Lecture Notes

for

B.TECH. III yr, VIth Semester

(Electrical Engg.)

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Subject: Power Station Practices

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Unit- 5 (Tidal and solar energy system)

Tidal energy:

Tidal power captures the energy of moving water masses due to tides and uses it to generate renewable electricity. A dam or barrage or underwater turbines are built across the estuary of a river. The river funnels the tides into narrow channels where the speeding water turns the turbines.

Tides are caused through a combination of forces created by the gravitational pull of the sun and the moon, and the rotation of the earth.

Energy naturally present in water bodies or in their movement can be used for generation of electricity. This is achieved broadly in the following ways:

1. Tidal energy: Using the "head" (height difference) between low and high tides to create a fall similar to that in a conventional hydropower project. This uses the potential energy of the water body.
2. Wave energy: Using the kinetic (dynamic) energy of the waves to rotate an underwater power turbine and generate electricity thereon. This can be loosely described as an underwater wind farm.
3. Thermal energy: Using the thermal energy of oceans to generate electricity. This is similar to geothermal power generation where heat trapped in the earth surface is converted into electrical energy.

The tidal energy method broadly works as follows. When a tide comes onto the shore, it is trapped in reservoirs constructed behind barrages (dams). When the tide drops, this collected water is released and is then used like in a regular hydropower project. For the tidal energy method to work effectively, the tidal difference (difference in the height of the high and low tides) should be at least 4m (around 13 ft) Tidal energy projects are extremely site specific. The quality of the topography of the basin also needs to facilitate civil construction of the power plant.

Tidal energy is a clean mechanism and does not involve the use of fossil fuels. However, environmental concerns exist mainly to do with higher silt formation at the shore (due to preventing tides from reaching the shore and washing away silt) and disruption to marine life near the tidal basin. Wave energy projects have lesser ecological impact than tidal wave energy projects.

In terms of reliability, tidal energy projects are believed to be more predictable than those harnessing solar or wind energy, since occurrences of tides are fully predictable.

APPLICATIONS OF TIDAL POWER:

Small-scale tidal mills were used in the Middle Ages for grinding corn. The barrages which are built can be used as a means to cross the estuary with much greater ease. The main application of tidal power is as an additional means of generating renewable, sustainable energy which does not affect the environment in a negative way.

Advantages of tidal energy :

1. It is very cheap to maintain.
2. There is no waste or pollution.
3. Very reliable.
4. We can predict when tides will be in or out.
5. The barrage can help to reduce the damage of very high tidal surges or storms on the land.

Disadvantages :

1.It changes the coastline completely and the estuaries are flooded so any mud flats or habitats that birds or animals live on are destroyed.

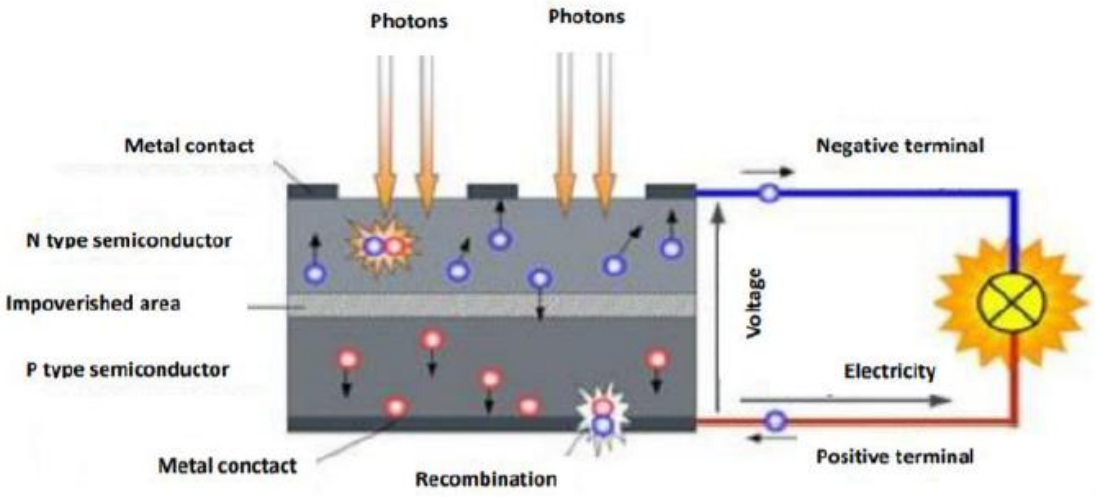
2. Initial building cost is very expensive.
3. Water is not replenished, it cannot flow away so any dirt or pollution lingers around the coast much longer.
4. Silt builds up behind the barrage.
5. Disrupts creatures' migration in the oceans
6. Needs a very big piece of sea to be cost effective.
7. Not many sites suitable for this kind of power generation; building the barrage.
8. Only produces power for about 10 hours of the day.

SOLAR ENERGY

It is also a renewable energy resource. In this case we get electricity directly from the sun light, contains radiation like ultraviolet, visible and infrared etc. The earth surface gets maximum energy when radiations strike at 90o (vertical). India received 4–8 kWh of solar radiation per square meter per day which is equal to 5000 trillion kWh per year. In order to give a boost to the solar energy sector, India saw the advent of Jawaharlal Nehru National Solar Mission (launched in 11 January, 2010). The mission was specifically aimed at developing comprehensive policies and strategies of technology diffusion that would catapult and establish India as a global leader in the arena of solar energy. This ambitious solar mission aims to install 100 GW grid-connected solar power plants by the year 2022.

Method of harvesting solar energy

Photovoltaic (PV) cell: Photovoltaic cell is a device which directly converts sun light (photons) into electricity. The term photovoltaic is composed by two words, photo means light and voltaic means electric. Photovoltaic cell formed by the semiconductor material like silicon. Silicon is an element that naturally releases electrons when exposed to sun light and increase the conductivity. The conductivity can also be increased by introducing impurities into their crystal structure. It is based on p-n junction diode. As we know that if we introduce impurity like phosphorus atom with five valence electron act as n- type donor (excess of electrons) and impurity like boron with three electron act as p-type donor (excess of holes). Diffusion of electron occurs from the area of high electron concentration into a region of low electron concentration. When electron diffused across the p-n junction, they combine with holes on p-type. Due to diffusion electricity produce.



Different types of photo voltaic cells

The most common material for the production of solar cells is silicon. Silicon is obtained from sand and is one of the most common elements in the earth's crust, so there is no limit to the availability of raw materials.

Electricity is produced in solar cells which, as noted, consist of more layers of semi-conductive material. When the sun's rays shine down upon the solar cells, the electromotive force between these layers is being created, which causes the flow of electricity. The higher the solar radiation intensity, the greater the flow of electricity

Solar cell manufacturing technologies are:

- monocrystalline,
- polycrystalline,
- Bar ‐ crystalline silicon,
- thin ‐ film technology.

Cells made from crystal silicon (Si), are made of a thinly sliced piece (wafer), a crystal of silicon (monocrystalline) or a whole block of silicon crystals (multicrystalline); their efficiency ranges between 12% and 19%.

Solar collector

Solar collector is a device which is used to collect the solar energy from sun and then convert it in to heat. A solar collector is basically a flat box and is composed of three main parts, a transparent cover, tubes which carry a coolant and an insulated back plate. The solar collector works on the green house effect principle; solar radiation incident upon the transparent surface of the solar collector is transmitted through though this surface. The inside of the solar collector is usually evacuated, the energy contained within the solar collect is basically trapped and thus heats the coolant contained within the tubes. The tubes are usually made from copper, and the back plate is painted black to help absorb solar radiation. The solar collector is usually insulated to avoid heat losses.

Typical solar collectors collect the sun’s energy usually with rooftop arrays of piping and net metal sheets, painted black to absorb as much radiation as possible. They are encased in glass or plastic and angled towards south to catch maximum sunshine. The collectors act as miniature greenhouses, trapping heat under their glass plates. Because solar radiation is so diffuse, the collectors must have a large area.

Solar collectors can be made in various sizes and constructions depending on requirements. They give enough hot water for washing, showers and cooking. They can be used also as pre-heaters for existing water heaters. Today there are several collectors on the market.

They can be divided into several categories. One of them is division according temperature they produce:

1. Low-temperature collectors provide low grade heat, less than 50 degrees Celsius, through either metallic or non-metallic absorbers for applications such as swimming pool heating and low-grade water.
2. Medium-temperature collectors provide medium to high-grade heat (greater than 50 degrees Celsius, usually 60 to 80 degrees), either through glazed flat-plate collectors using air or liquid as the heat transfer medium or through concentrator collectors that concentrate the heat to levels greater than “one sun.” These include evacuated tube collectors, and are most commonly used for residential hot water heating.
3. High-temperature collectors are parabolic dish or trough collectors primarily used by independent power producers to generate electricity for the electric grid.

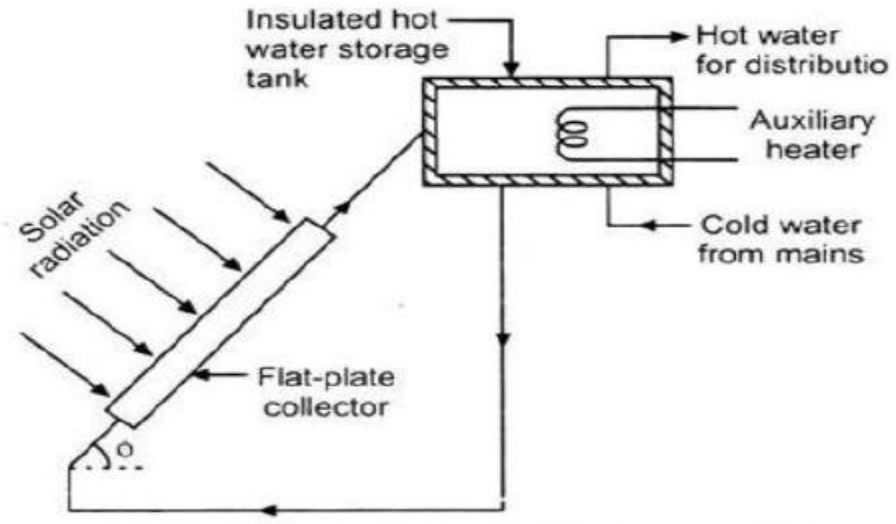
Types of solar collectors

There are several types of solar collectors :

1. Flat plate collector.
2. Evacuated-tube collectors.
3. Integral collector-storage systems

A flat-plate collector consists of an absorber, a transparent cover, a frame, and insulation. Usually an iron-poor solar safety glass is used as a transparent cover, as it transmits a great amount of the short-wave light spectrum.
Only very little of the heat emitted by the absorber escapes the cover (greenhouse effect).
In addition, the transparent cover prevents wind and breezes from carrying the collected heat away (convection). Together with the frame, the cover protects the absorber from adverse weather conditions. Typical frame materials include aluminium and galvanized steel; sometimes fibreglass-reinforced plastic is used.
The insulation on the back of the absorber and on the side-walls lessens the heat loss through conduction. Insulation is usually of polyurethane foam or mineral wool.

Solar water heater: Solar water heater consist collectors (flat-plate), insulated storage tank, interconnecting pipelines. The flat-plate collectors (absorb solar radiation) are place over the roof of building or home to capture the sun light. Small tube runs along the collector and carries water. When sun light incident on the collector, then water absorbs heat from the collector. Warm water stored into the insulated storage tank.



Advantage of solar energy

i) It is renewable source of energy.
ii) Low cost of maintenance.
iii) Solar energy is non polluting sources of energy.

Disadvantage of solar energy

i) Installation cost is high.
ii) Lots of space is needed to install the solar panels.
iii) During cloudy days and winter season energy production is lower down.