School of Engineering and Applied Science (SEAS), Ahmedabad University

BTech(ICT) Semester VI: Renewable Energy Technology

Assignment

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Selective Paints

In solar energy devices, a selective paint is applied on it to increase the efficiency of the solar panel. They are of both two types:

1. Transparent coating: Applied to transparent elements of the PV
2. Opaque (Non-transparent) coating: Applied to the radiation absorbing elements of the PV

Transparent Coating

A transparent coating has a very high transmissivity for solar radiation and relatively lower transmissivity for infrared radiation. It acts as a filter that rejects out the higher frequency electromagnetic radiation. They are used mainly to protect gas and oil tanks in open air. They can also be used on glasses of buildings which in-turn cools them. This is because after absorbing the sun's shortwave radiation, surfaces usually re-emit radiation in the form of longwave (infrared) radiation.

Opaque or Non-Transparent Coating

These types of paints are a means of increasing the operation temperature and/or efficiency of solar flat plate collectors. They have a very high selectivity ratio, which is defined as:

$$\text{Selectivity ratio}, r = \frac{\alpha_{sol}}{\epsilon_{therm}}$$

Usually, these coatings have a very high absorptivity of upto 95% in the visible and near infrared spectrum while their emissivity that is the ratio of emissions in far infrared to that of a black body is low of around 5%. Some materials and surfaces are also made using materials that have a very high absorptivity ratio. For example, copper with a layer of black cupric oxide, silicon on metal, black chromium and nickel plated anodized aluminium. Naturally, the question of why not simply use black paint arises. But even though ordinary black paint has a very high absorptivity ratio, it loses a lot of energy in black body radiation i.e. it also has a emissivity ratio.

Solar Cooling system

Solar cooling is an efficient and alternate way to help cool our homes and workplaces. Solar cooling is not the use of photovoltaics to generate electricity and then power the air conditioning system. The difference is as explained below:

Solar air conditioning system	**Solar cooling system**
Solar energy is then converted to electricity and then air conditioner is powered using that	Solar energy is used as thermal energy and is combined with modern adsorption technology
Electrical energy is the source of energy	Heat energy is the source of energy

But this idea can seem a bit flummoxing at first. How can the sun, which is a huge source of heat, help cool our homes. But thermally driven cooling machines such as absorption chillers or adsorption chillers have been used for many decades. On the downside, these systems are a bit trickier to build. There are three main types of solar cooling systems. They're as follows:

1. Open Cycle Solar Cooling
    - It is a desiccant system (hygroscopic or anhydrous) that can use solid/liquid refrigerant in direct contact with air.
    - It is considered open cycle because the coolant is discarded from the system after it comes into direct contact with air
2. Closed Cycle Solar Cooling
    - This method produces cool or chilled water that can be used in combination with blowers like fan coil system to create a cooling effect
    - It can also be used to cool walls or ceilings of a building and acts like a reverse heating system.
    - Absorption chillers are at the core of closed cycle cooling systems. They remove the heat from refrigerants either by vapour compression or through absorption refrigeration cycle.
3. Thermo-mechanical process
    - They usually use vapour compression in which vapour is compressed so that it loses all the heat and then a fan coil system is used to remove excess heat
    - They can also follow rankine cycle and can use heat to pressurise steam and run it through a turbine

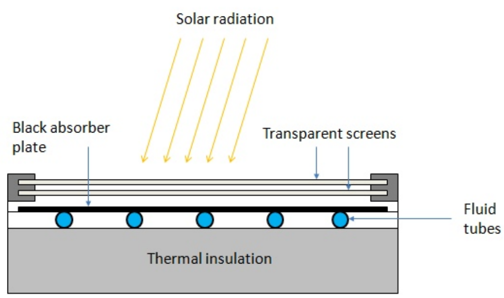
Solar thermal system for electric energy generation

Solar thermal systems can be used for electric energy generation by capturing their heat energy and converting it to usable mechanical energy. They usually are used to superheat a fluid that passes through them and this fluid can the be connected to a turbine to generate electricity.They have heat exchangers in them and are designed in such a way that they can concentrate their heat to the fluid which passes through the heat exchanger

Fluids like water or steam, oil or molten salt are used which is then transferred to a heat engine to generate electricity. Typically, fluids that have a high heat transfer and storage capabilities. Advanced designs these days are experimenting with molten nitrate salt made of 40% potassium nitrate and 60% sodium nitrate.

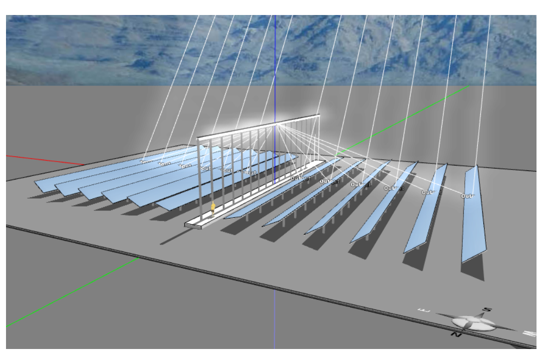
These solar thermal power plants are of two main types as follows:

1. *Flat Plate Collectors* (100℃)
   These types of power plants are the simplest in design. They simply heat up fluid passing in fluid tubes below the black absorber plate and transfer heat.

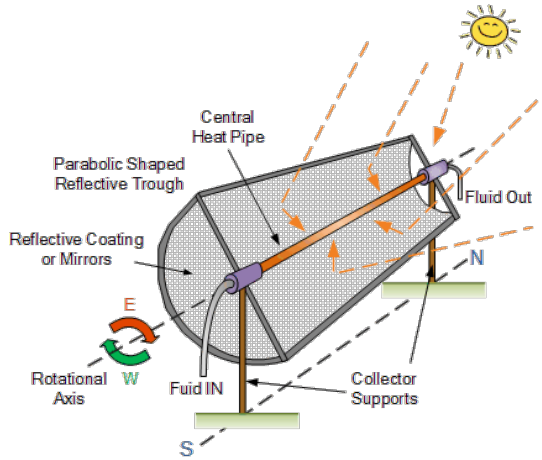


2. *Concentration collectors* (100-1000 ℃)
   Concentration collectors use a concentrator system to focus the solar energy on absorbing material. They are of following types:

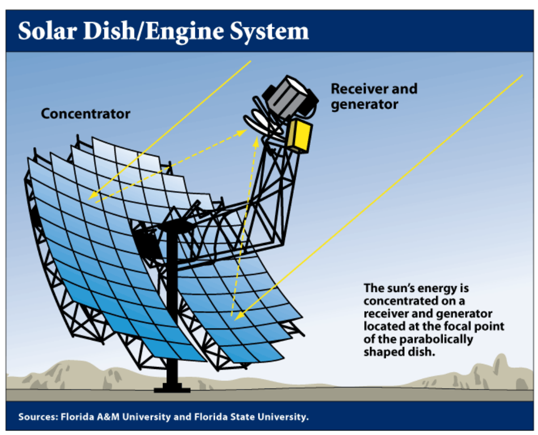
   (a) *Linear Concentrating system* (280℃)
   A linear concentrating collector has a large number of collectors aligned in north south direction to maximise solar energy collection throughout the day. They have receiver tubes placed in the center where the heat-transfer fluid flows.



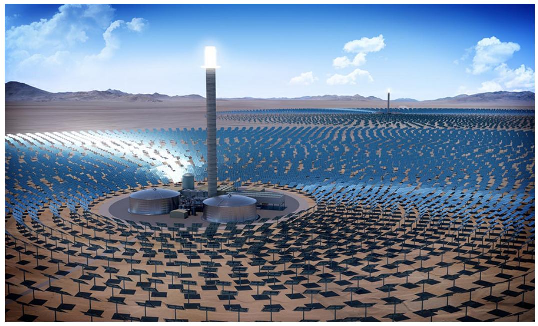
(b) *Parabolic trough*(400℃)
Just like linear collectors, they have the same principle, but the reflective surface is curved and the heat-transfer fluid passes through every reflector as clearly visible in image below.



(c) *Solar Dish/Engine system* (1000℃)
In this system, mirrors are placed parabolically to form a satellite dish like structure. To reduce cost, these mirrors can be reduced in size. This dish concentrates the heat on the focus of the concave mirror

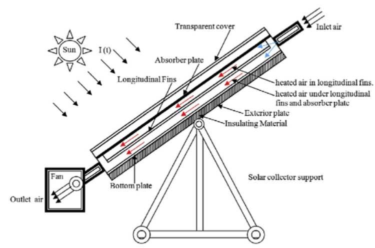


(d) Solar Power Tower (1000℃)
Solar power tower has a central tower in the center and a large number of reflectors around it as seen in the image. Newer designs use liquid sodium to transfer heat. These designs allow energy to be produced even when the sun is not shining brightly.



Solar air Collector

Solar air collectors are a type of solar thermal collectors that are used to actively keep a building warm in winter and colder environments. They're typically deployed onto the surface walls of buildings



These air collectors can be divided into two categories as follows:

1. *Unglazed air collectors*
   They're referred to as glazed air collectors because they don't have any glass or glazing over the top. The absorber comes in direct contact with the sunlight.

2. *Glazed air collectors*
   Glazed air collectors have a glass cover and an absorber material to capture radiation from the sun. It can also be covered with a selective pain to increase the capture of thermal energy.

In a solar air collector, air can be passed through back, front or a combination of back and front which can then be pumped into the building to provide air conditioning in places with colder environments.