

SOLAR SPACE HEATING AND COOLING SYSTEMS

- **Active systems** use mechanical devices like pumps and blowers to move heat, making special building design unnecessary. However, good insulation and thoughtful design are still beneficial to reduce energy consumption.
- **Passive systems** use natural processes like convection, conduction, and radiation for heat transfer without mechanical devices. They require specific building designs (*solar houses*) to enable natural heat flow. Though not always sufficient during peak loads, they reduce the burden on air conditioning systems. A solar passive space heating system is shown in Fig. 5.19.
- A Trombe Wall is a south-facing, thick wall made of materials like concrete or brick designed for thermal storage. Painted black to absorb more heat, it's covered with one or two transparent sheets (glass/plastic) with a 10–15 cm air gap. Solar radiation heats the wall, warming the air in the gap, which then circulates into the room through upper vents while cooler room air enters from lower vents. This natural airflow continues as long as the wall remains warm. Heat transfer can be regulated using shutters or dampers, which can also release excess heat when not needed.

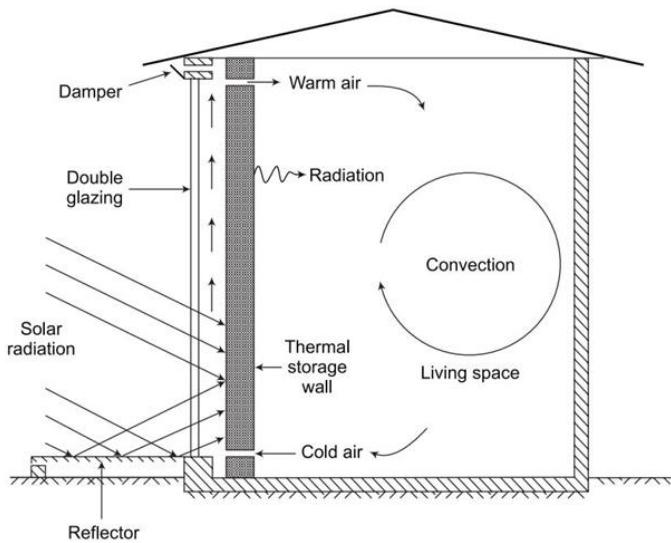


Figure 5.19 Solar space heating

- In Fig. 5.20 another variation of solar space heating system is shown. Here, a collector cum rock bed storage system is integrated with the apartment. During daytime when direct gain through the glaze is sufficient, the hot air from the air heater (collector) is not allowed to enter the room. The available thermal energy is stored in the rock bed to be used later, preferably during night.
- For natural cooling the first and best approach is to reduce unnecessary thermal loads entering the building. The techniques, generally used for passive cooling of the buildings include: (i) shading, (ii) ventilation, (iii) evaporation, (iv) radiation, (v) ground coupling, and (vi) dehumidification.

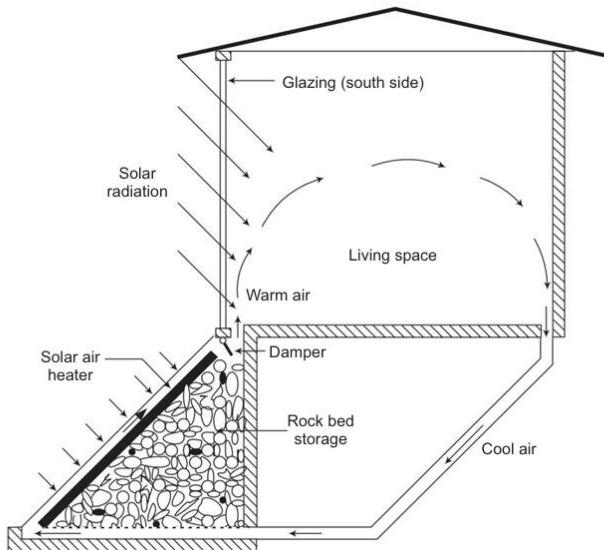


Figure 5.20 Solar space heating with rock bed storage

- Figure 5.21 shows the scheme for solar passive cooling through ventilation. Solar passive cooling through ventilation uses the chimney effect to ventilate buildings, especially in moderate climates. Solar radiation heats the air between the glazing and the interior south wall. This warm air rises and exits through a duct, creating a natural draft that pulls room air into the gap. In turn, cool outside air enters the room from a lower vent on the opposite side, promoting continuous airflow.

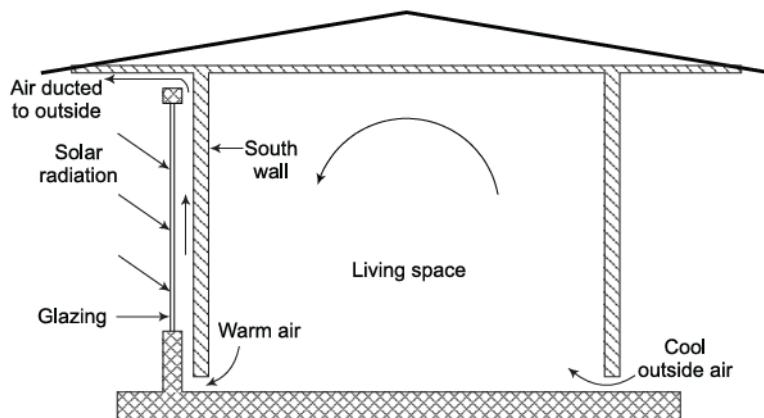


Figure 5.21 Solar passive cooling through ventilation

- In a solar dehumidification system, the air inside a room is cooled and dried using adsorption and evaporation, without mechanical devices. The east and west-facing walls are equipped with solid adsorbent materials and water baths. In the morning, solar radiation heats the east wall, causing the air to rise and exit due to the chimney effect. This creates a natural draught that pulls in air from the west side, where it is first dehumidified by the adsorbent, then cooled

by passing over water baths before entering the room. The hot air exiting through the east wall regenerates the adsorbent. In the evening, as the west wall gets heated, the airflow direction reverses, and the roles of the east and west walls are interchanged.

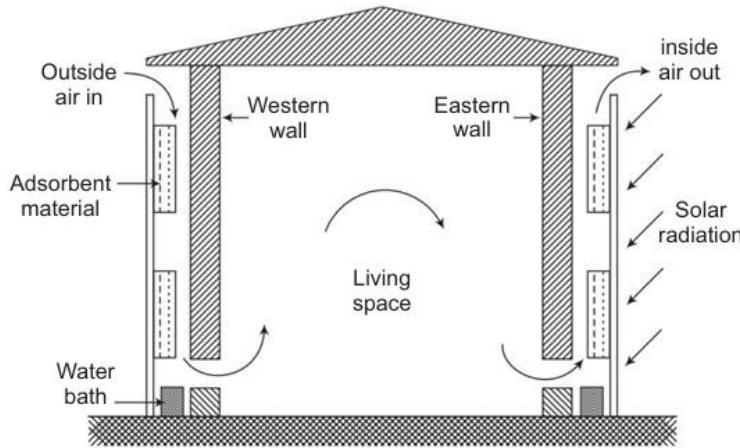


Figure 5.22 Solar passive cooling through dehumidification

SOLAR COOKERS

- Harnessing solar energy for cooking purpose is an attractive and relevant option instead of coal, kerosene, cooking gas, firewood, dung cakes and agricultural wastes. A variety of solar cookers have been developed, which can be clubbed in four types of basic designs: (i) box type solar cooker, (ii) dish type solar cooker, (iii) community solar cooker, and (iv) advance solar cooker.

1. Box Type Solar Cooker:- The construction of a most common, box type solar cooker is schematically shown in Fig. 5.27. This cooker is simple in construction and operation.

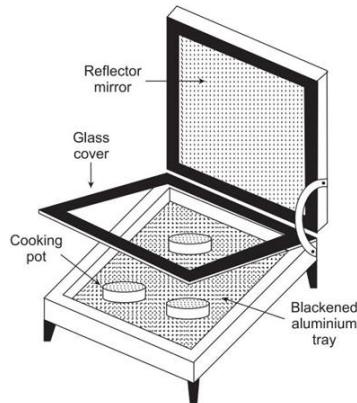


Figure 5.27 Box type solar cooker

- An insulated box of blackened aluminum contains the utensils with food material. The box receives direct radiation and also reflected radiation from a reflector mirror fixed on inner side

of the box cover hinged to one side of the box. The angle of reflector can be adjusted as required. A glass cover consisting of two layers of clear window glass sheets serves as the box door. The glass cover traps heat due to greenhouse effect. Maximum air temperature obtained inside the box is around 140–160 °C. This is enough for cooking the boiling type food slowly in about 2–3 hours.

2. Paraboloidal Dish Type (Direct Type) Solar Cooker:- A specially designed paraboloidal reflector surface concentrates the beam radiation at its focus, where a cylindrical brass vessel containing food material is placed. A commercial dish type solar cooker being manufactured in India is shown in Fig. 5.28. The vessel directly receives the concentrated solar radiation. The reflector is periodically adjusted to track the sun. A fairly high temperature of about 450 °C can be obtained and a variety of food requiring boiling, baking and frying can be cooked for 10–15 persons.



Figure 5.28 Paraboloidal dish type solar cooker

3. Community Solar Cooker:- Community solar cooker has been developed for indoor cooking. It has a large automatically tracked paraboloidal reflector standing outside the kitchen. The reflector reflects the sunrays into the kitchen through an opening in its north wall. A secondary reflector further concentrates the rays on to the bottom of the cooking pot, which is painted black. It can cook all types of food for about 40–50 people and can save up to 30 LPG cylinders in a year with optimum use.

4. Advance Solar Cooker:- Main disadvantage of the above cookers is that there is no provision for storing thermal energy so that cooking is possible only when sun is available (unless auxiliary source is available). An advance type cooker has been designed to overcome these difficulties. The cooker is schematically shown in Fig. 5.29.

- Basically, it consists of two parts: (i) an outdoor, parabolic cylindrical reflector and (ii) an indoor, insulated hotbox reservoir kept at a level higher than the collector. Oil is used as heat

transport fluid from collector to hot box reservoir. The oil in the receiver tube rises up due to natural convection after absorbing heat from reflector and stores it in the reservoir. The reflector has an equatorial mounting with adjustments for seasonal variation of sun. The temperature at the top of the reservoir on sunny days reaches to 150 °C and rarely falls below 100 °C even during nights. All types of cooking except that requires frying and roasting can be done with this cooker. Such types of solar cookers are especially useful as large size community cookers for military camps, temples, ashrams, gurdwaras and hostels.

- Major reasons for non-acceptability of a solar cooker are: (i) it is too expensive for an individual family ownership, (ii) it is incompatible with traditional cooking practices, (iii) it requires comparatively more time and menu has to be preplanned, (iv) it is to be used outdoors (except community and advance cookers), and (v) cannot be used during nights and cloudy days (except advance cooker).

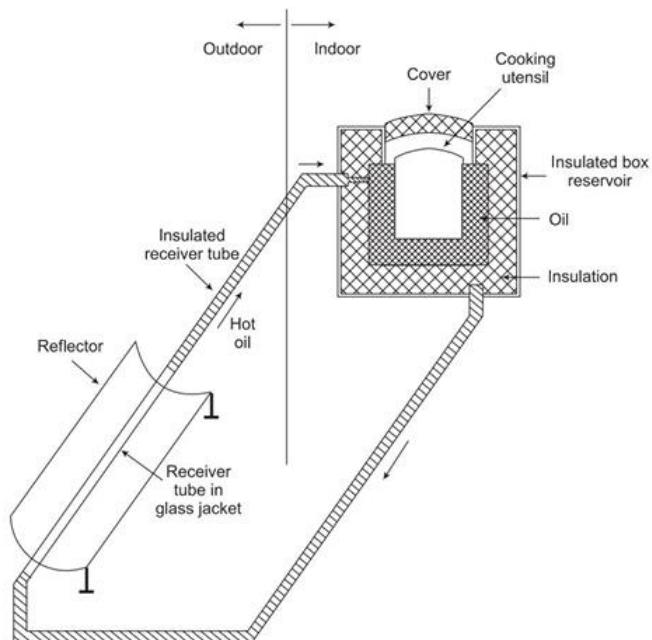


Figure 5.29 Advance solar cooker

SOLAR DISTILLATION (DESALINATION OF WATER)

- Fresh water (with less than 500 ppm salt) is essential for life, agriculture, and industry. Due rapid industrialization, population growth, pollution, and climate change in many part of the world fresh water, which was available in abundance from rivers, lakes and ponds, is becoming scarce. Over 2 billion people lack regular access to safe water, with some traveling up to 30 km to fetch it. Only 1% of Earth's water is fresh, while 79% is salty and 20% brackish. Thus, using solar energy to convert saline or brackish water into fresh water through distillation is a promising solution, especially in sun-rich regions.

- The device used for converting desalting seawater and brackish into fresh water is known as solar still. Several types of solar stills have evolved. However, only basin type has been tried commercially on a large scale. The construction is schematically shown in Fig. 5.35.

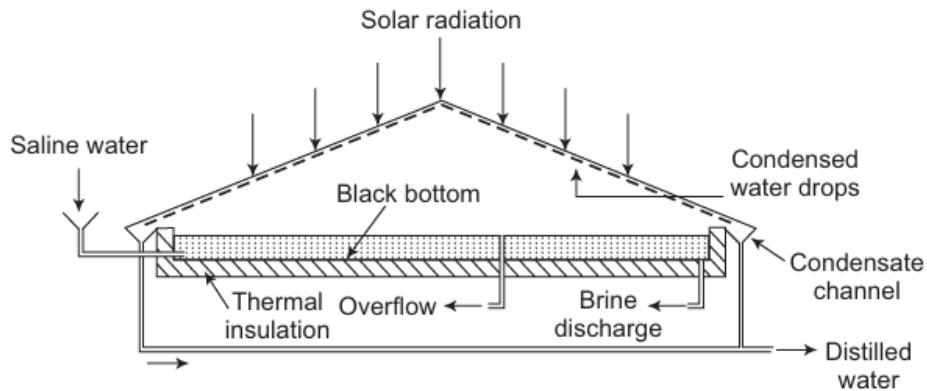


Figure 5.35 Simple basin type solar still

- A simple basin-type solar still uses a shallow blackened basin filled with saline water (5–10 cm deep), covered by a sloped transparent roof. The evaporated water increases the moisture content, which gets condensed on the cooler underside of the glass. The condensed water slips down the slope and is collected through the condensate channel attached to the glass. The still is oriented East-West and can be fed continuously or intermittently. The supply is generally kept at twice the rate at which the fresh water is produced but may vary depending on the initial salinity of input water.