Solar Applications

BOX TYPE SOLAR COOKER

Sunny Day: heats from 130-145 C (265-300 F)
Cloudy Day: heats from 95-105 C (200-220 F)
Hot enough to pasteurize water (at least 65-70 C for 20 minutes)
Hot enough to fully cook meats, breads, grains, vegetables, etc.
Kills disease- causing bacteria

The Saibaba Ashram at Shirdi in Maharashtra commissioned a solar cooking system in 2009,The system generates 3,600 kg of steam daily and saves nearly 100,000 kg of cooking gas annually. It cost Rs. 1.3 crore. Of this, the central government's Non-Renewable Energy Ministry provided Rs. 58 lakh as subsidy. This helps the shrine save Rs. 17 lakh a year. The system reduces carbondioxide

emissions by 1.2 tones per day.

LARGEST SOLAR COOKER

Here is an amazing example of successful use of cost efficient solar thermal energy on a large scale. In Mount Abu, Rajasthan is situated the world's largest solar cooker Established in 1992, the Brahma Kumar's Department of Renewable Energy is based at the University's Headquarters in Mount Abu. The solar reflectors in the cooker produce steam which used to cook vegetables and rice for up to 18 000 people. The steam can reach temperatures of 650 degrees Celsius at the focal point of the reflector, hot enough to cook food in massive industrial pots of 200 and 400 liters. On days of peak solar radiation the system can apparently cope with 38,500 meals per day . The Brahmakumari's organization has spent
$5 million on this project.

SOLAR POWER TOWER

- The **solar power tower**, also known as 'central tower' power plants or 'heliostat' power plants or power towers, is a type of solar furnace using a tower to receive the focused sunlight. It uses an array of flat, movable mirrors (called heliostats) to focus the sun's rays upon a collector tower (the target). Concentrated solar thermal is seen as one viable solution for renewable, pollution free energy.
- Early designs used these focused rays to heat water, and used the resulting steam to power a turbine. Newer designs using liquid sodium have been demonstrated, and systems using molten salts (40% potassium nitrate,
60% sodium nitrate) as the working fluids are now in operation. These working fluids have high heat capacity, which can be used to store the energy before using it to boil water to drive turbines. These designs also allow power to be generated when the sun is not shining.

SIERRA SUN TOWER(CALIFORNIA,USA)

Southern California Homes – Sierra Sun Tower will produce 5 MW of electricity powering up to 4,000 homes.

Steam temperature 440 C
Steam pressure 60 bar
24,000 mirrors reflecting the power of 20,000 suns
5 MW of clean, renewable energy supplied to 4,000 Southern California Edison households through a power purchase agreement

Greenhouse Gases – 5 MW of clean solar power generation will offset more than 7,000 tons of CO_2 each year.

PARABOLIC DISHES AND TROUGHS

Collectors in southern CA

Because they work best under direct sunlight, parabolic dishes and troughs must be steered throughout the day in the direction of the sun.

PHOTO CONVERSION

Sunlight can be converted directly into electricity using photovoltaic's(PV), or indirectly with concentrated solar power (CSP), which normally focuses the sun's energy to boil water which is then used to provide power. Other technologies also exist, such as Sterling
engine dishes which use a Sterling cycle engine to power a generator. Photovoltaic's were initially used to power small and medium-sized applications, from the calculator powered by a single
solar cell to off-grid homes powered by a photovoltaic array.

Solar Tech

- Cell Phones
- Tablets
- Calculators
- Road Signs
- Solar Light
- Music Speakers
- Rechargeable Flashlights

Satellites

There are lots of methods of using the solar energy , and the Solar Chimney is one of them, which can be seen below, in figure 1.

Fig. 1 The Prototype Manzanares Solar Chimney [2].

Since glazing increases the mass of the roof, glazed collectors should have stronger rods and should be attached as in figure

Fig. The glazed collector roof of Solar Chimney

- There is no limitation for the surface area. The larger the area, the more energy generated from the chimney.
- There should be slightly increasing height towards to the chimney in order to obtain minimum friction loss.
- Covering materials may be different, such as; glass, plastic film or glazed collector.The most efficient one is glazed collector.It can convert up to 70% of irratiated solar energy into heat a typical annual average is 50%. Also, with proper maintenance, its life span can easily be 60 years or more.

2.a.ii. ***Turbines***

Turbines, seen in figure, are used to convert air current to the mechanical energy.

Fig Turbine for Solar Chimney Power Station

Turbines are placed horizontally in chimney, vertically in the collector.In order to obtain maximum energy from the warmed air,turbines blades should cover all the cross-sectional area of the chimney.

To do this,one big turbine or a few small turbines should be used in chimney, as can be seen from the figure.

Solar Refrigeration:

Refrigerator which runs on electricity provided by Solar Energy is known as solar refrigeration.

Solar-powered refrigerators may be most commonly used in the future generation.

Need of solar refirgeration:

- Need refrigeration in areas not connected to power grid
- Need to minimize environmental impact and fuel cost
- Evaluate potential of solar energy to meet these needs
- Evaluate efficiencies of three types of solar refrigeration

Types of solar refrigeration:

- Photovoltaic Operated Refrigeration Cycle
- Solar Mechanical Refrigeration
- Absorption Refrigeration

Solar cooling can be considered for two related processes:

To provide refrigeration for food and medicine preservation and

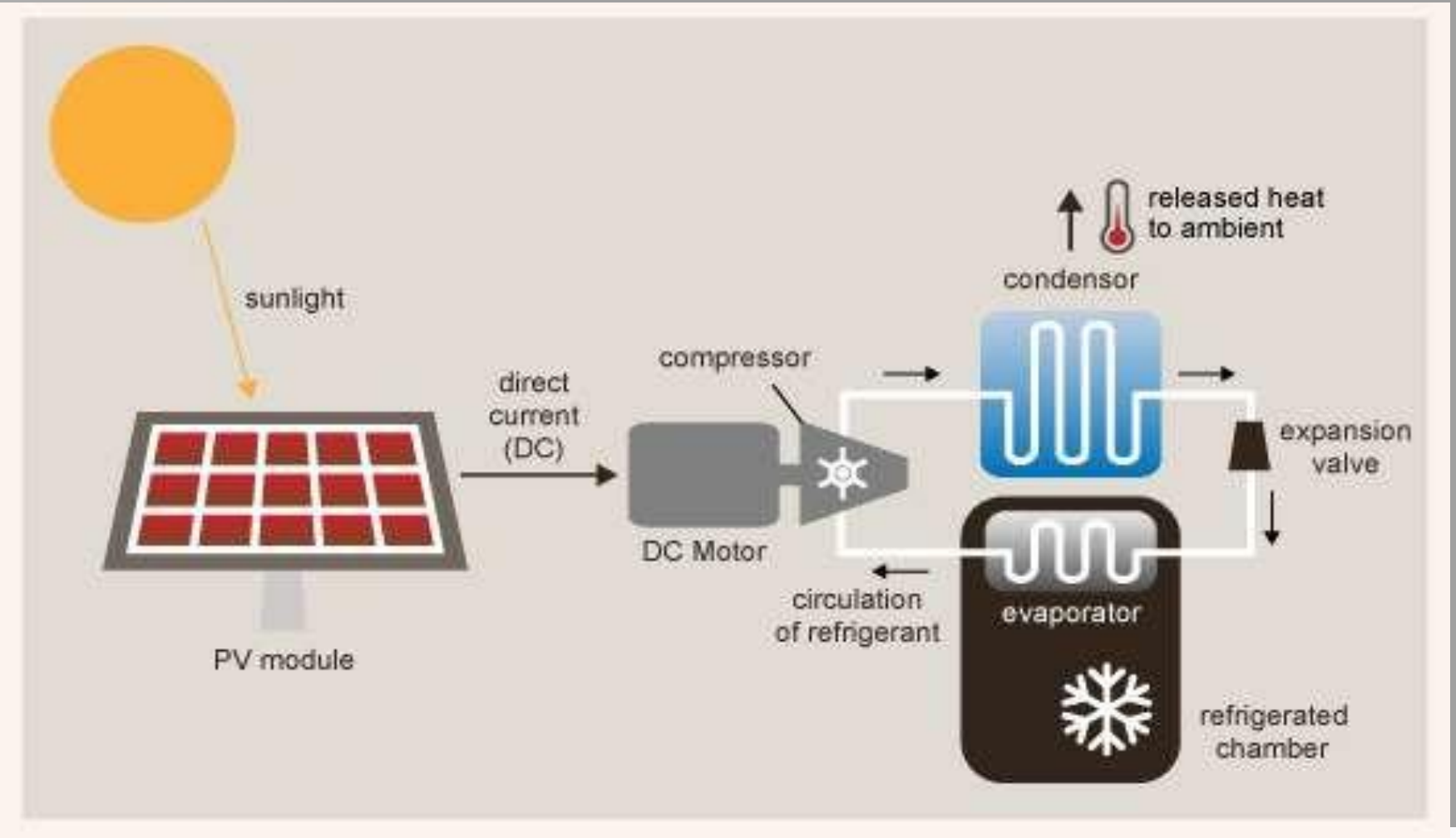
To provide comfort cooling.

Photovoltaic Operated Refrigeration Cycle:

- Vapor compression cycle with power input from Photovoltaic cells.
- DC electric power output from PV runs the compressor of a conventional cycle

- **Considerations:**
- Must match voltage imposed on PV array to the motor characteristics and power requirements of the refrigeration cycle
- For given operating condition (solar radiation and module temperature), single voltage provides maximum power output.
- Must find compressor motor closely matched to the electric characteristics of the PV module.

Schematic view of a conventional vapor compression cycle driven by solar photovoltaic:



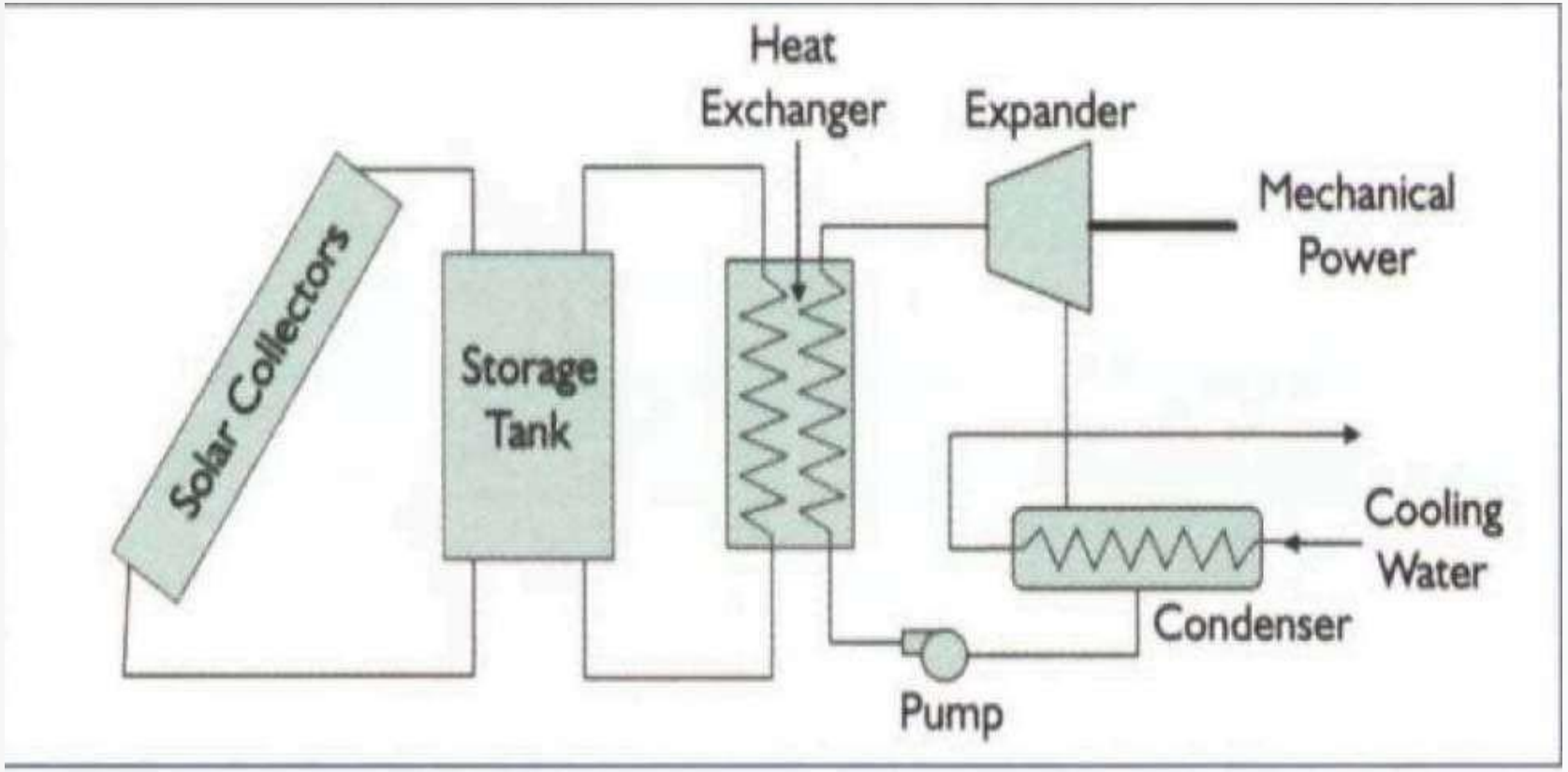
Solar Mechanical Refrigeration

Vapor compression cycle with power input from solar Rankine cycle.

Considerations:

- Efficiency optimization based on delivery temperature
- Efficiency of Rankinecycle increases with increased heat exchanger temperature
- Efficiency of solar collector decreases with increase in temperature.

Solar driven mechanical power cycle:



Absorption Refrigeration:

- Condenser, throttle, evaporator function exactly the same way.
- Replaces compressor with “thermal compression system”.
- Ammonia is working fluid

•Minimal mechanical power input (pump instead of compressor).

- Absorption into water solution allows it to be pumped.
- Desorbed in generator (rectifier required to separate out water).

- Heat into generator provided by solar collectors.

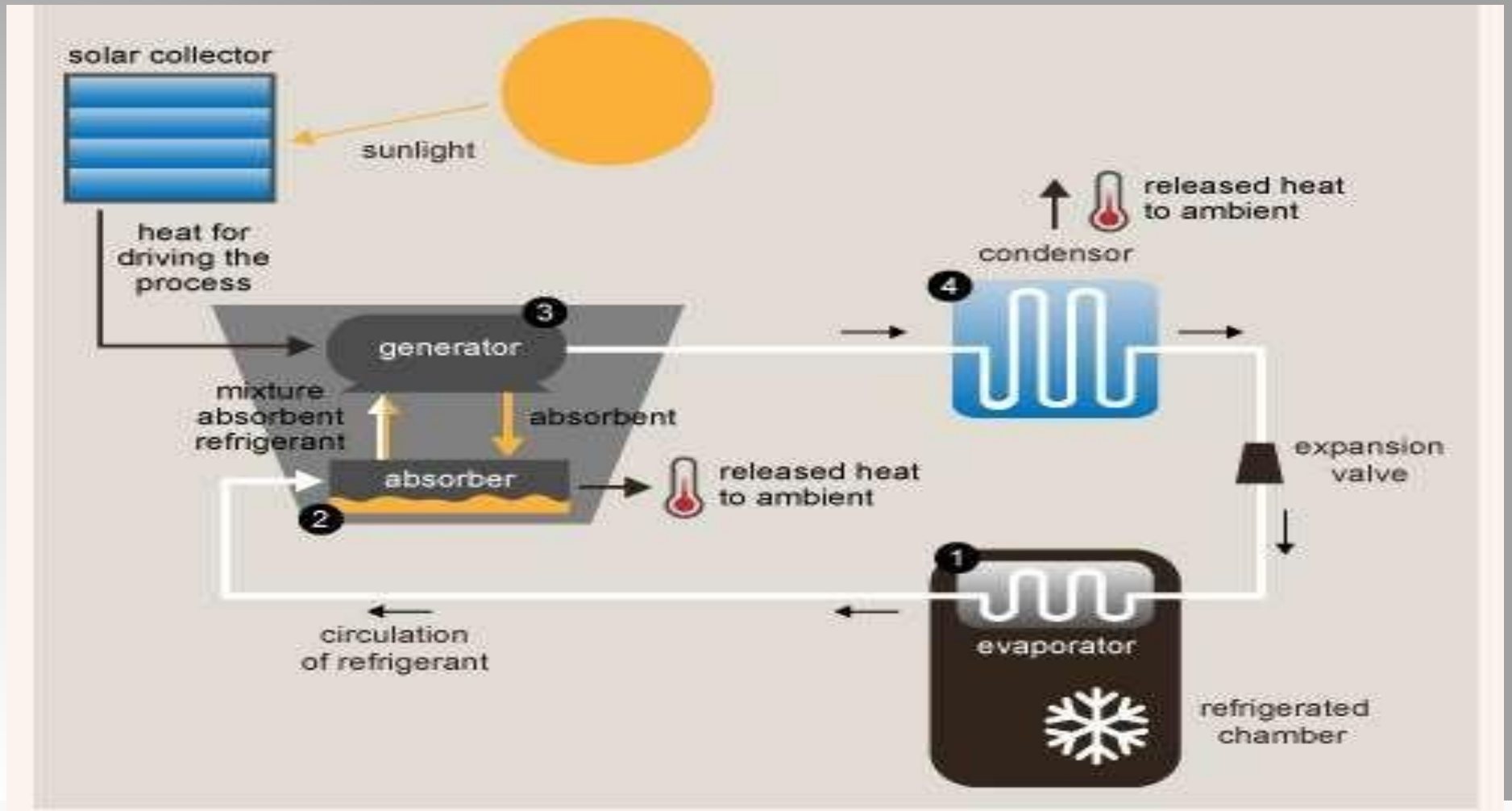
- The pressurisation is achieved by dissolving the refrigerant in the absorbent, in the absorber section.

- Subsequently, the solution is pumped to a high pressure with an ordinary liquid pump.

- In this way the refrigerant vapour is compressed without the need of large amounts of mechanical energy that the vapour-compression air conditioning systems demand.

- This system greatly increases complexity.

Schematic view of a absorption refrigerator driven by heat from solar radiation:



Benefits:

- Environmentally friendly
- Longevity
- Scalable

Application of solar refrigeration:

- Solar energy should be given a chance if we want to protect the environment.
- We own it to our children, our grandchildren and the generations to come.
- Refrigerators
- Freezers
- Ice-makers
- Coolers
- Building air-cooling systems

Solar power Tower and HelioStat

Solar Power Tower also known as a Central Receiver, is the big daddy of all concentrating solar collectors. Solar towers uses hundreds if not thousands of small sun tracking mirrored solar dish collectors, called heliostats similar to the ones in the previous parabolic and dish collector tutorials that are used to reflect the sunlight directly onto a centrally located heat absorbing receiver.