Power Generation by Insolation on Mirrors

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ABSTRACT:
Now a days all are using only conventional energy sources. By using the conventional energy source continuously after few years all conventional energy sources are exhausted on the earth. So, we develop the non-conventional energy sources in advance to avoid the energy crisis on the earth. So, we consider this factor and develop the project on solar energy converts into the electricity instead of conventional energy sources. In this project, we using heliostat mirrors to focus on the water tower. Water vapour is generated after the process in the water tower and it helps to run the turbine and finally, generated electricity at the output. So, this way generates the non-conventional energy. By this energy source, we generate the electricity more efficiently than compare with conventional energy sources.

I. INTRODUCTION
The energy demand is growing rapidly. To provide humanity with its increased need for energy, energy technology efficiency must be improved; furthermore, renewable resources must be explored and must be aggressively studied. One of the most promising resource is the solar energy.[2] Our sun produces a huge amount of energy, it is about 4x10^{26} watts of energy every second and it will continue emitting energy for a very long while; which makes it the most reliable and abundant source of energy that available at earth [3]. One hour of sun power emitted to earth provides the energy needed for everyone in our planet for an whole year.[4]. There are many technologies developed to collect energy from sun to provide energy for different applications like residence water heating, process heat, water treatment, solar power plants, etc. The main technologies used in solar power plants could be classified [3]. Among them Concentrated Solar Power systems recently has additional focus of researchers.

Thermal power technologies

Parabolic trough
Parabolic trough reflectors, concentrate sunlight onto receiver tubes in which a transfer fluid is circulated. The fluid flows in the tubes, usually a special oil, is then pumped through heat exchangers to produce superheated steam. The steam is converted to electrical energy in steam turbine generator, the latter can be integrated into a combined steam and gas turbine cycle. The use of oil-based working fluid limits this system to only around 400 °C.

Fresnel Mirror System
A linear concentrating Fresnel solar concentrator, is a planar array of linear mirror strips that reflect sunlight onto a stationary thermal receiver. The operation temperature range is 100–400 °C. Fresnel solar system is the most land-efficient solar system; it produces 1.5-3.0 times more power than other solar technology. It is seen as a potential low-cost alternative to the parabolic trough systems.
Parabolic dishes

Dish systems, like troughs, get benefits from the geometric properties of a parabola, but as a three-dimensional paraboloid. The reflected direct light is concentrated to a point focus receiver and heat the fluid inside this point to an operating temperature of over 1,000°C, similar to tower systems. Dish systems offer the highest potential solar conversion efficiencies of all the CSP technologies, because they always present their full aperture directly towards the sun and avoid the ‘cosine loss effect’ that the other approaches experience. They are, however, the least commercially mature. Dishes up to 24 m diameter have been demonstrated. It is also applied with micro dishes with diameters of just several centimetres.

Central Receiver Tower

A central receiver tower system involves an array of heliostats (large mirrors with two axis tracking) that concentrate the sunlight onto a fixed receiver mounted at the top of a tower. Higher concentration ratios are achieved compared to linear focusing systems (Fresnel and Parabolic trough concentrating solar systems) and this allows thermal receivers to operate at higher temperatures about 1,000 °C with reduced losses. A range of system and heliostat sizes have been demonstrating.

Solar Thermal Tower Power Plants

In solar thermal tower power plants, hundreds or even thousands of large two-axes tracked mirrors are installed around a tower. These slightly curved mirrors are also called heliostats; a computer calculates the ideal position for each of these, and a motor drive moves them into the sun. The system must be very precise in order to ensure that sunlight is really focused on the top of the tower. It is there that the absorber is located, and this is heated up to temperatures of 1000°C or more. Hot air or molten salt then transports the heat from the absorber to a gas turbine or to steam.
generator produces superheated water steam which drives a turbine and electrical generator.

Heliostats

A heliostat is a mirror that tracks the sun in order to constantly reflect the rays of sunlight onto a fixed target. They are a main element in the solar tower system; they present the sun reflecting and thus concentrating parts of the system. A field of heliostats concentrates the sunlight onto a central receiver at the top of the tower. The tower is fixed and the sun moves, so the heliostats have to track the sun in order to reflect the rays on the receiver. These mirrors have to have good reflectivity, accuracy of the tracking system, resistance to wind, and low specific costs. They are mounted on a frame, which has horizontal and vertical axes, which provide the ability of tracking the sun. The mirror facets are plane rectangular mirror with a slight convex curvature.

Tower

The role of the tower is mainly to keep the receiver on its top. It has to provide a space for the storage tank of the receiver. The main design parameter of the tower is its height.

Receiver

Receivers are the most important elements in concentrated solar power systems, because they are the translator of the concentrated radiation to heat. Their performance directly affects the plant’s output power [16]. Receivers might be assembled from various materials; those materials determine their heat properties. They receiver designs can be grouped in two main groups: external and cavity receivers. See Figure 14. Cavity receivers have an additional window around them to prevent heat loss to the air. Generally, they are used with the North-South heliostat fields. The external receivers do not have this covering box, so they have a larger heat loss due to the winds, but they have the advantage having a full acceptance angle, which means more energy input. External receivers usually used with the surrounding heliostat fields.

The position of each heliostat in the heliostats field follows the general pattern of the field. The basic patterns are the grid and the circular patterns. The performance of the heliostats field is affected by many factors; shading, cosine, reflectivity, cleanliness, blocking, atmospheric and spillage losses. To simulate these losses, two methods are used:

1. Convolution-based algorithms and
2. Ray-tracing algorithms.

- Shading losses: occur at the start and end of the day as the sun is low at the sky; some heliostat’s shadow will lay on another heliostat preventing the full surface reflecting the sun rays, it is expressed for each heliostat as a ratio of covered area by others’ shadow to the total mirror’s reflective area.
- The cosine losses: happen when the heliostat plane is not perpendicular to the sun vector and this way reflects less than its own area towards the
receiver. The cosine losses cannot be avoided. The cosine efficiency is given by the heliostat projection area along the sun vector divided by the heliostat total area, easily expressed by the cosine of the incidence angle.

- The reflectivity losses: are determined by the amount of light that is not reflected by the clean mirror, depends on the manufacturing quality of the mirror and on its resistance to corrosion, diffusion by dirt on the mirror. It depends on dust deposit and the frequency of cleaning or raining. These last two losses are described by a loss coefficient, which is equal for each heliostat and assumed constant over time at a given annual mean value.

- The blocking losses: occur when solar radiation reflected by a given heliostat is interrupted by another heliostat, partially or fully. It is calculated as the ratio of blocked reflected radiation for each heliostat. Unlike the shadow losses, blocking losses are fixed during the day and can be avoided totally by better design of the heliostat field.

- The atmospheric attenuation: affects the reflected solar radiation by absorption and diffusion through the air between the heliostat and the receiver. This effect is only roughly assumed because no such data for the air quality through the day.

- The spillage losses: occur from the fact that some reflected solar radiation misses the receiver.

PT plant is needed to produce an amount of energy EPB_nom during the nominal day. The nominal day is the day that includes the design point. The design point is commonly selected during the summer solstice to minimize energy losses (energy losses by devocalizing a part of the solar field when DNI is high or when the storage is full). One of the key design parameters is the nominal direct normal irradiance (DNInom). During the nominal day, the equivalent hours with DNI equal to DNInom can be expressed as follows:

\[ N(\text{hours-eq}) = \frac{D(\text{daily-nom})}{\text{DNI (nom)}} \]

Where D(daily-nom) is the nominal daily direct insolation.

We define the ratio \(R_h\) as follows:

\[ R_h = N(\text{hours_TES}) + N(\text{hours_eq})/N(\text{hours_eq}) \]

The nominal thermal power of the PB is a function of its efficiency.

\[ Q_{PB\_nom} = P_{PB\_nom}\eta_{PB\_nom} \]

The incident thermal power on the SR is calculated as a function of its nominal efficiency:

\[ PSR\_incident\_nom = PSR\_nom\eta_{SR\_nom} \]

Where \(PSR\_incident\_nom\) and \(\eta_{SR\_nom}\) is the nominal incident thermal power and the nominal efficiency of the receiver, respectively. The nominal thermal power of the PB is a function of its efficiency. 

\[ = \_ \_ (5) \]

The incident thermal power
on the SR is calculated as a function of its nominal efficiency:

A typical configuration of solarpower tower plants. In this case, it is assumed that a PT plant is needed to produce an amount of energy $E_{PB\_nom}$ during the nominal day. The nominal day is the day that includes the design point. The design point is commonly selected during the summer solstice to minimize energy losses (energy losses by devocalizing a portion of the solar field when DNI is high or when the storage is full). One of the key design parameters is the nominal direct normal irradiance ($DNI_{nom}$). During the nominal day, the equivalent hours with DNI equal to $DNI_{nom}$ can be expressed as follows:

$$N_{hours\_eq} = \frac{D_{daily\_nom}}{DNI_{nom}}$$

Where $D_{daily\_nom}$ is the nominal daily direct insolation. We define the ratio (Rh) as follows:

$$Rh = \frac{N_{hours\_TES}}{N_{hours\_eq}}$$

Where $N_{hours\_TES}$ is the number of hours of storage. A typical value of $N_{hours\_TES}$ is the difference between the number of hours of the day and the number of equivalent hours. It can also be given input data to meet specific objectives. The size of the TES that meets the nominal daily demand can be calculated as:

$$ETES\_nom = \frac{N_{hours\_TES}N_{hours\_eq} + N_{hours\_TES}E_{nom\_PB} \eta_{TES\_nom} \eta_{PB\_nom}}{N_{hours\_eq}}$$

Where $ETES\_nom$ is the capacity of the TES. $\eta_{TES\_nom}$ and $\eta_{PB\_nom}$ are the nominal efficiencies of the TES and the PB, respectively. The nominal power of the receiver is a function of the solar multiple ($SM$) and the nominal thermal power of the PB.

$$PSR\_nom = SM \cdot Q_{PB\_nom}$$

**EVALUATION:**

In this Project we have changed the working fluid as water by the replacement of molten salt solution. Because of contaminants stick on the inner surface of the pipes while cooling at after the day time heat absorption. To avoid the problems on the projects we improve by decrease the disadvantage.

We change working medium and also install water sensor at the receiver. To sense the level of water and also refill the water automatically by using the electronic control unit (ECU). And shown in below figure.

**II. RESULT:**

By install the various components increase efficiency in the solar tower plant.
REFERENCES:


