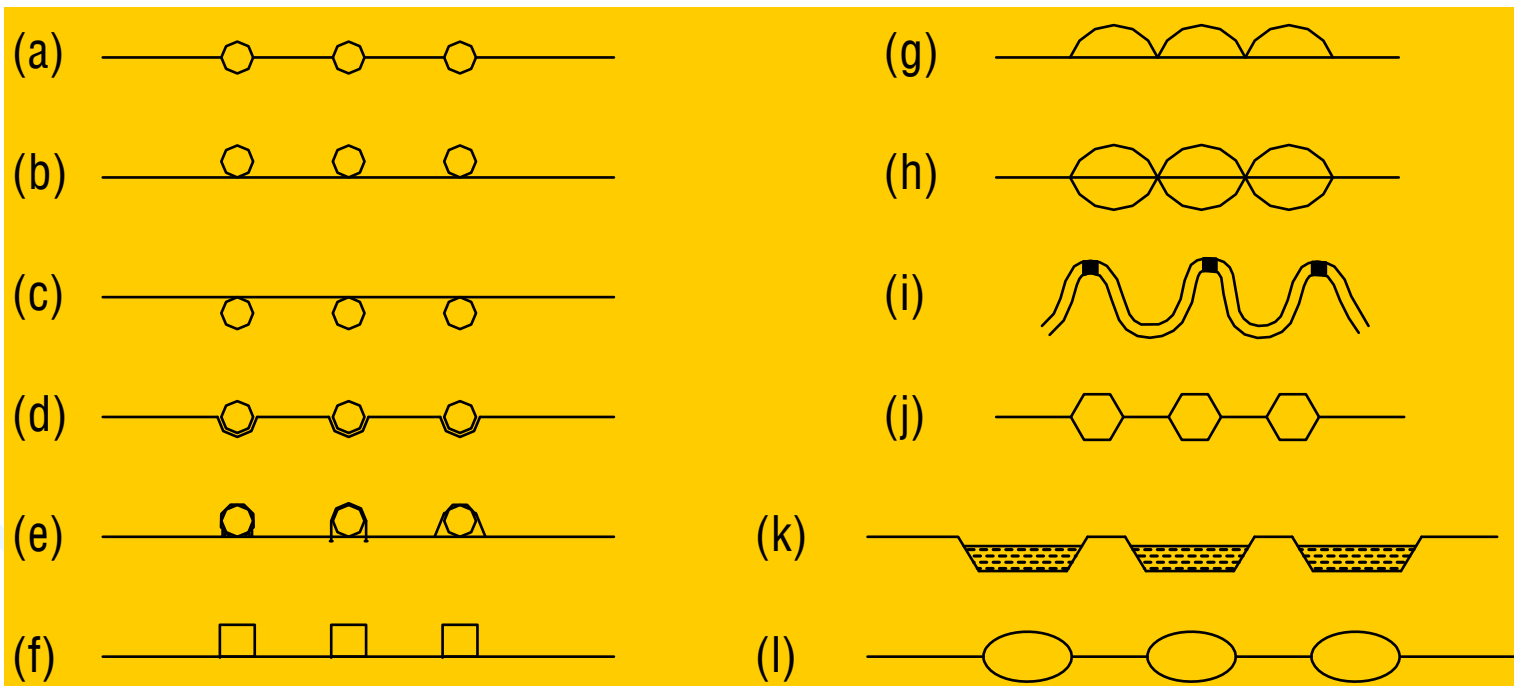
The below figure presents a relationship between the reflection index and absorption index with respect to wavelength in an actual surface





c. Working fluid drain

- Conduct working fluid into collector and get heat from absorbed surface.
- Usually put at the back side of absorbed surface.

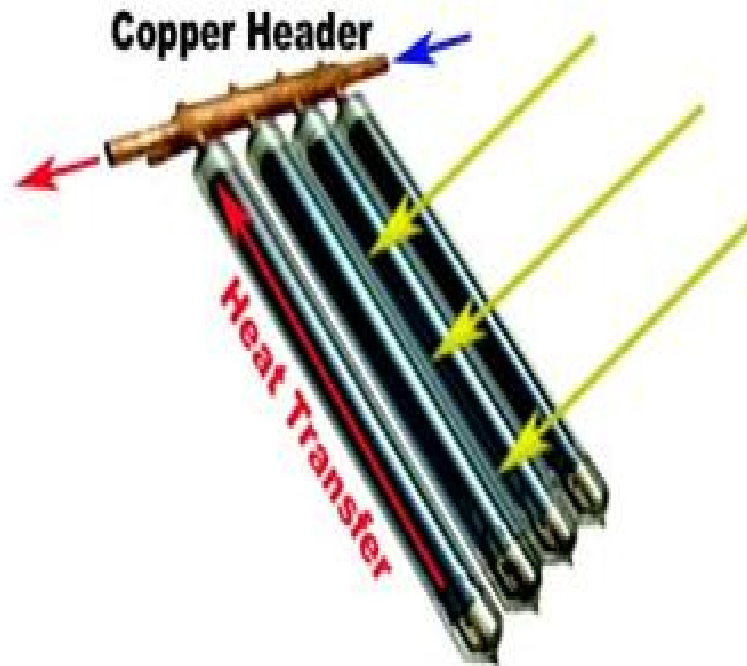


Three balloons (green, blue, and purple) are arranged vertically on the left side of the slide. Each balloon has a string and several yellow triangular flags attached to it.

d. Insulated box

- reduces heat loss from the back or sides of the collector .

2. EVACUATED-TUBE COLLECTOR



- is made from glass tubes with the enclosed space sealed and evacuated.



A decorative background on the left side of the slide featuring three balloons: a green one at the top, a light blue one in the middle, and a purple one at the bottom. Each balloon has several yellow triangular rays emanating from it, suggesting a festive or celebratory theme.

Basis Elements

- The cover is the glass tube
- Evacuated tube
- Other tubes

+ It is possible to combine the evacuated-tube collector and flat-plate collector (see the figure in next slide)

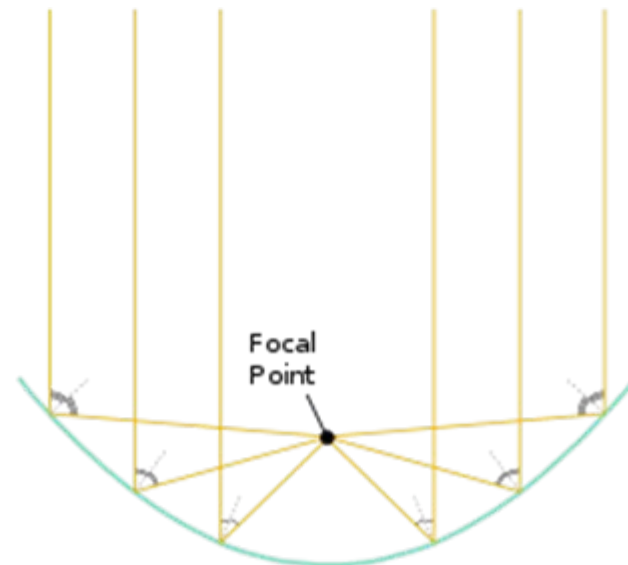
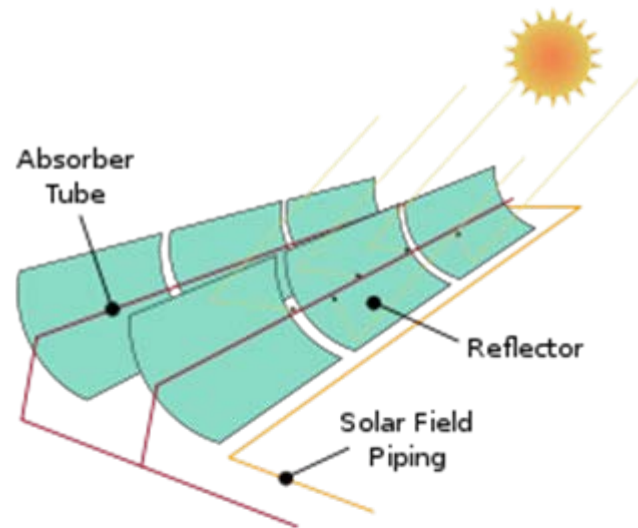


Three stylized balloons in green, blue, and purple are positioned on the left side of the slide. Each balloon has several yellow triangular rays emanating from it, suggesting light or air. The balloons are connected by thin, curved lines.

3. Concentrating Collector

- The shape should be as a parabola, gutter, or are separated reflection sheets
- is usually applied to high-temperature applications







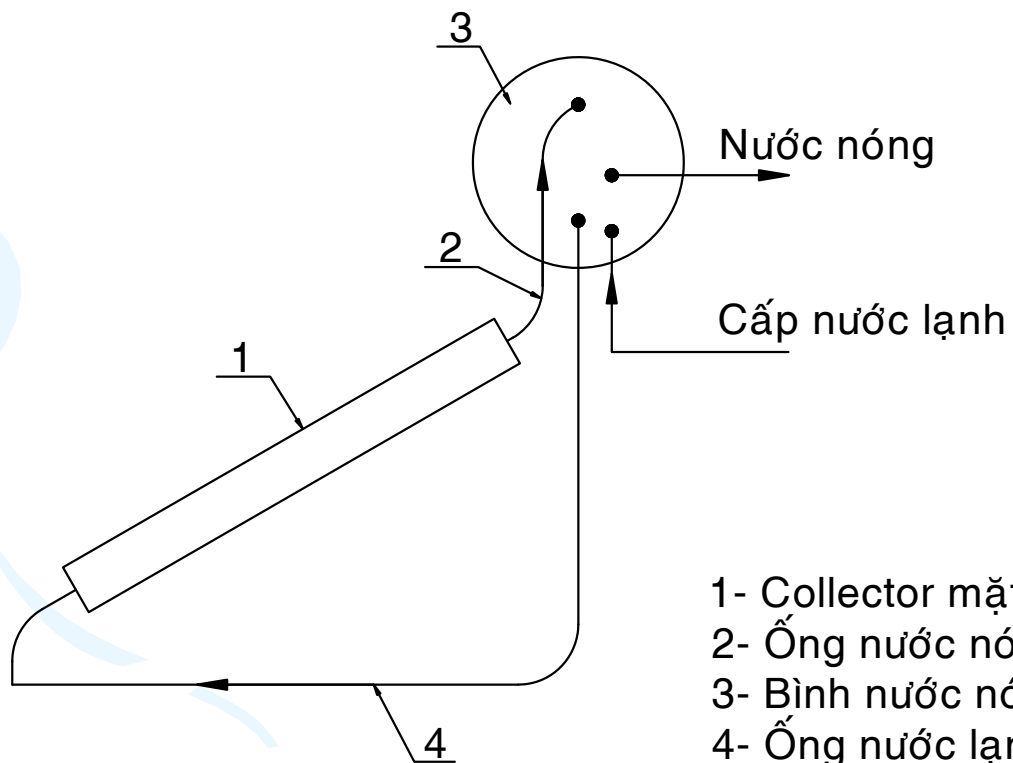
5.1.4.2. Applications

- Hot water
- Cooking
- Dried techniques
- Combined with heat pump
- To warm Swimming-pool water
- To warm and to light electric devices
- To distil water
- To supply technical water in high temperature
- Generator & air-condition machines



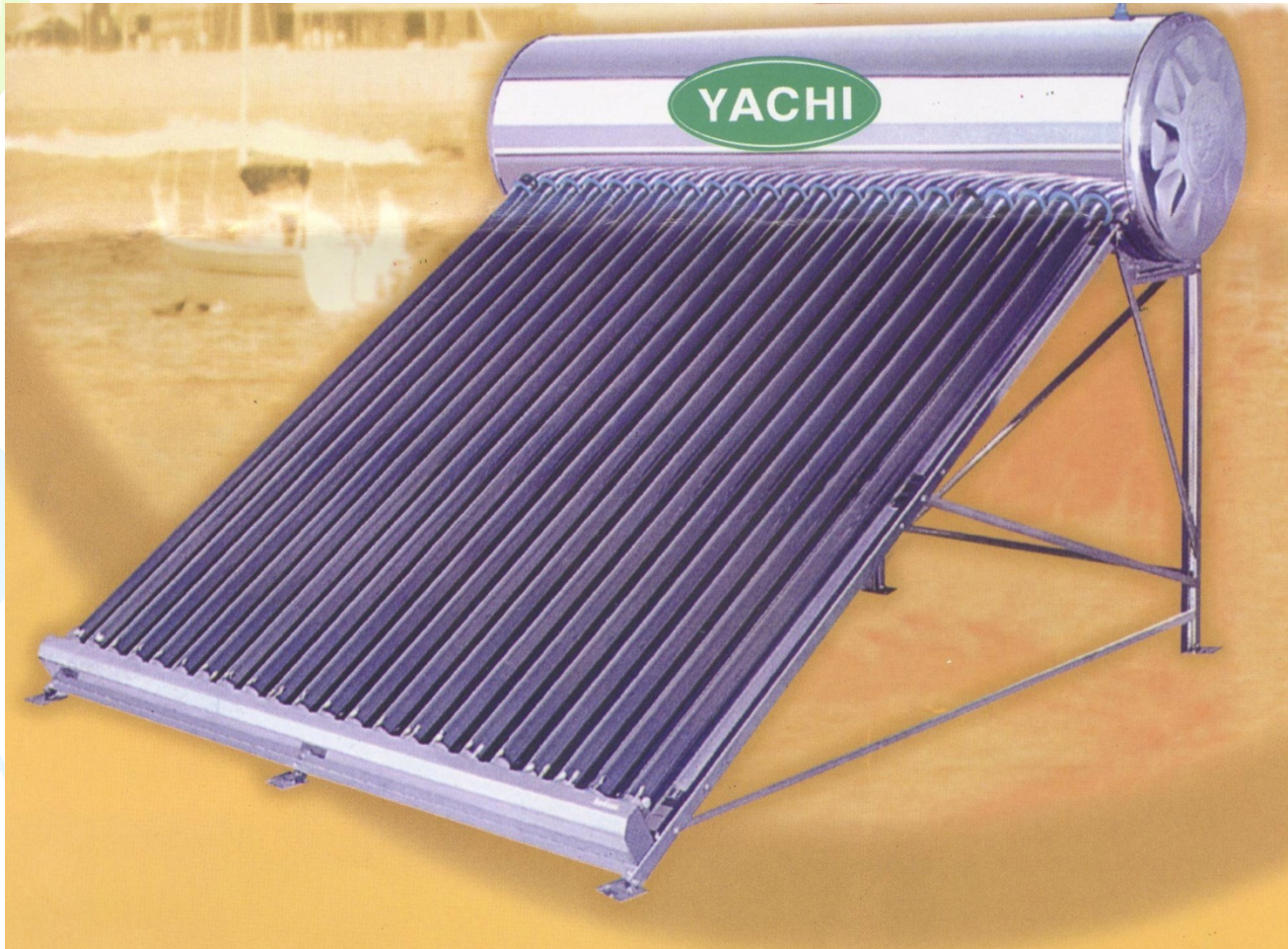
a. Hot water

- Use flat-plate collector or evacuated-tube
- Collector is put in a β angle with respect to a horizontal plane in a north-south direction
- β should be from ϕ to $\phi + 5^\circ$, where ϕ is latitude of the collector's position
- May have/have not auxiliary other powers

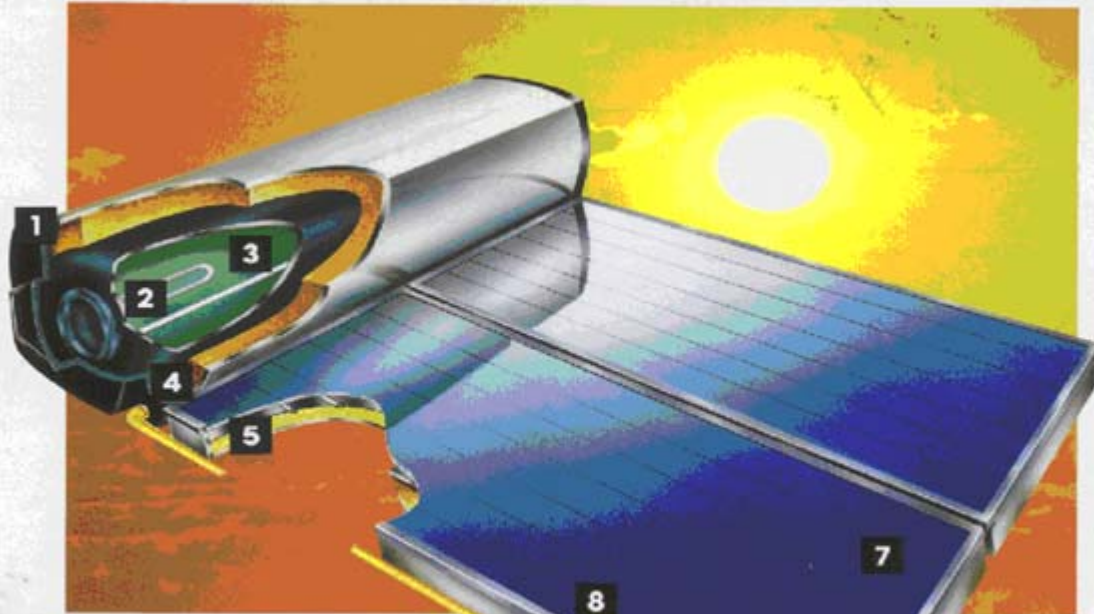


- 1- Collector mặt trời
- 2- Ống nước nóng tuần hoàn
- 3- Bình nước nóng
- 4- Ống nước lạnh tuần hoàn





SOLAHART 302L



The Solahart 302L is a proven performer in efficiency, style and quality.

8 powerful reasons why Solahart is one of the world's fastest selling solar hot water systems.

1 Stylish Silmline Design.

The sleek lines are enhanced with Solahart's distinctive trim.

5 Proven Insulation.

Solahart collectors are insulated with polyester for maximum heat retention.

A decorative graphic on the left side of the slide featuring three balloons in green, light blue, and purple, each with yellow triangular streamers. The balloons are arranged vertically, with the green one at the top, the light blue one in the middle, and the purple one at the bottom.

Discussions

- Select collector type and water storage volume
- Installing
- Maintaining
- Other notes

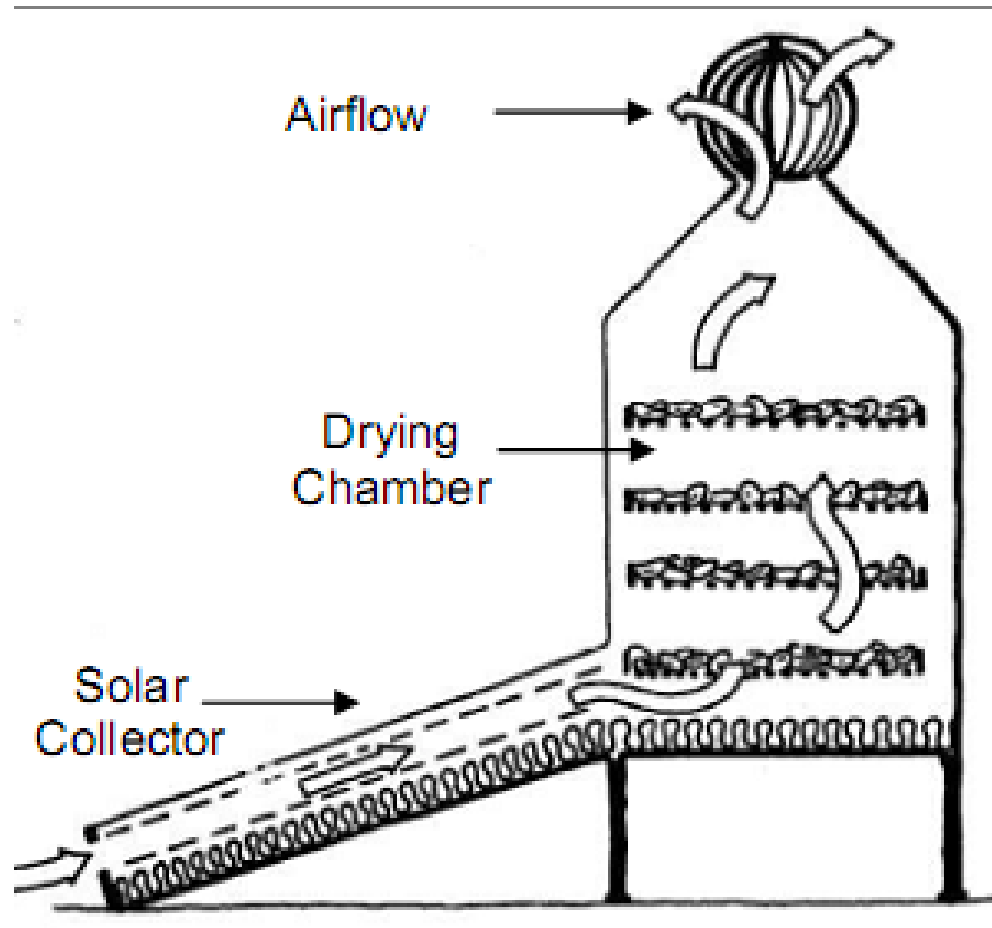
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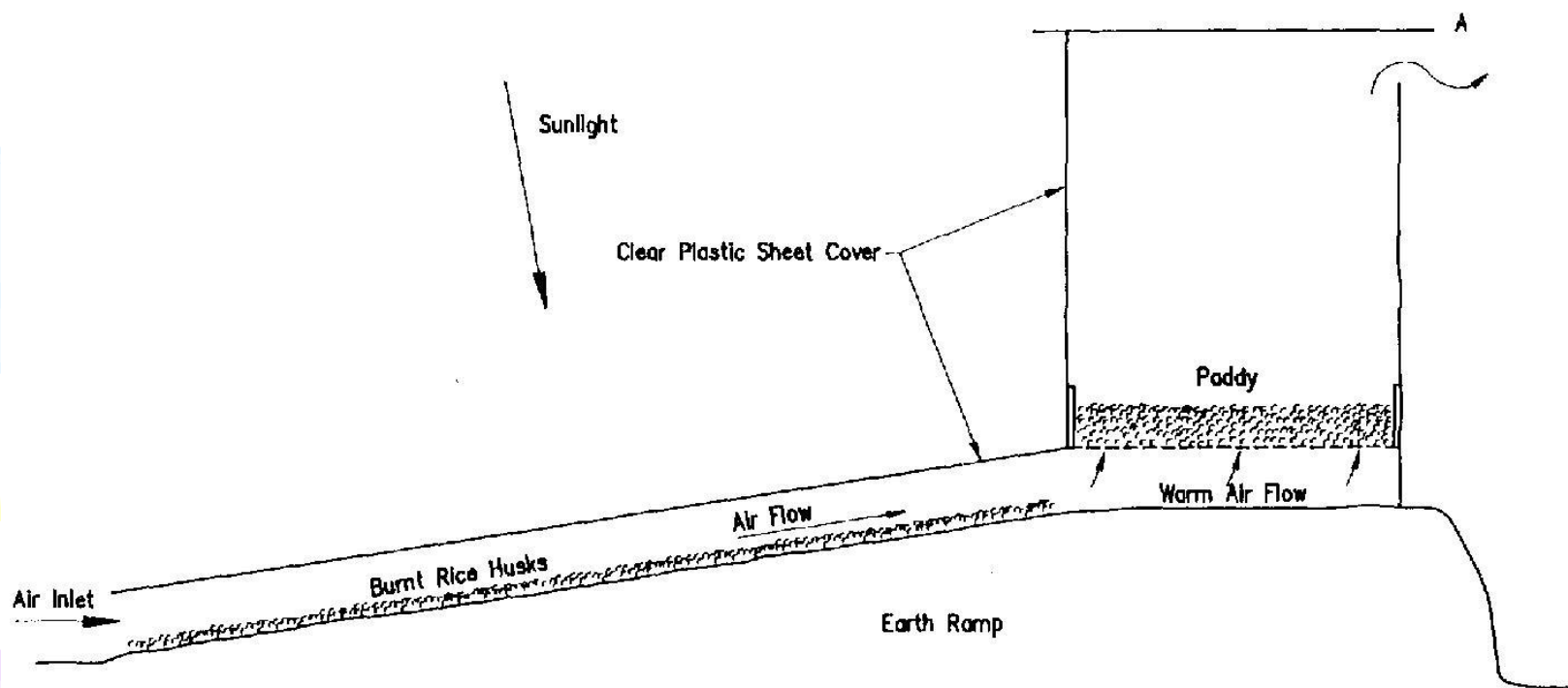
b. Dried techniques

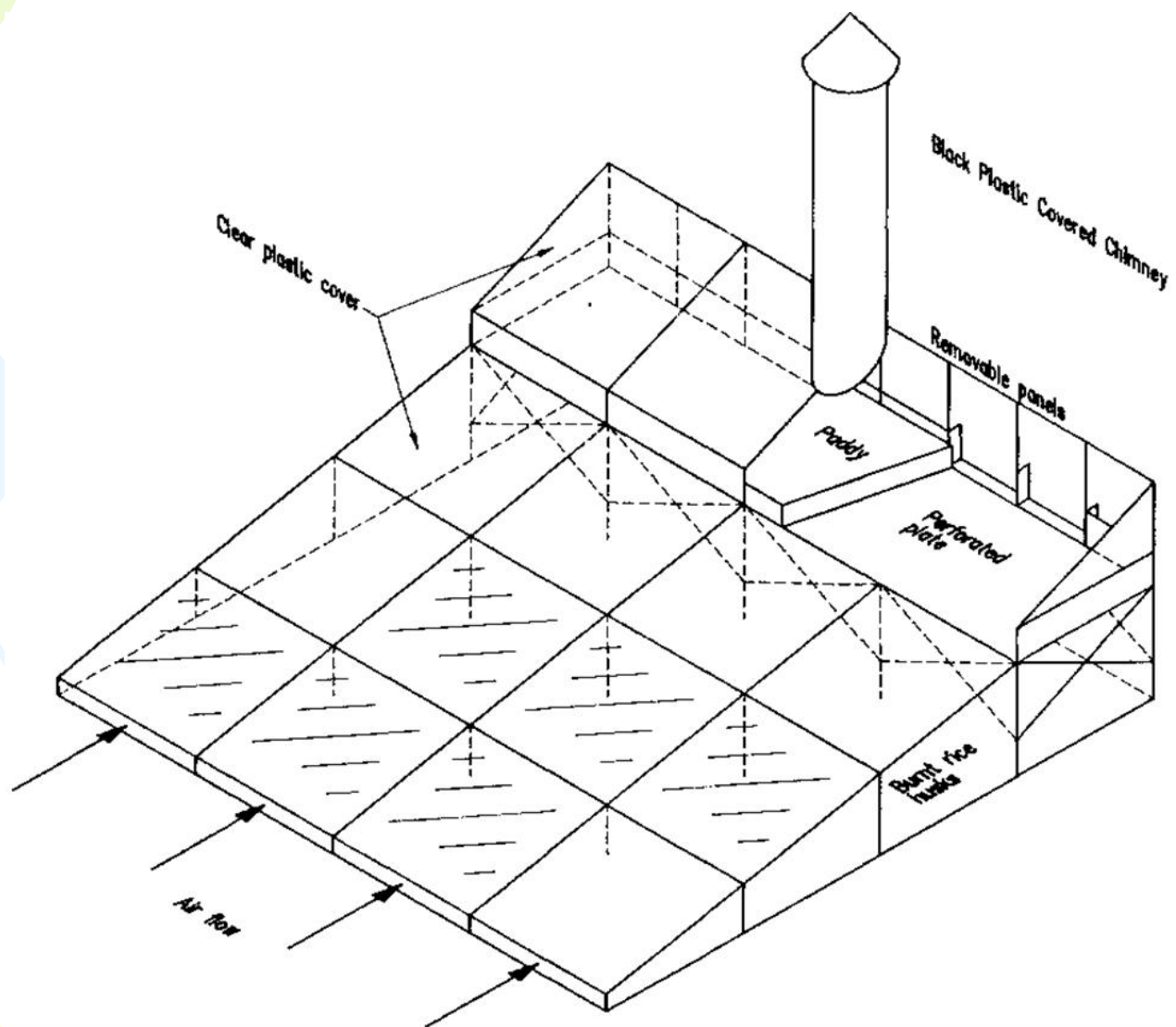
- Use Greenhouse effect, where the container's shape might be a box, chamber, arch or tube
- Nature convection or forced convection
- May have/have not auxiliary other powers

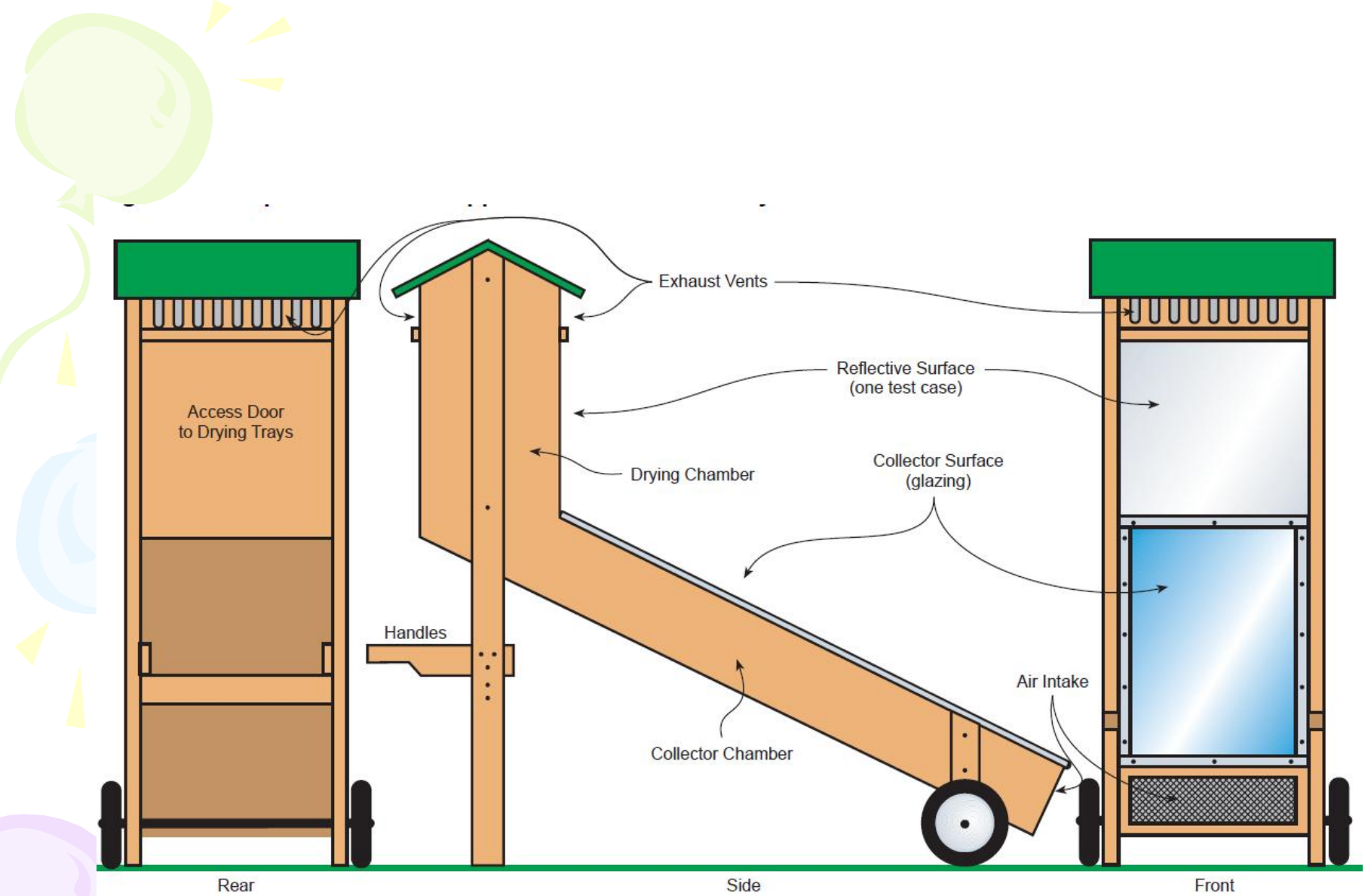


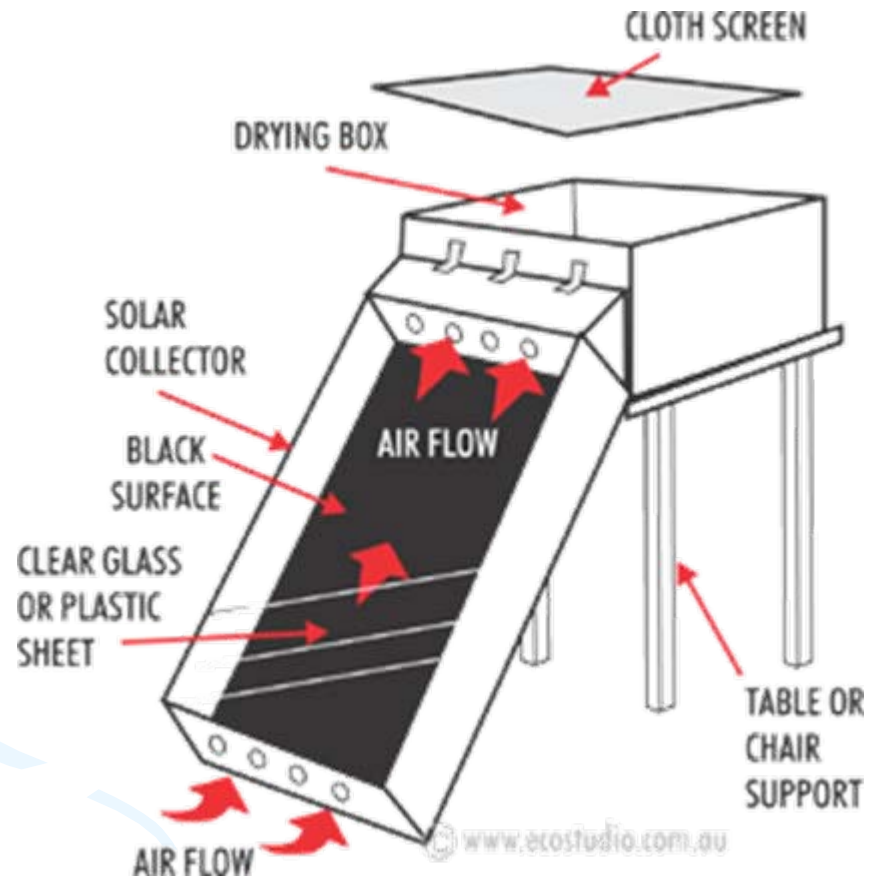
















Discussions

- Discussions on dried techniques using solar energy for some products such as chili, carrot, rice, fish,...
- Analyze advantages/disadvantages of some above dried techniques
- How can use other auxiliary powers if necessary?

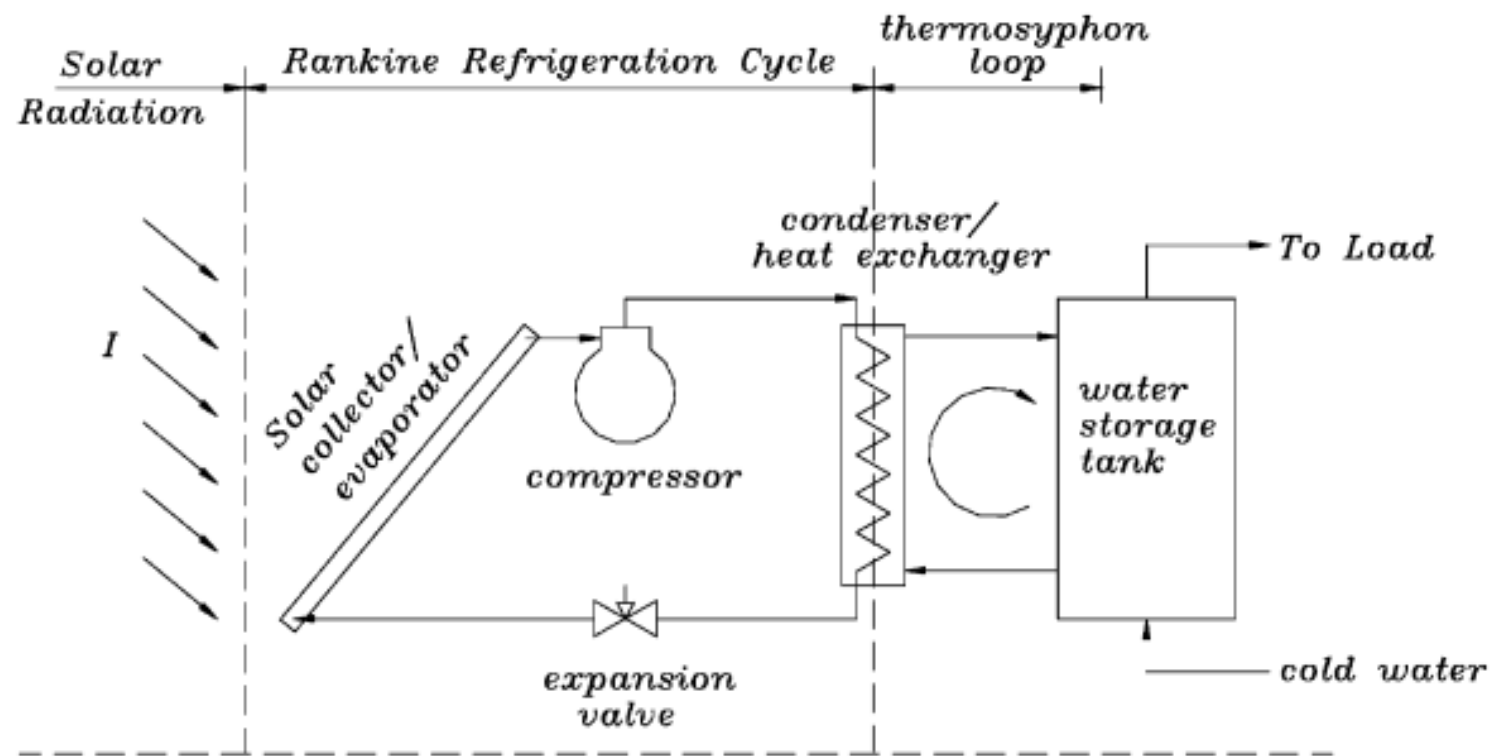


c. Combined with heat pump

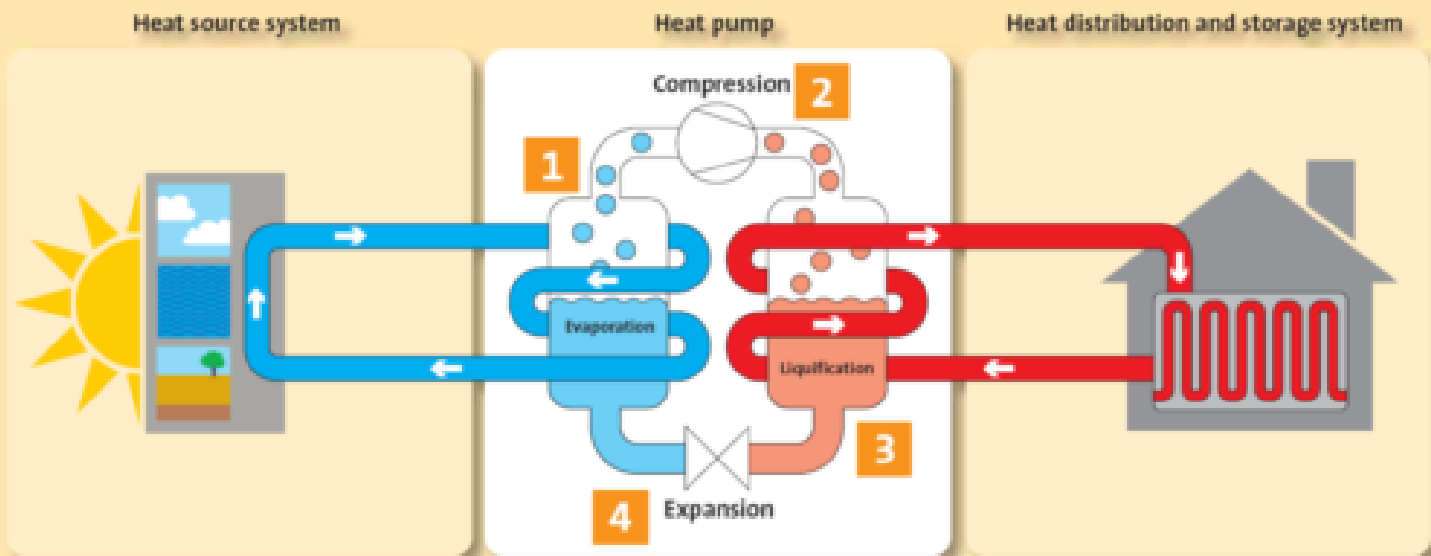
- Solar Collectors are used to increase the working temperature of evaporation devices of the heat pump so that also inncrease the efficiency.
 - Solar collectors could increase the temperature of the air or water, or reflect solar radiation depending on the design of evaporation devices
 - In some cases, solar collectors that supply hot water work independently from the heat pump. In these cases, the heat pump is considered as an auxiliary powers system if necessary.
- 
- 

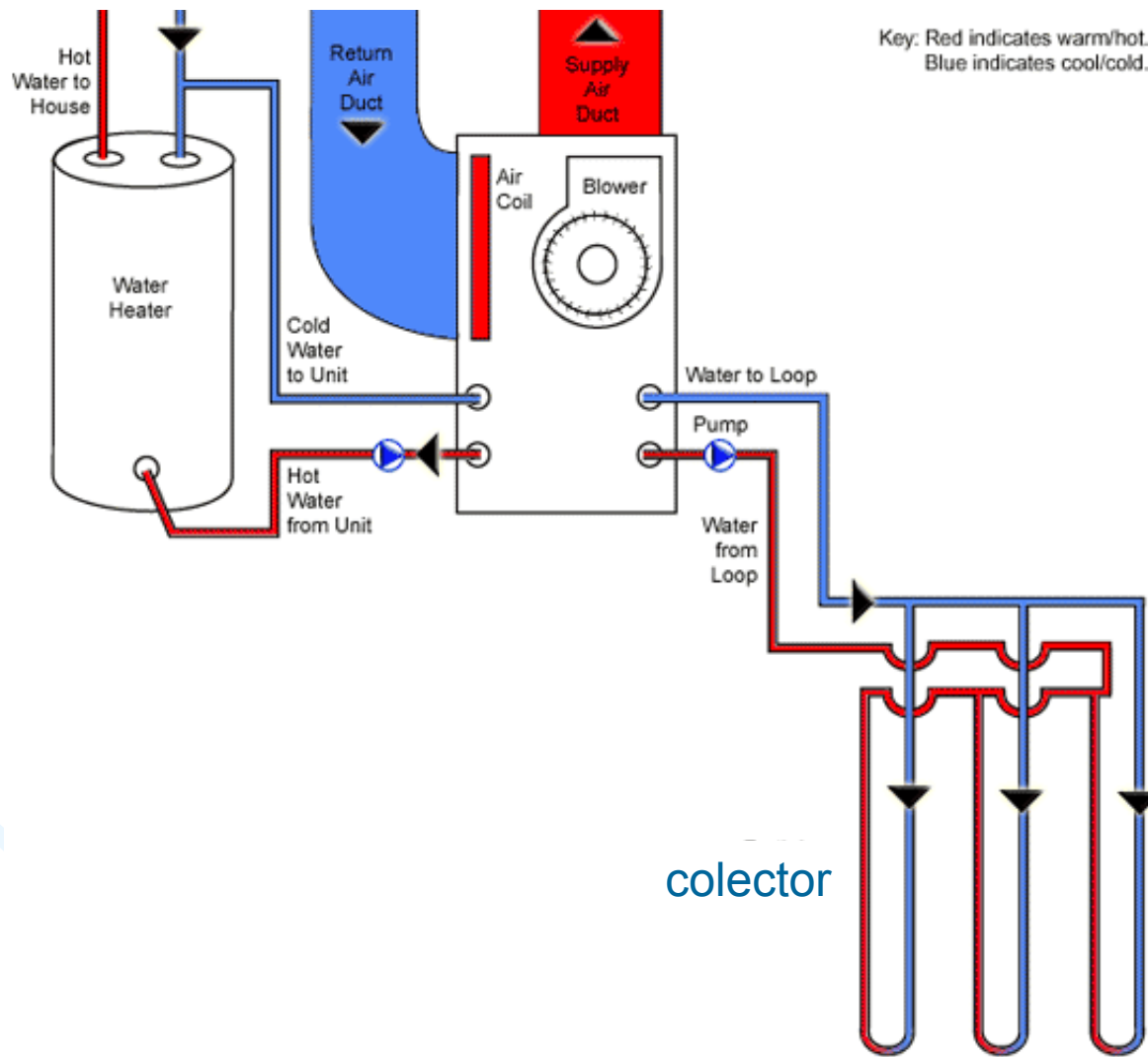
- In some cases, solar PV can be used to operate the heat pump's fan so that the energy can be saved (from 8% to 10%)





HEAT PUMP OPERATING PRINCIPLE





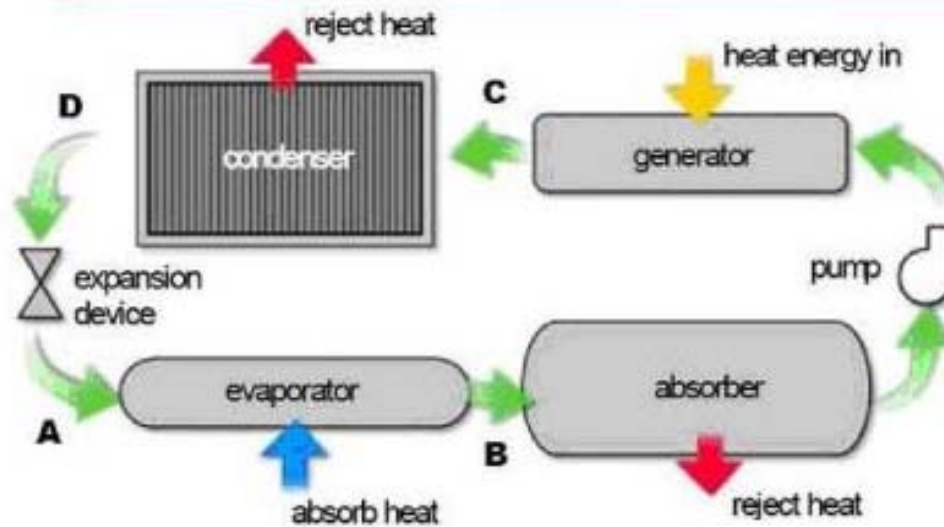


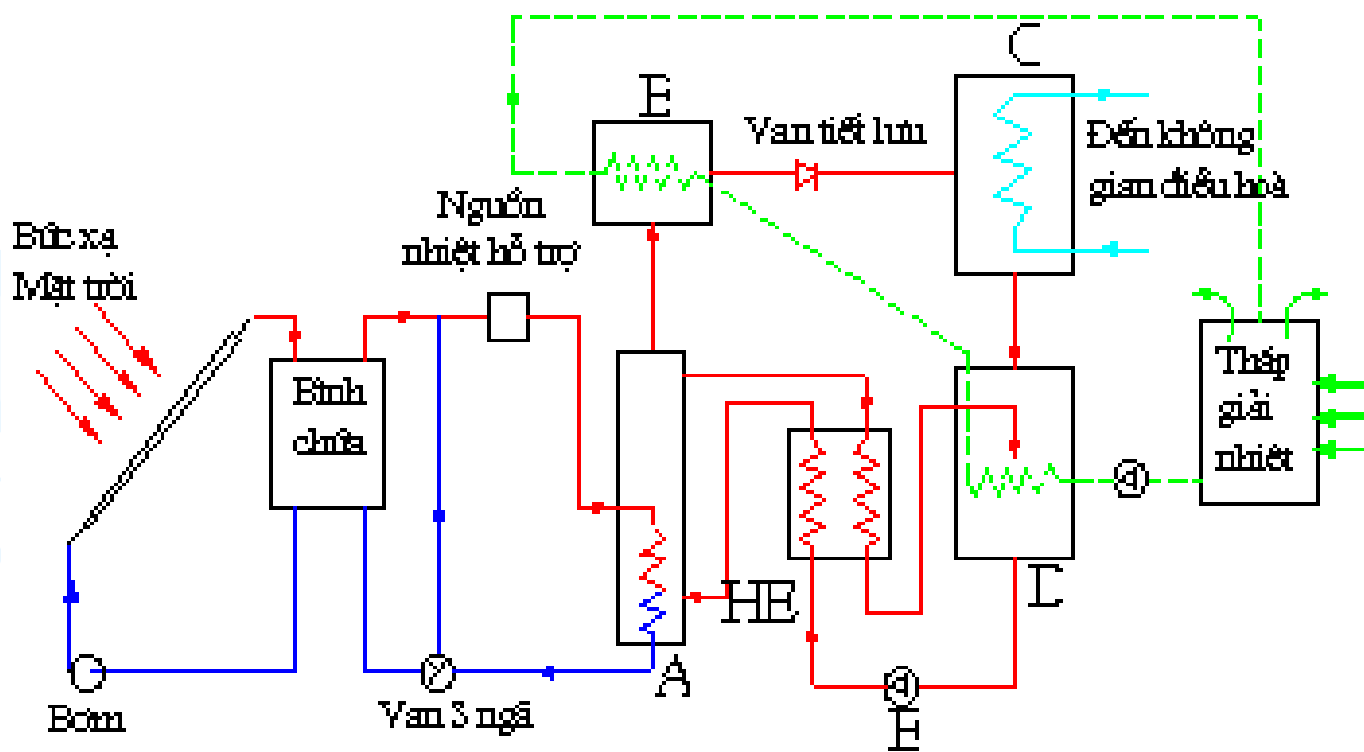
Discussions

- Explain why the efficiency of the heat pump can be increased when combining with solar collectors
- Present possible solution and combinations
- Direct and indirect combinations? Advantages and disadvantages

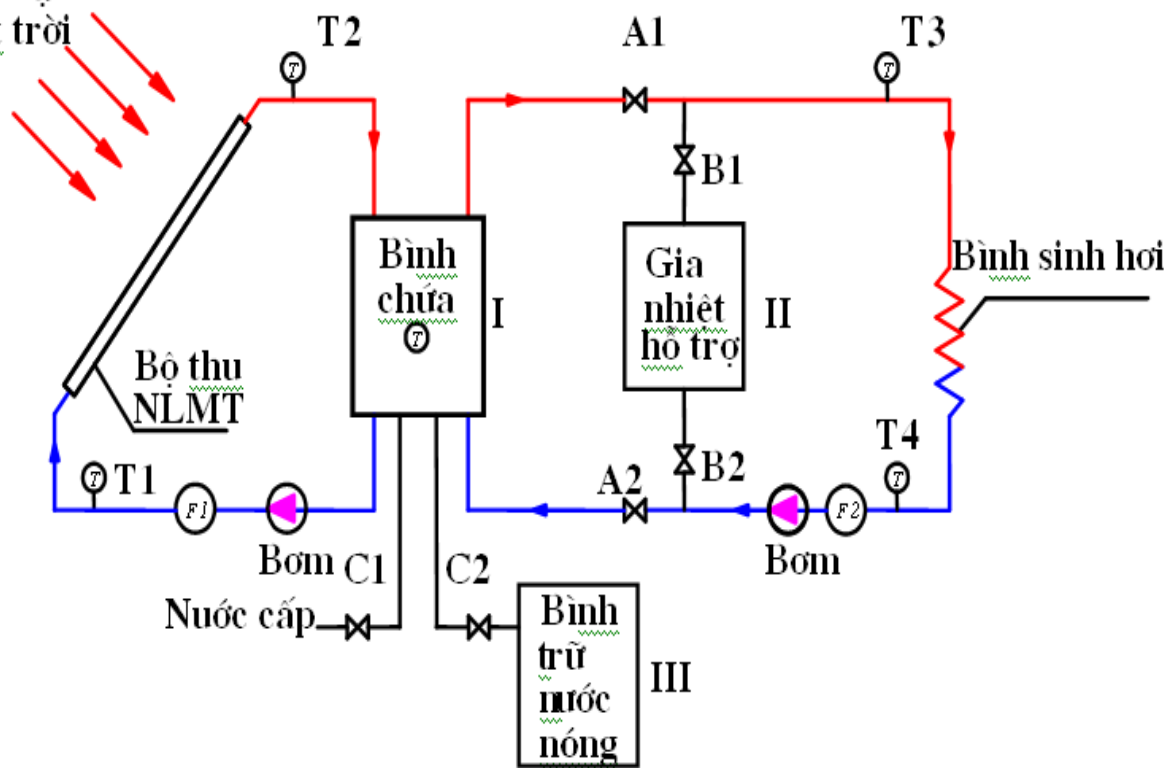
d. Operating Absorption & Adsorption Refrigeration

Absorption Refrigeration Cycle

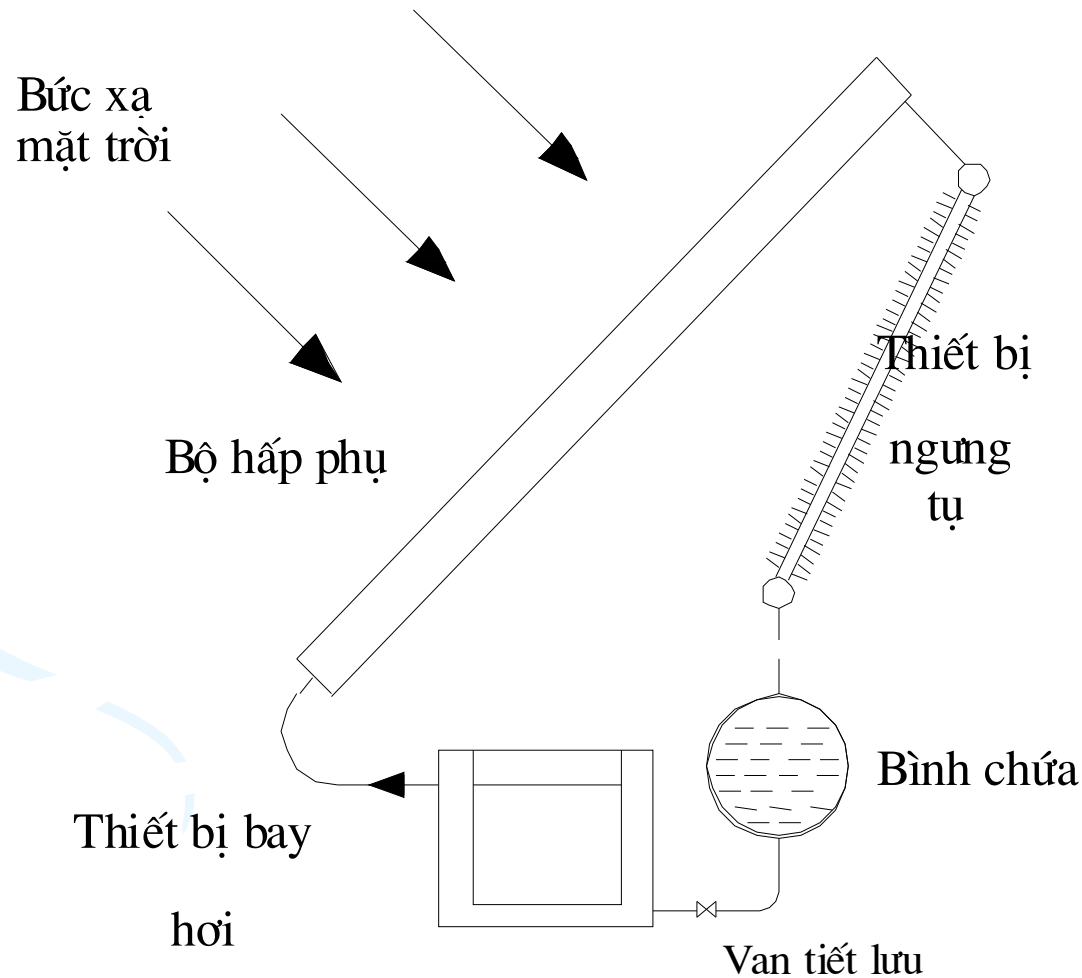




Bức xạ
mặt trời



Adsorption refrigeration (interrupted type) - collector consists of solid working fluid such as: Zeoolit, Silicagel, active coal or CaCl_2

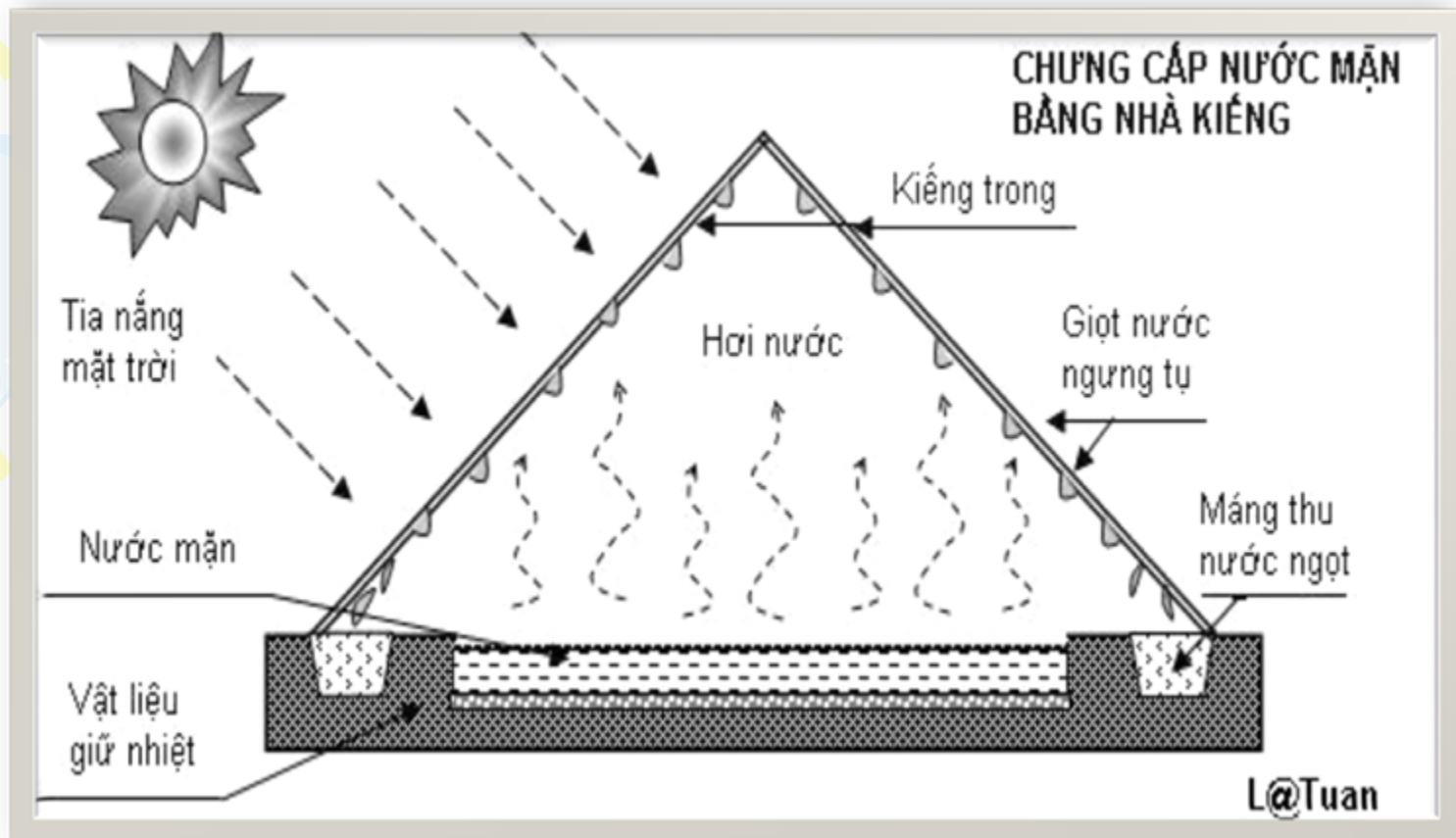


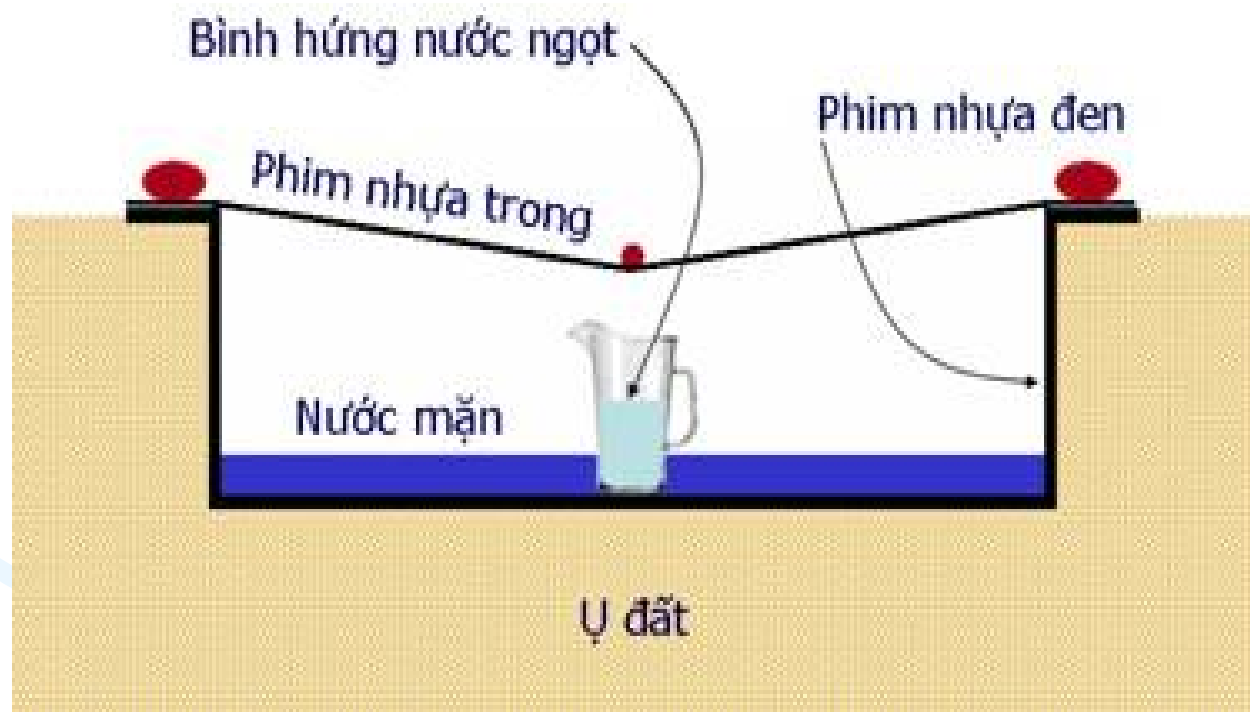
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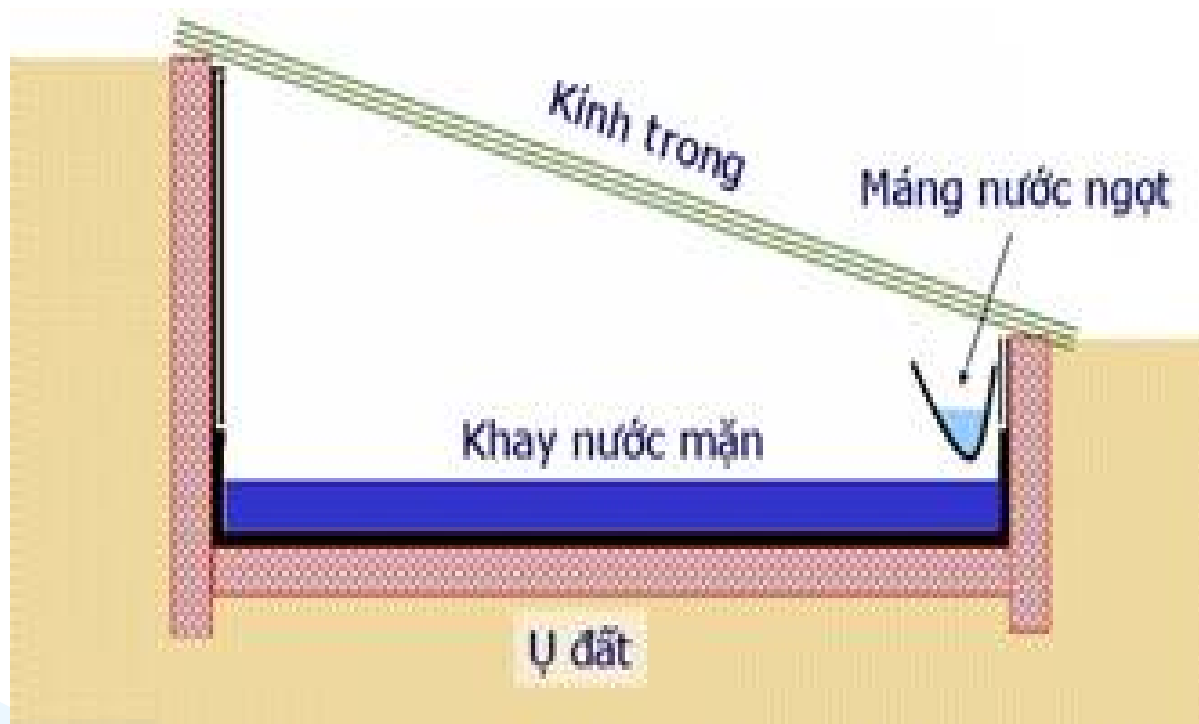
Discussions

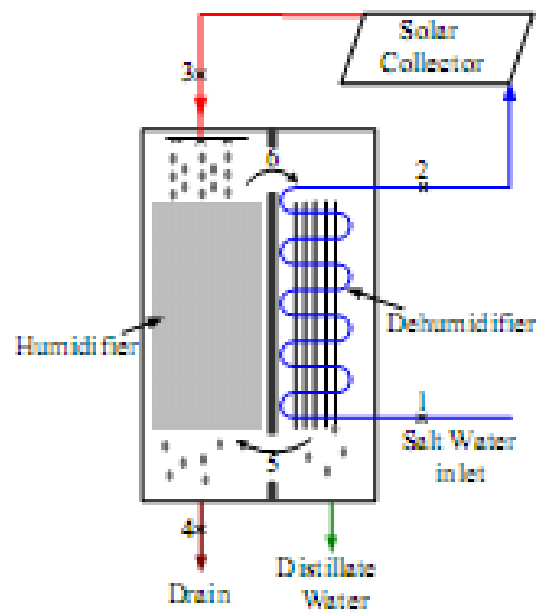
- Diagrams and Principles
- To evaluate practical capability

e. Water Distil

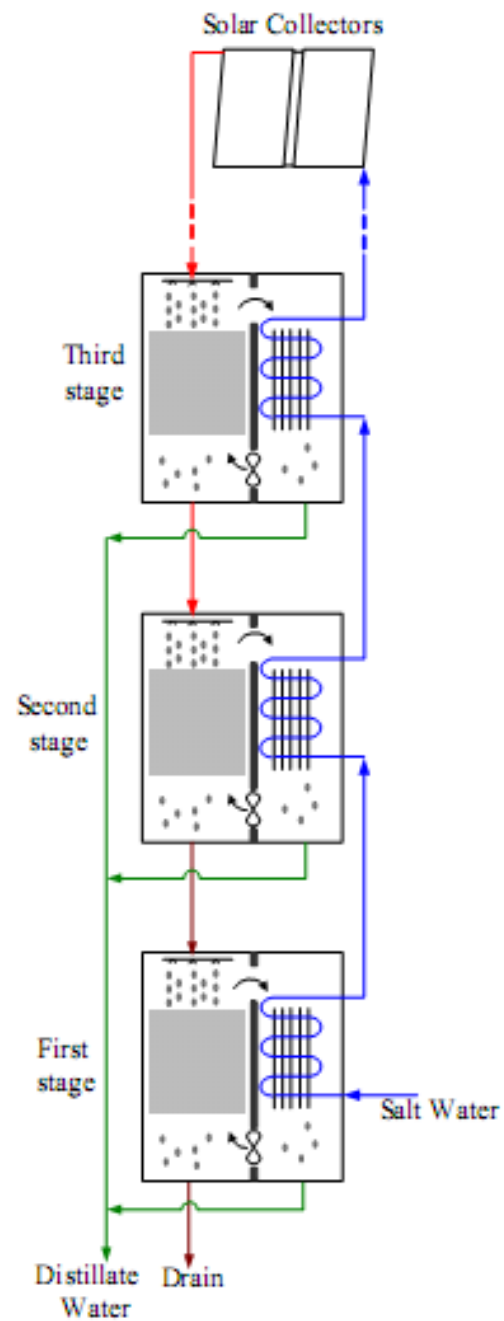








Single-stage solar HD unit



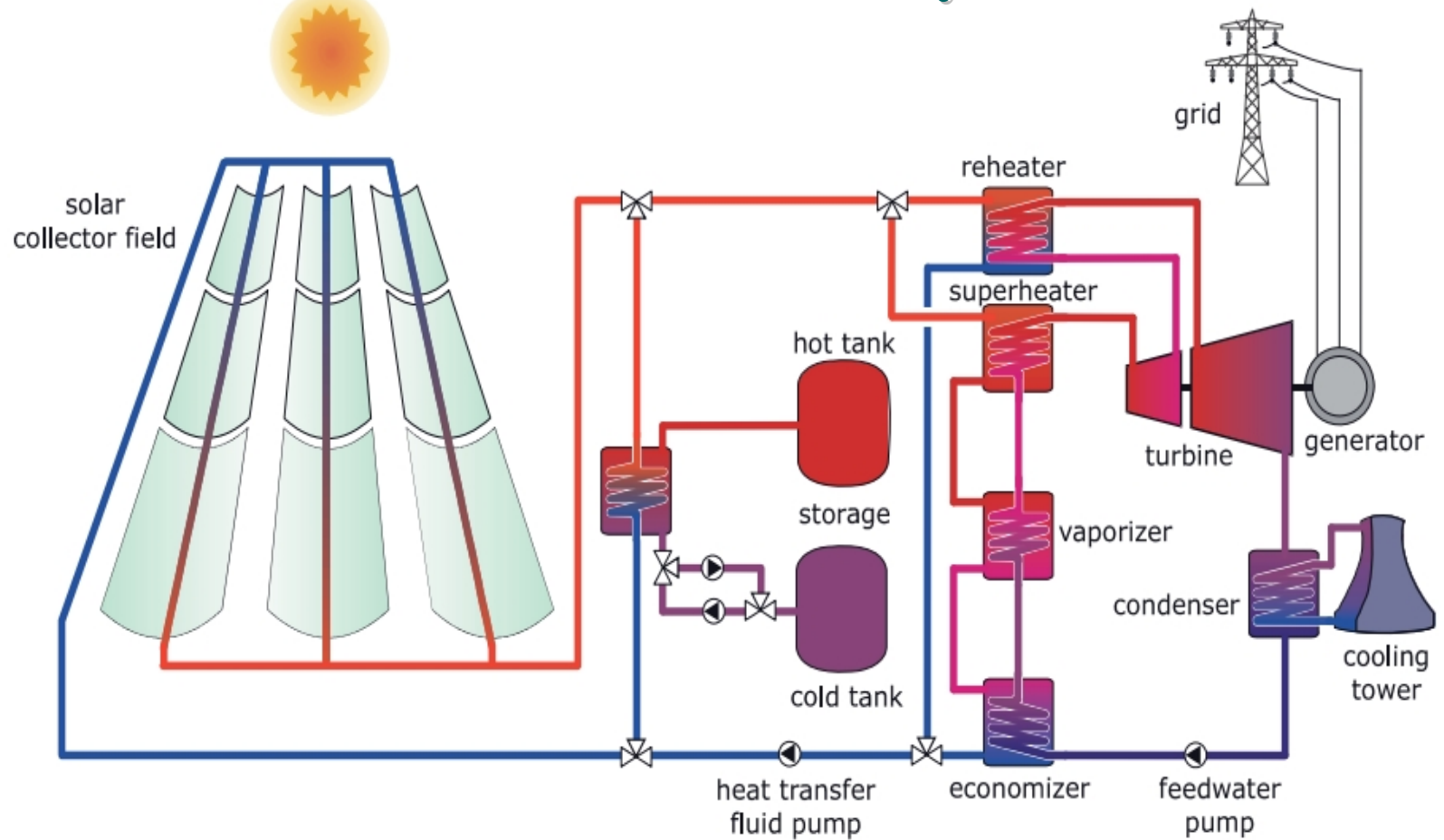
Multi-stage HD desalination unit

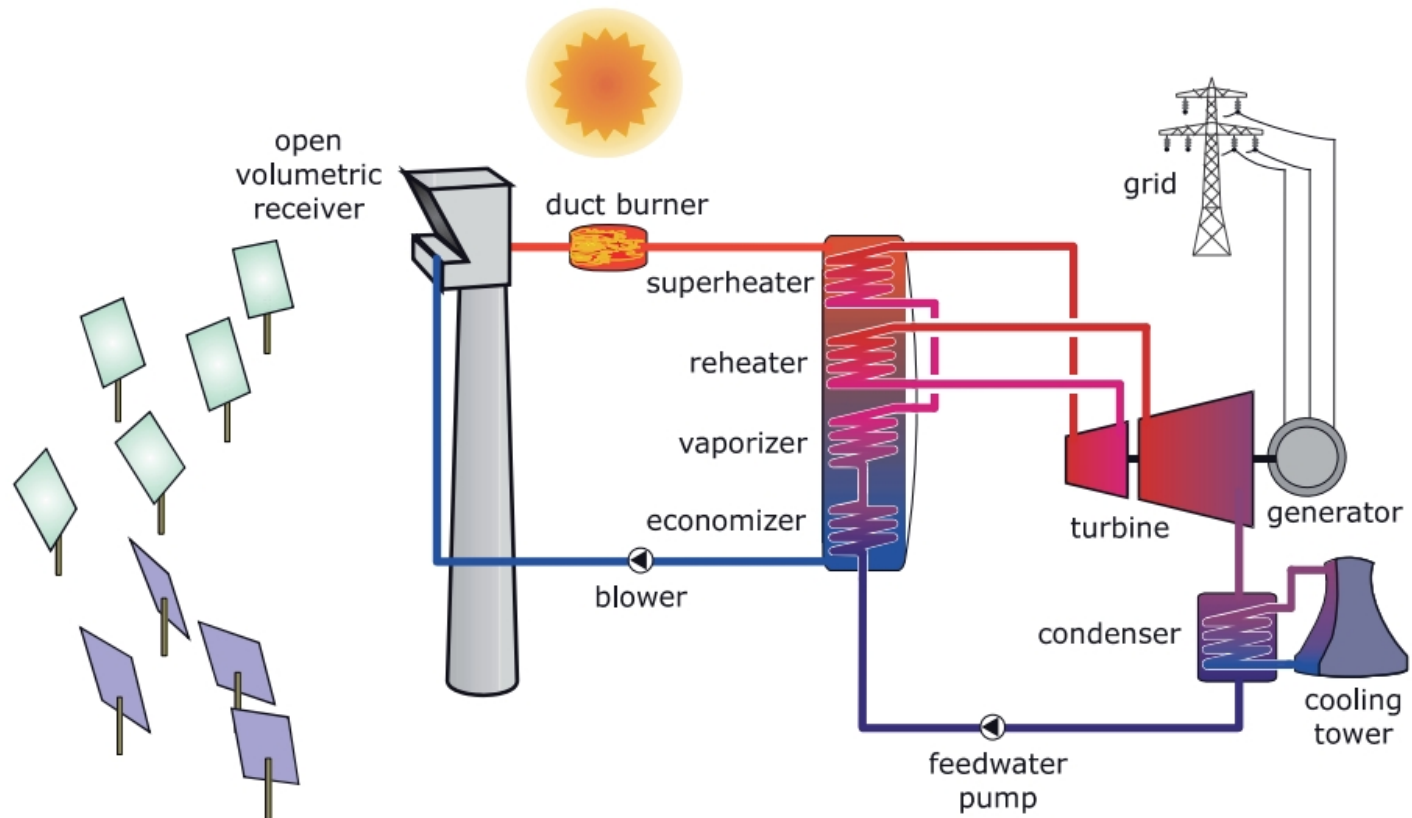
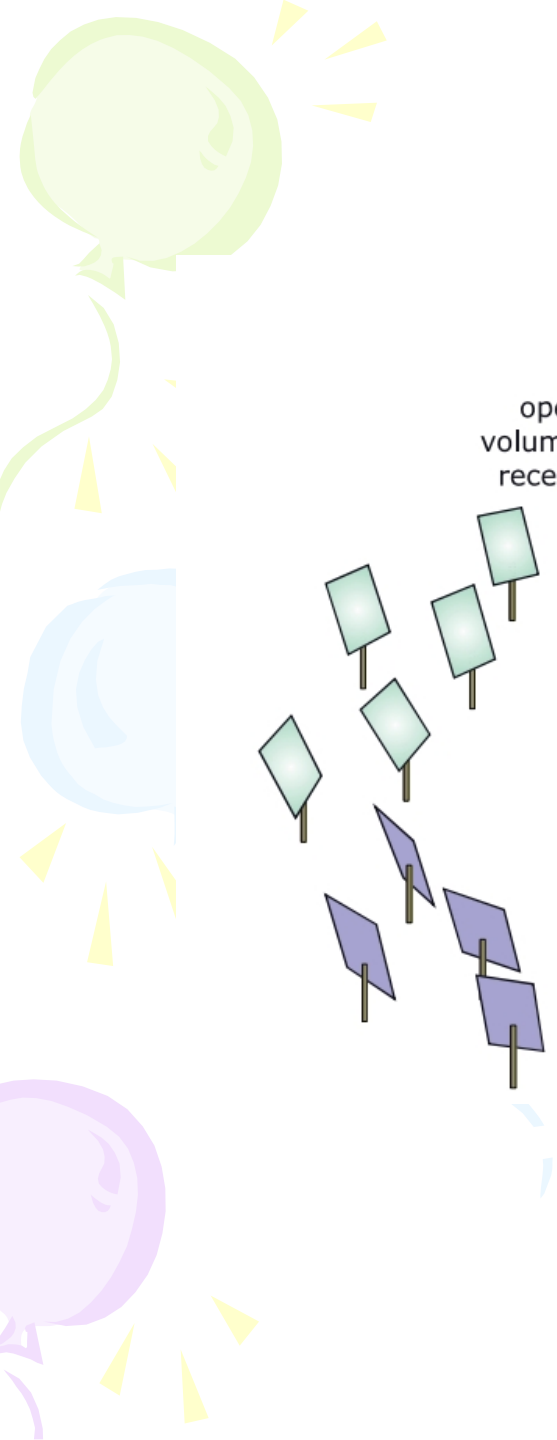
Three balloons in green, blue, and purple are positioned vertically on the left side of the slide. Each balloon has a string and several small yellow triangular flags attached to it.

Discussions

- Present different kinds of water distil diagrams using solar energy
- Analyze the capability of each diagram

f. Solar Electricity





The background features abstract, flowing lines in shades of green, purple, and blue, interspersed with small yellow triangles, creating a dynamic and artistic feel.

5.1.5. Solar photovoltaic (PV)

