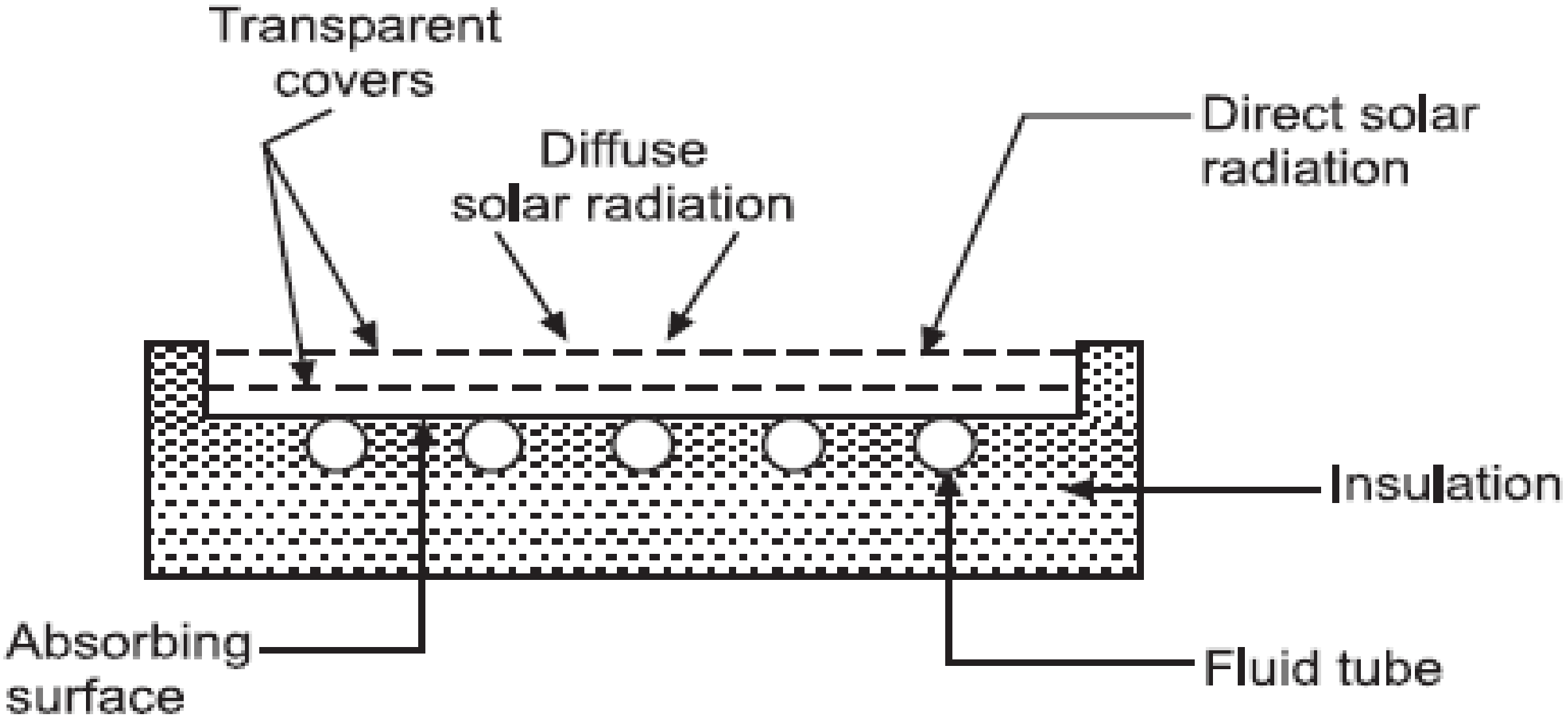
Solar Thermal systems

Flat plate collector:



Flat Plate Collector consists of four essential components:

1. **An absorber plate.**
    1. It intercepts and absorbs solar radiation.
    2. This plate is usually metallic (copper, aluminium or steel), although plastics have been used in some low temperature applications.
    3. In most cases it is coated with a material to enhance the absorption of solar radiation.
    4. The coating may also be tailored to minimize the amount of infrared radiation emitted.
    5. A heat transport fluid (usually air or water) is used to extract the energy collected and passes over, under or through passages which form an integral part of the plate.
2. **Transparent covers.**
    1. These are one or more sheets of solar radiation transmitting materials and are placed above the absorber plate.
    2. They allow solar energy to reach the absorber plate while reducing convection, conduction and re-radiation heat losses.
3. **Insulation beneath the absorber plate.**
    1. It minimizes and protects the absorbing surface from heat losses.
4. **Box-like structure.** It contains the above components and keeps them in position.

5. **A selective surface should possess the following *characteristics:***
    1. Its properties should *not change with use*;
    2. It should be of *reasonable cost*
    3. It should be able to *withstand the temperature levels* associated with the absorber plate surface of a collector over extended period of time;
    4. It should be able to *withstand atmospheric corrosion and oxidation*.
6. ***Some selective coatings*** **are:**
    1. Black chrome;
    2. Black nickel;
    3. Black copper;
    4. Silver foil;
    5. Enersorb (nonselective);
    6. Nextel (non-selective).

Materials for flat-plate collectors:

***1. Absorber plate*:** Copper, Aluminium, Steel, Brass, Silver etc.

***2. Insulation*:** Crown white wool, Glass wool, Expanded polystrene, foam etc.

***3. Cover plate*:** Glass, Teflon, Tedlar, Marlex etc.

Selective Absorber Coatings/Surfaces

1. In order to *reduce thermal losses* from the absorber plate of a solar heating panel, an efficient way is to *use selective absorber coatings*.
2. An ideal selective coating is a *perfect absorber of solar radiation* as well as a *perfect reflector of thermal radiation*.
3. A selective coating, thus, increases the temperature of an absorbing surface.
4. A "*selective surface*" has a *high absorptance* for shortwave radiation (less than 2.5 mm) and *low emittance* of longwave radiation (more than 2.5 mm).

Various types of flat-plate collectors have been designed and studied.

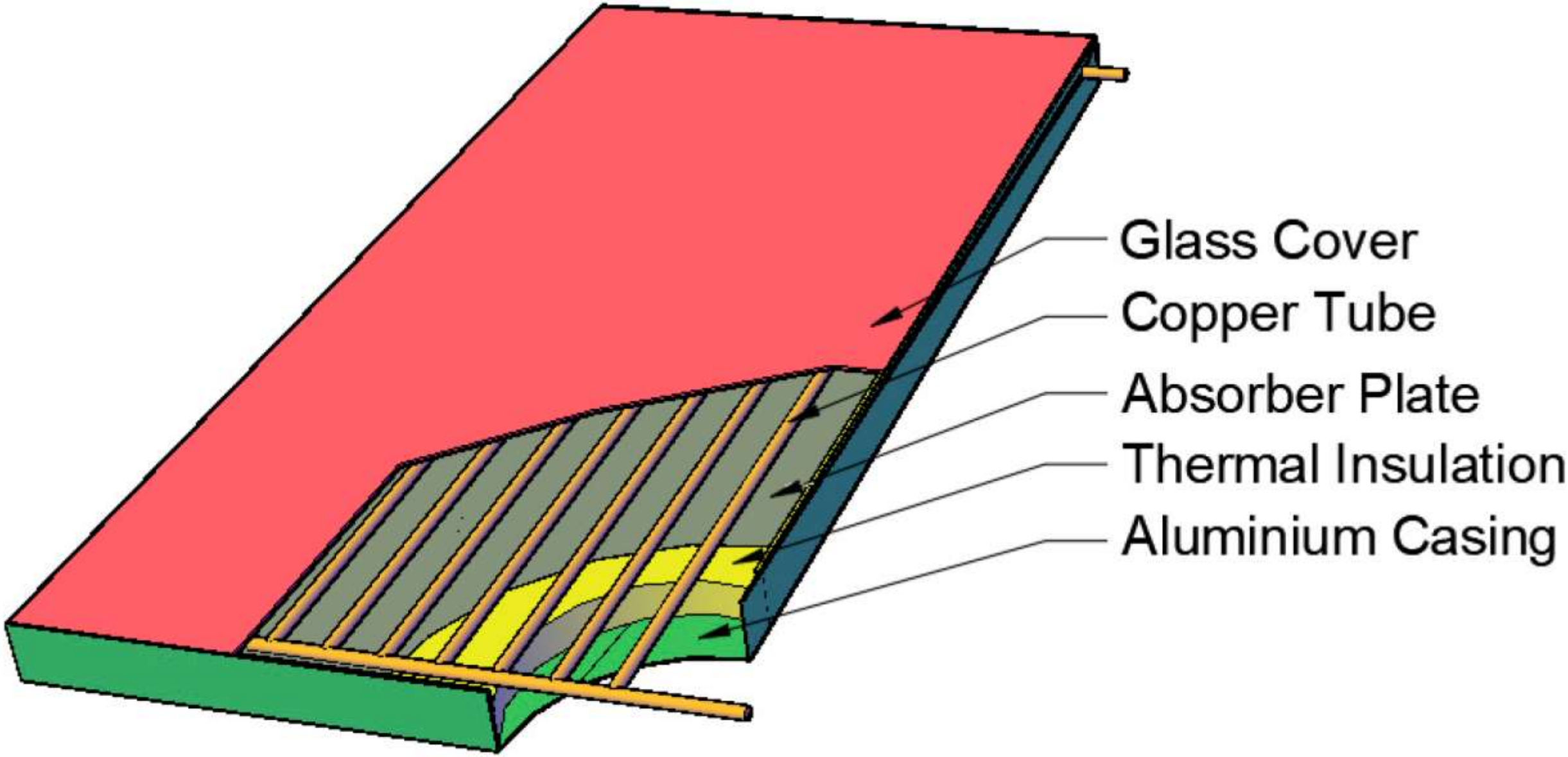
These include

1. *tube in plate, corrugated type, spiral wound type etc.*

Other criteria is

1. *single exposure, double exposure or exposure and reflector type.*

1. The collector utilizes sheets of any of the *highly conducting material viz*. copper, aluminium, or galvanized iron.
2. The *sheets are painted dead black for increasing the absorptivity.*
3. The sheets are provided with one or more glass or plastic covers with *air gap in between to reduce the heat transfer losses*.
4. The sides which are not exposed to solar radiation are *well insulated*.
5. The whole assembly is fixed in airtight wooden box which is mounted on *simple device* to give *the desired angle of inclination*.
6. The dimensions of collectors should be such as to make their handling easy.
7. The collector will absorb the sun energy (*direct as well as diffused*) and transfer it to the fluid (air, water or oil) flowing within the collector.


Glass Cover
Copper Tube
Absorber Plate
Thermal Insulation
Aluminium Casing

Basically, a flat-plate collector is *effective* most of time, *reliable* for good many years and also *inexpensive*.

Use of *flat mirrors in the flat-plate collectors improves the output, permitting higher temperatures of operation.*

Side mirrors are used either at north and south edges or at east and west edges of the collector or a combination of both. The mirrors may be of reversible or non-reversible type.

Factors affecting the performance of a flat-plate collector::

1. ***Incident solar radiation:***

   The collector's efficiency is directly related to solar radiation falling on it and increases with rise in temperature.

2. ***Number of cover plates:***

   The increase in number of cover plates reduces the internal connective heat losses but also prevents the transmission of radiation inside the collector

3. ***Spacing between absorber plate and glass cover.***

   The more the space between the absorber and the cover plate, the less is the internal heat loss.

4. Tilt of the collector.

In order to achieve better performance, flat-plate collector should be tilted at an angle of latitude of the location.

The collector is placed with south facing at northern hemisphere to receive maximum radiation throughout the day.

5. Selective surface:

The selective surface should be able to withstand high temperature, should not oxidize and should be corrosion resistant.

6. Fluid inlet temperature:

With the increase in the inlet temperature of the fluid, there is an increase in operating temperature of the collector and this leads to decrease in efficiency.

6. Dust on cover plate:

The collector's efficiency decreases as dust particles increase on the cover plate. Thus, frequent cleaning is required to get the maximum efficiency of the collector.

Advantages of Flat-plate Collectors:

1. *Both beam and diffuse solar radiations* are used.
2. Require *little maintenance*.
3. The orientation of the sun is *not required* (*i.e.* no tracking device needed)
4. Mechanically *simpler* than the focusing collectors.

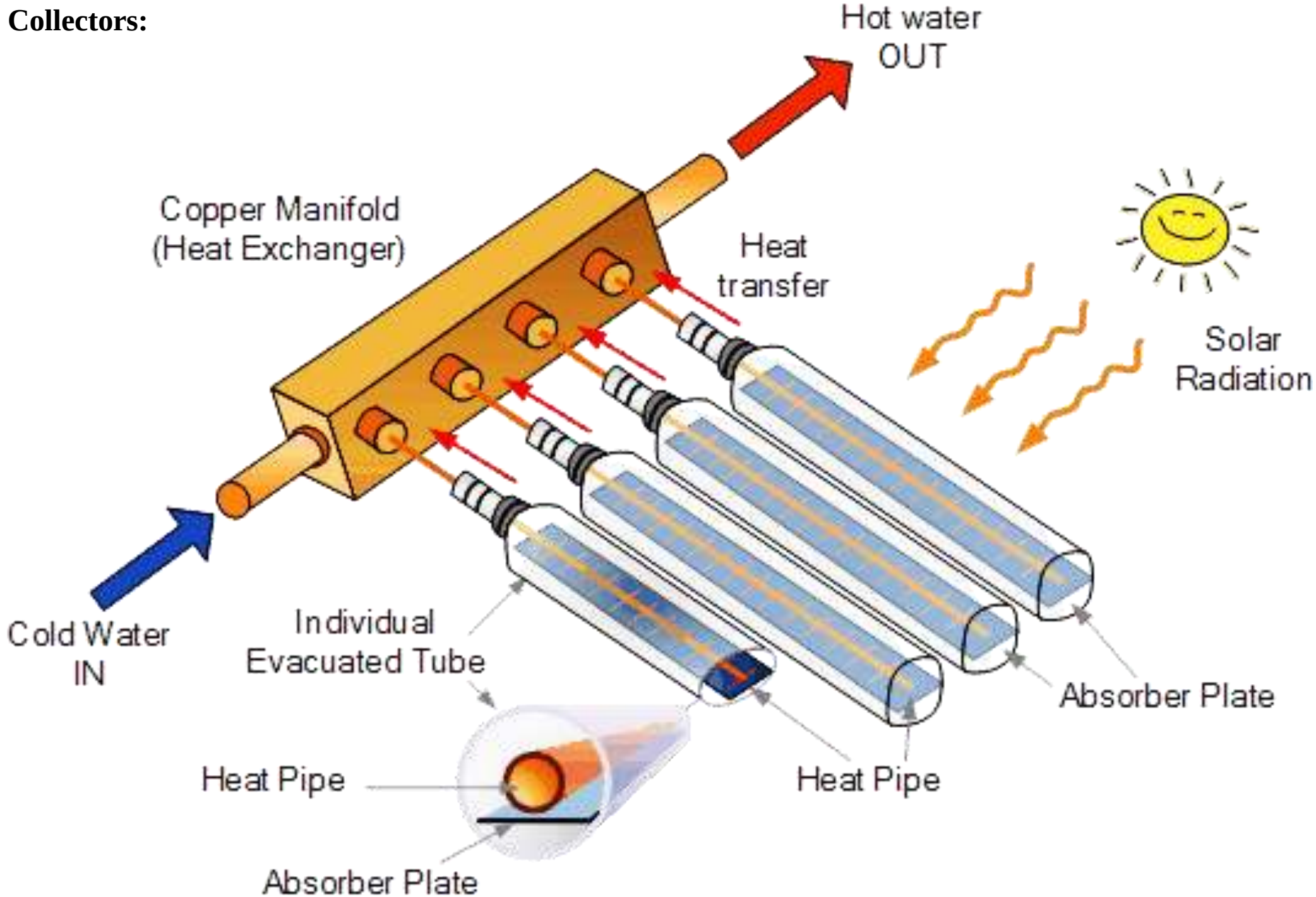
Disadvantages of Flat-plate Collectors:

1. *Low temperature* is achieved.
2. *Heavy* in weight.
3. Large heat losses by conduction due to large area.

Applications:

1. Used in *solar water heating*.
2. Used in *solar heating and cooling*.
3. Used in *low temperature power generation*.

Evacuated Collectors:



Evacuated Collectors:

1. Planar solar collectors of evacuated type often achieve efficiencies with an output temperature of above 80°C.
2. In these devices a vacuum occupies the space between the absorber and the aperture cover.
3. The absorber may consist of a heat pipe that is thermally bonded to collecting this, possibly in an evacuated glass tube.

In 1983 Collins and Duff, stated that, the efficiencies in excess of 40% or an output temperature of 200°C can be reached.

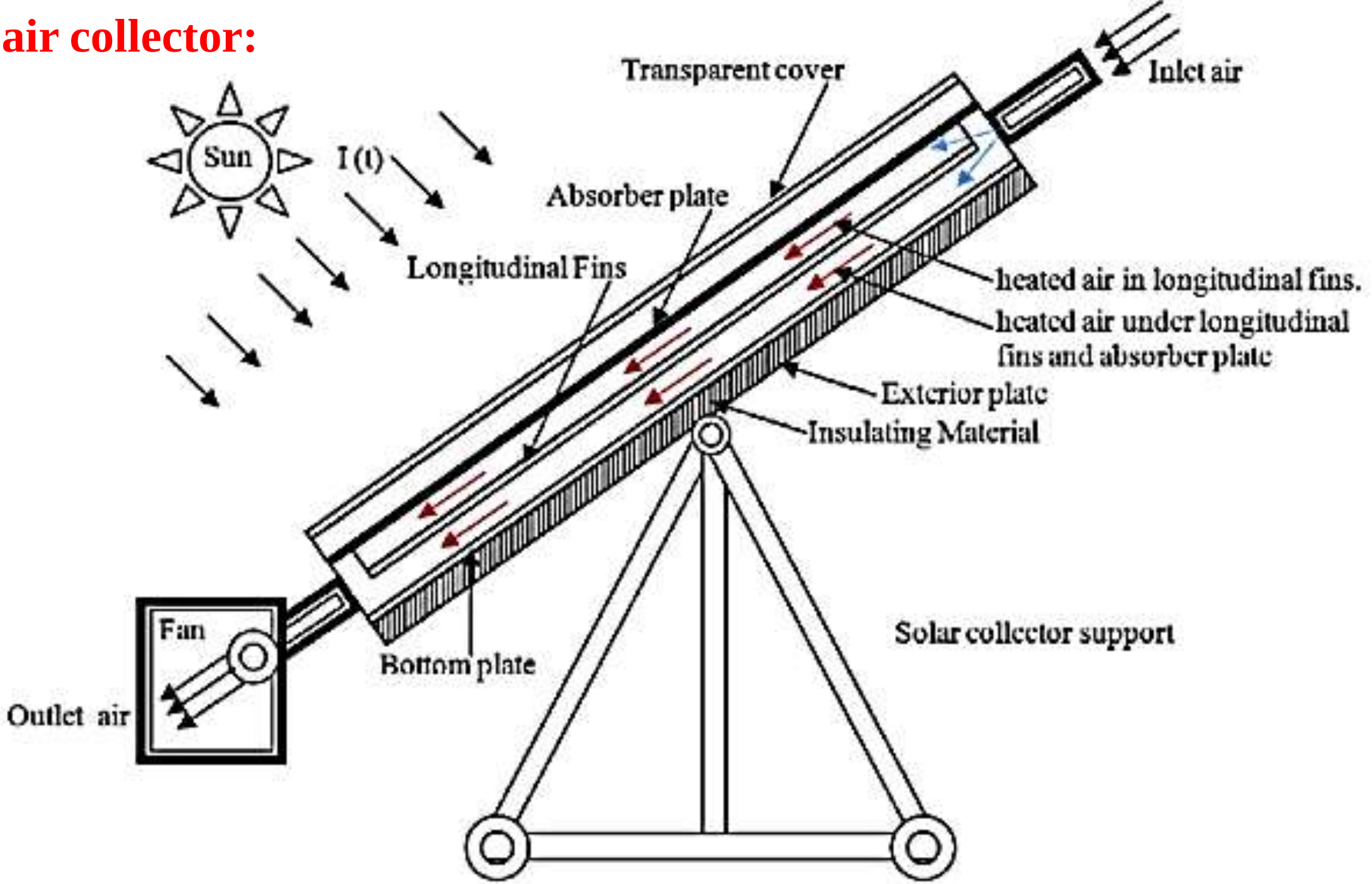
Problem 1:

The following data relate to a flate plate collector used for heating the building: Location and latitude = Baroda, 22°N; Day and time: January 22,11:30 – 12:30 (IST); Annual average intensity of solar radiation = 340 W/m2 hr; Tilt of the collector = latitude + 14°; Number of glass covers = 2; Heat removal factor for collector = 0.82; Transmittance of glass = 0.87; Aborptance of glass = 0.89; Top loss coefficient for collector = 7.9 W/m2 hr °C; Collector fluid inlet temperature = 48 °C; Ambient temperature = 16 °C.

Calculate the following:

1. Solar altitude angle;
2. Incident angle;
3. Efficiency of the collector.

solar air collector:

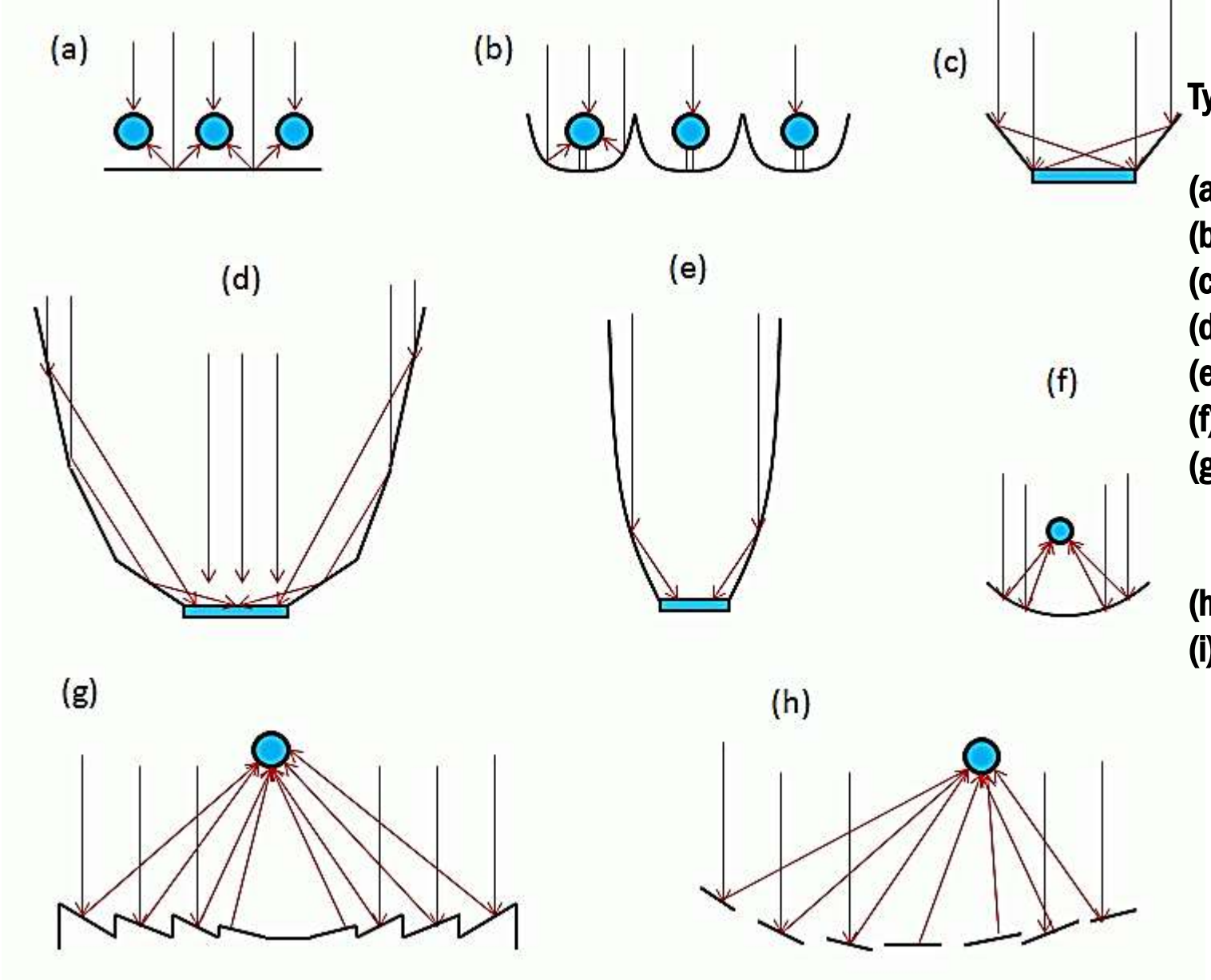


solar concentrator:

What does a solar concentrator do?

A solar concentrator uses lenses, called Fresnel lenses, which **take a large area of sunlight and direct it towards a specific spot by bending the rays of light and focusing them**.

Some people use the same principle when they use a magnifying lens to focus the Sun's rays on a pile of kindling or paper to start fires.



Types of concentrating sunlight collectors:

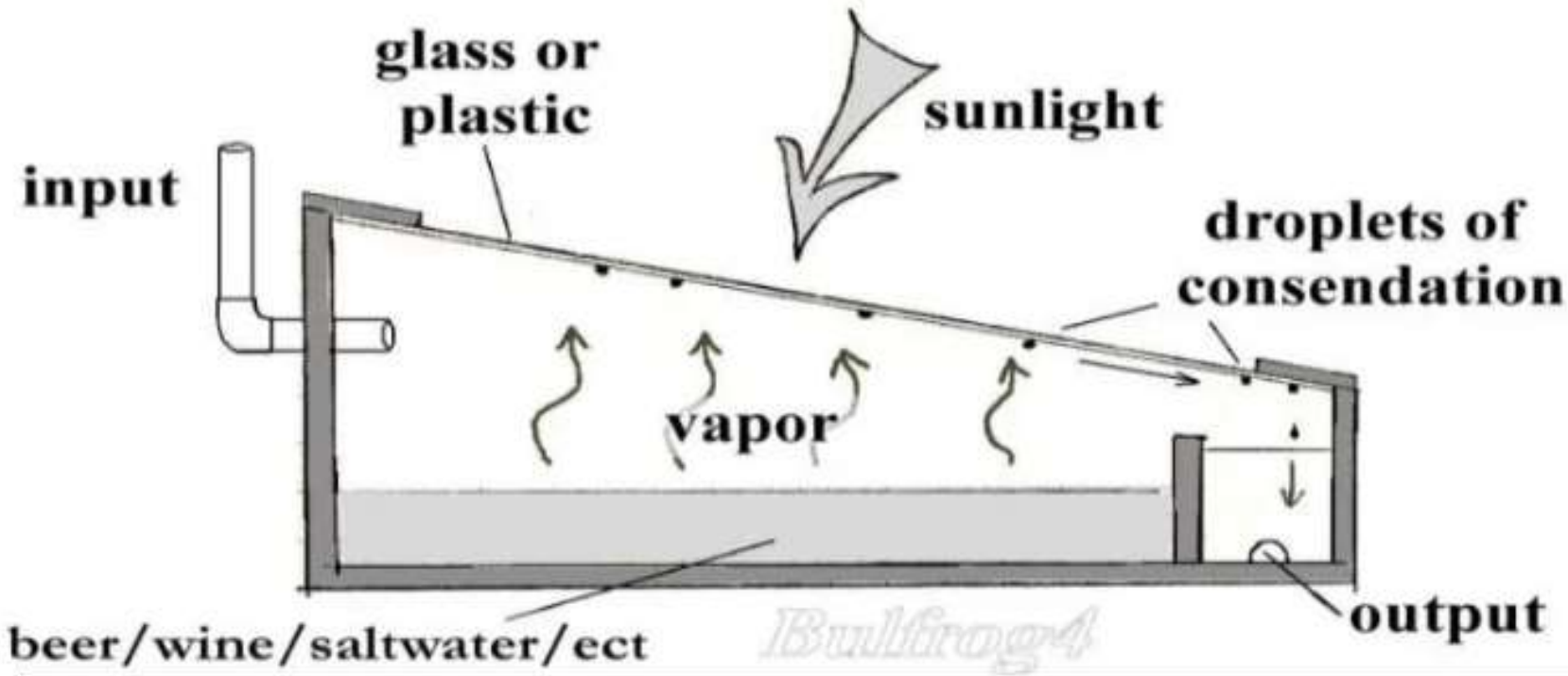
(a) tubular absorbers with diffuse back reflector,
(b) tubular absorbers with specular cusp reflectors,
(c) plane receiver with plain reflectors (V-trough),
(d) Multi-sectional planar concentrator,
(e) compound parabolic concentrator
(f) parabolic trough,
(g) fresnel concentrator, (a flat lens made of a number of concentric rings, to reduce spherical aberration)
(h) array reflectors (heliostats) with central receiver.
(i) Concentration of light on the receiver is achieved by shaping the reflectors (mirrors) around the receiver (represented by blue circles).

Solar distillation

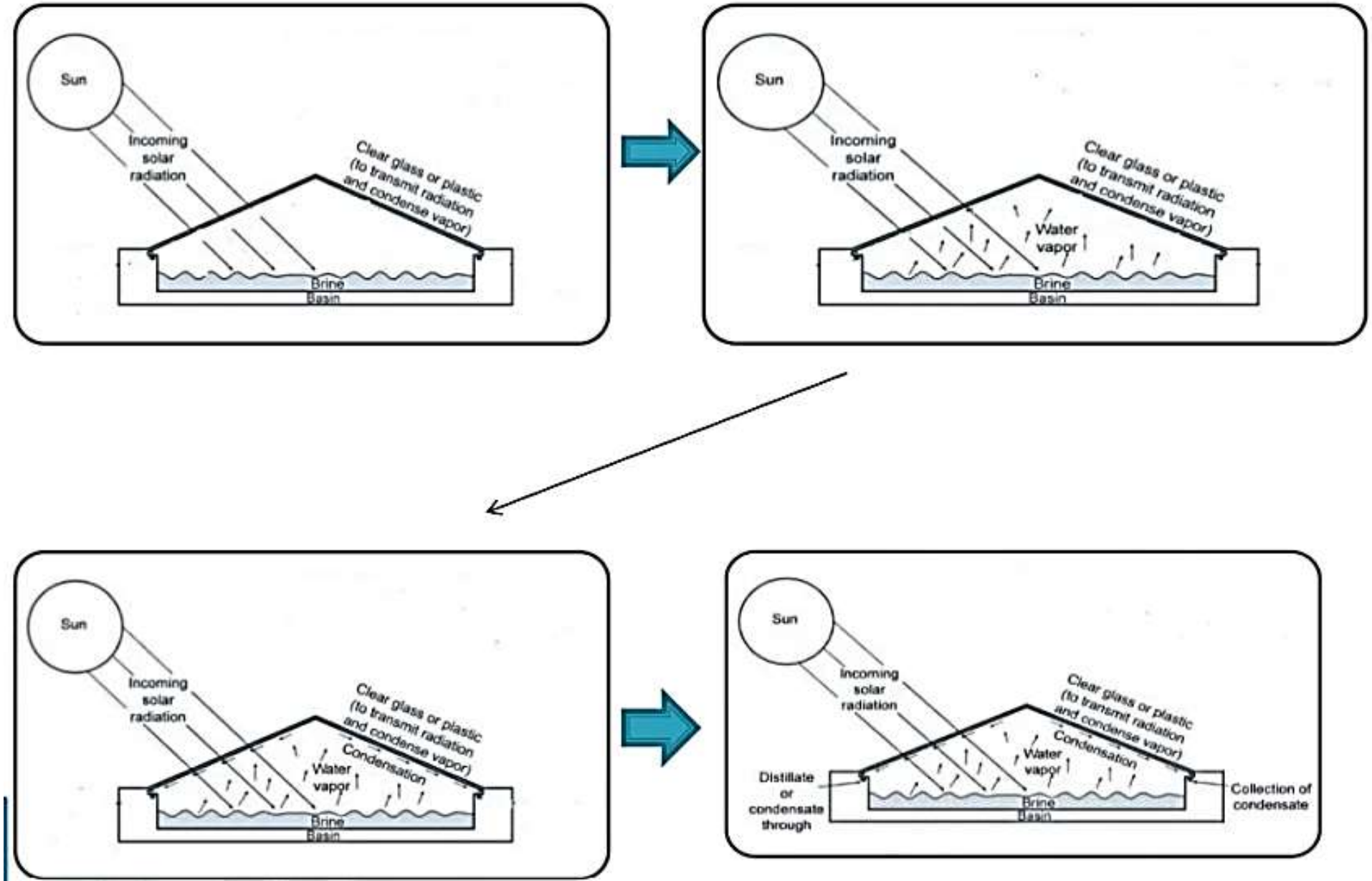
1. Solar distillation is by far the most reliable, least costly method of 99.9% true purification of most type of contaminated water especially in developing nations, where fuel is scarce or too expensive.
2. Solar distillation is used to produce drinking water or to produce pure water for lead acid batteries, laboratories, hospitals and in producing commercial products such as rose water.
3. The basic principles of Solar water distillation are simple yet effective, as distillation replicates the way nature makes rain.
4. The sun’s energy heats water to the point of evaporation.
5. As the water evaporates, water vapor rises, condensing on the glass surface for collection.
6. This process removes impurities such as salts and heavy metals as well as eliminates microbiological organisms.
7. The end result is water cleaner than the purest rainwater.
8. The Sola Aqua still is a passive solar distiller that only needs sunshine to operate.
9. There are no moving parts to wear out.

WORKING OF SLOAR STILL

Solar stills are called stills because they distill, or purify water. A solar still operates on the same principle as rainwater: evaporation and condensation. The water from the oceans evaporates, only to cool, condense, and return to earth as rain. When the water evaporates, it removes only pure water and leaves all contaminants behind.



WORKING PROCEDURE OF SOLAR DISTILLATION



ADVANTAGES

Solar Stills have got major advantages over other conventional Distillation / water purification /de-mineralisation systems as follows :

1. Produces pure water
2. No prime movers required
3. No conventional energy required
4. No skilled operator required
5. Local manufacturing/repairing
6. Low investment
7. Can purify highly saline water (even sea water)

DISADVANTAGES

1. Poor fitting and joints, which increase colder air flow from outside into the still
2. Cracking, breakage or scratches on glass, which reduce solar transmission or let in air
3. Growth of algae and deposition of dust, bird droppings, etc. To avoid this the stills need to be cleaned regularly every few days
4. Damage over time to the blackened absorbing surface.
5. Accumulation of salt on the bottom, which needs to be removed periodically

Solar Cooker

- Solar cooker is a device that allows you to cook food using the sun's energy as fuel.
- Depending on where you live and how you cook, solar cooking can save you time, work and fuel. And it's environmentally benign.
- The demand for the energy is increasing with the increase in population day and at the same time the generation of energy by using fossil fuel's is decreasing .
- The growing energy demands some alternative sources like energy that to non- renewable energy from sun is being developed.
- So in the present work we are studying about solar energy usage by solar cooker And construction of solar cooker

HISTORY OF SOLAR COOKER:

- IN 1767 – SWISS HORACE DE SAUSSURE(FRENCH)
- IN 1830 –BRITISH ASTRONOMER JOHN HERSCHEL
- IN 1881-SAMUEL P.LANGLY & MT.WHITNEY
- IN 1860-ALGERIA
- IN 1970 DISAPPERING TREES

DESIGN OF SOLAR COOKER

- A box type cooker consists of insulated box with a glass cover and a top lid, which has a mirror on its inner side to reflect sunlight into box when the lid is kept open.
- The inner part of the box is painted black usually four block painted vessels are placed inside thebox along with the materials.
- A normal box cooker of 0.6m*0.6m size having a weight of around 12kgs.
- The capable of cooking 2kgs of food and can save 3 to 4 LPG cylinder a year if used regularly.

Types of solar cookers

- Dish type solar cooker
- Indoor type solar cooker
- Solar steam cooking
- Heat trap boxes

ADVANTAGES:

- Solar cookers save money and time
- Solar cookers are safe, healthy and convenient
- Solar cookers are versatile and adaptable
- Solar cookers are life-saving devices for those in sunny, fuel-scarce regions

- It cooks up to 4items at a time
- It preserves the nutrition value of the food.
- It does not require constant attention.
- It is pollution free