Solar Parabolic Trough Collector

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Abstract— to facilitate rapid diffusion and widespread use of solar energy, the systems should also be easy to install, operate and maintain. In order to improve the performance of solar concentrator, different types of reflectors were evaluated with respect to their optical and energy conversion efficiency. To assure good performance and long technical lifetime of a concentrating system, the solar reflectance of the reflectors must be high and long term stable. Therefore, different types of reflector materials and absorbing materials were analyzed in this work; also the optical properties and degradation of the reflecting surfaces were assessed. The shift of focus was motivated by the need to assess long term system performance and possibilities of optimizing the optical efficiency or reducing costs by using new types of reflector materials and absorbing materials.

Key words: COLLECTOR, Parabolic

I. INTRODUCTION

The operation of any solar thermal energy collector can be described as an energy balance between the solar energy absorbed by the collector and the thermal energy removed or lost from the collector. If no alternative mechanism is provided for removal of thermal energy, the collector receiver heat loss must equal the absorbed solar energy. The temperature of the receiver increases until the convective and radiation heat loss from the receiver equals the absorbed solar energy. The temperature at which this occurs is termed the collector stagnation temperature. For control of the collector temperature at some point cooler than the stagnation temperature, active removal of heat must be employed. This heat will then available for use in a solar energy system. The rate at which heat is actively removed from the collector determines the collector operating temperature. For removal of a large fraction of the absorbed solar energy as useful heat, the amount of heat lost from the receiver must be kept small.

II. TYPES OF COLLECTOR

A. Flat Plate Collector
B. Evacuated Tube Collector
C. Parabolic Trough Collector
D. Parabolic Dish Collector

A. Flat Plate Collector:

They are most commonly used. They consist of (1) a dark flat-plate absorber, (2) a transparent cover that reduces heat losses, (3) a heat-transport fluid (air, antifreeze or water) to remove heat from the absorber, and (4) a heat insulating backing. The absorber consists of a thin absorber sheet (of thermally stable polymers, aluminium, steel or copper, to which a matte black or selective coating is applied) often backed by a grid or coil of fluid tubing placed in an insulated casing with a glass or polycarbonate cover. In water heat panels, fluid is usually circulated through tubing to transfer heat from the absorber to an insulated water tank.

B. Evacuated Tube Collector:

Evacuated heat pipe tubes (EHPTs) are composed of multiple evacuated glass tubes each containing an absorber plate fused to a heat pipe. The heat is transferred to the transfer fluid (water or an antifreeze mix—typically propylene glycol) of a domestic hot water or hydronic space heating system in a heat exchanger called a "manifold". The manifold is wrapped in insulation and covered by a protective sheet metal or plastic case. The vacuum that surrounds the outside of the tube greatly reduces convection and conduction heat loss, therefore achieving greater efficiency than flat-plate collectors, especially in colder conditions

C. Parabolic Trough Collector:

This type of collector is generally used in solar power plants. A trough-shaped parabolic reflector is used to concentrate sunlight on an insulated tube (Dewar tube) or heat pipe, placed at the focal point, containing coolant which transfers heat from the collectors to the boilers in the power station.

D. Parabolic Dish Collector:

With a parabolic dish collector, one or more parabolic dishes concentrate solar energy at a single focal point, similar to the way a reflecting telescope focuses starlight, or a dish antenna focuses radio waves. This geometry may be used in solar furnaces and solar power plants.

III. DESIGN CALCULATIONS

- Parabolic Trough Collector

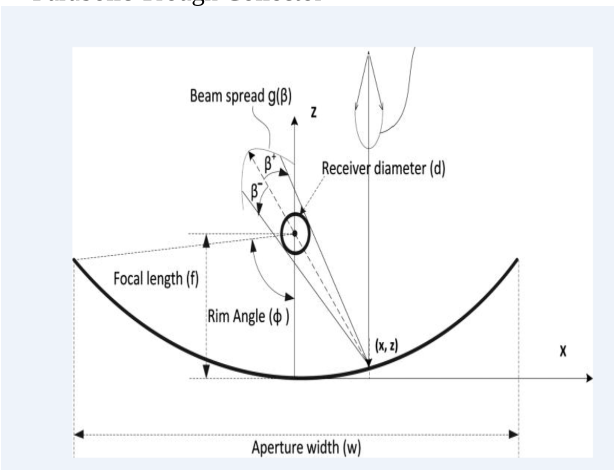


Fig. 1: Diagram of parabolic collector with important parameters

Consider the simple parabolic equation:

$X^2 = 2RY$

$F = R/2$

Where,
X=axial parabolic curve
Y=centre line of focal
R=radius of parabolic curve
F=focal length

Length =1500mm
Width/aperture length=1000mm
Width to length ratio=0.66

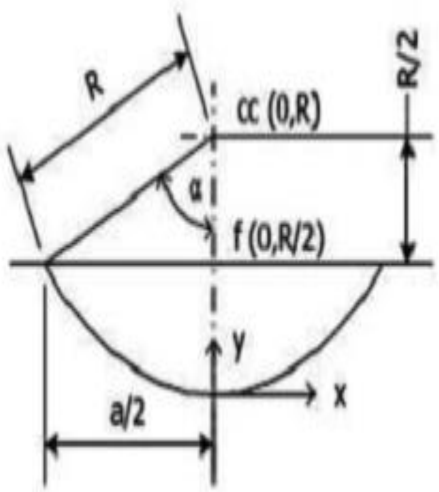
The sheet is 1000 mm wide, has a curve of R, and focal point 'f' is half of R,

Therefore, α is

$$R\cos\alpha = R/2$$
$$\cos\alpha = (R/2)(1/R)$$
$$\alpha = 60°$$

Concentration Ratio(C) =Collector/Absorber area
= Ac/Aa

Width of collector (a) = 2Rsinα
Area of Collector (Ac) = (a-d)*L
Area of Absorber (Aa) = πdL



IV. FOCAL LENGTH

Here X = 500 mm
Y = 200 mm

From simple parabolic equation we have

$$X^2 = 2RY$$

Radius (R) $= X^2 / 2Y$
$= 500^2 / 2*200$
$= 625$mm

Hence

Focal length = R / 2
Focal length = 312.50 mm.

Support Mechanism
Material Used – Cast Iron
Height - 1000mm
Length - 1500mm
Width - 1155mm

Collector aperture area	1.5x10^6 mm2
Collector aperture	1000mm
Length of collector	1500mm
Aperture to Length ratio	0.66
Rim angle	180°
Receiver diameter	35mm
Tracking mechanism type	Mechanical

Table 1: Parabolic collector parameters

V. WORKING

It consists of pump for discharge of water from one point to another point. As the sun rays are focused on the parabolic collector the sun rays are concentrated at the focal point of parabolic collector. At the focal point concentric pipe is held. The die thermic fluid in the outer pipe absorbs all the heat radiated by the parabolic collector.

The heat of the fluid is used to raise the temperature of water which is flowing through the inner pipe. This increases the temperature of the water, if we are able to increase the temperature above 100 degree Celsius then we can generate the steam.

Sun tracking mechanism is very useful in this project. As the sun is moved by 14.5 degree per hour, parabolic collector can also be rotated by that angle by using tracking mechanism. So that the sun rays will always be perpendicular to the collector plane resulting in its optimum use.

VI. CONCLUSION

There are different types of collector like flat plate, parabolic trough, parabolic dish but out of this parabolic trough is effective as reflecting surface require less material as compared to flat plate. Also heat loss per unit of solar energy is also less. The absorber area of this system is also less than flat plate system.

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