Assignment

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1. Selective Paints

The paints that have high absorptance over solar spectrum but low thermal emittance to reduce the thermal radiative heat loss are called selective paints and are useful as they maximize solar absorption and suppress thermal re-radiation. The paints mostly contain metal oxide in silicone suspense and needs to be restored. The metal oxides that are prepared in powdered form are ternary transition metal oxides. Often used in air and at high temperatures as they act as high solar absorptance. The criteria for selective paints is the ratio of solar absorptance to thermal emission. There are two major types of selectivity: Thickness Insensitive Spectrally Selective (TISS) and Thickness sensitive spectral selectivity (TSSS). The paints consist of a polyurethane resin binder in which various pigments are embodied in a way that they form stable paint dispersions, thereby satisfying the stability criteria for facade coatings. To achieve low emittance of paints, the low-emittance aluminium flake pigments are amalgamated with iron oxide i.e the paint of red color. To adjust the solar absorptance black pigment is added. Whereas, green and blue paints are formed by the adding colored aluminum flake pigment. Generally paint coating is preferred over other coating because they offer low cost, ease of processing, field maintenance and commercial availability. They have low cost and high efficiency. One of the application of selective paint is that they use high grade waste heat to produce electricity by means of infrared sensitive PV cells.

2. Solar Cooling Systems

Solar cooling system transforms the heat which is radiated from sun into cooling that can be further used for refrigeration and air conditioning purpose. The Solar power is collected by a solar cooling system and is used in a cooling process which is thus used to control and decrease the temperature for different purposes such as forming cold water or air conditioner. The below three components are included in the solar cooling system:

- A solar panel or collector are used to convert solar radiation to heat.
- A refrigerator or air conditioner to cool the system.
- A heat sink to collect and dump the extra heat away from system.

There are various cooling cycle techniques which use different principles for functions. Some of them are: absorption cycles, desiccant cycles and solar mechanical cycles. Refrigerant is a substance or mixture which when combined with other components like compressors or evaporators absorb heat from environment and create refrigerator or air conditioner. The main

goal is to use and external heat source to collect ambient temperature to create a pressure in the closed loop of refrigerant by using the heat produced with the refrigerant to cool the system.

The absorption cycle has four components and they are as follows: a) An absorber, b) generator, c) condenser and d) evaporator.

Cooling occurs in the evaporator hence it is used in almost all cooling systems. Vaporization takes heat from the system as energy input and the remaining fluid left is cooler than before. And is pressurized by dissolving a refrigerant in an absorbent to soak up the liquid instead of a mechanical compressor.

Desiccant cooling system is based on dehumidification-humidification process. This system can work with liquid as well as solid desiccants. The materials or the substances used for dehumidification are such that they attract water from their surroundings and are called desiccants. By applying solar energy they can be regenerated in cycles.

The solar mechanical cycles works differently as compared to absorption and desiccant cycles. It tries to combine solar powered devices with the conventional (existing) cooling system. In this technique, the engine that produces energy which is used to handle the whole cooling system is given fuel by solar power instead of fueling the absorption chiller.

Applications of solar cooling are:

- Refrigerating food storage
- Space cooling
- Air conditioner
- Also used in vehicles such as recreational vehicles that include accomodation for refrigeration purpose.
- It provides cooling to those countries which would not be able balance the energy cost and the load required by the conventional cooling system.

Solar cooling largely minimizes the proportion of energy required to refrigerate thereby, saving cost and benefit the environment by using the renewable energy source and reduced use of ozone depleting materials which harm the enviornment.

3. Solar Air Collector

Solar air collectors are heat exchangers. They are designed to collect the solar radiation and transform it to heat and then transfer that heat to air, water or some fluid. These collectors are mounted on the roof tops so they must be very sturdy as they are exposed to various weather conditions. A solar air heater is a flat plate collector with a black absorber plate, has some sort of transparent gazing cover on the top of absorber plate and covered with insulation on sides and bottom of the collector to minimize the heat loss. The absorber is a metal sheet of high thermal conductivity and its surface is coated so as to maximize the radiant energy absorptance and minimize the radiant emission. The cover sheet known as glazing allow the sunlight to pass

through the absorber and prevent the cool air to pass into this space by insulating the space above the absorber. There are two types of air collectors:

- Glazed air collectors: The panel tubes in which the carrier fluid flows are protected by a single or multiple transparent covering made from copper tubing on an aluminium plate and has an iron tempered glass covering, thus improving the performance. Hence they are more expensive. In colder periods they transfer the fluids thereby enabling the heat exchangers to absorb sunlight more efficiently as compared to unglazed collectors.
- Unglazed Collectors: The water that is flowing into the panel tubes is heated instantly by the sunbeams and then sent to a storage tank or directly to the end user. They are easy to install and low cost. The surrounding air temperature should be less than 20 degree Celsius and the required temperature for water is greater than 50 degree Celsius.

They can be used for heating water, heating swimming pools and drying crops or vegetation. The advantages of solar air collectors are:

- Less complicated and compact.
- Good corrosion resistance.
- Leakage of air does not cause a major problem like in systems with liquid fluid.
- The air heated in the tubes can be directly transferred to crops, vegetables and spaces hence no additional medium needed.
- Air collectors are cheap and easy to make
- The pressure inside the collector does not become very high.

The disadvantages of solar air collectors are:

- Because of low thermal capacity air cannot be used as a storage.
- To handle large volume of air due to its low density.
- If the system not designed properly the cost of solar air heater may become very high.

Initial Capital investment is high but later on maintenance cost is low hence it saves money.

4. Solar thermal system for electrical energy generation having solar collectors

Solar thermal systems collect and convert the concentrated sunlight to thermal or electric energy. All solar thermal systems focus and collect sunlight to generate higher temperatures resulting in greater quantities of electrical or thermal energy. Compared to the Solar Photovoltiac system, the solar thermal system is more spatially effective. The solar energy collectors in the solar thermal power has two components: reflector and receiver. Heat transfer fluid used in steam processing is heated and then circulated inside the recipient. The steam is used by transforming it into mechanical energy in a turbine to generate electricity for generation. Along with the change in the position of the sun in the sky, the tracking system of this thermal power system keeps the sunlight focused on the receiver. Solar thermal plants have a range of collectors to supply heat to the turbine and generator.

Concentrated solar power plants concentrate the heat radiation to increase the temperature and thus increase the amount of energy generated. Non-concentrating solar power plants are space dependent i.e. more the area, more will be the energy generated. Types of concentrating solar thermal power plants are:

- Linear Concentration System: This system absorbs the sun's energy through a curved rectangular mirror that helps to concentrate the sunlight on the receiver that heats the fluid within the tube; A heat exchanger which produces electricity by boiling water using a steam turbine generator. Two distinct Linear Concentration System types:
    - Parabolic trough systems: They also known as line focus collectors. Such types of collectors are formed into parabolic form which concentrates on these panels the incident of solar power. The collector adjusts(tilts) it position to keep the sun focused along the receiver as it moves it position during the day time. It keeps the sunlight focused from thirty to hundred times than its usual intensity on receiver pipes due to its parabolic shape which are located around the center point of the trough. They can heat water upward till 400C.
    - Linear Fresnel reflectors: They have similarity with the parabolic systems where in the reflectors help focus the sunlight on the receiver which is situated on top of the mirrors. The reflectors use the fresnel lens thereby enabling a large opening in the lens and having a short focal length. They can concentrate sun’s energy to thirty times its usual intensity.
- Solar Power Towers: To concentrate and reflect the sunlight on the receiver which is located above a tower it uses big flat mirrors that are able to track the sun. These solar panels are called heliostats. They are large towers that act as central receivers of solar energy. It can concentrate the sunlight to fifteen hundred times. They are installed in middle of large number of solar panels (heliostats). In the tower there is a heat exchanger that heats the fluid, which is then used to generate mechanical energy using turbine and the process continues.
- Solar dish design: They use a mirror dish similar to satellite dish. Mirror dish comprises of small flat mirrors, formed in dish shape. A thermal receiver collects the heat from sunlight and transfer it to a generator. The commonly used engine generator is the Stirling engine. The striling engine converts heat into mechanical energy. Then a generator is used to convert mechanical energy into electrical energy. The concentration ratio of solar dish is higher than linear concentrating systems.

This thermal system with solar collectors has few pros and cons. Its advantages are as below:

- It is renewable form of energy hence is available infinitely.
- They are environment friendly as the produce no pollutants or toxic gases. Hence there is no negative effect on climate.
- The initial installation cost is generally high but then after it has low maintenance cost.
- Can store energy to use later on in absence of sunlight.

The disadvantages of this system are as under:

- They are expensive as the initial installation cost is high.
- Cannot store sunlight or water hence the energy needs be produces when these factors are available.
- They have less consistency for generating solar energy as compared to fossil fuels as they cannot generate on cloudy and darks days.

Still the thermal energy generation system has clean source of electricity generation. And is in much demand. It still has a long way to go as it environment friendly, efficient and affordable.