Use of Renewable Energy Resources

To produce work output from Heliostats with solar central receiver

Rajat Vashishtha

Abstract-- **A solar receiver system has been designed installed and tested under real conditions in the faculty of Engineering, Tula's Institute, Dehradun. The system consists of a heliostats with a solar central receiver. The function of this arrangement is to heat the basin water in order to increase temperature and pressure thus increase the solar still productivity. The influence of coupling the heliostats with the solar central receiver is reported, especially concerning distilled water productivity. A simple transient mathematical model is presented. The model is based on analytical solution of the energy-balance equations for different parts of the model. Numerical calculations have been carried out for climatic Dehradun conditions (30N18' 57' latitude, 078E0201" longitude). It is observed that the use of the proposed solar desalination system is to improve the accumulative productivity of arrangement by up to 90% when using 28 heliostats in three circle.**

Keywords- Solar energy - Solar Desalination – Heliostat– Central receiver- Solar still.

I. Introduction

Drinking water of acceptable quality has become a scarce commodity. In many places of the world only saline or brackish water is available. This leads to an increasing interest in new desalination technologies. The standard thermal methods of water desalination such as multi-stage-flash-evaporation and multi-effect-evaporation, vapour compression and reverse osmosis are reliable in the capacity range of some 100 to 50,000 m3 per day fresh water production. They are not used in regions with low infrastructure either for the supply in decontrols regions due to their permanent need of qualified maintenance and electricity supply. Here the use of solar desalination systems is desirable and makes economic sense [1, 2]. Desalination is one of many processes available for water Purification, and sunlight is one of several forms of energy that can be used to power the process. The single effect solar still is a relatively simple device to construct and operate. However, the low productivity of the solar still triggered the initiatives to look for ways to improve its productivity and efficiency. These may be classified into passive and active methods. Passive methods include the use of dye or charcoal to increase the solar absorptivity of water, applying good insulation, lowering the water depth in the basin to lower its thermal capacity, Ensuring vapour tightness, using black gravel and rubber, using floating perforated black plate, and using reflective side walls [3-4]. Active methods include the use of solar collector or waste heat to heat the basin water, the use of internal] and external condensers or applying vacuum inside the solar still to enhance the evaporation/condensation processes, and cooling the glass cover to increase the temperature difference between the glass and the water in the basin and hence increase -the rate of evaporation [5-6].Central receiver system or central power tower is an attractive method to achieve tremendously huge power and high concentration of solar irradiance for electricity generation or thermal processes . This system involves the use of many

Individual sun-tracking mirrors (or heliostats) to reflect and to suppose the concentrated sunlight at a common receiver attached on top of the central tower. The performance of the heliostat field is defined in terms of the optical efficiency which is the ratio of the net power absorbed by the receiver to the power incident normally on the field.

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II. about Central Receiver

Central receivers are one of the most promising applications in the utilization of solar energy to produce heat. Basically, reflecting surfaces called heliostats are laid around a central tower and used to reflect solar irradiance to a receiver on the top of the rower. Radiation absorbed by the receiver is then utilized to produce heat. The heliostat field consists of a number of flat or focusing mirrors (heliostats) distributed in a surround-field arrangement (360 arrangement). Each heliostat is continuously rotating around two axes (two degree of freedom) to follow the sun so that solar ray is always reflected to the central receiver. This means that the tilt and the orientation angles of each heliostat are continuously adjusted by a single computer or sensors arrangement. The reflected radiation from the heliostat field is absorbed by the receiver surface. Heat is then removed from the receiver by means of heat removal fluid. The overall dimensions and costs of a central receiver system depend on the design of the system. The mathematical equations required to determine the tilted angle and the orientation angle of a give n heliostat in a field were given by many workers. The centre of a heliostat is defined in terms of the radius r and the azimuth angle up where r is the horizontal radial distance from the centre of the tower, and ψ_p is the azimuth angle of the heliostat arrangement measured from the south direction. The heliostat tilt angle is the angle between the unit vectors N Normal to the heliostat surface and the vertical direction. The heliostat azimuth angle (also called heliostat orientation angle) is the angle between the horizontal projection of the unit vector N and the south direction, with clockwise rotation as positive. The Heliostat tilt angle "s" is given by:

$$\cos s = \left\{ \frac{\cos\theta_z + \cos\theta_r}{2 + 2[\cos\theta_z \cos\theta_r - \sin\theta_z \cos(\psi-\psi_p)\sin\theta_r]} \right\}^{1/2}$$

Where θ_z and ψ are the solar zenith and azimuth angles], respectively and θ_r is the receiver altitude angle which is defined as follows:

$$\Theta r = \tan^{-1} r / H$$

The heliostat azimuth angle γ (orientation angle) is given by:

$$\cos(\gamma - \psi_p) = \frac{\sin\theta_z \cos(\psi - \psi_p) - \sin\theta_r}{\{[\sin\theta_z \cos(\psi - \psi_p) - \sin\theta_r]^2 + [\sin\theta_z \cos(\psi - \psi_p)]^2\}^{1/2}}$$

$$\sin(\gamma - \psi_p) = \frac{\sin\theta_z \sin(\psi - \psi_p)}{\{[\sin\theta_z \cos(\psi - \psi_p) - \sin\theta_r]^2 + [\sin\theta_z \cos(\psi - \psi_p)]^2\}^{1/2}}$$

Several research studies were carried out to recommend the radial and azimuth spacing between heliostats in a radial staggered field. A common feature between these works is to minimize or eliminate the losses due to shadowing and blocking. In many cases additional criteria were considered. Several researchers recommended the following constant azimuth spacing:

$$S\psi / D = 2.1$$

On the contrary, several correlations were recommended in the literature for the radial spacing Sr,

$$Sr / D = 0.2 + r / H$$
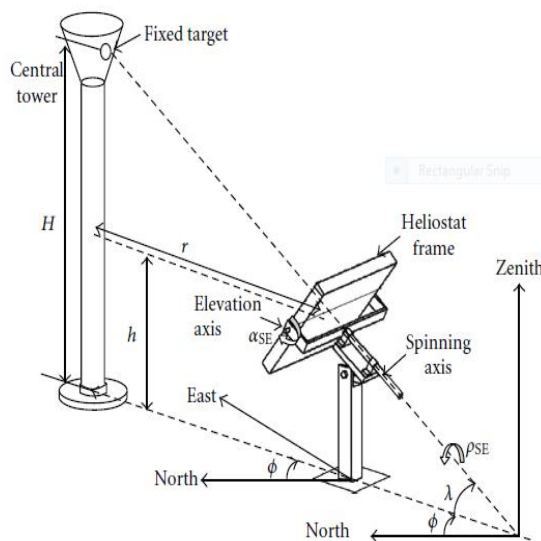
III. Result and Discussion

The simulation of the annual optical efficiency of heliostat field has been carried out to consider the cosine, shadowing, and blocking factors for both sun-tracking methods in different latitudes, that is, 0◦, 15◦ N, 30◦ N.

A computer program prepared for the solution of the energy balance equation for the proposed distillation system. The input parameter to the program include climatic, design and operational parameter. The climatic parameter are the ambient temperature, wind speed and solar intensity. The values of these parameters are taken from there measured value for Dehradun (latitude 30N 18'57', Longitude 078E 20'1').

IV. Nomenclature

Θr- receiver altitude angle measured from centre of heliostat
Θz- solar zenith angle
σ -Stefan- Boltzmann constant, = 56.7x 10-9 W/ m2
K4
Tg - Transmissivity of the still cover
Ψ- Solar azimuth angle, measured from south in clockwise direction
Ψp- heliostat arrangement angle, measured from south in clockwise direction
s- Heliostat tilt angle with the ground plane
Sr- spacing of heliostats along the radial distance of the heliostat field
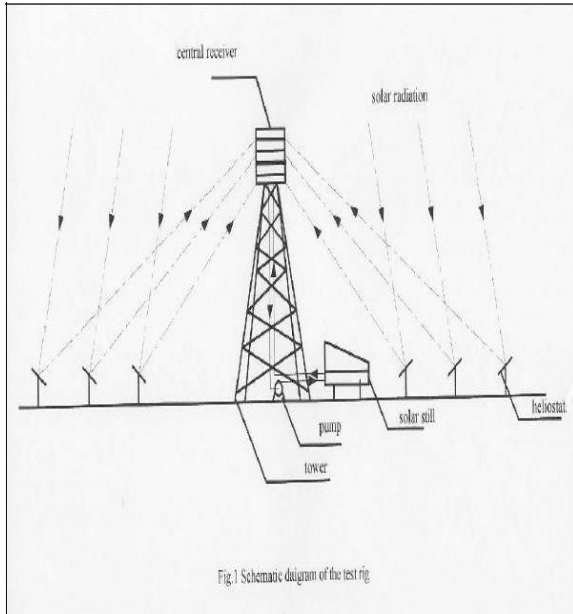Sψ- spacing of heliostat s along the azimuthal direction of the heliostat field

(a) Spinning-elevation sun-tracking method
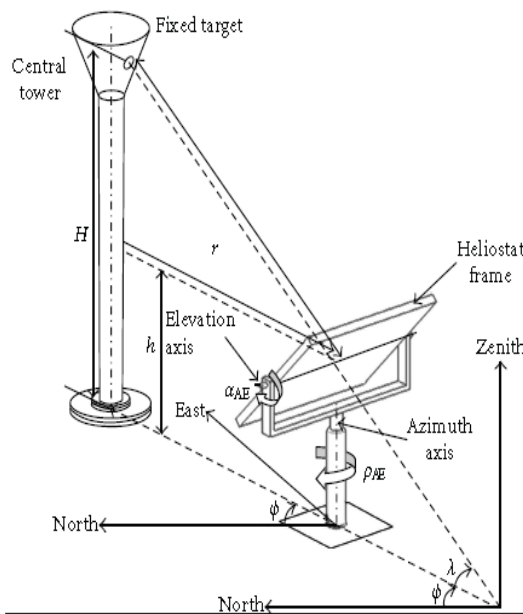
(b) Azimuth-elevation sun-tracking method

V. Figure of spinning and angle azimuth-elevation

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About Authors-

Renewable energy is the best source of the energy but it is found in the distributed form. Due to its distributed form we are not able to use it more efficient. But with help of solar central receiver we can use it more accurately and efficiently from other methods of utilisation of   solar energy.

Schematic diagram of the test rig

VI. Acknowledgment

VII. References

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