

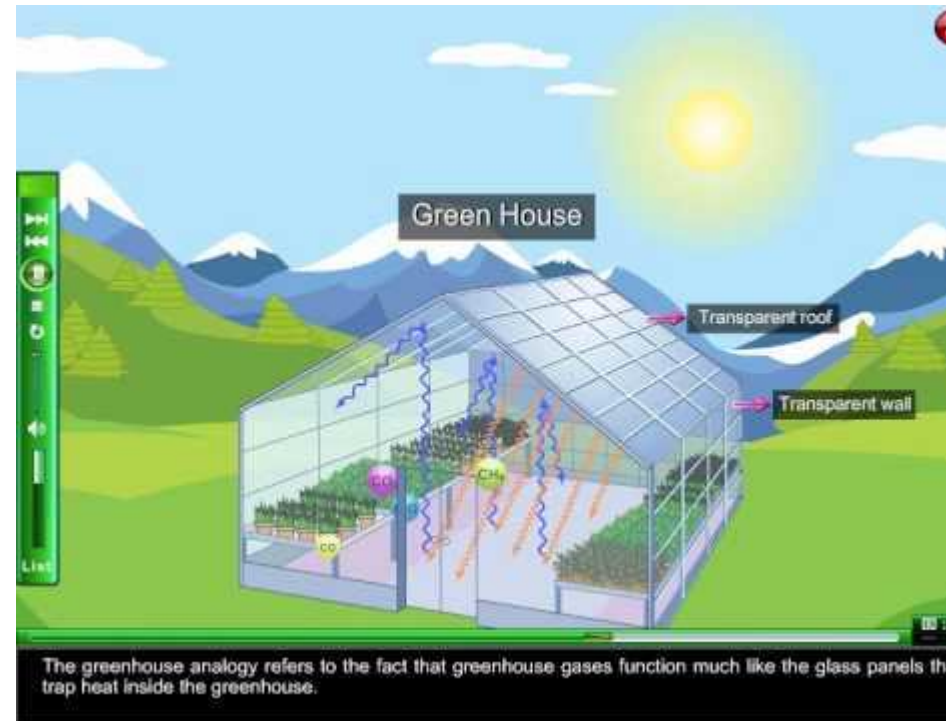
Solar Energy Collectors

Introduction

- A solar collector is a device for collecting solar radiation and transfer the energy to a fluid passing in contact with it
- These can be classified in two types:
 1. Non concentrating or flat type solar collector
 2. Concentrating (focusing) type solar collector
- Absorber is essential component for conversion of solar radiation energy into more useful form

Physical principle of flat collector

- A basic mechanism behind solar energy collector is greenhouse effect
- It causes accumulation of heat in enclosure
- Selective transmittivity of glass coating plays key role here
- Glass allows the high frequency radiation to come in, but doesn't allow the infrared emission go out through it



Wien's Law

The re-emitted light is so progressively shorter wavelength and greater energy as the temperature of the black body increases.

This is expressed by Wien's law, which may be written as:

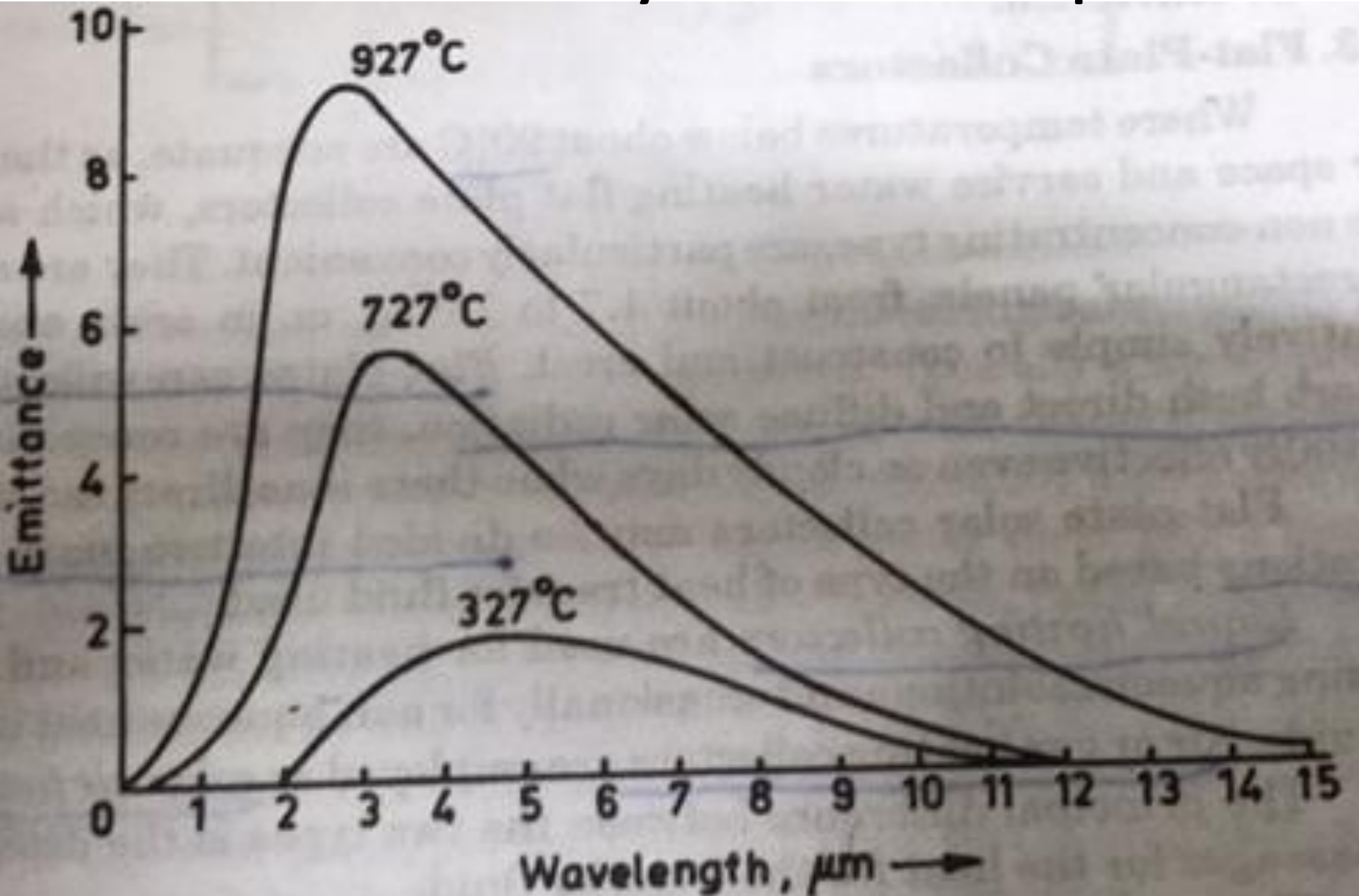
$$\lambda_{\max} T = \text{constant} = 2989 \mu\text{m Kelvin}$$

Where,

λ_{\max} = wavelength at which light emission reaches maximum

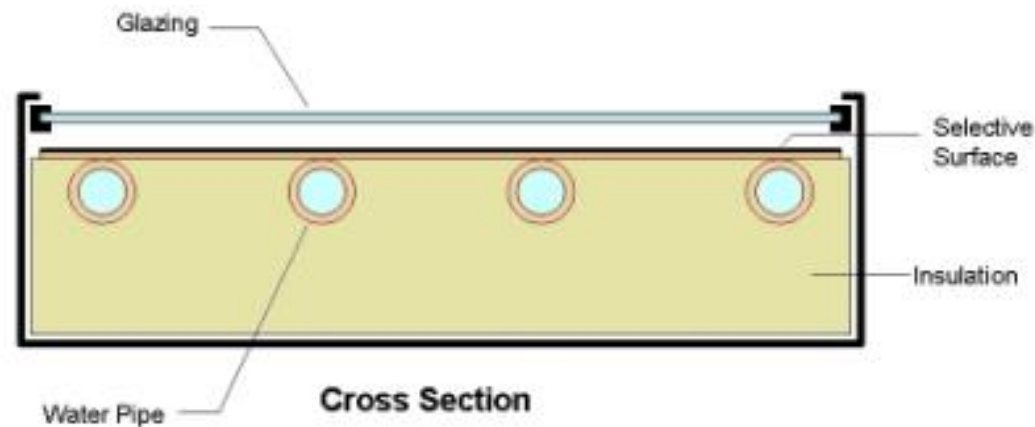
T = surface temperature of black body

Emittance of blackbody at different temperature



Flat plate collector

- Exposer of dark surface to solar radiation
- Heat transfer to the working fluid
- If no optical concentration -> Flat plate collector (FPC) (for 40°C to 100°C)



Flat plate collector

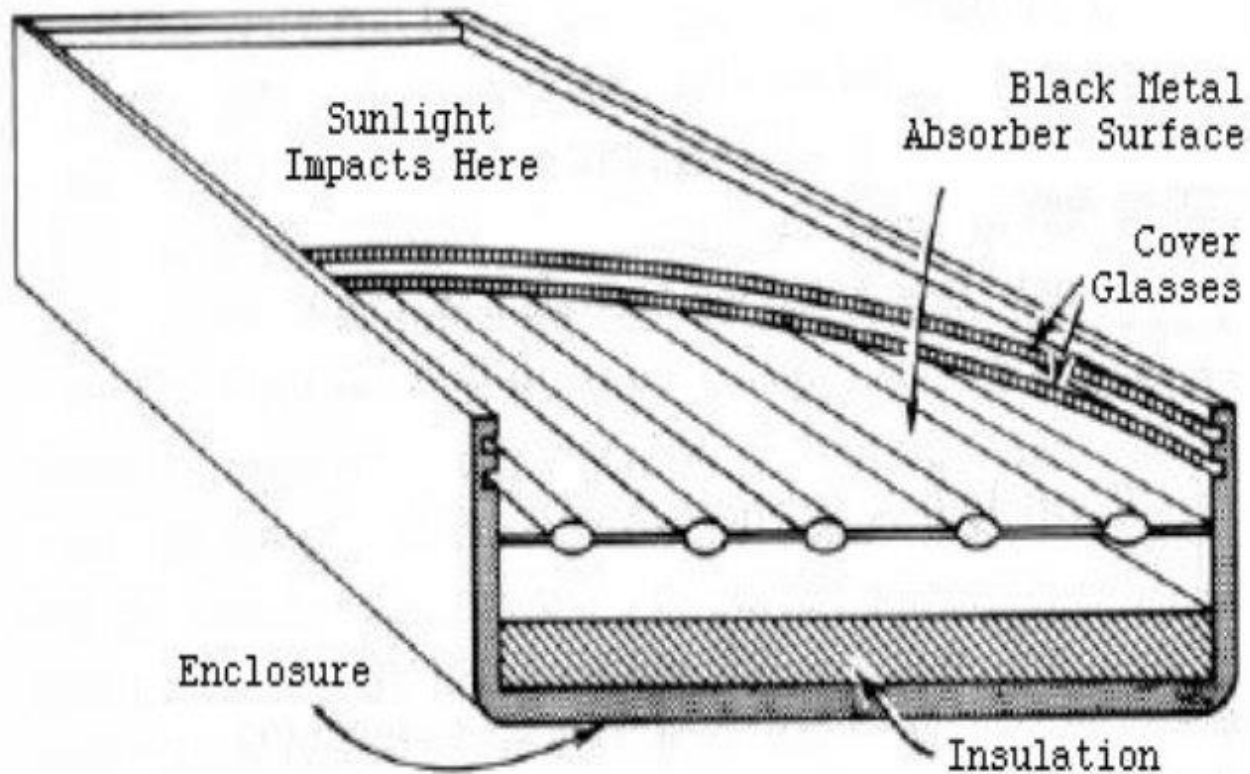
- Where temperatures below about 90°C are adequate such as space heating and service water heating, flat plate collectors are particularly convenient
- Generally made of rectangular panels from 1.7 to 2.9 m²
- Easy to manufacture and install
- Absorb both direct and diffuse radiation

Flat plate collector

- They may be classified as:
 1. Liquid heating collector
 2. Solar air heater
- Main components of flat plate collector
 1. A transparent cover
 2. Tubes or passages
 3. The absorber plate
 4. Insulation
 5. The casing or container

Flat plate collector

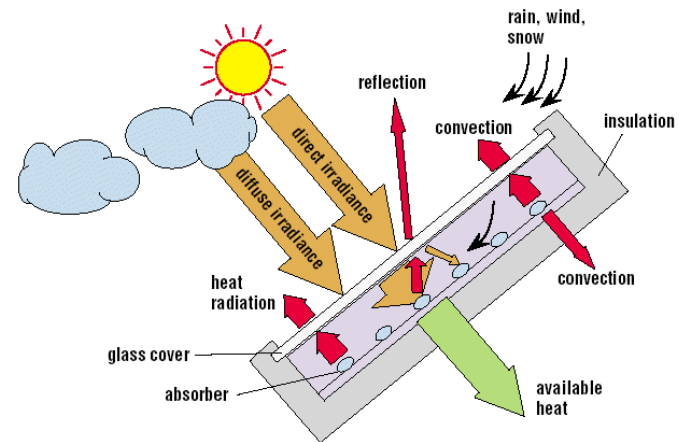
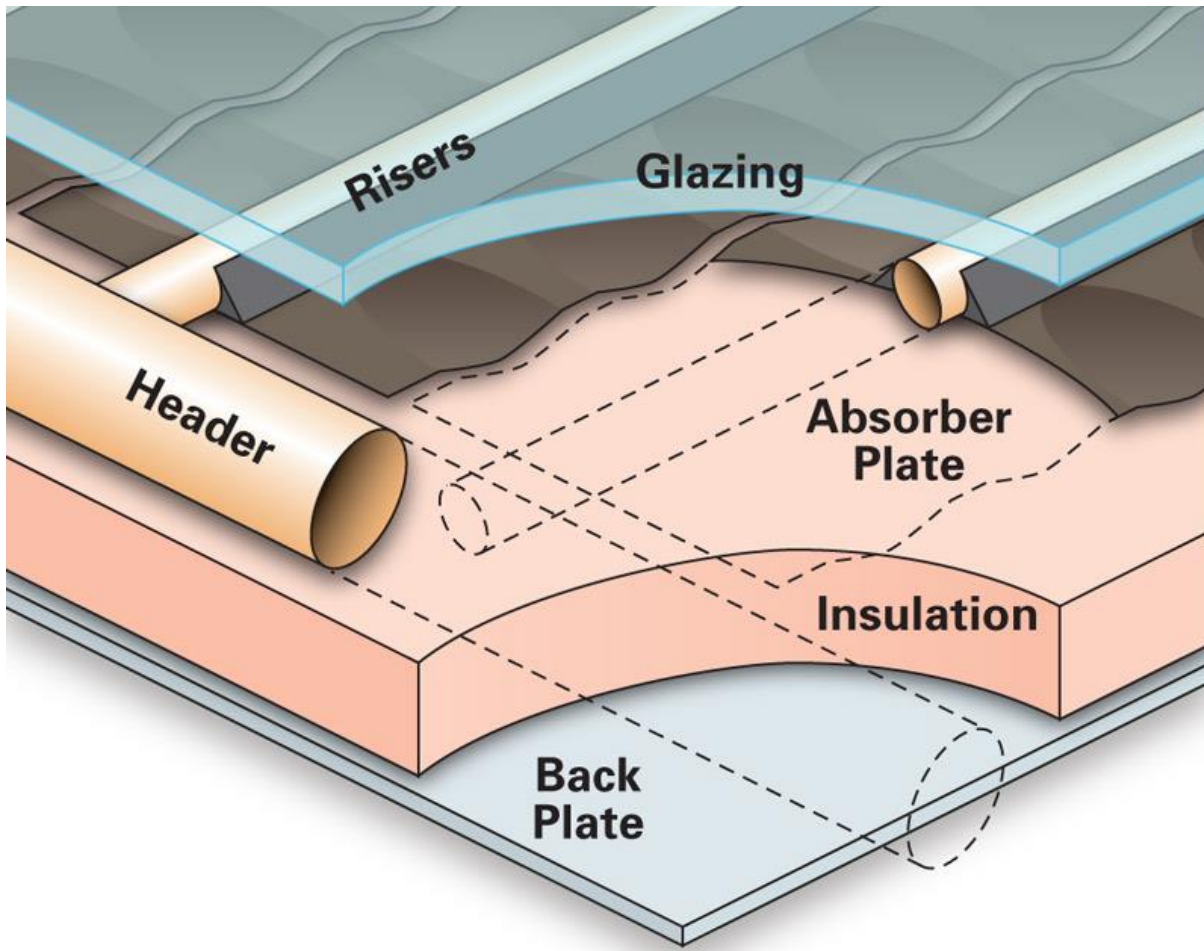
Flat Plate Collector



Flat plate collector

- A plate and tube type collector uses flat surface with high absorptivity, typically a metal plate of copper, steel or aluminium (Generally of corrugated galvanised sheet)
- Plate is usually made of metal sheet of thickness 1 to 2 mm thickness and tube range of diameter from 1 to 1.5cm
- They are soldered, brazed or clamped with absorber with pitch ranging from 5 to 15 cm

Flat plate collector



Flat plate collector

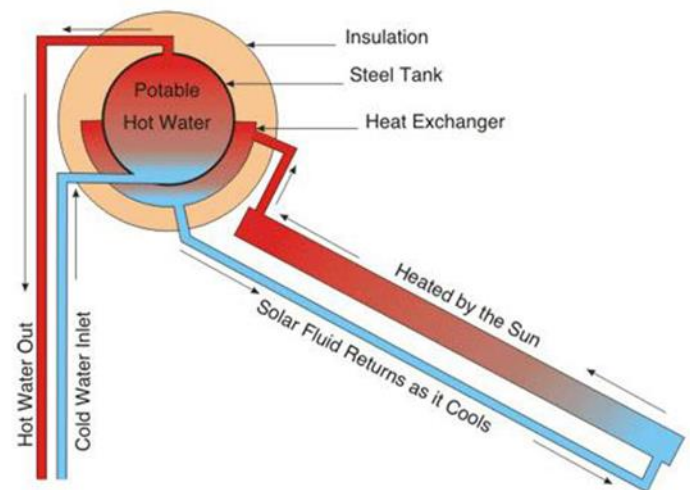
- Heat is transferred from absorber to point of use by circulating fluid
- Thermal insulation of 5 to 10 cm thickness is usually placed behind absorber to prevent heat losses from rear surface
- Insulation material is generally mineral wool or fiberglass
- The front cover is generally of glass that is transparent to incoming solar radiation and opaque to the infrared reradiation

Flat plate collector

- Glass is generally preferred over certain plastic cover films of 3 to 4 mm thickness
- Second glass cover improves
 - Reduction in convection losses through air
 - Radiation losses in infra-red spectrum are further reduced
- Sometimes mixture of water and ethylene glycol are used, if ambient temperature may go below 0°C

Flat plate collector

- Heat transport system
- The heat generated in the absorber is removed by continuous flow of a heat transport medium either water or air
- Water is passed through metal tubes with either circular or rectangular cross section
- Natural circulation is employed in the in the flat plate collectors



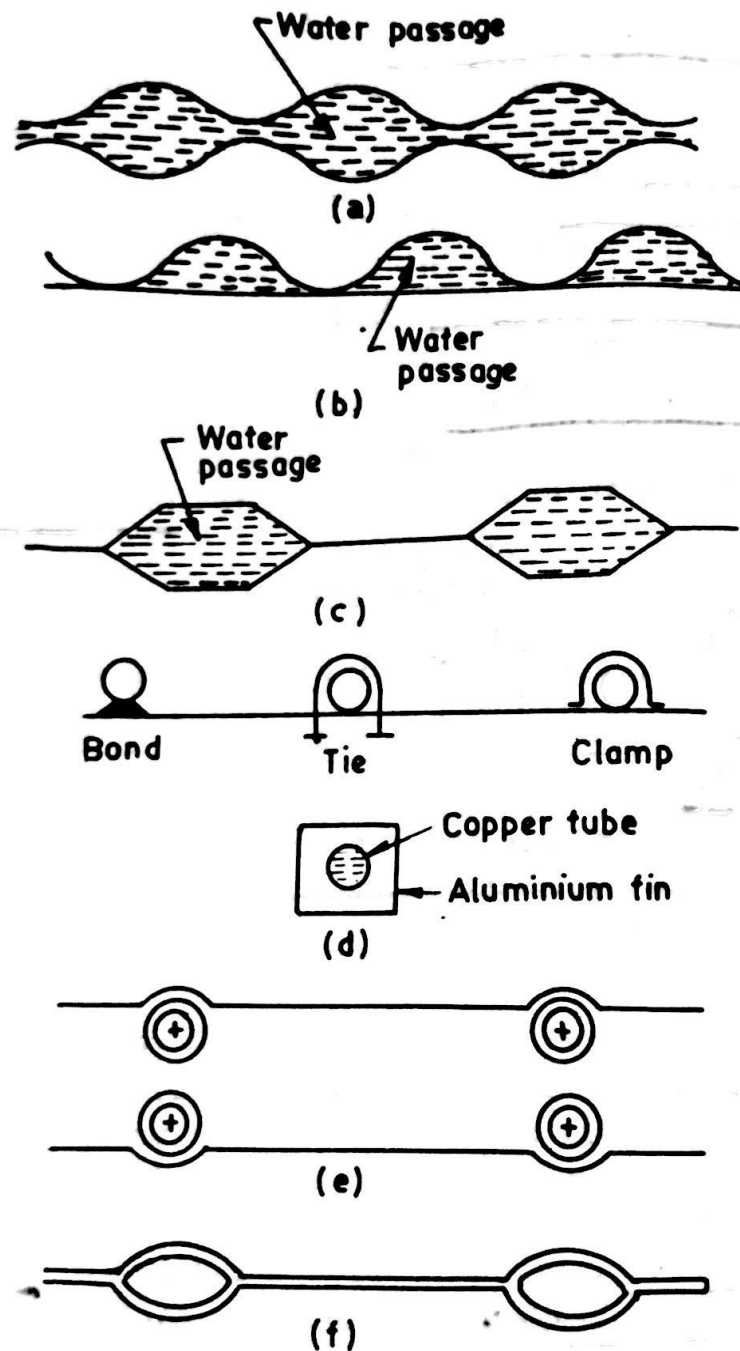


Fig. 3.3.2. Cross-section through collector plates.

Solar Air Heater

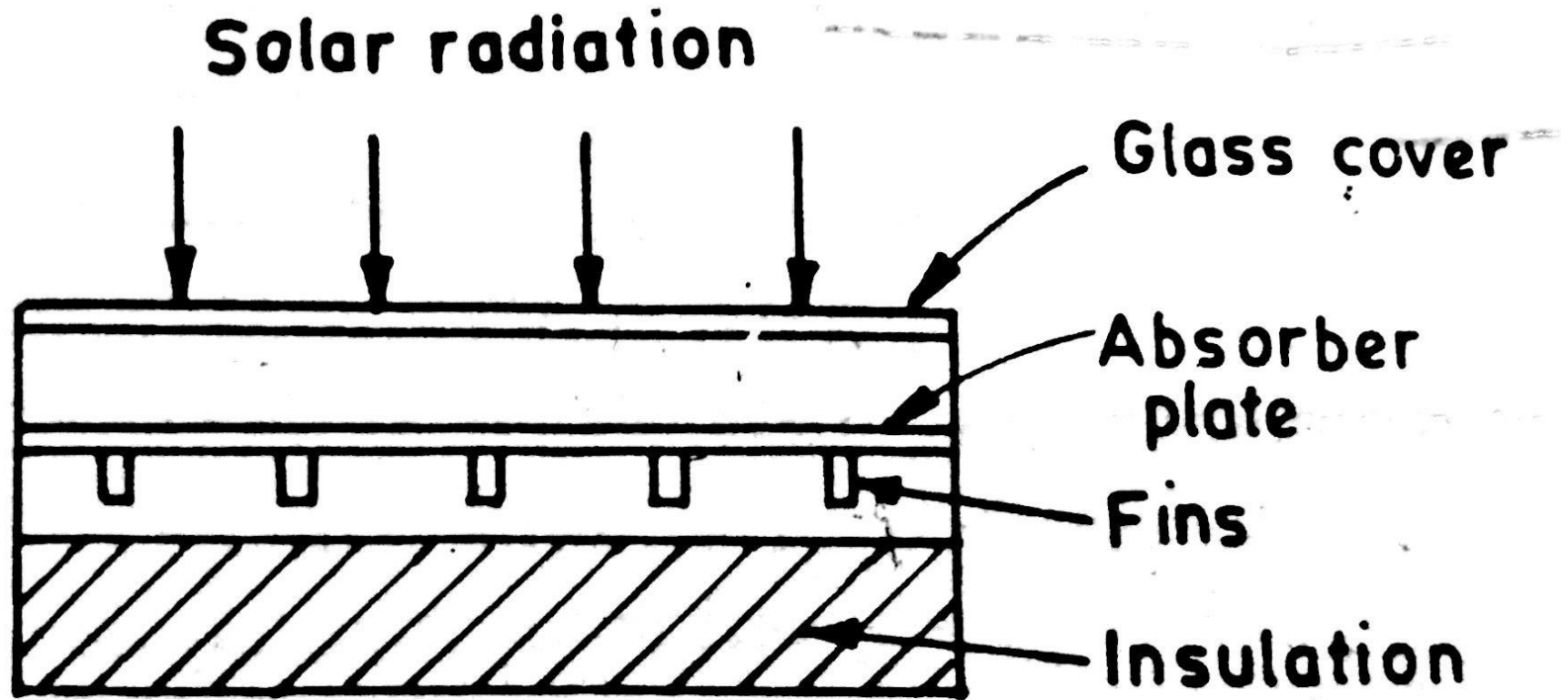


Fig. 3.3.4. Typical Solar Air Collector.

Types of Solar air heater

1. Non porous absorber plate type collectors
2. Collectors with porous absorber

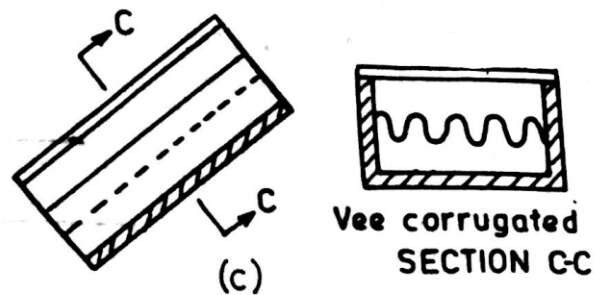
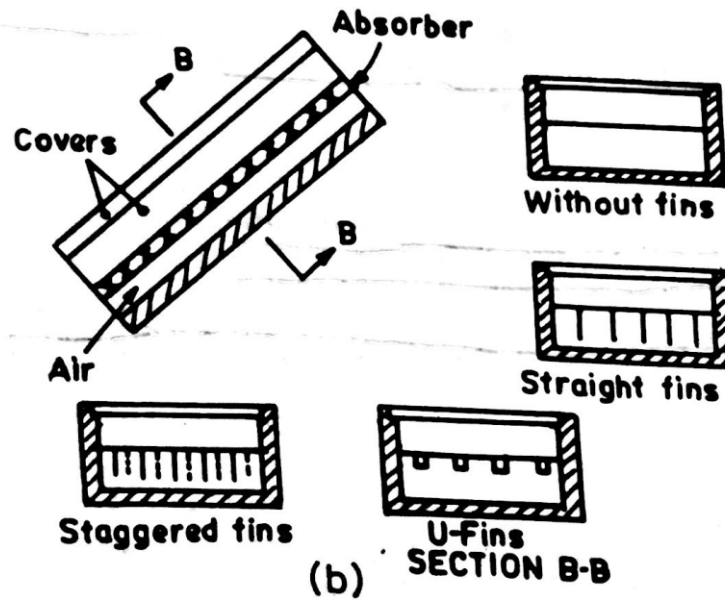
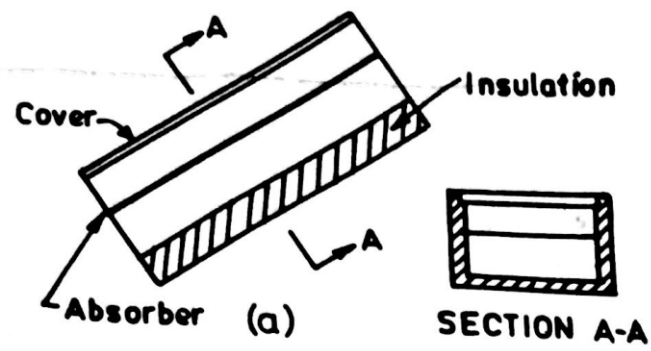
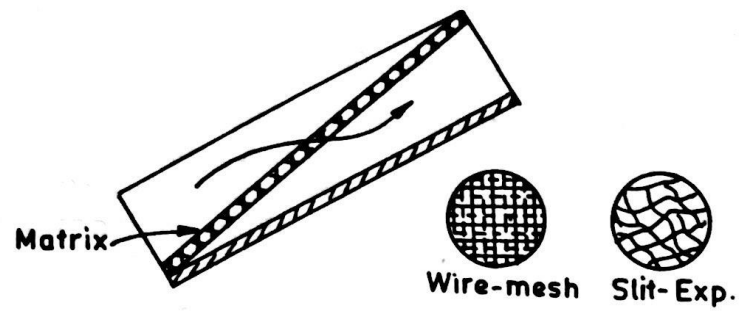
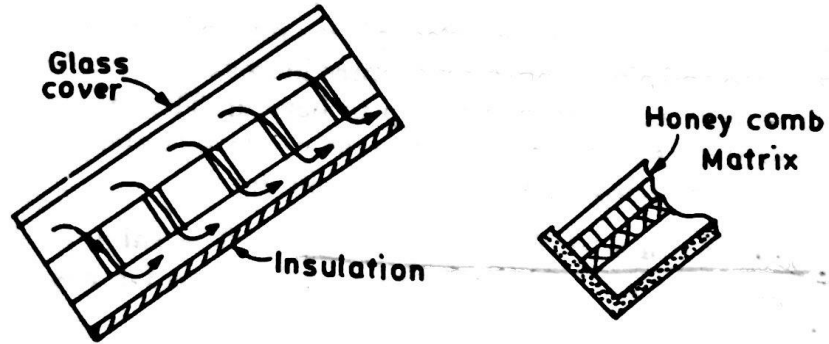


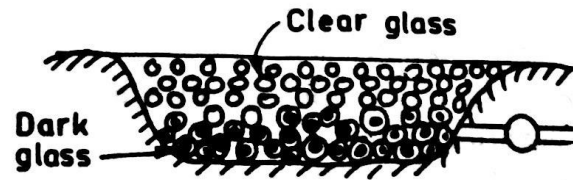
Fig. 3.3.6. Non-porous type air heaters.



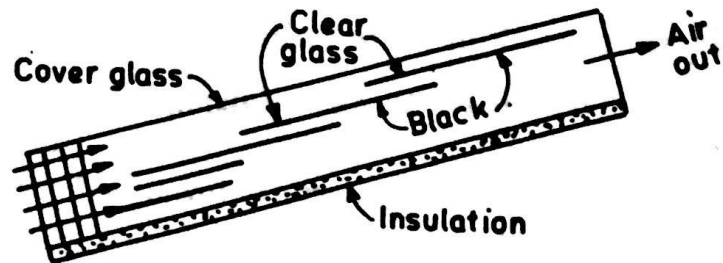
(a) Slit or expanded metal.



(b) Transpired Honey Comb.



(c) Broken bottles absorber.



(d) Over-lapped-glass plate air-heating collector.

Fig. 3.3.7. Sketches of porous absorber-type air heaters.



Thank you!